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Newtons Coulomb Laws

Transverse Plasma Resonance

Highlights

High Power/Energy Optics

Origin of Gravity and Universe

Discovering Thoughts, Inventing Future

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By F. F. Mende

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Keywords: plasma, plasma resonance, kinetic inductance, Maxwell equation.

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F. F. Mende

Abstract- During shot explosions, which result in the formation of a hot plasma, electromagnetic radiation takes place in a very wide range, up to the radio waveband. But to date, those physical mechanisms that could explain the origin of such radiation are unknown. It is known that plasma resonance is longitudinal, but longitudinal resonance can not radiate transverse radio waves. There were no other resonances other than plasma resonances in an unmagnetized plasma. However, it turns out that in a bounded unmagnetized plasma there can also exist a transverse resonance with respect to the propagation direction of the waves. It is this resonance that can be associated with the loss of electromagnetic waves in explosions of the flow of charges. This resonance can be used to create high-power lasers and to heat the plasma.

Keywords: plasma, plasma resonance, kinetic inductance, Maxwell equation.

I. Introduction

In explosions of nuclear charges, as a result of which a hot plasma is formed, electromagnetic radiation takes place in a very wide frequency range, down to the long-wave radio range. But to date, those physical mechanisms that could explain the origin of such radiation are unknown. It is known that plasma resonance is longitudinal, but longitudinal resonance can not radiate transverse radio waves. The existence in the non-magnetized plasma of any other resonances, other than the plasma resonance, was previously unknown. However, it turns out that in a bounded unmagnetized plasma there can be a transverse resonance with respect to the propagation direction of the wave. It is this resonance that can be the cause of radiation of radio waves during explosions of nuclear charges. This resonance can be used to create high-power lasers and to heat the plasma [1].

II. Plasma in the Two-Wire Circuit

For explaining the conditions for the excitation of this resonance let us examine the long line, which consists of two ideally conducting planes, as shown in Fig 1.

Author: *Kharkov, Ukraine. e-mail: fedormende@gmail.com*

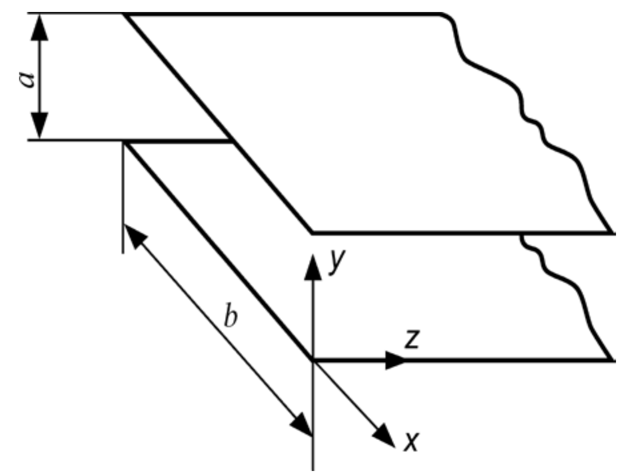

Fig. 1: The two-wire circuit, which consists of two ideally conducting planes

Linear (falling per unit of length) capacity and inductance of this line without taking into account edge effects they are determined by the relationships $C_0=\varepsilon_0\frac{b}{a}$ и $L_0=\mu_0\frac{a}{b}$. Therefore with an increase in the length of line its total capacitance $C_\Sigma=\varepsilon_0\frac{b}{a}z$ and summary inductance $L_\Sigma=\mu_0\frac{a}{b}z$ increase proportional to its length.

If we into the extended line place the plasma, charge carriers in which can move without the losses, and in the transverse direction pass through the plasma the current I, then charges, moving with the definite speed, will accumulate kinetic energy. Let us note that here are not examined technical questions, as and it is possible confined plasma between the planes of line how. This there can be, for example, magnetic traps or directed flows of plasma. The case also of other plasma media of the type of semiconductors can be examined. In this case only fundamental questions, which are concerned transverse plasma resonance in the nonmagnetic plasma, are examined.

Since the transverse current density in this line is determined by the relationship $j=\frac{I}{bz}=nev$, that summary kinetic energy of all moving charges will be written down

$$W_{k\Sigma} = \frac{1}{2}\frac{m}{ne^2}abzj^2 = \frac{1}{2}\frac{m}{ne^2}\frac{a}{bz}I^2 . \quad (1)$$

Relationship (1) connects the kinetic energy, accumulated in the line, with the square of current; therefore the coefficient, which stands in the right side of this relationship (1) before the square of current, is the summary kinetic inductance of line.

$$L_{k\Sigma} = \frac{m}{ne^2}\cdot\frac{a}{bz} . \quad (2)$$

Thus, the parameter

$$L_k = \frac{m}{ne^2} \quad (3)$$

presents the specific kinetic inductance of charges. Relationship (3) is obtained for the case of the direct current, when current distribution is uniform. We also will not thus far consider the ionic constituent of current, since at the high frequencies she is considerably less than electronic constituting.

Subsequently for the larger clarity of the obtained results, together with their mathematical idea, we will use the method of equivalent diagrams. The section, the lines examined, long dz can be represented in the form the equivalent diagram, shown in Fig. 2 (a).

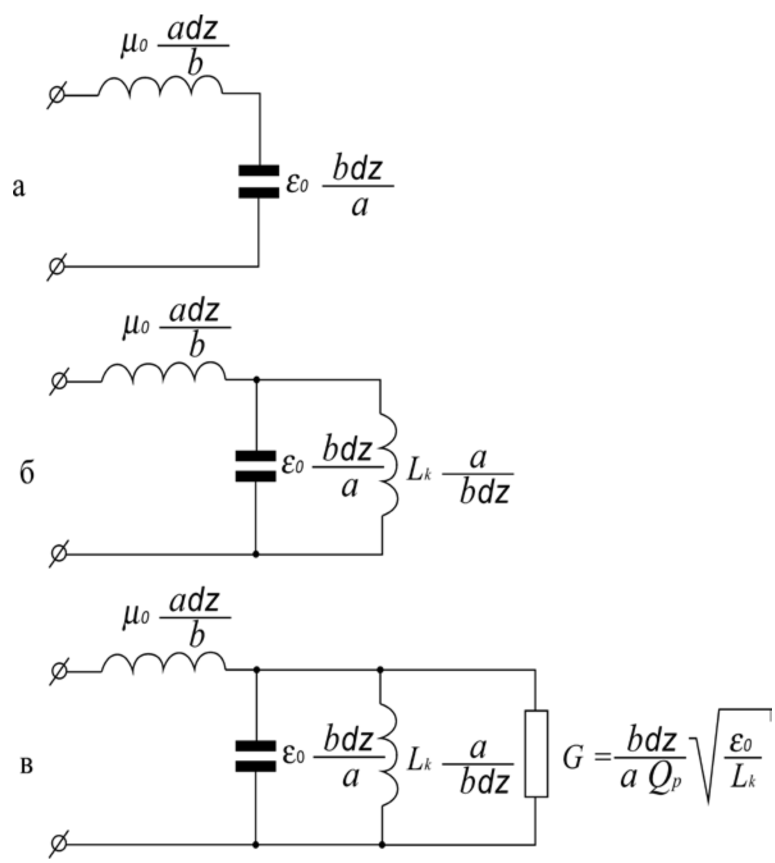

Fig. 2: a - the equivalent the schematic of the section of two-wire circuit

б - the equivalent the schematic of the section of the two-wire circuit, filled with plasma without the losses;
в - the equivalent the schematic of the section of the two-wire circuit, in which there are ohmic losses.

From relationship (2) is evident that in contrast to C_Σ and L_Σ the value $L_{k\Sigma}$ with an increase in z does not increase, but it decreases. This is understandable from a physical point of view, connected this with the fact that with an increase in z a quantity of parallel-connected inductive elements grows. For the case, when the length of line is considerably lower than the length, which is extended in it wave, it is equivalent to the parallel circuit with the lumped parameters, capacity and inductance of which is determined by the following relationships: $C = \frac{\varepsilon_0 bz}{a}$, $L = \frac{L_k a}{bz}$ in series with which is connected the inductance $\mu_0 \frac{adz}{b}$.

But if we calculate the resonance frequency of this outline, then it will seem that this frequency generally not on what sizes depends, actually:

$$\omega_\rho^2 = \frac{1}{CL} = \frac{1}{\varepsilon_0 L_k} = \frac{ne^2}{\varepsilon_0 m} \quad .$$

Is obtained the very interesting result, which speaks, that the resonance frequency macroscopic of the resonator examined does not depend on its sizes. Impression can be created, that this is plasma resonance, since the obtained value of resonance frequency exactly corresponds to the value of this resonance. But it is known that the plasma resonance characterizes longitudinal waves in the long line they, while occur transverse waves. In the case examined the value of the phase speed in the direction z is equal to infinity and the wave vector $\mathbf{k}=0$. In this case the wave number is determined by the relationship:

$$k_z^2 = \frac{\omega^2}{c^2}\left(1 - \frac{\omega_\rho^2}{\omega^2}\right), \tag{4}$$

and the group and phase speeds

$$v_g^2 = c^2\left(1 - \frac{\omega_\rho^2}{\omega^2}\right), \tag{5}$$

$$v_F^2 = \frac{c^2}{\left(1 - \frac{\omega_\rho^2}{\omega^2}\right)} \quad , \tag{6}$$

where $c = \left(\frac{1}{\mu_0 \varepsilon_0}\right)^{1/2}$ - speed of light in the vacuum.

For the present instance the phase speed of electromagnetic wave is equal to infinity, which corresponds to transverse resonance at the plasma frequency. Consequently, at each moment of time pour on distribution and currents in this line uniform and it does not depend on the coordinate z, but current in the planes of line in the direction z is absent. This, from one side, it means that the inductance L_Σ will not have effects on electrodynamic processes in this line, but instead of the conducting planes can be used any planes or devices, which limit plasma on top and from below. With the explosion of nuclear charges the boundaries of the cloud of explosion can be the boundaries, which limit plasma.

From the relationships (6) it is not difficult to see that at the point $\omega = \omega_p$ we deal concerning the transverse resonance with the infinite quality. The fact that in contrast to the Langmuir, this resonance is transverse, will be one can see well for the case, when in the plasma dissipative losses will occur and the quality of this resonance will not be equal to infinity. In this case $k_z \neq 0$, and in the line will be extended the transverse wave, the direction of propagation of which will be perpendicular to the direction of the motion of charges. The examination of this task was begun from the examination of the plasma, limited from two sides by the planes of long line. But in the process of this examination it is possible to draw the conclusion that the frequency of this resonance generally on the dimensions of line does not depend.

Before to pass to the more detailed study of this problem, let us pause at the energy processes, which occur in the line in the case of the absence of losses examined. Pour on the characteristic impedance of plasma, which gives the relation of the transverse components of electrical and magnetic, let us determine from the relationship

$$Z = \frac{E_y}{H_x} = \frac{\mu_0 \omega}{k_z} = Z_0\left(1 - \frac{\omega_\rho^2}{\omega^2}\right)^{-1/2} \quad ,$$

where $Z_0 = \sqrt{\frac{\mu_0}{\varepsilon_0}}$ - characteristic (wave) resistance of vacuum. The obtained value Z is characteristic for the transverse electrical waves in the waveguides. It is evident that when $\omega \to \omega_p$, then $Z \to \infty$, and $H_x \to 0$. When $\omega > \omega_p$ in the plasma there is electrical and magnetic component of field, and the specific energy of these pour on it will be written down

$$W_{E,H} = \frac{1}{2}\varepsilon_0 E_{0y}^2 + \frac{1}{2}\mu_0 H_{0x}^2 .$$

Thus, the energy, concluded in the magnetic field, in $\left(1 - \frac{\omega_\rho^2}{\omega^2}\right)$ of times is less than the energy, concluded in the electric field. Let us note that this examination, which is traditional in the electrodynamics, is not complete, since. in this case is not taken into account one additional form of energy, namely kinetic energy of charge carriers. Occurs that pour on besides the waves of electrical and magnetic, that carry electrical and magnetic energy, in the plasma there exists even and the third - kinetic wave, which carries kinetic energy of current carriers. The specific energy of this wave is written:

$$W_k = \frac{1}{2}L_k j_0^2 = \frac{1}{2}\cdot\frac{1}{\omega^2 L_k}E_0^2 = \frac{1}{2}\varepsilon_0 \frac{\omega_\rho^2}{\omega^2}E_0^2 .$$

Consequently, the total specific energy of wave is written as

$$W_{E,H,j} = \frac{1}{2}\varepsilon_0 E_{0y}^2 + \frac{1}{2}\mu_0 H_{0x}^2 + \frac{1}{2}L_k j_0^2 \quad .$$

Thus, for finding the total energy, by the prisoner per unit of volume of plasma, calculation only pour on E and H it is insufficient.

At the point $\omega = \omega_p$ is carried out the relationship

$$W_H = 0$$

$$W_E = W_k ,$$

i.e. magnetic field in the plasma is absent, and plasma presents macroscopic electromechanical resonator with the infinite quality, ω_p resounding at the frequency.

Since with the frequencies $\omega > \omega_p$ the wave, which is extended in the plasma, it bears on itself three forms of the energy: electrical, magnetic and kinetic, then this wave can be named electromagnetokinetic wave. This term, which completely reflects physics of processes for the wave examined, earlier was not used and it was for the first time used in the works [2,3]. Kinetic wave represents the wave of the current density $\mathbf{j} = \frac{1}{L_k}\int \mathbf{E}dt$. This wave is moved with respect to the electrical wave the angle $\frac{\pi}{2}$.

Until now, the physically unrealizable case has been considered, when there are no losses in the plasma, which corresponds to an infinite Q-factor of the plasma resonator.If losses are located, moreover completely it does not have value, by what physical processes such losses are caused, then the quality of plasma resonator will be finite quantity. For this case of Maxwell's equation they will take the form:

$$rot\ \mathbf{E} = -\mu_0 \frac{\partial\ \mathbf{H}}{\partial\ t},$$

$$rot\ \mathbf{H} = \sigma_{p.ef}\ \mathbf{E} + \varepsilon_0 \frac{\partial\ \mathbf{E}}{\partial\ t} + \frac{1}{L_k}\int \mathbf{E}dt. \qquad (7)$$

The presence of losses is considered by the term $\sigma_{p.ef}\mathbf{E}$, and, using near the conductivity of the index ef, it is thus emphasized that us does not interest very mechanism of losses, but only very fact of their existence interests. The value σ_{ef} determines the quality of plasma resonator. For measuring σ_{ef} should be selected the section of line by the length z_0, whose value is considerably lower than the wavelength in the plasma. This section will be equivalent to outline with the lumped parameters:

$$C = \varepsilon_0 \frac{bz_0}{a}, \qquad (8)$$

$$L = L_k \frac{a}{bz_0}, \qquad (9)$$

$$G = \sigma_{\rho.ef} \frac{bz_0}{a}, \qquad (10)$$

where G - conductivity, connected in parallel C and L.

Conductivity and quality in this outline enter into the relationship:

$$G = \frac{1}{Q_\rho}\sqrt{\frac{C}{L}},$$

from where, taking into account (8 - 10), we obtain

$$\sigma_{\rho.ef} = \frac{1}{Q_\rho}\sqrt{\frac{\varepsilon_0}{L_k}}. \qquad (11)$$

Thus, measuring its own quality plasma of the resonator examined, it is possible to determine $\sigma_{p.ef}$. Using (11) and (7) we will obtain

$$rot\ \mathbf{E} = -\mu_0 \frac{\partial\ \mathbf{H}}{\partial\ t},$$

$$rot\ \mathbf{H} = \frac{1}{Q_\rho}\sqrt{\frac{\varepsilon_0}{L_k}}\ \mathbf{E} + \varepsilon_0 \frac{\partial\ \mathbf{E}}{\partial\ t} + \frac{1}{L_k}\int \mathbf{E}dt. \qquad (12)$$

The equivalent the schematic of this line, filled with dissipative plasma, is represented in Fig. 2 (в).

Let us examine the solution of system of equations (12) at the point $\omega = \omega_p$, in this case, since

$$\varepsilon_0 \frac{\partial\ \mathbf{E}}{\partial\ t} + \frac{1}{L_k}\int \mathbf{E}dt = 0,$$

and further we will obtain

$$rot\ \mathbf{E} = -\mu_0 \frac{\partial\ \mathbf{H}}{\partial\ t},$$

$$rot\ \mathbf{H} = \frac{1}{Q_P}\sqrt{\frac{\varepsilon_0}{L_k}}\ \mathbf{E}.$$

These relationships determine wave processes at the point of resonance.

If losses in the plasma, which fills line are small, and strange current source is connected to the line, then it is possible to assume:

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$$rot\ \mathbf{E} \cong 0,$$

$$\frac{1}{Q_p}\sqrt{\frac{\varepsilon_0}{L_k}}\ \mathbf{E} + \varepsilon_0 \frac{\partial\ \mathbf{E}}{\partial\ t} + \frac{1}{L_k}\int \mathbf{E}dt = \mathbf{j}_{CT}, \quad (13)$$

where $\mathbf{j}_{CT}$ - density of strange currents. After integrating (13) with respect to the time and after dividing both parts to , we will obtain

$$\omega_p^2\ \mathbf{E} + \frac{\omega_p}{Q_p}\cdot\frac{\partial\ \mathbf{E}}{\partial\ t} + \frac{\partial^2 \mathbf{E}}{\partial\ t^2} = \frac{1}{\varepsilon_0}\cdot\frac{\partial\ \mathbf{j}_{CT}}{\partial\ t}. \quad (14)$$

If we relationship (14) integrate over the surface of normal to the vector of and to introduce the electric flux of we will obtain:

$$\omega_p^2 P_E + \frac{\omega_p}{Q_p}\cdot\frac{\partial\ P_E}{\partial\ t} + \frac{\partial^2 P_E}{\partial\ t^2} = \frac{1}{\varepsilon_0}\cdot\frac{\partial\ I_{CT}}{\partial\ t}, \quad (15)$$

where I_{CT} - strange current. Equation (15) is the equation of harmonic oscillator with the right side, characteristic for the two-level laser [4]. If the source of excitation is absent, then we deal concerning "cold" laser resonator, in which the fluctuations attenuate exponentially

$$P_E(t) = P_E(0)\ e^{i\omega_P\, t}\cdot e^{-\frac{\omega_P}{2Q_P}\, t},$$

i.e. the macroscopic electric flux $P_E(t)$ will oscillate with the frequency ω_p, relaxation time in this case is determined by the relationship:

$$\tau = \frac{2Q_P}{\omega_P}.$$

The problem of developing of laser consists to now only in the skill excite this resonator.

If resonator is excited by strange currents, then this resonator presents band-pass filter with the resonance frequency to equal plasma frequency and the passband $\Delta\omega = \dfrac{\omega_p}{2Q_p}$.

Another important practical application of transverse plasma resonance is possibility its use for warming-up and diagnostics of plasma. If losses in the plasma are small, which occurs at high temperatures, the quality of plasma resonator is also great, and can be obtained the high levels of electrical pour on, and it means high energies of charge carriers.

III. Conclusion

Work examines transverse plasma resonance in the nonmagnetized plasma, limited by two planes. This resonance can explain low-frequency radiation spectrum with the explosions of nuclear charges, since the cloud of the explosion of nuclear explosion is limited. It can be used for creating the powerful laser generators with collective plasma oscillations, and also for the warming-up of plasma.

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Enhancement of Squeezing in a Coherently Driven Degenerate Three-Level Laser with a Closed Cavity

By Samuel Mosisa, Tamirat Abebe, Milkessa Gebeyehu & Gelana Chibsa
Jimma University

Abstract- In this paper, we investigated the steady-state analysis of the squeezing and statistical properties of the light generated by *N* two-level atoms available in a closed cavity pumped by a coherent light with the cavity coupled to a singele mode vacuum reservoir. Here we consider the noise operators associated with the vacuum reservoir in normal order. Applying the solutions of the equations of evolution for the expectation values of the atomic operators and the quantum Langavin equations for the cavity mode operators, we obtain the mean photon number, the photon number variance, and the quadrature squeezing. The three-level laser generates squeezed light under certain conditions, with maximum global squeezing being 43%. Moreover, we found that the maximum local quadrature squeezing is 80:2% (and occurs at $\lambda = 0:08$). Furthermore, our results have shown that the local quadrature squeezing, unlike the local mean of the phonon number and photon number variance does not increase as the value of λ increases. It is also found that, unlike the mean photon number, the variance of the photon number, and the quadrature variance, the quadrature squeezing does not depend on the number of atoms. This implies that the quadrature squeezing of the two-mode cavity light is independent of the number of photons.

Keywords: *operator dynamics; quadrature squeezing; power spectrum.*

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ENHANCEMENTOFSQUEEZINGINACOHERENTLYDRIVENDEGENERATETHREELEVELLASERWITHACLOSEDCAVITY

Strictly as per the compliance and regulations of:

Enhancement of Squeezing in a Coherently Driven Degenerate Three-Level Laser with a Closed Cavity

Samuel Mosisa [α], Tamirat Abebe [σ], Milkessa Gebeyehu [ρ] & Gelana Chibsa [ω]

Abstract- In this paper, we investigated the steady-state analysis of the squeezing and statistical properties of the light generated by N two-level atoms available in a closed cavity pumped by a coherent light with the cavity coupled to a singele mode vacuum reservoir. Here we consider the noise operators associated with the vacuum reservoir in normal order. Applying the solutions of the equations of evolution for the expectation values of the atomic operators and the quantum Langavin equations for the cavity mode operators, we obtain the mean photon number, the photon number variance, and the quadrature squeezing. The three-level laser generates squeezed light under certain conditions, with maximum global squeezing being 43%. Moreover, we found that the maximum local quadrature squeezing is 80:2% (and occurs at $\lambda = 0{:}08$). Furthermore, our results have shown that the local quadrature squeezing, unlike the local mean of the phonon number and photon number variance does not increase as the value of λ increases. It is also found that, unlike the mean photon number, the variance of the photon number, and the quadrature variance, the quadrature squeezing does not depend on the number of atoms. This implies that the quadrature squeezing of the two-mode cavity light is independent of the number of photons.

Keywords: operator dynamics; quadrature squeezing; power spectrum.

I. Introducion

Squeezed states of light has played a crucial role in the development of quantum physics. Squeezing is one of the nonclassical features of light that have been extensively studied by several authors [1-8]. In a squeezed state the quantum noise in one quadrature is below the vacuum-state level or the coherent-state level at the expense of enhanced fluctuations in the conjugate quadrature, with the product of the uncertainties in the two quadratures satisfying the uncertainty relation [1, 2, 4, 9]. Because of the quantum noise reduction achievable below the vacuum level, squeezed light has potential applications in the detection of week signals and in low-noise communications [1, 2]. Squeezed light can be generated by various quantum optical processes such as subharmonic generations [1-5, 10-12], four-wave mixing [13, 14], resonance fluorescence [6, 7], second harmonic generation [8, 15], and three-level laser under certain conditions [1, 3, 4,9, 16-27]. Hence it proves useful to find some convenient means of generating a bright squeezed light.

A three-level laser is a quantum optical device in which light is generated by three-level atoms in a cavity usually coupled to a vacuum reservoir via a single-port mirror. In one model of a three-level laser, three-level atoms initially prepared in a coherent superposition of the top and bottom levels are injected into a cavity and then removed from the cavity after they have decayed due to spontaneous emission [9, 16-21]. In another model of a three-level laser, the top and bottom levels of the three-level atoms injected into a cavity are coupled by coherent light [22-27]. It is found that a three-level laser in either model generates squeezed light under certain conditions [28-34]. The superposition or the coupling of the top and bottom levels is responsible for the squeezed of the generated light [35-38]. It appears to be quite difficult to prepare the atoms in a coherent superposition of the top and bottom levels before they are injected into the cavity. In addition, it should certainly be hard to find out that the atoms have decayed spontaneously before they are removed from the cavity.

Author: Department of Physics, Jimma University, P. O. Box 378, Jimma, Ethiopia. e-mail: tam1704@gmail.com

In order to avoid the aforementioned problems, Fesseha [28] have considered that N two-level atoms available in a closed cavity are pumped to the top level by means of electron bombardment. He has shown that the light generated by this laser operating well above threshold is coherent and the light generated by the same laser operating below threshold is chaotic light. In addition, Fesseha [28] has studied the squeezing and statistical properties of the light produced by a degenerate three-level laser with the atoms in a closed cavity and pumped by electron bombardment. He has shown that the maximum quadrature squeezing of the light generated by the laser, operating far below threshold, is 50% below the vacuum-state level.

In this paper, we investigate the steady-state analysis of the squeezing and statistical properties of the light generated by a coherently driven degenerate three-level laser with a closed cavity which is coupled to a single-mode vacuum reservoir via a single-port mirror. We carry out our calculation by putting the noise operators associated with the vacuum reservoir in normal order and by taking into consideration the interaction of the three-level atoms with the vacuum reservoir.

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II. The Master Equation

Let us consider a system of N degenerate three-level atoms in cascade configuration are available in a closed cavity and interacting with the two (degenerate) cavity modes. The top and bottom levels of the three-level atoms are coupled by coherent light. When a degenerate three-level atom in cascade configuration decays from the top level to the bottom levels via the middle level, two photons of the same frequency are emitted. For the sake of convenient, we denote the top, middle, and bottom levels of these atoms by $|a\rangle_k$, $|b\rangle_k$, and $|c\rangle_k$, respectively. We wish to represent the light emitted from the top level by $\hat{a}_1$ and the light emitted from the middle by $\hat{a}_2$. In addition, we assume that the two cavity modes a_1 and a_2 to be at resonance with the two transitions $|a\rangle_k \rightarrow |b\rangle_k$ and $|b\rangle_k \rightarrow |c\rangle_k$, with direct transitions between levels $|a\rangle_k$ and $|c\rangle_k$to be dipole forbidden.

The interaction of one of the three-level atoms with light modes a_1 and a_2 can be described at resonance by the Hamiltonian

$$\hat{H} = ig[\hat{\sigma}_a^{\dagger k}\hat{a}_1 - \hat{a}_1^{\dagger}\hat{\sigma}_a^{k} + \hat{\sigma}_b^{\dagger k}\hat{a}_2 - \hat{a}_2^{\dagger}\hat{\sigma}_b^{k}], \tag{1}$$

where

$$\hat{\sigma}_a^k = |b\rangle_{k\ k}\langle a|, \tag{2}$$

$$\hat{\sigma}_b^k = |c\rangle_{k\ k}\langle b|, \tag{3}$$

are the lowering atomic operators, g is the coupling constant between the atom and the light mode a_1 or light mode a_2, and $\hat{a}_1$ and $\hat{a}_2$ are the annihilation operators for light modes a_1 and a_2. And the interaction of the three-level atom with the driving coherent light can be described at resonance by the Hamiltonian

$$\hat{H} = \frac{i\Omega}{2}[\hat{\sigma}_c^{\dagger k} - \hat{\sigma}_c^k], \tag{4}$$

where $\hat{\sigma}_c^k = |c\rangle_{k\ k}\langle a|$, and $\Omega = 2\varepsilon\xi$, in which ε considered to be real and constant, is the amplitude of the driving coherent light, and ξ is the coupling constant between the driving coherent light and the three-level atom.

Thus upon combining Eqs. (1) and (4), the interaction of a degenerate three-level atom with the coherent light and with the light modes a_1 and a_2 can be described by the Hamiltonian

$$\hat{H} = ig[\hat{\sigma}_a^{\dagger k}\hat{a}_1 - \hat{a}_1^\dagger\hat{\sigma}_a^k + \hat{\sigma}_b^{\dagger k}\hat{a}_2 - \hat{a}_2^\dagger\hat{\sigma}_b^k] + \frac{i\Omega}{2}[\hat{\sigma}_c^{\dagger k} - \hat{\sigma}_c^k]. \tag{5}$$

We assume that the laser cavity is coupled to a vacuum reservoir via a single-port mirror. In addition, we carry out our calculation by putting the noise operators associated with the vacuum reservoir in normal order. Thus, the noise operators will not have any effect on the dynamics of the cavity mode operators [1, 28, 29]. Therefore, with the help of the expression (1), one can drop the noise operators and write the quantum Langevin equations for the operators $\hat{a}_1$ and $\hat{a}_2$ as

$$\frac{d\hat{a}_1}{dt} = -\frac{\kappa}{2}\hat{a}_1 - i[\hat{a}_1, \hat{H}], \tag{6}$$

$$\frac{d\hat{a}_2}{dt} = -\frac{\kappa}{2}\hat{a}_2 - i[\hat{a}_2, \hat{H}], \tag{7}$$

where κ is the cavity damping constant. With the aid of Eq. (1), one can easily obtain

$$\frac{d\hat{a}_1}{dt} = -\frac{\kappa}{2}\hat{a}_1 - g\hat{\sigma}_a^k, \tag{8}$$

$$\frac{d\hat{a}_2}{dt} = -\frac{\kappa}{2}\hat{a}_2 - g\hat{\sigma}_b^k. \tag{9}$$

III. Equations of Evolution of Atomic Oprators

The procedure of normal ordering the noise operators renders the vacuum reservoir to be a noiseless physical entity. We uphold the view point that the notion of a noiseless vacuum reservoir would turn out to be compatible with observation [29]. Furthermore, employing the relation

$$\frac{d}{dt}\langle\hat{A}\rangle = -i\langle[\hat{A}, \hat{H}]\rangle \tag{10}$$

along with Eq. (1), one can readily establish that

$$\frac{d}{dt}\langle\hat{\sigma}_a^k\rangle = g[\langle\hat{\eta}_b^k\hat{a}_1\rangle - \langle\hat{\eta}_a^k\hat{a}_1\rangle + \langle\hat{a}_2^\dagger\hat{\sigma}_c^k\rangle] + \frac{\Omega}{2}\langle\hat{\sigma}_b^{\dagger k}\rangle, \tag{11}$$

$$\frac{d}{dt}\langle\hat{\sigma}_b^k\rangle = g[\langle\hat{\eta}_c^k\hat{a}_2\rangle - \langle\hat{\eta}_b^k\hat{a}_2\rangle - \langle\hat{a}_1^\dagger\hat{\sigma}_c^k\rangle] - \frac{\Omega}{2}\langle\hat{\sigma}_a^{\dagger k}\rangle, \tag{12}$$

$$\frac{d}{dt}\langle\hat{\sigma}_c^k\rangle = g[\langle\hat{\sigma}_b^k\hat{a}_1\rangle - \langle\hat{\sigma}_a^k\hat{a}_2\rangle] + \frac{\Omega}{2}[\langle\hat{\eta}_c^k\rangle - \langle\hat{\eta}_a^k\rangle], \tag{13}$$

$$\frac{d}{dt}\langle\hat{\eta}_a^k\rangle = g[\langle\hat{\sigma}_a^{\dagger k}\hat{a}_1\rangle + \langle\hat{a}_1^\dagger\hat{\sigma}_a^k\rangle] + \frac{\Omega}{2}[\langle\hat{\sigma}_c^k\rangle + \langle\hat{\sigma}_c^{\dagger k}\rangle], \tag{14}$$

$$\frac{d}{dt}\langle\hat{\eta}_b^k\rangle = g[\langle\hat{\sigma}_b^\dagger\hat{a}_2\rangle + \langle\hat{a}_2^\dagger\hat{\sigma}_b^k\rangle - \langle\hat{\sigma}_a^{\dagger k}\hat{a}_1\rangle - \langle\hat{a}_1^\dagger\hat{\sigma}_a^k\rangle], \tag{15}$$

$$\frac{d}{dt}\langle\hat{\eta}_c^k\rangle = -g[\langle\hat{\sigma}_b^\dagger\hat{a}_1\rangle + \langle\hat{a}_2^\dagger\hat{\sigma}_b^k\rangle] - \frac{\Omega}{2}[\langle\hat{\sigma}_c^k\rangle + \langle\hat{\sigma}_c^{\dagger k}\rangle], \tag{16}$$

where $\hat{\eta}_a^k = |a\rangle_{k\,k}\langle a|$, $\hat{\eta}_b^k = |b\rangle_{k\,k}\langle b|$, $\hat{\eta}_c^k = |c\rangle_{k\,k}\langle c|$.

It can be noted that expressions (11)-(16) are nonlinear and coupled differential equations. Therefore, it is not possible to obtain exact solutions. Then, employing the large-time approximation scheme on Eqs. (8) and (9), one obtains

$$\hat{a}_1 = -\frac{2g}{\kappa}\hat{\sigma}_a^k, \tag{17}$$

$$\hat{a}_2 = -\frac{2g}{\kappa}\hat{\sigma}_b^k. \tag{18}$$

Now introducing Eqs. (17) and (18) into (11)-(16) and sum over the N three-level atoms, it is possible to see that

$$\frac{d}{dt}\langle\hat{m}_a\rangle = -\gamma_c\langle\hat{m}_a\rangle + \frac{\Omega}{2}\langle\hat{m}_b^\dagger\rangle, \tag{19}$$

$$\frac{d}{dt}\langle\hat{m}_b\rangle = -\frac{\gamma_c}{2}\langle\hat{m}_b\rangle - \frac{\Omega}{2}\langle\hat{m}_a^\dagger\rangle, \tag{20}$$

$$\frac{d}{dt}\langle\hat{m}_c\rangle = -\frac{\gamma_c}{2}\langle\hat{m}_c\rangle + \frac{\Omega}{2}[\langle\hat{N}_c\rangle - \langle\hat{N}_a\rangle], \tag{21}$$

$$\frac{d}{dt}\langle\hat{N}_a\rangle = -\gamma_c\langle\hat{N}_a\rangle + \frac{\Omega}{2}[\langle\hat{m}_c\rangle + \langle\hat{m}_c^\dagger\rangle], \tag{22}$$

$$\frac{d}{dt}\langle\hat{N}_b\rangle = -\gamma_c\langle\hat{N}_b\rangle + \gamma_c\langle\hat{N}_a\rangle, \tag{23}$$

$$\frac{d}{dt}\langle\hat{N}_c\rangle = -\gamma_c\langle\hat{N}_b\rangle - \frac{\Omega}{2}[\langle\hat{m}_c\rangle + \langle\hat{m}_c^\dagger\rangle], \tag{24}$$

in which

$$\gamma_c = \frac{4g^2}{\kappa} \tag{25}$$

is the stimulated emission decay constant, $\hat{m}_a = \sum_{k=1}^N \hat{\sigma}_a^k$, $\hat{m}_b = \sum_{k=1}^N \hat{\sigma}_b^k$, $\hat{m}_c = \sum_{k=1}^N \hat{\sigma}_c^k$, $\hat{N}_a = \sum_{k=1}^N \hat{\eta}_a^k$, $\hat{N}_b = \sum_{k=1}^N \hat{\eta}_b^k$, $\hat{N}_c = \sum_{k=1}^N \hat{\eta}_c^k$, with the operators $\hat{N}_a$, $\hat{N}_b$, and $\hat{N}_c$ representing the number of atoms in the top, middle, and bottom levels, respectively.

Furthermore, employing the completeness relation

$$\hat{\eta}_a^k + \hat{\eta}_b^k + \hat{\eta}_c^k = \hat{I}, \tag{26}$$

one can easily arrive at

$$\langle \hat{N}_a \rangle + \langle \hat{N}_b \rangle + \langle \hat{N}_c \rangle = N. \tag{27}$$

Furthermore, applying the definition given by (2) and setting for any k

$$\hat{\sigma}_a^k = |b\rangle\langle a|, \tag{28}$$

we have

$$\hat{m}_a = N|b\rangle\langle a|. \tag{29}$$

Following the same procedure, one can easily find $\hat{m}_b = N|c\rangle\langle b|$, $\hat{m}_c = N|c\rangle\langle a|$, $\hat{N}_a = N|a\rangle\langle a|$, $\hat{N}_b = N|b\rangle\langle b|$, $\hat{N}_c = N|c\rangle\langle c|$.
Moreover, using the definition

$$\hat{m} = \hat{m}_a + \hat{m}_b \tag{30}$$

and taking into account the above relations, we observe that

$$\hat{m}^\dagger \hat{m} = N[\hat{N}_a + \hat{N}_b], \tag{31}$$

$$\hat{m}\hat{m}^\dagger = N[\hat{N}_b + \hat{N}_c], \tag{32}$$

$$\hat{m}^2 = N\hat{m}_c. \tag{33}$$

Now upon adding Eqs. (8) and (9), we have

$$\frac{d}{dt}\hat{a}(t) = -\frac{\kappa}{2}\hat{a}(t) - g[\hat{\sigma}_a^k(t) + \hat{\sigma}_b^k(t)], \tag{34}$$

where

$$\hat{a}(t) = \hat{a}_1(t) + \hat{a}_2(t). \tag{35}$$

In the presence of N three-level atoms, we can rewrite Eq. (34) as

$$\frac{d}{dt}\hat{a}(t) = -\frac{\kappa}{2}\hat{a}(t) + \lambda^{'}\hat{m}(t), \tag{36}$$

in which $\lambda^{'}$ is a constant whose value remains to be determined. The steady-state solution of Eq (34) is

$$\hat{a}(t) = -\frac{2g}{\kappa}[\hat{\sigma}_a^k(t) + \hat{\sigma}_b^k(t)]. \tag{37}$$

Taking into account Eq. (37) and its adjoint, the commutation relation for the cavity mode operator is found to be

$$[\hat{a}, \hat{a}^\dagger] = \frac{\gamma_c}{\kappa}[\hat{\eta}_c - \hat{\eta}_a], \tag{38}$$

and on summing over all atoms, we have

$$[\hat{a}, \hat{a}^{\dagger}] = \frac{\gamma_c}{\kappa}[\hat{N}_c - \hat{N}_a], \tag{39}$$

where

$$[\hat{a}, \hat{a}^{\dagger}] = \sum_{k=1}^{N}[\hat{a}, \hat{a}^{\dagger}]_k \tag{40}$$

stands for the commutator $(\hat{a}, \hat{a}^{\dagger})$ when the superposed light mode a is interacting with all the N three-level atoms. On the other hand, using the steady-state solution of Eq. (36), one can verify that

$$[\hat{a}, \hat{a}^{\dagger}] = N\left[\frac{2\lambda'}{\kappa}\right]^2\left(\hat{N}_c - \hat{N}_a\right). \tag{41}$$

Thus inspection of Eqs. (39) and (41) show that

$$\lambda' = \pm\frac{g}{\sqrt{N}}. \tag{42}$$

Hence in view of this result, Eq. (36) can be rewritten as

$$\frac{d}{dt}\hat{a}(t) = -\frac{\kappa}{2}\hat{a}(t) + \frac{g}{\sqrt{N}}\hat{m}(t). \tag{43}$$

IV. Solutions of the Expectation Values of the Cavity and Atomic Mode Operators

In order to determine the mean photon number and the variance of the photon number, and the quadrature squeezing of a single-mode cavity light in any frequency interval at steady state, we first need to calculate the solution of the equations of evolution of the expectation values of the atomic operators and cavity mode operators. To this end, the expectation values of the solution of Eq. (43) is expressible as

$$\langle\hat{a}(t)\rangle = \langle\hat{a}(0)\rangle e^{-\kappa t/2} + \frac{g}{\sqrt{N}}e^{-\kappa t/2}\int_0^t dt' e^{-\kappa t'/2}\langle\hat{m}(t')\rangle. \tag{44}$$

We next wish to obtain the expectation value of the expression of $\hat{m}(t)$ that appear in Eq. (44). Thus applying the large-time approximation scheme to Eq. (20), we get

$$\langle\hat{m}_b\rangle = -\frac{\Omega}{\gamma_c}\langle\hat{m}_a^{\dagger}\rangle. \tag{45}$$

Upon substituting the adjoint of this into Eq. (19), we have

$$\frac{d}{dt}\langle\hat{m}_a(t)\rangle = -\mu\langle\hat{m}_a(t)\rangle, \tag{46}$$

where

$$\mu = \frac{2\gamma_c^2 + \Omega^2}{2\gamma_c}. \tag{47}$$

We notice that the solution of Eq. (46) for μ different from zero at steady state is

$$\langle\hat{m}_a(t)\rangle = 0. \tag{48}$$

In a similar manner, applying the large-time approximation scheme to Eq. (19), we obtain

$$\langle \hat{m}_a \rangle = -\frac{\Omega}{2\gamma_c}\langle \hat{m}_b^\dagger \rangle. \tag{49}$$

With the aid of the adjoint of Eq. (49), one can put Eq. (20) in the form

$$\frac{d}{dt}\langle \hat{m}_b(t) \rangle = -\frac{\mu}{2}\langle \hat{m}_b(t) \rangle. \tag{50}$$

We also note that for μ different from zero, the solution of Eq. (50) is found to be

$$\langle \hat{m}_b(t) \rangle = 0. \tag{51}$$

Upon adding Eqs. (46)and (50), we find

$$\frac{d}{dt}\langle \hat{m}(t) \rangle = -\frac{\mu}{2}\langle \hat{m}(t) \rangle - \frac{\mu}{2}\langle \hat{m}_a(t) \rangle. \tag{52}$$

We note that in view of Eq. (48) with the assumption the atoms initially in the bottom level, the solution of Eq. (52) turns out at steady state to be

$$\langle \hat{m}(t) \rangle = 0. \tag{53}$$

Now in view of Eq. (53) and with the assumption that the cavity light is initially in a vacuum state, Equation Eq. (44) goes over into

$$\langle \hat{a}(t) \rangle = 0. \tag{54}$$

Therefore, in view of the linear equations described by expressions (43) with (54), we claim that $\hat{a}(t)$ is a Gaussian variable with zero mean. We finally seek to determine the solution of the expectation values of the atomic operators at steady state. Moreover, the steady-state solution of Eqs. (21)-(24) yields

$$\langle \hat{N}_a \rangle_{ss} = \left[\frac{\Omega^2}{\gamma_c^2 + 3\Omega^2}\right] N, \tag{55}$$

$$\langle \hat{N}_b \rangle_{ss} = \left[\frac{\Omega^2}{\gamma_c^2 + 3\Omega^2}\right] N, \tag{56}$$

$$\langle \hat{N}_c \rangle_{ss} = \left[\frac{\gamma_c^2 + \Omega^2}{\gamma_c^2 + 3\Omega^2}\right] N, \tag{57}$$

$$\langle \hat{m}_c \rangle_{ss} = \left[\frac{\Omega\gamma_c}{\gamma_c^2 + 3\Omega^2}\right] N. \tag{58}$$

Up on setting $\eta = \frac{\Omega}{\gamma_c}$, we can rewrite Eqs. (55)-(58) as

$$\langle \hat{N}_a \rangle_{ss} = \left[\frac{\eta^2}{1 + 3\eta^2}\right] N, \tag{59}$$

$$\langle \hat{N}_b \rangle_{ss} = \left[\frac{\eta^2}{1 + 3\eta^2}\right] N, \tag{60}$$

$$\langle \hat{N}_c \rangle_{ss} = \left[\frac{1+\eta^2}{1+3\eta^2}\right] N, \tag{61}$$

$$\langle \hat{m}_c \rangle_{ss} = \left[\frac{\eta}{1+3\eta^2}\right] N. \tag{62}$$

Initially (when $\Omega = 0$), all the atoms are on the lower level ($\langle \hat{N}_c \rangle_{ss} = N$) while the number of atoms on the top and intermediate levels are zero.

V. Photon Statistics

Here we seek to obtain the global (local) mean photon number and the global (local) variance of the photon number for a single-mode cavity light beam at steady state.

a) *The Global Mean Photon Number*

To learn about the brightness of the generated light, it is necessary to study the mean number of photon pairs describing the two-mode cavity radiation that can be defined as

$$\bar{n} = \langle \hat{a}^\dagger \hat{a} \rangle. \tag{63}$$

On account of the steady state solution of (43) together with (31), the mean photon number of the two-mode cavity light is expressible as

$$\bar{n} = \frac{\gamma_c}{k}\left[\langle \hat{N}_a \rangle_{ss} + \langle \hat{N}_b \rangle_{ss}\right]. \tag{64}$$

With the aid of equations (59) and (60), one can readily show that

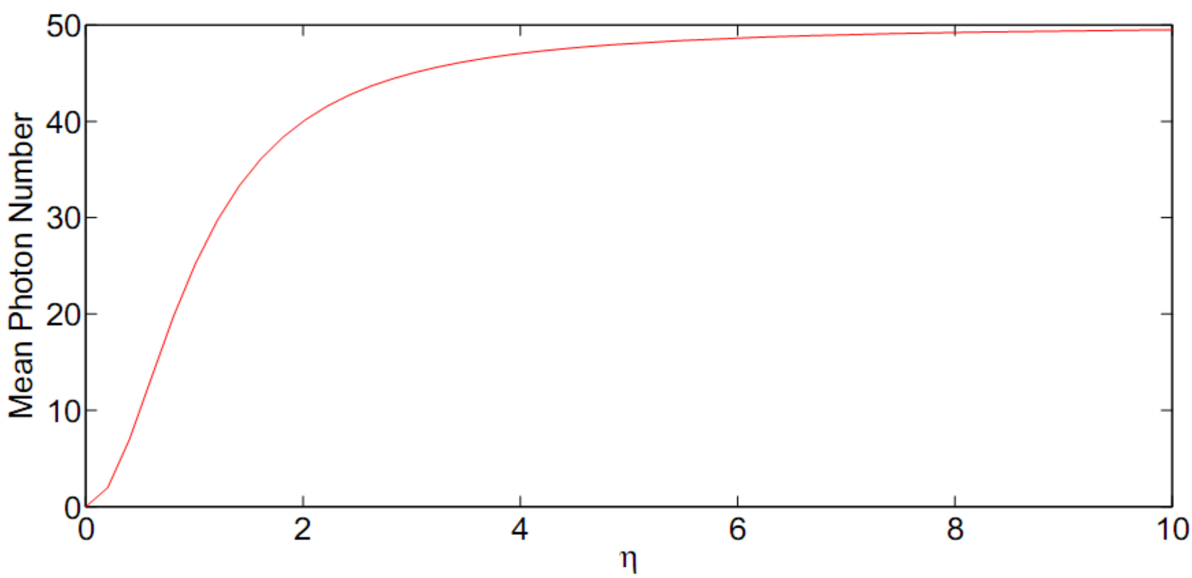

Figure 1: Plots of $\bar{n}$ vs. η for $\gamma_c = 0.4$, $\kappa = 0.8$, and $N = 50$

$$\bar{n} = \left(\frac{2\gamma_c}{k}N\right)\left[\frac{\eta^2}{1+3\eta^2}\right]. \tag{65}$$

It is not difficult to see, for $\Omega \gg \gamma_c$, that

$$\bar{n} = \frac{2\gamma_c}{3\kappa}N. \tag{66}$$

We see from Fig. (1) that the mean photon number of the two-mode light increases with η. In addition, as shown on Fig. (2) when Ω (the amplitude of coherent light) and γ_c (the stimulated emission decay constant) increase the global mean photon number also increases.

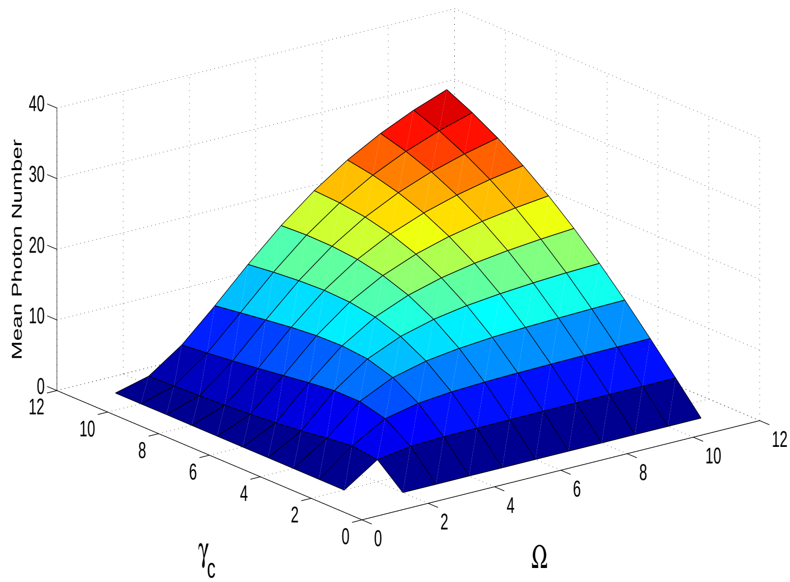

Figure 2: Plots of $\bar{n}$ vs. γ_c and Ω for $\kappa = 0.8$ and $N = 50$

b) The Local Mean Photon Number

We seek to determine the mean photon number in a given frequency interval, employing the power spectrum for the two-mode cavity light. The power spectrum of a two-mode cavity light with central common frequency ω_0 is defined as

$$\Gamma(\omega) = \frac{1}{\pi}Re\int_0^\infty d\tau e^{i(\omega-\omega_0)\tau}\langle\hat{a}^\dagger(t)\hat{a}(t+\tau)\rangle_{ss}. \tag{67}$$

Next we seek to calculate the two-time correlation functions for the two-mode cavity light. To this end, we realize that the solution of Eq. (43) can write as

$$\hat{a}(t+\tau) = \hat{a}(t)e^{-\kappa\tau/2} + \frac{g}{\sqrt{N}}e^{-\kappa\tau/2}\int_0^\tau d\tau' e^{-\kappa\tau'/2}\hat{m}(t+\tau'). \tag{68}$$

On the other hand, one can put Eq. (52) in the form

$$\frac{d}{dt}\hat{m}(t) = -\frac{\mu}{2}\hat{m}(t) - \frac{\mu}{2}\hat{m}_a(t) + \hat{F}_m(t), \tag{69}$$

in which $\hat{F}_m(t)$ is a noise operator with zero mean. The solution of this equation is expressible as

$$\hat{m}(t+\tau) = \hat{m}(t)e^{-\mu\tau/2} + e^{-\mu\tau/2}\int_0^\tau d\tau' e^{-\mu\tau'/2}\Big[-\frac{\mu}{2}\hat{m}_a(t+\tau') + \hat{F}_m(t+\tau')\Big]. \tag{70}$$

In addition, one can rewrite Equation (134) as

$$\frac{d}{dt}\hat{m}_a(t) = -\mu\hat{m}_a(t) + \hat{F}_a(t), \tag{71}$$

where $\hat{F}_a(t)$ is a noise operator with vanishing mean. Employing the large-time approximation scheme to Equation (71), we see that

$$\hat{m}_a(t+\tau) = \frac{1}{\mu}\hat{F}_a(t+\tau). \tag{72}$$

Furthermore, introducing this into Equation (70), we have

$$\hat{m}(t+\tau) = \hat{m}(t)e^{-\kappa\tau/2} + e^{-\kappa\tau/2}\int_0^\tau d\tau' e^{-\kappa\tau'/2}\Big[-\frac{1}{2}\hat{F}_a(t+\tau') + \hat{F}_m(t+\tau')\Big]. \tag{73}$$

Now combination of Eqs (68) and (73) yields

$$\hat{a}(t+\tau) = \hat{a}(t)e^{-\kappa\tau/2} + \frac{g}{\sqrt{N}}e^{-\kappa\tau/2}\Big[\hat{m}(t)\int_0^\tau d\tau' e^{-(\kappa-\mu)\tau'/2} + \int_0^\tau d\tau' e^{-(\kappa-\mu)\tau'/2}$$

$$\times \int_0^{\tau'} d\tau'' e^{-\mu\tau''/2}\Big(-\frac{1}{2}\hat{F}_a(t+\tau'') + \hat{F}_m(t+\tau'')\Big)\Big]. \tag{74}$$

On multiplying both sides on the left by $\hat{a}^\dagger(t)$ and taking the expectation value of the resulting equation, we get

$$\langle\hat{a}^\dagger(t)\hat{a}(t+\tau)\rangle = \langle\hat{a}^\dagger(t)\hat{a}(t)\rangle e^{-\kappa\tau/2} + \frac{g}{\sqrt{N}}e^{-\kappa\tau/2}\Big[\langle\hat{a}^\dagger(t)\hat{m}(t)\rangle\int_0^\tau d\tau' e^{-(\kappa-\mu)\tau'/2}$$

$$+\int_0^\tau d\tau' e^{-(\kappa-\mu)\tau'/2}\int_0^{\tau'} d\tau'' e^{-\mu\tau''/2}\Big(-\frac{1}{2}\langle\hat{a}^\dagger(t)\hat{F}_a(t+\tau'')\rangle + \langle\hat{a}^\dagger(t)\hat{F}_m(t+\tau'')\rangle\Big)\Big]. \tag{75}$$

Moreover, applying the large-time approximation scheme to Eq. (43), we obtain

$$\hat{m}(t) = \frac{\kappa\sqrt{N}}{2g}\hat{a}(t). \tag{76}$$

With this substituting into Eq.(75), there follows

$$\langle\hat{a}^\dagger(t)\hat{a}(t+\tau)\rangle = \langle\hat{a}^\dagger(t)\hat{a}(t)\rangle e^{-\kappa\tau/2} + \frac{g}{\sqrt{N}}e^{-\kappa\tau/2}\Big[\frac{\kappa}{2}\langle\hat{a}^\dagger(t)\hat{a}(t)\rangle\int_0^\tau d\tau' e^{-(\kappa-\mu)\tau'/2}$$

$$+\int_0^\tau d\tau' e^{-(\kappa-\mu)\tau'/2}\int_0^{\tau'} d\tau'' e^{-\mu\tau''/2}\Big(-\frac{1}{2}\langle\hat{a}^\dagger(t)\hat{F}_a(t+\tau'')\rangle + \langle\hat{a}^\dagger(t)\hat{F}_m(t+\tau'')\rangle\Big)\Big]. \tag{77}$$

Since the cavity mode operator and the noise operator of the atomic modes are not correlated, we see that

$$\langle \hat{a}^\dagger(t)\hat{F}_a(t+\tau'')\rangle = \langle \hat{a}^\dagger(t)\rangle\langle \hat{F}_a(t+\tau'')\rangle = 0, \tag{78}$$

$$\langle \hat{a}^\dagger(t)\hat{F}_m(t+\tau'')\rangle = \langle \hat{a}^\dagger(t)\rangle\langle \hat{F}_m(t+\tau'')\rangle = 0. \tag{79}$$

On account of these results and on carrying out the integration of Eq. (77) over τ' , we readily ge

$$\langle \hat{a}^\dagger(t)\hat{a}(t+\tau)\rangle = \langle \hat{a}^\dagger(t)\hat{a}(t)\rangle\left[\frac{\kappa}{\kappa-\mu}e^{-\mu\tau/2} - \frac{\mu}{\kappa-\mu}e^{-\kappa\tau/2}\right]. \tag{80}$$

On introducing (80) into Eq. (67) and carrying out the integration, we readily get

$$\Gamma(\omega) = \bar{n}\left\{\left[\frac{\kappa}{\kappa-\mu}\right]\left[\frac{\mu/2\pi}{(\omega-\omega_0)^2+(\mu/2)^2}\right] - \left[\frac{\mu}{\kappa-\mu}\right]\left[\frac{\kappa/2\pi}{(\omega-\omega_0)^2+(\kappa/2)^2}\right]\right\}. \tag{81}$$

The mean photon number in the frequency interval between $\omega' = -\lambda$ and $\omega' = +\lambda$ is expressible as

$$\bar{n}_{\pm\lambda} = \int_{-\lambda}^{+\lambda} \Gamma(\omega')d\omega', \tag{82}$$

in which $\omega' = \omega - \omega_0$. Thus upon substituting (81) into Equation (82), we find

$$\bar{n}_{\pm\lambda} = \left[\frac{\kappa\bar{n}}{\kappa-\mu}\right]\int_{-\lambda}^{+\lambda}\left[\frac{\mu/2\pi}{(\omega-\omega_0)^2+(\mu/2)^2}\right]d\omega' - \left[\frac{\mu\bar{n}}{\kappa-\mu}\right]\int_{-\lambda}^{+\lambda}\left[\frac{\kappa/2\pi}{(\omega-\omega_0)^2+(\kappa/2)^2}\right]d\omega' \tag{83}$$

and on carrying out the integration over ω', applying the relation

$$\int_{-\lambda}^{+\lambda}\frac{dx}{x^2+a^2} = \frac{2}{a}\tan^{-1}\left(\frac{\lambda}{a}\right), \tag{84}$$

we arrive at

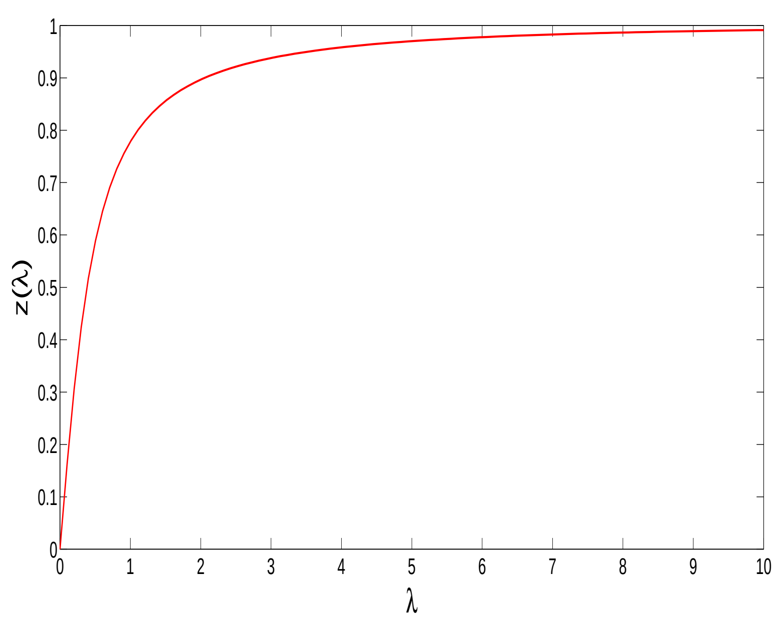

Figure 3: Plot of $z(\lambda)$ vs. λ for $\gamma_c = 0.4$, $\Omega = 3$, and $k = 0.8$

$$\bar{n}_{\pm\lambda} = \bar{n}z(\lambda), \tag{85}$$

where

$$z(\lambda) = \left[\frac{2\kappa/\pi}{\kappa-\mu}\right]\tan^{-1}\left(\frac{2\lambda}{\mu}\right) - \left[\frac{2\mu/\pi}{\kappa-\mu}\right]\tan^{-1}\left(\frac{2\lambda}{\kappa}\right). \tag{86}$$

One can readily get from Fig. (3) that $z(0.5) = 0.5891$, $z(1) = 0.7802$, and $z(2) = 0.8978$. Then combination of these results with Eq. (85) yields $\bar{n}_{\pm 0.5} = 0.5891\bar{n}$, $\bar{n}_{\pm 1} = 0.7802\bar{n}$, and $\bar{n}_{\pm 2} = 0.8978\bar{n}$. We therefore observe that a large part of the total mean photon number is confined in a relatively small frequency interval.

c) The Global Variance of the Photon Number

The variance of the photon number for the two-mode cavity light is expressible as

$$(\Delta n)^2 = \langle(\hat{a}^\dagger\hat{a})^2\rangle - \langle\hat{a}^\dagger\hat{a}\rangle^2. \tag{87}$$

Since $\hat{a}$ is Gaussian variable with zero mean, the variance of the photon number can be written as

$$(\Delta n)^2 = \langle\hat{a}^\dagger\hat{a}\rangle\langle\hat{a}\hat{a}^\dagger\rangle + \langle\hat{a}^{\dagger 2}\rangle\langle\hat{a}^2\rangle. \tag{88}$$

With the aid of the steady-stae solution of Eq. (43), one can easily establish that

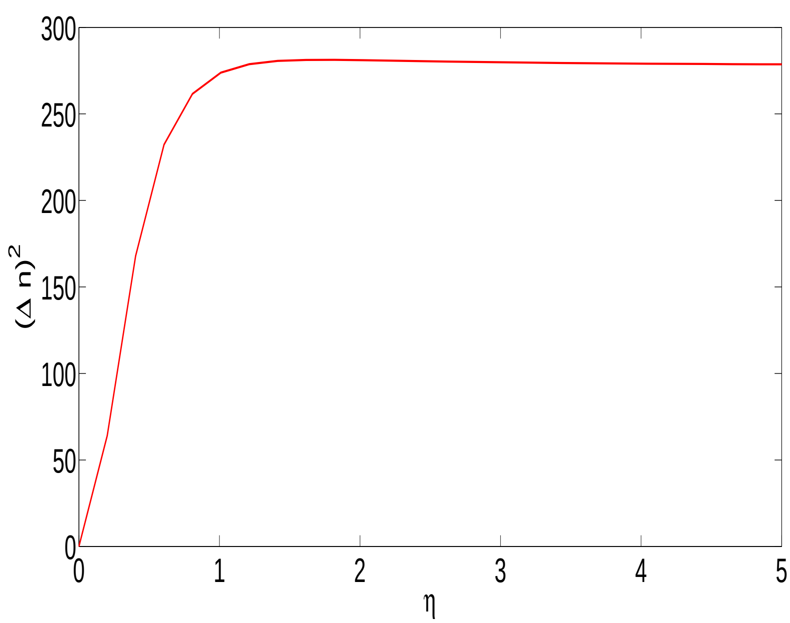

Figure 4: Plot of $(\Delta n)^2$ vs. η for $\gamma_c = 0.4$, $\kappa = 0.8$, and $N = 50$

$$\langle\hat{a}\hat{a}^\dagger\rangle = \frac{\gamma_c}{\kappa}[\langle\hat{N}_b\rangle + \langle\hat{N}_c\rangle] \tag{89}$$

and

$$\langle\hat{a}^2\rangle = \frac{\gamma_c}{\kappa}\langle\hat{m}_c\rangle. \tag{90}$$

Since $\langle\hat{m}_c\rangle$ is real, then $\langle\hat{a}^2\rangle = \langle\hat{a}^{\dagger 2}\rangle$. Therefore, with the aid of Eqs. (64), (89) and (90), Eq. (88) turns out to be

$$(\Delta n)^2 = (\frac{\gamma_c}{\kappa})^2[(\langle\hat{N}_a\rangle + \langle\hat{N}_b\rangle)(\langle\hat{N}_b\rangle + \langle\hat{N}_c\rangle) + \langle\hat{m}_c\rangle^2]. \tag{91}$$

Furthermore, upon substituting of Eqs. (59)-(62) into Eq. (91), we see that

$$(\Delta n)^2 = \left(\frac{\gamma_c}{\kappa}N\right)^2\left[\frac{3\eta^2+4\eta^4}{1+6\eta^2+9\eta^4}\right]. \tag{92}$$

This is the steady-state photon number variance of the two-mode light beam, produced by the coherently driven degenerate three-level laser with a closed cavity and coupled to a two-mode vacuum reservoir. Moreover, we note that for $\eta \gg 1$, Eq. (92) reduces to

$$(\Delta n)^2 = \left[\frac{2\gamma_c}{3\kappa}N\right]^2 \tag{93}$$

and in view of Eq. (66), we have

$$(\Delta n)^2 = \bar{n}^2, \tag{94}$$

which represents the normally-ordered variance of the photon number for chaotic light.

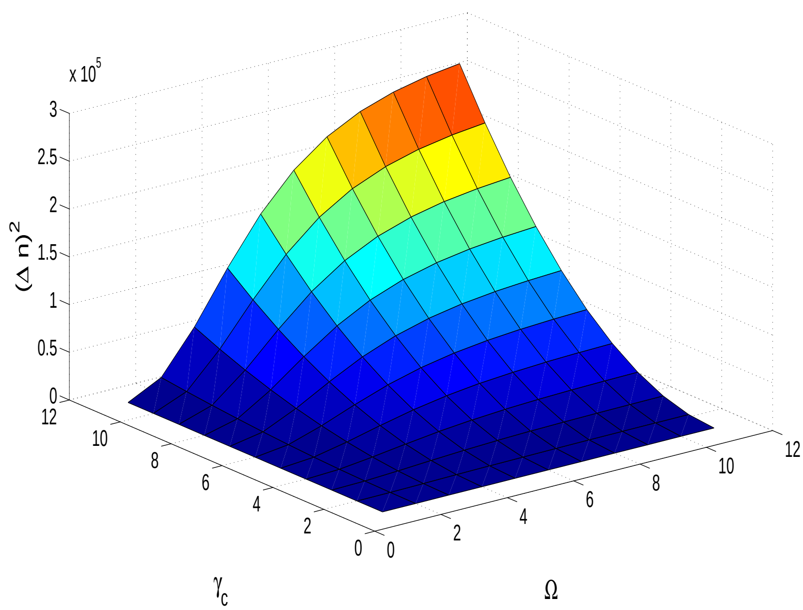

Figure 5: Plot of $(\Delta n)^2$ vs. γ_c and Ω for $\kappa = 0.8$ and $N = 50$

We see from Fig. (4) that the global photon number variance of the cavity light increases with η. In addition, as shown on Fig. (5) when Ω (the amplitude of coherent light) and γ_c (the stimulated emission decay constant) increase the global photon number variance also increases.

d) The Local Variance of the Photon Number

Here we wish to obtain the variance of the photon number in a given frequency interval, employing the spectrum of the photon number fluctuations for the superposition of light modes a_1 and

a_2. We denote the central common frequency of these modes by ω_0. The spectrum of the photon number fluctuations for the superposed light modes can be expressed as

$$\Lambda(\omega) = \frac{1}{\pi} Re \int_0^\infty d\tau e^{i(\omega-\omega_0)\tau} \langle \hat{n}(t), \hat{n}(t+\tau)\rangle_{ss}, \tag{95}$$

where

$$\hat{n}(t) = \hat{a}^\dagger(t)\hat{a}(t), \tag{96}$$

$$\hat{n}(t+\tau) = \hat{a}^\dagger(t+\tau)\hat{a}(t+\tau). \tag{97}$$

Applying the realtion [39]

$$\langle \hat{n}(t), \hat{n}(t+\tau)\rangle = \langle \hat{n}(t)\hat{n}(t+\tau)\rangle - \langle \hat{n}(t)\rangle\langle \hat{n}(t+\tau)\rangle. \tag{98}$$

With the aid of Eqs. (96), (97) and (54), the photon number fluctuation can be expressed as

$$\Lambda(\omega) = \frac{1}{\pi} Re \int_0^\infty d\tau e^{i(\omega-\omega_0)\tau} [\langle \hat{a}^\dagger(t+\tau)\hat{a}(t+\tau)\rangle\langle \hat{a}(t+\tau)\hat{a}^\dagger(t+\tau)\rangle$$

$$+\langle \hat{a}^\dagger(t+\tau)\hat{a}^\dagger(t+\tau)\rangle\langle \hat{a}(t+\tau)\hat{a}(t+\tau)\rangle] \tag{99}$$

Following the same procedure to determine (80), one can readily get

$$\langle \hat{a}(t)\hat{a}^\dagger(t+\tau)\rangle = \langle \hat{a}(t)\hat{a}^\dagger(t)\rangle \left[\frac{\kappa}{\kappa-\mu} e^{-\mu\tau/2} - \frac{\mu}{\kappa-\mu} e^{-\kappa\tau/2}\right] \tag{100}$$

$$\langle \hat{a}(t)\hat{a}(t+\tau)\rangle = \langle \hat{a}^2(t)\rangle \left[\frac{\kappa}{\kappa-\mu} e^{-\mu\tau/2} - \frac{\mu}{\kappa-\mu} e^{-\kappa\tau/2}\right] \tag{101}$$

$$\langle \hat{a}^\dagger(t)\hat{a}^\dagger(t+\tau)\rangle = \langle \hat{a}^{\dagger 2}(t)\rangle \left[\frac{\kappa}{\kappa-\mu} e^{-\mu\tau/2} - \frac{\mu}{\kappa-\mu} e^{-\kappa\tau/2}\right] \tag{102}$$

Upon introducing (100)-(102) into Equation (99) and on carrying out the integration over τ, the spectrum of the photon number fluctuations for the two-mode cavity light is found to be

$$\Lambda(\omega) = (\Delta n)^2 \Bigg\{ \left[\frac{\kappa^2}{(\kappa-\mu}\right)^2\Bigg] \left[\frac{\mu/2\pi}{(\omega-\omega_0)^2 + (\mu/2)^2}\right] + \left[\frac{\mu^2}{(\kappa-\mu)^2}\right] \left[\frac{\kappa/\pi}{(\omega-\omega_0)^2 + (\kappa/2)^2}\right]$$

$$-\left[\frac{2\kappa\mu}{(\kappa-\mu)^2}\right] \left[\frac{(\kappa+\mu)/2\pi}{(\omega-\omega_0)^2 + (\kappa+\mu)^2/4}\right] \Bigg\}, \tag{103}$$

where $(\Delta n)^2$ is given by (92). Furthermore, upon integrating both sides of (103) over ω, we find

$$\int_{-\infty}^\infty \Lambda(\omega) d\omega = (\Delta n)^2_{ss}, \tag{104}$$

On the basis of Eq. (104), we observe that $\Lambda(\omega)d\omega$ represents the steady-state variance of the photon number for the two-mode cavity light in the interval between ω and $\omega + d\omega$. We thus realize that the photon- number variance in the interval between $\omega' = -\lambda$ and $\omega' = +\lambda$ can be written as

$$(\Delta n)^2_{\pm\lambda} = \int_{-\lambda}^{+\lambda} \Lambda(\omega)d\omega, \tag{105}$$

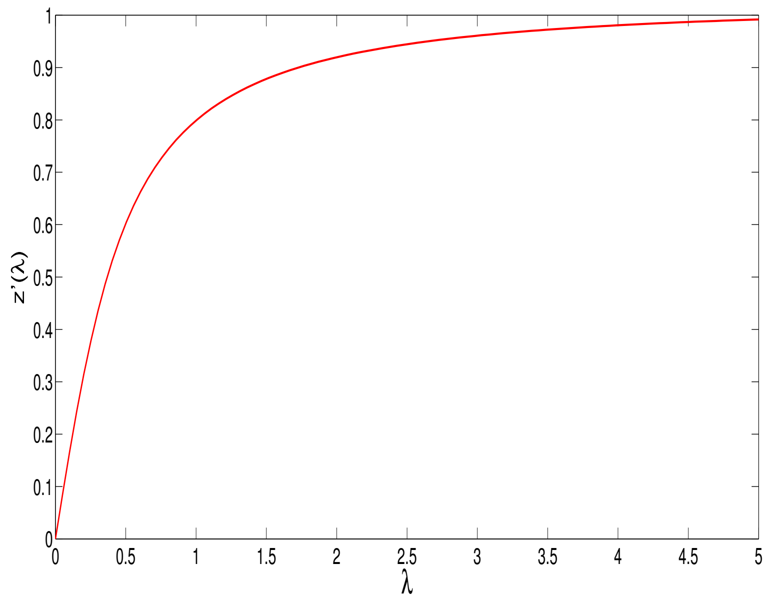

Figure 6: Plot of $z'(\lambda)$ vs. λ for $\gamma_c = 0.4$, $\Omega = 3$, and $k = 0.8$

in which $\omega' = \omega - \omega_0$. Thus upon substituting (103) into Eq. (105) and on carrying out the integration over ω', applying the relation described by Eq. (84), we readily get

$$(\Delta n)^2_{\pm\lambda} = (\Delta n)^2 z'(\lambda), \tag{106}$$

where

$$z'(\lambda) = \left[\frac{2\kappa^2/\pi}{(\kappa-\mu)^2}\right]\tan^{-1}\left(\frac{\lambda}{\mu}\right) + \left[\frac{2\mu^2/\pi}{(\kappa-\mu)^2}\right]\tan^{-1}\left(\frac{\lambda}{\kappa}\right) - \left[\frac{4\kappa\mu/\pi}{(\kappa-\mu)^2}\right]\tan^{-1}\left(\frac{2\lambda}{\kappa+\mu}\right), \tag{107}$$

One can readily get from Fig.(6) that $z'(0.5) = 0.6587$, $z'(1) = 0.8074$, and $z'(2) = 0.9254$. Then combination of these results with Eq. (106) yields $(\Delta n)^2_{\pm 0.5} = 0.6587(\Delta n)^2 z'(\lambda)$, $(\Delta n)^2_{\pm 1} = 0.8074(\Delta n$ and $(\Delta n)^2_{\pm 2} = 0.9254(\Delta n)^2$. We therefore observe that a large part of the total variance of the photon number is confined in a relatively small frequency interval.

VI. Quadrature Squeezing

In this section, we seek to obtain the quadrature variance and squeezing of the two-mode light in a closed cavity produced by a coherently driven nondegenerate three-level laser.

a) Quadrature Variance

The squeezing properties of the two-mode cavity light are described by two quadrature operators

$$\hat{a}_+ = \hat{a}^\dagger + \hat{a}, \tag{108}$$

$$\hat{a}_- = i(\hat{a}^\dagger - \hat{a}), \tag{109}$$

It can be readily established that

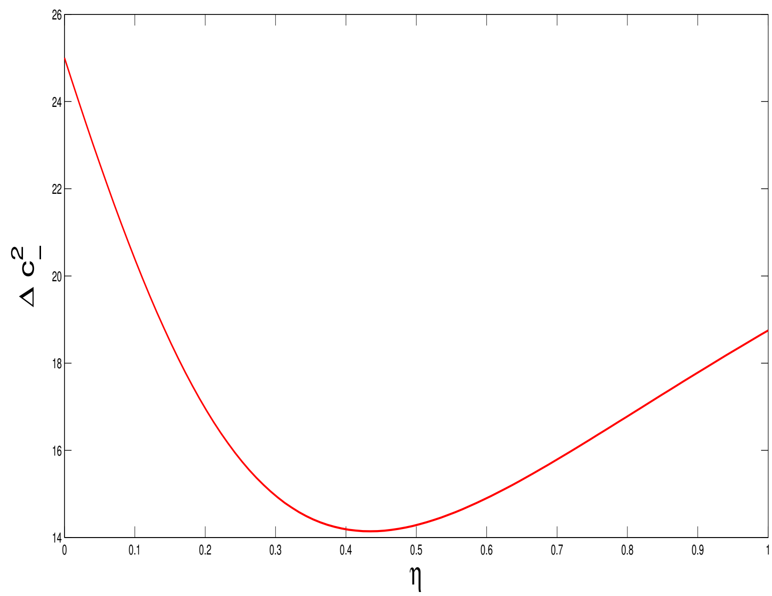

Figure 7: Plot of $(\Delta a_-)^2$ vs. η for $\gamma_c = 0.4$, $k = 0.8$, and $N = 50$

$$[\hat{a}_-, \hat{a}_+] = 2i\frac{\gamma_c}{\kappa}[\hat{N}_a - \hat{N}_c], \tag{110}$$

It then follows that

$$\Delta a_+ \Delta a_- \geq \frac{\gamma_c}{\kappa}\left|\langle\hat{N}_a\rangle - \langle\hat{N}_c\rangle\right|. \tag{111}$$

Now upon replacing the atomic operators that appear in Eq. (39) by their expectation values, the commutation relation for the two-mode light can be written as

$$[\hat{a}, \hat{a}] = \lambda, \tag{112}$$

in which

$$\lambda = \frac{\gamma_c}{\kappa}\left[\langle\hat{N}_c\rangle - \langle\hat{N}_a\rangle\right]. \tag{113}$$

Making use of the well-known definition of the variance of an operator, the variances of the quadrature operators (108) and (109) are found to have the form

$$(\Delta a_{\pm})^2 = \lambda + 2\langle \hat{a}^\dagger(t)\hat{a}(t)\rangle \pm \langle \hat{a}^2(t)\rangle \pm \langle \hat{a}^{\dagger 2}(t)\rangle \mp \langle \hat{a}(t)\rangle^2 \mp \langle \hat{a}^\dagger(t)\rangle^2 - 2\langle \hat{a}(t)\rangle\langle \hat{a}^\dagger(t)\rangle. \tag{114}$$

In view of Equation (54), one can put Equation (114) in the form

$$(\Delta a_{\pm})^2 = \lambda + 2\langle \hat{a}^\dagger(t)\hat{a}(t)\rangle \pm \langle \hat{a}^2(t)\rangle \pm \langle \hat{a}^{\dagger 2}(t)\rangle. \tag{115}$$

With the aid of Eqs. (64), (90), and (113) one can easily establish that

$$(\Delta a_{+})^2 = \frac{\gamma_c}{k}[N + \langle \hat{N}_b\rangle_{ss} + 2\langle \hat{m}_c\rangle_{ss}], \tag{116}$$

$$(\Delta a_{-})^2 = \frac{\gamma_c}{k}[N + \langle \hat{N}_b\rangle_{ss} - 2\langle \hat{m}_c\rangle_{ss}]. \tag{117}$$

Finally, on account of (60) and (62), the global quadrature variance of the two-mode cavity light

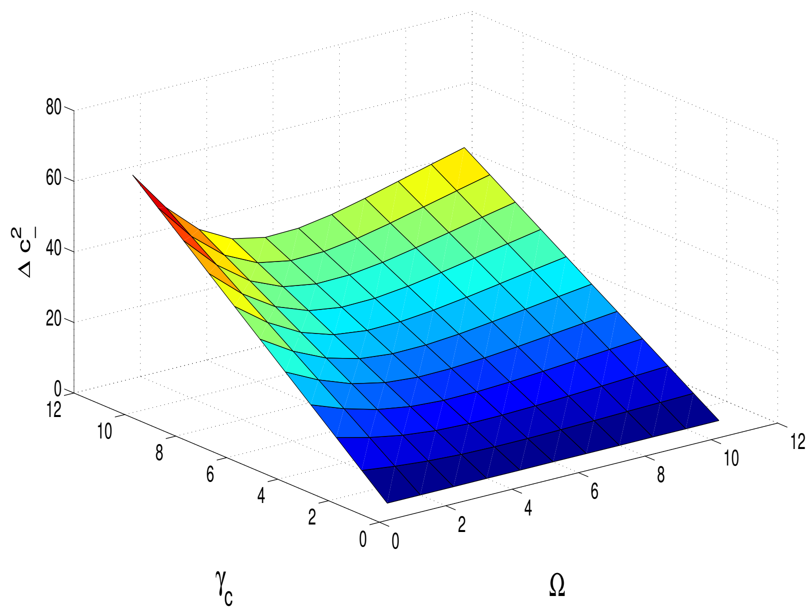

Figure 8: Plots of $(\Delta a_{-})^2$ vs Ω and γ_c for $k = 0.8$, $N = 50$.

turns out at steady state to be

$$(\Delta a_{+})^2 = \frac{\gamma_c}{k}N\left[\frac{4\eta^2 + 2\eta + 1}{1 + 3\eta^2}\right], \tag{118}$$

$$(\Delta a_{-})^2 = \frac{\gamma_c}{k}N\left[\frac{4\eta^2 - 2\eta + 1}{1 + 3\eta^2}\right], \tag{119}$$

and for $\Omega \gg \gamma_c$

$$(\Delta a_{\pm})^2 = \frac{4\gamma_c}{3k}N = 2\bar{n}, \tag{120}$$

where $\bar{n}$ is given by equation (66). It can be seen that expression (120) represents the normally ordered quadrature variance for chaotic light. Moreover, for the case in which the deriving coherent light is absent, one can see that

$$(\Delta a_+)^2_v = (\Delta a_-)^2_v = \frac{\gamma_c}{k} N, \tag{121}$$

which is the normally ordered quadrature variance of the two-mode cavity light in vacuum state. It is also observed that, the uncertainty in the plus and minus quadratures are equal and satisfy the minimum uncertainty relation.

b) The quadrature squeezing

The quadrature squeezing of the two-mode cavity light relative to the quadrature variance of the two-mode vacuum light can be defined as

$$S = \frac{(\Delta a_\pm)^2_v - (\Delta a_-)^2}{(\Delta a_\pm)^2_v}, \tag{122}$$

where $(\Delta a_\pm)^2_v$ is the quadrature variance in vacuum state given by equation (121). Taking into

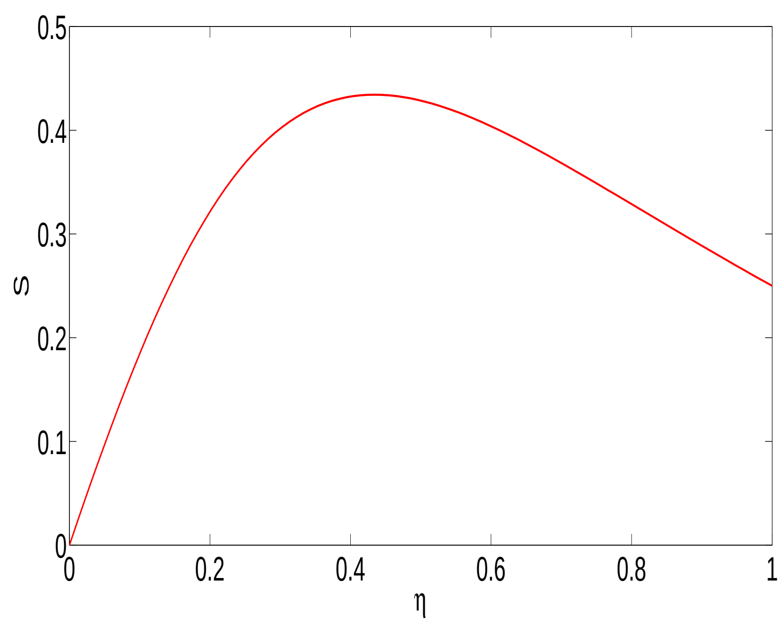

Figure 9: Plot of the quadrature squeezing vs. η for $\gamma_c = 0.4$.

account equations (118) and (121), (122) yields

$$S = \frac{2\eta - \eta^2}{1 + 3\eta^2}. \tag{123}$$

Equation (123) is indicates that the quadrature squeezing of the light produced by degenerate three-level laser with the N three-level atoms available inside a closed cavity pumped to the top level by electron bombardment which has been reported by Fesseha [1, 28].

We observe that in Eq. (123), unlike the mean photon number, the quadrature squeezing does not depend on the number of atoms. This implies that the quadrature squeezing of the cavity light is independent of the number of photons.

The plot in Figs. 9 shows that the maximum squeezing of the cavity light is 43% degree of squeezing and occurs when the three-level laser is operating at $\eta = 0.4$. Hence one can observe that a coherently driven light produced by a degenerate three-level laser can exhibit less than degree of squeezing when, for example, compared to the light generated by a three-level laser in which the three-level atoms available in a closed cavity are pumped to the top level by means of electron bombardment [1, 28, 29].

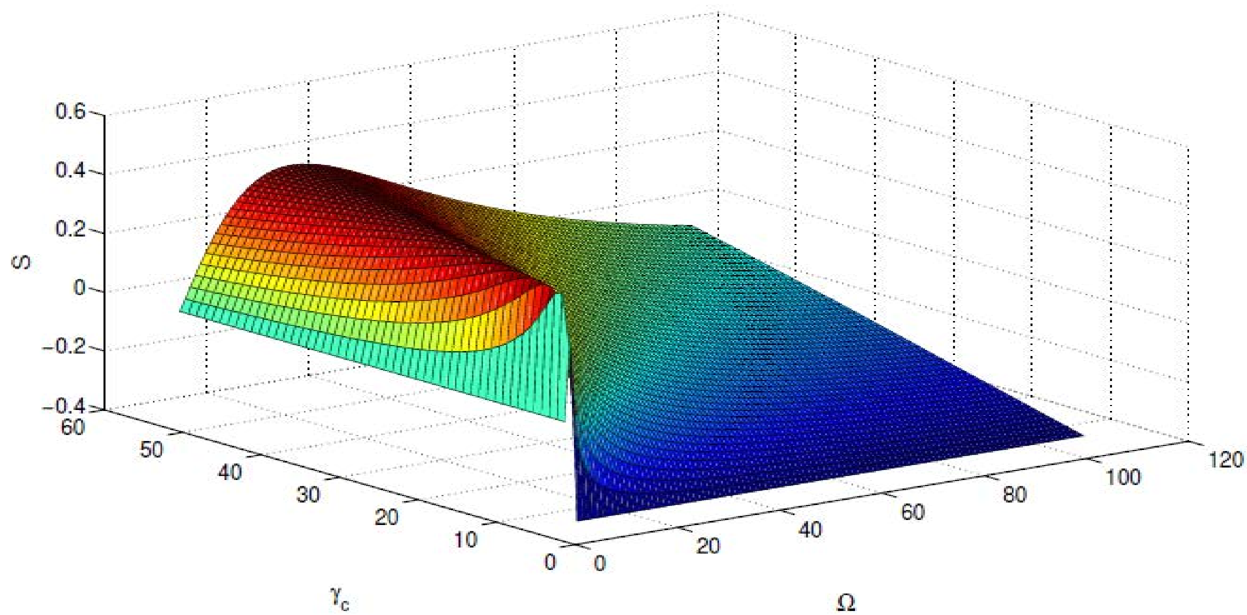

Figure 10: Plot of the quadrature squeezing vs. Ω and γ_c.

VII. Local Quadrature Squeezing

Here we wish to obtain the quadrature squeezing of a cavity light in a given frequency interval. To this end, we first obtain the spectrum of the quadrature fluctuations of the superposition of light modes a_1 and a_2. We define this spectrum for the two-mode cavity light by

$$S_{\pm}(\omega) = \frac{1}{\pi} Re \int_0^{\infty} d\tau e^{i(\omega-\omega_0)\tau} \langle \hat{a}_{\pm}(t), \hat{a}_{\pm}(t+\tau)\rangle_{ss}, \tag{124}$$

in which

$$\hat{a}_{+}(t+\tau) = \hat{a}^{\dagger}(t+\tau) + \hat{a}(t+\tau), \tag{125}$$

$$\hat{a}_{-}(t+\tau) = i(\hat{a}^{\dagger}(t+\tau) - \hat{a}(t+\tau)), \tag{126}$$

and ω_0 is the central frequency of the modes a_1 and a_2. In view of Eq. (54), we obtain

$$\langle \hat{a}_{\pm}(t), \hat{a}_{\pm}(t+\tau)\rangle = \langle \hat{a}_{\pm}(t)\hat{a}_{\pm}(t+\tau)\rangle. \tag{127}$$

Then on account of Eqs. (108), (109), (125), and (126), one can write Equation (127) as

$$\langle \hat{a}_\pm(t), \hat{a}_\pm(t+\tau)\rangle = \langle \hat{a}^\dagger(t)\hat{a}(t+\tau)\rangle + \langle \hat{a}(t)\hat{a}^\dagger(t+\tau)\rangle \pm \langle \hat{a}^\dagger(t)\hat{a}^\dagger(t+\tau)\rangle \pm \langle \hat{a}(t)\hat{a}(t+\tau)\rangle. \quad (128)$$

Upon substituting of Eqs. (80), (100)-(102) into Eq. (128), we arrive at

$$\langle \hat{a}_\pm(t), \hat{a}_\pm(t+\tau)\rangle = \Big[\langle \hat{a}^\dagger(t)\hat{a}(t)\rangle + \langle \hat{a}(t)\hat{a}^\dagger(t)\rangle \pm \langle \hat{a}^\dagger(t)\hat{a}^\dagger(t)\rangle \pm \langle \hat{a}(t)\hat{a}(t)\rangle\Big]$$

$$\times\left[\frac{\kappa}{\kappa-\mu}e^{-\mu\tau/2} - \frac{\mu}{\kappa-\mu}e^{-\kappa\tau/2}\right]. \quad (129)$$

This can be put in the form

$$\langle \hat{a}_+(t), \hat{a}_+(t+\tau)\rangle = (\Delta a_+)^2\left[\frac{\kappa}{\kappa-\mu}e^{-\mu\tau/2} - \frac{\mu}{\kappa-\mu}e^{-\kappa\tau/2}\right] \quad (130)$$

and

$$\langle \hat{a}_-(t), \hat{a}_-(t+\tau)\rangle = (\Delta a_-)^2\left[\frac{\kappa}{\kappa-\mu}e^{-\mu\tau/2} - \frac{\mu}{\kappa-\mu}e^{-\kappa\tau/2}\right]. \quad (131)$$

Now introducing (131) into Eq. (124) and on carrying out the integration over τ, we find the spectrum of the minus quadrature fluctuations for a two-mode cavity light to be

$$S_-(\omega) = (\Delta a_-)^2_{ss}\left\{\left[\frac{\kappa}{\kappa-\mu}\right]\left[\frac{\mu/2\pi}{(\omega-\omega_0)^2+(\mu/2)^2}\right] - \left[\frac{\mu}{\kappa-\mu}\right]\left[\frac{\kappa/2\pi}{(\omega-\omega_0)^2+(\kappa/2)^2}\right]\right\}. \quad (132)$$

Upon integrating both sides of (132) over ω, we get

$$\int_{-\infty}^{+\infty} S_-(\omega)d\omega = (\Delta a_-)^2. \quad (133)$$

On the basis of Equation (133), we observe that $S_-(\omega)d\omega$ is the steady-state variance of the minus quadrature in the interval between ω and $\omega + d\omega$. We thus realize that the variance of the minus quadrature in the interval between $\omega' = -\lambda$ and $\omega' = +\lambda$ is expressible as

$$(\Delta a_{\pm\lambda})^2 = \int_{-\lambda}^{+\lambda} S_-(\omega')d\omega', \quad (134)$$

in which $\omega - \omega_0 = \omega'$. On introducing (132) into Eq. (134) and on carrying out the integration over ω', employing the relation described by Eq. (84), we find

$$(\Delta a_-)^2_{\pm\lambda} = (\Delta a_-)^2 z(\lambda), \quad (135)$$

where $z(\lambda)$ is given by Eq. (86). We define the quadrature squeezing of the two-mode cavity light in the $\lambda_\pm$ frequency interval by

$$S_{\pm\lambda} = 1 - \frac{(\Delta a_-)^2_{\pm\lambda}}{(\Delta a_-)^2_{v\pm\lambda}}, \quad (136)$$

Furthermore, upon setting $\eta = 0$ in Eq. (135), we see that the local quadrature variance of a two-mode cavity vacuum state in the same frequency is found to be

$$(\Delta a_-)^2_{v\pm\lambda} = (\Delta a_-)^2_v z_v(\lambda), \tag{137}$$

in which

$$z_v(\lambda) = \left[\frac{2\kappa/\pi}{\kappa-\gamma_c}\right]\tan^{-1}\left(\frac{2\lambda}{\gamma_c}\right) - \left[\frac{2\gamma_c/\pi}{\kappa-\gamma_c}\right]\tan^{-1}\left(\frac{2\lambda}{\kappa}\right) \tag{138}$$

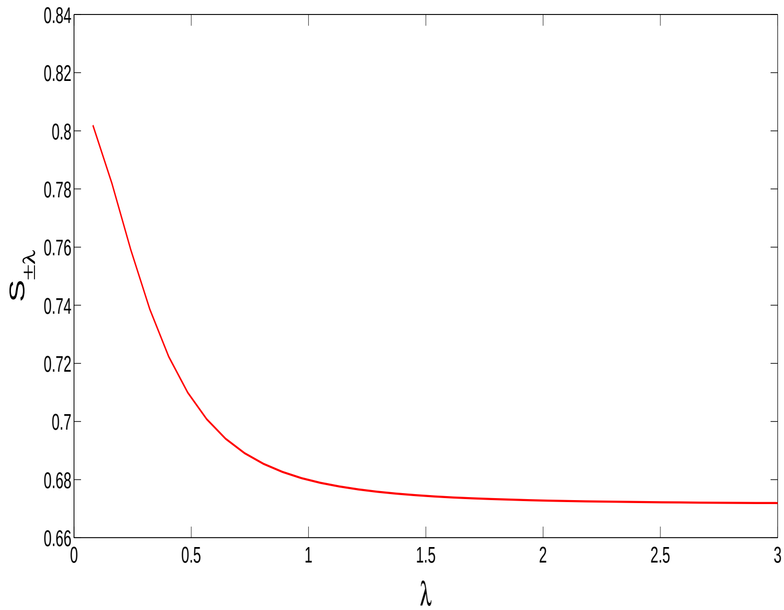

Figure 11: Plot of $S_{\pm\lambda}$ vs. λ for $\gamma_c = 0.4, \Omega = 0.1717$, and $k = 0.8$

and $(\Delta a_-)^2_v$ is given by (121). Finally, on account of Equations (119), (121), and (137) along with (136), we readily get

$$S_{\pm\lambda} = \frac{1}{z_v(\lambda)}\left\{z_v(\lambda) - z(\lambda) - \left[\frac{2\eta-\eta^2}{1+3\eta^2}\right]z(\lambda)\right\}. \tag{139}$$

This shows that the local quadrature squeezing of the two-mode cavity light beams is not equal to that of the global quadrature squeezing. Moreover, we found from the plots in Figure 6 that the maximum local quadrature squeezing is 80.2% (and occurs at $\lambda = 0.08$). Furthermore, we note that the local quadrature squeezing approaches the global quadrature squeezing as λ increases.

VIII. Conclusion

The steady-state analysis of the squeezing and statistical properties of the light produced by coherently pumped degenerate three-level laser with closed cavity and coupled to a single-mode vacuum reservoir is presented. We carry out our analysis by putting the noise operators associated with the vacuum reservoir in normal order and by taking into consideration the interaction of the three-level atoms with the vacuum reservoir inside the cavity. We observe that a large part of the total mean photon number (variance of the photon number) is confined in a relatively small frequency interval. In addition, we find that the maximum global quadrature squeezing of the light produced by the system under consideration operating at $\eta = 0.1717$ is 43.43%.

Moreover, we find that the maximum local quadrature squeezing is 80.2% (and occurs at $\lambda = 0.08$). Furthermore, our results have shown that unlike the local mean of the phonon number and photon number variance, the local quadrature squeezing does not increase as the value of λ increases. We observe that the light generated by this laser operating under the condition $\Omega \gg \gamma_c$ is in a chaotic light. And we have also established that the local quadrature squeezing is not equal to the global quadrature squeezing. Furthermore, we point out that unlike the mean photon number and the variance of the photon number, the quadrature squeezing does not depend on the number of atoms. This implies that the quadrature squeezing of a cavity light is independent of the number of photons.

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Ferromagnetic and Ferroelectric Transformers

By F. F. Mende

Abstract- Physics of the work of transformer with the ferromagnetic core is examined. The new types of transformers with the ferroelectric cores are proposed, and physics of the work of such transformers is also examined.

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I. Introduction

In the technology the transformers with the ferromagnetic cores widely are used [1-7]. The possibility of the energy transfer of one winding to another without the presence of galvanic contact between them is the special feature of the work of any transformer. Moreover the nearer are located the turns of primary and secondary windings, the greater the coupling coefficient between the windings. If the discussion deals with the transformer without the presence of the magnetic core, then ideal version is that case, when windings are wound by the bifilar method, when the windings, which present primary and secondary windings, it hurries about into two wires. The coils of the wire of windings are located maximally closely with this method, that also gives the possibility to obtain maximum coupling coefficient. The windings, raspolozhenye on the common ferromagnetic core, also have very high coupling coefficient; however, in the existing literature there is no description of physics of the work of transformers with this core.

Is well known the experimental fact, which indicates that the presence of ferromagnetic core in the coil essentially increases its inductance. But physics of this process is nowhere described.

A large drawback in the transformers with the ferromagnetic cores is the fact that they cannot work at the high frequencies. This is connected with the large inertness of the process of the reversal of polarity of ferromagnetic material.

In the article physics of the work of transformer with the ferromagnetic core is examined.

Is examined also the new type of transformers with the ferroelectric core. The merit of such transformers is the fact that they can work at the very high frequencies.

Author: *Kharkov, Ukraine. e-mail fedormende@gmail.com*

II. Physics of the Work of Transformer with the Ferromagnetic Core

If current flows along the coil or the separate wire, then the energy, accumulated in their inductance, is determined by the relationship

$$W_L = \frac{1}{2} L I^2$$

The inductance of wire, along which flows the current, they connect with the presence around this wire of magnetic pour on and since magnetic fields they possess the specific energy

$$W_{0H} = \frac{1}{2} \mu H^2 ,$$

their integration for the volume, occupied by fields, also gives the energy

$$W_H = \frac{1}{2} \mu \int_V H^2 dV .$$

It is obvious that

$$W_L = W_H .$$

But the magnetic fields, which surround conductor, depend on current; therefore inductance is the coefficient, which connects the energy, accumulated in this conductor, the current in it current. Until now we always connected this inductance with the magnetic fields, which surround the conductor in question. But there is another mechanism of loading of the conductor, when inductance depends not only on its configuration and those magnetic pour on, which this conductor surround (Figure 1)

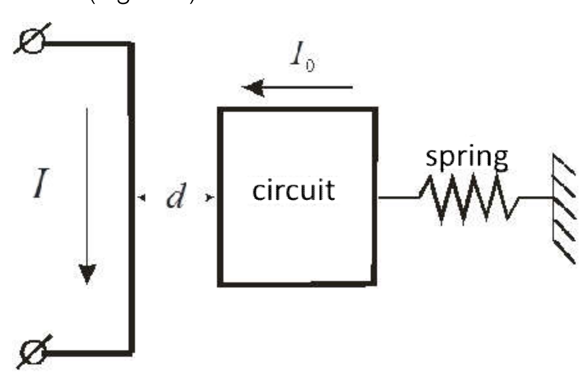

Figure. 1: Outline with the frozen current near the conductor, along which flows the current

Let us assume that we have the superconductive outline, in which is frozen the current I_0 located at a distance d from the conductor, along which flows the current I. Outline with the frozen current is fixed with the aid of the spring to the rigid base. If we carry the current through conductor, then outline with the frozen current will begin to it to be attracted, extending spring and thus, stocking in the spring energy. Moreover, the greater the current in the outline will be, the stronger it will be attracted to the wire, and the greater the energy will be accumulated in the spring. Therefore with one and the same values of current in the conductor, the energy, spent for the tension of spring, will be different and there will be it to zavisettakzhe, also, from the current in the short-circuited outline. The system examined is equivalent to inductance with the only difference that energy in this inductance will be equivalent accumulated not in the magnetic field, but in the spring. Moreover inductance in this case will depend also on the distance between the outline and the conductor, and from the current, which flows along the conductor also of the current, frozen in the outline. The characteristic property of the system examined is the fact that the approximation of outline with the frozen current to the wire, along which flows the current, will lead to the excitation it the currents, opposite to initial current. Thus, the resulting current will prove to be less than that current, which would take place in the absence of outline with the frozen current. This behavior of summed current testifies about loading of wire, along which flows the current.

It is possible to present another type of this system. For this it is necessary outline with the frozen current to place on the axis, which passes, through its center, and to the axis to fasten the helical spring, which ensures the steady state of outline in the situation, when its conductors are exist equidistantlyed from the conductors of outer ducts (Figure 2) Then with the flow of the current through conductor outline with the frozen current will be turned in that or other side, turning helical spring. In this case in the spring the energy will be accumulated, and the direction of the twisting of spring will depend on direction of flow in the conductor. Specifically, this specific form of inductance works with interaction of conductors with the current with the magnetic materials.

Until to the ferromagnetic material is superimposed strange external magnetic field, its atoms or the molecules, which represent the microscopic of outline by the szamorozhennym current, they be in the disordered state. This state appears for them it is equilibrium. But external field as soon as is superimposed on the ferromagnetic material, begins to occur their orientation, similar to that, which is depicted in Figure 1. To the realization of the process of deviation from the state of equilibrium the energy, which presents inductive energy of conductor with the current, is expended. Moreover, as it was already said, the distance between conductor itself and ferromagnetic material can be different, and it depends on the strength of microscopic frozen currents.

If the current, which flows through conductor, is variable, then the process examined is reactive. In this case the atoms or the molecules, which represent of outline with the current, accomplish rotational-vibrational motion and the energy, accumulated in the spring, alternately that

Let us examine the process, with which the magnetic core ensures high coupling coefficient between that removed by conductors, transferring thus energy of one conductor in another.

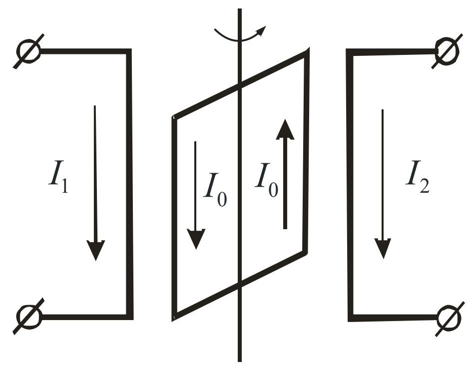

Figure 2: Transfer of the currents of induction of one conductor in another with the presence between them of ferromagnetic material

If in the core circuit current increases, then the conductor of this outline begins to attract to itself the conductor of turn with the frozen current. The rotation of turn leads to the fact that its opposite side begins to approach a conductor of second outline, inducing in it the current of induction. If second outline is extended, and energy in it is not expended, thus it does not influence processes in this system. But if second outline is loaded to the effective resistance, then the turning of outline with the frozen current requires the expenditure of active energy. This turning achieves the core circuit, from which this energy takes away. This leads to the fact that the core circuit for the power source is converted from the purely inductive load into the load, in which will be present the active component. This active component will be determined by voltage drop across the terminals of second outline and by resistance to them of that connected.

If there are two coils, located on the general magnetic core, then the primary coil, into which is introduced the current, the synchronous turning of all microscopic outlines with the frozen current is achieved. The addition of the currents of these outlines leads to the formation of macroscopic current inside the ferromagnetic material, which according to the diagram,

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depicted in Figure 2, it interacts with the conductors also of primary, and second outline. This property of ferromagnetic material ensures the energy transfer from the primary winding to the second. In the case, when energy in the secondary winding is not consumed ferromagnetic material only increases primary inductance.

III. Ferroelectric Transformers

In connection with the fact that the law of magnetoelectric and electromagnetic induction, recorded in the total derivatives [8], they are symmetrical

$$\oint \vec{E}' d\vec{l}' = -\int \frac{\partial \vec{B}}{\partial t} d S - \oint [\vec{B}\times\vec{V}] d\vec{l}'$$

$$\oint \vec{H}' d\vec{l}' = \int \frac{\partial \vec{D}}{\partial t} d S + \oint [\vec{D}\times\vec{V}] d\vec{l}' \quad ,$$

therefore must exist and the symmetrical technical solutions. Such solutions exist. For example, with the aid of the revolving magnetic field it is possible to create electric motors. For the same purposes it is possible to use the revolving electric field, and the engines, which use this principle, exist. There exists the transformers c ferromagnetic [serdechnikkom], in which with the aid of the magnetic flux they transfer energy of one winding into another. The symmetry of the laws indicated tells us, that must exist the transformer, whose core will be executed not of the ferromagnetic material, but of the ferroelectric. In the technology the transformers with the ferromagnetic cores widely are used. Their incapacity to work at the high frequencies is a large drawback in such transformers. Is connected this with the large inertness of the processes of the reversal of polarity of transformer core. And in this connection question arises, and is it possible to create the transformer, in which as the core is used not the ferromagnetic material, but ferroelectric. Since the processes of electrical polarization have very small inertia, this transformer could work at the very high frequencies.

Let us examine the schematics of ferroelectric transformers [9,10]

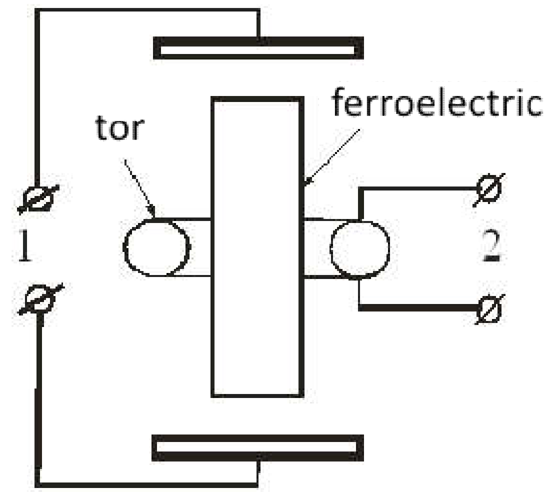

Figure 3: Schematic of ferroelectric transformer

Into the composition of transformer enters the parallel-plate capacitor, between plates of which is placed the cylinder from the ferroelectric with the large dielectric constant. On the cylinder is placed the winding of torus, whose ends are connected to terminals 2. During the supplying to the capacitor of alternating voltage in the cylinder there will be leak polarization currents and the time-varying circulation of magnetic field will arise around the cylinder. This circulation will excite in the torus-shaped winding currents and a variable potential difference will appear on terminals 2.

Transformer with the toroidal ferroelectric core is depicted in Figure 4.

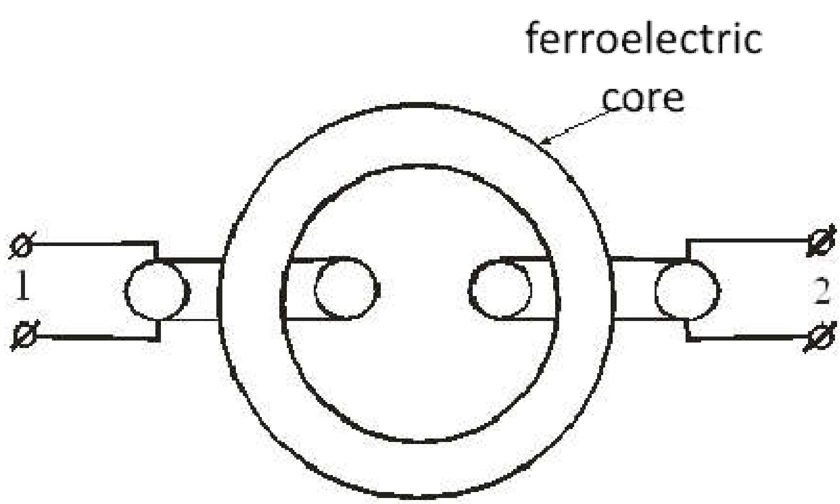

Figure 4: Transformer with the toroidal ferroelectric core

It consists of the torus-shaped core, made from the ferroelectric, on which are placed two torus-shaped windings. The transformation ratio of this transformer depends on the relationship of the number of turns in the windings. The merit of ferroelectric transformers is the fact that they can work at the very high frequencies.

IV. Conclusion

In the article is examined physics of the work of transformer with the ferromagnetic cores and trasformatorov with the ferroelectric cores. In spite of simplicity both ideas and constructions transformers and amplifiers with the ferroelectric cores before the appearance of works [9,10] are nowhere described. But indeed they open very large prospects. It is known that the magnetic amplifiers, which possess high reliability, cannot find wide application only because they work at the low frequencies. In this case there are no such limitations in practice, since the processes of electrical polarization have very small inertia, and, using the transformer examined, it is possible to create the reliable wideband amplifiers, which work at the very high frequencies.

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High Power/Energy Optics

By Prof. Victor V. Apollonov

Introduction- History of high power/energy optics is inextricably associated with the creation of a single-mode CO_2 laser (P = 1.2 kW), operating in the master oscillator-power amplifier regime and employing the principle of a quasi-optical transmission line, at the Laboratory of Oscillations of the P.N. Lebedev Physics Institute headed at that time by A.M. Prokhorov. Its creator was A.I. Barchukov, who worked with a team of young scientists on the problem of scaling of single-mode electric-discharge laser systems [1–5]. Due to the research conducted on such a laser system, we managed to study many physical phenomena occurring when high intensity radiation interacts with matter, including with the elements of the optical path of laser systems, which subsequently greatly facilitated creation of high-power lasers. Then, in the early 1970s, we paid attention to a phenomenon that was to limit undoubtedly the further growth of the power generated by lasers being developed [6]. More than twenty years of fundamental and applied research devoted to the study of this phenomenon and to the solution of problems associated with it allow a conclusion that its essence consists in the following. An optical surface of a highly reflecting power/energy optics element (POE) or any element of an optical path does not fully reflect radiation falling on it. A small portion of energy (fractions of a percent, depending on the wavelength) is absorbed by this reflecting element and turns into heat.

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HIGHPOWERENERGYOPTICS

Strictly as per the compliance and regulations of:

High Power/Energy Optics

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I. Introduction

History of high power/energy optics is inextricably associated with the creation of a single-mode CO_2 laser (P = 1.2 kW), operating in the master oscillator-power amplifier regime and employing the principle of a quasi-optical transmission line, at the Laboratory of Oscillations of the P.N. Lebedev Physics Institute headed at that time by A.M. Prokhorov. Its creator was A.I. Barchukov, who worked with a team of young scientists on the problem of scaling of single-mode electric-discharge laser systems [1–5]. Due to the research conducted on such a laser system, we managed to study many physical phenomena occurring when high intensity radiation interacts with matter, including with the elements of the optical path of laser systems, which subsequently greatly facilitated creation of high-power lasers. Then, in the early 1970s, we paid attention to a phenomenon that was to limit undoubtedly the further growth of the power generated by lasers being developed [6]. More than twenty years of fundamental and applied research devoted to the study of this phenomenon and to the solution of problems associated with it allow a conclusion that its essence consists in the following. An optical surface of a highly reflecting power/energy optics element (POE) or any element of an optical path does not fully reflect radiation falling on it. A small portion of energy (fractions of a percent, depending on the wavelength) is absorbed by this reflecting element and turns into heat. As the output power increases, even a small amount of it is sufficient to induce thermal stresses in a POE. Thermal stresses distort the geometry of the reflecting surface, affecting thereby, for example, the possibility of long-distance delivery of radiation and its concentration in a small volume. The discovered effect of thermal deformations of a POE required a theoretical study of the problem that had not been solved in such a setting ever before. Very useful was the experience in solving the problems of thermo elasticity, gained by the theoretical department headed at that time at by B.L. Indenbom at the Institute of Crystallography, USSR Academy of Sciences. Minimisation of the thermoelastic response of the optical surface of the POE exposed to intense laser radiation is one of the key problems of power optics. Improving the efficiency of laser systems, increasing the output power/energy and imposing stricter requirements to the directivity of generated radiation fluxes are inextricably linked with the need to design and create a POE with elastic distortions $\lambda_0/10-\lambda_0/20$ (λ_0 is the wavelength) at specific radiation loads up to several tens of kW cm^{-2} [7–10].

Interest in high power/energy optics and its physical, technical and technological solutions is unabated to this day. An almost simultaneous creation of first lasers in the USA and the USSR gave birth to annual symposia on Optical Materials for High-Power Lasers (Boulder, USA) and Nonresonant Laser–Matter Interaction (Leningrad, USSR). Regular meetings of scientists and engineers, as well as proceedings of the symposia have had a significant impact on the development of research in the field of power optics in many countries [11–13].

The data presented in this review allow one to reconsider important aspects of temperature fields, thermoelastic stresses and thermal deformations in POEs, resulting from the exposure of their surfaces to high power/energy laser radiation. In this case, use is made of the relations (which are similar to Duhamel's integral formula from the theory of heat conduction) between the quantities characterising the thermal stress state in any nonstationary regimes of energy input into a solid. A peculiar feature of the analysis of the thermal stress state in this case consists in the fact that these relations comprise time t not as an independent variable, which is used in the differentiation (as, for example, in review [14]) but as a parameter, which is a consequence of incoherence of the quasi-stationary problem of thermoelasticity presented below. Thus, by using the theory we developed in the early 1970s, we consider in this review a wide range of phenomena related to the thermal stress state of a solid-body surface exposed to radiation arbitrarily varying in time [15–21]. This consideration is particularly important for the optics of high power/energy, high-pulse repetition rate laser systems that are being actively developed. The review published [14] contains data (important for the development of high power/energy optics) on the use of capillary porous structures with a different degree of the surface development, which can be efficiently employed to increase the heat exchange at a temperature below the boiling point of the coolant. The evaporation–condensation mechanism of heat transfer in the POE on the basis of porous structures and the idea of lowering the boiling temperature under reduced pressure of the coolant in cellular materials, developed by us at the same time [14, 21], are not considered in this review.

Author: A.M. Prokhorov GPI RAS, Vavilov str.38, 119991, Moscow, Russia. e-mail: vapollo@kapella.gpi.ru

II. Static POEs based on Monolithic Materials

Consider the most important aspects of the problem of static POE fabrication, namely, the conditions needed to achieve high optical damage thresholds for a mirror surface. Note that in our first studies [4–9] we obtained only stationary expression for the limiting intensities, leading to the optical destruction of POEs, and the stability parameters of optical surfaces based on them.

a) *Thermal stress state of a solid body exposed to laser radiation*

i. *Temperature field*

We considered a strongly absorbing isotropic body, which at the initial moment of time has a fixed temperature. The body surface with the absorption coefficient *A* is exposed to an axisymmetric radiation flux of arbitrary temporal shape. It is assumed that the intensity distribution in the laser beam cross section obeys the Gaussian law: $I(r)=I_0\exp(-K_0r^2)$, where $K_0=2/r_0^2$. Energy absorption takes place directly on the irradiated surface. Physically, this means that the skin-layer depth δ is smaller than the depth of the temperature field penetration in the body under consideration during the characteristic times τ of changes in the radiation intensity, i.e., $\delta<<\sqrt{a^2\tau}$, where a^2 is the thermal diffusivity of the material.

The problem of determining the temperature field was considered in the linear formulation: it was assumed that all thermal and mechanical characteristics of the materials are independent of temperature and energy loss by radiation and convection was neglected. Provided that the characteristic size of the beam is $r_0 < L$, where L is the characteristic size of the irradiated body, and the energy input time is $t<L^2/a^2$, in solving this problem one can use the half-space model. The heating of the sample material is described in this case by the heat conduction equation [22]

$$\frac{\partial T}{\partial t}=a^2\Delta T \tag{1}$$

at the following initial and boundary conditions:

$$\left.\frac{\partial T}{\partial z}\right|_{z=0}=-\frac{I_0A_0}{\lambda}f(t)\exp(-K_0r^2),$$
$$T(r,z,0)=0, \tag{2}$$
$$\lim_{r,z\to\infty}T<M,$$

where M is the finite quantity; $f(t)$ is the time function of the laser beam intensity normalised to I_0; A_0 is the absorption coefficient of laser radiation on a metal surface; λ is the thermal conductivity of the body material; and T is the temperature.

Using the method of successive integral Hankel and Laplace transforms, we obtain the solution to (1):

$$T(r,z,t)=T^*\frac{I_0A}{2\lambda\sqrt{K_0}},$$

$$T^*=\frac{1}{2\pi i\sqrt{K_0}}\int_{\sigma-i\infty}^{\sigma+i\infty}dp\Psi(p)\exp(pt)\int_0^\infty\xi\frac{\exp(-\xi^2/4K_0)}{\gamma}\exp(-\gamma z)J_0(\xi r)d\xi, \tag{3}$$

where p and ξ are the parameters of Laplace and Hankel transforms; $\gamma^2=p/a^2+\xi^2$; $\Psi(p)$ is the Laplace transform of $f(t)$; and J_0 is the zero-order Bessel function.

This expression allows us to describe the thermal state of a solid body heated by laser radiation, whose intensity varies with time in an arbitrary manner.

ii. *Thermoelastic stresses*

The thermoelastic behaviour of the body is analysed by using the system of equations [22, 23]

$$\mu\nabla^2u+(\lambda'+\mu)\operatorname{grad}\operatorname{div}u-(3\lambda'+2\mu)\alpha_T\nabla T+F-\rho\ddot{u}=0,$$

$$\nabla^2T-\frac{1}{a^2}\frac{\partial T}{\partial t}+\frac{W_0}{\lambda}-\frac{(3\lambda'+2\mu)\alpha_TT}{\lambda}\operatorname{div}u=0, \tag{4}$$

where λ' and μ and are the Lame coefficients [24]; u is the deformation vector; ρ is the density of the material; F is the external force; α_T is the coefficient of thermal expansion; and W_0 is the density of volume heat sources.

In considering the deformation of an elastic metal halfspace whose surface is exposed to pulsed laser radiation, when the inequalities

$$|\rho\ddot{u}| << (3\lambda' + 2\mu)\alpha_T |\nabla T|,$$

$$\nabla^2 T \sim \frac{1}{a^2}\frac{\partial T}{\partial t} >> \frac{(3\lambda' + 2\mu)\alpha_T T}{\lambda}\operatorname{div} u \qquad (5)$$

are fulfilled, we can pass to the system of equations of the quasi-stationary thermoelasticity theory:

$$\mu\nabla^2 u + (\lambda' + \mu)\operatorname{grad}\operatorname{div} u - (3\lambda' + 2\mu)\alpha_T \nabla T = 0,$$

$$\nabla^2 T - \frac{1}{a^2}\frac{\partial T}{\partial t} = 0. \qquad (6)$$

In this case, from the first inequality we obtain the duration of a single pulse

$$\tau >> \max\left(\frac{\rho a^2}{\lambda'}; \frac{\rho a^2}{\mu}\right) \sim 10^{-6} - 10^{-8}\ \text{s}, \qquad (7a)$$

and from the second –

$$\tau^{3/2} << \frac{\rho^2 c^2 a}{\mu\alpha_T^2 I_0 A}. \qquad (7b)$$

We represented the stress tensor components in the general form [21]:

$$\hat{\sigma}_{zz} = 2GD\int_0^\infty \xi^2 J_0(\xi r)\varphi(\xi)\{e^{-\gamma z} - e^{-\xi z}[1 + z(\xi - \gamma)]\}d\xi,$$

$$\hat{\sigma}_{rr} = 2GD\int_0^\infty \varphi(\xi)\Big\{J_0(\xi r)[\xi(\xi z - 2)(\xi - \gamma)e^{-\xi z} + \xi^2 e^{-\xi z} - \gamma^2 e^{-\gamma z}] +$$

$$+ \frac{J_1(\xi r)}{r}[\xi e^{-\gamma z} - [(\xi - \gamma)(\xi z - 2(1 - \nu)) + \xi]e^{-\xi z}]\Big\}d\xi, \qquad (8)$$

$$\hat{\sigma}_{rz} = 2GD\int_0^\infty \xi\varphi(\xi)J_1(\xi r)[\gamma(e^{-\gamma z} - e^{-\xi z}) - \xi z(\xi - \gamma)e^{-\xi z}]d\xi,$$

$$\hat{\sigma}_{\varphi\varphi} = 2GD\int_0^\infty \varphi(\xi)\Big\{J_0(\xi r)[(\xi^2 - \gamma^2)e^{-\gamma z} - 2\nu\xi(\xi - \gamma)e^{-\xi z}] +$$

$$+ \frac{J_1(\xi r)}{r}\{[(\xi - \gamma)(\xi z - 2(1 - \nu))] + \xi\}e^{-\xi z} - \xi e^{-\gamma z}]\Big\}d\xi,$$

where G is the shear modulus; J_1 is the first-order Bessel function;

$$D = \frac{\alpha_T}{2}\frac{1+\nu}{1-\nu}\frac{I_0 A a^2}{K_0\lambda p}\Psi(p);\ \ \varphi(\xi) = \frac{\xi}{\gamma}\exp(-\xi^2/4K_0);$$

and ν is Poisson's ratio. Analysis of the expression reveals the nature of the time changes at any point in the half-space.

iii. *Thermal deformations*

The stress state occurring in a solid body is accompanied by its deformation, its largest amplitude being achieved on the irradiated surface. The expression for the normal displacement of the surface, corresponding to a given temperature distribution, has the form:

$$W(r, z, t) = W^* \frac{(1+\nu)\alpha_T I_0 A}{\lambda K_0}, \qquad (9)$$

$$W^* = \frac{F_0}{2\pi i}\int_0^\infty d\nu \int_{\sigma - i\infty}^{\sigma + i\infty} dp \frac{\Psi(p/t)}{p}\exp(p - \nu)J_0(\sqrt{\nu}\delta_r)\frac{\sqrt{\nu} - \sqrt{\nu + p/F_0}}{\sqrt{\nu + p/F_0}}, \qquad (10)$$

where $F_0 = 4K_0 a^2\tau$. The resulting expression allows us to trace the changes in the surface shape during irradiation.

Thus, this consideration has made it possible to describe fully the characteristics of temperature fields, thermoelastic stresses and thermal deformations occurring in solids whose surface is exposed to high-power laser radiation varying with time in an arbitrary manner. In addition, the following relations are fulfilled between the quantities characterising the thermal stress state in the continuous-wave and any other nonstationary regime of energy input into the solid [22, 24]:

$$T^{tr} = \int_0^t f(t-\tau)\frac{\partial T^{st}}{\partial \tau}d\tau,$$

$$\sigma_{ik}^{tr} = \int_0^t f(t-\tau)\frac{\partial \sigma_{ik}^{st}}{\partial \tau}d\tau, \quad (11)$$

$$W^{tr} = \int_0^t f(t-\tau)\frac{\partial W^{st}}{\partial \tau}d\tau.$$

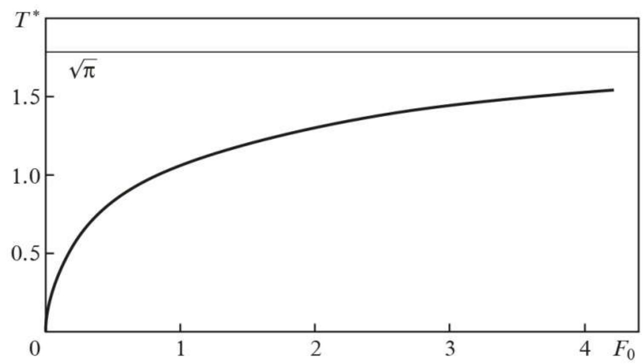

Figure 3.7.1: Time dependence of the sample surface temperature at the centre of the region (number F_0) exposed to cw radiation

These relations are similar to Duhamel's integral formula from the theory of heat conduction. It should be noted that the local deformation of the POE surface is the determining factor of the laser impact and the bending deformation component of the POE as a whole can be reduced to zero due to the large thickness of its effectively cooled base. Later, both components of the POE deformation were examined in the book of L.S. Tsesnek et al. [25].

b) Continuous-wave irradiation

i. *Temperature field*

If the time of laser irradiation satisfies the inequality $r_0^2/a^2 \le t \le L^2/a^2$, a steady-state temperature field can be established in the sample material. The main property of the process of its establishment is described by the expression [21]

$$T^* = \frac{2}{\sqrt{\pi}}\arctan\sqrt{F_0}. \quad (12)$$

It follows from (12) that for instants of times *t*, at which $F_0 \ge 4$, the current temperature is 10% less than the steady-state value. We therefore assume that, starting at time *t*, at which $F_0 > 4$, a stationary thermal state is established in the sample material (Fig. 3.7.1).

The expression for the temperature field in the half-space has the form [21]

$$T^* = \int_0^\infty J_0(\sqrt{\nu}\delta_r)\exp[-\sqrt{\nu}(\delta_z+\sqrt{\nu})]\frac{d\nu}{\sqrt{\nu}}, \quad (13)$$

where $\delta_z = 2\sqrt{K_0}z$ and $\delta_r = 2\sqrt{K_0}r$. From this expression we obtain the locality of the temperature field, the characteristic values of which decrease with increasing distance from the centre of the surface irradiation region and inside the material (Figs. 3.7.2–3.7.4).

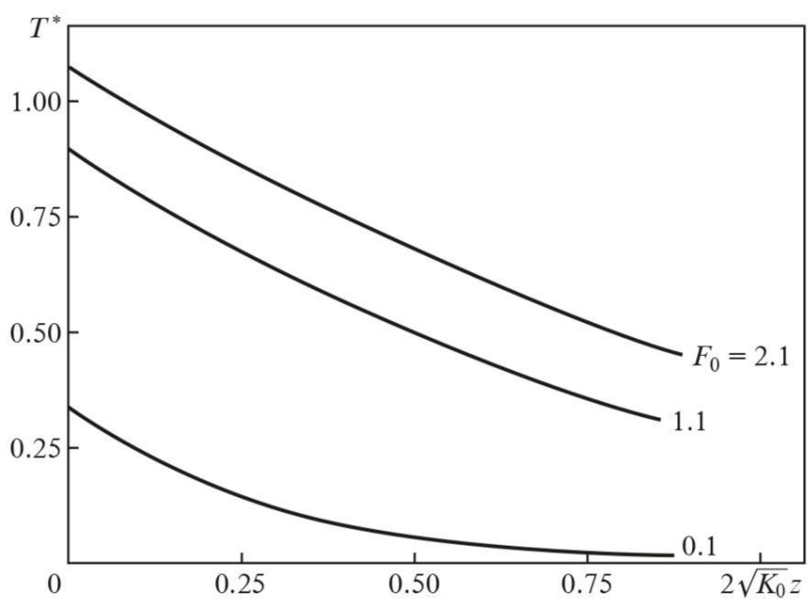

Figure 3.7.2: Temperature field distribution on the *z* axis

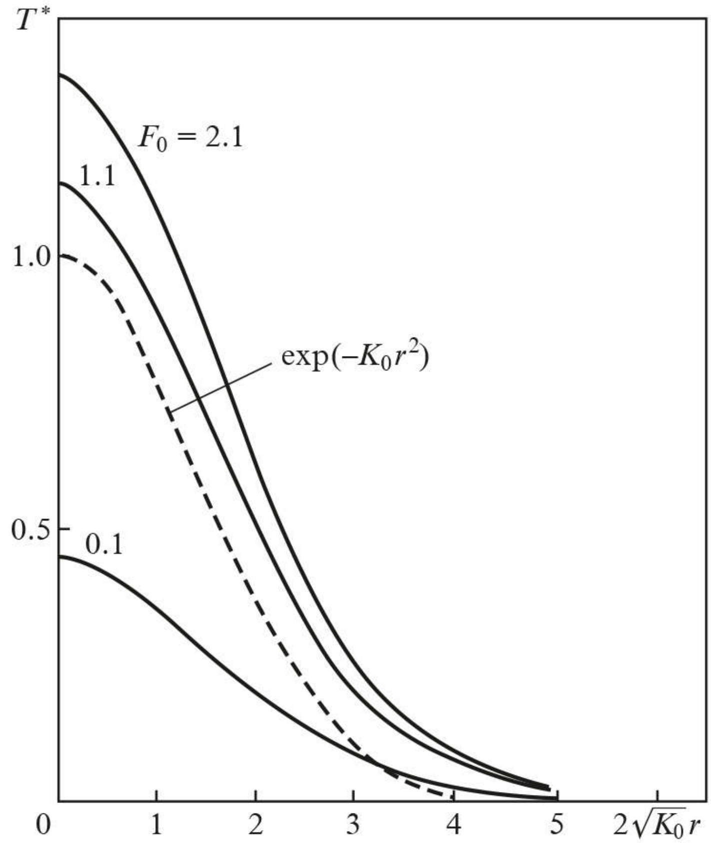

Figure 3.7.3: Temperature field distribution on the sample surface

ii. *Thermoelastic stresses*

In the steady-state regime $(p \to 0)$, nonzero are only the components of the tensor of thermal stresses σ^*_{rr} and $\sigma^*_{\varphi\varphi}$ [21]:

$$\sigma^*_{rr} = 2(1-\nu)\int_0^\infty \exp[-\sqrt{\nu}(\sqrt{\nu}+\delta_z)][J_1(\sqrt{\nu}\delta_r) - J_0(\sqrt{\nu}\delta_r)]\frac{d\nu}{\sqrt{\nu}}, \tag{14}$$

$$\sigma^*_{\varphi\varphi} = 2(1-\nu)\int_0^\infty \exp[-\sqrt{\nu}(\sqrt{\nu}+\delta_z)][-J_1(\sqrt{\nu}\delta_r)/(\nu\delta_r)]d\nu,$$

where

$$\sigma^*_{ik} = \frac{\lambda\sqrt{K_0}(1-\nu)}{I_0 A G \alpha_T (1+\nu)}\sigma_{ik}(r).$$

The maximum values of these components are achieved in the centre of the irradiated region (Fig. 3.7.5) on the surface of the half-space, where the stationary field of thermoelastic stresses have the form (Figs. 3.7.6 and 3.7.7)

$$\sigma^*_{rr} = \frac{\sqrt{\pi}(1-\nu)}{2}\,{}_1F_1\left(\frac{1}{2};2;-\delta_r^2/4\right),$$

$$\sigma^*_{\varphi\varphi} = \frac{\sqrt{\pi}(1-\nu)}{2}\left[{}_1F_1\left(\frac{1}{2};2;-\delta_r^2/4\right) - {}_1F_1\left(\frac{1}{2};1;-\delta_r^2/4\right)\right]. \tag{15}$$

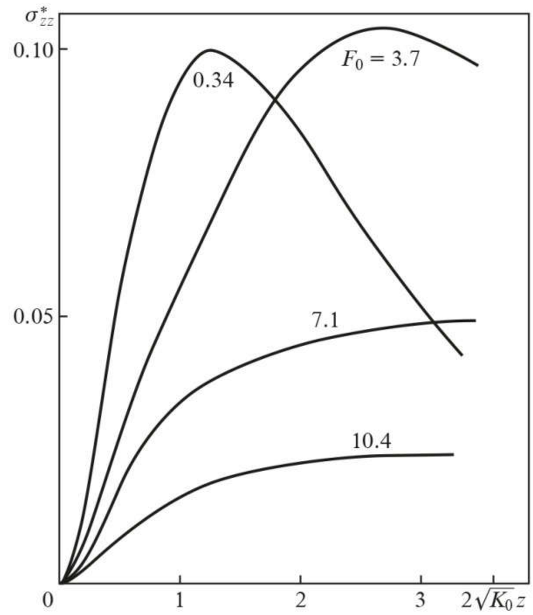

Figure 3.7.4: Dependence of the axial stress σ_{zz} on the exposure time of laser irradiation

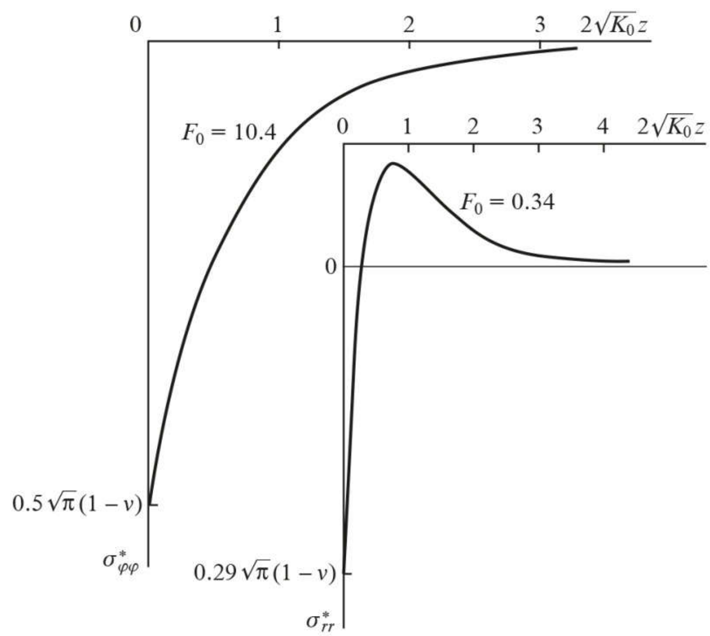

Figure 3.7.5: Distribution of the peripheral $(\sigma_{\varphi\varphi})$ and radial (σ_{rr}) tensor components on the z axis for different exposure times of laser irradiation

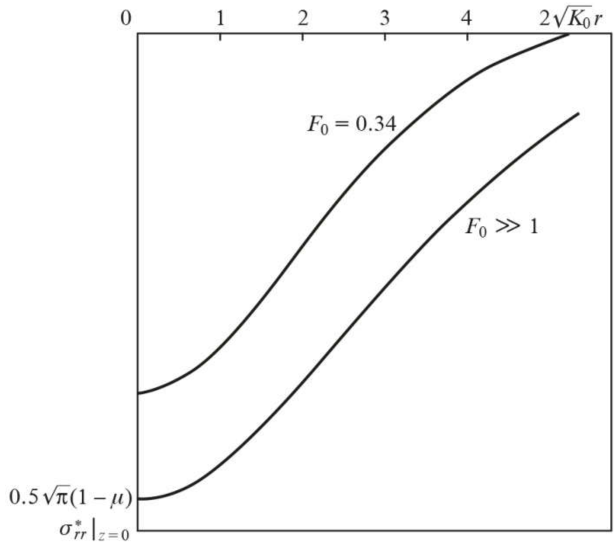

Figure 3.7.6: Stress field σ_{rr} on the surface of the half-space

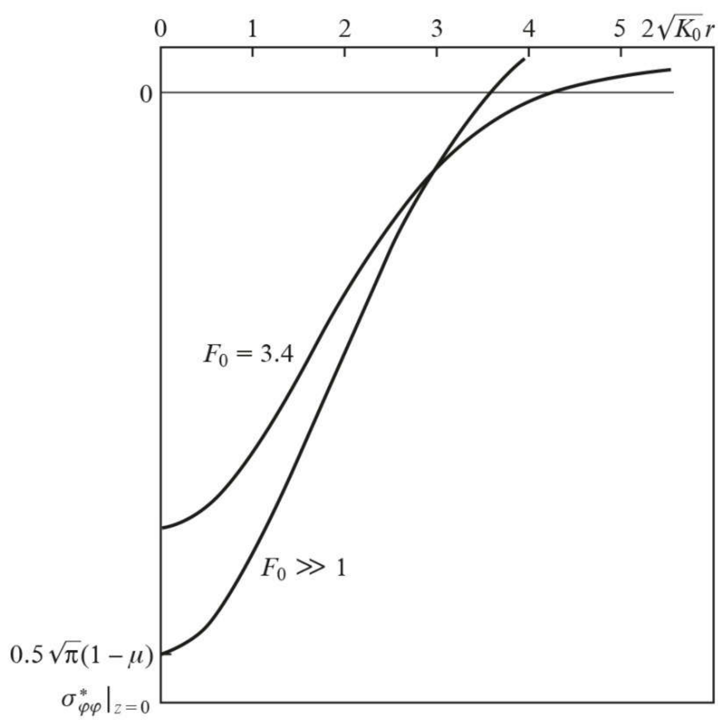

Figure 3.7.7: Stress field $\sigma_{\varphi\varphi}$ on the surface of the half-space

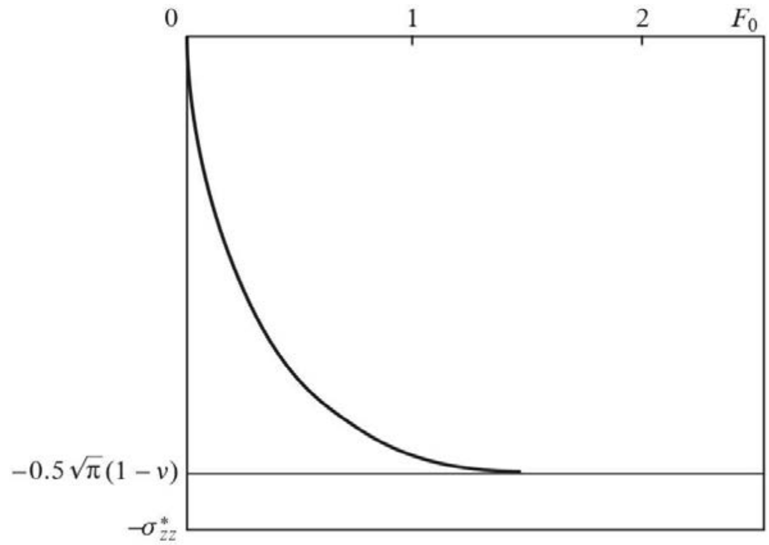

Figure 3.7.8: Establishment of a stationary stress sate on the surface, in the centre of the irradiated region

The main property in establishing a steady state for σ_{rr} and $\sigma_{\varphi\varphi}$ are characterised by the dependence shown in Fig. 3.7.8:

$$\sigma^*_{ii}(\delta_r=\delta_z=0)=\frac{1+\nu}{\sqrt{\pi}}\left[F_0\left(\arctan\frac{1}{\sqrt{F_0}}-\frac{1}{\sqrt{F_0}}\right)-\frac{1-\nu}{1+\nu}\arctan\sqrt{F0}\right]. \tag{16}$$

This expression completely describes the characteristics of the stressed state arising in a solid when its surface is irradiated by cw laser radiation.

iii. *Thermal deformation of the surface*

The expression for the displacement W^* of the reflective surface in the half-space model has the form [21]:

$$W^*=-\frac{1}{2}\left\{F_0\exp(-\delta_r^2/4)-\left[\frac{4\sqrt{F_0}}{1+F_0}-2\ln(\sqrt{F_0}+\sqrt{F_0+1}\right]{}_1F_1\left(\frac{3}{2};1;-\frac{\delta_r^2}{4}\right)\right\}. \tag{17}$$

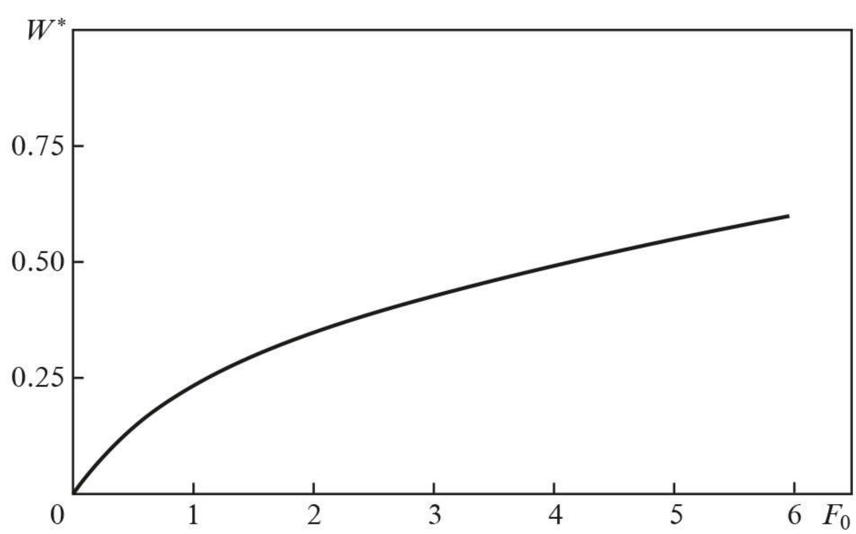

Figure 3.7.9: Establishment of a quasi-stationary deformation state on the surface, in the centre of the irradiated region

Deformation surface profiles for different exposure times are shown in Fig. 3.7.9.

c) *Pulsed irradiation*

i. *Temperature field*

In the case of short irradiation times, the depth of the temperature field penetration into the material is proportional to $\sqrt{a^2 t} << r_0$; therefore, the radial heat spreading can be ignored, and the temperature distribution over the surface repeats the laser beam intensity distribution profile [26]:

$$T^* = \frac{2}{\sqrt{\pi}}[\Theta(t^*)\arctan(\sqrt{F_0 t^*}) - \Theta(t^*-1)\arctan(\sqrt{F_0(t^*-1)}]\exp(-K_0 r^2), \quad (18)$$

where $\Theta(t^*)$ is the Heaviside function; $t^* = t/\tau$; and τ is the pulse duration.

ii. *Thermoelastic stresses*

Thermoelastic stresses arising in a solid irradiated by laser light play an important role in the destruction of the optical surface of the POE. Under pulsed irradiation $(F_0 << 1)$ the expressions for the stress tensor components are given by (15), because in this case the propagation of heat in a solid is of quasi-one-dimensional character and the radial heat spreading can be neglected. The depth of penetration of thermal stresses in the material is $\sqrt{a^2\tau} << r_0$, which follows from the form of σ_{ik} on the *z* axis:

$$\sigma_{rr}^*(\delta_r = 0) = -\frac{2}{\sqrt{\pi}}\sqrt{F_0}\left[\exp(-\delta_z^2/4F_0) - \frac{\sqrt{\pi}\delta_z}{2F_0} erfc\left(\frac{\delta_z}{2\sqrt{F_0}}\right)\right] \approx$$

$$\approx \frac{8F_0^{3/2}}{\sqrt{\pi}\delta_z^2}\exp\left(-\frac{\delta_z^2}{4F_0}\right), \quad (19)$$

where

$$\frac{\delta_z}{2\sqrt{F_0}} >> 1.$$

The maximum values of the components σ_{rr}^* and $\sigma_{\varphi\varphi}^*$ are achieved on the surface,

$$\sigma_{rr}^* = \sigma_{\varphi\varphi}^2 = -2\sqrt{F_0/\pi}\exp(-\delta_r^2/4), \quad (20)$$

i.e., the distribution of the components σ_{rr}^* and $\sigma_{\varphi\varphi}^*$ on the surface repeat the laser beam intensity distribution.

The components σ_{rr}^* and $\sigma_{\varphi\varphi}^*$ on the surface *z* = 0 are equal, and the expression for $\sigma_{ii}^*(\delta_r, \delta_z = 0)$ has the form:

$$\sigma_{ii}^* = -\frac{2}{\sqrt{\pi}}[\Theta(t^*)\sqrt{F_0 t^*} - \Theta(t^*-1)\sqrt{F_0(t^*-1)}]. \quad (21)$$

In the case of small irradiation times

$$\sigma_{zz}^* = 2\delta_z F_0 t^* \int_0^\infty V^3 \exp(-V^2 - V\delta_z)dV,$$

$$\sigma_{rz}^* = -\frac{\delta_r}{2}\exp\left(-\frac{\delta_r^2}{4}\right)\left[F_0 t^* erf\left(\frac{\delta_z}{2\sqrt{F_0 t^*}}\right) + \frac{\sqrt{F_0 t^*}}{\pi}\delta_z \exp\left(-\frac{\delta_z^2}{4F_0 t^*}\right)\right], \quad (22)$$

where *V* is a transform variable. The difference in signs of the components means that in the case of thermal deformation of the sample by laser radiation, for σ_{zz} tension of a material is realised, whereas for σ_{rz} – compression. The maximum value of σ_{zz} is achieved on the *z* axis; in this case, $\delta_z^{max} \approx \sqrt[4]{12}$, i.e., $z_0^{max} \approx 0.66 r_0$, and $\sigma_{zz}^{*max} \approx 1.9 F_0$. The component σ_{rz}^* reaches its maximum value at point $r_0^{max} = r_0/2$ and $z_0^{max} \approx 2\sqrt{a^2 t}$:

$$\sigma_{rz}^{*max} \approx -0.5F_0. \quad (23)$$

A distinctive feature of the behaviour of the σ_{zz}^* component is that if the inequality $F_0 << 1$ is fulfilled, the position of its maximum on the *z* axis is determined by the spatial characteristics of the laser beam rather than the irradiation time. The maximum of this component is achieved by the end of the laser pulse. This feature is explained by the fact that at $F_0 t^* << 1$ the region of thermoelastic perturbations lies on the sample surface and localises in the irradiation region, because heat due to heat conduction has no time to spread over the sample material. In the opposite case, i.e., at $F_0 t^* > 1$, the point of this component maximum is determined from the condition $\delta z^2/(4F_0 t^*) = 1$.

iii. *Thermal deformations*

The expression for the thermal deformation of the reflecting surface irradiated by a rectangular laser pulse, whose duration satisfies the condition $F_0 << 1$, has the form [21]:

$$W^* = -\frac{F_0}{2}\exp(-K_0 r^2)[\Theta(t^*)t^* - \Theta(t^* - 1)(t^* - 1)]. \quad (24)$$

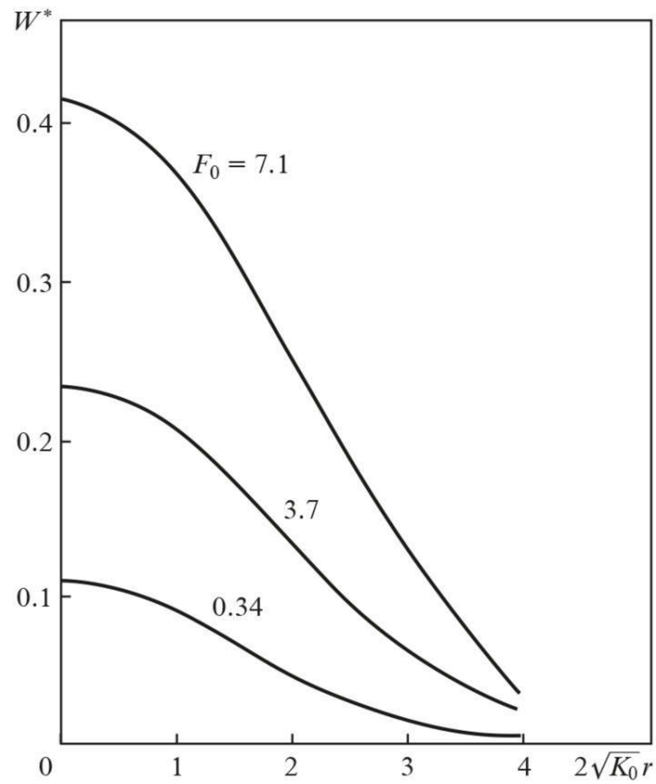

Figure 3.7.10: Deformation surface profiles for different exposure times

The distribution of thermal deformations of the reflecting surface repeats the laser beam intensity distribution (Fig. 3.7.10), which we used in our method of the dynamic control of the intensity distribution of laser radiation [27].

d) *Repetitively pulsed irradiation*

Thermal deformations of a solid body exposed to repetitively pulsed laser radiation were analysed by using the previously derived relations that are similar to Duhamel's integral formulas. The energy flow was treated as a train of rectangular pulses having a duration r, period T_0 (repetition rate $v_0 = 1/T_0$) and off-duty ratio SQV $= \tau/T_0$. It was assumed that $F_0 = 4K_0 a^2 T_0 < 1$. The arising thermal stresses and deformations of the temperature field are expressed in terms of the integrals (typical of the cw regime) that are similar to Duhamel's integrals [28]:

$$F^{PP} = \int_0^t f(t-\tau)\frac{\partial F^{\text{cw}}}{\partial \tau}d\tau. \quad (25)$$

At the initial instants of time, i.e., when $F_0 t^* < 1$, repetitively pulsed irradiation is similar to pulsed irradiation. The geometric meaning of (25) is characterised by the area of the integrals in Fig. 3.7.11. (For the temperature and the components $\sigma_{\varphi\varphi}$ and σ_{rr}, the value of $\partial F^{\text{cw}}/\partial\tau$ tends to infinity as $1/\sqrt{t}$ at $t \to 0$ and to zero at $t \to \infty$; for deformation $\partial F^{\text{cw}}/\partial\tau$ tends to const at $t \to 0$ and to zero at $t \to \infty$.) In the case of long irradiation times, i.e., when $F_0 t^* > 1$, the temperature and thermal stresses reach their quasi-steady states, i.e., a constant component of these values becomes similar to that in the cw regime of energy input with a reduced intensity I_0SQV. In this case, against the background of this component, along with changes in the laser beam intensity, there will be the characteristic peaks of temperature and stress, which are similar to peaks during pulsed irradiation. A separate 'pulse' of thermal deformations of the reflecting surface exists against the background of a 'stationary component' tending to infinity.

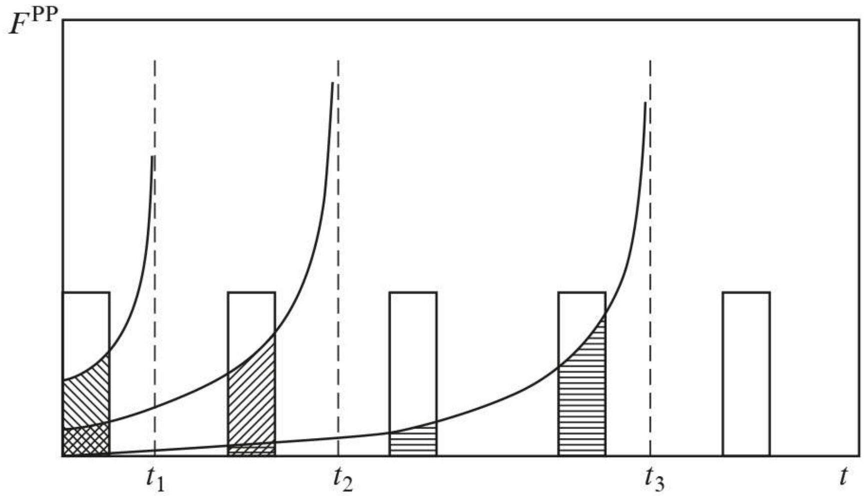

Figure 3.7.11: Geometrical interpretation of Duhamel's integrals

i. *Temperature field*

The expression for the temperature has the form [21]

$$T^* = \frac{1}{2\pi i}\int_{\sigma_i+i\infty}^{\sigma_i-i\infty} dp\Psi(p)e^p \int_0^\infty \frac{e^{-V}J_0(\sqrt{V}\delta_r)\exp[-\sqrt{V}(\sqrt{V}+\delta_z)]}{\sqrt{8/F_0+V}}dV, \quad (26)$$

since for a train of pulses

$$\Psi(p) = \frac{[1-\exp(-p\tau)]\{1-\exp[-p(N+1)T]\}}{p[1-\exp(-pT)]} \quad (27)$$

is the Laplace transform of *f*(*t*); and *N* is the number of propagated laser pulses.

In the centre of the irradiation region the temperature reaches a maximum value by the time the next pulse terminates ($F_0 > 1$):

$$T^*_{\max} = \sqrt{\pi}\mathrm{SQV} + \frac{2}{\sqrt{\pi}}\arctan\sqrt{F_0\mathrm{SQV}}, \quad (28)$$

where SQV is the off-duty ratio of the temporal structure of radiation.

ii. *Thermoelastic stresses*

Maximum values of the radial and circumferential tangential stress are achieved in the centre of the irradiation region, where they are equal to each other:

$$\sigma_{ii}^{PP} = \int_0^t f(t-\tau)\frac{\partial\sigma_{ii}^{\mathrm{cw}}}{\partial\tau}d\tau \quad (29)$$

[$\sigma_{ii}^{\mathrm{cw}}$ is determined from (16)]. The field distribution of stresses σ_{ii}^* on the surface by the time when the next laser pulse terminates has the form:

$$\sigma_{ii}^* = \mathrm{SQV}\sigma_{ii}^{*(1)} + \sum_{n=0}^{N}\Theta(n+1-t^*)[\Theta(t^*-n)\times$$

$$\times\sigma_{ii}^{*(2)}(t^*-n) - \Theta(t^*-n-\mathrm{SQV})\sigma_{ii}^{*(2)}(t^*-n-\mathrm{SQV})], \quad (30)$$

where $\sigma_{\varphi\varphi}^{*(1)}$ and $\sigma_{rr}^{*(1)}$ are determined from (16), and $\sigma_{\varphi\varphi}^{*(2)} = \sigma_{rr}^{*(2)}$ – from (21). Because in the steady stress state σ_{zz} and σ_{rz} are identically zero, their values in the case of repetitively pulsed irradiation are the same as in the case of pulsed irradiation (accuracy ~SQV).

iv. *Deformation of the surface*

The displacement of a solid-body surface exposed to repetitively pulsed radiation also has sta-tionary' and pulse components [21]:

$$W^* = \mathrm{SQV}W^{*(1)} + W^{*(2)}.$$

When the quasi-stationary state is reached

$$W^* = -\mathrm{SQV}\ln 2\sqrt{F_0}F1\left(\frac{3}{2};1;-\frac{\delta_r^2}{\pi}\right)-$$

$$-\frac{F_0}{2}\sum_{n=0}^{N}\Theta(n+1-t^*)[\Theta(t^*-n)(t^*-n)- \quad (31)$$

$$-\Theta(t^*-n-\mathrm{SQV})(t^*-n-\mathrm{SQV})]\exp(-K_0 r^2).$$

e) *Criteria for the optical surface stability*

Expressions given for the characteristics of the thermal stress state of a solid whose surface is irradiated by high-power cw, pulsed and repetitively pulsed laser radiation allowed us to determine the limiting intensities corresponding to different stages of the optical damage of mirror surfaces [21, 29]. To this end, the parameters of the optical surface stability include not only the thermophysical and mechanical properties of the material but also the parameters of a Gaussian-like beam, namely the intensity in the centre of the irradiation region, the size of the irradiation region and the duration of a single pulse and, in the case of repetitively pulsed irradiation, – the pulse train off-duty ratio. The stability parameters of the reflector contain the ratio of a maximum value of the thermal stress state characteristic to its value at which the solid material experiences irreversible macroscopic changes – melting, plastic (brittle) or fatigue deformation or achievement of a critical value $\lambda_0/20$ by the amplitude of thermal deformation of the optical surface, where λ_0 is the wavelength of the laser used. The thus introduced stability parameters of mirrored POE surfaces made it possible not only to compare different pure metals and their alloys in terms of applicability in power optics but also to create specific types of combined POEs capable of withstanding high-power fluxes of cw, pulsed and repetitively pulsed laser radiation.

i. *Continuous-wave regime*

A solid body whose surface is exposed to cw laser radiation is destroyed when the temperature field in the centre of the irradiation region reaches the melting point of the material and the components of the stress field reach the yield point. The stability of the optical surface under cw irradiation is haracterized by the parameters

$$\gamma_{T_{\mathrm{melt}}}^{\mathrm{cw}} = \frac{\sqrt{\pi}I_0 A}{2\lambda\sqrt{K_0}T_{\mathrm{melt}}}, \quad \gamma_{\sigma_T}^{\mathrm{cw}} = \frac{\sqrt{3\pi}(1+\nu)I_0 AG\alpha_T}{2\lambda\sqrt{K_0}\sigma_T} \quad (32)$$

If $\gamma_{T_{\mathrm{melt}}}$ and $\gamma_{\sigma_T} < 1$, the material will undergo no irreversible changes. The values of these parameters in the case of cw laser radiation at a power density I_0A = 1 kW cm^{-2} and K_0 = 8 x 10^2 m^{-2} are shown in Table 3.7.1 for Cu, A1 and Mo. The main reason for the damage of the optical surface can be determined from the relation

$$\gamma_{\mathrm{rel}}^{\mathrm{cw}} = \frac{\gamma_{\sigma_T}^{\mathrm{cw}}}{\gamma_{T_{\mathrm{melt}}}^{\mathrm{cw}}} = \frac{\sqrt{3}(1+\nu)G\alpha_T T_{\mathrm{melt}}}{\sigma_T}. \quad (33)$$

If $\sigma_{\mathrm{rel}}^{\mathrm{cw}} > 1$, the material will be destroyed when the component σ_{ii} reaches the yield point, or when the melting point of the material, $T(0,0,\infty)$ is reached.

For the materials in question (Table 3.7.1), the main reason for the deterioration of the optical surface at lower laser intensities is irreversible plastic deformations of the POE in the centre of the irradiation region. There is another important reason for the deterioration of the optical surface – excess of the critical value $\lambda_0/20$ by the value of thermal deformation of the optical surface – which is implemented at long exposure times of high power laser radiation and in the range of the parameters corresponding to the elastic deformation of the material. In this case, phase and energy characteristics of the reflected laser beam are markedly impaired. The criterion for the optical surface stability to such changes in the optical characteristics of the reflector is given by parameter

$$\gamma_{\lambda_0/20}^{\mathrm{cw}} = \frac{20(1+\nu)\alpha_T I_0 A}{\lambda K_0 \lambda_0}\ln 2\sqrt{F_0}. \quad (34)$$

The value $\gamma_{\lambda_0/20}^{\mathrm{cw}} < 1$ can be reached if use is made of some types of reflector designs with efficient cooling [30].

Table 3.7.1: Parameters of stability and threshold intensities for Al, Mo and Cu at I_0A = 1 kW cm^{-2}, r_0 = 5 cm, and t = 5 x 10^{-5} s

Parameter	Material Cu	 Mo	 Al
	CW regime		
$\gamma_{T_{\rm melt}} = \dfrac{\sqrt{\pi} I_0 A}{2\lambda\sqrt{K_0}} \dfrac{1}{T_{\rm melt}}$	0.74	0.8	2.3
$I_{\rm th} = \dfrac{1}{\gamma_{T_{\rm melt}}} / \mathrm{kW\,cm^{-2}}$	1.4	1.3	0.44
$\gamma_{\sigma_T} = \dfrac{\sqrt{3\pi} I_0 A G \alpha_T (1+\nu)}{2\lambda\sqrt{K_0}\sigma_T}$	19.3	10^4	38.3
$I_{\rm th} = \dfrac{1}{\gamma_{\sigma_T}} / \mathrm{kW\,cm^{-2}}$	0.05	10^{-4}	2.6 x 10^{-2}
	Pulsed regime		
$\gamma_{T_{\rm melt}} = \dfrac{\sqrt{\pi} I_0 A}{2\lambda\sqrt{K_0}} \dfrac{1}{T_{\rm melt}}$	2.0 x 10^{-3}	1.45 x 10^{-3}	5.4 x 10^{-3}
$I_{\rm th} = \dfrac{1}{\gamma_{T_{\rm melt}}} / \mathrm{kW\,cm^{-2}}$	500	700	190
$\gamma_{\sigma_T} = \dfrac{\sqrt{3\pi} I_0 A G \alpha_T (1+\nu)}{2\lambda\sqrt{K_0}\sigma_T}$	0.16	55	0.28
$I_{\rm th} = \dfrac{1}{\gamma_{\sigma_T}} / \mathrm{kW\,cm^{-2}}$	6.3	1.8 x 10^{-2}	3.6

ii. *Pulsed regime*

The parameters of the optical surface stability under pulsed irradiation by a Gaussian-like laser beam having a duration τ and intensity I_0 in the centre of the irradiation region, determined by the ability to reach critical values $T_{\rm melt}$, σ_T and $\lambda_0/20$ by temperature $T(0,0,\tau)$, thermoelastic stresses $\sigma_{ii}(0,0,\tau)$ and thermal deformations $W(0,0,\tau)$, have the form [29]:

$$\gamma^P_{T_{melt}} = \frac{2I_0A}{\sqrt{\pi}\lambda T_{\rm melt}}\sqrt{a^2\tau},$$

$$\gamma^P_{\sigma_T} = 4\sqrt{\frac{3}{\pi}}\frac{I_0AG\alpha_T(1+\nu)}{\lambda G_T(1-\nu)}\sqrt{a^2\tau}, \qquad (35)$$

$$\gamma^P_{\lambda_0/20} = \frac{40(1+\nu)I_0A\alpha_T a^2\tau}{\lambda\lambda_0}.$$

The values of these parameters, found for copper, aluminium and molybdenum at I_0A = 1 kW cm^{-2}, K_0 = 2.82x 10^2 m^{-2} and $\tau = 50$ μs, and the heat flow values I_0A, at which $\gamma_i^p = 1$, are presented in Table 1. In the cw regime, the optical surface properties are mainly degraded due to irreversible plastic deformations in the centre of the irradiation region. Under pulsed irradiation the behaviour of the thermal stress state is more complicated than under cw irradiation. Thus, in contrast to the stationary thermal stress state, the nonstationary state in the material of a solid is characterised by the presence of the nonzero components σ_{zz} and σ_{rz}. In this case, the highest value is reached by the component σ_{zz} on the *z* axis at a distance of ~0.66r_0 from the optical surface. If at some level of these I_0A values the component σ_{zz} is greater than the strength modulus σ_b, it is possible to implement the conditions of brittle fracture, at which the surface layer of the POE material will be detached. For this type of destruction the parameter of the optical surface stability has the form:

$$\gamma^p_{\sigma_b} = \frac{4I_0AE\alpha_T a^2\tau\sqrt{K_0}}{(1-\nu)\lambda\sigma_b},$$

and the stability parameter defined with respect to plastic deformation, has the form:

$$\gamma^p_{\sigma_T} = \frac{\sqrt{3}I_0AE\alpha_T F_0}{\lambda\sqrt{K_0}(1-\nu)\sigma_T}\left[1+2\frac{\sqrt{F_0}}{3\pi}\exp\left(-\frac{\sqrt{3}}{2F_0}\right)\right], \qquad (36)$$

The values of the parameters and their corresponding intensities for Al, Mo and Cu are listed in Table 3.7.1.

iii. *Repetitively pulsed regime*

The state of a solid body, whose surface is irradiated by repetitively pulsed laser pulses, combines the characteristic features of thermal stress states under pulsed and cw irradiation. In this case, for the temperature fields, the fields of the components σ_{rr} and $\sigma_{\varphi\varphi}$, the stress tensor and the thermal deformation fields the realisable temperature and thermal stress states are a combination of stationary and nonstationary states. In this regard, the stability parameters of the reflecting surfaces, defined by the ability of the temperature to reach the melting point of the material, of the components σ_{rr} and $\sigma_{\varphi\varphi}$ to reach the yield point and of thermal deformation to reach the threshold $\lambda_0/20$, are as follows [21]:

$$\gamma_i^{PP} = \mathrm{SQV}\gamma_i^{cw} + \gamma_i^{p}. \tag{37}$$

Under repetitively pulsed irradiation, a nonstationary, cyclically repeated stress state arises on a solid surface in the material. As a result, the material of the solid body may experience irreversible fatigue damage. The conditions under which the POE surface undergoes macroscopic fatigue fracture can be assessed by Wohler curves, determining the dependence of modulus of the amplitude of fatigue stresses on the number of cycles of the loading pulses N_p [21, 31].

f) *Irreversible changes in the optical surface*

Dynamics of the fatigue and brittle fracture is characterised by the emergence and extension of microcracks. Therefore, inadmissibility of destruction of the optical POE surface is dictated by the need to preserve the diffusely scattered component of laser radiation at negligible levels. Moreover, the origin and development of microcracks is accompanied by microstructural and phase transformations of the material, leading to a change in the structural and phase composition of the reflecting surface and, as a consequence – to an increase in its absorption coefficient *A,* whereas the adsorption of various substances on the resulting system of microcracks initiating an optical breakdown leads to a decrease in radiation resistance of the reflecting surface. Furthermore, the optical breakdown of air near the target can occur without the segregation of impurities directly in the vicinity of emergence of microcracks, because they become the nucleus of the electric fields, etc. We considered sequentially the basic mechanisms of microstructural and phase transformations preceding the stage of plastic, fatigue and brittle fracture or accompanying these stages, as well as analysed the possible reasons for the change in the optical surface quality. The expressions obtained are important not only for the problems of power optics. They are effectively used today for the analysis of the conditions of fracture of solids of different nature due to excess of limiting stresses for the various components of the stress tensor.

III. Static OPEs based on Materials with a Porous Structure

The feasibility of using porous structures for cooling thermally stressed POEs was justified theoretically and experimentally in our papers [32–39]. An increase in the optical damage threshold of laser reflectors based on porous structures was provided by a ‘minimum’ thickness of the separating layer (tens of microns), by the heat transfer intensification, by high permeability of the heat exchanger for the selected coolants pumped through the porous structure and by the use of the heat exchanger with a significantly developed surface. The test results of water-cooled POEs that are based on the porous structures indicated the possibility of removal of high heat flows at low values of the mirror surface deformations. The maximum density of the heat flow being removed, which does not lead to destruction of the mirror surface, was equal to 8.2 kW cm^{-2}. At q = 2 kW cm^{-2} the value of thermal deformation was $\sim\lambda_0/20$, where $\lambda = 10.6$ μm [32, 33].

A further increase in the optical damage threshold of cooled mirror surfaces can be realized by the optimization of the porous structure parameters [34, 38, 39], the appropriate choice of the coolant [21], the development of the technology of fabrication of a thin separating layer based on intermetallic compounds [32] and the rational design of the POE on the whole [35–37]. The development of a cooled POE requires a detailed study of heat and mass transfer in porous structures. These processes at the beginning of research in the field of high power/energy optics were either insufficiently studied or not studied at all.

a) *Temperature field in porous structures under convective cooling*

The temperature fields in porous structures are calculated in the one-dimensional formulation under the following assumptions: the incident radiation is uniformly distributed over the irradiated surface; the thickness of the porous layer Δ_p is much greater than the depth of heating, which makes it infinitely large $(\Delta_p \to \infty)$ and allows consideration of the half-space model; and the temperature and velocity of the flow through the thickness the porous layer are constant. The heat transfer equation, which describes the temperature distribution over the thickness of the porous layer, can be written in the dimensionless form:

$$\frac{d^2\Theta}{d\bar{x}^2} = N(\Theta - 1), \tag{38}$$

where $\Theta = t/t_T$, $\bar{x} = x/d_m$ and $N = \widetilde{\mathrm{Nu}}N'$ are the dimensionless temperature, coordinate and Nusselt number, respectively; d_m is the mean diameter of the structure particles; $\widetilde{\mathrm{Nu}} = h_m d_m / \tilde{\lambda}$ is the modified Nusselt number, which characterises the ratio of the convective cooling to the heat transfer due to skeleton thermal conductivity; $N' = S_V d_m$ is a dimensionless parameter; and S_V is the heat transfer surface.

The boundary conditions of this equation can be written in the form:

$$\bar{x} = 0, \;\; d\Theta / d\bar{x} = -\widetilde{\mathrm{Nu}}\bar{q}\,\bar{x} \to \infty, \;\; \Theta \to 1, \tag{39}$$

where $\bar{q} = q/(h_m t_T)$ is the dimensionless heat flux density and q is the heat flux density transmitted through the separating layer. The solution to this equation has the form [21, 34]

$$\Theta(\bar{x}) = 1 + \bar{q}\sqrt{\widetilde{\mathrm{Nu}}/N'}\exp(-\sqrt{N}\bar{x}). \tag{40}$$

It follows from (40) that the rate of temperature decrease over the thickness of the porous structure is determined by the parameter $\sqrt{N}$. The maximum heat flux density, removed from the reflector due to convective cooling, follows from the condition of equality of the coolant temperature Θ_p at a fixed pressure to the boiling temperature Θ_{boil} of the coolant $(\Theta_p = \Theta_{\mathrm{boil}})$ at a chosen pressure and has the form:

$$\bar{q}_{\max} = (\Theta_{\mathrm{boil}} - 1)\sqrt{N'/\widetilde{\mathrm{Nu}}}. \tag{41}$$

The degree of heat transfer intensification in a porous structure as a result of the turbulent flow circulation and the surface development is determined by the coefficient K_{int}, which characterises the ratio of the amount of heat removed by the coolant in the structure under consideration to the amount of heat that would be removed directly from the cooling surface of the separating layer by the coolant when it flows in a slot gap of depth Δ [40]:

$$K_{\mathrm{int}} = q / h_\Delta (t_{\bar{x}=0} - t_T), \tag{42}$$

where h_Δ is the coefficient of convective heat transfer in the coolant flow in a slot gap. For example, for the turbulent regime of the coolant flow the Nusselt number has the form

$$\mathrm{Nu}_\Delta = 0.023\mathrm{Re}^{0.8}\,\mathrm{Pr}^{0.4}, \tag{43}$$

where Re and Pr are the Reynolds and Prandtl numbers.

In the case of removal of heat fluxes, the depth of heating is [41]

$$\bar{\Delta}_{\max} = N^{-1/2}\ln 10^2(\Theta_{\mathrm{boil}} - 1). \tag{44}$$

In combination with the expressions describing the flow hydrodynamics, the obtained dependences are the basis for optimising the parameters of porous structures, ensuring minimal thermal deformations of POE surfaces or, if necessary, the maximum heat fluxes, removed in the case of convective cooling.

b) Convective heat transfer in a porous structure

The regime of the coolant flow in porous materials, which is of interest for high-power optics, is a transition between laminar and turbulent regimes. The criterion equation of the interporous convective heat transfer for gases and droplets can be represented in the form [41]

$$\mathrm{Nu} = c(\mathrm{Re}\,\mathrm{Pr})^n, \tag{45}$$

where c and n are the constants depending only on the structural characteristics of the porous material.

Using known experimental data from the literature [42], we analysed the dependences of c and n on the structural characteristics of porous structures for which these constants are quite authentically known. As a result, we found that c and n depend mainly on the bulk porosity Π_V. Thus, relation (45) for the dimensionless Nusselt number with account for correlation expressions $c(\Pi_V)$ and $n(\Pi_V)$ allows one to calculate the coefficient of convective heat transfer in porous structures.

c) Hydrodynamics of a single-phase flow in a porous structure

The temperature field and thermal deformation of the POE are largely determined by the flow rate of the coolant pumped through a porous layer, which depends on the hydrodynamic characteristics and conditions of the coolant inlet and outlet. Hydrodynamic characteristics of a single-phase fluid flow in porous structures, mainly in the region $\Pi_V \le 0.5$, were studied in many experimental papers [41, 42]. In the general case, the hydrodynamics of the flow in porous structures is described by the modified Darcy's equation (Dupuit–Reynolds–Forchheimer equation) [43–45]:

$$-\frac{dp_0}{dx} = \alpha\mu_0 u + \beta\rho u^2, \tag{46}$$

where p_0 is the flow pressure; u is the filtration rate, equal to the ratio of the specific mass flow rate of the coolant G_0 to the density ρ; α and β are the viscous and inertial resistance coefficients, respectively; and μ_0 is coefficient of dynamic viscosity of the coolant.

From equation (46) we obtained the equation for the coefficient of friction, C_f, in the form

$$C_f = 2/(\mathrm{Re}+2), \tag{47}$$

where $C_f = -2(dp_0/dx)\rho / G_0^2\beta$ and $\mathrm{Re} = G_0\beta/\mu_0\alpha$ (the characteristic size β/α).

Known also is a slightly different approach to the calculation of C_f: as a characteristic size use is made of $\sqrt{K}$, where K is the permeability coefficient, characterising the hydrodynamics of the flow according to Darcy's law $(\mathrm{Re}_{\sqrt{K}}\ G\sqrt{K}/\mu)$, then

$$C_f = 2(1/\mathrm{Re}_{\sqrt{K}} + c)/c. \tag{48}$$

The relationship between the coefficients α, β and parameters c and K can be represented as $\alpha = 1/K$ and $\beta = c/\sqrt{K}$. The parameter c is a universal constant for identical porous structures. For example, for all the materials made of metal powders with spherical or close-to-spherical particles $c \approx 0.55$, and for materials made of powders of arbitrary particle shape $0.45 < c < 0.566$. Thus, when calculating the hydraulic characteristics of the structures we assumed $c = 0.55$, although in our case this provides a somewhat higher value of the friction coefficient C_f.

The permeability coefficient K, which is a structural characteristic of a porous structure, does not depend on the flow regime and is determined experimentally from Darcy's law. In connection with the development of works in the field of heat pipes, many experimental data are currently available to determine K for powder and metal fibrous structures. The dependence of the permeability coefficient for metal fibrous structures on bulk porosity has the form [46]:

$$K = A\Pi_V^m, \tag{49}$$

where A and m are the coefficients depending on the relative length of the fibers l/d. Similar expressions can be obtained for powder porous structures. In addition, the permeability coefficient is calculated from the known Carman–Kozeny relation [41]:

$$K = \varphi\Pi_V^3 d_m^2/(1-\Pi_V)^2 \approx \Pi_V^3/5S_V, \tag{50}$$

where φ is a constant depending on the structure.

We used the expressions presented to determine the hydraulic characteristics of power optics elements utilising porous structures made of metal powders and metal fibrous structures.

d) Effect of the coolant inlet and outlet conditions on the hydraulic characteristics of the POE

Usually, in cooled POEs the coolant is supplied to and removed from the porous structure through evenly distributed alternating channels on the surface being cooled. In the case of inlets and outlets in the form of alternating holes we may deal with a significant nonuniformity of the velocity field in calculating the flow in radial directions. This leads to additional pressure drops in the circulation of the coolant, which are accounted for by the coefficient K_g. In this case, the total pressure drop in a porous structure has the form

$$\Delta P_0 = \Delta p_0 K_g, \tag{51}$$

where Δp_0 is the pressure drop in the case of a uniform velocity field.

The coefficient K_g, characterising the influence of collector effects on hydraulic resistance during the motion of the fluid in a porous structure, can be written as:

$$K_g = \frac{F}{\pi s^2 n(1-a)} \frac{cG(1/a-1)/\pi n\rho s\Delta - (v/\sqrt{K})\ln a}{v\sqrt{K} + cv}. \tag{52}$$

Here F is the area of the irradiated surface; n is the number of channels for the inlet (outlet) of the coolant; and $a = 2r_0/s$ is a relative spacing between the holes. One can see from equation (52) that K_g depends both on the geometric characteristics of the supply and removal of the coolant (on a) and on G; with increasing a and G, the coefficient K_g increases. Thus, the coefficient K_g characterises the design excellence of the inlet and outlet system of the POE coolant.

When K_g is known, the total pressure drop in the porous structure is calculated by formula (51), taking into account the expression for calculating Δp_0:

$$\Delta p_0 = v\rho s(1-a)(v/\sqrt{K} + cv)/\sqrt{K}, \tag{53}$$

where $v = Cs/(\rho F\Delta)$ is the coolant filtration rate.

e) Thermal conductivity of porous structures in POEs

As for the problems of cooling of POEs, of interest is to study the thermal conductivity of a porous structure skeleton. In most cases, data are summarised in the form of the dependence $\tilde{\lambda}(\Pi_V)$ for the samples, manufactured using the single technology and the same type of material. In calculations use can be made of the Odolevsky equation [47]:

$$\tilde{\lambda} = \lambda_c \frac{1-\Pi_V}{1+\Pi_V}, \tag{54}$$

where λ_c is the thermal conductivity of a compact material.

Effective thermal conductivity of metal fibrous felt structures may have a considerable anisotropy depending on the direction of the fibres in the felt. Usually, $\widetilde{\lambda}$ is generalised by the relations [47]:

$$\widetilde{\lambda}_{\parallel} = \lambda_c (1 - \Pi_V) \exp(-\Pi_V), \tag{55a}$$

$$\widetilde{\lambda}_{\perp} = \lambda_c (1 - \Pi_V)^2, \tag{55b}$$

where $\widetilde{\lambda}_{\parallel,\perp}$ is the effective thermal conductivity in the direction parallel and perpendicular to the felt-making plane. In the latter case one can also use the expression

$$\widetilde{\lambda}_{\perp} = \lambda_c (1 - \Pi_V)^3. \tag{56}$$

The expressions presented satisfactorily approximate the experimental data [40, 47] and can be used in the determination of the thermal characteristics of cooled POEs made of metal fibrous structures. In this case, expression (55b) describes the upper limit of the experimental data (an optimistic estimate), and (56) – the lower (a pessimistic estimate).

f) Thermal deformation of the optical surface

To assess small distortions of the optical surface, which are characteristic of POE deformation, we made an assumption of free expansion of the porous structure and the separating layer according to the temperature fields. Then, the thermal deformation of the mirror surface W^* is the sum of expansions of the separating (thickness Δ_s) and porous (thickness Δ) layers:

$$W^* = \alpha_s \Delta_s t_T [1/2(\Theta_1 + \Theta_2) - \Theta_0] + \alpha_p \Delta t_T [(1 - \Theta_0) + \bar{q} d_m / (N' \Delta)], \tag{57}$$

where α_s and α_p are the temperature coefficients of linear expansion of the separating and porous layers, respectively; $\Theta_i = t_i / t_T$ is the dimensionless temperature; t_0 is the coolant temperature at the inlet of the reflector; t_1 and t_2 are the temperatures of the outer and inner surfaces of the separating layer, respectively.

The above-derived expressions describing the processes of heat and mass transfer in porous structures were used to calculate the characteristics of cooled POEs.

Figure 3.7.12 shows the qualitative dependence of thermal deformation on the maximum density of the heat flow being removed (the variable Π_V at a constant d_m) for two selected regions of the reflector, corresponding to the regions of injection $[W_1^*(q_{\lim 1})]$ and outflow $[W_2^*(q_{\lim 2})]$ of the coolant. Varying the average grain size d_m (or the diameter of the fibre), we can construct a family of curves, characterised by a constant value of d_m and variable porosity V, for reflectors with the same type of the capillary structure. The curves were plotted at a constant pressure drop and by taking into account the coolant heating in the porous structure; in addition, the temperature of the coolant at the inlet was assumed equal to the POE temperature.

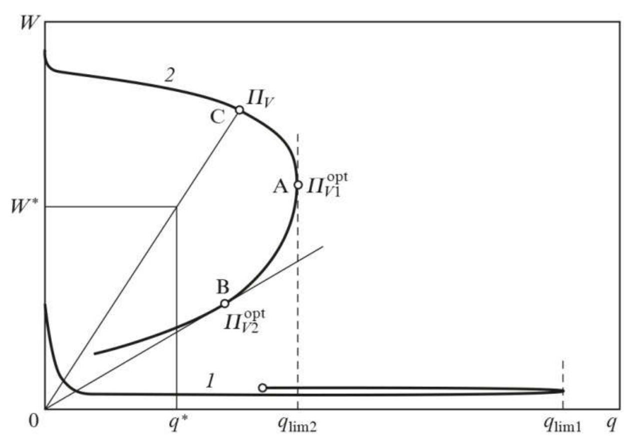

Figure 3.7.12: Qualitative dependence of thermal deformations on the maximum power density for the heat flow removed from two POE zones, corresponding to the regions of (1) injection and (2) outflow of the coolant

The deformation of the optical surface in the coolant outflow region is $W_2^* > W_1^*$; hence, crucial to the selection of the structural characteristics of the porous structure is curve (2), and the difference between curves (1) and (2) characterises the degree of perfection of the cooling system. The curves are the envelopes of the working thermal deformation characteristics of a family of reflectors with this type of structure. The performance characteristic of the reflector with a given porosity of the structure Π_V is obtained by connecting the straight line from point C with the origin of the coordinates. Point C corresponds to the maximum density of the heat flow, removed due to convective cooling, and the line segment 0C is a dependence of

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thermal deformations of the mirror surface on the heat load.

In general, curve (2) has two points: point A corresponding to optimal porosity Π_{V1}^{opt} which facilitates removal of the heat flow having the maximum density for the selected grain size, the coolant pressure drop, and coolant inlet and outlet conditions; and point B [the point of tangency of curve (2) with the straight line from the origin of the coordinates] corresponding to the porosity Π_{V2}^{opt}, for which in the porous structure the optimal thermal distortions of the mirror surface are realised.

The choice of material and the basic parameters of the structure (d_m and Π_V) must be based on a comparison of a family of curves (2) with possibilities of obtaining the desired porous structures and separating layers. In our review [14] we presented the results illustrating the feasibility of the experimental method and numerical calculations of thermal deformation characteristics of water-cooled POEs made of widely used copper and molybdenum powders.

g) Liquid-metal coolants in POEs based on porous structures

In 1978, we were first to suggest that a further increase in the optical damage threshold of mirror surfaces of POEs based on porous structures is possible when liquid alkali metals and their alloys are used as coolants [38]. Prospects of utilising liquid-metal coolants in POEs were determined by the possibility of achieving a high heat transfer coefficient in the porous structure due to a favourable combination of thermophysical properties of liquid metals. This allowed one to lessen the requirements to the thermal conductivity of the porous structure material, which opened up the possibility of using new structural materials with a low thermal expansion coefficient and thermal conductivity in reflectors. Of particular interest was the employment of eutectic alloys of liquid metals with low melting points in POEs.

Consider some results of theoretical and experimental investigations of heat and thermal deformation characteristics of POEs cooled by the eutectic alloy Na–K. As part of earlier assumptions the heat transfer equation can be written as

$$\frac{d^2 t}{dx^2} = \frac{h_e}{\tilde{\lambda}} S_V (t - t_T), \tag{58}$$

where h_e is the heat transfer coefficient between the porous structure material and the coolant. Due to the lack of published data on the heat transfer of liquid metals in porous structures, the lower bounds of the heat transfer coefficient were estimated by using the known data on the heat transfer of liquid-metal coolants in triangular arrays of nuclear reactor fuel elements [48]. To calculate the heat transfer of liquid metals in the nuclear fuel assemblies, use was made of the relations:

in densely packed structures ($s/d = 1$)

$$\mathrm{Nu} = \mathrm{Nu}_{\mathrm{lam}} + 0.0408(1 - 1/\sqrt{1.24\varepsilon + 1.15})\mathrm{Pe}^{0.65}; \tag{59}$$

in not densely packed structures ($1.0 < s/d < 1.2$)

$$\mathrm{Nu} = \mathrm{Nu}_{\mathrm{lam}} + \frac{3.67}{90(s/d)^2} \times \\ \times \left\{1 - \left[\frac{1}{[(s/d)^{30} - 1]/6 + \sqrt{1.24\varepsilon + 1.15}}\right]\mathrm{Pe}^{m_1}\right\}; \tag{60}$$

in not densely packed structures ($1.2 < s/d < 2$)

$$\mathrm{Nu} = \mathrm{Nu}_{\mathrm{lam}} + 3.67 Pe^{m_2} / 90(s/d)^2. \tag{61}$$

Here, $m_1 = 0.56 + 0.19 s/d - 0.1/(s/d)^{80}$; Pe is the Peclet number;

$$\mathrm{Nu}_{\mathrm{lam}} = \left[7.55\left(\frac{s}{d} - \frac{6.3}{(s/d)^{17(s/d)(s/d-0.81)}}\right)\right]\left[1 - \frac{3.6}{(s/d)^{20}(1 + 2.5\varepsilon^{0.86}) + 3.2}\right]$$

is the Nusselt number for the laminar flow; s/d is the relative spacing of the fuel elements in the array; and $\varepsilon = \lambda_{st} / \lambda_T$ is the ratio of the thermal conductivity of the fuel element cladding material to the thermal conductivity of the coolant. The relations (59)–(61) are valid for $\varepsilon > 0.01$ and $1 \le \mathrm{Pe} \le 4000$.

Assuming that the hydraulic diameter of the array of the fuel elements corresponds to the hydraulic diameter of the POE porous structure ($d_s = d_p$), and the diameter of a set of rods – to the wire diameter (for metal-fibrous porous structures), we can obtain the dependence $d_s = d_m \Pi_V / (1 - \Pi_V)$ for felt porous structures.

Figures 3.7.13 and 3.7.14 show the results of numerical calculations of thermal deformation characteristics of the POE cooled by the eutectic coolant Na–K. It was assumed that the porous structures of the reflectors were made of molybdenum and invar felt. The mean diameter of the felt and the bulk porosity of the structure varied within $20 \le d_m \le 200$ μm and $0.1 \le \Pi_V \le 0.9$. The curves in Figs. 3.7.13 and 3.7.14 are the envelopes of the thermal deformation characteristics of the POE family and plotted at a constant pressure drop of the coolant and a maximum temperature of the cooling surface equal to 100°C.

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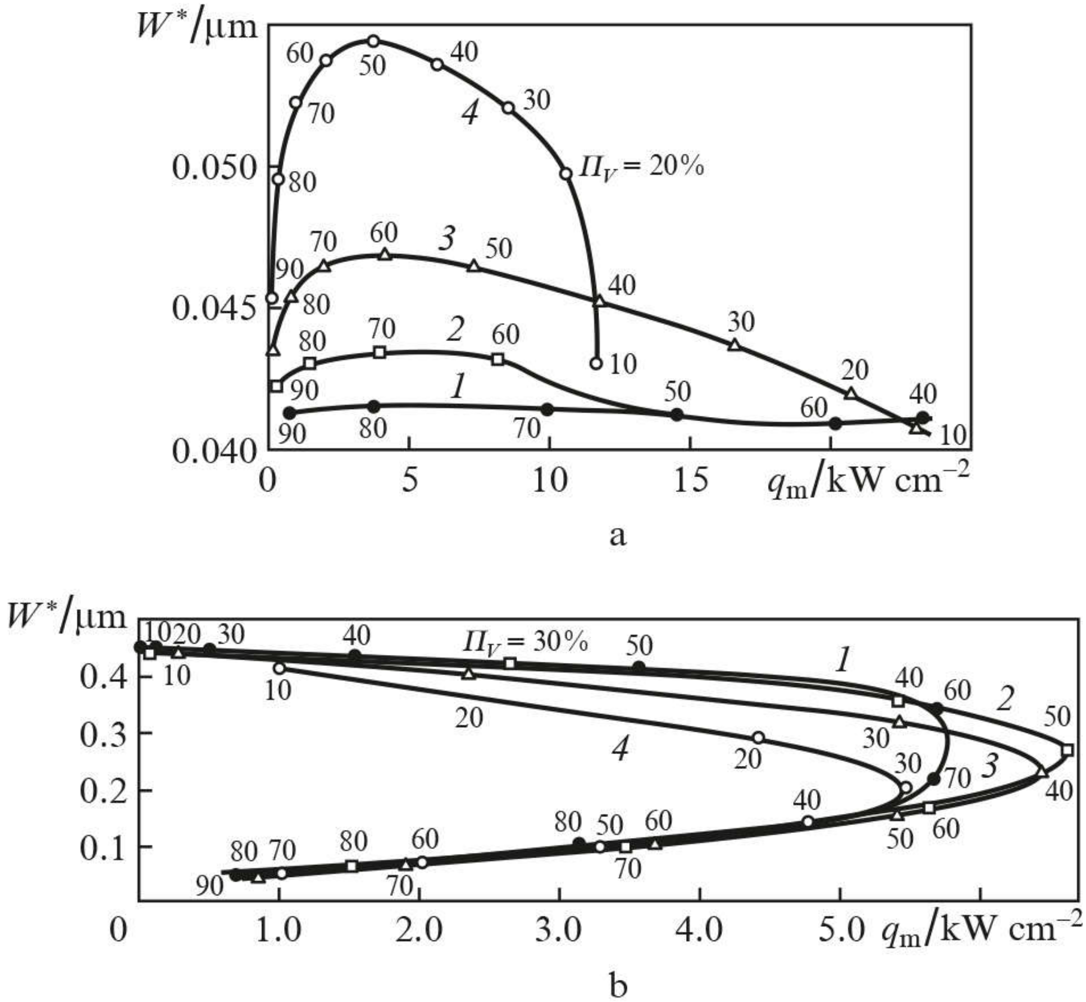

Figure 3.7.13: Nomograms of thermal deformation characteristics of POEs based on metal-fibrous porous structures made of molybdenum, which are cooled by a Na–K coolant in the regions of its inlet (a) and outlet (b) at d_m = (1) 20, (2) 50, (3) 100 and (4) 200 μm.

One can see from Fig. 3.7.13 that the deformation of the optical surface in the region of the coolant outlet, calculated with account for its heating in the porous structure, substantially exceeds the deformation in the region of the coolant inlet $(W_2^* > W_1^*)$. The maximum power densities of the heat flux for the POE in question are as follows: $q_1 > 20$ kW cm^{-2} in the region of the coolant inlet and $q_1 = 6.6$ kW cm^{-2} in the region of the coolant outlet; in this case, $W_2^* = 0.3$ μm. The minimum deformation W_2^* in the region of the coolant outflow at a power density of 4.2 kW cm^{-2} is 0.12 μm, which is significantly lower than the optical damage threshold of the POEs for CO_2 lasers.

Analysis of the data in Fig. 3.7.14 shows that the use of porous structures made of materials with a low thermal expansion coefficient (invar fibres) allows one to significantly (approximately by 3–4 times) reduce thermal deformations of the mirror surface both in the region of the coolant inlet and outlet in the case of liquid-metal cooling. Thus, the maximum thermal loads, experimentally allocated from the mirror surface, exceeded 10 kW cm^{-2}. The experimentally measured thermal deformations of POEs made of invar fibres in the region of minimum deformations were less than 0.5 μm.

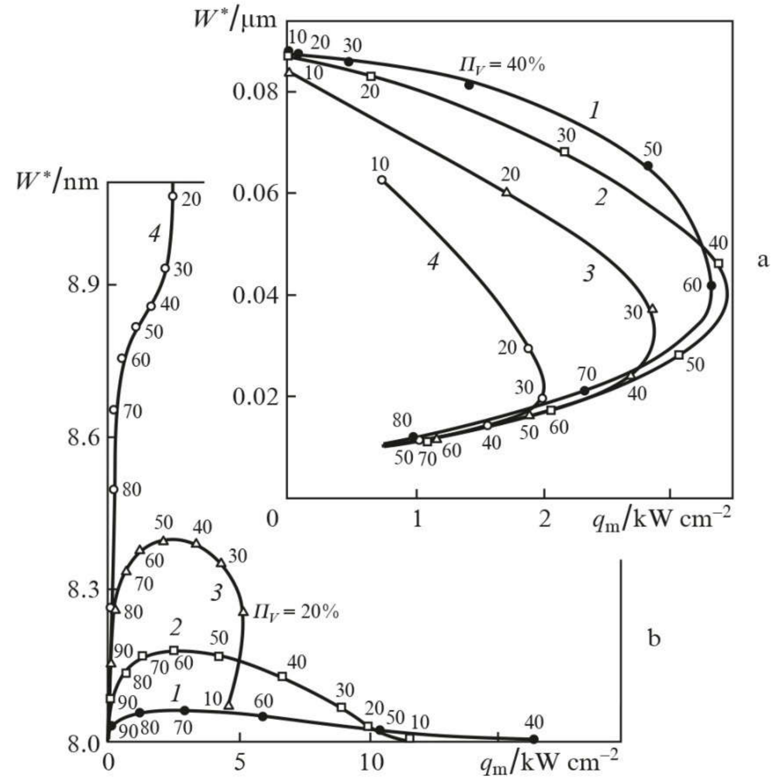

Figure 3.7.14: Nomograms of thermal deformation characteristics of POEs based on metal-fibrous porous structures made of invar, which are cooled by a Na–K coolant in the regions of its inlet (a) and outlet (b) at d_m = (1) 20, (2) 50, (3) 100 and (4) 200 μm.

It should be noted that the results presented in Figs. 3.7.13 and 3.7.14 clearly show that liquid metals are very promising for POE cooling. Such cooling in combination with porous structures made of materials with relatively low coefficients of thermal expansion opens up fundamentally new possibilities for creating a class of very precise POEs with a high optical damage threshold.

Today, due to the accumulation of experimental data on convective heat transfer and hydrodynamics in porous structures, such structures are widely used in space instrumentation and nuclear power systems exposed to high radiation doses. Due to the structural features, metal porous structures have no blind pores, which eliminates unwanted thermal processes. They provide good permeability, high thermophysical characteristics, ability to use POEs at a boiling point of working fluids in heated regions, high heat transfer rates and high limiting values of critical heat fluxes. Metal porous structures exhibit good physicomechanical and performance characteristics. Metallurgical production technology ensures their stability and reproducibility, long service life, and high reliability. One of the first mirrors based on porous structures is shown in Fig. 3.7.15.

The new areas of research, which have been successfully developed recently, include the study of boiling on surfaces with porous coatings with their structural and hydrodynamic characteristics taken into account, the study of the influence of these characteristics on the contact thermal resistance between the porous and solid layers, and the study of heat transfer during condensation of liquids on the working surfaces of porous structures. It should be noted that our investigations of heat transfer in porous structures made it possible to develop the technological basis for creating a series of water-cooled mirrors for power lasers by employing chemical etching of metal foils with subsequent soldering to fabricate a multilayer heat exchanger with a moderate degree of development of the heat exchange surface [49–52].

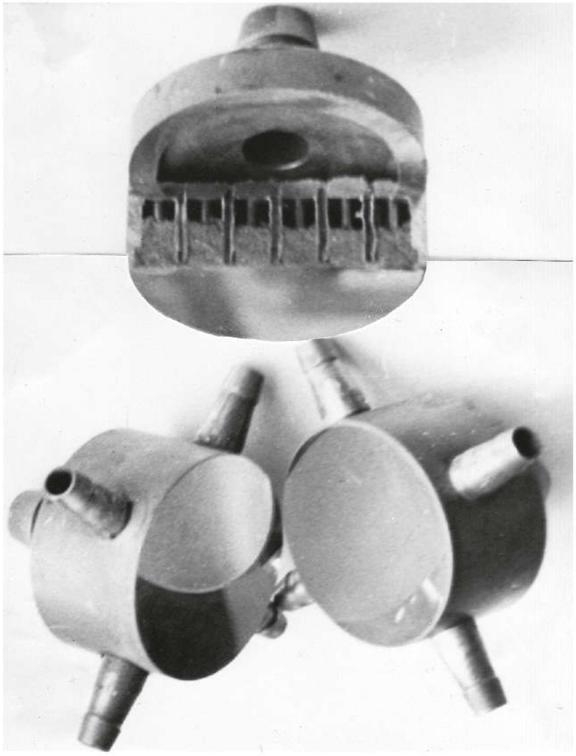

Figure 3.7.15: Cooled POE with a powder porous structure

IV. Adaptive POEs and Optical Systems Based on Them

The variety of the phenomena that change the optical characteristics of the medium in the propagation path of radiation and in the optical system of the laser-leads to degradation of the quality of the wavefront (WF), which is manifested by a significant increase in the angular divergence of the generated beam and by a reduction in the peak intensity upon focusing. Most fully the entire range of requirements to WF correctors in adaptive optics systems is met by POEs with adjustable shape of the reflecting surface, in which the WF distortion are compensated for by changing the shape of the mirror surface. In this case it is possible: 1) to fabricate cooled and uncooled adaptive POEs with a high optical damage threshold in a wide range of radiation exposures [21, 53]; 2) to produce adaptive optics systems for the entire set of currently known schemes for generation of cw and repetitively pulsed laser radiation in wavelengths ranging from far-IR to ultraviolet; and 3) to manufacture adaptive POEs for correcting and measuring non-stationary phase distortions in the time interval up to several milliseconds, by selecting the substrate materials of the mirror surface which provide their predetermined static and dynamic deformation properties [54–56].

The most challenging, in our view, is the realisation of adaptive POEs with a high optical damage threshold of the reflecting surface, because it is necessary in this case to combine the shape and cooling control systems in the reflector. Our approach to creating adaptive POEs was based on the methods of forced heat removal for cooling the mirror surface while shaping the reflecting surface by controlled elastic deformation of the porous structure of the heat exchanger.

Prospects of our proposal consisted in the possibility of providing the necessary static and dynamic deformation and thermal characteristics of adaptive POEs, because the use of porous structures allows one to implement the optical damage threshold (up to several tens of kW cm^{-2}) of the mirror surface, whereas their use as a substrate material of the mirror surface having low stiffness enables control of the shape of the reflecting surface in a wide range of local displacement amplitudes of its individual regions. Moreover, since in the operating condition the material of the porous heat exchanger of an adaptive POE is filled with a liquid coolant, natural resonant oscillations of the mechanical design of the adaptive POE may be effectively damped in the dynamic regime of the device operation.

Studies on modelling the correction of basic WF distortions by the adaptive POE, determining the optical quality of the intense laser radiation flux (including the WF tilt, defocusing, spherical aberrations), showed that at a consistent satisfaction of the power optics requirements, involving realisation of high values of the optical damage threshold (the porous structure thickness of the exchanger must be several millimetres), inaccuracy of conjugation of the WF shape with the shape of the reflecting surface for CO_2 laser radiation is $\lambda_0/10-\lambda_0/20$ using a control system with 50–60 actuators on the aperture of the adaptive POE up to 100 mm in length.

Along with the well-known solutions [56, 57], our approach to creating adaptive POEs is very promising in the development of adaptive optics systems for high-power lasers [58–63]. However, its implementation required complex investigations to establish the peculiarities of dynamic and static regimes of deformation of porous structures, to study the influence of the processes of internal friction in porous materials on the dynamics of their cyclic loading, to determine the effect of anisotropy of mechanical properties of the structure on the form of the response function of the reflecting surface, to establish an optimal (for these devices) control of an adaptive optical system, and to create new types of actuators with high energy capacity. It is important to note the major role of the design bureaus headed at that time by B.V. Bunkin and N.D. Ustinov in achieving these goals.

Great importance in the development and creation of adaptive POEs with specified static and dynamic characteristics was given to actuators providing the required amplitudes of deformation over a wide dynamic range. Solutions related to the use of piezoelectric materials in physical problems associated with adaptive POEs are not free from drawbacks. These include the need for high strains required for the realisation of amplitude displacements and the inevitability of hysteresis phenomena that hinder the formation of a phase-conjugated laser beam WV by the relief of the reflecting surface. In the regimes of 'modulation' and 'phase conjugation' the amplitudes of local displacements of the reflecting surface should reach $0.1-0.5\lambda_0$ and $1-5\lambda_0$, respectively. To ensure such displacement amplitudes we proposed adaptive POE actuators of new types, which are made of magnetostrictive materials and implement the conditions for the Joule and Wiedemann effects [62, 63]. At the same time we pointed out the prospect of creation of compact highly efficient actuators, providing a stable amplitude displacement in the frequency range up to 10 kHz.

The employment of the designed and built adaptive POEs utilising porous structures is not confined to adaptive optics, although in this field they solve a number of important problems. According to the results of modelling intracavity optical systems [64–68], the use of adaptive POEs allows one to obtain the diffraction angular divergence of radiation fluxes when use is made of unstable resonators in high-power carbon dioxide laser systems. Adaptive POEs were essentially a new type of devices ensuring the local control of phase characteristics of coherent radiation fluxes. As a result, they served as prototypes for different laser beam modulation, selection and scanning devices. For example, the use of an adaptive POE in the laser cavity made it possible to convert high-power cw radiation into high-frequency repetitively pulsed radiation by *Q*-switching [68], and the employment of adaptive POEs in a Fabry–Perot interferometer allowed for automated analysis of spectral and modal composition of laser radiation, etc. Undoubted are the advantages of this class of adaptive POEs in traditional applications of adaptive systems, such as laser ranging. Here we should mention paper [57], which presents the characteristics of a number of adaptive mirrors.

V. Large POEs based on Multilayer Honeycomb Structures

Actual operating conditions of large POEs put forward in most cases contradictory requirements, significantly complicating the process of their manufacture. With low weight and high specific stiffness, large POEs should continue to operate under intense unilateral heating and rapidly changing ambient temperature. However, increasing the size of the POEs, while preserving the predetermined level of the optical surface distortion, dramatically increases their mass. To reduce the weight of large POEs while maintaining the stiffness of their structures, along with new approaches such as the use of materials with synthesised physical and technical properties promising is also the search for new solutions to the problem. In some cases, the POE weight is reduced by creation of internal voids with relatively large cells. This allows one to decrease the POE weight by 6–7 times for the value of optical surface distortion by its own weight, which is 0.7–0.8 of monolithic mirror distortion. However, it is difficult to create a system of thermal stabilisation without significant loss of rigidity in POEs with large internal voids.

An alternative way to reduce the weight of bulky POEs, as in the case of highly loaded POEs, is the use of highly porous honeycomb materials [69, 70]. We theoretically and experimentally investigated the possibility of creating lightweight bulky POEs based on multilayer honeycomb structures. Such structures have a relatively small mass at high specific stiffness, good thermal insulation properties and high absorption of elastic vibrations. Multilayer structures also provide the ability to create a highly efficient system of thermal stabilisation.

In the case of axisymmetric thermal loading the problem of thermal distortions of the optical surface of a cooled multilayer honeycomb POE was solved in [71]. In this case, to calculate the temperature fields in a large POE, we considered the problem for a multilayer cylinder whose end and side surfaces were heated, and inside the layers the heat was removed by a coolant. Thermal deformations W^* of the optical surface were determined as the sum of the normal thermal expansion of the POE and its bending

$$W^* = W_n^* + W_{\text{bend}}^*, \tag{62}$$

where $W_n^* = \int_0^H \beta(z)T(z,r)dz$ is the normal extension; $\beta(z)$ is the linear expansion coefficient; $T(z, r)$ is the temperature; and H is the POE thickness.
Bending was determined from the equation

$$\nabla^4 W_{\text{bend}} = -\nabla^2 \frac{M_T}{D},$$

where

$$M_T = \int_{z_0-H}^{z_0} \frac{E\beta z}{1-\nu} T(z,r)dz$$

is the temperature moment;

$$D = \int_{z_0-H}^{z_0} \frac{Ez^2}{1-\nu} dz$$

is the bending stiffness; and E is Young's modulus. Poisson's ratio $\widetilde{\nu}$ and the position of the neutral surface were determined from the conditions

$$\int_{z_0-H}^{z_0} \frac{E}{1-\nu^2}(\widetilde{\nu}-\nu)dz = 0, \qquad \int_{z_0-H}^{z_0} Ezdz = 0,$$

$$W_{\text{bend}}(r) = C_1 + C_2 \ln r + C_3 r^2 + C_4 r^2 \ln r + \frac{1}{D}\int_0^2 \frac{1}{\rho}\int_0^\rho \xi H(\xi) d\xi d\rho, \tag{63}$$

and the constants C_1, C_2, C_3 and C_4- from the boundary conditions.

Studies showed [72, 73] that for the absorbed heat flux equal to ~10 W cm^{-2} the optical surface distortions of the POE based on multilayer honeycomb invar structures do not exceed 0.7 μm at the POE diameter of 1 m. Constant thermal stabilisation (time needed to reach steady-state operation), which is determined from the solution of the nonstationary problem, for such structures is a few tenths of a second. A peculiar feature of lightweight honeycomb POEs is the fact that a relatively non-rigid filling material may experience a shear strain and transverse compression, significantly affecting the POE operation. In this connection, there appeared a problem of its optimisation, which was considered in the framework of nonlinear programming. The relative displacement of the POE surface under the influence of gravitational, mechanical and thermal loadings was determined by the finite element method [73].

Figure 3.7.16 shows the dependence of M^*/M and H^*/H on the allowable distortion W^* of the optical surface of the POE under its own weight. Here M^* and H^* are the weight and thickness of a circular monolithic plate, and M and H are the weight and thickness of the three-layer honeycomb invar structure with a diameter of 2 m. It can be seen that the effectiveness of the multilayer honeycomb structure increases with toughening the requirements for an acceptable distortion of the optical surface. Figure 16 also shows that for certain ratios of the structural parameters, the optical surface distortion can be minimised. The example of employment of multilayer honeycomb structures during the manufacture of large POEs 1 m in diameter is shown in Fig. 3.7.17. Lightweight bulky POEs made of invar are currently used in laser facilities and confirm their high efficiency. This class of POEs is described in detail in [74].

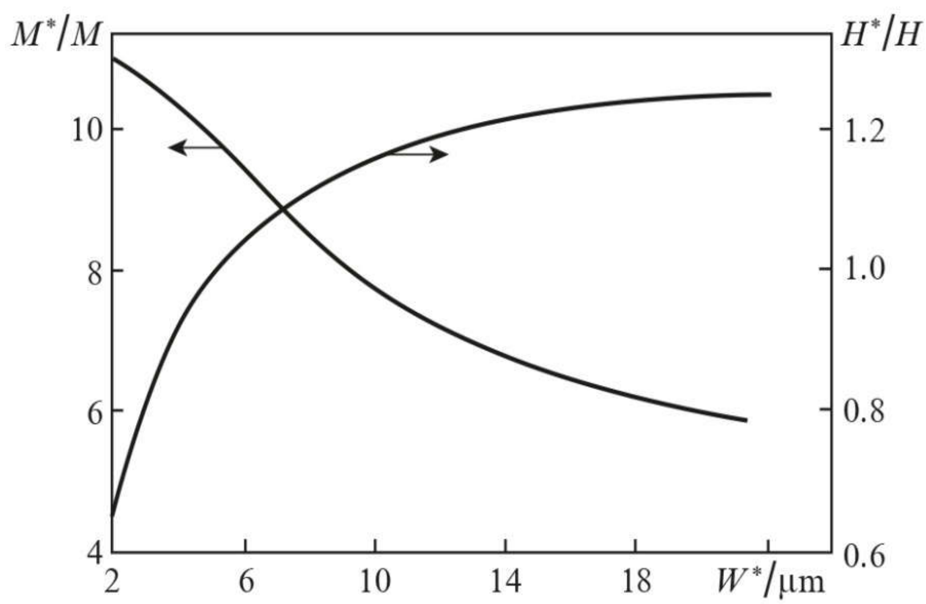

Figure 3.7.16: Dependences of the thickness and weight of a bulky honeycomb invar POE 2 m in diameter on distortions of the optical surface

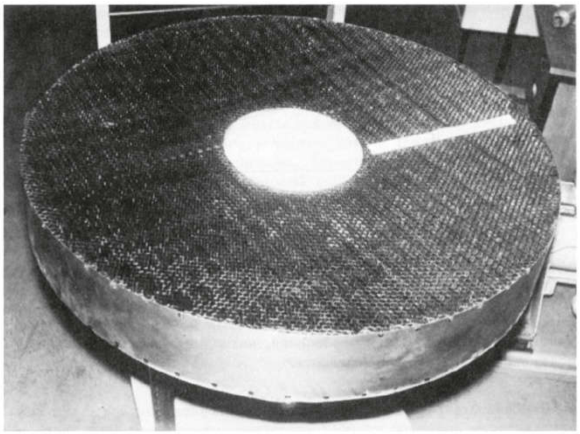

Figure 3.7.17: Preform of a large multilayer honeycomb invar POE 1 m in diameter

VI. Large POEs based on Composite Materials

Progress in this area is largely provided by the rapid development of new technologies and the synthesis of materials with fundamentally new properties. The need for such a development is associated with an ever-expanding range of problems faced by modern science and practice.

A common disadvantage of large POEs made of glass, glass ceramics, fused quartz and other materials, which are used in optical astronomy and laser technology, is their low thermal conductivity. Such mirrors cannot be used effectively in unilateral heating and technological features of their production do not allow one to significantly reduce weight and ensure effective thermal stabilisation.

Good results in the fabrication of lightweight large POEs have been achieved using composite materials, the methods of their manufacture being well developed [75–78]. Of greatest interest is the silicon infiltrated carbon-fibre-reinforced silicon carbide composite. The process is based on the deposition of carbon on a free surface during gas phase pyrolysis. Precipitating carbon strengthens frame filaments and combines them into a rigid three-dimensional lattice. The thus obtained porous silica preforms are impregnated with silicon melt in an inert atmosphere. By varying the amount of silicon and impregnation temperature, one can produce samples, significantly different in porosity and phase composition. One can also fabricate virtually carbide porous structures with advanced open porosity, which, except for weight reduction, provides an effective system for thermal stabilisation. Heat treatment removes residual stresses in the composite, increasing its structural stability.

A significant weight reduction of POEs while maintaining their specific rigidity can be achieved also by creating a honeycomb structures. For a honeycomb frame to be manufactured, we used the slip-casting method. Specially prepared slip mass was poured into a mold and polymerised. After removal of the mold the preform was annealed and siliconized.

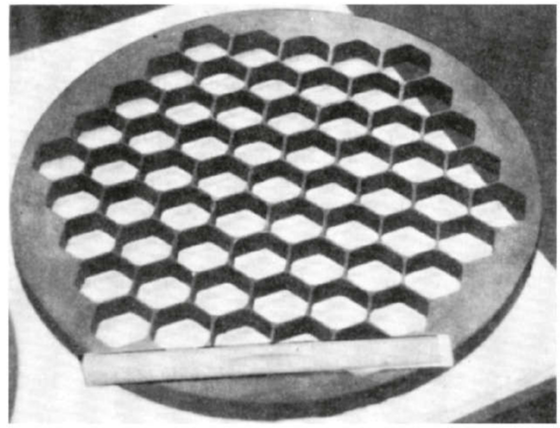

Figure 3.7.18: Honeycomb frame of the POE

Figure 3.7.18 shows a honeycomb frame, produced by the slip-casting method. By joining the resultant honeycomb frame with monolithic plates made of the same material one can form a multilayer honeycomb structure with highly efficient thermal stabilisation.

Figure 3.7.19 shows a photograph of a lightweight uncooled POE 500 mm in diameter, placed on a polishing/lapping machine. A highly reflecting coating was deposited on the optical surface of the silicon carbide wafer having a surface roughness of 0.010 μm.

The optical damage threshold of cooled and uncooled POEs based on silicon infiltrated carbon-fibre-reinforced silicon carbide composites was measured experimentally, high power densities being simulated by the electron beam heating facility we developed [79–81]. The POE was installed in a vacuum chamber and served as an anode of an electro-optical system. The optical damage threshold of the cooled POE 500 mm in diameter was achieved under thermal loading by an electron beam with a power density of ~300 W cm^{-2}, which at characteristic values of the reflection coefficients of the POE materials for laser radiation is equivalent to a power density up to a few tens of kW cm^{-2}. Significant expansion of the range of new materials and the development of modem processing methods and technologies of their connection favours the manufacture of effective large POEs made of C/SiC materials based with record-high thermal stabilisation and high optical performance.

Figure 3.7.19: Large POE 500 mm in diameter on a polishingdapping machine

VII. High Power/Energy Optics and its New Applications

a) *Cooling of laser diode assemblies*

One of the brightest and most promising implementations of the ideas of power optics is now the introduction of forced heat transfer in high power/energy semiconductor lasers, which are widely used today to pump solid-state lasers having active elements of different geometry: rods, disks, slabs, fibres [82–86]. Solid-state lasers have the highest efficiency reaching 80% in some case. Modem manufacturing technologies of semiconductor structures made it possible to significantly increase the laser lifetime (tens of thousands of hours of continuous operation). The variation of the semiconductor material composition can change the wavelength range of radiation from the near-IR to the UV. These lasers are very compact, reliable and easy to operate. The power output can be increased by the simultaneous use of a large number of laser diodes, which are formed in one-dimensional or two-dimensional effectively cooled structures (Fig. 3.7.20).

Cooled laser diode assemblies possess almost all the remarkable properties of single semiconductor lasers: high intensity, high reliability and long lifetime. These lasers have much smaller weight and size dimensions in comparison with other types of lasers, can easily be fed from independent low-voltage power supplies (solar, nuclear energy) without bulky transformers. Equipment based on laser diode assemblies really becomes a reliable high-performance instrument that can be used in industry, medicine, research and military applications.

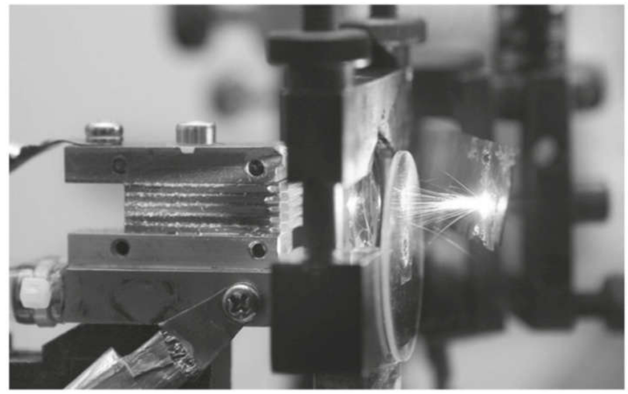

Figure 3.7.20: Cooled laser diode assembly

The stability of operation of laser diode assemblies and the value of their output are completely determined by the heat transfer efficiency. Laser diode arrays are soldered with a low-temperature solder to the surface of the heat exchanger, which is produced in accordance with high-power optics technology. It should be noted that the levels of heat fluxes which are to be removed from the contact region of the array with the heat exchanger have already approached the characteristic values of the power optics and are equal to several hundreds of W cm^{-2}.

b) *New generation of high power/energy optics based on silicon carbide*

Currently, the development of high-power optics stimulates three trends of efficient use of its technical and technological solutions:

- Lightweight, highly stable, large ground- and space-based telescopes for studying the universe and transmitting energy over long distances;
- Astronomical optical instruments for remote sensing of the Earth and near space from spacecrafts;
- Highly efficient cooled POEs for high-power lasers and laser systems.

All the three trends are based on cutting-edge technologies. The choice of the POE material is a key issue in production of a new generation of optical objects. Thus, a bulky silicon carbide POE has a weight that is 7–10 times lower than that of the POE made of glass ceramics, the best quality in terms of radiation scattering, high thermal stability and a minimum time constant (Fig. 3.7.21). Comparative evaluation of materials with the help of optical quality criteria developed by us in the early 1970s showed that silicon carbide has a distinct advantage over traditional materials [19, 20]. This conclusion is consistent with more recent conclusions of foreign experts from Germany, France, Japan and China. It is appropriate here to note the contribution of acad. E.P. Velikhov, who initially supported the creation of the technology of silicon carbide production and the development of large optics.

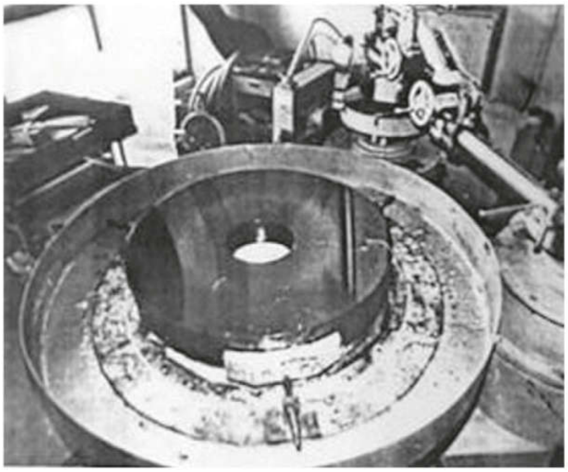

Figure 3.7.21: Silicon carbide POE

Obviously, the development of bulky POEs for high power/energy lasers and transition to a new generation of space-based telescopes is accompanied by the introduction of silicon carbide and related technologies into everyday practice.

VIII. Conclusions

In concluding this chapter of theoretical and experimental works in the field of high power/energy optics we should note one very important point: Effective development of any of the areas of modem cutting-edge technologies, as a rule, gives a result not only in the related fields of technological applications, but also in completely different branches of science and technology. Thus, the appearance of one- and two-dimensional cooled high-power laser diode arrays, large astronomical cooled POEs based on silicon carbide and complex composite materials is largely a consequence of the success of power optics [94–99] – a recognized effective donor for many areas of science and advanced technology of the XXI century. Its successful development continues.

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The Origin of Gravity and Universe

By Markos Georgallides

Abstract- In prior Articles[68-70] was shown that all Particles are Quaternion having, their mass as the Real part and energy as their Imaginary part. Energy is the Work produced, i.e. a force acting on a Displacement in One-Two and or Three directions, and which is conserved. In order that this *Motion is conserved as Displacement* in all directions, then this Displacement must be kept, *Quantized*, in a Finite Space differently is annihilated. In Mechanics the only-possible motion in a Finite-Space, is the Periodic excitation and the Revolving motion. Oscillation or Displacement is the Removal of a point A to another point B, not coinciding with point A. Vibration is the Periodic motion of a point A to another point B and vice versa. Line-segment AB is the Material-Point, *the dipole*[⊕↔⊖] *of the Material geometry*, in-where Point A is the Positive ⊕ and Point B is the Negative ⊖. Material Points, Segments etc. consist the Physical Structures.

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THEORIGINOFGRAVITYANDUNIVERSE

Strictly as per the compliance and regulations of:

The Origin of Gravity and Universe

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Abstract- In prior Articles[68-70] was shown that all Particles are Quaternion having, their mass as the Real part and energy as their Imaginary part. Energy is the Work produced, i.e. a force acting on a Displacement in One-Two and or Three directions, and which is conserved. In order that this *Motion is conserved as Displacement* in all directions, then this Displacement must be kept, *Quantized*, in a Finite Space differently is annihilated. In Mechanics the only-possible motion in a Finite-Space, is the Periodic excitation and the Revolving motion. Oscillation or Displacement is the Removal of a point A to another point B, not coinciding with point A. Vibration is the Periodic motion of a point A to another point B and vice versa. Line-segment AB is the Material-Point, *the dipole*[⊕↔⊖] *of the Material geometry*, in-where Point A is the Positive ⊕ and Point B is the Negative ⊖. Material Points, Segments etc. consist the Physical Structures.

In the finite-Space, *cave* r, of the Material-point *is stored the Work*, *or the motion*, produced by the eternal rotation of opposites, which Work becomes from the *Angular-Momentum Vector* $\overline{\mathbf{B}}$ *,* which is equal to the *Golden-ratio-Spin,* and is stored in the r cave fix-ends *as a* r – *Stationary Wave* with the infinite *Golden-ratio-frequencies* $\mathbf{f_P}$, $[\mathbf{f_1}..\mathbf{f_n} \rightarrow \mathbf{f_\infty}] \equiv \mathbf{B_P}$ ≡ The Box $\mathbf{B_P} \equiv$ *The moving Energy-Storage*. The Golden ratio frequencies are $\rightarrow \mathbf{f_n} = (\frac{\mathbf{n\sigma}}{\mathbf{8\,r^2}}).\overline{\mathbf{B}} \equiv \frac{(1+\sqrt{5}\,])\,.\sigma}{4\pi r} = \frac{\mathbf{E}}{\mathbf{h}}$.

Gravity is the minimum energy becoming from the in-storages acceleration a = v²/r ≡ 9,8076941 *Photon is a Material-point* ,a Box$\mathbf{B_P}$, *with the fix-ends Inward-caver, which is the Energy Storage* $\mathbf{B_P}$, and *Outward caver* as *an Electromagnetic Radiation* on wavelength λ = cT= c /$\mathbf{f_P}$ *which carries* Box $\mathbf{B_P}$. *Electromagnetic Radiation follows* the*Golden-ratio-frequency*, $\mathbf{f_P}$,of *Photon, produced in Box* from the *Centripetal-Centrifugal forces* equal to main *Stresses* ± $\boldsymbol{\sigma}$.
This is the Why Golden-ratio-frequency $\mathbf{f_P}$ exists in nature from the micro to the macro scale.

Energy as motion defines In-Box the minimum *Resonance-Golden-ratio-frequency* $\mathbf{f_R} = \mathbf{f_1}$ which *follows Kepler constant for microcosm* and frequency $\mathbf{f_R}$ defines in Outer-Box the *Electromagnetic Radiation* which is the *Conveyer*, *the carrier* of energy-cave r, *All above Physical Structures Vibrate, oscillating under the action of the Inherent forces and are the Instruments that the→Golden-ratio-frequency* uses←to Kick-Start *everything in this world*.

I. Introductory Summary

Quaternion is a Mould, a form, where exists Segment AB with points A and B, and their Inherent-forces. These forces exist in Material-Point only, because of the eternal rotation of the ⊕ constituent around the ⊖ constituent [⊕↻↺⊖] and thus creating an *Angular-momentum-Vector*, $\overline{\mathrm{B}}$,an *Angular-velocity-Vector* $\overline{\mathrm{w}}$, and the Work produced equal to→ W = 2L = $\overline{\mathrm{B}}.\overline{\mathrm{w}}$= J . w² ← consisting the First-Energy-Store. In Material -Point $\overleftrightarrow{\mathrm{AB}}$, this Energy-Store as a *Stationary Wave* with, n, lobes, which Outwards becomes $\overleftrightarrow{\mathrm{AB}}$, *under conditions*, an *Electromagnetic Radiation*, i.e. it is the only way of transporting motion ≡ energy. Energy of all these *Moving-Energy-Stores* is dependent on the *Golden -ratio- frequency* of cave $\overleftrightarrow{\mathrm{AB}}$, (not intensity).This *Electromagnetic Radiation* while travelling interacts with another matter by Emitting and Spreading Energy as Stretching [⊕↔⊖]-[$\bar{\mathrm{v}}$.∇i] and Bending [⊕↻↺⊖]-[$\bar{\mathrm{v}}$.∇i]following the Breakage-principle. For compound monads as atoms are, these move in the same or opposite directions as the bonds shrink or stretch while, the bending occurs when different, *two,* atoms move downward and Upward away from the axis-lobe. *All above exist in Photon.*

In [64-70] is analyzed The How Energy from Chaos [±s²∇i] ≡ MFMF Field becomes Spin S≡ ± Λ∇i ≡$\overline{\mathrm{B}}$ of the Discrete Elementary monads which are the constituents of the Breakage-Principle as is, [Space ↔Anti space – Energy ≡ motion] ≡ [⊕↔⊖]-[$\bar{\mathrm{v}}$.∇i], or, [⊕↻↺⊖]-[$\bar{\mathrm{v}}$.∇i],
In [65-70]is analyzed, The Spin S≡ $\overline{\mathrm{B}}$ of monads and their Energy Stores as frequencies, $\mathrm{f_n} = (\frac{\mathrm{n\sigma}}{8\,\mathrm{r}^2})\,.\overline{\mathrm{B}}$
In [66-70]are analyzed The Energy-Stores in monads which are the n *loops* → $\mathrm{W_{n(n+1)}} = [\frac{4\pi \mathrm{r}^2 \mathrm{f1}}{3}]$.n.(n+1) $\mathrm{f_1} = \frac{(1+\sqrt{5}\,])\,.\sigma}{4\pi r} = \frac{\mathrm{E}}{\mathrm{h}}$ and n = 1,2,3,4… n = w² =[2πf]²…∞, Body [$\mathrm{B_P}$ ≡ EM-R ≡ $\mathrm{f_{1=N}}$, $\mathrm{f_2}$,$\mathrm{f_3}$,$\mathrm{f_D}$,,$\mathrm{f_n}$].

In [70] is analyzed, Energy-Structure of Atoms-Photons, where Kinetic-Energy as Electromagnetic wave moves Outward the cave, following Breakage-Principle which is → {(+)EF⊥(-)MF →$\lambda = \frac{c}{f}$≡ E-loop}.

One of the most important concept in geometry is, *distance*, which is the Quanta in geometry, while in Material-Geometry the composition of opposite, *the Material-point*, which is the Quanta in Chemistry and Physics. *As in Algebra* Zero, 0, is the *Master-key* number for all Positive and Negative numbers and this because their sum and multiplication becomes zero, *and the same* on any coordinate-system where ± axes pass from zero, *Exists also Apriori in Geometry the Material-Point* in where the Rolling of the Positive ⊕, constituent on the Negative ⊖,

Author: *Larnaca (Expelled from Famagusta town occupied by the Barbaric Turks Aug-1974), Cyprus, Civil-Structural Engineer (NATUA), Athens.*
e-mail: georgallides.marcos@cytanet.com.cy

constituent, creates the Neutral Material point which Equilibrium , and consists the *First – Discrete - Energy-monad* which occupies, *Discrete Value and Direction*, in contradiction to the point which is, nothing, *Dimensionless* and *without any Direction*. Material-point was proved to be the *First Energy monad* because occupies a Space, *a Cave ≡ Store*, in where exists an Eternal intrinsic rotation with a constant Angular-velocity $\overline{w}$ and an Angular-momentum vector $\overline{B}$. This Angular – momentum is identical with *Spin*, which is trapped in caves`s loops and which are in Phase with each other. From the definition of Work, *Work = Force* x *Displacement = Energy,* results the where this Energy as, *Momentum Vector*$\overline{B}$≡ *Spin ≡ Energy,* is stored in this, r cave.

Is was proved, the, r, cave, IS, *Outward a Stationary Box*, *Inward a Stationary Wave*, with infinite Frequencies $f_1 .... f_n \to f_\infty$ and with Energy, E = h.$f_n = \frac{h(1+\sqrt{5})}{4\pi}.\ [\frac{\sigma}{r}] = (\frac{n\sigma}{8\,r^2})$.Spin$\overline{B}$= W_d= v² $[\frac{h}{2\pi}]$. and the outward Electromagnetic Radiation in Storage $B_P$as $[B_P$≡ cT≡ EM-R ≡ $f_{1=N}, f_2, f_3, f_D,, f_n$].

Photon is a Particle and also an Electromagnetic Wave with above properties and because Material-Point originates from Cycloidal-motion, *Changes Outward to a Rotating Box* and this of Space –Anti-space. *Monad in Mechanics and Physics* is → The Material-point = *the discrete continuity* |{⊕+⊖}| = *The Quantum*through mould of Space –Anti-space in itself, *which is the material dipole in inner monad Structure and is Identical with the Electromagnetic cycloidal field of Energy monads. This is* the Energy distance, ds ≡ |⊕↻↺⊖|, *the deep concept of Material-geometry.*

Energy monads presuppose Energy-Space Base (*the caves beyond Planck`s length, Gravity`s and Spaces levels*) the [PNS] Space Anti-Space as work → W = ∫ P.ds = 0, which is the cause of Spaces existence and the motion of particles. Since are also Quantized, then this property is encountered in Stationary waves where energy, E, is proportional to angular velocity w. This property of particles, *Angular momentum*≡ The *Spin*, becomes from the Intrinsic, *Inward*, *cycloidal wave motion* , where is then produced centrifugal acceleration which causes the external motion *as outward waves as Photon*. [43]

The varying lever arms, on cycloid-evolute is the cause of vibrations and which cause the EM-waves and Spin. Common-circle of radius, r_c, is the common source of vibration excitation for the Space, Anti –space, considered as rotating with angular velocity, w, and then their relative motion becomes the, Rolling of Space, ABC, on Anti-space $A_E B_E C_E$ and since also this relative motion is applied on STPL[Six Triple Points Line] Mechanism, then D_A, P_A , points on it are the corresponding linear links of vibrations and Poles of rotation. [STPL] is a *Geometrical Mechanism* that produces and composite all opposite Space and Anti - space Points to *Material-points* → Waves ← the three velocity - Breakages {[s² = ± ($\overline{w}$.r)², [∇i] = 2(wr)²] of [MFMF] mechanism under $\overline{v} = \overline{c}$ thrust }, and through it becoming, *The Fermions* →[±$\overline{v}$.s²]and *The Bosons* → [$\overline{v}$.∇i = [$\overline{v}$.2($\overline{w}$.r)²] = [$\overline{v}$.2s²], [35] It was shown [33-36] that Un-clashed Fragments through center, O, consist the Medium-Field Material-Fragment → [± s²] = [MFMF] ≡*The Chaos*, as base for all motions, and Gravity as force [∇i], whilethe clashed with the constant velocity, $\overline{c}$, consist the Dark matter [± $\overline{c}$.s] and the Dark energy [$\overline{c}$.∇i]*, declaring that →* Antimatter-Galaxies and Antimatter – Asteroids can exist only as Dark-matter or and Dark-Energy and Not as Antimatter light, - c, alone, or from → velocity - Breakages, [± s² = ± (wr)²] and [∇i = 2(wr)²], where then become Waves {*The distance* ds = |AA_E|*is the Work embedded in monads and it is what is vibrated* }with the Vibrating equations of motion, to become,

A → Particles , with Inherent Vibration occupying distancer = ds = |AA_E|,
B → Gravity-Field-Energy without Vibration, the only Stationary-rotating material-points.
C → Dark-matter-Energy constituents as below,
A. [±$\overline{v}$.s²] → Fermions, *Quarks and Leptons*, and → [$\overline{v}$.∇i] → Bosons,
B. [± s²] → [MFMF] Field ≡ *The Energy - Chaos*, and the binder Field is [∇i] → Gravity force,
C. [±$\overline{c}$.s²] → Dark matter, and the binder Gravity force [∇i], [$\overline{c}$.∇i] → The Expanding Dark energy, which both are moving with light velocity, c, causing the universe to grow.

From above in, A, *and,* C, *case → Energy as velocity,* $\overline{v}$, *exists in the Discrete monads,*±$\overline{v}$.s² *and* ±$\overline{c}$.s². B, *case, → is the transportation of Energy,* from Chaos*, to the Stationary-pointy-Material points,* Dark Energy DE ≡ [$\overline{c}$.∇i] (©) → Acting on the Five Constituents → {(∇i),(+s²),(-s²),(+cs²),(-cs²)} gives [± s²] → MFMF Field [$\overline{c}$.(±s²)] → DM-DE Field, of, Dark matter and Anti-matter. [±$\overline{v}$.s²] → Fermions [∇i] → G_f= Gravity-Force in DM-DE Stationary Field . [$\overline{v}$.∇i] → Bosons, [$\overline{c}$.∇i] ≡ DE → Dark Energy c x (©)[∇i] → Gravity Force DE ≡ [$\overline{c}$.∇i] =$\overline{c}$[∇i] = The Travelling-Energy with, c, velocity.

In all above is proved that issue Kepler-Orbit-laws, denoting that Macrocosm and Microcosm Obey Newton`s Laws of motion in all Scales.

Photon isa Material-point, the moving Storage or box B_P ≡ [B_P≡ c /f_1≡ EM-R ≡ $f_{1=N}, f_2, f_3, f_D,, f_n$] with the fix-ends *of a standing wave Inward-caver* the Energy–StorageB_P, and *Outward-caver* as an Inverse-Electromagnetic-Radiation on wavelength λ= cT= c / f, which I-E&M-Radiation *carries* the *Energy-Storage* B_P, *as the wings of an insect which carry their body*.[70]

In [68] is shown that Motion may be *Linear or Rotational* for any displacement ,r, so exists a constant-work $\rightarrow$ k = $\bar{v}x\bar{v}.\bar{r}$= v².r. $\bar{n}$.→ k = v². r = (wr)².r = $[\frac{2\pi}{T}r]^2.r = \frac{4\pi^2 r^2}{T^2} r = \frac{4\pi^2 r^3}{T^2} = 4\pi^2. \frac{r^3}{T^2} = 4\pi^2.r^3.f^2{}_p$ ← It was shown that Photon is a Material-point, a box B_P , with the fix-ends inward-cave r, called the Energy-Storage-Box B_P and Outward cave r as an Electromagnetic Radiation on wavelength λ = cT, which carries the Energy-Box B_P. Conservation of energy is the Placing of frequency f_p in a cave r.

A Photon during Motion in [MFMF] Chaos, collides with other Photons by means of Cross-Product and produces a constant Work which is stored *into the Only-Four* Energy –Geometrical-Shapes, of the motion which are the Conic-sections. The Interior motion is kept in its Wavelength-Tank 2r = nλ while the Linear motion is continued by the Propagating Electromagnetic-Wave → as Energy-conveyer, i.e. The stored energy in the loop is → W_1 = v² $[\frac{h}{2\pi}] = 4\pi^2.r^3.f^2{}_p$, and is dependent on velocity, v, and on Planck`s constant h, or *on loop*, r, *and frequency*, f_p. It is proved that k = g = Gravity acceleration. *Photon is quaternion and when colliding with other particles the Complex frequency Response* H(w) *is given by the Imaginary - Part as H(w)* = -i.[1/2ζ]*only, while the Real - Part is zero.*

a. *Kinetic Energy*, *motion*, *in Orbits* becomes from the, *Piezoelectric-effect*, where Orbit is subject to a Mechanical-stress, $\sigma = \pm \frac{4\pi r}{(1+\sqrt{5})}.f_p$, *becoming from the Centripetal-acceleration* $\bar{a}_P$ *of the Planet* and thus is appeareda Positive charge at the *Nucleus* and a Negative-charge at the *Planet*, so is created an electric-signal with a given frequencyf_p. The two faces at N and P are connected by the in-between *Energy-Vectors* $\bar{B}=\frac{\pi r^3\sigma}{8}[1+\sqrt{5}]$ ≡ Spin, of the Gravity-field-Material-Points [∇i]=[⊕↻↺⊖].
b. *Orbit* or, *Negative – Energy-Rim in monad Atom,* is the Stable and Stationary Granular - lattice-Energy-Disk, which is kept in the Plane-Orbit of motion*, Ellipse area* πab*, in Gravity–field*, and in a way is *Opposite* to that which *follows the Central motion*, i.e. the Gravity-Force-Vectors $\bar{B}$ of Material-points-Spin[⊕↻↺⊖] *-is packet into the Orbit-Rim as the Energy-Granular-Conveyer* for the interactions between*,* Nucleus N and the orbiting object, *the* Planet P*,* and consists the quanta, *the minimum constant energy*, MCE, of rotational motion → [⊕↻↺⊖] ← and equal tog. It is proved that MCE = g, is the same in atoms and galaxies and in microcosm and macrocosm.
c. *Energy Changes in Reactions* [The Breakage Principle is as Matter (+s²), Antimatter (-s²) and as Energy part, 2L = ± 2s², replacing the two conservation laws of Energy and mass]. When a *Chemical reaction* occurs , then Bonds in the *Reactant* Break, while new Bonds Form in the *Product*, issuing≫Reactants± Energy → Products, as example *The Hydrogen* reacting with *Oxygen* to form water as $2H_2$(g) + O_2(g) → $2H_2O$ (g)

In this reaction, the bond between the two Hydrogen atoms in the H_2 molecule will break as the same will the bond between the Oxygen atoms in the O_2 molecule. *Breaking and Formulation of Bonds* is as *Absorbing or Releasing energy*. *A Proton* p, in nucleus and an *electron* e, form a neutron N and a neutrino, v, or p + e^-→ N + v issuing ≫ Reactants → Products± Energy In Atoms-Orbits issues the same Energy-Principles, beginning from the lowest Energy-point of the energy-path with r > 0.

Question ?? How and When lowest-Energy-point changes to r→ 0.

d. *Black Holes* Follow Kepler laws where , *On any moving Particle when is Tangentially-colliding* or *under any angle* φ *with a Material-Point executing Circular motion*, the Total Energy is Negative*,* the Particle follows constant Elliptical-Energy-Orbits on the same semi major axis as, 1 =C.$f_n{}^2.a^3$, and of the same constant Energy .C = 1/k is a State-space-constant for min-energy g . Semi major axis ,a, is related to energy as → a = GMm / 2E, where energy E is related to axis a , in inverse way in each Energy-Path independently of any other reaction, but only when in *State-Space* . i.e. for very large Energies ,semi major axis tents to a Negative-Energy-Point , which is the beginning of the Black hole in microcosm and macrocosm. *For axis* a → 0, *then* f_n → ∞, which is Black-hole.

II. THE {N} ENERGY - STORAGESOF THE MOVING –MONADS

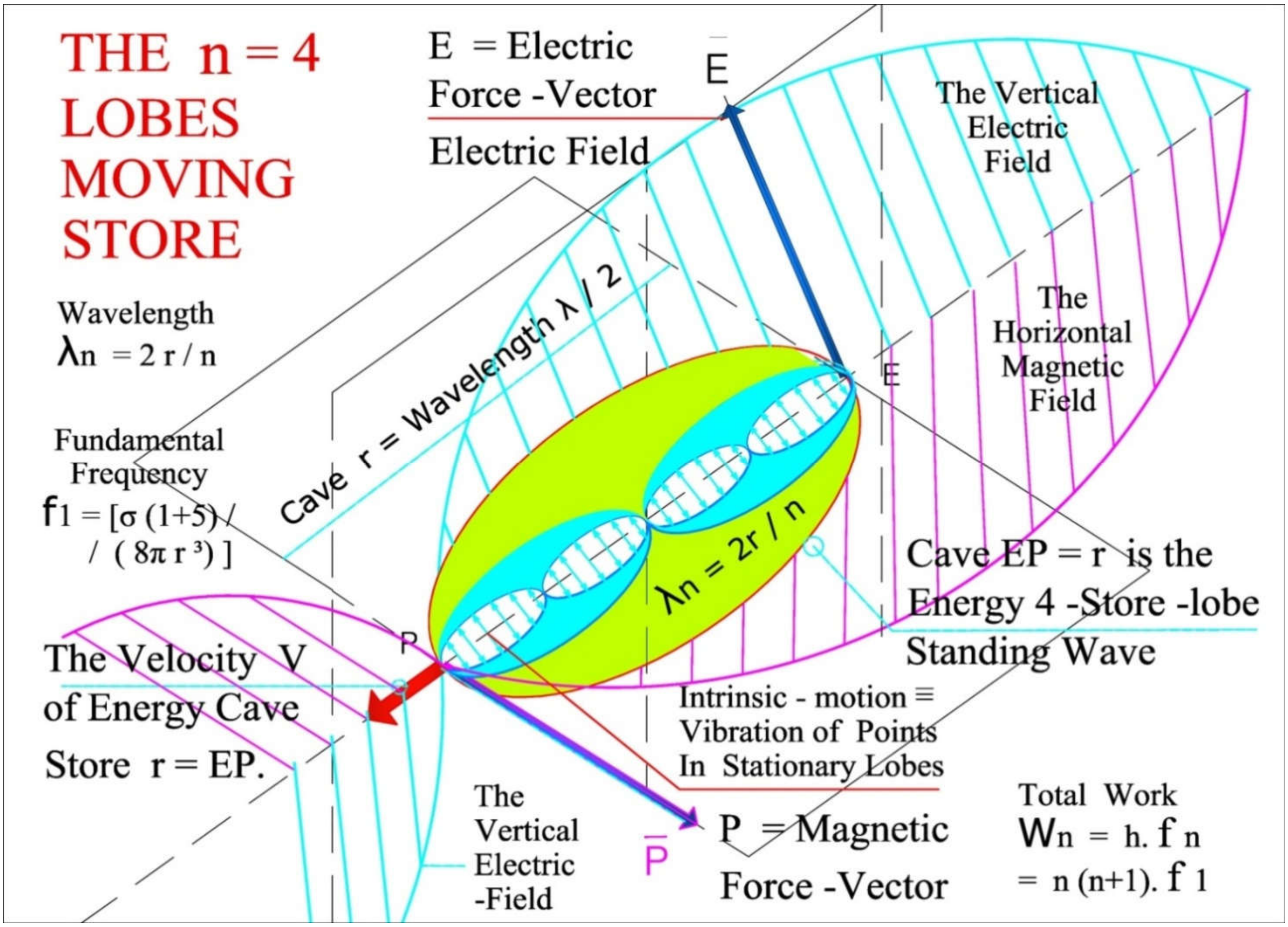

Figure 1: The Photon as a n-Lobes *Energy-Store* ≡ Particle ≡ [nλ=2r] *and* E-M *Wave* ≡ [λ=cf]

In Store, r, Wavelength $\boldsymbol{\lambda_n}=\frac{\mathbf{2\,r}}{\mathbf{n}}$, Fundamental-frequency $\mathbf{f_{\,1}}$ $=[\frac{\boldsymbol{\sigma}(\mathbf{1+\sqrt{5}})}{\mathbf{4\pi r}}]$, Work = Energy = h.$\mathbf{f_{\,1}}$

The Energy-Storage length E-P= λ/2, and is composed of 4 Lobes with $\boldsymbol{\lambda_4}=\frac{\mathbf{2\,r}}{\mathbf{4}}$, $\mathbf{f_4}=\frac{\mathbf{4\,v}}{\mathbf{2r}}$ = 4$\mathbf{f_o}$, $\mathbf{W_4}=\frac{\mathbf{h}}{\mathbf{2r}}\mathbf{v_4}$

for → Total-Work W = $[\frac{\mathbf{4\pi r^2 f1}}{\mathbf{3}}]$.n.(n+1) or W = $\frac{\mathbf{80.\pi r^2 f1}}{\mathbf{3}}$, $\mathbf{v_4}=\boldsymbol{\lambda_4}.\mathbf{f_4}$ =4.$\boldsymbol{\lambda_4}.\mathbf{f_o}$

n = 1 → $\mathbf{f_{\,1}}$ = 1 . $[\frac{\boldsymbol{\sigma}(\mathbf{1+\sqrt{5}})}{\mathbf{4\pi r}}]$, Wavelength $\boldsymbol{\lambda_{\,1}} = \frac{\mathbf{2\,r}}{\mathbf{1}}$, Energy $\mathbf{W_1}=[\frac{\mathbf{4\pi r^2}}{\mathbf{3}}].\mathbf{f_{\,1}}$ = 1.$\frac{(\mathbf{1+\sqrt{5}})\boldsymbol{\sigma}\,\mathbf{r}}{\mathbf{3}}$

n = 2 → $\mathbf{f_{\,2}}$ = 2 . $[\frac{\boldsymbol{\sigma}(\mathbf{1+\sqrt{5}})}{\mathbf{4\pi r}}]$, Wavelength $\boldsymbol{\lambda_{\,2}} = \frac{\mathbf{2\,r}}{\mathbf{2}}$, Energy $\mathbf{W_2}=[\frac{\mathbf{4\pi r^2}}{\mathbf{3}}].\mathbf{f_{\,2}}$ = 2.$\frac{(\mathbf{1+\sqrt{5}})\boldsymbol{\sigma}\,\mathbf{r}}{\mathbf{3}}$

n = 3 → $\mathbf{f_{\,3}}$ = 3 . $[\frac{\boldsymbol{\sigma}(\mathbf{1+\sqrt{5}})}{\mathbf{4\pi r}}]$, Wavelength $\boldsymbol{\lambda_{\,3}} = \frac{\mathbf{2\,r}}{\mathbf{3}}$, Energy $\mathbf{W_3}=[\frac{\mathbf{4\pi r^2}}{\mathbf{3}}].\mathbf{f_{\,3}}$ = 3.$\frac{(\mathbf{1+\sqrt{5}})\boldsymbol{\sigma}\,\mathbf{r}}{\mathbf{3}}$

n = 4 → $\mathbf{f_{\,4}}$ = 4 . $[\frac{\boldsymbol{\sigma}(\mathbf{1+\sqrt{5}})}{\mathbf{4\pi r}}]$, Wavelength $\boldsymbol{\lambda_{\,4}} = \frac{\mathbf{2\,r}}{\mathbf{4}}$, Energy $\mathbf{W_4}=[\frac{\mathbf{4\pi r^2}}{\mathbf{3}}].\mathbf{f_{\,4}}$ = 4.$\frac{(\mathbf{1+\sqrt{5}})\boldsymbol{\sigma}\,\mathbf{r}}{\mathbf{3}}$

In figure r = λ/2 = EP is the *Energy-Storage- monad* → {[$\mathbf{B_P}$ ≡ EM-R ≡ $\mathbf{f_{1=N}}$, $\mathbf{f_2}$,$\mathbf{f_3}$,$\mathbf{f_D}$,,$\mathbf{f_{\,n}}$] with wavelength $\boldsymbol{\lambda_N}=\frac{\boldsymbol{\sigma}.(\mathbf{1+\sqrt{5}})}{\mathbf{4\pi r}} = \frac{\boldsymbol{n}\,.\bar{\mathbf{B}}}{\mathbf{4\pi r^2}}$, velocity $\bar{\mathbf{v}}$ = w.r}, following the *Breakage-Principle* for monads which is Quaternion $\bar{\mathbf{z}}$ = [s +$\bar{\mathbf{v}}\boldsymbol{\nabla}\mathbf{i}$or → s² - |$\bar{\mathbf{s}}$| ² + 2|s|².∇i← →[εE² + μB²] ≡ *The monad EP* as,

Matter(+) ≡ Magnetic-field → [μB²]

Antimatter(-) ≡ Electric-field →[εE²]

Energy (+↔ -)≡ Motion in n lobes → [$\boldsymbol{\partial}\mathbf{E}/\boldsymbol{\partial}\mathbf{t}$, $\boldsymbol{\partial}\mathbf{H}/\boldsymbol{\partial}\mathbf{t}$] i.e.

The stationary-cave-lobes, as motion in the $\mathbf{B_P}$≡r = n [λ/2]Energy-Storage.

Energy-Storage-monads are consisted of the above *three-constituents* all-together, or each-one of them Work ratio

$$\mathbf{W_n} / \mathbf{W_1} = \mathbf{f_{\,n}} / \mathbf{f_{\,1}} = n\,(n+1)\,.[\mathbf{v_n}/\,\mathbf{v_1}] = n\,(n+1)\,\frac{\boldsymbol{\lambda}_n\mathbf{f}_n}{\boldsymbol{\lambda_1}\mathbf{f_1}} = n\,(n+1)\,\frac{\boldsymbol{n}\boldsymbol{\lambda}_n\mathbf{f}_n}{\mathbf{2}\boldsymbol{r}.\mathbf{f_1}} = n^2(n+1)\,\frac{\boldsymbol{\lambda}_\mathbf{n}}{\mathbf{2r}} = n\,(n+1)$$

i.e. n.$\boldsymbol{\lambda}_{\,\mathbf{n}}$= 2.r or

The Work, W, *produced from the Wave-Energy-Pattern with wavelengths* $\boldsymbol{\lambda_n}$, *and created from all Points of the Periodic Oscillation in any Cave,* r, *is Stored into the,* n, *Integer and Energy - Lobes of cave* r. From Mechanics, the *Only - Possible motions* are, *the Periodic excitation*, and *the Revolving motion* therefore all *Moving - Energy - Stores travel* as *a Wave and Not* as a *Particle* . The n, Energy tanks, the N Antinodes in its Store $2\lambda = r = h/p \equiv [\mathbf{f_1}, \mathbf{f_2}, \mathbf{f_n} \equiv$ n lobes] follows the *Stationary-Wave-Nodes-Principle, i.e. The Glue-Bond-Stress Rotation of opposites on Small - circles creates* Integer number of lobes*, which is the Wave-Nodes-Principle of the moving-energy-stores* , one of which is the Photon.

III. Monads from the Stationary Chaos:→ *Wave Energy - Pattern*

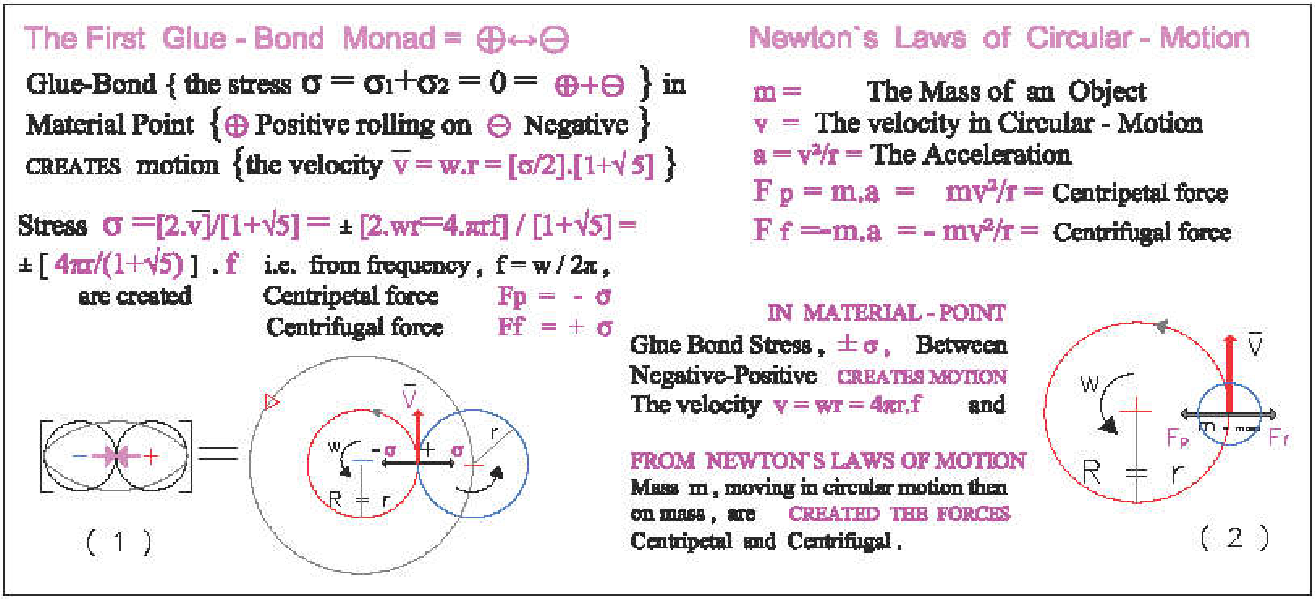

Figure 2: The *Glue-Bond* of opposites in Material-Point *Create the Centripetal-Centrifugal forces*

In (1)The Glue-Bond pair of opposites [⊖⊕] in MFMF Field, *Creates Rotation* with angular velocity w = v/r, and velocity $v = w.r = \frac{\mathbf{2\pi r}}{\mathbf{T}} = 2\pi r \cdot f = [\frac{\sigma}{2}].(1+\sqrt{\mathbf{5}})$, and or *the golden-ratio frequency* $f = \frac{\mathbf{(1+\sqrt{5}]) \cdot \sigma}}{\mathbf{4\pi r}}$, with Period $T = \frac{\mathbf{4\pi r}}{\mathbf{\sigma(1+\sqrt{5})}}$ where $\pm\, \sigma$, are the two equal and opposite, Centripetal $\mathbf{F_p}$ and Centrifugal $\mathbf{F_f}$ Glue-bond forces.

In (2) Mass, m, of an object rotating with velocity, $\bar{\mathbf{v}}$, in a cave of radius, r, creates a pair of equal and opposite forces the Centripetal $\mathbf{F_p}$and Centrifugal $\mathbf{F_f}$.

Newton`s, First - Law states that, *Any change in motion involves an acceleration, a*.

In circular motion, for an object of mass, m, acceleration is equal to, $a = \frac{\mathbf{v^2}}{\mathbf{r}}$ and force, F, acted is $F = m\, a = \mathbf{m}\, \frac{\mathbf{v}^2}{\mathbf{r}}$, which is the Centripetal force $\mathbf{F_p}$.

From Newton`s Third-Law, *All forces in the universe occur in equal but opposite directed pairs*, then For any *Centripetal force*, $\mathbf{F_p}$, there is a force of equal magnitude but of opposite direction, the *Centrifugal force*, $\mathbf{F_f}$, which acts back on the object, *without specifying the nature, or origin of forces*.

In Material-point, [⊕⊖], *both forces exist apriori*, as the Glue-Bond between the two opposites which is the main Stress $\sigma = \pm\, \frac{\mathbf{2.v}}{\mathbf{(1+\sqrt{5})}}$, and since $v = w.r = 2\pi r/ T = (2\pi.r) .f = \frac{\mathbf{(1+\sqrt{5}]) \cdot \sigma}}{\mathbf{2}}$, dependent on, σ, only where r = the radius of the Energy cave ≡ *Store*(*the inner monad discrete Chaos*). f = the frequency of this rotation where, *then*

$$\sigma = \pm\, \frac{\mathbf{4\pi r}}{\mathbf{(1+\sqrt{5})}} \cdot \mathbf{f} \text{ or } \rightarrow f = \frac{\mathbf{\sigma\,(1+\sqrt{5}])}}{\mathbf{4\pi r}} \qquad \text{(a)}$$

i.e. a relation between the Glue-Bond, σ, and the frequency, f, of the rotation, or,

In *Chaos* where r = r → 0 between the ⊕, ⊖, Opposites, exists a Stress, σ, The Centripetal $\mathbf{F_p}$, and Centrifugal force, $\mathbf{F_f}$, which nature is only the frequency in a complete rotation, and from Planck`s equation E = h.f

$= \frac{h(1+\sqrt{5}]).\sigma}{4\pi r} = \frac{h(1+\sqrt{5}])}{4\pi}.[\frac{\sigma}{r}]$, and then *from Chaos* r = r → 0, *becomes the Monad*, [⊕⊖], which is *the Neutral – Material – Point*. A wide analysis in [59].

IV. The Spin of Monads

a) Introduction

The intrinsic rotation of an elementary particle is called *Spin*, and is the amount of the quantized *Angular momentum* which is conserved as Potential or Kinetic Energy and *vice versa.* Is proved that *Spin is vector*, $\overline{\mathbf{B}}$, which interacts with magnetic fields and have an effect on bulk properties. The Glue-Bond motion in Material point (*The Rolling of the Positive on Negative*) may be either on Great-circles, or on Small circles in the two Semi-spherical of the Stationary [⊖] constituent. Motion of the [⊕] constituent on each Semi-Spherical of the [⊖] constituent, is in the opposite Direction, *and this accidentally because such is the Geometry of Space*, so this Property defines, Spin to be either Clockwise or Anti- clockwise, that is to say Positive [+] or Negative [-] *which is the Symmetry in Opposites* and where the Total Energy is L =[B/2].w.[70]

The Geometrical construction of the Particle`s Spin is shown in Figure.3.

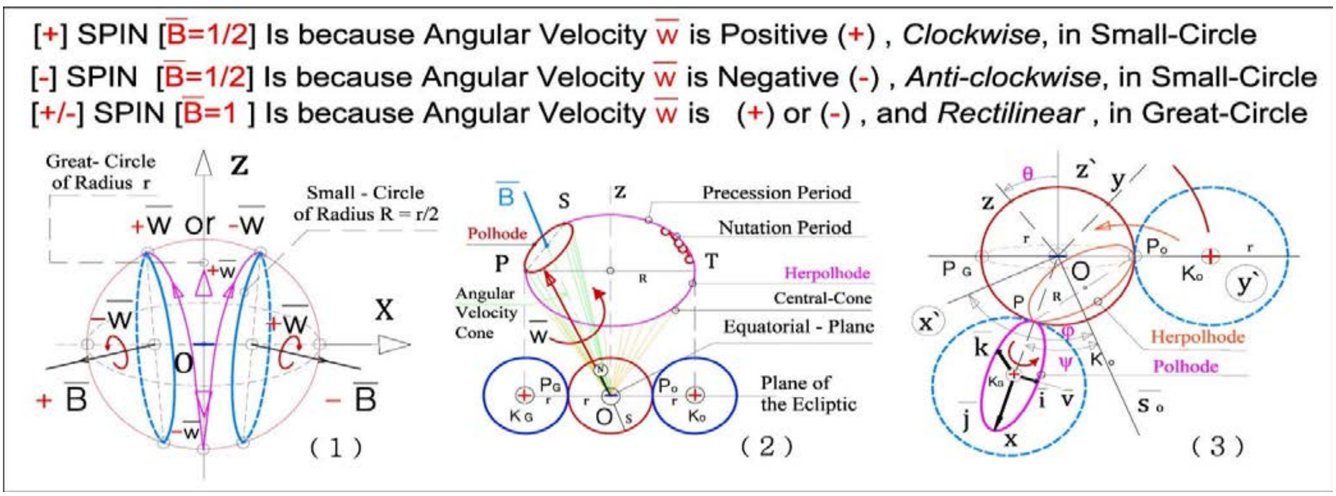

Figure 3: The How and Why, *Spin* is equal to 1 and ½

In (1) The Glue-Bond pair of opposites [⊖⊕] of the *Rectilinear motion for both,*the *Great circles* and *the Small circles,* creates on the *Stress-common-curve* rotation on circle of radius, r, with velocity v = w.r $=\frac{2\pi}{T}$.r =2πr. f $= [\frac{\sigma}{2}].(1+\sqrt{5})$, where frequency f $= \frac{(1+\sqrt{5}]).\sigma}{4\pi r}$, Period T $= \frac{4\pi r}{\sigma(1+\sqrt{5})}$ and ±σ, are the two equal and opposite Centripetal, $\mathbf{F_p}$, Centrifugal, $\mathbf{F_f}$ forces. The Energy is → E = h.f$=\frac{(1+\sqrt{5}]).\sigma h}{4\pi r}$*in Zero Wave-note ,* which is the *Golden ratio of* σ in the Material-Point. In (1) The Glue-Bond pair of opposites [⊖⊕] in the *Left Direction of Small circles*, creates rotation on circle of radius, R, with velocity v = w.2r $=\frac{2\pi}{T}$.2r =4πr. f = $[\frac{\sigma}{2}].(1+\sqrt{5})$, where frequency f $=\frac{(1+\sqrt{5}]).\sigma}{8\pi r}$, Period T = $\frac{8\pi r}{\sigma(1+\sqrt{5})}$ and ± σ are the two equal and opposite Centripetal,$\mathbf{F_p}$, Centrifugal,$\mathbf{F_f}$forces . Energy is → E = h.f $=\frac{(1+\sqrt{5}]).\sigma h}{8\pi r}$in One Wave-note.

In (1) The Glue-Bond pair of opposites [⊖⊕] in the Right Direction of Small circles , creates rotation on circle of radius, R, with velocity v = w.2r $=\frac{2\pi}{T}$.2r =4πr. f = $[\frac{\sigma}{2}].(1+\sqrt{5})$, where frequency f $=\frac{(1+\sqrt{5}]).\sigma}{8\pi r}$, Period T $=\frac{8\pi r}{\sigma(1+\sqrt{5})}$and ± σ are the two equal and opposite paradox Centripetal,$\mathbf{F_p}$, Centrifugal, $\mathbf{F_f}$ forces. Energy is → E = h.f $=\frac{(1+\sqrt{5}]).\sigma h}{8\pi r}$ in One Wave-note.

In (2) The hollow-Cone of 90º, between angular-momentum-vector$\overline{\mathbf{B}}$and angular-velocity-vector$\overline{\mathbf{w}}$ when illuminated by a circularly polarized light beam, then any changes in Spin ≡$\overline{\mathbf{B}}$ of the-Polhode Cone POT and the exchange of Linear and Angular momentum between Electromagnetic fields and material media are shown as the profiles of the phase and the angular – velocity - vector in the POT cone cross-sectional plane, i.e. Space can be eternally twisted but cannot disappear. [70]

Measurements of Physical-Properties such as Position, Momentum, Spin and Polarization, performed on Entanglement particles gives rise to seemingly paradoxical effects considering systems as whole and the ERP paradox. The answer is given in Figure 3-(2) where is showed each Property of Material-point.

V. The Photon

Electromagnetic waves are created by the vibration of an electric charge.

In Material-point, the eternal rotation of the ⊕ constituent around the ⊖ constituent creates the, n, Energy-lobes in a tank $r = n\frac{\lambda}{2}$ or $\lambda = \frac{2r}{n}$ since the velocity of the wave is $\bar{\mathbf{v}} = f \times \lambda$. The frequency is $f = \frac{n.\bar{v}}{2.r}$ where n is a positive integer number as in Figure-1.

Because in lobes the inner particles are the [+], [-] constituents of Space and Anti-space, the maximum amplitude of each constituent is related with its position and each amplitude oscillates periodically as the wave equation

$$x = \mathbf{v_o}.\ \mathbf{\sin wt} = A.\sin[\sqrt{(\mathbf{a/Am}).\mathbf{t}} + \pi/2], \quad \ldots\ldots\ldots\ldots\ldots(1)$$ where

a. Velocity → $|\bar{\mathbf{v}}| = w.r/2 = \frac{2\pi}{2T}.r = 4\pi r.$, and $\mathbf{f_n} = \frac{\mathbf{n.v}}{\mathbf{4r}} = \frac{\mathbf{n\sigma}}{\mathbf{8}r}[1+\sqrt{\mathbf{5}}]$,

b. Angular velocity→ $|\bar{\mathbf{w}}| = \frac{\sigma}{2r}[1+\sqrt{\mathbf{5}}]$ and *Fundamental frequency* $f = \frac{(1+\sqrt{5}).\sigma}{4\pi r}$ in cave, r.

and then, *Wave propagate in Golden-ratio,* GR, as in a magnetic-device the arced pattern*, by travelling from the North to the South Pole and thus creating* GR *Inner-Electromagnetic-Displacement-current* $\rightarrow \partial E/\partial t,\ \partial H/\partial t \leftarrow$ *and when reduced to one line as ,* E $\rightarrow \mathbf{\partial E/\partial t} \rightarrow$ H $\rightarrow \mathbf{\partial B/\partial t} \rightarrow \mathbf{H}$.

This vibration of opposites creates a wave which has both an Electric, E, and an Magnetic component, H, perpendicular each other and is as

$$[E^2 + H^2] = 2.(2r).c.\mathbf{\sin 2\varphi} \ldots\ldots\ldots\ldots\ldots\ldots (2)$$

and existstheSkin-effect .

This happens because of the difference in density *on Stress-common-curve* ρ = σ instead – ofρ = 0 .

This Property in Material-point Launches The Inner-Electromagnetic-Wave $[E^2 + H^2] = 2(2r).c.\mathbf{\sin 2\varphi}$, of wavelength λ, *Outward λ*, as *The Outer Electromagnetic-Wave*→{[$\varepsilon E^2 + \mu B^2$]= 2.λc.sin.2φ} ← and allows all the *Energy-Wave-Storages* to Propagate any Distance in Vacuum without dissipation.

This Inner-motion ≡ Work W, from the Wave-Energy-Pattern with Wavelengths $\boldsymbol{\lambda_n}$, is created from all ±Points of the Periodic Oscillation in any caver, and is stored in the n lobes as motion. This motion is conserved and is transported through vacuum at the speed of light c . Since Medium-Field Material-Fragment → [± s^2] = [MFMF] ≡*The Chaos*, is the base for all motions, *then issues,*

Motion of Photons: All motions create Work which is conserved, Motion presupposes velocity vector $\bar{\mathbf{v}}$ which, *when it is in motion collides with other velocity vectors* , creating a Constant Work k. Motion may be *Linear or Rotational* for any displacement, r, so exists constant-work → $k = \bar{\mathbf{v}} \times \bar{\mathbf{v}}.\bar{\mathbf{r}} = v^2.r$.

Constant-Work $k = v^2.\ r = (wr)^2.r = [\frac{2\pi}{T}\mathbf{r}]^2.r = \frac{4\pi^2 r^2}{T^2}\ r = \frac{4\pi^2 r^3}{T^2} = 4\pi^2\frac{r^3}{T^2} = 4\pi^2.r^3.\mathbf{f^2_p}$ →The Kepler Laws *i.e. Photon during Motion in* [MFMF] *Chaos collides with other* Photons*, by means of Cross-Product produces a constant Work which is stored into the* Only-Four *Energy-Geometrical-Shapes, of the motion , the Conic-sections. The Interior motion is kept in its Wavelength-Box*2r = nλ, *and the Linear motion is continued by the Propagating Electromagnetic-Wave*≡ *the conveyer.*

The mechanism of *Energy-transport through a Medium* involves the *Absorption and the Reemission* of the wave-energy by the atoms of the material. Since Quanta of Energy occupy a finite space λ = 2r , as motion, then an electromagnetic wave impinging upon the atoms of a material, its energy is absorbed by the atoms of the material, and since Energy ≡ motion then occurs *Resonance*, and electrons within the atoms undergo vibrations. After a short period of vibrational-motion, the vibrating electrons create a *New Electromagnetic wave* with the same frequency as the first one and thus delaymotion through the medium. Because energy is related to wavelength λ, then once the energy of EM-wave is reemitted then it travels through a small region of space between atoms and once it reaches the next atom the EM-wave is absorbed and transformed into electron vibrations and then reemitted as an Electromagnetic-wave.

The actual *speed of an Electromagnetic-wave through a material-medium*, due to the Absorption and Reemission-process, is dependent upon the *optical-density* of the medium, or when their atoms are closely packed upon their, *material -density*. i.e.

Photon is an Energy-store r, in a Stationary-wave of wavelength n λ = 2r, consisted of n stationary lobes filled in λ with inner motion the Electromagnetic-Displacement-current, while is Outward Propagating with light speed as Energy-store λ = 2r / n, [+] Electric-field as Space, [-] Magnetic-field as Anti-space.

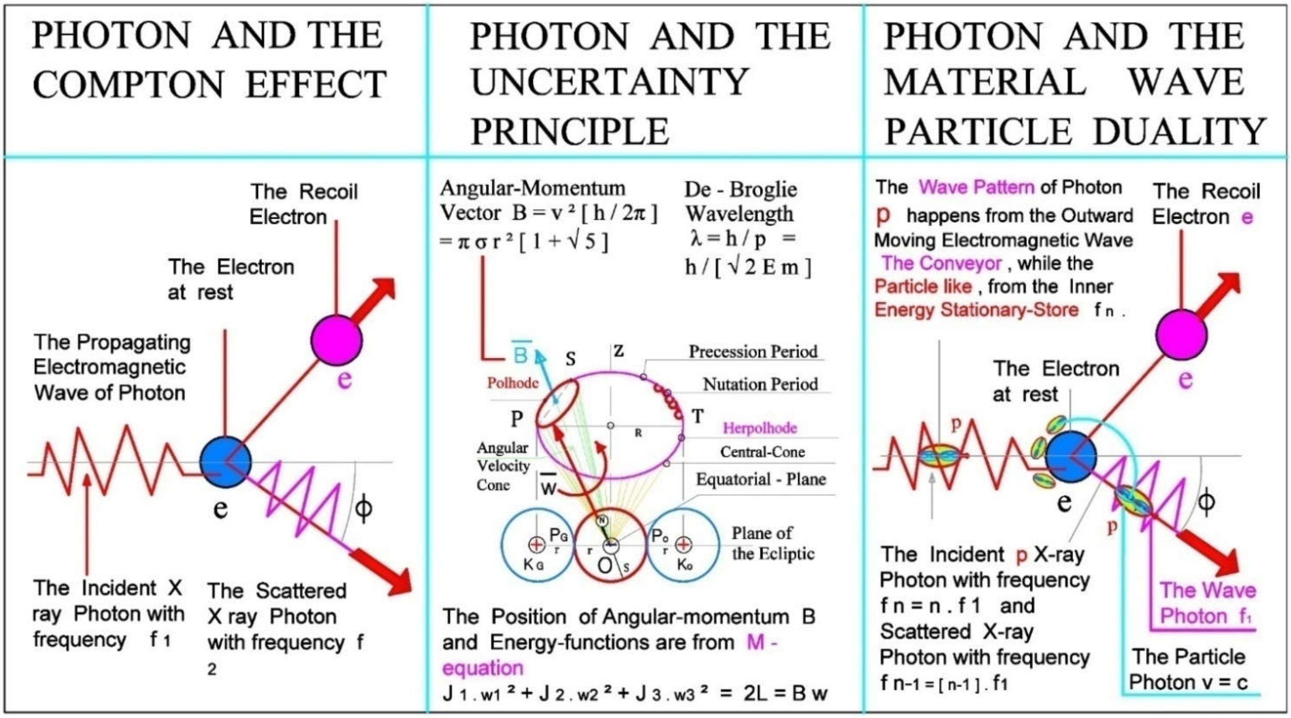

Figure 4: The Wave [$\mathbf{f_1}$= (E² + H²)] - Particle [$\bar{\mathbf{v}}$ =$\bar{\mathbf{c}}$= λf] → Duality

1. The experiment of A-Compton, *light behaves as a wave*, is consisted on an X-ray Photon of frequency $\mathbf{f_1}$ which collides with a stationary electron and Scattered with frequency $\mathbf{f_2}<\mathbf{f_1}$ which is energy loss.
2. The Uncertainty Principle for the Wave-Particle accepts each particle with a definite momentum can be described by a Wave-function, which created the suspicious of finding a Particle in the biggest envelope of the wave . *Instead of it momentum* B*rotates into the, Angular – Velocity-cone.*
3. The Material Wave-Particle Duality: All moving Energy-Storages are *Standing –Waves*-Particles as *all Quantum-Particles*, and their *Propagating-Energy as Electromagnetic-Wave* is their Conveyer.

In Energy-Storages issues the *Stability of Equilibrium* and this is Energy-Rims ≡ Orbitals, also.

a. *Compton Effect*

The moving stores which are the EM-Waves are consisted of three parts,

1. The Energy-store r = n.$\frac{\lambda}{2}$, is consisted of, n, energy lobes in the Stationary –Wave of cave, r, as the *Golden-ratio-frequency* $\mathbf{f_n} = \frac{\mathbf{n\sigma}}{\mathbf{8r}}[1+\sqrt{\mathbf{5}}]$, and consists the Massive-energy-part of Photon, p.
2. The Vertical Electric-field E is perpendicular to r axis and consists the Space-energy-part of Photon.
3. The Horizontal Magnetic-field P perpendicular to r axis and field E , both being always in Phase and consists the Anti-space-energy-part of Photon.

b. *Wave-Particle duality and Uncertainty Principles*:

All quantum objects and Photon, exhibit Wave-like and Particle-like properties such as diffraction and interference on the length scale of their wavelength. Experiments confirm that the Photon is not a short pulse of Electromagnetic radiation because it does not spread-out as it propagates, nor does it divide when it encounters a beam splitter. Because Photon is a *Material-point* is absorbed or emitted as a whole by arbitrary smaller than its wavelength or even point-like electrons or small-systems. It was shown [66] that Photon which is an *Energy-Storage-monad* is consisted of *two-real-constituents,and one Energy.*

That imaginary-constituent which creates the Electromagnetic field, *is resulting from the local and Energy–cave*, by launching The Inner-Electromagnetic-Wave of monad λ = 2r / n outward the λ.

c. *Material Wave-Particle Duality*

The Recoiled-electron position can be resolved to the New position as well as the Scattered Photon of the Energy-storage by its new frequency. Momentum equal to Spin is not changed because issues the law of energy-conservation. Electromagnetic energy is supplemented by the incoming wavelength $\lambda = 2r/n$, or by angle φ. The Storage r, modifies the Intrinsic-radiation and avoids spontaneous emission.[68] A photon with $E \perp B$ wave when entering a transparent material, Photon is absorbed by an atom and the reemitted, because wave vector would not be preserved , by the material and there would be scattering .

Light Storage $r \equiv E \perp H$, using electromagnetically-induced transparency, interaction between photon and an Ensemble of atoms *is tuned*, *to the group velocity of the photon reduced to zero* and to the remaining $\mathbf{B_P}$-Storage-field within the interaction zone. The excitation is not purely photonic, but instead has been mapped smoothly from a single photon to an ensemble of EB-Storage atoms. Photon is regenerated by its Intrinsic Electromagnetic $\mathbf{B_P}$-wave $E \perp B$ and is indistinguishable from the input one, *exactly the same*.

The interpretation that the Photon has been stored within the material is false, on the contrary Storage is the $\mathbf{B_P}$-Energy-tank with n, frequencies, $\mathbf{f_n}$ in Photon, and the Electromagnetic Radiation E, B, is the conveyer → *the carrier*. When Photon interacts E, B radiation is emitted and light behaves as $\mathbf{B_P}$-particle.

i. *The Moving – Energy - Stores*

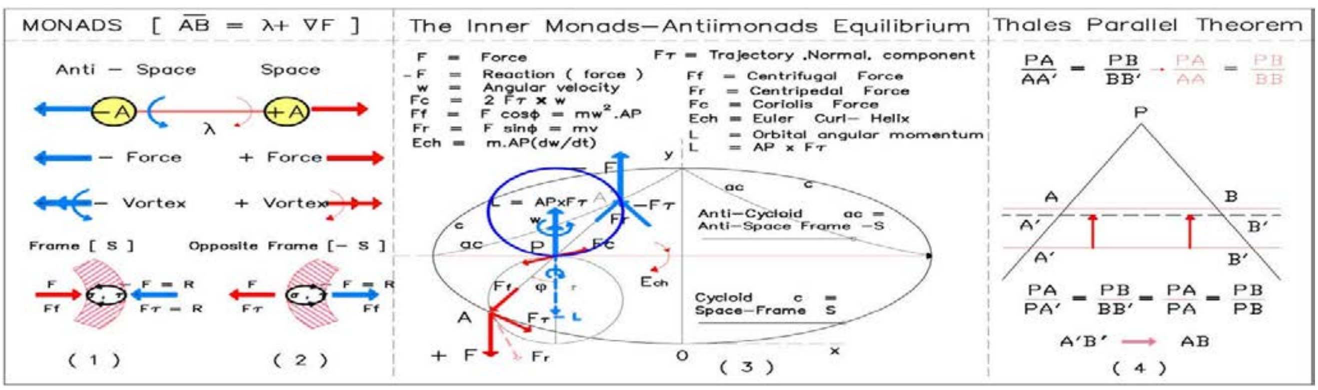

Figure 5: The inner structure of a *Stationary Wavelength* $\lambda = 2\pi r$ executing a *Free vibration,* and under Equilibrium of forces *in Cycloid, Anti-cycloid*

[-A≡⊖↔ A≡⊕] ≡ Monads ----Equilibrium of Plane Cycloidal-motion ---Thales Extrema-theorem

In (1-2). Normal stresses on area, S, from force, P, become → a moving Velocity-vector $\bar{\mathbf{v}}$.

In (3). For Cycloid (+) exists the equilibrium Orbital Evolute ≡ Anti-cycloid (-) with $\rho = \frac{\mathbf{v}}{\sqrt{\mathbf{g/4r}}}$

Motion happens on ρ, between Space (+ Point A) and Anti-space (- Point A\`), and energy $L = \bar{\mathbf{B}}.\bar{\mathbf{w}}/2$, and the eternal rotation of Spin $= \vec{\mathbf{B}}$ with its equilibrium Anti-Spin $= \vec{\mathbf{B}}$or$\overleftarrow{\mathbf{B}}$.

In (4). Thales Extrema theorem for Proportion with Zero denominator are the Infinite Vectors.

The moving Energy-Stores, r, with the Energy-Wavelength $\boldsymbol{\lambda_n} = \frac{\mathbf{2\,r}}{\mathbf{n}}$, acquire the Fundamental frequency $\mathbf{f}_{\mathbf{1}} = [\frac{\boldsymbol{\sigma}(\mathbf{1}+\sqrt{\mathbf{5}})}{\mathbf{4\pi r}}]$ with one lobe n=1, and carry the inner-motion as Work = Energy = h.$\mathbf{f}_{\mathbf{1}}$.

ii. *Material Points and Energy Fields: [QUANTA] . $W = 2L = \bar{\boldsymbol{B}}.\bar{\boldsymbol{w}}$*

The Quantization of Energy in space is the stationary Electromagnetic wave in monad and quantization of Space ds is the work W in breakage $s^2 = \lambda = 2r$, the Energy-Space Quanta. From work equation $W = [\lambda, \pm \Lambda\nabla i]$ where, λ = the Wavelength of quaternion=monad and $\pm \Lambda\nabla i = \Lambda = pv = M.\bar{\mathbf{c}} = [\lambda|\Lambda|].\bar{\mathbf{c}} = (\lambda m).\bar{\mathbf{c}} = (\lambda m).\bar{\mathbf{w}}.r = \bar{\mathbf{w}}.[\lambda(m.r)] = \bar{\mathbf{w}}.[\lambda(\bar{\mathbf{v}})] = \bar{\mathbf{w}}.[(cT).\bar{\mathbf{v}}]$ = the Energy, $\bar{\mathbf{w}}$, is the angular velocity vector ,$\bar{\mathbf{c}} = \bar{\mathbf{B}}$ is the spin, c the constant velocity equal to that of light ,$\bar{\mathbf{v}}$ is the velocity of monad, T is the period in wavelength\`s monad. As before Monads become from relationc. $\mathbf{L_s} = \mathbf{L_v}$,

Quantization of Energy confined in a monad say ($\bar{\mathbf{v}}$), (it is the inner structure of monad) is the Stationary wave of the Real part $|\lambda|$ of $\bar{\mathbf{v}}$, due to the Electric Displacement field ($|\bar{\mathbf{v}}| = \boldsymbol{\varepsilon}.E + P$), alternately in terms of The Electric field E $= (\partial P/\partial t)$ and The Magnetic field $P = (\partial E/\partial t)$, $\boldsymbol{\varepsilon}$ is the Permittivity as a measure of how much the wavelength opposes E-field .Object in mechanics, is the Quantized Material point (1) at Euclidean point (2), which is now Breakage $\pm [(\bar{\mathbf{w}}.r)^2]$ magnitude, in the Rest, Homogenously,Quantized mass-less Field $\{\pm [(\bar{\mathbf{w}}.r)^2]\}$ and consists the required coordinate System and the base for all motions and forces. This Rest-Space-System (the Base) is [MFMF] Field with the less space distance ds = $|\bar{\mathbf{w}}.\bar{\mathbf{r}}|^2$ extended beyond Planck`s length, and is the Space Quanta.

Object in mechanics may be also the Quantized Energy as wavelength λ=(1)-(2) in [Medium-Field Material Fragment →[± s^2] = $|\bar{\mathbf{w}}.\bar{\mathbf{r}}|^2$ = [MFMF] Field ←] which is a standing wave in cavity (1)-(2) with scalar breakage {|+($\bar{\mathbf{w}}$.r)^2|↔|-($\bar{\mathbf{w}}$.r)^2|} as medium (1)-(2) field, and (J1= $\bar{\mathbf{v}}$) the Energy as velocity at point (1) and carried to point (2) by following the isochrones cycloid motion from point (1) to (2). Velocity, $\bar{\mathbf{v}}$, during shifting , and because A=0, is analyzed into two transverse velocity vectors $\bar{\mathbf{v}}$1,$\bar{\mathbf{v}}$2, which undergo vibrations and causes two waves which are the two Quantized Electric and Magnetic isochrones components, and this because follow cycloid trajectories or The Energy Quanta, in Space Quanta.

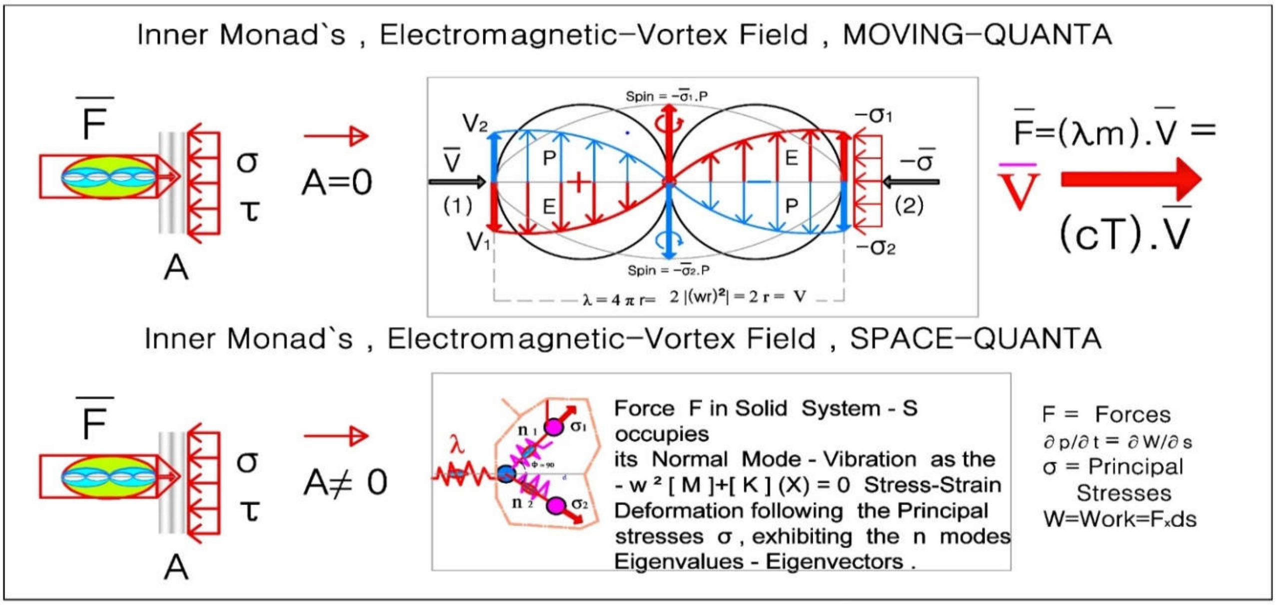

Figure 6: The Energy-Space, *Stress-Strain* in wave length λ=2πr, of a moving Photon

1. For area A = 0, *the Force* F *which is an Energy-Space-cave*, is manifested into the transverse Principal stresses, σ, τ, and then as *an Moving-Storage*(1)-(2) is transported as Velocity-Vector $\bar{\mathbf{v}}$, as F = σ.A → $\bar{\mathbf{p}}$ vector = M.$\bar{\mathbf{v}}$ = (m λ).$\bar{\mathbf{v}}$ = (m.c/f).$\bar{\mathbf{v}}$ = [c.T].$\bar{\mathbf{v}}$ =(m/f).c.$\bar{\mathbf{v}}$*i.e. a Velocity-Vector*$\bar{\mathbf{v}}$.
2. For area A > 0, *Force* F *which is an Energy-Space-cave*, resolves as Electromagnetic-*Radiation* in Principal stresses ±$\boldsymbol{\sigma_1}$, ±$\boldsymbol{\sigma_2}$, ±$\boldsymbol{\sigma_3}$, which *is the Passage* through which *Forces travel* in moving Solid.
3. For area A <0, *because Force* F *is an Energy-Space-cave which at first passes from the Zero area*

A=0 *and becomes velocity-vector* $\bar{\mathbf{v}}$, this velocity-vector $\bar{\mathbf{v}}$ is entering any trough and transformed to an Energy-Rim, as are the Orbits of electrons . Because Photon is one of the moving-energy-stores when enters a cave $\mathbf{L_s}$, the cave becomes an Discrete-Energy-Packet which is Rim $\mathbf{L_v}$.

Question: When maximum velocity occurs in Common circle ??.

From Fig-5 maximum velocity occurs when the two velocities $\bar{\mathbf{c}}$, $\bar{\mathbf{v}}$ are perpendicular between them, where then dispersion follows Pythagoras theorem and the consultant Quantized Space, r, becomes r =$\sqrt{\mathbf{v^2+c^2}}$. The total Rotating energy is → ± $\bar{\boldsymbol{\Lambda}}$ = $\bar{\mathbf{p}}$.r = (M.c).r = (M.c).$\sqrt{\mathbf{v^2+c^2}}$ and [± $\bar{\boldsymbol{\Lambda}}$]^2 = p^2.r^2 = M ^{2}.c^2.(v^2+c^2) = (M^2.v^2).c^2 + M^2.$\mathbf{c^4}$ = [p^2.c^2] + M ^{2}.$\mathbf{c^4}$ = [p.c] ^{2} + [$\mathbf{m_o}$.c^2] ^{2}, which is the known relativistic energy - momentum equation of Lorentz transformations equation.

The mechanism of Energy Transport as ($\bar{\mathbf{v}}$) through its quantized wavelength |λ = $\bar{\mathbf{v}}$.T|, is a property of any standing wave, into the Medium |λ| = (1)-(2), and involves the Absorption and Reemission of the wave quantized energy J =(J1)=(J2) by the two neighbor edges (1) and (2) of the medium. The Absorption of energy causes, J1, within edge (1) to undergo vibrations as [ds1^2/dt^2] = - (g/4r).s which causes a new wave with the same frequency (because f=E/h) as the first wave but delaying the motion through the medium until Reemission by travelling, J1 to J2, through this small region of space between edges (1) and (2) and once the energy of wave is reemitted by its neighbor edge (2) then mechanism is recycled. This mechanism is succeeded by the intrinsic property of the waves (→ quaternion`s, monads, vectors, Tensors) which is, the Stationary wave nature of Spaces, and works as follows, →

It was shown in [27] that on dipole AB = [(λm), Λ] under the influence of Space Anti-Space forces dP = $\mathbf{P_B}$-$\mathbf{P_A}$ are created from forces dP// Space lines the Static Force Field, E, from forces dP⊥ Space lines the Static Force Field ,P, where P ⊥ E , which then experience on any moving dipole AB with velocity $\bar{\mathbf{v}}$, a total force F = $\mathbf{F_E}$+ $\mathbf{F_P}$= (λm).E+(λm).$\bar{\mathbf{v}}$xP which combination of the two types result in a helical motion ,with stability demand → E = - ($\bar{\mathbf{v}}$xP) = - ($\bar{\mathbf{v}}$. P) ⊥ *which is the alternative conservation of momentum* $Λ^2$/2(λm), *in the two perpendicular fields* E , P.

In case (λm) = q , then total force F = $\mathbf{F_E}$ + $\mathbf{F_P}$= q.E + q.$\bar{\mathbf{v}}$ x P = q.[E + $\bar{\mathbf{v}}$ x P]

which is Lorentz force in the Electromagnetic crossed fields E *and* P *with electric charge* q= λm *and are the two beyond Gravity Fields, interpreting the fundamental cause (effect) of motion, in small and large scales.*

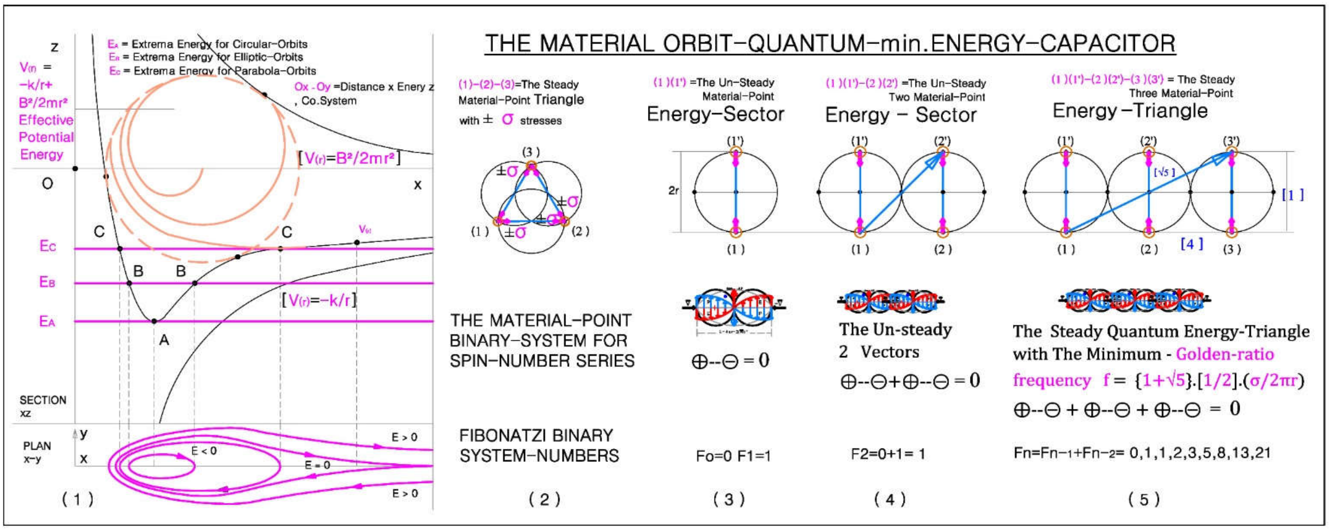

Figure 7: The minimum-energy, Quantum, in any Central-motion, and on the Material-point

The *Golden-ratio-frequency* $\mathbf{f_n}$, Quanta on Vector, Plane and Triangle.

1. In (1) is the Graph of *Effective-Potential-energy* in a Central-motion becoming from Kepler constant k = $4π^2.r^3.\mathbf{f_P}^2$, or $1 = [\frac{4\pi^2}{k}]r^3.\mathbf{f_P}^2$ or → $1 = c.\ r^3.\mathbf{f_P}^2$.
2. In (2) is the Graph of the *minimum-Quantum-energy* of the Triangle Pointy-Material-Stationary Energy-Point in *Gravity field* and equal to the Gravity-acceleration g.
3. In (3)-(4)-(5) is the Graph of the *minimum-Quantum-energy in* the *Sector*, two Sectors ≡ *Plane*, *Triangle of* Pointy-Material-Steady-point in Gravity field .Because of the *Golden-ratio-frequency relation* $\mathbf{f_n} = [\frac{(1+\sqrt{5})}{2}]\ \frac{\mathbf{n.\sigma}}{\mathbf{2\pi r}}$, predicts the *Ubiquity of the Golden-ratio* in Nature from the microcosm to the macrocosm, *the macro scale*.

iii. *Gravity Force*$\boldsymbol{F_G}$, *Gravity field*$\boldsymbol{F_{FG}}$

The *standing wave in cavity*(1)-(2) with scalar breakage |±($\bar{\mathbf{w}}$.r)²| *as medium* (1)-(2)= |(+$\bar{\mathbf{w}}$.r)²↔(−$\bar{\mathbf{w}}$.r)²| *Field, and Energy* [Λx∇i] = (J1) =2.($\bar{\mathbf{w}}$.r)² *as velocity* $\bar{\mathbf{v}}$ *only at point* (1), [and this because Work as Force is ,*in extreme case where zero area* (A=0) and becomes velocity $\bar{\mathbf{v}}$], *need the same time*(different velocities and different energy on (1) are isochrones)*and this because are following cycloid trajectories in medium* (1)-(2)) *to reach edge* (2). *Energy* (J1) *as velocity vector,*$\bar{\mathbf{v}}$, *is the* cross product *of two velocity vectors* $\bar{\mathbf{v}}$1,$\bar{\mathbf{v}}$2*or* → $\bar{\mathbf{v}}$ =$\bar{\mathbf{v}}$1x$\bar{\mathbf{v}}$2 ,*with head at point* (1) *and analyzed , in a perpendicular to* (1)-(2) *directional plane, into the two orthogonal velocity vectors* $\bar{\mathbf{v}}$1, $\bar{\mathbf{v}}$2 *which heads are at point* (1).

Energy J1 *is carried to point* (2) *by following the cycloid motion* (1)-(2). Fig-15(3)

During contracting (shifting), *velocity vectors* $\bar{\mathbf{v}}$1, $\bar{\mathbf{v}}$2, *being vectors undergo vibrations (expand as oscillation) which causes two waves that represent the two Electric* E, *and Magnetic* B, *perpendicular components* (*The combination of vibration* (O) *and oscillation* (↔) *is what determines the frequency rate, the cyclic pattern of scalar waves*) *until reaching point (2) which is the Reemission of the wave and it is the new head of velocity,*$\bar{\mathbf{v}}$, *where then mechanism is recycled.*

These scalar waves are standing waves that flash on and off. Since wavelength, λ, as distance (1)-(2) is equal to product velocity (v).period (T) then λ = $\bar{\mathbf{v}}$ T = $\bar{\mathbf{v}}$ f = 2r / n, since r = n.(λ/2).

Medium in cavity λ = (1)-(2), *is breakage* $|\pm(\bar{\mathbf{w}}.r)^2|$ *and Energy* (J1) *is the momentum* $\bar{\mathbf{B}}$= *the Spinas velocity vector*$\bar{\mathbf{v}}$ =2($\bar{\mathbf{w}}$.r)², *so this velocity vector fits to the scalar magnitude* [$|(\bar{\mathbf{w}}.r)^2|$ = (1)-(2)] *which is the force in all Inertial systems and is called* GRAVITY *or Momentum* GM . *Because any particle of mass, m =* 2(wr)² *tied to a fix point* (1) *executes a Simple harmonic motion in Medium* (1)-(2) which is *breakage* $|\pm(\bar{\mathbf{w}}.r)^2|$, *then* GM = 2($\bar{\mathbf{w}}$.r)², *is a Force or acceleration, and it is the intrinsic Electromagnetic Stationary velocity vector. The Magnetic field , which is binding points of this Homogenous- Isotropic, Rest and mass-less nature field of chains of Spins*, *is tuning the chains of Spins to a minimum Quantum-Energy-state,* with the characteristic *Golden-frequencies* of the Spin chains $\mathbf{f_n} = \frac{\mathbf{n.(1+\sqrt{5}\,])\,.\sigma}}{\mathbf{4\pi r}}$ The tension σ , comes from $\bar{\mathbf{B}}$ interactions between Spins, causing them to magnetically-resonate.

Because Gravity-Force $\mathbf{F_G}$ becomes from the in-storages acceleration a = v²/r of MFMF material-points and force [∇i] is stationary because from the pointy-rotation [-s²℧℧s²+], then $\mathbf{F_G}$ *for Planck length* is, *Gravity force*

$$[\nabla i] \equiv \mathbf{F_G} \equiv \mathbf{m_G} g = g.\nabla[\tfrac{\sigma}{c^2}]^2.r = \mathbf{m_G}\frac{\mathbf{v^2}}{\mathbf{r}} = Jw^2.\mathbf{g_G} = [\frac{\mathbf{\pi r^4}}{\mathbf{2}}]\, w^2.\frac{\mathbf{v^2}}{\mathbf{r}} = \frac{\mathbf{v^2}}{\mathbf{r}}[\frac{\mathbf{\pi r^4}}{\mathbf{2}}]\frac{\mathbf{v^2}}{\mathbf{r^2}} = [\frac{\mathbf{\pi r v^4}}{\mathbf{2}}] \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots(s)$$

and from relation, Spin S = $\bar{\mathbf{B}} = \frac{\mathbf{h\sqrt{3}}}{\mathbf{4\pi}}$ then, $\mathbf{F_G} \equiv [\frac{\mathbf{\pi v^4}}{\mathbf{2}}]\frac{n\pi}{2h(1+\sqrt{5})}\bar{\mathbf{B}} = [\frac{\mathbf{n\pi^2}}{\mathbf{4h(1+\sqrt{5})}}]\bar{\mathbf{B}}\mathbf{v^4}$ and, *Gravity-force* → $\mathbf{F_G} \equiv \frac{\mathbf{n\pi\sqrt{3}}}{\mathbf{16(1+\sqrt{5})}}\mathbf{v^4} = \frac{\mathbf{n\pi\sqrt{3}}}{\mathbf{(1+\sqrt{5})}}(\frac{v}{\mathbf{2}})^4$, *which is the Black-hole-gravity-equation related to the Inner velocity* v, *and to its* n, *lobes*.

From equation (s), Gravity-Acceleration is,

$$\mathbf{g_G} = s[\frac{\mathbf{\pi r v^4}}{\mathbf{2}}] = [\frac{\mathbf{3{,}1415926([\sqrt{5}+1].\sqrt[4]{2}.10^{-35}).(299793458)^4}}{\mathbf{2}}]\boldsymbol{e^3} = 6{,}044981.\mathbf{10^{-35}}.80{,}776078.\mathbf{10^{32}}.20{,}085536 =$$

$\mathbf{g_G}$ = 9,8076941,

where 1/$\mathbf{m_G}$ = s = mass-coefficient [√5+1] .$\sqrt[4]{\mathbf{2}}.\ \mathbf{e^3}$ i.e.

Bodies produce Gravity {*the change of Spin-direction of* M-P-Dipole [⊕s²℧℧⊖s²]*in* MFMF *field*} *from stationary force*[∇i]= ± s², *and because Gravity ≡ acceleration not by the change of velocity vector but by the changing of the direction of the Spin* $\bar{\mathbf{B}}$of the above Spin-chains-dipole [⊕s²℧℧⊖s²].

Remarks:

1. Spin chains of the Material-points occupy the characteristic frequency $\mathbf{f_n} = \frac{\mathbf{n.(1+\sqrt{5}\,])\,.\sigma}}{\mathbf{4\pi r}}$ which is the Golden-ratio of magnitude, σ. What this means in Material-geometry ???

In Figure-7, The Work produced by the eternal rotation of [⊕℧⊖] is W = h.$\mathbf{f_n}$,dependent on stress σ only of cave r, and the *Quantum ≡ critical quantity ≡* $\mathbf{f_n} \equiv [\frac{\mathbf{1+\sqrt{5}}}{\mathbf{2}}]\frac{\boldsymbol{\sigma}}{\mathbf{2\pi r}}$ →*The Golden-ratio of cave,* r.

In Figure-11 is shown that If cave r, is a Sector , a Circle, a Triangle, a Rectangle, or any other Shape, then *The Golden-ratio is formulated on the,* Sector, Circle, Triangle, Rectangle, or to any other Shape by following the Euclidean geometry of the *cave.* The golden ratio is of one-two- and three-dimensional chains .Golden ratio for *vectors* exists in velocity-vectors, for *two vectors* exists in Electromagnetic radiation vectors, *for three vectors*, *triangle and the circumscribed circle*, all shapes in triangles and the relation of triangles to the circle. For *four vectors* golden ratio is visualized as spiral shapes and for equal vectors *square*, is the Archimedes Spiral since σ is constant in Material-geometry, All geometrical shapes of the golden-ratio can be seen in Euclid geometry, Since Quaternion z = a + i**∇** does not occupy any mass so m =1.

2. The constant tensor $\mathbf{T_z}$ =Tensor (the length) of Quaternion-vector, z ≡ m, in Euclidean coordinates and which magnitude is $\mathbf{T_z} = \sqrt{\mathbf{y_1}^2 + \mathbf{y_2}^2 + \mathbf{y_3}^2 + \mathbf{y_n}^2}$ denotes the Energy-Space minimum relation. so, the Quantum Golden-quantity [$\frac{\mathbf{1+\sqrt{5}}}{\mathbf{2}}$] issues, as the Material-cave coefficient.

The Unity-Plane-Quaternion coefficient is $\sqrt[2]{\sqrt[2]{\mathbf{2}}} = \sqrt[4]{\mathbf{2}}$, or, $\overleftrightarrow{\mathbf{\imath \perp \jmath \equiv \sqrt{2}}}$ + $\overleftrightarrow{\mathbf{k \perp \sqrt{2} \equiv \sqrt[2]{\sqrt[2]{2}}}} = \sqrt[4]{\mathbf{2}}$ The Three dimensions-coefficients of Euler`s-Rotation-System is e. e. e =$\boldsymbol{e^3}$

3. The minimum Energy ≡ Force, *acceleration*, becomes from the Centrifugal acceleration with the inertial mass of the cave for the Quantum-critical-state which is proved to be the g Gravity-acceleration.

iv. *The Conic Sections and Planar – curves*

Menaechmus came to think of producing curves by cutting a cone *from the circle definition which is,* → *Since the center* O *of a circle is of equal distance to all points in Plane of the circumference the same also to all Centers* $\mathbf{O_n}$ *from center* O *which are online* $\mathbf{OO_n}$ and *Perpendicular to this Plane* ← In figure-8, Line$\mathbf{OO_n}$is the generator axis of a right-angled cone and all the shapes of the curve produced by cutting a right-cone by a plane obliquely inclined to its axis is a conic section. In circle [O,OP] with only one center issues for point P, OP + PO = 2R is constant, while in ellipse [$\mathbf{O_1P}$,$\mathbf{PO_2}$] of two centers $\mathbf{O_1}$, $\mathbf{O_2}$ issues for point P, P$\mathbf{O_1}$+ P$\mathbf{O_2}$= major-axis, is constant. This property allows Central-motion to be seen as a Geometrical problem of Proportions on Points and lines [44].

In [70] was shown that $\bar{\mathbf{M}} = [\bar{\mathbf{r}} x \bar{\mathbf{p}}] = \frac{d\bar{\mathbf{B}}}{dt} \rightarrow$ *the Theorem of Equal-Areas* and Kepler`s 1st Law, i.e. Momentum $\bar{\mathbf{p}}$, of a force $\bar{\mathbf{P}}$, to a constant center O, of radius $\bar{\mathbf{r}}$, is equal to the change of the angular -momentum $\bar{\mathbf{B}}$ at time t, related to the same center O, and its trajectory lies on the same Plane.

a. *The Geometrical Central motion*

Huygens and Johannes Bernoulli came to think of producing the Shortest-Time curve between Two points on a vertical Plane *by a point acted only by gravity and which is, → To find the Path - curve or surface for which a given variation has a Stationary value*,
Stationary or Extrema is the maximum or minimum between two points (1) and (2) ←

It was proved that this curve is the Cycloid as in Figure -5(3). From Geometry of Figure - 8, Equality

$$\mathbf{A_1}O = p/e = AP + OP.\mathbf{cos\,\varphi} = r/e + r.\ \mathbf{cos\,\varphi} \ \textit{and} \ p = r + r\,e.\mathbf{cos\,\varphi} = r\,(1 + e.\mathbf{cos\,\varphi}) \quad \ldots\ldots\ldots\ldots(1)$$

where , p = a constant parameter, r = the orbit radius from O.

Inversing (1) then $\rightarrow \frac{1}{r} = \frac{1+e.\cos\varphi}{p}$ and Derivative $\rightarrow \frac{d^2 1/r}{d\varphi^2} = -\frac{e.\cos\varphi}{p}$, $\rightarrow \frac{d^2 1/r}{d\varphi^2} + \frac{1}{r} = \frac{1}{p}$ ………………. (2)

Integrating (2) is the acceleration at point P and equal to $\rightarrow \quad a = -\frac{4A^2}{r^2}\frac{1}{p}$ …… ……….. ………….. (3)

where the constant area O, P, $\mathbf{P_1}$ = A = $\frac{1}{2}$. r^2.$\frac{d\varphi}{dt}$, and for ellipse the Area = ($\pi \mathbf{a_e b_e}$).

For ellipse $\mathbf{a^2_P}$ = p .$\mathbf{b_P}$, or $\frac{1}{p} = \frac{a_P}{b^2_P}$ and period of rotation T, then the Constant area *for a period T* is

$$A = (\pi \mathbf{a_P b_P}) / T \ \text{ and (3) becomes } \ a = -\frac{4\pi^2.}{T^2 r^2}\mathbf{a^2_P b^2_P}\frac{a_P}{b^2_P} = -\left[\frac{4\pi^2}{T^2}\mathbf{a^3_P}\right]\frac{1}{r^2} = -\left[\frac{4\pi^2}{T^2}\right]\frac{a^3_P}{r^2} = -k\frac{1}{r^2} \ \ldots\ldots\ldots\ldots\ (4)$$

or acceleration $\quad a = -\left[\frac{4\pi^2}{T^2}\right]\frac{a^3_P}{r^2} = -k\frac{1}{r^2}$, *where* $k = \left[\frac{4\pi^2 a^3_P}{T^2}\right] = 4\pi^2.\mathbf{a^3_P}.f^2 \rightarrow$ a consta nt ……………….(4a)

Equation (4a) is Kepler`s second Planetary law, *Spotting constant* k, to be a function of the Orbit ≡ $\mathbf{a^3_P}$≡ the Semi-major axis ≡ Space and as a function of Time, T, or the frequency, $\mathbf{f_P}$, of orbiting.
This significant property can be used also in atom`s structure .
For circular motion $\mathbf{a^3_e}$= r, and (4a) becomes $a = -\left[\frac{4\pi^2}{T^2}\right]\frac{r^3}{r^2} = -\left[\frac{4\pi^2 r}{T^2}\right] = 4\pi^2.r.f^2$ and $k = \left[\frac{4\pi^2 r^3}{T^2}\right] = 4\pi^2.r^3\mathbf{f_e}^2$ i.e.

1. Kepler`s First law of Orbits : All Planets move in Elliptical orbits , with the sun at one focus.
2. Kepler`s Second law of Areas : A line that connects a Planet to the sun sweeps out equal areas in equal times.
3. Kepler`s Third law of Periods : The square of the period of any Planet is proportional to the cube of the semimajor axis of its orbit.
4. Kepler`s constant k= $4\pi^2 r^3(1/T)^2$: The constant k , is Not-Only constant during the motion of a Planet, because being also k ≅ $r^3.(1/T)^2$ = constant for all Planets
5. Spotting on Kepler`s constant k : During the Central-Plane -motion of a Planet ≡ Momentum $\bar{\mathbf{B}}$ and a Sun ≡ focus O, the coefficient $r^3.(1/T)^2$ = $r^3.\mathbf{f_P}^2$ is Constant.

Applying above property to Caves ≡ Energy-Storages ≡ Orbits, then since $r^3.\mathbf{f_P}^2$ = C = Constant, then change of r, follows change of $\mathbf{f_P}$, or Electromagnetic-wave $\mathbf{E_1} = [\frac{4\pi r^2}{3}].\mathbf{f_1}$ = C is absorbed or emitted.

Remark :

1. In [54] , was shown The Periodic Table of Particles with the 118 Elements and The Proposed New elements are becoming from the completion of the Open-Rim (7) . A New Rim (8) is consisted of 50 Positions which are filled with Protons with 218 Elements. The New is following Pascal`s-Triangle-Array where Rims are numbers contained in the Prior ones and so then, follow the Positions in each Orbital and so for Electrons as the Base for Protons.

Since, Caves≡ Energy-Storages≡ Orbits≡ Stationary-lobes≡ Energy-Rims≡ $r^3.\mathbf{f_P}^2$ = $\mathbf{E_n}$ = n.$[\frac{4\pi r^2}{3}].\mathbf{f_1}$ = C
Therefore, *Atoms Wheel-Rim,* the Protons-Neutrons in Nucleus and Electrons in Orbital-Positions, *is an Energy - Rim for each Energy-Orbit of electrons. Because in this Energy-Rim is placed the minimum energy which is equal to* g, becoming from$\mathbf{f_n}$ ≡$[\frac{1+\sqrt{5}}{2}]\frac{\sigma}{2\pi r}$ →The Golden-ratio of cave, r, *therefore, all microcosm,* atoms and subatomic particles

Planck-scale till reaching the Material-point, *and macrocosm,* Galaxies, Dark-matter and Dark-energy, Black-holes, the far extension universe *follows the Archimedes-Spiral and the Golden-ratio relation* $\mathbf{f_n}$ *, of the Material-point*. Fig-11

2. It was shown that all particles have the same acceleration, g, in our gravitational field with frequency unchanged, and → velocity, d$\bar{\mathbf{v}}$, with wavelength, λ, to be changed← so light being a particle also is deviated in gravity field and, *Inertial mass* is equal to the *Gravitational mass* which is the Necessary and Sufficient Condition only in Mass of Material-point where c.T = λ, of this Isochronous motion.
3. The Spotting on Kepler`s constant k.

Question: Since the Central-Plane-motion of point P=*Planet* ≡Momentum $\bar{\mathbf{B}}$, *and a Sun* ≡ Focus O is a Conic–section, to find of producing the *Shortest - closed-Surface on any Plane*, such that *Energy*≡ *motion, to be minimum-constant* ≡ *The closed-Surface of the two points and which is→ To find the Energy -Path-closed-Curve of the two Points which Surface is of a Constant-Energy.* Constant is nota maximum or minimum magnitude between the two points P and O, instead it is a Fixed sum from rotation≡ [⊕↻↺⊖]≡ motion, trapped in a *closed-curve* ←

It was proved that this *closed-curve* is the Energy-curve of, Constant k = 4π².r³.$\mathbf{f_P}$², as in Figure-8, *It is proved that the minimum-Quantized-energy in Material-point is the Centrifugal-acceleration and it is the Gravity-acceleration which is equal to* g.

From relation, c.$\mathbf{L_s}$ = $\mathbf{L_v}$, the *Light-velocity*-moving-Store3.$\mathbf{10^8}$m/s, *enters* cave 1.$\mathbf{10^{-42}}$m *and becomes equal to* 3.$\mathbf{10^{-34}}$ m²/s *which is the Plane* - Energy-Cave - *Rim. i.e.* the moving-Energy-Store *of light as velocity,* v, *Enters in* Stationary Energy-cave1.$\mathbf{10^{-42}}$m, *and becomes the Constant* –Stationary-Energy- *Plane - cave* and equal to 3.$\mathbf{10^{-34}}$m²/s.

The Energy-quantity k is constant in Planck`s scale cave $\mathbf{10^{-34}}$ m and exists, in Plane Rims, becoming from the continuous *Central - Rotation of masses* in scales. It is shown in, *Kepler`s third law*, that this constant is k = [$\frac{\mathbf{4\pi^2 r^3}}{\mathbf{T^2}}$] =4π².r³ $\mathbf{f_P}$², where for the Sun-Earth-Rim Semi-major-axis , r = 15.$\mathbf{10^{10}}$ m, and the period T = 1 year the Energy in this *Plane-Sun-Earth Rim* is k = 3.$\mathbf{10^{-34}}$ = [3.$\mathbf{10^8}$].$\mathbf{10^{-42}}$ y²/m³.

b. *The Two Material-points Problem*

From classical mechanics and for Two bodies of mass $\mathbf{m_1}$, $\mathbf{m_2}$, of Polar radius $\mathbf{r_1}$, $\mathbf{r_2}$, from a Center of mass coordinate system lying on line 1 – 2, exist,

1. The interacting via a Gravitational force, is mathematically equivalent to the single body motion and has the absolute value

$$F = k\,(\mathbf{m_1}.\,\mathbf{m_2})\,/\,(\mathbf{r_1} + \mathbf{r_2})^2 \qquad \ldots\ldots(1)$$

where k = a constant

2. By setting $\mathbf{m`_1} = [\frac{\mathbf{m_1}}{(\mathbf{1+m_2/m_1})^2}]$, then $$\mathbf{F_{21}} = k\,\frac{\mathbf{m`_1 .m_2.}}{\mathbf{r_2}^2} \qquad \ldots\ldots(2)$$
3. By setting $\mathbf{m`_2} = [\frac{\mathbf{m_2}}{(\mathbf{1+m_1/m_2})^2}]$, then $$\mathbf{F_{12}} = k\,\frac{\mathbf{m`_2 .m_1.}}{\mathbf{r_1}^2} \qquad \ldots\ldots(3)$$ i.e.

motion is exactly as, An attractive force $\mathbf{m`_1}$*exists at the center of mass*, *and mass* $\mathbf{m_2}$ *is revolving in elliptic trajectory around this point of mass*.

From the mass proportion is seen that, the center of mass is on line (1-2) and very close to the big mass a property of the Central - Rotation of masses issuing in our Solar-system.

4. If motion of any point P is expressed in orthogonal coordinates as x = a $\mathbf{\cos ft}$, y = b$\mathbf{\sin ft}$, to show the Orbit of P, where a, b, f, are constants.

From relation $\mathbf{\cos ft} = \frac{\mathbf{x}}{\mathbf{a}}$, $\mathbf{\sin ft} = \frac{\mathbf{y}}{\mathbf{b}}$, using Pythagoras theorem gives ellipse $\mathbf{\cos^2 ft} + \mathbf{\sin^2 ft} = 1 = \frac{\mathbf{x^2}}{\mathbf{a^2}} + \frac{\mathbf{y^2}}{\mathbf{b^2}}$ If X, Y are the components of forces then,

X = m $\frac{\mathbf{d^2x}}{\mathbf{dt^2}}$ = - m.af². $\mathbf{\cos ft}$ = - mf ².x and Y= m $\frac{\mathbf{d^2y}}{\mathbf{dt^2}}$ = - m.bf². $\mathbf{\sin ft}$ = - m.f ².y and by division

X: Y = x : y *i.e. the Force is directed to the center of rotation and is proportional to the distance*.

For rotational motion after t`, moment of time mass is at the same position issuing, $\mathbf{\cos f\,`t}$ = $\mathbf{\cos ft}$ and $\mathbf{\sin f\,`t}$ = $\mathbf{\sin ft}$, so t` - t = k $\frac{\mathbf{2\pi}}{\mathbf{f}}$ = T, where k is an integer and T = $\frac{\mathbf{2\pi}}{\mathbf{f}}$, which is the Period of the rotation. In times t, radius r, sweeps out the same area $\mathbf{S_n}$ and , $\mathbf{S_n}$= π ab /T = π ab f /2π = (ab / 2) . f → *is constant* since f = (2.$\mathbf{S_n}$)/ab, *is constant*, *Kepler Law*.

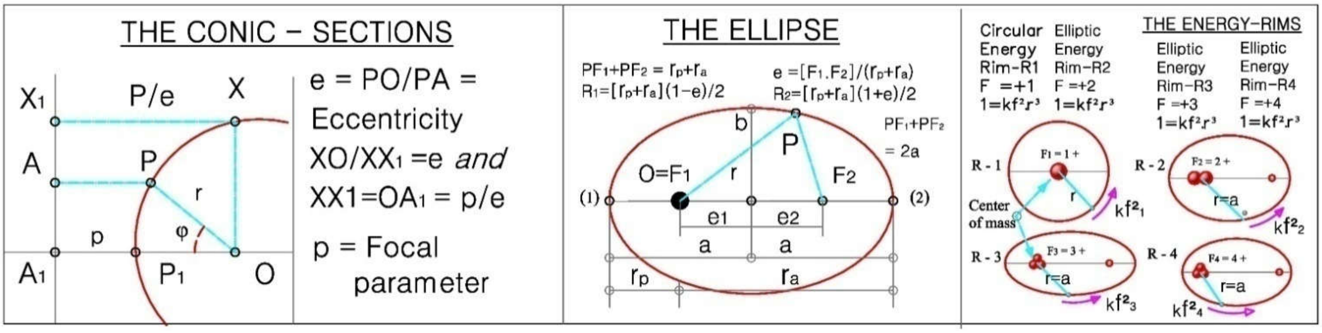

Figure 8: The Conic-sections as Planar and Atoms-curves, under Equilibrium of forces

1. The generation of the Conic-sections. O = The constant center of rotation, P = The movable Point on Orbit, p = The parameter of the conic, e = the eccentricity of the conic $0 \leq e \leq 1$
2. The Central Ellipse and Gravity relation for masses $\mathbf{m_P}$→ Planet, On - $\mathbf{m_S}$ → Sun.
3. The Energy-Rim $\mathbf{R_1}$ *is circle* because focus $\mathbf{F_1}$ is consisted of one center ,while the others for Focus $\mathbf{F_n}$ is of 2,3,4,,n.. centers due to ⊕ elements *are Ellipse* for every one ⊖mass$\mathbf{m_P}$.

Kepler`s constant Planets relation $\frac{T^2}{a^3}$=k= $[\frac{4\pi^2}{G.m}]$ = 2,97.$\mathbf{10^{-19}}$(s²/m³) , where G = 6,67.$\mathbf{10^{-11}}$(Nm²/Kg²) becomes from the Light-velocity-Storage,$\bar{\mathbf{v}}$, when, $\bar{\mathbf{v}}$, is entering the cave r =1.$\mathbf{10^{-42}}$m, where is produced the Energy *Plane-Cave-Rim* equal to$\mathbf{R_n}$ = 3.$\mathbf{10^{-34}}$m²/s.

Since also exists the relation k.$\mathbf{f_n}^2$.r³ = 1 where r = semi major axis a, *then*,

An Energy-Rim is a Plane-Surface representing a Constant-Energy becoming from the squared Frequency $\mathbf{f_n}^2$, *representing the Imaginary -Energy-Part of monad, and* $\mathbf{r_n}^3$ *representing the Real-Space-Part of monad* 1 = k.$\mathbf{f_n}^2$.r³. *All these Energy-Rims consist the Quantized-Plane-curves*

c. *Central motion and Gravity*

Kepler`s third law of harmonics suggested that , the ratio of the period of orbit squares (T²) to the mean radius of orbit cubed (R³) is the same value , k = 2,97.$\mathbf{10^{-19}}$ s²/m³ = T²/R³, for all the Planets that orbit the sun.

Centripetal force $\mathbf{C_F}$ = $\mathbf{m_P}$v² / R is the result of the Gravitational force that attracts the Planet towards the Sun and can be represented as *Gravity-force* → $\mathbf{G_F}$ = [G.$\mathbf{m_P m_S}$] / R² and is $\mathbf{C_F}$= $\mathbf{G_F}$.

Since the mean-velocity of a Planet is $\mathbf{v_P}$ = (2πR) / T then v² = (4π²R²) / T² and substituting to prior Centripetal force $\mathbf{m_P}$ [4π²R²]/RT² =[G.$\mathbf{m_P m_S}$] / R² and by cross-multiplication is transformed to T² / R³ = [$\mathbf{m_P}$4π²] / [G. $\mathbf{m_P m_S}$] and canceling the same from numerator and the denominator then

$$T^2 / R^3 = [4\pi^2] / [\,G.\mathbf{m_S}] \quad \text{or} \quad G.\mathbf{m_S} = [\,4\pi^2.\mathbf{f_P}^2\,]R^3 = w^2.\,R^3 \quad \text{where} \quad \mathbf{E_1}=[\frac{4\pi r^2}{3}].\mathbf{f_P} \quad \text{and} \quad k = R^3.\mathbf{f_P}^2$$

The period T(s) for an elliptical orbit is $T = 2\pi \sqrt[3]{\frac{a^3}{G[M1+M2]}}$ ....(1),

which is the same for all ellipse with the same semimajor-axis a. Inversely for calculating the distance, *in meters*, where a body has to orbit in order to have a given orbital period, *in second*, is

$$a = \sqrt[3]{\frac{G[M_1+M_2]T^2}{4\pi^2}} \quad ....(2)$$

where,

G = The gravitational constant = 6,67.$\mathbf{10^{-11}}$ Nm²/Kg², $\mathbf{M_1}$,$\mathbf{M_2}$ the masses of any two material-points.

From above relation is seen that *Energy – Rim -Shapes* C, are Discrete-Packets of *Energy-levels* i.e.

1. *Atraction* of opposite forces $\mathbf{F_o}$↔$\mathbf{F_P}$ at points O , P creates the Central motion and Kepler`s laws where *Orbits are Plane-curves representing a Constant-Energy becoming from the squared Periods* T²*,* or Frequency $\mathbf{f_P}^2$, *representing the Imaginary-Energy-Part of monad and* $\mathbf{r_n}^3$ *representing the Real - Space -Part of monad* 1 = C.$\mathbf{f_n}^2$.r³. *These constants are the* Quantized-Curve-Rims.
2. Since both semimajor axis $\bar{\mathbf{a}}$, *the Position-vector*, and velocity $\bar{\mathbf{v}}$, *the Velocity-vector*, define the Orbital-Plane, then Angular-momentum-vector $\bar{\mathbf{L}}$, is perpendicular to $\bar{\mathbf{a}}$,$\bar{\mathbf{v}}$, and is $\bar{\mathbf{L}} \perp \bar{\mathbf{a}}.\bar{\mathbf{v}}$.

The magnitude $\bar{\mathbf{L}}$ = $\bar{\mathbf{a}}$ x $\bar{\mathbf{v}}$ = *constant for all central motions*

For circular orbits gravitational force $\mathbf{G_F}$ equals the centripetal force $\mathbf{C_F}$, so $\mathbf{C_F}$ = $\mathbf{G_F}$ and $\mathbf{m_P}$v²/ R= [G.$\mathbf{m_P m_S}$] / R² and velocity

$$v^2 = GM/R \quad \ldots\ldots(1)$$

Substituting the expression into the formula for Kinetic energy then ,

$$\mathbf{K_E} = \frac{\mathbf{mv^2}}{\mathbf{2}} = \frac{\mathbf{m.GM}}{\mathbf{2.\ R}} = \frac{\mathbf{GMm}}{\mathbf{2.\ R}} \quad \ldots\ldots(2)$$

or $\mathbf{K_E}$ = (1/2) (- $\mathbf{P_E}$) = - $\frac{\mathbf{P_E}}{\mathbf{2}}$ and - $\mathbf{P_E}$ = 2.$\mathbf{K_E}$ ……(3)

The Total-energy $E = \mathbf{K_E} + \mathbf{P_E} = \mathbf{K_E} - 2.\mathbf{K_E} = -\mathbf{K_E}$ ……(4)

i.e. from (3), *The Potential-Energy is always Negative and Twice the Kinetic-energy,*
while from (4), *The Total - Energy of an Central - Orbiting - System is Negative.*

Conservation laws in Astronomy:

1. Newton`s second law tell us that acceleration on an object is proportional to the net force acting on it so objects move at constant velocity if no force acts on them. Because of conservation of Momentum the Interacting objects exchange momentum through equal and opposite forces [⊕↔⊖] ≡ [$\bar{\mathbf{v}}$.∇i], therefore *constant*, C = $r^3.\mathbf{f_e}^2$, is a Quantized-Energy-Storage, *a Constant Energy-Plane-Rim*, in where Planets move at constant velocities without any force acting on them.
2. In [70], the Work produced In Material-Point $\overleftrightarrow{\mathbf{AB}}$ is equal to → W = 2L = $\bar{\mathbf{B}}.\bar{\mathbf{w}}$= J.$w^2$ ← consisting the First-Energy-Store which is a *Stationary Wave* with, n, lobes as, $\mathbf{W_{n(n+1)}}$= [$\frac{\mathbf{4\pi r^2 f1}}{\mathbf{3}}$].n.(n+1) and wavelength $\boldsymbol{\lambda}_{\mathbf{N}} = \frac{\boldsymbol{\sigma}.(\mathbf{1}+\sqrt{\mathbf{5}})}{\mathbf{4\pi r}} = \frac{\boldsymbol{n}.\bar{\mathbf{B}}}{\mathbf{4\pi r^2}}$, *i.e.* that which Happens in Material point , *Momentum as Work* is $\mathbf{W_{n(n+1)}}$= *constant in n-lobe* , Happens to Planets orbiting the Sun, *so* Because of conservation of angular momentum in the *Constant Energy-Plane-Rim-Orbits*, Planets with no twisting forces are continually rotating and orbiting the sun. Energy is concentrated at the Trajectories ≡Rims≡ Orbits.
3. Energy = motion = Work, and makes the matter move. In [70] the Work produced In Material-Point is conserved but can travel from one object to another, or change in form. From figure-1 Energy ≡ motion is kept in the Storages r = n (λ/2), and is so conserved and transferred from one object to another, or change in form. The types of energy-forms are, The Rotational, *the eternal rotation of positive* ⊕ *around the negative* ⊖, The Kinetic, *motion*, The Potential, *stored motion*, The Radioactive , *wave motion*. *So*, objects get their energy = motion, from the *Primary-Material-Points* in-which motion exists Apriori , and is transformed from one type to another.
4. Angular momentum is the *Constant Energy-Plane-Rim-Orbits* of the System Sun-Planet. Only friction or atmospheric drag can change the orbit, and if an object gains orbital energy it moves to a more distant orbit with more energy. This is obvious from this Planet State-Space-constant C = $r^3.\mathbf{f_e}^2$, since frequency is increased.

The Kepler`s Planar constant Principle:

Planet :	Period of Rotation (y) :	Frequency (n) :	Semi-major axis (m) :	T^2 / R^3 (s^2/m^3) :	k.$\mathbf{f_n}^2.r^3$ = 1
Mercury	0,2410	4,1494	5,79 .$\mathbf{10^{10}}$	2 , 993	1
Venus	0,6150	1,6260	10,80 .$\mathbf{10^{10}}$	3 , 000	1
Earth	1,0000	1,0000	15,00 .$\mathbf{10^{10}}$	2 , 974	1
Mars	1,8800	0,5319	22,80 .$\mathbf{10^{10}}$	2 , 983	1
Jupiter	11,9000	0,0840	77,80 .$\mathbf{10^{10}}$	3 , 010	1
Saturn	29,3000	0,0341	143,00 .$\mathbf{10^{10}}$	2 , 984	1
Uranus	84,0000	0,0119	287,00 .$\mathbf{10^{10}}$	2 , 983	1
Neptune	165,3000	0,0060	450,00 .$\mathbf{10^{10}}$	2 , 992	1
Pluto	248,3000	0,0040	590,00 .$\mathbf{10^{10}}$	2 , 993	$\mathbf{10^{-42}}$ ≡ 1

Each of the above Orbits consist an Energy-Plane- monad with a Constant –Quantized-energy.

We will show that above issues for Atom`s structure ,where Nucleus at focus is consisted of 1 , 2, 3, 4 n, [⊕] Protons which define the figure of (1) focus to be Circular-Rim and for (2) and more focus to be Ellipse-Rim. Each Proton in Atom creates only one Energy-Rim, and this,

Since Medium-Field Material-Fragment → [± s^2] = [MFMF] ≡ *The Chaos* , is the base for all motions.

v. *The Scales of The Universe*

All motions create Work which is conserved. Motion presupposes velocity vector $\bar{\mathbf{v}}$ which, *when it is in motion collides with other velocity vectors* and creates a Constant Work k. Motion may be *Linear, or Rotational* for any displacement, r, so exists The-Constant-Work → k = $\bar{\mathbf{v}}$x$\bar{\mathbf{v}}$.$\bar{\mathbf{r}}$ = v². r This Constant-Work is →

$$W= k = v^2.\, r = (w\, r)^2.r = [\frac{2\pi}{T}\mathbf{r}]^2.r = \frac{4\pi^2 r^2}{T^2} r = \frac{4\pi^2 r^3}{T^2} = 4\pi^2.\frac{r^3}{T^2} = 4\pi^2.r^3.\mathbf{f}^2_{\mathbf{p}} \quad \ldots\ldots\ldots\ldots\ldots(k)$$

Equation (k) is *Kepler-third-law,* denoting that Macrocosm and Microcosm *Obey Newton`s Laws of motion in all Scales*. *Photon* during Motion in[MFMF] *Chaos, collides with other* Photons*, by means of Vectors-Cross-Product, and produces a constant Work which is stored into the* Only-Four Energy –Geometrical-Shapes*, of the motion,* which are the Conic-sections*. The Interior motion is kept in its Wavelength-Storage-Tank* 2r = nλ, *and the Linear motion is continued by the Propagating Electromagnetic-Wave which is the conveyer of the Storage.*

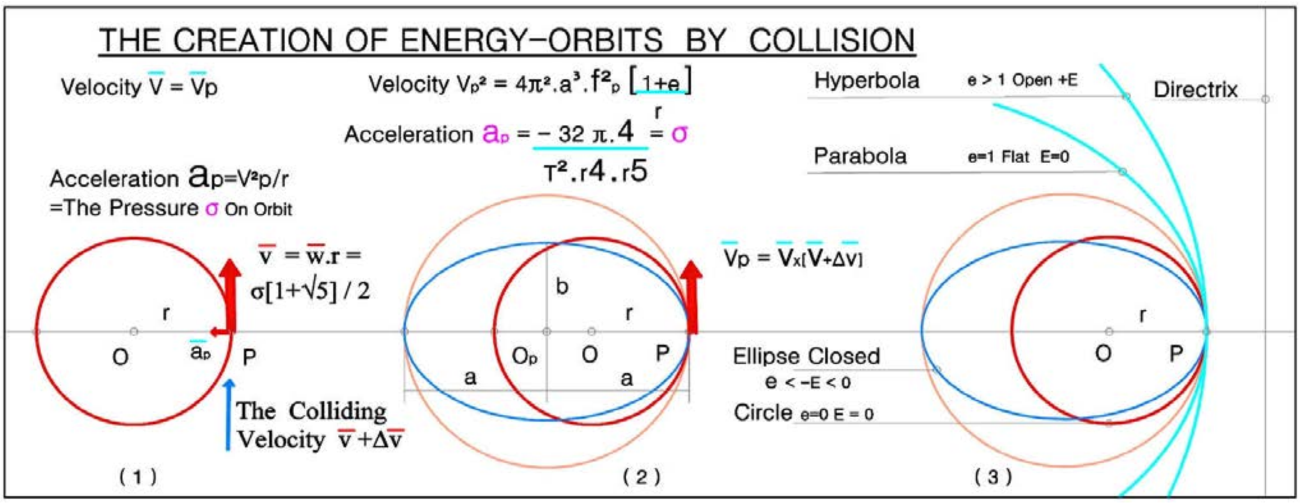

Figure 9: Velocities and Accelerations on, Planar and Atom*, Orbits after any Collision*

In (1) is presented the Circular motion where the constant velocity is equal to v = $\mathbf{v_p}$ = wr and the Centripetal-acceleration $\mathbf{a_p} = \frac{\mathbf{v}^2}{\mathbf{r}}$.

In (2) is presented the Elliptical motion after collision , where the acceleration is increased,

The velocity is equal to $\mathbf{v}^2_{\mathbf{p}}= 4\,\pi^2 a^3.\, \mathbf{f_p}^2[\frac{\mathbf{1+e}}{\mathbf{r}}]$ and the Centripetal-acceleration equal to $\mathbf{a_p} = -\frac{\mathbf{32C^2a^2}}{\mathbf{r^5}} = -\frac{\mathbf{32\pi a^4[1]}}{\mathbf{T^2 r^4\ [r^5]}}$, and for r = a → $\mathbf{a_p} = -\frac{\mathbf{32\,\pi}}{\mathbf{T^2 r^5}}$, where C = $\frac{\mathbf{dS}}{\mathbf{dt}}$= r²dφ/2 = constant

In (3) are presented the Circular , Elliptical , Parabola, Hyperbola motion after collision , where acceleration is increased. The velocity is equal to $\mathbf{v}^2_{\mathbf{p}}= 4\pi^2\, \frac{\mathbf{a^3}}{\mathbf{T^2}}\, [\frac{\mathbf{1+e}}{\mathbf{r}}] = 4\pi^2 a^3 \mathbf{f_p}^2[\frac{\mathbf{1+e}}{\mathbf{r}}] = k\, [\,\frac{\mathbf{2}}{\mathbf{r}} - \frac{\mathbf{1-e^2}}{\mathbf{p}}]$ and the Centripetal-acceleration $\mathbf{a_p} = \frac{\mathbf{d^2r}}{\mathbf{dt^2}} - \frac{\mathbf{4\,c^2}}{\mathbf{z^3}}$, *where* k = $\frac{\mathbf{4C^2}}{\mathbf{p}}$=constant , $\frac{\mathbf{d^2r}}{\mathbf{dt^2}}$= Natural acceleration

a. *The Conservative System, Mechanical-energy and Shapes*

Conservative System is that, when the Total energy E = $\mathbf{K_E} + \mathbf{P_E}$, is constant , where $\mathbf{K_E}$= the Kinetic energy and $\mathbf{P_E}$= the Potential energy and $\mathbf{K_E} + \mathbf{P_E}$= constant or $\frac{\mathbf{d}}{\mathbf{dt}}[\mathbf{K_E} + \mathbf{P_E}] = 0$, from the conservation of energy can be written E =$\mathbf{K_1} + \mathbf{P_1} = \mathbf{K_2} + \mathbf{P_2}$, where, 1, 2, represent two instances of time.

If at time, 2, is the time corresponding to *the maximum displacement* of the mass then velocity of the mass is zero and $\mathbf{K_2} = 0$, where $\mathbf{K_1} + 0 = 0 + \mathbf{P_2}$.

If the System is undergoing harmonic motion, *the motion is repeated in equal intervals of time* t, and x(t) = x(t + w), then $\mathbf{K_1}$ and $\mathbf{P_2}$ are maximum values and issues $\mathbf{K_{max}} = \mathbf{P_{max}}$.

Summing the Kinetic and Potential energy we have

$$\dot{\mathbf{x}}^2/2 + P(x) = E = constant \quad \ldots\ldots\ldots\ldots\ldots\ldots(1)$$

and solving for $\dot{\mathbf{x}}$ = y then

$$y = \dot{\mathbf{x}} = \pm\sqrt{2[\mathbf{E} - \mathbf{P(x)}}\ \ldots\ldots\ldots(2)$$

where trajectories must be symmetric about the x-axis,

$$\ddot{\mathbf{x}} = f(x)\ \ldots\ldots\ldots(3)$$

or $\ddot{\mathbf{x}} = \dot{\mathbf{x}}\,(d\dot{\mathbf{x}}/dt) = f(x)$ and (3) is written

$$\dot{\mathbf{x}}\, d\dot{\mathbf{x}} - f(x).dx = 0\ \ldots\ldots\ldots(4)$$

By integrating $\frac{\dot{x}^2}{2} - \int_0^x \mathbf{f(x)dx} = E$ and by comparison with (1) then $P(x) = -\int_0^x \mathbf{f(x)dx}$ and $f(x) = -dP/dx$ i.e. *for a conservative System the Force is equal to the negative gradient of the Potential-energy*, and is

$$\frac{\mathbf{dy}}{\mathbf{dx}} = \frac{\mathbf{f(x)}}{\mathbf{y}}\ \ldots\ldots\ldots(5)$$

Equations note that, at the equilibrium points the slope of the potential energy curve $P(x) = 0$. It can be shown that the minima of P(x) are stable equilibrium while, positions corresponding to the maxima of P(x) and are positions of unstable equilibrium. Since the trajectories maybe closed curves as this happens in orbitals, the period associated with them is $T = 2\int_{x1}^{x2} \mathbf{dx}/\sqrt{\mathbf{2[E - P(x)}}$ where $\mathbf{x_1}$, $\mathbf{x_2}$, are extreme points of the trajectory on the x-axis.

In Figure-8, mass m, at point P, is orbiting with velocity vector $\bar{\mathbf{v}}$, analyzed into the radial $\overline{\mathbf{v_1}}$, and the tangential $\overline{\mathbf{v_2}}$, both perpendicular to $P\mathbf{F_1}$, $P\mathbf{F_2}$. Since sum $P\mathbf{F_1} + P\mathbf{F_2} = 2a =$ constant , therefore $\mathbf{v_1}+\mathbf{v_2} = 0$, and $\mathbf{v_1} = -\mathbf{v_2}$, i.e. the two velocities are of equal magnitude and opposite sign and ,velocity on tangent at P is the external bisector of $P\mathbf{F_1}$, $P\mathbf{F_2}$ vectors.
The Kinetic energy breaks into two parts as

$$\mathbf{K_E} = m\mathbf{v_1}^2/2 + m\mathbf{v_2}^2/2\ \ldots\ldots\ldots (a),$$

and the magnitude of the Angular-momentum $L = r.\,m\,\mathbf{v_2}$, and in terms of L, $\mathbf{K_E} = \frac{1}{2}m\mathbf{v_1}^2 + \frac{L^2}{2mr^2}$ and adding the Negative Potential energy $\mathbf{P_E} = -G\frac{\mathbf{Mm}}{\mathbf{r}}$, then Total energy $E = \mathbf{K_E} + \mathbf{P_E}$,

$$E = \frac{1}{2}m\mathbf{v_1}^2 + \frac{L^2}{2mr^2} - G\frac{\mathbf{Mm}}{\mathbf{r}}\ \ldots\ldots\ldots(b)$$

Turning points $\mathbf{r_p}$, *perihelion*, $\mathbf{r_a}$, *aphelion*, are the distances of closest approach and further recession, where $\mathbf{v_1} = 0$, $\mathbf{v_2} = 0$, and (b) becomes $\frac{L^2}{2mr^2} - G\frac{\mathbf{Mm}}{\mathbf{r}} = E$ or $\rightarrow$ $r^2 + G\frac{\mathbf{Mm}}{\mathbf{E}}r - \frac{L^2}{2mE} = 0$, an equation with the two roots $\mathbf{r_p}$ and $\mathbf{r_a}$, as $(r - \mathbf{r_p}).(r - \mathbf{r_a}) = 0$, or $r^2 - (\mathbf{r_p}+\mathbf{r_a}).r + (\mathbf{r_p}\mathbf{r_a}) = 0$ *where is*

Sum of roots $[\mathbf{r_p}+\mathbf{r_a}] = -G\frac{\mathbf{Mm}}{\mathbf{E}} = 2a$ from where $\frac{\mathbf{2E}}{\mathbf{m}} = \frac{\mathbf{GM}}{\mathbf{a}}$, and

Product of roots $[\mathbf{r_p}.\,\mathbf{r_a}] = -\frac{L^2}{2mE}$ from where $L = r.mv$, $v = L/r.m$, $E = \frac{1}{2}m[\frac{\mathbf{L}}{\mathbf{rm}}]^2 = \frac{L^2}{2mr^2}$

The turning points are related to the axes of the ellipse by $\mathbf{r_p}+\mathbf{r_a} = 2a$, and $\mathbf{r_p}.\mathbf{r_a} = b^2 = -\frac{L^2}{2mE}$ so,

Energy on Orbit $E = \frac{\mathbf{GMm}}{\mathbf{2a}}$, Angular-momentum $L^2 = -2m.E.b^2$ ……………………………… ....(c)

From Kepler laws, the area, S, swept out by the line $P\mathbf{F_1} = r$ is $dS = r^2.d\theta/2$ and the rate of swept is $\frac{\mathbf{dS}}{\mathbf{dt}} = (r^2/2).(d\theta/dt) = \frac{1}{2}r^2 w = \frac{1}{2}r\,(r\,w) = \frac{\mathbf{L}}{\mathbf{2m}}$, since $r\,w = v$ and $m\,r^2 w = L\,.\,\mathbf{f}^2{}_{\mathbf{n}}$

Since L is a constant according to Kepler second law radius r, sweeps out equal areas during equal intervals of time and for the total area $\rightarrow \pi\,ab = S = \int \frac{\mathbf{L}}{\mathbf{2m}}dt = \frac{\mathbf{LT}}{\mathbf{2m}}$, and T is the period of rotation.

From above $S^2 = \frac{L^2T^2}{4m^2} = \pi^2a^2$ $[\,b = \pi\,a(\frac{L^2}{2mE})]$, or $\frac{T^2}{a^2} = \frac{4\pi^2 m}{2E} = \frac{4\pi^2}{2E/m} = \frac{4\pi^2 a}{GM}$ and $\rightarrow$ $\frac{T^2}{a^3} = \frac{4\pi^2}{GM} =$ *constant*

From relation $\frac{T^2}{a^3} = \frac{4\pi^2}{GM} = k = \frac{1}{f^2{}_n . a^3}$ becomes $\rightarrow 1 = k\,.\mathbf{f}^2{}_{\mathbf{n}}.\,\mathbf{a^3} = \frac{4\pi^2}{GM}.\mathbf{f}^2{}_{\mathbf{n}}.\,\mathbf{a^3}$ ……………………………(d)

From Web $r^2(\theta) = [\frac{L^2/m}{E \pm\sqrt{E^2 - kL^2/m}\,)\sin 2(\theta-\theta_0)}]$ ……………………………(e)

which is an ellipse.

Equation (e) denotes Ellipses and circle, having a constant Energy-Shape when are given the Geometrical parameters related to the Physical parameters, Angular momentum (L), Total energy (E).
For a central gravitational force, the Potential-energy $\mathbf{P_E} = -GMm/r$ and,

$$\theta(r) = \int d\theta = \pm\frac{l}{\sqrt{2m}}\int_0^r \frac{dr/r^2}{\sqrt{E\,r^2 + GMmr - L^2/2m}} \quad \ldots\ldots(f)$$

Placing a = - L²/2m , b = GMm, c = E, then , $\int_0^r \frac{dr/r}{\sqrt{a + br + c\,r^2}} = \frac{1}{\sqrt{-a}}.\sin^{-1}\left(\frac{br+2a}{r\sqrt{b^2-4ac}}\right)$ ……(f1)

and $\theta - \theta_0 = \pm\sin^{-1}\left(\frac{GMm^2 - L^2}{GMm^2 r}\right)$ and eccentricity $e = \sqrt{1 + 2EL^2/G^2M^2m^3}$ ……(f2)

where θ_0 is a constant of integration. Solving for r then $r = \frac{L^2/GMm^2}{1 \pm e\sin(\theta - \theta_0)} = \frac{L^2/GMm^2}{1 + e.\cos\theta}$ at periapse ……(f3)

creates only one Energy-Rim .

The Velocity Related to the distance [r] *of the Planet*[the Orbiter] *to the Sun* [the Focus]:

From Fig-8, the velocity equation in a Central motion is $v^2 = 4C^2.[\frac{e^2\sin^2\varphi}{p} + \frac{1}{r^2}]$……(f4)

where constant $C = \frac{\pi ab}{T} = \pi\, ab\, f_p = \frac{dS}{dt} = r^2 d\varphi/2$ = The covered orbiting area per time second, and $\frac{d(1/r)}{d\varphi} = -\frac{e\sin\varphi}{p}$.

From (1) $r = \frac{p}{1 + e\cos\varphi}$ and velocity is,

$$v^2 = 4C^2.[\frac{e^2\sin^2\varphi}{p^2} + \frac{1 + e^2\cos^2\varphi + 2e\cos\varphi}{p^2}] = \frac{4C^2}{p^2}[e^2 + 1 + 2e\cos\varphi] = \frac{4C^2}{p}[\frac{e^2+1}{p} + \frac{2}{r} - \frac{2}{p}] = \frac{4C^2}{p}[\frac{2}{r} - \frac{1-e^2}{p}] \quad \ldots(f5),$$

and for ellipse issuing $2a = r_{\varphi=0} + r_{\varphi=a} = \frac{p}{1+e} + \frac{p}{1-e} = \frac{2p}{1-e^2}$

therefore , $v^2 = \frac{4C^2}{p}[\frac{2}{r} - \frac{1-e^2}{p}] = v^2 = \frac{4C^2}{p}[\frac{2}{r} - \frac{1}{a}]$ ……(f6)

From (f6) , when Planet is at Perihelion, *near the Sun* $\frac{1}{r} = \frac{1+e}{p}$], and velocity at Perihelion is,

$v^2 = \frac{4C^2}{p}[\frac{2}{r} - \frac{1-e^2}{p}] = \frac{4C^2}{p}[\frac{2}{r} - \frac{1-e}{r}] = \frac{4C^2}{p}[\frac{1+e}{r}]$, where $\frac{4C^2}{p} = \frac{4(\pi ab/T)^2}{b^2/a} = 4\pi^2\frac{a^3}{T^2}$, *Kepler constant*, and

$$v^2 = 4\pi^2\frac{a^3}{T^2}[\frac{1+e}{r}] = 4\pi^2 a^3.\, f_p^{\,2}[\frac{1+e}{r}] = K[\frac{1+e}{r}] \quad \ldots(f6)$$

The velocity at Perihelion.

For eccentricity $e < 1 \rightarrow v^2 = K[\frac{1+e}{r}] < K\frac{2}{r}$ *Planet follows Elliptic Orbit*

For eccentricity $e = 1 \rightarrow v^2 = K[\frac{1+e}{r}] = K\frac{2}{r}$ *Planet follows Parabolic Orbit*

For eccentricity $e > 1 \rightarrow v^2 = K[\frac{1+e}{r}] > K\frac{2}{r}$ *Planet follows Hyperbolic Orbit*

In a circular motion show that, velocity is proportional to the inverse square of radius r, and Newton –force, *acceleration*, the fifth, where $C = \frac{\pi ab}{T} = \frac{\pi a}{T}[\frac{1}{r^2}] = \frac{\pi a}{T\,r^2}$

From relation r = 2a.$\cos\varphi$ is , $\cos\varphi = \frac{r}{2a}$, $\frac{1}{r} = \frac{1}{2a\cos\varphi}$ and $\frac{d1/r}{d\varphi} = \frac{1}{r}\tan\varphi$, and (f4) is

$$v^2 = 4C^2.[\tan^2\varphi + 1] = \frac{4C^2}{r^2}\frac{1}{\cos^2\varphi} = \frac{16C^2a^2}{r^4} \quad \text{and} \quad \textit{velocity}\; v = \frac{4Ca}{r^2} \quad \ldots(f7)$$

Centripetal – acceleration $a_p = \frac{v^2}{r} = -\frac{16C^2a^2}{r^4}.\frac{1}{a} = -\frac{16\,C^2a}{r^4}$ and equal to $\frac{a_p}{\cos\varphi}$, therefore ,

Centripetal – acceleration $a_p = \frac{32C^2a^2}{r^5} = -\frac{32\pi a^4[1]}{T^2 r^4\;[r^5]}$ and for r = a then $a_p = -\frac{32\,\pi}{T^2 r^5}$ ……(f8)

vi. *Orbital - Geometry and Orbital – Physics*

The Geometrical elements in orbit is the semimajor axis a , and eccentricity e.

For radius r, issues $\frac{2E}{m} = \frac{GM}{a}$ and solving for $a = \frac{GM\,m}{2E}$, and $e = \sqrt{1 + 2EL^2/G^2M^2m^3}$ ……(g)

For $r_p(1 + e) = l^2/GMm^2$ radius of Planet $r_p = \frac{l^2}{(1+e)GMm^2}$ ……(g1)

The Physical parameters in orbit is Total energy $E = K_E + P_E$, and Angular-momentum $L = \bar{r}m\,\bar{v}$.

From above $E = -\frac{GM\,m}{2\,a}$ and $L = \sqrt{(1-e^2).GMm^2.a}$ …………(p)

Energy in Orbit $E = -\frac{GM\,m}{2\,r_p}(e-1)$ and $L = \sqrt{(1+e).GMm^2.r_p}$ …………(p1)

For $e = 1$, issues for Parabolas and Hyperbolas where $r_p(1 + e) = L^2 / GM\,m^2$.

Remarks

1. The two constituents of energy, $\frac{L^2}{2mr^2}$, - G $\frac{Mm}{r}$, depend on, r, so at points where the total energy E is equal to them and the radial motion along the line PF_1 is zero, which is at the turning points. For $r \to \infty$ issues also zero meaning that energy E is positive or zero.

If $E > 0$ is Positive, then mass m of point P approaches mass M at F_1, and moves away never return.
If $E = 0$ is Zero, then mass m of point P approaches mass M at F_1, and moves Not bounded.
If $E < 0$ is negative then exist two turning points and are created bound orbits. Energy is related to frequency as, $E = h\,f = h.[\frac{2S_n}{ab}]$, *therefore*, *Positive frequencies*(Positive or zero Total energy) give Unbound-motion while, *Negative frequencies* (Negative Total energy)*create Bound motion.*

This Property of Energy, frequency*, between Positive and Negative Energy, arises from the Reality for*Potential –Energy*, to be zero or Negative and twice the Kinetic*, $P_E = -2.K_E$.

2. The turning points (1), (2) are the maxima of the System P, F_1, and from Energy-equation $E = \frac{GMm}{2a}$ is seen that the Energy E depends only on the length of the orbit (1) - (2) = 2a, while the Angular momentum L is proportional to, b, therefore the more eccentric orbits happen for the smaller b corresponds to lower L, while maximum L occurs for a circular orbit where b = a.
3. From the last equation, $\frac{T^2}{a^3} = \frac{4\pi^2}{GM}$ = k*constant*→ Kepler 3rd law , by measuring period T, or frequency f, can determine the mass M. Simultaneously since, $1 = k.f_n^2.r^3$, $\rightarrow f_n^2 = \frac{1}{k\,r^3}$ i.e.
Frequency squared is proportional to the inverse cube of Radius, is useful in Material-point.
4. From above, *Shapes* in a Conservative System related to Mechanical-energy are only four types,

   1. For $a = b$ then $e = 0$, and the Shape are the Circles, with Zero Total-energy.
   2. For $a > b$ then for $e > 0$ the Shape are the Ellipses, with Negative Total-energy.
   3. For $a > b$ then for $e = 1$ the Shape are the Parabolas, with Zero Total-energy.
   4. For $a > b$ then for $e > 1$ the Shape are the Hyperbolas .with Positive Total-energy.

From F.9-(3), Total energy in Bounds orbits, *Circles and Ellipse*, is *Negative*, in Critical-Bound Orbits, *Circle and Parabola*, is, *Zero*, while in Open, unbound orbits, *Parabola, Hyperbola*, *Positive,* extended to infinity.
Circles with $e = 0$, and Parabolas with $E = 0$, occur in Nano-Nature in the Material-Points.
For Zero, Angular-momentum L , eccentricity is $e = 1$.

The Extrema cases for Energy - Orbits are,

For Circle to Ellipse is as $e \rightarrow 0$ where then Energy from Negative becomes Zero.

For Ellipse to Parabola is as $e \rightarrow 1$ where then Energy from Negative becomes Zero.

For Hyperbola to Parabola is as $1 \leftarrow e$ where then Energy from Positive becomes Zero.

From eccentricity e equation $e = \sqrt{1 + 2EL^2/G^2M^2m^3}$, $e^2 - 1 = \frac{2E\,L^2}{G^2M^2m^3} = \frac{E\,k^2\,L^2}{8\pi^4m^3} \equiv \frac{A\,L^2}{GMm^2} \equiv \frac{b^2}{a^2}$

The Extrema Energy - Orbits help, The Moving – Energy - Stores, to enter the Caves.

Negative-Energy represents the fact that, to free the Planet, an orbiting mass, from the Central Potential requires *a Way to Add-Energy. Kinetic Energy is always Positive, therefore it is possible the Total Energy of the Orbiting-mass to be Negative, Zero, or Positive*, which happens in a circular motion with a constant velocity $v = wr$. It is later proved that Energy in Orbits is conserved in Planet-Focus-axis, by using the Material-LRC circuit to change the Direction of the Momentum-Vector of the between dipoles.

Force $F_1 = A_1 \sin(wt + \varphi)$ colliding with another force $F_2 = A_2 \sin(wt)$, by cross product, gives Power.

Power is D = $\mathbf{F_1 F_2}$= $\mathbf{A_1}$ **sin** $(\mathbf{wt+\varphi})$. $\mathbf{A_2}$ **sin** $(\mathbf{wt})$ = $\mathbf{A_1A_2}$ [**sin** $(\mathbf{wt+\varphi})$. **sin** $(\mathbf{wt})$] and by using Trigonometry, the Power D =$\mathbf{A_1A_2}$ [**cos** $(\mathbf{2wt+\varphi})$.**cos** $\boldsymbol{\varphi}$] = $\mathbf{A_1A_2}$/2 [- **cos** $(\mathbf{2wt+\varphi})$ + **cos** $(-\boldsymbol{\varphi})$] = $\mathbf{A_1A_2}$ /2 [**cos** $(-\boldsymbol{\varphi})$ – 2 **cos** $\frac{\mathbf{2wt+\varphi}}{\mathbf{2}}$.**cos** $\frac{-\boldsymbol{\varphi}}{\mathbf{2}}$] = $\frac{\mathbf{A_1A_2}}{\mathbf{2}}$ [– **cos** $(\boldsymbol{\varphi})$ + 2 **cos** $^2\frac{\boldsymbol{\varphi}}{\mathbf{2}}$], and by analyzing

Power D = $\frac{\mathbf{A_1A_2}}{\mathbf{2}}$[- **cos** $^2\frac{\boldsymbol{\varphi}}{\mathbf{2}}$ + **sin** $^2\frac{\boldsymbol{\varphi}}{\mathbf{2}}$ + 2 **cos** $^2\frac{\boldsymbol{\varphi}}{\mathbf{2}}$] = $\frac{\mathbf{A_1A_2}}{\mathbf{2}}$ [**sin** $^2\frac{\boldsymbol{\varphi}}{\mathbf{2}}$ + **cos** $^2\frac{\boldsymbol{\varphi}}{\mathbf{2}}$] = $\frac{\mathbf{A_1A_2}}{\mathbf{2}}$, and since wave is twice of the frequency this represents the fluctuating component of Power , meaning that the average value of which is zero, and are,

$$D = -\frac{\mathbf{A_1A_2}}{\mathbf{2}}[\ \mathbf{cos}\ (\mathbf{2wt+\varphi}) + \mathbf{cos}\ (\boldsymbol{\varphi})\ ],\quad \text{and at } t = 0,\ D = -\mathbf{A_1A_2}\ [\ \mathbf{cos}\,\boldsymbol{\varphi}\ ]\text{i.e.}$$

By collision at perihelion $\boldsymbol{r_p}$ *, with another object of velocity v ,then velocity becomes* $\boldsymbol{v^2}_{\boldsymbol{p}}$*, or*

$$\mathbf{v^2}_{\mathbf{p}} = 4\pi^2\ \frac{a^3}{T^2}\ [\frac{\mathbf{1+e}}{\mathbf{r}}] = 4\ \pi^2 a^3.\ \mathbf{f_p}^2[\frac{\mathbf{1+e}}{\mathbf{r}}],\ \text{acceleration}\ \mathbf{a_p} = -\frac{\mathbf{32\ \pi}}{\mathbf{T^2\ r^5}},\ \text{and}\ L = 0\ ,\ e = 1\ ,\ D = -\ \mathbf{A_1A_2} \qquad ....(pe)$$

From Energy-State-equations (pe) is transparent that,

Any moving Particle when is Tangentially-colliding with Any Material-Point, P , executing Circular motion on a circle of radius, r, then the Total Energy, E, is Negative , and the Particle follows constant Elliptical – Energy - Orbits on the same semi major axis, and of the same constant Energy.

If the New Orbit is of eccentricity e = 0, and Zero Total Energy*, then is a Circle, If it is 0 < e < 1,* and Zero Total Energy*, then is the Ellipse , If it is e = 1,* and Zero Total Energy*, is a Parabola and If it is e>1,* and Positive Total Energy*, is the Hyperbola .*

So all Planets move in this way either in Atoms or in, Planetary-System*, obeying Newton`s equations of motion, such in microcosm as in macrocosm.*

The How this Begins from Material-Point and where this Finishes in Universe ??? markos 31-8-2018

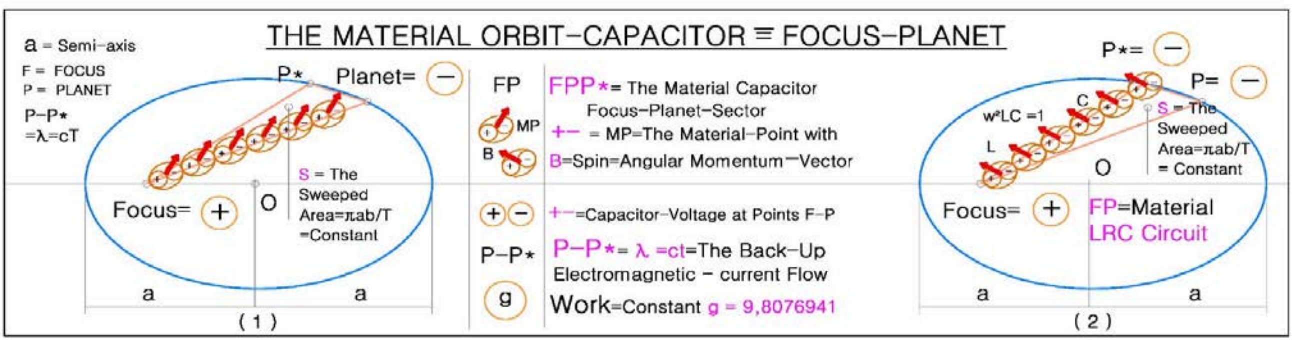

Figure 10: The Material, LRC Circuit on Orbit, on Focus-Planet-Sector FP

In (1). Force g, as wave, is directed to the center of rotation F, and is proportional to the distance PF ≡ Focus-Planet. The Gravitational Potential-Energy $\mathbf{g_G}$ =9, 8076941is stored in → Focus-Planet-Sector ≡ FP ← which is The Material-Capacitor-Stores-charge, *as that of Material-LRC-circuit*, and Inductors .Because of the chains of Spins, is thus created a Magnetic field due to LRC-circuit and which is tuning to the critical Quantum-critical-State $\mathbf{g_G}$. The chains of Spins are pointy vibrating with their characteristic frequencies. Since Inner-stresses $\boldsymbol{\sigma_{1,2}} = \boldsymbol{\sigma_1/2} \pm (½)\sqrt{\boldsymbol{\sigma 1^2 + 4.\sigma 1^2}} = \boldsymbol{\sigma_1/2}$ [1±√5] follow the *Golden ratio on stresses* then this Quantum-energy $\mathbf{g_G}$ produced, is the State causing them to Magnetically-Resonate.

In (2) is presented the Back-Up Electromagnetic current flowing in opposite direction FP by changing the Spin direction of the Sector-Material-Points such that work W = g.

From Kepler`s 2nd law the area , S , swept by any*Focus-Planet-Sector* ≡ FP is constant and equal to,

$$S^2 = \frac{\mathbf{L^2\,T^2}}{\mathbf{4m^2}} = \pi^2 a^2[b = \pi a(\frac{\mathbf{L^2}}{\mathbf{2mE}})],\ \text{or}\ \frac{\mathbf{T^2}}{\mathbf{a^2}} = \frac{\mathbf{4\pi^2 m}}{\mathbf{2E}} = \frac{\mathbf{4\pi^2}}{\mathbf{2E/m}} = \frac{\mathbf{4\pi^2\,a}}{\mathbf{GM}}\ \text{and} \to \frac{\mathbf{T^2}}{\mathbf{a^3}} = \frac{\mathbf{4\pi^2}}{\mathbf{GM}} = k = \frac{\mathbf{1}}{\mathbf{f^2_n.a^3}} \to 1 = k.\mathbf{f^2}_{\mathbf{n}}.\mathbf{a^3}$$

For *Planck`s length* light velocity c=2,9979.$\mathbf{10^8}$ m/s , *time*$\mathbf{t_P}$=5,391.$\mathbf{10^{-44}}$ sec ,$\boldsymbol{\lambda_P}$ = c$\mathbf{t_P}$=1,6162.$\mathbf{10^{-35}}$

The number $\mathbf{N_S}$, of possible swept areas S = r².dθ/2 , *in circle* is$\mathbf{N_c}$ =(2πa) / ($\boldsymbol{\lambda_P}$) m/s or

$$\mathbf{N_{Sc}} = (2\pi a) / (1{,}6162.\mathbf{10^{-35}}) = 3{,}8876.a.\mathbf{10^{\,35}}\ \text{m/s} \quad ....(1)$$

For Ellipse is

$$\mathbf{N_{SE}} \cong [2\pi\sqrt{\frac{a^2+b^2}{2}}/\ (\boldsymbol{\lambda_P})\ ]\ \text{m/s} = 2{,}74897.\sqrt{\mathbf{a^2+b^2}}.\mathbf{10^{\,35}}\ \text{m/s} \quad ....(2)$$

Above equations consist the *minimum Granular-Capacitors* of the *Orbit-Swept-areas*, with the minimum Gravity-Energy in $\boldsymbol{\lambda_P}$ / c time $\mathbf{t_P}$ → $\mathbf{g_G}$ = 9, 8076941 $\frac{\mathbf{N}}{\mathbf{Kg}}$

vii. *The Energy - Orbits in Microcosm - Macrocosm*

Piezoelectric-effectmeans, when *Using a Lattice-Disk* (as *Orbits, Caves, Material-Points, Particles, Atoms, Molecule, Crystals, Microchips, etc.*) *Converts the Mechanical energy which is Work*, *into Electricity*, (*Electrical Potential as a Voltage*), *across the sides of the Disk* or vice versa, i.e. *When on a Lattice-Disk, is Put a Voltage across the Disk, and thus its Inside-content is subjecting to an electrical-Pressure then Inside-content has to move to rebalance,* and thus deformed*.*

Gravity is Potential-energy with binder Energy-Field{ [∇i]= [± s²] a constituent in MFMF Field, *the called Gravity force without Vibration but only local rotation*}, *occurring from Energy-Vectorsof the Material-Points*[⊕↻↺⊖]*in Gravity-field ,and this because are axially on their Spin-Vector* $\overline{\mathbf{B}}$ ≡ *Spin* ≡ *Rotational -Energy*, *and which Energy-Vectors is the* Inside-content of the Gravity-field.

The Dot-product happens for interactions between *Similar dimensions*, while the *Cross-product* between *Different-dimensions*. Cross-product of two vectors $\bar{\mathbf{a}}$, $\bar{\mathbf{b}}$ is $\bar{\mathbf{a}}$ x$\bar{\mathbf{b}}$ = |$\bar{\mathbf{a}}$|.|$\bar{\mathbf{b}}$| $\mathbf{sin\,\theta}$.$\bar{\mathbf{n}}$ and for $\bar{\mathbf{a}}$=$\bar{\mathbf{b}}$ and θ=90º then $\bar{\mathbf{a}}$ x $\bar{\mathbf{a}}$ = $\bar{\mathbf{a}}^2$, and for Quaternion, s, which performs the Work of rotating the one vector around the other is → Work = $\bar{\mathbf{a}}$ x $\bar{\mathbf{a}}$ = $\bar{\mathbf{a}}^2$.$\bar{\mathbf{r}}$, and for $\bar{\mathbf{a}}$= $\bar{\mathbf{v}}$ then → Work = $\bar{\mathbf{v}}^2$.$\bar{\mathbf{r}}$=|$\bar{\mathbf{v}}$|.|$\bar{\mathbf{v}}$|.$\bar{\mathbf{r}}$ = v². r.$\bar{\mathbf{n}}$ = (wr)²r. $\bar{\mathbf{n}}$, *or* Work = (wr)²r. $\bar{\mathbf{n}}$= (2*π*r/T)² $\mathbf{r}\,\bar{\mathbf{n}}$ = (4*π*²r²/ T²). r. $\bar{\mathbf{n}}$= $\frac{\mathbf{4\pi^2 r^3}}{\mathbf{T^2}}$. $\bar{\mathbf{n}}$ → W = 4*π*² . $\frac{\mathbf{r^3}}{\mathbf{T^2}}$. $\bar{\mathbf{n}}$ = 4*π*².r³.$\mathbf{f^2_p}$.$\bar{\mathbf{n}}$*i.e.*

Kepler constant celestial law for microcosm

Kinetic Energy, *motion*, in Orbits becomes from the, *Piezoelectric-effect*, where Orbit is subject to a Mechanical-stress, σ = ± $\frac{\mathbf{4\pi r}}{\mathbf{(1+\sqrt{5})}}$.$\mathbf{f_p}$, *becoming from the Centripetal-acceleration* $\bar{\mathbf{a}}_{\mathbf{P}}$ *of the Planet* and thus is appeareda Positive charge at the *Nucleus* and a Negative-charge at the *Planet*, so is created an electric-signal with a given frequency $\mathbf{f_p}$. The two faces at N and P are connected by the in-between *Energy-Vectors*$\overline{\mathbf{B}}$*,* of the Stationary-material-points [⊕↻↺⊖] in Gravity-field [∇i]

In Orbits which are Negative-Energy-Rims, with binder Energy the atraction between the two opposite forces $\mathbf{P_N}$↔$\mathbf{P_P}$at points, Focus N and Planet P, is created the Central motion where, *Orbital-Resonance* is the Plane Surfaces, representing a Constant-Energy-Rim followingthe Celestial Kepler Laws*and say this as an Plane-Energy-Resonance ,*because happens in-Plane and on Energy-Field-vectors →Spin $\overline{\mathbf{B}}$.

In Figure -8-9-10- are shown the Ellipse-Orbits,1=c.$\mathbf{f_n}$².r³, with their content which is The Spin-Field-vectors $\overline{\mathbf{B}}$ in all area *π* ab of MFMF field, where Centripetal-acceleration $\bar{\mathbf{a}}_{\mathbf{P}}$ = σ= ±$\frac{\mathbf{4\pi r}}{\mathbf{(1+\sqrt{5})}}$.$\mathbf{f}$.

i.e. *Orbit is subject to a Mechanical-stress,* σ*, becoming from the Centripetal-acceleration* $\bar{\mathbf{a}}_{\mathbf{P}}$, *and so is appeared the* Piezoelectric-effect with Positive-charge *at the Focus* ≡ *Nucleus* and Negative-charge *at the Planet*. The two faces at N, P *are connected by the* Spinning-stationary-material-points [⊕s²↻↺⊖s²] forming the → *Focus-Planet-Sector* ≡ *Store-Charge field*[∇i] =[± s²] in [MFMF] Field ≡ ← and thus is *flowing Current which is the Resonance on Orbit,* and it is the Gravity Force, g.

In the *Inverse* Piezoelectric-effect on Orbit, *when a voltage is applied across its opposite* faces at N, P becoming from the[⊕↔⊖] stretching, then Orbit becomes mechanically stressed, *Deformed in Shape by the Resonance at* N *and* P. The way that *Potential-Energy is stored*, *is that of the Material-LRC-circuit*, which is for the Gravitational Potential-Energy the *Material-Capacitor* or the → *Focus-Planet-Sector-Stores-charge* ←which develop a voltage in response to that charge. The coil of wire is the *infinite Stationary-Dipole-Spinning Material Points* of this → *Focus-Planet-Sector* ← which develops the Back Electromagnetic-flux , when the current through them changes.

Orbit or, *Negative-Energy-Rim,* is the Stable and Stationary Granular-lattice-Energy-Disk , *which is kept in the Plane-Orbit of motion,*{ *The-Focus-Planet-Sector in Ellipse area* *π*ab = *π*a²$\sqrt{\mathbf{1-\boldsymbol{e}^2}}$, sweeps out equal areas in equal times and on *Focus-Planet-Sector a voltage is applied as Gravity-field*} *,which is an Electromagnetism,* and in a way is *Opposite* to that which follows the Central motion, i.e

Gravity-Force-Vectors $\overline{\mathbf{B}}$ *of Material-points as Spin*[⊕↻↺⊖] *is packet from the Focus-Planet-Sector to Orbit-Rim as Energy-conveyer for the interactions between,* Nucleus N *and the orbiting object*, *the* Planet P, and consists the energy-quanta, *the minimum constant energy* ,of motion →[⊕↻↺⊖]← *in monad Rim in atom.*

viii. *The minimum Energy RIM and The Golden ratio frequency*

From equation 1 =c.$\mathbf{f_n}$².a³, and constant work 1/k =$\mathbf{f_n}$².a³ the constant energy in Orbit is k = $\frac{\mathbf{T^2}}{\mathbf{a^3}}$............(e)

It was shown that the maximum Energy in Hydrogen atom is E = h f = -13,6 eV =- 13,6 x 1,6.$\mathbf{10^{-19}}$= 2,176.$\mathbf{10^{-18}}$ Joule, the frequency is f = E / h or, f = 2,176.$\mathbf{10^{-18}}$ J/6,6262.$\mathbf{10^{-34}}$ J.s = 3,28393.$\mathbf{10^{15}}$/s and the Period in Orbit, T = $\mathbf{f^{\,-1}}$= 3,04513.$\mathbf{10^{-16}}$ s

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The motion of all moving Energy-Storages is Sinusoidal as equation {[εE² + μB²] = 2.λc.sin.2φ} ...(e1) and the work produced is stored in their sine curve area of x, y, coordinate axis as $\int_0^{\pi}\mathbf{\sin x\, dx}$ = 2 as equation (e1). Simultaneously unity-Work = sine Integral = $\int_0^{t}\frac{\sin t}{t}\mathbf{dt}$ = 1, at Critical-Energy-point where point is such that Si(x=1) work becomes equal to monad 1, and this critical-energy-unit happens at the point x = 1, 0572508754, or at axis → a = 2x = 2,1145016 m .

From Sphere relation $(4\pi a^3/3)^3$ = 1,616229.$\mathbf{10^{-35}}$, a = 5,447.$\mathbf{10^{-11}}$, or semi-major axis in Hydrogen cave is a =$\mathbf{10^{-11}}$ m, and the Basic-coefficient [2Si(1)] , is the constant a = 2x = 2 ,1145016.$\mathbf{10^{-11}}$ m.
Placing in Hydrogen-Rim the Period T, and the prior Semi-major axis a ,then constant energy E = k,

$$k = \frac{\mathbf{T^2}}{\mathbf{a^3}} = \frac{[3{,}04513.10^{-16}]^2}{[2{,}1145016.10^{-11}]^3} = \frac{9{,}272817.10^{-32}}{9{,}4541768.10^{-33}} = 9,\,808238\frac{s^2}{m^3} = \frac{\mathbf{N}}{\mathbf{Kg}}$$, *agreeing with Gravity* g, *measured.*

i.e. The Minimum-Work → W= $4\pi^2\,\frac{r^3}{T^2}\,.\,\bar{\mathbf{n}} = 4\pi^2.r^3.\,\mathbf{f^2}_{\mathbf{p}}.\bar{\mathbf{n}}$←*in an Negative-Elliptic-energy-field-Disk as is* PNS, is stored as a Voltage[N≡⊕↔⊖ ≡P] across the Disk-Orbit-Sectors between the rotating Planet P and the Nucleus N, Produced from *the pressure*, σ, *of the frequency* $\mathbf{f_p}$ *and of the semi-major axis* $\mathbf{a_p}$ of the Planet. This minimum work in Atom is equal to Gravity acceleration g = 9,808238 m/s²

Motion is Kept, *is quantized,* as work → W =1= k ≡ [∇i].[±s²] ≡ MFMF Field ← *in the Orbit-area*, πab upon the Spin $\bar{\mathbf{B}}$ *Orientation of the Pointy-Material-points* [±s²]. Orientation of Spin becomes from the Energy in the sinusoidal gravity-fields in orbit , created by the motion of oscillation of the material points [⊕↻↺⊖]. Any *Interaction* between this *Oriented-Energy-Sector Disk-Rim* and a *Body-Planet* creates disturbances in Disk and *Reorientation of Spin* $\bar{\mathbf{B}}$≡ motion ≡ work ≡ k = constant = quanta and is transformed as, *The Gravity-Force in Disk*, and which Energy is equal to the Gravity acceleration g, and this because *g = force,* as equation g = F/m.

Remarks:

Since constant k = $\frac{\mathbf{T^2}}{\mathbf{a^3}}$ = 9,808 and 1 = k.$\mathbf{f_n}^2$.a³, is easy to calculate, a cave, a = $\sqrt[3]{\frac{1}{9{,}808.\mathbf{f_n}^2}}$ ……………....(e2)

1. Hydrogen Z=1 electron is of frequency $\mathbf{f_H}$= 1,3.$\mathbf{10^{17}}$/sec and $\mathbf{f_H}^2$ = 1,69.$\mathbf{10^{34}}$, so $\mathbf{a_H}$ cave is

$$\mathbf{a_H} = \sqrt[3]{\frac{1}{9{,}808.1{,}69.10^{34}}} = \sqrt[3]{\mathbf{6{,}0329928.10^{-36}}} = 1{,}0820445.\ \mathbf{10^{-12}}\ \text{m}$$

2. Uranium Z=92 electron is of frequency $\mathbf{f_U}$= 1,1.$\mathbf{10^{21}}$/sec and $\mathbf{f_U}^2$ = 1,21.$\mathbf{10^{42}}$, so $\mathbf{a_U}$ cave is
$\mathbf{a_U} = \sqrt[3]{\frac{1}{9{,}808.1{,}21.10^{42}}} = \sqrt[3]{\mathbf{84{,}262462.10^{-45}}}$ = 4,3840830. $\mathbf{10^{-15}}$ m i.e. the energy-circuits.
3. Constant k, becoming from the microcosm by measuring the energy of a cave or Atom-orbit and the semi major axis, or from the macrocosm be measuring the energy of Planetary system and the axis of orbiting , gives the same result.
4. In the next Figure-11 is shown the Way that Universe is formulated by following the basic Internal *Material-Point-eternal-motion* as *Frequency-Golden-ratio* → $\mathbf{f_n}$ ≡$[\frac{1+\sqrt{5}}{2}]\frac{\sigma}{2\pi r}$ ← from Photons to Atoms, to Molecules, to Crystals, to ,,,,, or to the all Planetary-System obeying Newton`s equations of motion, such in microcosm as in macrocosm and to the expanding universe.

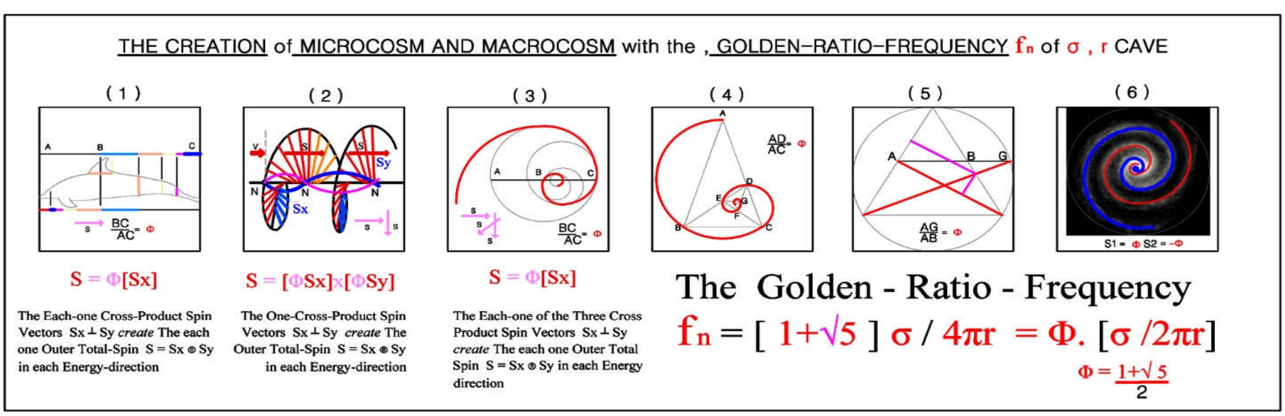


Figure 11: The Why Universe is formulated by the *basic golden-ratio-frequency* $\mathbf{f_n}$ ≡$[\frac{1+\sqrt{5}}{2}]\frac{\sigma}{2\pi r}$ *Electromagnetic fields undulate within fieldsin the Universal Electromagnetic process of Dipole*[±s²]

≡ [⊕Ʊ↺⊖], *in*[MFMF] ≡ *The Chaos* as base for all motions, *for the Centripetal-Centrifugal forces*.

(1) One-Vector → From velocity vectors, to Animals, to comets to all expanding universe ….

(2) Two-Vectors → From Photons, to Pine-cone, Plants, to Galaxies, to expanding universe …

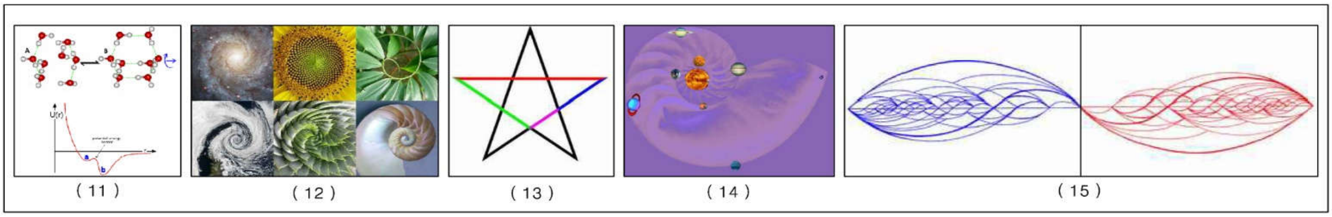
(3) Three-Vectors → From Sub-atomic particles, to DNA molecules, to Inorganic Chemistry, to Elliptical Galaxies, to expanding universe ……

(4) Three -Vectors → From Elements, molecules, to Fruits, to Milky-Wave Galaxies, to ………

(5) Tree –Vectors in a Circle → From Elements, molecules, to Fruits, to Milky-Wave Galaxies, to all caves and to expanding universe …

(6) N–Vectors in a Circle → From Sub atomic particles, Elements, molecules, to all Organic and Inorganic elements, to all types of Galaxies, to expanding universe ….

Since Frequency in Material-point of cave $\mathbf{10^{-62}}$ m *exists as Golden-ratio pattern*, is seen that *exists also in the Structure and motion of the Atom and Molecule* within the materials, *and in all Universe*.



(11) From Web, the Water molecules-structure follows the *golden-ratio-frequency* $\mathbf{f_n}$

(12) From Web, the Animals and Plant-structures follows the *golden-ratio-frequency* $\mathbf{f_n}$

(13) From Web, the Geometrical Pentagon-structure follows the *golden-ratio-frequency* $\mathbf{f_n}$

(14) From Web, the Planetary Position-structure follows the *golden-ratio-frequency* $\mathbf{f_n}$

(15) From Web, the *Space Anti-space Electromagnetic-fields* in [MFMF] Chaos follow the *Golden-ratio-frequency* $\mathbf{f_n}$ *for the Centripetal-Centrifugal forces*.

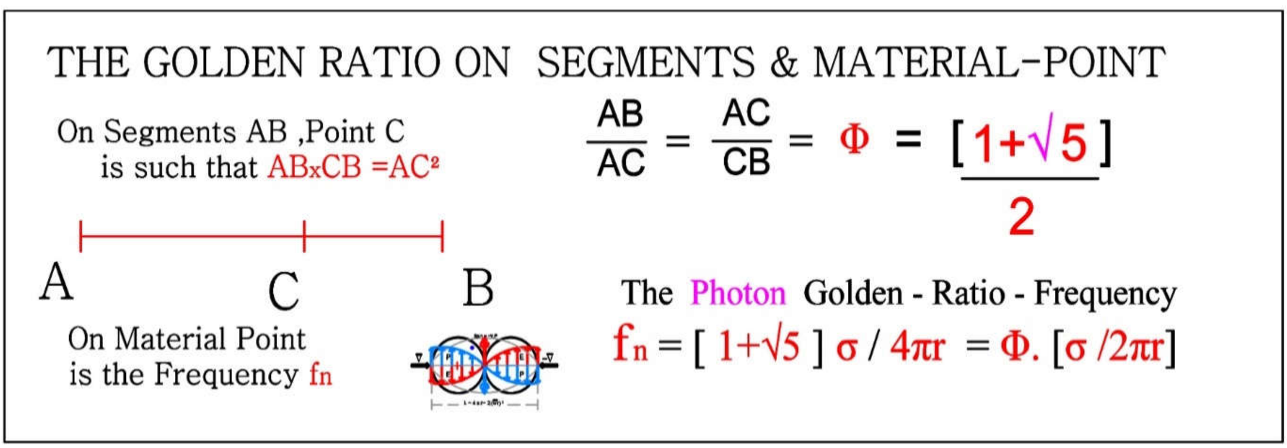


Figure 12: The Golden ratio on Segment AB is at point C, while on Material point[⊕Ʊ↺⊖] is on Principal Stress σ, as frequency $\mathbf{f_n} \equiv [\frac{1+\sqrt{5}}{2}]\frac{\sigma}{2\pi r} \equiv [\frac{n\sigma}{8r^2}].\bar{\mathbf{B}} \equiv \frac{\mathbf{E}}{\mathbf{h}}$ i.e.

Frequency $\mathbf{f_n}$ in Material-point and cave $\mathbf{10^{-62}}$ m *exists as Golden-ratio pattern*

Remarks:

1. *Addition, Subtraction, multiplication and Division*

Addition combines two Numbers or two same magnitudes, *the addends or terms*, into a single number or magnitude. Addition is commutative and associative so the order in which finitely many terms are added does not matter. The inverse of a number with respect to a binary operation is that number when combined with any number, yields the identity with respect to this operation, therefore the inverse of a number with respect to addition, *its additive inverse or the opposite number*, is the number that yields the additive identity, 0, when added to the original number, and which is the negative of the original number, i.e. The additive inverse of a number, N, or Segment $\overrightarrow{\mathbf{AC}}$ is → - N, or $\overleftarrow{\mathbf{AC}} \equiv \overrightarrow{\mathbf{CA}}$.

Above logic is that of Inverse elements.

Subtraction is neither commutative nor associative , so was introduced the concept of inverse elements as in Addition, i.e. [a - b = a + (- b)], or Segment $\overrightarrow{\mathbf{AB}} - \overrightarrow{\mathbf{AC}} = \overrightarrow{\mathbf{AB}} + (- \overrightarrow{\mathbf{AC}}) = \overrightarrow{\mathbf{AB}} + (\overrightarrow{\mathbf{CA}}) = \overrightarrow{\mathbf{CB}}$ *Multiplication* combines any two numbers into a single number, *the product*, and is a scaling operation so for any number N, greater than one, 1, is as stretching everything away from zero, 0, uniformly in such a way that number,1, is stretched to N, while for any number N, less than one, 1, is as squeezing towards zero 0. Multiplication is commutative and associative, and it is distributive over Addition and Subtraction. The multiplicative Inverse for any number, *and for* 0, is the Reciprocal of this number because multiplying the reciprocal of any number by the number itself yields the multiplicative identity 1.

For number Zero , 0, the Reciprocal is ∞ and issues $0.[\frac{\mathbf{1}}{\mathbf{0}} = \infty] \equiv 1- 0 \equiv 1\equiv \rightarrow$ any Constant.

The process for multiplying two arbitrary numbers a, b, *or any two Segments* AB, AC, *is similar to the process for Addition* a. (1 / b).

Division is the inverse operation to multiplication and is neither commutative nor associative, so was introduced the concept of inverse elements as in Multiplication and thus Division becomes multiplication with the dividend and the Reciprocal of the divisor, *as factors*, i.e.$[\frac{\mathbf{a}}{\mathbf{b}} = a .\frac{\mathbf{1}}{\mathbf{b}}]$, and for the Segment $AB\frac{\mathbf{AB}}{\mathbf{AC}} = AB .[\frac{\mathbf{1}}{\mathbf{AC}}]$.

2. *Inverse elements*

Inverse Elements are applied to all operations in Arithmetic and Algebra.

For any number N exists an Inverse or an Reciprocal number 1/N , or – N such that, *in Addition*, *its additiveinverse or the opposite* number, yields the additive identity equal to zero 0,
Subtraction, *itssubtrahend or the opposite* number, yields the additive identity equal to a difference,
Multiplication, yields the multiplicative identity equal to monad 1 or zero 0,
Division, yields the identity equal to N squared.

3. *The Extreme and Mean ratio*

In figure -12 , AB Sector is divided by point C such that $AC = \frac{\mathbf{AB}}{\mathbf{2}} [\sqrt{\mathbf{5}}+1]$ ……………………………..(1)

Proof:

According to the definition of Mean ratio is

AB / AC = AC / CB , or AC^2 = AB.CB = AB.[AB-AC]=AC^2 = - AC.(AB) + $AB^2 \rightarrow AC^2$ +AC (AB) - AB^2 = 0 ……..(2)

Solving the second degree equation (2)

then $AC = \frac{\mathbf{AB}}{\mathbf{2}} [\sqrt{\mathbf{5}}+1]$, i.e. Point C on AB sector, is such that issues (1).

The Physical meaning is from Mechanics where, when a force P acting on a surface S of a differential volume ds [3] then Principal stresses σ1,σ2 , Shear stresses $\boldsymbol{\tau_{12}}$ are as $\sigma = \sqrt{(\boldsymbol{\sigma 1} - \boldsymbol{\sigma 2})^2 + 4\, \boldsymbol{\tau_{12}}}$ and

$$\sigma 1,2 = (\sigma 1+ \sigma 2)/2 \pm (½) \sqrt{(\boldsymbol{\sigma 1} - \boldsymbol{\sigma 2})^2 + 4\, \boldsymbol{\tau_{yz}}^2} \text{ where } \rightarrow \tan\theta = 2.\boldsymbol{\tau_{12}}/ (\sigma 1 - \sigma 2) \quad .... (3)$$

When the surface becomes a point [This is the Extreme case *where surface is interchanged as line or line-segment, it is the same as the infinite small,* ds, *in Calculus*], *then*σ2 = 0 *and* $\boldsymbol{\tau_{12}}$is very small i.e. it is a type of vanishing-shear due to layers laterally shifted . Since force P is a vectorthen as in cross-product to a right–handled coordinate system, where exists σ2 = 0 and $\boldsymbol{\tau_{12}}$= σ1, equation (3)

becomes → $\sigma 1,2 = \sigma 1 /2 \pm (½).\sqrt{\boldsymbol{\sigma 1^2 + 4.\sigma 1^2}} = \frac{\boldsymbol{\sigma 1}}{\mathbf{2}}.[1\pm (\sqrt{5})] = \frac{\boldsymbol{\sigma}}{\mathbf{2}}.[1\pm (\sqrt{5})]$ ……………………..(4)

Equation (4) denotes the way that Stresses σ1, 2 are shaped on any Volume according to the Principal Stress σ , and which is the Golden-ratio $\Phi = \frac{\mathbf{1}}{\mathbf{2}}[1\pm (\sqrt{5})]$of Stress σ.

Since also *Stress* σ eternally exists in Material point and *is of the Golden-ratio-pattern* Φ, therefore microcosm and sequence all macrocosm follows, *the Stress* σ *Property*, of the Golden-ratio-pattern Φ

4. The Φ Properties:

To show that $\Phi = 1+\frac{\mathbf{1}}{\boldsymbol{\Phi}} = 1,6180339887$: Proof,

It is holding → $1+\frac{\mathbf{1}}{\boldsymbol{\Phi}} = 1 + \frac{\mathbf{1}}{\mathbf{[1+\sqrt{5}]\,/\,2}} = 1 + \frac{\mathbf{2}}{\mathbf{[1+\sqrt{5}]}} = \frac{\mathbf{2[\sqrt{5}-1]}}{\mathbf{[\sqrt{5}+1].[\sqrt{5}-1)]}}$ or,

$$1+ \frac{\mathbf{1}}{\boldsymbol{\Phi}} = 1 + \frac{\mathbf{2[\sqrt{5}-1]}}{\mathbf{4}} = 1+\frac{\mathbf{[\sqrt{5}-1]}}{\mathbf{2}} = \frac{\mathbf{2+\sqrt{5}-1}}{\mathbf{2}} = \frac{\mathbf{[\sqrt{5}+1]}}{\mathbf{2}} = \Phi \text{ , therefore,} \Phi = 1+ \frac{\mathbf{1}}{\boldsymbol{\Phi}} ....(5)$$

Equation (5) is a very Special property of the Golden ratio because is that *it can be defined in terms of itself*, i.e. of unit 1 equal to a new Φ which defines *the Space*, and of $\frac{1}{\Phi}$ defining *the Anti-Space*, and as continuous fraction,

$$\Phi = 1+\left[\frac{1}{1+\frac{1}{1+\frac{1}{1+\frac{1}{\cdot}}}}\right] \text{......} (6)$$

Because number Φ, multiplied with its Reciprocal number $\frac{1}{\Phi}$, *is process of Addition*, and equal to unit 1,

$$\text{so} \rightarrow \Phi \cdot \frac{1}{\Phi} = [1+\frac{1}{\Phi}]\frac{1}{\Phi} = 1 \text{ or } \rightarrow \frac{1}{\Phi}+\frac{1}{\Phi^2} = 1 \text{ and } \Phi + 1 = \Phi^2 \text{ or } \rightarrow \Phi^2 = \Phi + 1 \text{ ......} (7)$$

Equation (7) is also a very Special property of the Golden ratio because, *according to Euclid*, A straight line AB is said to have been cut in Extreme and Mean ratio when as the whole line is to the greater segment AB / AC, so is the greater to the lesser AC / CB, *and according to Markos,*

Since frequency in Material-point $\rightarrow \mathbf{f_n} = (\frac{n\sigma}{8r^2}).\overline{\mathbf{B}} \equiv \frac{(1+\sqrt{5}]).\sigma}{4\pi r} \equiv \frac{E}{h}$, *is occupying the Property of the Golden-ratio-pattern*Φ, equation (7) defines that Material Point of frequency $\mathbf{f_n}$, *when collide with another* Material Point, *or with another Particle or particles,* then Produces another monad as 1 ≡*a New quaternion*, and the first continuous to be of the same Identity, *frequency* $\mathbf{f_n}$, as before ,i.e.

The Frequency of Photon*, embodied with the Golden-ratio-pattern* Φ, Uses *the Vibrating Physical Structures*, *the Granular Material-Instruments*, to Kick-Start *everything in this world.*

VI. General

1. *The Theory of Material Geometry and article[70]*

Energy is the Work, the *motion* in a Material-point A-Bin all directions and which is conserved.

In order that *Motion*, *Displacement*, maybe conserved, then must be *Quantized in a finite Space* because differently *gets annihilate*. Motion in a finite-space, r, can be realized *only as a Reciprocating* [⊕s²↔⊖s²] *or a Revolving motion*[⊕s²Ʊↄ⊖s²] which is Periodic and then happens an Eternal-Quantized-motionin r. All above happen in Material-Point AB ≡[⊕⊖], where Point A = Positive ⊕ and Point B =Negative ⊖.

Since *Energy is the motion of Opposites ,or the* [⊖↔⊕] ≡ [Space ↔ Anti-space] charge in all Levels, *as is the Electrostatic force*, and then the N loops as *Work can be stored in the,* n, *Energy lobes of the Stationary-Wave of cave,* r. The N loops are the Energy-Stores of M-P, and *mass the Reaction* to this *Up - Down oscillatory motion in Loop* of each wave Segment at frequency, $\mathbf{f_n}$, which describe each *mode* and characterized by a different λ , and , f , *into the Energy-Geometrical-Shape of motion*.

This happens because of charges alternation [+, - to - , +], i.e. (AC) which exists on Antinodes amplitude of this local *Inverse* oscillation. The Work produced is stored into the Shape of motion.

All monads can immediately be other monads with different frequency, f, following the *Breakage rule* → s² - $|\bar{\mathbf{s}}|^2 + 2|s|^2.\nabla i\leftarrow$ i.e. matter (+) , antimatter (-), energy (+↔ -) or, *Material Point* A - $\mathbf{K_R}$≡ monad ≡ The Dipole ≡ [⊕⊖] = ∅ =$\mathbf{K_r}$ **A** $\mathbf{K_{R=r}}$*where* → { $\mathbf{K_R}$≡ [⊕] }↔ { $\mathbf{K_r}$≡ [⊖] } → ≡ 0.

The Trapped - Energy into the Stationary Energy – Lobes of monads becomes the Outward Wave with Kinetic Energy for those monads, the Photons, when in cave is followed the Cycloidal-motion where there wavelength λ *is the moving Energy-store, and from EM-radiation, the Electric- field is the Matter and the Magnetic- field is the equilibrium Anti-matter of the Energy-monad -Photon.*

From [66] Angular – Momentum – Vector$\overline{\mathbf{B}} = \frac{\pi r^3\sigma}{8}[1+\sqrt{\mathbf{5}}] \equiv [\frac{\mathbf{h}}{2\pi}]$ and , $\sigma = \pm\frac{4\pi r}{(1+\sqrt{5})}.\mathbf{f_1}$

Energy $E = h.\mathbf{f_n} = \frac{h(1+\sqrt{5})}{4\pi}.[\frac{\sigma}{r}] = (\frac{n\sigma}{8r^2}).\overline{\mathbf{B}}\rightarrow$ i.e. *The Energy for the Short or Strong-range forces is dependent*, on Principal stresses, σ, the Spin vector $\overline{\mathbf{B}}$, and on inverse square cave, r. *The Strong Forces as Energy in Nucleus is due to the fact that Proton is a compound element and nucleons* (protons and neutrons) *are held together within an atom`s nucleus by the presence of additional particles as holds for the Breakage-Principle ,While the Short range forces exist on Primary and Neutral Particles only.*

From [66] The First harmonic is $\mathbf{f_1} = \frac{(1+\sqrt{5}]).\sigma}{4\pi r}$, and mass $m = \frac{E}{2r^2.w^2} = \frac{(1+\sqrt{5}])4r^2\sigma}{6r\sigma^2(1+\sqrt{5})^2} = [\frac{4\pi r^2}{3}].\mathbf{f_1}$ .... (12)

i.e. *Mass is dependent*, on fundamental frequency $\mathbf{f_1}$, and on the square of cave r, is a number measuring the time-rate of changes in cave, *so Energy, the motion, and Mass, a number, are not equivalent*. All Clashed and all The-Un-clashed Material-Fragments exist only in *Chaos* [±s²]≡ [MFMF].

The Geometries:[53-58]This is *the Euclidean Quantization* of points A, B in geometry.

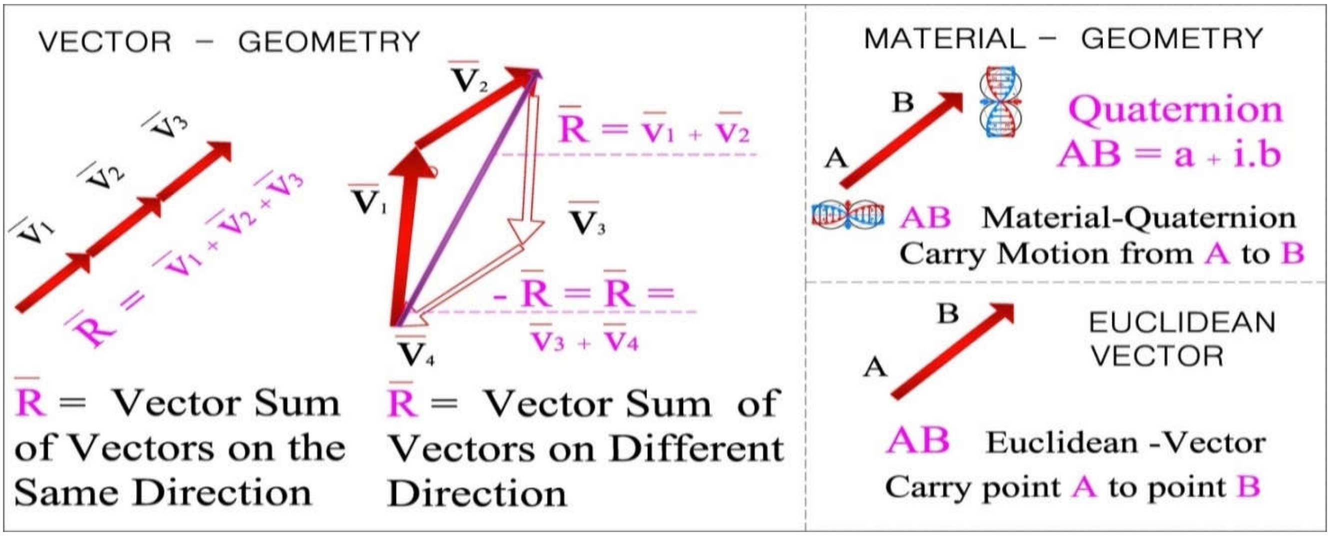


Figure 13: Explanation for the, Vector, in Euclidean and Material-geometry Properties

The Euclidean-Vector carries *point* A to point B, while in M-G *carries motion* from A to B point.

a. *Point in Euclidian-Geometry* is nothing and is possessing Zero-magnitude and Infinite-directions.

b. *Two Points* consist the Straight-line-segment, possessing |AB| - magnitude and the |A→B| Directions.

Euclidean-vector $\overrightarrow{\mathbf{AB}}$ carries Point A to point B, possessing |AB|-magnitude and the two opposite directions $\overrightarrow{\mathbf{AB}}$, $\overleftarrow{\mathbf{BA}}$ respectively. *Atraction* of opposite forces $\mathbf{P_A} \leftrightarrow \mathbf{P_B}$at points A, B creates the Central motion and Kepler`s laws where ,*Orbitsare Plane-Surfaces representing a Constant-Energy becoming from the squared Periods T* ^{2}, or Frequency $\mathbf{f_n}^2$, *representing the Imaginary -Energy- Part of monad and* $\mathbf{r_n}^3$ *representing the Real-Space -Part of monad* $1 = c.\mathbf{f_n}^2.r^3$,The constant Quantized-Plane-Rims *These energy-Rims are of constant Energy equal to* g*, and follow The Celestial Kepler Laws.*

c. *Three Points* A, B, P, consist the Plane ABP, i.e. the line AB and point P, not on AB, and is the First-Rigid figure , *The Triangle* , In E-Geometry is the First-Shape-Stable figure in Mechanics.
d. *Four Points* A, B, C, P, consist the Space-shape ABCP, i.e. the Plane ABC and point P, not in Plane ABC, and is the First Stable-Solid-figure, *The Tetrahedron* , in E-Geometry.
e. *N- Points* A, B, C, .. P, consist the Space-shape ABC... P, i.e. the Space ABC. and point P, not in Space ABC…., and is the First Stable-Solid-figure, *The N - edron*, in E-Geometry.

1. *Pointin Material-geometry* is the Glue-Bond [⊕⊖] of opposite caves, r, possessing the finite Magnitude |r|, where *both forces exist apriori*, as the Glue-Bond ,σ, between the opposites and as Direction that of the inside Spin $\overline{\mathbf{B}}=\frac{\pi r^3\sigma}{8}[1+\sqrt{5}] \equiv \frac{\pi^2 r^4}{2}\mathbf{f_1} \equiv [\frac{h}{2\pi}]$ where $\sigma = \pm\frac{4\pi r}{(1+\sqrt{5})}\cdot\mathbf{f_1}$ i.e.

→ Material-Pointconsists *the first Energy-Automobile-Quantum-Space of Euclidean-Geometry*.

2. *Two Points* A ↔ B consist, Quaternion, a + i b , carrying *Energy* = *motion* from A to B.

where,a, is a scalar quantity that has *Magnitude* but NOT *Direction*.

b, is a vector quantity that has both *Magnitude* AND *Direction*. i.e.

Direction is the $\overrightarrow{\mathbf{AB}}$, $\overleftarrow{\mathbf{BA}}$ denoted as (+) the Right and (-)the Left-direction, axis,[- ← O → +] .

→ Material-Segment consists *the first Energy-Automobile-Quantum-Space-Vector and is equal to the Material-Quaternion* { Real-axis O → Oand Imaginary-axis O → $\sqrt{-1}$ }*of Euclidean-Geometry* Two Points create all , The maximum-minimum and constant Energy-Shapes of M-Geometry. [54]

3. *Three Points* A ↔ B ↔ C consist, the Plane-Quaternion, a + i b, carrying *Energy* = *motion* from point A to B and C, from B to C and A, and from C to A and B.

where, a, is a scalar quantity that has *Magnitude* but NOT *Direction*., b, is a vector quantity that has both *Magnitude* AND *Direction* . i.e.

→ Material-Plane consists *the first Energy-Automobile-Quantum-Planeand is equal to the Material-Plane-Quaternion* {Real-axis O → x and Imaginary-axis O → $\sqrt{-1}$ }, it isa Field a Region in which each point is affected by a force ,*in Euclidean-Geometry.*

Because the three points in E-Geometry correspond to Six in Material-Geometry therefore the First-Stable figure in Mechanics is the Regular-Hexagon , which is followed by nature. [56]

4. *Four Points* A ↔ B↔ C ↔ P consist ,the Space-Quaternion ,a + i b , carrying *Energy* = *motion* from point A to B, C and P, from B toC, P and A , from C to P, A and B, from P to A, B and C. *where*, a, is a scalar quantity that has *Magnitude* but NOT *Direction* .

b, is a vector quantity that has both *Magnitude* AND *Direction* . i.e.

→ Material-Space consists *the first Energy-Automobile-Quantum-Space-Plane and is equal to the Material-Volume-Quaternion* { Real-axis O → x , Imaginary-axis O →$\sqrt{-1}$, and O →z }, a Volume, a Region in which each point is affected by a force, *in Euclidean-Geometry.*

Because four points in E-Geometry correspond to eight in Material-Geometry therefore the First-Stable figure in Mechanics is the Regular-Octagon which is followed by nature.

5. *N - Points* A, B ,,, P,,, $\mathbf{P_N}$, consist the, N-Spaces-Quaternion, a + i b, carrying *Energy* = *motion* from point A to B, P and $\mathbf{P_N}$, fromB toP, $\mathbf{P_N}$ and A, from $\mathbf{P_N}$ to A, B and P, *where*,

a, is a scalar quantity that has *Magnitude* but NOT *Direction*.

b, is a vector quantity that has both *Magnitude* AND *Direction*. i.e.

→ Material-N-Space consists *the first Energy-Automobile-Quantum-N-Space and is equal to the Material-N-Volume-Quaternion* {Real-axis O → x, Imaginary-axis O →$\sqrt{-1}$, and O → $\mathbf{Z_N}$}

N-Volume, the N-Regions in which each point and each volume is affected by a force, *in Euclidean Geometry.* Because N-points in E-Geometry correspond to 2N in Material-Geometry therefore the First Stable figure in Mechanics is the Regular N-gone which is followed by nature.

Regular-N-Edges shape, ABP$\mathbf{P_N}$, is The RegularN - Edges – Polyhedrons.

It was shown in [25] that → Quaternion $\overline{\mathbf{AB}}$ ≡ monad [AB] ≡ ($\mathbf{s} + \bar{\mathbf{v}}\nabla\mathbf{i}$) = 1 ……..(a)

Since also from [33] Action (©) of a quaternion $\bar{\mathbf{z}}$= s + $\bar{\mathbf{v}}$.i= s + $\bar{\mathbf{v}}$.∇i on itself is a Binomial type

$$(s + \bar{\mathbf{v}}.\nabla i)(©)(s + \bar{\mathbf{v}}.\nabla i) = [s + \bar{\mathbf{v}}.\nabla i]^2 = s^2 + |\bar{\mathbf{v}}|^2.\nabla i^2 + 2|s|.|\bar{\mathbf{v}}|.\nabla i = s^2 - |\bar{\mathbf{v}}|^2 + 2|s|.|\bar{\mathbf{w}}r|.\nabla i = s^2 - |\bar{\mathbf{v}}|^2 + [2\bar{\mathbf{w}}].|s|.|r|.\nabla I = s^2 - |\bar{\mathbf{s}}|^2 + 2|s|^2.\nabla i \quad \{ \text{for } s = v = w.r \text{ and } s \perp v \}$$

where ,

s^2 → is the real part, *Matter*, of the new quaternion and is *a Positive Scalar magnitude*.

- s^2 → is the always negative part, *Anti-matter*, which is always *a Negative Scalar magnitude*.

$2.s^2\nabla i$ → is the double Angular-velocity term, *Energy*, which is *a Vector magnitude,*

or → $z^2 = s^2 - s^2 + 2.s.s = 1$, the same becomes from (a) $s^2 + (iv)^2 = 1$ or → $s^2 - v^2 = 1$ so,

Breakage – Principle on Material-Geometry is identified with Euclidean-Geometry Principles.

It was proved from Mohr circle that,$(\bar{\boldsymbol{\rho}})^2 + (\bar{\mathbf{a}})^2 = (\bar{\mathbf{M}} = \mathbf{J_a})^2$, which is

[Work ≡ Energy ≡ Torsional-momentum] ^{2} = [Moving-Space-Energy] ^{2} + [Rest-Space-Energy] ^{2}

or [The Energy-vector] ^{2} = [The Space-vector] ^{2} + [The Mass-meter] ^{2} is the Ellipsoid of motion

Rotational-Momentum Ellipsoid ≡ *Work* ≡$\bar{\boldsymbol{\rho}}$, → *The Energy-vector*

Angular-Velocity–Inertial-Ellipsoid ≡ *Force* ≡ $\bar{\mathbf{a}}$, → *The Space - vector*

Reaction to velocity-change-motion ≡ *Mass-scalar* M ≡ $\mathbf{J_a}$, → *The Mass – meter*

Above Breakage-Principle issues in Euclidean and Material-Geometry and in all others Geometries. Applying Pythagoras theorem in any circle [63M] or, angles on diameters of circles being always 90º then →

$z^2 = s^2 - s^2 + 2.s.s = 1$, and from Unit-quaternion $s^2 + (iv)^2 = 1$ or → $s^2 - v^2 = 1$ ……………………….(b)

Equation (b) is a *Cone relation* on where Total-energy, *Kinetic and Potential* is conserved and for Photon Particle , Electromagnetic radiation is the *Kinetic-energy* and the Velocity-vector-energy-tank is the *Potential*. Photon is an Energy-store r , in a Stationary-wave of wavelength n λ = 2r, consisted of n stationary lobes filled in λ with inner motion the Electromagnetic-Displacement-current ,while Outward Propagating with light speed as Energy-store λ = 2r / n , [+] Electric-field as Space, [-] Magnetic-field as Anti-space.Above relation of squares is one way of Energy-transferring from one system to another.

The two Forces *Newton`s Inertia Force* → ma = m$\ddot{\mathbf{x}}$ and *Glue-Bond Force* of opposites $\mathbf{F_p} = \mathbf{F_f}$→ m.v²/R = σ = m.c² / r and m = [σ r] / c² or, Force F = m.v²/R = ∇(σ².r²) / ($\mathbf{c^4}$r) = $\nabla[\frac{\sigma}{c^2}]^2$. r and for Gravitational Force becomes → a constant, $\nabla(\mathbf{m_1}.\mathbf{m_2})/(\mathbf{x_1}-\mathbf{x_2})$ = g.$\nabla[\frac{\sigma}{c^2}]^2$. r markos 30 / 1 / 2018

2. *The Energy Quantization-States in all Levels*

State 1. In the equilibrium Space-cave of radius, r, the equilibrium opposite rotating velocities $\pm\bar{\mathbf{v}}$ collide resulting to the three Fragments, $s^2 - |\bar{\mathbf{s}}|^2 + 2|s|^2.\nabla i$. [26-29]

State 2. The constant maximum velocities, $\bar{\mathbf{c}}$ and $\bar{\mathbf{v}}$, as *Thrust* in cave, r, acting On the three Breakages { [$s^2 = \pm(\bar{\mathbf{w}}.r)^2$, [∇i] = 2(wr)²] and through *Geometrical Mechanism*[STPL] are becoming, *Fermions* →[$\pm\bar{\mathbf{v}}.s^2$]and *Bosons* → [$\bar{\mathbf{v}}$.∇i = [$\bar{\mathbf{v}}.2(\bar{\mathbf{w}}.r)^2$] = [$\bar{\mathbf{v}}.2s^2$], [35] which become Waves {*Distance* |ds| = |A$\mathbf{A_E}$| *is the Work embedded in monads and it is what is vibrated* } and are Particles, with Inherent Vibration.

The Un-clashed Breakages [± s² = ± (wr)²] and [∇i = 2(wr)²] , *Outward*[STPL] *Mechanism*, consist the Medium-Field-Material-Fragment [MFMF]=[± s²]= *The Chaos* ,as base for all motions and the Gravity as the force [∇i] , whilethe Clashed with the constant velocity,$\bar{\mathbf{c}}$, consist the Dark matter [± $\bar{\mathbf{c}}.s^2$] and the Dark Energy [$\bar{\mathbf{c}}$.∇i] ≡ [∇i = 2(wr)²] . $\mathbf{r^4}$. All above Obey Newton`s Laws of motion in all Scales.

From the Properties of Vibrating-Systems , the Elastic behavior can be expressed either in terms of the Stiffness [K], or the Flexibility $[\mathbf{K}]^{-1}$, so the equations of motion for the normal vibration in terms of the stiffness is →

$$(-w^2[M] + [K])\ \{X\} = \{0\} \quad \text{……………………………………..……………(a).}$$

Forces are expressed in terms of the displacement

$$\{F\} = [K]\{X\} \quad \text{……………………………..……………………… (b),}$$

where displacement

$$\{X\} = [\mathbf{K}]^{-1}\{F\} = [a]\ \{F\} \quad \text{……………………………………………...(c)}$$

and the equation of motion in terms ofthe Flexibility is determined by equation →

$$(-w^2[a][M] + I)\ \{X\} = \{0\} \quad \text{…………………………………………….……(d)}$$

where $[\mathbf{K}]^{-1}$K = I = Unit matrix . Equation (d) is altered as

$$-\bar{\boldsymbol{\lambda}}\,X + \bar{\mathbf{A}}X = \{0\} \ \text{ or },\ \bar{\mathbf{A}}X = \bar{\boldsymbol{\lambda}}\,X \quad \text{…………………………………….……(d1)}$$

where $\bar{\mathbf{A}}$ = [a] [M] = $[\mathbf{K}]^{-1}$[M] *and* $\bar{\boldsymbol{\lambda}}$ = 1/w² , and $\mathbf{w_1}$ is the natural frequency, *i.e.*

Energy ≡ motion in Vibrating Systems are the *Golden-ratio-frequencies* →$\mathbf{f_n} = \mathbf{w_1}/2\pi = n\frac{(1+\sqrt{5})\sigma}{4\pi r} = \frac{\lambda_N}{c}$

Equation (a) may be written in Exponential form as

$$(-w^2[M]+[K])\ \{X\} = [-w^2M + K]\ u.\mathbf{e^{iwt}} = 0 \quad \text{………………………………….....(e)}$$

From equation [-w²M +K] u.$\mathbf{e^{iwt}}$ = 0 , isinterpreted $\mathbf{m_G}$= - Jw² Gravity-force $\mathbf{F_G}$ becomes from the in-storage acceleration a = v² / r , and this because force [∇i] is stationary and from the pointy-rotating [-s²ᘎᘏ+s²] exists in the Material-point, *and for Planck length the gravity*g, *is as*,

Gravity force $$[\nabla i] \equiv \mathbf{F_G} \equiv \mathbf{m_G}g = \nabla[\tfrac{\sigma}{c^2}]^2\, r.g = \mathbf{m_G}\frac{v^2}{r} = Jw^2.\ \mathbf{g_G} = [\frac{\pi r^4}{2}]w^2.\frac{v^2}{r} = [\frac{\pi r^4}{2}]\frac{v^2}{r^2}\frac{v^2}{r} = [\frac{\pi r v^4}{2}] \quad \text{……………..…(a)}$$

$$\mathbf{g_G} = [\frac{\pi r v^4}{2}] = [\frac{3{,}1415926\left([\sqrt{5}+1].\sqrt[4]{2}.10^{-35}\right).(299793458)^4}{2}]\,\boldsymbol{e^3} = 6{,}044981.\mathbf{10^{-35}}.80{,}776078.\mathbf{10^{32}}.20{,}085536 =$$

$\mathbf{g_G}$ = 9,8076941, *where* π = Euclidean number pi,

r = Planck`s cave with the dimensionless coefficient [√5+1] of Material-cave,

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$\sqrt[4]{2}$ = The unity-Quaternion coefficient,

e^3 = The three dimensions Rotation-System coefficient of Euler`s number.

The difference between, *Vacuum - Energy* [$\mathbf{W_{n(n+1)}}$] *and Dark - Energy*[$\bar{\mathbf{c}}$.∇i], is that Vacuum [r] *is a Stationary Wave* with Energy $\mathbf{W_n}$in n, Loops of the Material point while Dark-Energy is a *Pushing Kinetic Energy* {DE}≡ [$\bar{\mathbf{c}}$.∇ i], travelling with the → DM-DE ≡ [± s²], Field ← with the light velocity, c, and the binding Gravity-Force [∇i] *as*, [$\bar{\mathbf{c}}$.∇ i] (©)→{ (∇i),(+s²),(-s²),(+cs²),(-cs²) } *i.e. The Cause Expansion of the Universe, is the continuous and simultaneous effection of Dark-Energy* DE = [$\bar{\mathbf{c}}$.∇i] *on all Five Energy-Fragments with light velocity*$\bar{\mathbf{c}}$, *as* [$\bar{\mathbf{c}}$.∇i] → {(∇i),(+s²),(-s²),(+cs²),(-cs²)} *which is the rolling Heap. Energy Quantities* [∇i = 2(wr)²], *in the rolling Heap, acting on the dipole breakages* [± s²] *formulate the Gravity-Field and Gravity-Force while acting on dipole breakages* [±$\bar{\mathbf{c}}$.s²] *formulate Dark matter*, DM, *and Dark Energy*, DE, *respectively, while* DE *acting on Leptons and Quarks Anti-Leptons and Anti - Quarks, Bosons, formulate the whole existing Material worlds*.

State 3. The *Quantized Energy-levels, States, result* from the relation between a particle`s energy E, and its wavelength, λ, because following the *Breakage - Principle* where *The - Energy-part* ≡ E =$\frac{h.c}{\lambda}$, the in Planck Scale h, c, constituents are both constants. From relations v = c = w r, $\mathbf{f_n} = \mathbf{w_1}/2\pi$ then $\mathbf{f_n} = \frac{\mathbf{w}}{2\pi} = \frac{\mathbf{c}}{2\pi r}$ and → c = 2πr. $\mathbf{f_n}$, i.e. either velocity, c, or Golden-frequency $\mathbf{f_n}$, creates Energy ≡ motion.

For a *confined - particle* such an atom or monad, *wave function*, has the form of a Standing wave, *its peaks and any other point of the wave do not move spatially*, *i.e. a Quaternion* AB = $\bar{\mathbf{q}}$= [s+$\bar{\mathbf{v}}$∇i] ,*with* s ≡ the real part ≡ wavelength λ, and $\bar{\mathbf{v}}$∇i ≡ The Energy-part consisted of the frequencies $\mathbf{f_n}$= n.$\mathbf{f_1}$=$\frac{\mathbf{E}}{\mathbf{h}}$ in Energy-loop of Lobes where, n represents → *a Normal mode vibration* with natural frequency $\mathbf{f_n}$ determined by the equation →$\mathbf{f_n}$= $\frac{\mathbf{n.v}}{\mathbf{4r}} = \frac{\mathbf{n\sigma}}{\mathbf{8r}}[1+\sqrt{\mathbf{5}}]$ ← and *is an Energy-cave* (the n, modes of $\mathbf{f_n}$) in where, Energy ≡ Spin exists, and *stored*. Above relation denotes the Energy-Storages in Material-point or Oscillations or and monads which are the Quantization of frequencies as the harmonics $\mathbf{f_1}$, $\mathbf{f_2}$,…., $\mathbf{f_n}$ of cave, r = *l*, depended on, σ, only. *Only stationary states*, [the eigenvectors with the eigen values are the loops which correspond to integer numbers n = 1,2,3, … of wavelengths *as this happens in all Homogenous equations*], *can exist* ,[and this *because rotation is considered as a grating having n lines per,* r , as this happens for Spin $\bar{\mathbf{B}}$] *while* for other states The Waves , *Interfere-Destructively*, resulting in zero wavelength λ = s = 0 , and then is remaining the Energy-part, $\bar{\mathbf{v}}$∇i only, *it is the M-P- density*.

Since the, n, modes of vibration are the n, energy-levels in monads in case of Bohr-model and radius for minimum acceleration the cave $\mathbf{10^{-13}}$ m = $\mathbf{10^4}$nm, then in Hydrogen-atom for,

$$\lambda = 2\pi\mathbf{r_1} = 6{,}28.\mathbf{10^{-13}}\text{ m corresponds to an Energy E(eV)} = \frac{\mathbf{hc}}{\boldsymbol{\lambda}} = \frac{\mathbf{19{,}864510^{-24}}}{\boldsymbol{\lambda}\mathbf{1.1{,}6021810^{-19}}} = 1{,}9744.\mathbf{10^8}\text{ eV.}$$

$$\lambda = 2\pi\mathbf{r_2} = 12{,}57.\mathbf{10^{-13}}\text{ m corresponds to an Energy E(eV)} = \frac{\mathbf{hc}}{\boldsymbol{\lambda}} = \frac{\mathbf{19{,}864510^{-24}}}{\boldsymbol{\lambda}\mathbf{2.1{,}6021810^{-19}}} = 0{,}9862.\mathbf{10^8}\text{ eV.}$$

$$\lambda = 2\pi\mathbf{r_3} = 18{,}85.\mathbf{10^{-13}}\text{ m corresponds to an Energy E(eV)} = \frac{\mathbf{hc}}{\boldsymbol{\lambda}} = \frac{\mathbf{19{,}864510^{-24}}}{\boldsymbol{\lambda}\mathbf{3.1{,}6021810^{-19}}} = 0{,}6579.\mathbf{10^8}\text{ eV.}$$

State 4. The next state for *Non-confined - particle*, such an atom or molecule, *monad*, is Crystal. Crystals are solids that form by a Regular-repeated-Pattern of atoms or molecules connecting together. In some solids the arrangements of the building blocks, *atoms and molecules* , can be random or very different throughout the material. In crystals however, a collection of atoms called the *Unit-cell* is the *repeated in exactly the same arrangement* , over and over throughout the entire material.

Microscopically, atoms and molecules of Crystal, are in a near-perfect *Periodic-or -Not* arrangement following the *Breakage – Principle of Material-Geometry*, where Crystal - lattice – Position consist the Space and Anti - space equilibrium, and Energy part is the binding amorphous solid in order the whole to be a monad. Since Golden-ratio frequency $\mathbf{f_n}$ = c / 2πr is motion then, All monads are motion i.e. →

Energy ≡ Motion ≡ Space + Anti space + Kinetic Energy.

In case Crystal-lattice is *Non-equilibrium* then consist a *New moving monad for New-Future-Technology*. From above is seen that the quantized Grouped-Crystal-Systems, *either these are in Equilibrium or Not*, follow the Material-geometry Principles.

State 5. The Parallel to Crystal state-4 is Organic chemistry , where all organic molecules contain carbon and nearly all hydrogen. *The first three dimensioned simplest ordinary convex in Geometry is Tetrahedron* and, in Material Geometry the 3D-link $\mathbf{CH_4}$ methane, which consists the simplest organic compound in chemistry. This happens because Monads ≡ Energy ≡ Motion ≡ Space + Anti space + Kinetic Energy.

State 6. The combination of Inorganic-Compounds, *as the Crystals* , and Organic Compounds, *as the methane and benzene*, is the evolutionary cosmos. Again, velocity $c = 2\pi r.\mathbf{f_n}$ is related to the *Golden-ratio-frequencies* → $\mathbf{f_n} = \mathbf{w_1}/2\pi = n\frac{(1+\sqrt{5})\sigma}{4\pi r} = \frac{\lambda_N}{c}$ which formulates theEvolutionary and Expanded cosmos with the Golden-ratio Formation $\Phi = \frac{1}{2}[\,1 \pm (\sqrt{5})]$ of Stress σ.

Euclidean`s Geometry Quantized Spaces		Euclidean Geometry	Material Geometry	Material Dimensions	Permitted Units ⊖⊕	MOULDS Permitted Positions	S L U The Full Orbital Units
1		2				3	4
1	Point	A	⊕⊖ V	The First ONE Dimention Point - Space	2	2 P²	
2	Line Segment	A B	⊕⊖ ⊕⊖	The First ONE Dimention Line - Space	4	1	H = 1s Hydrogen
3	Plane Reg.3gon	A B C N = 3		The First TWO Dimention Plane - Space	6	2	He = 1s Helium
4	Volume Reg.4gon	A B D C N = 4		The First THREE Dimention Volume - Space	8	8	Ne = 2p Neon
5	Space Reg.5gon	N = 5		The First FOUR Dimention Volume -Space	10	18	Ar = 3p Argon
6	Space Reg.6gon	N = 6		The First FIVE Dimention Volume - Space	12	32	Kr = 4p Krypton
7	Space Reg.7gon	N = 7		The First SIX Dimention Volume - Space	14	50	Xe = 5p Xenon
8	Space Reg.8gon	N = 8		The First SEVEN Dimention Volume - Space	16	72	Rn = 6p Radon
9	Space Reg.9gon	N = 9		The First EIGHT Dimention Volume - Space	18	98	Uuo = np Ununoctium
10	Space Reg.10gon	N = 10		The First NINE Dimention Volume - Space	20	128 162	P = Number of Positives = N-2 and N=Spaces = The Number of Points
N	Space Reg.Ngon	N = N	⊖⊕ = 2N ⊕ = N - 2	The First N - 1 Dimention Volume - Space	2 N	2 N²	

Figure 14: The Euclidean and *Material Geometry* in Particles and monads in Monad.

The Uniform Circular motion is the First Possible Position of Monads.

The Number of Neutrons in Space represent Isotopes in Nucleus→[$\mathbf{s} + \bar{\mathbf{v}}\nabla\mathbf{i}$]

In 1. Euclidean Geometry is defined on the Number of Points which can define a Space , i.e.

The Point is defined from one Point , The Line Segment consisted of two Points , The Triangle consisted of three Points , The regular Tetragon consisted of four Points in , The regular Pentagon consisted of five Points in Space and so on , represent the Steady , *Regular and stable* , formations of Geometry.

In 2. Are shown the Material-Points , Positives and Negatives on each Point which is Zero and can be added to any other Positives and Negatives , and which represent Protons and Electrons in Physics.

In 3. Are shown the Permitted number in Units and in Moulds , which represent Electron Positions.

In 4. Are shown the Number of Neutrons in Space and the satiation states of electrons →[$\mathbf{s} + \bar{\mathbf{v}}\nabla\mathbf{i}$] From the definition of Work, *Work* = *Force* x *Displacement* = *Energy,* results the where this Energy as, *Momentum Vector*$\bar{\mathbf{B}}$≡ *Spin* ≡ *Energy ,is stored in* r, cave of$\mathbf{KK_1} = \bar{\mathbf{q}}$ = [s+$\bar{\mathbf{v}}\nabla$i]≡ Quaternion.

Cave, r, IS, *Outward a moving-Stationary Box* , *Inward a Stationary Wave*, with infinite frequencies $\mathbf{f_1} \ldots \mathbf{f_n} \rightarrow \mathbf{f}_\infty$ and with Energy, E = h.$\mathbf{f_n} = \frac{\mathbf{h(1+\sqrt{5})}}{\mathbf{4\pi}}$. $[\frac{\sigma}{r}] = (\frac{\mathbf{n\sigma}}{\mathbf{8\,r^2}})$.$\overline{\mathbf{B}} = \mathbf{W_d} = 8.\mathrm{k}.\mathbf{f_n A_r}$.

The How and Why, *This Inward Stationary Wave* becomes an, *Outward moving Wave*, follows ↻.

3. *The Cycloid*

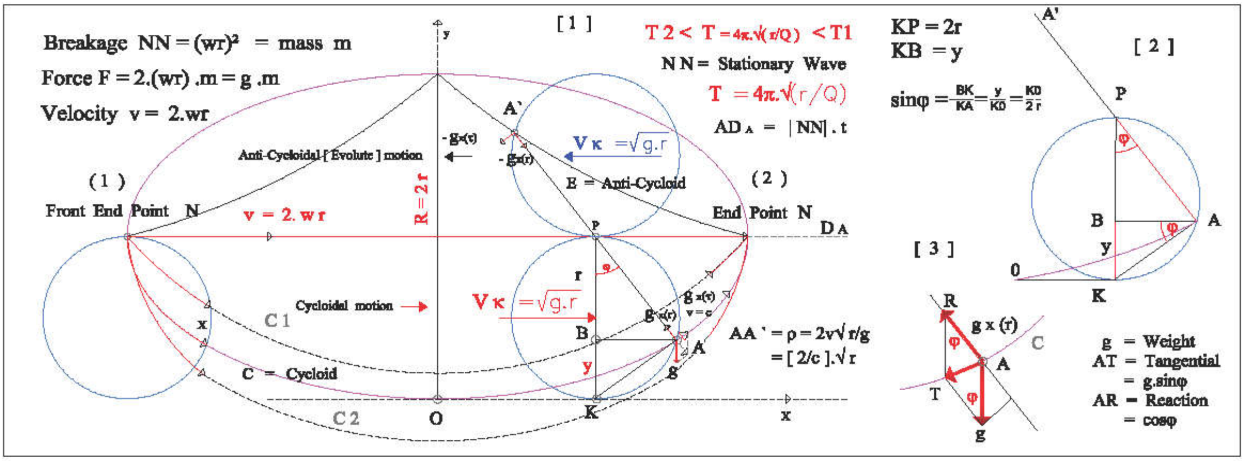

Figure 15: The Cycloid

The Cycloidal motion in , *Material Point* ≡ *Monad is* the Dipole ≡ [⊕⊖]= ∅ =AA` *where* → A≡[⊕] →A`≡[⊖] → |AA`|≡ ∅≡*The Brachistochrone Curve* C ≡ N1→N2.

Motion of Dipole [AA`] on curve C1 acquires a period T1 > $4\pi\sqrt{\mathbf{r/g}}$ while on C2, T2 < $4\pi\sqrt{\mathbf{r/g}}$ which is not Isochronous. Motion of Dipole [ AA`] on Curve C ,*The Cycloid* , acquires a CONSTANT period T = $4\pi\sqrt{\mathbf{r/g}}$ which is Isochronous.

Monad (1) –(2) = NN is The Electromagnetic-Wave in NN , *and* [AA`] ≡ *Energy Distance*.

Properties: Cycloid is the curve described (traced) by a point P, on the circumference of a circle of radius, r, as this rolls along a straight line, AA, without slipping on an orthogonal coordinate System (x, y) at O. Let find the equation of this curve using the geometry logic in mechanics.

In absolute magnitudes $\frac{\mathbf{dy}}{\mathbf{dx}} = \frac{\mathbf{KB}}{\mathbf{KA}} = \frac{\mathbf{BA}}{\mathbf{BP}} = \frac{\mathbf{BA}}{\mathbf{2r-y}}$ and (BA)² = (BP).(BK) = (2r-y).y and

by squaring → $(\frac{\mathbf{dy}}{\mathbf{dx}})^2 = \frac{\mathbf{y}}{\mathbf{2r-y}}$ ……………………………………………………(a)

which is the differential equation of cycloid, and or as → $(\frac{\mathbf{dx}}{\mathbf{dy}})^2 + 1 = \frac{\mathbf{2r}}{\mathbf{y}}$

For any element on trace, ds, issues (a) and Pythagoras theorem as, (ds)²=(dx)²+(dy)² = $(\frac{\mathbf{2r}}{\mathbf{y}} - 1).(\mathrm{dy})^2 + (\mathrm{dy})^2 = (\frac{\mathbf{2r}}{\mathbf{y}}).(\mathrm{dy})^2$ and ds $=\sqrt{\mathbf{2r}}.\mathbf{y^{-1/2}}.\mathrm{dy}$ and by integrating, $\int \mathbf{ds/dy} =$ s $=\sqrt{\mathbf{2r}}.\int_0^y \mathbf{y^{-1/2}} = \sqrt{\mathbf{2r}}.\frac{\mathbf{y^{+1/2}}}{\mathbf{-1/2}} = 2.\sqrt{\mathbf{2ry}}+\mathrm{C}$ and since in axis for y=0 *exists* s=0 and C=0,

so $\mathrm{s}=2\sqrt{\mathbf{KP.KB}}=2.\sqrt{\mathbf{KA^2}}= 2.\mathrm{KA} = 4\mathrm{r}.\mathbf{\sin\varphi}$ ………………………… (b)

i.e. the length of Cycloid Curve, *from point O to point* A, *is twice the* Segment *of chord KA and when point* A *is at the end point (2) then* → 2.KA = 4r *for the semi-cycloid.*

The area between the curve and the straight line is A=3πr² and the arc length l = 8r.

For motion on cycloid, we consider a Weight Q, at point A, moving with free motion.

Since reaction N, is vertically acting, doesn`t give any Tangential component therefore the only one becomes from Q which is equal to AT= g.$\mathbf{\sin\varphi}$,and since from (b) ,$\mathbf{\sin\varphi} = \frac{\mathbf{s}}{\mathbf{4r}}$ then AT= g.$\frac{\mathbf{s}}{\mathbf{4r}}$.

Since acceleration $= \frac{\mathbf{d^2s}}{\mathbf{dt^2}} = \frac{\mathbf{dv}}{\mathbf{dt}} = \frac{\mathbf{d}}{\mathbf{dt}}(\frac{\mathbf{ds}}{\mathbf{dt}}) = -g.\frac{\mathbf{s}}{\mathbf{4r}}$ then $\frac{\mathbf{d^2s}}{\mathbf{dt^2}} = -g.\frac{\mathbf{s}}{\mathbf{4r}}$ *or*$\{\ddot{\mathbf{x}} = -w^2\dot{\mathbf{x}}$ *where* $w = \frac{\mathbf{2\pi}}{\mathbf{T}}\}$ ………………………………(c)

Equation (c) is a Harmonic Oscillatory motion showing that Acceleration is proportional to displacement and is directed towards the origin with a period

$$T=\frac{\mathbf{2\pi}}{\mathbf{w}}=2\pi.\sqrt{\frac{\mathbf{4r}}{\mathbf{g}}}=4\pi\,.\sqrt{\frac{\mathbf{r}}{\mathbf{g}}} \qquad \text{......(d)}$$

since $w^2=\frac{\mathbf{g}}{\mathbf{4r}}$ i.e.

Equation (d) *denotes that the Harmonic Oscillation due to any Force or Weight which follows the free motion on cycloid, is Independent of the amplitude of oscillation and, is Isochronous*.

Since total period of oscillation T= $4\pi.\sqrt{r/g}$ and which does not depend on speed of rolling, (Huygens cycloid pendulum) but only from rolling radius, r, means that the arc length l=8r is completed for faster, as one revolution in less time than the slower one, meaning that,

On cycloid all points of y axis reach x-x axis at the same time, regardless of the height from which they begin (isochrones). This property is used for breakages to reach STPL line isochrones. Evolute also of a cycloid is a cycloid itself, (apart from coordinate shift). Velocity vector of any motion is directed along the tangent and is the sum of the velocity vectors of the constituent motion, thus at each point A, of a cycloid, the line joining that point, to the point P, that circle is, then at the top of the generative circle is tangent to the Anti-cycloid and the line joining point A`, that is to that of bottom (of circle) is normal to the cycloid. Evolutes of a cycloid, *The Space≡ matter*, is the balancing cycloid, *The Anti -Space≡ Anti-matter*, and is called Anti-cycloid, [A↔ A`].

The *Tangential component of Acceleration* is AT $=g.\mathbf{sin\,\varphi}=\frac{\mathbf{g}}{\mathbf{4r}}$. s and analogous to OA arc, While the *Centrifugal component of Acceleration* $\frac{\mathbf{v^2}}{\boldsymbol{\rho}}$*,* is dependent on initial point of motion.

Any Material point moving from A to P point, acquires velocity $v^2 = 2.g.PB = 2g(2r\text{-}y)$ and

$$\frac{\mathbf{v^2}}{\boldsymbol{\rho}}=\frac{\mathbf{2g(2r-y)}}{\mathbf{2.PA}}=g.\mathbf{cos\,\varphi}=g.\frac{\mathbf{PA}}{\mathbf{2r}}=\frac{\mathbf{g}}{\mathbf{4r}}\,.\,\rho \qquad \text{.........(e)}$$

i.e. The *Centrifugal component of Acceleration is proportional to curvature radius*, ρ, *and extended on this Stress – common - curve of motion*, *with the same proportionality ratio*g/4r *meaning that any motion on cycloid is outward directed,* and this because acceleration $\ddot{\mathbf{x}} = -w^2.x$ and also since force

F=m $\ddot{\mathbf{x}}$,*due to the Skin-effect exists on this* , Surface - Stress– common - curve*, Outward during the cycloidal motion of Space and Anti-space* . [5]

Skin-Effect happens at Stress-common-curve because of the difference in density ρ = σ, on great or small circles, *instead of*ρ=0 at the center.Figure-3 .

This Property on Cycloid applied on Photons Launches The-Inner-Electromagnetic-Wave →

$\{[E^2+H^2]/2 = 2rc.\sin.2\varphi\}$ of wavelength λ, Outward λ as The-Outer-Electromagnetic-Wave →

$\{[\varepsilon E^2 + \mu B^2] = 2.\lambda c.\sin.2\varphi\}$

The velocity v = $\sqrt{\mathbf{g/4r}}$. ρ is proportional to curvature radius ρ, with proportionality ratio the root of g/4r. On cycloid, all moving points on y axis reach x-x axis at the same time (isochrones motion) regardless of the height from which they begin (they do not depend on the oscillation amplitudes), or if, a particle of mass $m=|(wr)^2| =1$ tied to a fix point A executes a Simple harmonic motion under the action (Thrust) of the tangential velocity $\bar{\mathbf{v}}=\bar{\mathbf{w}}.\bar{\mathbf{r}}$. Since also → the linear momentum$\bar{\mathbf{p}}$= [Breakage x Velocity] then, $\bar{\mathbf{p}}$= [Breakage x Velocity] = $|\bar{\mathbf{w}}.r|.\sqrt{\mathbf{g/4r}}.\,\rho = \bar{\mathbf{w}}.\sqrt{\mathbf{gr}}.\,\rho = \sqrt{\mathbf{gr}}.\rho.|\bar{\mathbf{w}}|$, and follows that, a Cycloid`s trajectory with, a Total time period T = 4p v(r/)g = $\frac{\mathbf{r}}{\mathbf{2v}}.\sqrt{\frac{\mathbf{r}}{\mathbf{g}}}$, and dependent, on angular velocity $\bar{\mathbf{w}} = \bar{\mathbf{v}}/r = \bar{\mathbf{c}}/r$ only and it is the Spin of particle |AA|.

Remarks:

a. Breakage x Velocity = $\sqrt{\mathbf{gr}}.\rho.|\bar{\mathbf{w}}|$, and force F = $[(\bar{\mathbf{w}}.r)^2.(\bar{\mathbf{w}}.r)] = 2(mg/\bar{\mathbf{c}}).\bar{\mathbf{w}} = 2mg.(\frac{\bar{\mathbf{w}}}{\bar{\mathbf{c}}})$, This property is used to show that the wavelength of norm $|\bar{\mathbf{v}}|$, of vectors ,$\bar{\mathbf{v}}$, is a Stationary wave, with the two edges as Energy material nodes ,Cycloidally carried on wavelength $|\lambda| = 2|\mathbf{A_1}\text{-}\ \mathbf{A_2}|$ twice the norm. KA = 2.r.$\mathbf{sin\,\varphi}$ and KA.$\mathbf{sin\,\varphi}$ = y so $\mathbf{sin^2\,\varphi}$ = y/2r and $\mathbf{cos^2\,\varphi}$ = 1-y/2r = $\frac{\mathbf{2r-y}}{\mathbf{2r}}$ and by division becomes $\frac{\mathbf{v}}{\mathbf{cos\,\varphi}}=\sqrt{\mathbf{4gr}}$, which means that any Weight falling , or rolling on Cycloid from upper point A, the ratio $\frac{\mathbf{v}}{\mathbf{cos\,\varphi}}$ *remains constant*, and for the center of PK, $\mathbf{v_K}$ = $v.\frac{\mathbf{r}}{\mathbf{PA}}=\frac{\mathbf{1}}{\mathbf{2}}.\frac{\mathbf{v}}{\mathbf{cos\,\varphi}}=\sqrt{\mathbf{gr}}$, i.e. the rolling circle has a constant *velocity* and with an area of moving circle A = $\pi.r^2$ = $\pi.(2r.\mathbf{cos\,\varphi})^2=4\pi R^2.\mathbf{cos^2\,\varphi}$.

b. Thrust is the velocity vector $\bar{\mathbf{v}}=\bar{\mathbf{w}}.r$ on the circumference of common circle of the inversely rotating Space, anti-Space becoming from the rotational energy vector ±Λ of PNS. The wavelength of norm of velocity |v∴| is the static equilibrium position vector of amplitude, ds, of dipole $|AB| = |\bar{\mathbf{v}}|$ =ds and in terms of the static deflection, ds, then T =1/f= 2π/w where ds = z = $\bar{\mathbf{v}}$ = A.$\mathbf{e}^{\,\mathbf{i.wt}}$= $\bar{\mathbf{v}}.\mathbf{cos\,wt}$ + i.$\bar{\mathbf{v}}.\mathbf{sin\,wt}$.

i.e. Breakages acquire different velocities and different energy, and because are following cycloid trajectories, thus, need the same time (isochrones) to reach [STPL] line. Simultaneity is a property of Absolute system and the intrinsic property of vectors and Poinsot's ellipsoid now becomes a <Cycloidal ellipsoid> since on $c1(\mathbf{T_1}) > c > c2(\mathbf{T_2})$.

Any material point [Medium-Field Material-Fragment] →[± s²]=|$\bar{\mathbf{w}}$x$\bar{\mathbf{r}}$|²→[MFMF] Field following trajectory, in=(c1), or, out=(c2), Cycloid=(c)=|A1-A2| needs more or less time ($\mathbf{T_2}$)< T = $4\pi\sqrt{(r/g)}$<($\mathbf{T_1}$)to reach end A2. And since frequency f = 1/T and energy E = h.f then Cycloid motion Controls constancy of Energy by changing velocity, $\bar{\mathbf{v}} = \bar{\mathbf{w}}$.r, and the period, T, of monads.

Breakage quantity 2.(wr)² under the tangential action $\bar{\mathbf{v}}$ = wr becomes 2.(wr)³ acting on point A → 2wr.m of common circle. The same also for points A,B,C of Space and $\mathbf{A_E}$,$\mathbf{B_E}$, $\mathbf{C_E}$ of Anti-Space. Because all velocity vectors AA,BB,CC carry material points A,B,C at points $\mathbf{D_A}$,$\mathbf{D_B}$,$\mathbf{D_C}$, in time , t, isochrones, then material points follow a cycloid with period the norm of wavelength of velocities |AA|,|BB|,|CC|.

This Simultaneity is succeeded by Lorentz factor where transformations between Inertial frames that preserve the velocity of light will not preserve simultaneously. [65]

c. Work W, by a constant force F = 2(wr)² exerted on an object [breakage ±(wr)²] which moves with a distance times dx=|(wr)²| is capable of Vibration and is calculated in two perpendicular Formulations (dx⊥dy) which is as, Stiffness k = N/m → velocity vector v1 → *Electric field E* → and Flexibility f = m/N → velocity vector v2 → *the Magnetic field P*. For more in [39-40]. The why Energy is transformed into velocity, and velocity to a field is explained also through Extrema Principle. [41]

Cycloid of Figure.14. is a cave and let this be IN Common-circle of STPL mechanism.

[1] *The applied force on this* NN *cave is*E = h.f = w.(h/2p)= w. Spin, and Spin = $\frac{\mathbf{E}}{\mathbf{w}}$ = [±$\bar{\mathbf{v}}$.s²]/w = (r.s²)

[2] For E = ±$\bar{\mathbf{v}}$ then → Spin =$\frac{\mathbf{E}}{\mathbf{w}}$ = [± $\bar{\mathbf{v}}$.s²] / w =(± r . s²)→Producing ± *Fermions with spin*$\frac{1}{2}$

[3] For E = [∇i=2(wr)²=2.$\bar{\boldsymbol{v}}$s²]=2.(r.s²) then Spin =$\frac{\mathbf{E}}{\mathbf{w}}$=[2.$\bar{\mathbf{v}}$.s²]/w = 2.(r.s²) → Producing *Bosons of spin* 1.

i.e. Double energy [2.(r.s²)] on a constant cave creates 2 crests and doubling the frequency (f) , with Spin 1. For N-times energy[N.(r.s²)] on a constant cave creates N crests N-times the frequency (f) with Spin N/2 .Since Energy in cave is an Electromagnetic Wave [$\bar{\mathbf{E}}$x$\bar{\mathbf{H}}$] = Pressure = Spin S = ρ.c.w , or [εE²+μH²] / 2 = 2rc. sin.2φ → then Energy /sin2φ = [εE²+μH²] / $\mathbf{sin\,2\varphi}$ = 2rc/ ρw = 4r² /ρ = constant , happening only for Cycloidal motion on the Stress-common-curve, where ε=Permittivity for electric and μ =Permeability for magnetic fields.[41]

Since in Cycloid acceleration$\ddot{\mathbf{x}}$ = - w².x *produces the* Skin-effect → *therefore on material-point the Inner-Energy as rotational Momentum* ≡ *Spin is transformed into the Outer Electromagnetic-Wave and Cancel, during the cycloidal motion, the propagation of Space and Anti-space, towards* AA\`*axis*[33]

Because of above Force F = m$\ddot{\mathbf{x}}$on AA\`≡ Stress-common-curve, happens Skin-effect on this because of the difference in density ρ = σ instead-of ρ = 0. *This Property on Cycloid Launches The Inner Electromagnetic-Wave* {[εE²+μH²]/2 = 2rc.sin.2φ} *of wavelength* λ, to the *Outward*, λ, *as The Outer Electromagnetic-Wave* and allows all → *The -Energy-Wave-Storages- monads to Propagate any Distance in Vacuum without dissipation*. The *Inner -motion in cave* ≡*Work* W *becomes from the Wave Energy-Pattern with Wave lengths* $\boldsymbol{\lambda_n}$, *created from all Points of the Periodic Oscillation in any Cave* r = (1)-(2) , *and is Stored into the,* n, *Integer and Energy - Lobes of cave* r, as Photon in Galaxies.

4. *The flexible String*

Material point may be considered as a *flexible String of mass*, ρ, per unit length, which is stretched under tension T = ± σ, due to the principal stresses on $\mathbf{KK_1}$ axis. The lateral deflection, y, of the string K$\mathbf{K_1}$ to be small, the change in tension with deflection, is negligible and is ignored.

The equation of motion in the, y, direction according to Newton\`s second law is,

$$T\left[\theta + \frac{\partial\theta}{\partial x}dx\right] - T\theta = \rho.dx.\frac{d^2y}{dt^2} \quad \text{or} \quad \rightarrow \quad \frac{\partial\theta}{\partial x} = \frac{\rho}{T}.\frac{d^2y}{dt^2} \quad \ldots\ldots\ldots\ldots\ldots\ldots(1)$$

and because the slope of the string K$\mathbf{K_1}$ is $\theta = \frac{\partial y}{\partial x}$ equation (1) reduces to

$$\frac{\partial^2 y}{\partial x^2} = \frac{1}{c^2}.\frac{\partial^2 y}{\partial t^2} \quad \ldots\ldots\ldots\ldots\ldots\ldots(2)$$

where $c = \sqrt{\frac{T}{\rho}} = \sqrt{\frac{\sigma}{\rho}}$and can be shown to be the velocity of wave propagation along the string.

The general solution of the equation (2) can be expressed in the form y = $\mathbf{F_1}$(ct - x) + $\mathbf{F_2}$(ct + x) where, $\mathbf{F_1}$, $\mathbf{F_2}$, are arbitrary functions and regardless of the type of function, the argument (ct ± x) upon differentiation leads to equation

$$\frac{\partial^2 F}{\partial x^2} = \frac{1}{c^2}.\frac{\partial^2 F}{\partial t^2} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (3)$$

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and hence the differential equation is satisfied, the wave profile moves in the ±x, direction with speed, c, therefore refer to, c, as the velocity of wave propagation. The solution of (3) using the separation of variables is

$$y(x\ t) = Y(x).G(t) \quad \ldots\ldots(4)$$

and by substitution to (2) then → $\frac{1}{Y}.\frac{d^2Y}{dx^2} = \frac{1}{c^2}.\frac{1}{G}.\frac{d^2G}{dt^2}$ ……(5)

where the left side is independent of, t, and the right side independent of, x, so both sides must be constant. Letting this constant be $-[\frac{w}{c}]^2$, are obtained the two ordinary differential equations,
$\frac{d^2Y}{dx^2} + [\frac{w}{c}]^2 = 0$ and $\frac{d^2G}{dt^2} + w^2 G = 0$ with the general solution,

$$Y = A\ .\mathbf{sin}(\frac{w}{c})\,x + B\ .\mathbf{cos}(\frac{w}{c})\,x, \quad G = C\ .\mathbf{sin\,wt} + D\ .\mathbf{cos\,wt} \quad \ldots\ldots(6)$$

The arbitrary constants A, B, C, D, depend on the boundary conditions and the initial conditions.
When the string $K\mathbf{K_1}$ = ds is stretched between ds = *l*, the boundary conditions are y(0,t) = y(*l*t) = 0.

The condition that y(0,t) = 0, leads to the solution $y = [C\ .\mathbf{sin\,wt} + D\ .\mathbf{cos\,wt}].\mathbf{sin}(\frac{w}{c}).x$ ……(7)

The condition that y(*l*, t) = 0, leads to the equation $y = \mathbf{sin}(\frac{wl}{c}) = 0$ or , $\rightarrow \mathbf{sin}\frac{wl}{c} = 0$

and , $\frac{w.l}{c} = \frac{w_n\ .\ l}{c} = n.\pi$, where n = 1 , 2 , 3 , 4, … n …… ∞ ……(8)

and so $\lambda = \frac{c}{f}$ is the wavelength , f = the frequency of oscillation , ρ = density i.e.
Each , n , represents a Normal - Mode - Vibration with natural frequency determined from equation,

Natural frequency → $\mathbf{f}_{\ \mathbf{n}} = \frac{n}{2.l}c = \frac{n}{2.l}.\sqrt{\frac{T}{\rho}} = \frac{n}{2.l}\sqrt{\frac{\sigma}{\rho}} = \frac{n}{4r}\sqrt{\frac{\sigma}{\rho}} = \frac{n}{4r^3}.\sqrt{\frac{(1+\sqrt{5})^2\sigma^2}{4\pi^2 r4}} = [\,\mathbf{n}\frac{\sigma(1+\sqrt{5})}{\pi\,(2r)^3}]$ ……(9)

and the sinusoidal mode shape → $Y = \mathbf{sin}(\mathbf{n\pi}\frac{x}{l}) = \mathbf{sin}(\mathbf{n\pi}\frac{x}{2r})$ for caves *l* = 2r i.e. Fig-1 Equation (9) is the *Golden ratio frequency* on the strings and is

$$\mathbf{f}_{\ \mathbf{n}} = [\frac{(1+\sqrt{5})}{2}]\frac{\sigma}{4\pi r^3} \quad \ldots\ldots(10)$$

The rotating axis AA\` *creates the*, Linear vibration of string , *and the Natural - frequency* $\mathbf{f_n}$, *in Material – point* A\`≡ [⊖] ↔ A ≡ [⊕] *as well the* Rotational vibration of string[⊕s² ↻↺⊖s²].

In the more general case of free vibration of Material-point , *Linear* [⊕s² ↔ ⊖s²] *or Rotational* [⊕s² ↻↺⊖s²] in any manner , the solution contains many of the normal modes and the equation for displacement is written as,

$$y(x,t) = \sum_{n=1}^{\infty} \mathbf{C_n\,sin\,w_n t + D_n\,cos\,w_n t\ .\,sin}(\mathbf{n\pi}\frac{x}{l})\text{and}\ \ \mathbf{w_n} = \frac{\mathbf{n\pi c}}{\mathbf{l}} = \frac{\mathbf{n\pi c}}{\mathbf{2r}} \quad \ldots\ldots(11)$$

where, by fitting equation to the initial conditions of y(x,0) and $\acute{\mathbf{y}}$(x,0), the $\mathbf{C_n}$,$\mathbf{D_n}$, can be evaluated.

From Planck\`s Energy E = h.f = (h/λ).c is equal to the Isochromatic pattern fringe-order in monad as $\boldsymbol{\sigma_1}$-$\boldsymbol{\sigma_2}$ = (a/d).N = (a/d).n.$\mathbf{f_1}$ = (8πr²/3).n$\mathbf{f_1}$ where, n = the order of isochromatic, *a number*, and, $\mathbf{f_1}$ = The frequency of Fundamental-Harmonic. This is the why colors exist in fringe-order and are of wave form. In different modes, Antinodes Phase at a particular instant is either plus (+) or minus (-).

Since total Energy in cave, (wr)², is dependent on frequency only, and stored in the Fundamental and the first Six Harmonics, so the summations bands of these Seven Isochromatic Quantized interference fringe order-patterns, is the Total Energy, E, in the same cave (wr)² and for n=7 is as,

E = Spin , *work* → W = $\bar{\mathbf{S}}$.w = (h/2π).2πf = $[\frac{8\pi r^2 f1}{3}].[\frac{n(n+1)}{2}] = [\frac{4\pi r^2 f1}{3}]$. n.(n+1) and, ……(12)

Represents the Total Energy Stored in cave, r, *and of* n *fringes, where*→ $\mathbf{f}_{\ \mathbf{1}} = \frac{(1+\sqrt{5}\,])\,.\sigma}{4\pi r}$

When stress ($\boldsymbol{\sigma_1}$-$\boldsymbol{\sigma_2}$) go up then, n = order fringe defining Energy goes up also, and the colors cycle through a more or less repeating pattern and the Intensity of the colors diminishes .Since phase φ = kx-wt = Spatial and Time Oscillation dependence, For n = 1, Energy in the First Harmonic is, E = 2πr.c = $[\frac{2\pi r^2}{3}].\mathbf{f_1}$, and for n = 2 , Energy in the First and Second Isochromatic Harmonic is,

E = 2 $[\frac{2\pi r^2}{3}].\mathbf{f_1}$ in threes, and, φ, is trisected with Energy-Bunched variation $\mathbf{f_2}$, i.e.

Energy, motion, *stored in a homogeneous resonance,* r, *is spread into the First of the Seven-Harmonics beginning from the* (first) *Fundamental* $\mathbf{f_1}$, *and after the filling with frequency,* $\mathbf{f_1}$, *follows the Second - Harmonic with frequency,* 2.$\mathbf{f_1}$, 3.$\mathbf{f_1}$,,,,, and so on , thus representing the *Store of Energy in cave* r.

In this - *way the Energy-Space monads are generated from the golden-frequency in caves, or from slits. Also this is the How Spin is*1 or½ or$\frac{1}{N}$, . . *The Why Spin is* , $\frac{l}{2},\frac{l}{3},\frac{l}{4},\frac{l}{5}$, ……..$\frac{1}{N}$, in monads *i.e.*

One, Half, Third …$\frac{1}{N}$. - Lengths → $[\frac{l}{1}]$,$[\frac{l}{2}\frac{l}{2}]$, $[\frac{l}{3}\frac{l}{3}\frac{l}{3}]$,, , ,$[\frac{l}{N},,,\frac{l}{N}]$, with One, Two, Three ,,, N.

The same also to wavelengths of the harmonics which are simple fractions of the fundamental λ ,$\frac{\lambda}{2},\frac{\lambda}{3},\frac{\lambda}{N}$, *Wave-nodes*, where Spin =$\overline{\mathbf{B}}$= $\mathbf{f_n}$. $(\frac{8r^2}{n\sigma})$ = Energy in Nwave-node-loops as energy frequencies.

In Second- Harmonic Energy as frequency is doubled and this because of the sufficient keeping homogeneously in Spatial dependence , Quantity kx =(2π/λ).x , which is in threes , meaning that, *Dipole–energy is Spatially-trisected* in Space - Quantity Quanta the Spin=h/2π as the angle φ , of phase φ=kx-wt=(2π/λ).x , *and Bisected* by the Energy-Quantity Quanta as this happens in an RLC circuit [49].

Since Momentum-Ellipsoid, $\overline{\mathbf{B}}$, is perpendicular to the*, Angular - velocity-Ellipsoid,* $\overline{\mathbf{w}}$ *, no Work is produced and the Status is Neutral. This property issuing in Material-point, allows Spin* ≡$\overline{\mathbf{B}}$ *Vector and the Velocity-Magnitude* ≡$\overline{\mathbf{w}}$*, be conserved as Total Energy* 2L=$\overline{\mathbf{B}}.\overline{\mathbf{w}}$= J . w². [70]

5. *An analysis of the vacuum Energy*

Galileo`s Principle of Equivalence states that, Inertial mass is equal to the Gravitational mass and *acceleration* a = d$\overline{\mathbf{v}}$/ dt equal to *acceleration due to gravity*, g . [39] Gravity is the Stationary force → [∇i = 2(wr)²] ← on the base for all motions, which is the → Medium – Field – Material - Fragment, |±s²| = (wr)² = [MFMF] ← in all universe and so, Newtonian theory of gravity, acting instaneousley between two separated masses is correct as above.

Maxwell`s equations predict Electromagnetic waves in and out of monads, while Einstein`s equations of GR predict Gravitational waves that travel at the speed of light in order to explain Simultaneity.

GR failed to conceive Gravity force as a Stationary force restraining breakages for monads between the Gravity length cave$\mathbf{10^{-62}}$and the beyond Planck`s length$\mathbf{10^{-35}}$.

Let call this in between distance Space → [$\mathbf{10^{-62}}$~$\mathbf{10^{-35}}$] ≡ *Vacuum*.

Breakages acquire different velocities and different energy and because follow cycloid trajectories thus need the same time (isochrones) to reach [STPL] line . Fermat`s Principle of Least time in Isochrones Principle is embedded in all wavelength, λ, as vector monads [59].

During Intrinsic Diffraction, d$\overline{\mathbf{s}}$=λ, of isochronous motion of vectors, *frequency*, f, *doesn't change* and only velocity, $\overline{\mathbf{v}}$, and wavelength, λ, changes so from equation → λ = $\overline{\mathbf{v}}$T = $\overline{\mathbf{v}}$/ f , → $\overline{\mathbf{v}}$= λf and

Acceleration a = d$\overline{\mathbf{v}}$/ dt = (dλ/dt).f + λ(df/dt) then → a = g = d$\overline{\mathbf{v}}$/ dt = (dλ/dt).f *since* f = *constant,*

or, let

λ→ be the wavelength of a moving monad, t = λ/c →is the needed time to cross length λ

s = at² / 2 → Deflection due to acceleration, a,

H = gt² / 2 → Deflection due to acceleration of

g, and → t² = 2. H / g ………………………………………………………………………………………… (1)

For monad s = λ then s = at² /2 = c.T where , T is the period of Isochronous displacement and,

t² = 2. cT / a ………………………………………………………………...(2)

Equating (1), (2) then cT /a = H /g, and since in gravity field the cycloidal motion (Simultaneity) defines the same displacements cT, H *then* ct = H *and so* a = g

Therefore, all particles have the same acceleration , g , *in our gravitational field with frequency unchanged, and →* *velocity*, d$\overline{\mathbf{v}}$, *with wavelength,* λ, *to be changed so light being a particle also, is deviated in gravity field and, Inertial mass* is equal to the *Gravitational mass.*

i.e. The *Necessary and Sufficient Condition* for this Equality happens only in *Mass of Material-point*, where c.T = H, of this Isochronous motion where then *Inertial mass* ≡ *Gravitational mass* →

m =$\frac{\mathbf{2E}}{a_a}$= $[\frac{\overline{\mathbf{B}}.\overline{\mathbf{w}}}{\overline{\mathbf{B}}\mathbf{x}\overline{\mathbf{w}}}]$. J = a number, meaning that mass is a Number only, which measures the magnitude of any two charges $\boldsymbol{q_1} \equiv \boldsymbol{m_1}$, $\boldsymbol{q_2} \equiv \boldsymbol{m_2}$, or reactions to any change of motion.

In C → *The Energy Stores in the Material point*, is proofed that Energy is stored in the, n, loops of

Monads ≡ Energy Vectors ≡ Quaternion and ,NOT *in mass* , with the current concordance model.

Energy in n = 1 *loop* → W = $[\frac{4\pi r^2}{3}].\mathbf{f_1}$*and for the*$\mathbf{n^{th}}$ → $\mathbf{W_n} = [\frac{4\pi r^2}{3}]\ .\mathbf{f_n} = n^{\frac{(1+\sqrt{5}).\sigma r}{3}}$

Total Energy in n = n *loops* → $\mathbf{W_{n(n+1)}} = [\frac{4\pi r^2 f1}{3}]$. n.(n+1) where n = 1,2,3,4… n .... ∞ *by using the Summation of series.*

Issuing that Mass → m $\equiv \frac{2E}{a_a} \equiv [\frac{\bar{B}.\bar{w}}{\bar{B}x\bar{w}}]$.J ≡ W ≡ $[\frac{4\pi r^2 f1}{3}]$. n.(n+1) ← a number k as,

k = $\mathbf{T_z}$ = Tensor (the length) of vector , z ≡ m , in Euclidean coordinates and which magnitude is,

k = $\mathbf{T_z} = \sqrt{\mathbf{y_1}^2 + \mathbf{y_2}^2 + \mathbf{y_3}^2 + \mathbf{y_n}^2}$.

From above the dimensionless coefficient of work W is that of frequency-golden-ratio, [√5+1] / 2 for any Material-cave r,

The Unity-Plane-Quaternion coefficient is $\sqrt[2]{\sqrt[2]{2}} = \sqrt[4]{2}, \overleftrightarrow{\mathbf{\imath} \perp \mathbf{\jmath} \equiv \sqrt{2}} + \overleftrightarrow{\mathbf{k} \perp \sqrt{2} \equiv \sqrt[2]{\sqrt[2]{2}}} = \sqrt[4]{2}$

The Three dimensions for the Rotation-System ofEuler`s number is e . e . e $= \boldsymbol{e^3}$

Remarks:

1. Since mass is dependent on $\bar{\mathbf{B}}$ vector which is *clock-wise* or *anti-clock-wise*, the same happens to *Mass – Anti mass*, or and, *Matter-Antimatter*, meaning that are different entities and, *Anti - mass*, *Antimatter → are counterpart to → Mass*, *Matter,* i.e. with opposite electric charge.
2. Since also,$\pm\bar{\mathbf{B}}$ vector on *Stress-common-curve* are of opposite direction ,*their Sum-Vector is zero,* i.e. mutual annihilation . This Summation of vectors exists at the intrinsic-motion in monads and in Vacuum where Energy as Work is stored in the, n, Stationary loops of cave.
3. Since also [33], Action (©) of a quaternion $\bar{\mathbf{z}}$= s + $\bar{\mathbf{v}}$.i= s + $\bar{\mathbf{v}}$.∇i on itself is a Binomial type, (s + $\bar{\mathbf{v}}$.∇i)(©) (s + $\bar{\mathbf{v}}$.∇i) = [s + $\bar{\mathbf{v}}$.∇i]² =s² + |$\bar{\mathbf{v}}$| ² .∇i ² + 2|s|.|$\bar{\mathbf{v}}$|.∇i = s² - |$\bar{\mathbf{v}}$| ² + 2|s|.|$\bar{\mathbf{w}}$r|.∇i = s² - |$\bar{\mathbf{v}}$| ² + [2$\bar{\mathbf{w}}$].|s|.|r|.∇I = s² - |$\bar{\mathbf{s}}$| ² + 2|s|².∇i {for s = v = w.r} where, s² → is the real part, *Matter*, of the new quaternion and is *a Positive Scalar magnitude*.- |$\bar{\mathbf{v}}$| ² → is the always negative part, *Anti-matter*, which is always *a Negative Scalar magnitude*. [2$\bar{\mathbf{w}}$].|s| |$\bar{\mathbf{r}}$|.∇i →is the double Angular-velocity term, *Energy*, which is *a Vector magnitude,* therefore when Anti-space comes in contact with its regular Space counterpart, they mutually destroy each other and all of their mass is converted to the three above Breakages → s² , -|$\bar{\mathbf{v}}$| ², [2$\bar{\mathbf{w}}$].|s| |r|.∇i .

In case of Proton and Antiproton annihilate at rest , they produce 10 / 2 = 5 pions, of which 3/2 = 1,5 Positive charged,+|s|², 3/2 = 1,5 Negative charged ,- |s|² , and 4/2 = 2 neutral 2|s|².∇i.

In case of Electron and Positron have Kinetic Energy annihilate to an Equivalent-Energy Balance.

It was shown [40-42] that in STPL - Mechanism with intrinsic velocity, v, and under the Thrust of velocity, c, is created the whole universe with its constituents as,

A. [±$\bar{\mathbf{v}}$.s²] → Fermions and → [$\bar{\mathbf{v}}$.∇i] → Bosons, *which are Particles*, *with Inherent Vibration*

b. [± s²] → [MFMF]- Field ≡ *The Energy - Chaos*, and the binder Energy-Field [∇i] called Gravity force, *without Vibration but only local rotation*, which follows $\Phi = \frac{1}{2}[1 \pm (\sqrt{5})]$ of Stress σ

c. [±$\bar{\mathbf{c}}$.s²] → Dark matter and the binder Gravity-Force [∇i], *The Expanding Dark-Energy* [$\bar{\mathbf{c}}$.∇i] constituents which are moving with light velocity, c, causing the universe to grow. Since velocity c =2pr.$\mathbf{f_n}$ is related to the *Golden-ratio-frequencies* →$\mathbf{f_n} = \mathbf{w_1}/2\pi$then follow $\Phi = \frac{1}{2}[1 \pm (\sqrt{5})]\sigma$

Since galaxies travel with light velocity, Obeying Newton`s Laws of motion, thenafter a collision of galaxies, Dark–matter{DM}≡[±$\bar{\mathbf{c}}$.s²] is left behind and by bumping into regular matter is get destroyed.

Because Dark–matter {DM} and Dark–energy{DE}≡ [$\bar{\mathbf{c}}$.∇i], travel with light velocity , *cannot be seen* using light, *while* {DM} interacting gravitationally *can be seen* through its gravitational effect on other matter and {DE}≡ [$\bar{\mathbf{c}}$.∇i] can be seen as pushing apart galaxies and causing universe to expand at an increasing rate. Because{DE}≡ F is a force and, c, continually acting on matter, then according to Newton`s second law, matter is accelerated so galaxies are accelerated and expanded as →

ds = $\frac{\mathbf{F}}{\mathbf{2m}}[\frac{\mathbf{1}}{\mathbf{f}^2}] \equiv \frac{\mathbf{F} = [\bar{\mathbf{c}}.\nabla\mathbf{i}]}{\mathbf{2m}}[\frac{\mathbf{1}}{\mathbf{f}^2}] \equiv \frac{[\bar{\mathbf{c}}.\nabla\mathbf{i}]}{\mathbf{2m}}[\frac{\mathbf{1}}{\mathbf{f}^2}]$ …….. *the equation of motion for galaxies*.

Any Breakage with non- measurable magnitude is called *Degenerate Matter*.

It was proved that the more general case of free vibration in Material- point , *Linear* [⊕s² ↔ ⊖s²] *or Rotational* [⊕s² ↻↺⊖s²] in any manner, the solution will contain many of the normal modes and the equation (11) for the displacement can be written as,

$$y(x\,,t) = \sum_{n=1}^{\infty} \mathbf{C_n \sin}\,(\boldsymbol{w_n}\,\mathbf{t}) + \mathbf{D_n \cos}\,(\boldsymbol{w_n}\,\mathbf{t})\,.\mathbf{sin}(\mathbf{n\pi}\tfrac{x}{l})\ \text{and}\ \mathbf{w_n} = \frac{\mathbf{n\pi c}}{l} = \frac{n\pi c}{2r} \qquad \ldots\ldots\ldots\ldots(11)$$

where,

by fitting equation to the initial conditions of y(x,0) and $\dot{y}$(x,0) , the $\mathbf{C_n}$,$\mathbf{D_n}$, can be evaluated.

Above happens in regular matter that has been compressed until atoms break down and the particles lock into a giant mass as this happens to gas, *that particles are not bound to each other*, and liquid gas, *that particles are packed closely to each other,* and cannot move much since velocity c =2πr.$\mathbf{f_n}$.

Since *Matter Antimatter destroy each other* when they come into contact under normal conditions shows the way to develop a Mechanism of, *High-Energy-Particles-Beam* , [HEPB] combined with an, [ILP] *Intense-Laser-Pulse*, to Rip-Apart the Under-Planck`s length Vacuum .Since also was shown that Energy is stored in Energy-loops of Stationary waves, i.*e. a Sink-mechanism ≡ Recessional – motion* , so a very Strong Electromagnetic - Field is the suitable *mechanism for reaching vacuum*.

It was shown also that the *Quality of monads* depends on the *Golden-ratio-frequency*$\mathbf{f}_{\mathbf{n}} = [\frac{(1+\sqrt{5})}{2}]\frac{\sigma}{4\pi r^3}$ And the Total-work $\mathbf{W_n} = [\frac{4\pi r^2}{3}]\mathbf{f_n} = [\frac{(1+\sqrt{5})}{2}]\frac{\sigma}{3r}$,so all monads can be immediately be *Another monads with different frequency* (f) , by following the Breakage rule → s² - |$\bar{\mathbf{s}}$| ² + 2|s|².∇i← i.e. matter (+), antimatter (-), energy (+ -) or *Material Point* ≡ *monad* ≡ Dipole ≡ [⊕⊖] = ∅=$\mathbf{K_r}\,\mathbf{AK_{R=r}}$ *where* → $\mathbf{K_R}$≡ [⊕]↔ $\mathbf{K_r}$≡ [⊖] → ≡ 0, always on the *Stress-common-curve*. Since this Infinite Vacuum is *a Lattice – Granular - Space, connected by Energy*, i.e. *an Energy Space Universe*, *therefore* thus is shown The Way of penetration and The How this is succeeded. [39]. In Electromagnetism, density ρ per two unit length is declared as Permittivity-Permeability $\boldsymbol{\varepsilon_o}, \boldsymbol{\mu_o}$ → ε, μ related to velocity in vacuum as $\bar{\mathbf{v}} = \frac{1}{\sqrt{\varepsilon\mu}}$ and for Material-point, $c = \sqrt{\frac{T}{\rho}} = \sqrt{\frac{\sigma}{\rho}} = \frac{1}{\sqrt{\rho/\sigma}} = \frac{1}{\sqrt{\varepsilon\mu}}$, the known relation $c^2 = \frac{1}{\varepsilon\mu}$

6. *The Energy in Stationary loops and Photon*

In Material point*, and because of rotation, Stretched- String Energy* $\bar{\mathbf{B}}$ *is not transmitted , but trapped in the,* N loops*, where* $\bar{\mathbf{B}}$ =Motion in Loops*, are all in Phase with each other, and the amplitude of oscillation varies from zero, at the* N *nodes, to maxima at the antinodes. By considering rotation as a grating having* N *lines per,* r*, then maximum values of,* n*, is* n <$\frac{1}{N\lambda}$*, i.e. the biggest whole number less than* $\frac{1}{N\lambda}$ *which is* Always Integer *and* → the N loops are the N Energy- Stores in M-P.

This is the Why Spin is , $\frac{l}{2}, \frac{l}{3}, \frac{l}{4}, \frac{l}{5}$, ……..$\frac{1}{N}$, *i.e. to* $\boldsymbol{N^{th}}$*- loop*

One, Half, Third …$\frac{1}{N}$. – of Length as the loops → $[\frac{l}{2},\frac{l}{2}]$, $[\frac{l}{3},\frac{l}{3},\frac{l}{3}]$, , ,$[\frac{l}{N},\frac{l}{N},\frac{l}{N},\frac{l}{N}$,,,, N….. ∞], with → One, Two, Three ,,,,,,, N …... ∞ *loops* → *and Wave-nodes with* L =$\frac{1}{2}\lambda$,$\frac{2}{2}\lambda$, $\frac{3}{2}\lambda$,,, $\frac{n}{2}\lambda$

Above is the, Stationary - Wave - Nodes Principle, in Material – point, and issues in all monads.

The Energy $\bar{\mathbf{B}} = \frac{\mathbf{h}}{2\pi}$= Spin = $\frac{\mathbf{h.f_1}}{\bar{\mathbf{w}}}$= as velocity , v = (wr) in cave, *l*, is the Spin ½ , while Doubled $\bar{\mathbf{B}} = \frac{\mathbf{h}}{2\pi}$= Spin = 2 =$\frac{\mathbf{h.f}}{\bar{\mathbf{w}}}$= 2.$\bar{\mathbf{B}}$, in the same cave , *l* , then → f = 2.$\mathbf{f_1}$ = $\mathbf{f_2}$, *it is the How is quantization* i.e.

In the same cave, *l*, Energy is quantized as → $\frac{1}{2}$ | $\mathbf{2}.\frac{1}{2}$ =1 | $\mathbf{3}.\frac{1}{2}$ =1,5 | $\mathbf{4}.\frac{1}{2}$ =2 , …|$\mathbf{n}\ \frac{1}{2}$ = n.$\mathbf{f_1}$| and so on, depending on the number, n, of wave-nodes in cave, *l*, and Energy in, n, fringes is,

Energy in n = 1 *loop* → W = $[\frac{4\pi r^2}{3}].\mathbf{f_1}$*and for the*$\mathbf{n^{th}}$→ W = $[\frac{4\pi r^2}{3}]$.$\mathbf{f_n}$= n$\frac{(1+\sqrt{5}).\sigma r}{3}$

Total Energy in n = n *loops*→ W = $[\frac{4\pi r^2 f1}{3}]$. n.(n+1) where n = 1,2,3,4… n .... ∞

by using the Summation of series .

The Work is $W = [\frac{4\pi r^2}{3}].\mathbf{f_1} = [\frac{4\pi r^2}{3}]\frac{(1+\sqrt{5}\,]).\sigma}{4\pi r} = \frac{(1+\sqrt{5}\,])r.\sigma}{3}$ dependent on cave ,r, and Glue-Bond ,σ.

It was proved that Energy of wave is , → E = m.$\dot{y}^2$ / 2 = (m/2).(-w$\mathbf{A_o}$)² , and m = $\frac{E}{2r^2.w^2}$i.e.

$$\text{Mass in cave ,r, is} \rightarrow m = \frac{E}{2r^2.w^2} = \frac{\bar{B}}{2r^2.w^2} = \frac{W}{2r^2.w^2} = \frac{(1+\sqrt{5}\,])\,4r^2\sigma}{6r\sigma^2\,(1+\sqrt{5}\,)^2} = \frac{2\,r}{3\sigma\,(1+\sqrt{5}\,]} = [\frac{4\pi r^2}{3}].\mathbf{f_1} \qquad \ldots\ldots(12)$$

i.e. mass is dependent on cave , r , *and on first-Harmonic , or and Principal Glue-Bond-Stress*, σ *and is not any Store in where Energy can be stored. On the contrary , Energy is the motion of the* [⊖↔⊕]≡[Space ↔ Anti-space] charge, *as this is the Electrostatic force*, and the N loops of n lobes are the Stores in where *Work as Energy can be stored in Stationary Wave of cave* r.

The N loops are the Energy- Stores in M-P, and *mass the Reaction* to the *Up - Down oscillatory motion in Loop* of each wave Segment at frequency, $\mathbf{f_n}$, which describe each *mode* characterized by a different , λ and f. The Loop, *Antinode*, vibration gives no appearance of motion along the length of the loop and this because the accelerating motion happens in the Up-Down axis only.

Alternative current (AC) is an electric current which periodically reverses direction in contrast to Direct current which flows only in one direction. This happens because of charges alternation i.e. +, - *to* - , + *charges which exists on Antinodes amplitude of oscillation*. Since Cycloidal motion in M-P is Isochronous, *The acceleration*, $\ddot{\mathbf{x}} = -w^2\dot{\mathbf{x}}$ *where* w = 2π/T, *produces the Skin-effect*.

As the acceleration of an electric charge in an alternative current produces waves of Electromagnetic Radiation that *Cancel* the propagation of charges (electrons) towards the axis of the Loop the same happens *in Material point* where , *The driving force*[⊖↔⊕ ≡ σ]*on the Up – Down oscillatory motion of Loop is developing* the *Amplification factor* on Stress-common-curve where the weak force, σ, causes a powerful motion, *an Electromagnetic Wave whose Golden-frequency* $\mathbf{f_P} = \frac{(1+\sqrt{5}\,]\,).\sigma}{4\pi r} = \frac{E}{h}$

Skin-Effect *happens at Stress-common-curve because of the difference in density* ρ = σ *instead-of* ρ=0. Because of the Skin-Effect *This Electromagnetic Wave* produced from the, *Driving force* ≡ $\overline{\mathbf{B}}$, travels with speed velocity. At Rest, this *Stationary-Material -Point*, is absorbed and destroyed, while created when emitted. All above properties of, *Stationary-Material-Point,* occur in *Photon* and since it is Quaternion, issues the *Complex-Frequency-Response* H(w) and the Wave Energy-Pattern Energy particles are as $\mathbf{z}^{1/w} = |\mathbf{zo}|^{-w}.\mathbf{L_v} = \rightarrow$ *Energy Monads* and for sin.(φ+kπ)/w = 0 then exists only the Imaginary part of monad , s=0,where φ =-2π±k.π, and then $\mathbf{z}^{1/w} = |z_o|^{-w}.e^{i.\varphi} = e^{i.(-2.\pi).b}$and it is the *Diffraction Energy mechanism* for all Space Levels of quantization which are particles with least mass only . Extending cave $\mathbf{L_v} = \mathbf{e^i.(-2\pi \pm k\pi).b}$ for *minimum acceleration* [31] then *Energy Balanced tank caves for Regulating Valves,* [*massive – energy , from* 3,56.$\mathbf{10^{-14}}$*to* 9,31 .$\mathbf{10^{-28}}$m], is for base e = 2,71828 and k = 0 $\mathbf{L_v} = e^{i.(-2\pi)\,b}$ and then $e^{-31{,}41593}$ = 3,56237.$\mathbf{10^{-14}}$(m) = r,

The frequency of Photon with light velocity v = c = 2πr.fis → f = $\frac{v}{2\pi.r} = \frac{3.10^8}{2\pi.3{,}5610^{-14}}$ = 1,34.$\mathbf{10^{21}}$ Hz.

From Photon and (12), mass → m = $[\frac{4\pi r^2}{3}].\mathbf{f_1}$ = 4,18879.[86,73.$\mathbf{10^{-56}}$].(1,34.$\mathbf{10^{21}}$) = 4,868.$\mathbf{10^{-33}}$ Kg

i.e. *Photon has a frequency*$\mathbf{f_{Ph}}$ = 1,34.$\mathbf{10^{21}}$ Hz *and mass*$\mathbf{m_{Ph}}$ = 4,868.$\mathbf{10^{-33}}$ Kg.
The Wavelength $\boldsymbol{\lambda}_\mathbf{p}$ = c / $\mathbf{f_{Ph}}$ = 2,00.$\mathbf{10^{-13}}$ m *momentum* mv =1,458.$\mathbf{10^{-22}}$ Kg.m /s

On Natural base , e, and decimal base b = 10 , the Total Energy is [$\mathbf{z}^{\frac{1}{w}} = |\mathbf{zo}|^{-w}$|.Lo], is Stored in the quantized Space $\mathbf{L_o}$ = 3,56237.$\mathbf{10^{-14}}$, then passing through the Regulating Valves, [massive energy from 3,56.$\mathbf{10^{-14}}$m and 9,31.$\mathbf{10^{-28}}$m] and is quantized as 18 Particles (the Fermions and Bosons) in the Planck's length $\mathbf{L_p}$ = 8,906.$\mathbf{10^{-35}}$m. which creates all others.

On the same Sub-Spaces and on the same exponential base exist also the infinite, *Spaces - Anti-spaces and Sub-spaces*, in loops. i.e. the infinite monads in one monad.
This is → The How→ (by following the Stationary - Wave -Nodes Principle) and,
The Where →(In the first Energy Stationary-monad of Material-Geometry cave, r).
The How this →(Practically can be succeeded, is left to Laboratory Nuclear Physicists).
i.e. *In Material – point, Complex - Frequency - Response ,* H(w), *which is an Energy – monad, is composed of the Real – part which represents the Granularity of Energy as Particle, and the Imaginary – part which represents the Wave Energy--Pattern which carries Particle.*

The rotating axis, l = 2r = K$\mathbf{K_1}$ *in Material–point, creates the* Linear vibration of string*, l , which is in String* K≡ [⊖] ↔ $\mathbf{K_1}$≡ [⊕]*, and the Natural - frequency ,* $\mathbf{f_n} = \frac{(1+\sqrt{5}\,]\,).\sigma}{4\pi l}$ *in points* K, $\mathbf{K_1}$ or*, the* Rotational vibration Plan Energy *which is, The Spin as* [K ≡ ⊖ s² ↻ ↺ $\mathbf{K_1}$≡ ⊕s²] ≡ $\overline{\mathbf{B}}$.

Above relation of this Plane Work is the Quantization in Geometry-Shapes *of motion and becomes into the Plane-Stores of Anti-Space and, consists the Unification of Geometry-monads with those of the Energy monads, which Energy-monads is the Work in Caves, the Up-down oscillation, stored as Angular momentum,* $\overline{\boldsymbol{B}}$*, and Angular velocity Ellipsoids,* $\overline{\mathbf{w}}$*, which was prior analyzed.*

7. *Gravitational red shift and Time Dilation: [39]*

Gravitational red shift is the Phenomenon where low frequencies of light [long T=620-750 nm] shifted to red (redshift → f = 400 - 484 THz) and higher frequencies of light [short T=450-495 nm] are shifted to blue (blue-shifted→ f = 606 - 668 THz) and Time Dilation the opposite Phenomenon for time.

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Using the intrinsic property of constant light velocity vector $|\bar{\mathbf{v}}|$, *which is a Stationary wave in Photon`s wavelength* λ , *as*→ $\bar{\mathbf{v}} = \lambda / T = \lambda.f$ and $\mathbf{f_1} = \frac{(1+\sqrt{5}]).\sigma}{4\pi r} = \frac{E}{h}$ and then $\bar{\mathbf{v}} = \lambda\frac{(1+\sqrt{5}]).\sigma}{4\pi r}$,

In a Stress-Strain System, the State of Principle Stresses , $\pm\ \sigma$ at each point, is the double refraction in Photo-Elasticity and expressed as the Isochromatic lines [$(\boldsymbol{\sigma_1}$-$\boldsymbol{\sigma_2})$ = J.(λ/d), [J, constant, λ, wavelength, d, thickness] or as Isochromatic surfaces, depending on the direction of force (or and pressure) which is the same in gravity field as the length-contracted and the length-expanded in a given piece of quantized s. Streching Removal of λ creates, - $\boldsymbol{\sigma_1}$, while, Compressed Removal of λ creates,+$\boldsymbol{\sigma_1}$, and since velocity, c, is constant, long and short period T, or low and high, f, varies and a vector with Low energy E = h.f is at Red, →(Redshift) → low f = 400-484THz , long λ= 620-750nm and (Blueshift)→ high f = 606-668THz, short λ= 450-495nm and High energy since E = h.f at Blue .

In this way Light as caver = s = Particle is Photon, 2s = λ = 380-780 nm = (3,8-7,8).$\mathbf{10^{-7}}$m and as Wave, the Outer-moving Electromagnetic fields E , P = ∇i x Di= is of an Wave-nature-force→*or an Wave–Energy-Pattern* where∇i =$\bar{\mathbf{v}}$= λ.f = λ/T, since Lightis also ≡ quaternion → [q = s+∇i].

The Stationary Wave in 2s = λ means that, since Photon is the only Electric Displacement field in λ/2, D=ε.E+P, then in the rate of change is alternately in terms of The Electric field (∠P/∠t) and the traverse Magnetic field (∠E/∠t), i.e. for Low - Energy Red shift and for High energy Blue-shift is then |2s|≡as Particle.*The Breakage-Principle, is the way of Energy conservation, where Energy never annihilates and which is always reverted into* the *two Opposites* (+ E , - P) *and an Neutral Part* in care r as 2 .∇i.

Total Energy is Spin $\equiv\bar{\mathbf{B}} = [\mathbf{r}.\boldsymbol{\sigma}.(\mathbf{1}+\sqrt{\mathbf{5}})] = (\frac{\mathbf{8\,r^2}}{\boldsymbol{n}}).\mathbf{f_n} \equiv$ [εE²+μH²]/2 = 2rc.sin.2φ, or as *Matter*(+ E) ,as *Antimatter* (- P) *and as Energy part* , 2L = $\bar{\mathbf{B}}.\bar{\mathbf{w}}$, *and always to its constituents, either to all or separate* following → Total Energy as L = ($\bar{\mathbf{B}}.\bar{\mathbf{w}}$/2).

Since also frequency f = 1/T and energy1.$\bar{\mathbf{v}}$=E= h.f, then Cycloidal motion Controlls constancy of Energy by changing velocity$\bar{\mathbf{v}}=\bar{\mathbf{w}}$r , and period ,T≡1 / f,of monads.

Relativity failed to explain this reality and to explain the WHY → Wave nature*, is the Intrinsic Electromagnetic Wave of Particles and speed of light is constant in a Stress - Strain System with* (*Redshift, as low,* f, *and Blue-shift as high*, f) *Photon to be as Particle and also Wave, but considering constancy of light as an axiom from which* GR *was derived.*

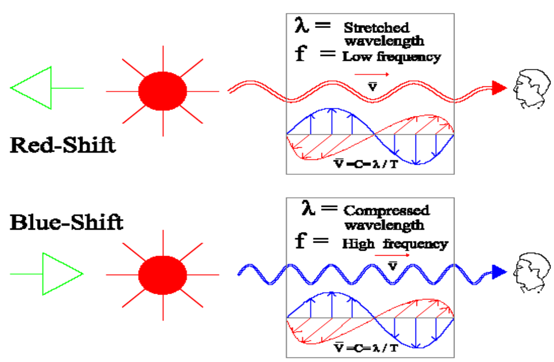


Figure 16: Redshift as low f, and Blue-shift as high f Photon as an Intrinsic-Stationary-Wave and a Removal Source F(f)

Since During Intrinsic Diffraction, d$\bar{\mathbf{s}}$= λ, of isochronous motion of vectors , *frequency*, f, *doesn't change,* and only velocity , $\bar{\mathbf{v}}$, and wavelength, λ, changes, so from equation →λ = $\bar{\mathbf{v}}$T = $\bar{\mathbf{v}}$/ f, then is $\bar{\mathbf{v}}$= λf and Acceleration a = d$\bar{\mathbf{v}}$/ dt = (dλ/dt).f + λ(df/dt) i.e. → a = g = d$\bar{\mathbf{v}}$/ dt = (dλ/dt).f ← and Since also The Total-Energy of a Photon is conserved in the Energy-Storages of, λ , which are the quantization of frequencies as the harmonics $\mathbf{f_1}$, $\mathbf{f_2}$, ,$\mathbf{f_n}$ = $\mathbf{w}^2$ of, *cave* ≡ *recession* λ = 2.r ≡ n loops , *Therefore* the Photos emitted by a nebula lose energy on their journey to the observer by any effect, leads to a decrease in frequency , i.e. *Intrinsic Red-Shift*.

Since Total energy is conserved and happens decreasing in frequency then from formula E = h f = $\frac{\mathbf{hc}}{\boldsymbol{\lambda}}$, λ, is increasing , i.e. *corresponds to an increase in light`s wavelength* λ ≡ [$\mathbf{f_1}$, $\mathbf{f_2}$,,, ,$\mathbf{f_n}$ = w ² ≡N loops≡n lobes]which is following the *Stationary-Wave-Nodes Principle*.

In this way Total-energy is conserved as the hedgehog in its shell because differently, *the said tired light* should be annihilated. It was shown [58-59] Black-holes, *the quasars*, exist in the centers of galaxies and are the beacons for astronomers and consist the *Recycled Space machines* of the Universe.

Photon is a Material-point in caver, *Inner as Stationary*-Electromagnetic-Wave [E²+H²]=2(2r).c.$\mathbf{sin\,2\varphi}$ with n Lobes representing the *Normal mode vibration* with frequencies $\mathbf{f_n}$= n.$\mathbf{f_1}$=$\frac{\mathbf{E}}{\mathbf{h}}$= $[\frac{(1+\sqrt{5})}{2}]\frac{\sigma}{4\pi r^3}$ *Outward as the Propagating Electromagnetic-Wave* → { [εE² + μB²] = 2.λc.sin.2φ } ← where E ⊥ B ⊥ r *Directions along which may Propagate without Birefringence,* the Caver=n.[λ/2]Is the *Electromagnetic Energy-Storage* and, the E, B Electromagnetic-RadiationIs *The conveyer of the Energy*-Cave.

7a. *Numeric Analysis*

Planck constant, h = 6,62606957. $\mathbf{10^{-34}}$ joules, 1 eV = 1,60218 . $\mathbf{10^{-19}}$ J

Light velocity c = 2,998.$\mathbf{10^{8}}$m/s , 1 THz = $\mathbf{10^{12}}$ Hz , 1 nm = $\mathbf{10^{-9}}$m , 1 μm =$\mathbf{10^{-6}}$m

Total-Energy E = h.f = $\frac{\mathbf{hc}}{\boldsymbol{\lambda}}$ = $\frac{\mathbf{6{,}62606957.10^{-34}.2{,}998.10^{8}}}{\boldsymbol{\lambda}}$ = 1,99.$\mathbf{10^{-25}}$m .($\mathbf{10^{6}}$μm/m) = $\frac{\mathbf{1{,}2398}}{\boldsymbol{\lambda}.(\boldsymbol{\mu}\mathbf{m})}$ (eV)

and for redshift → f = 400 THz = 400.$\mathbf{10^{12}}$ Hz = 4.$\mathbf{10^{14}}$ Hz then corresponds a light`s wavelength

λ = $\frac{\mathbf{c}}{\mathbf{f}}$ = $\frac{\mathbf{2{,}998.10^{8}m/s}}{\mathbf{4.10^{14}\,Hz}}$ =7,495. $\mathbf{10^{-7}}$m.($\mathbf{10^{6}}$μm) = 0,07495 μm and Total-Energy E =$\frac{\mathbf{1{,}24}}{\boldsymbol{\lambda}.(\boldsymbol{\mu}\mathbf{m})}$ (eV) ……………………...(a)

$\mathbf{E_R}$= $\frac{\mathbf{1{,}24}}{\mathbf{0{,}7495}}$ = 1,6542 eV = 2,65.$\mathbf{10^{-19}}$ Joules . Where 1 eV =1,6022.$\mathbf{10^{-19}}$ Joules.

Because Photon may have any wavelength and also that of Planck cave 1,616.$\mathbf{10^{-35}}$ m, then Energy $\mathbf{E_P}$= $\frac{\mathbf{1{,}24}}{\mathbf{1{,}616.10^{-35+6}}}$ = 7,673.$\mathbf{10^{28}}$ eV = 1,229.$\mathbf{10^{21}}$ Joules . The differenc***e*** in Energy is E = $\mathbf{E_P}$ -$\mathbf{E_R}$= 7,673.$\mathbf{10^{28}}$ eV = 1,229.$\mathbf{10^{21}}$ Joules, *i.e* *The Energy - Stores of Photon are always full of Energy* ≡ The Up - Down Motion in Lobes, *following on wavelength,* λ*, The Stationary Wave - Nodes Principle.*

Considering the wavelength equal to Planck`s length r=4,453.$\mathbf{10^{-35}}$ then to observe this length we need the wavelength to be smaller than this cave r , being viewed.

The frequency is as $\mathbf{f_P}$= c/λ = (3.$\mathbf{10^{8}}$ m/s) / (4,453. $\mathbf{10^{-35}}$ m) = 6,73 .$\mathbf{10^{42}}\boldsymbol{s^{-1}}$ corresponding to an Energy E = h.$\mathbf{f_P}$ = [6, 6260696.$\mathbf{10^{-34}}$Js].[6,73 .$\mathbf{10^{42}}\boldsymbol{s^{-1}}$] = 4,459.$\mathbf{10^{9}}$ J = 2,783.$\mathbf{10^{28}}$ eV.

Planck`s constant h, is the ratio of a Quantum of Energy to its frequency and equal to h = [6,6260696.$\mathbf{10^{-34}}$Js] where →1 eV =1,6022.$\mathbf{10^{-19}}$ Joules →1 J = 6,24141.$\mathbf{10^{18}}$ eV The relation of wavelengths and colors, *energy*, is given from equations λ = hc / E and λf = c.

The seven light-colors are as below with wavelength in nm = 1.$\mathbf{10^{-9}}$ m, and energy in eV as, *Red* →700, *Orange* → 620, *Yellow* → 580, *Green* → 530, *Blue* → 475,*Indico*→ 450, *Violet* → 400 *nm*, f = 4,29.$\mathbf{10^{14}}$, f = 4,84.$\mathbf{10^{14}}$, f = 5,17.$\mathbf{10^{14}}$, f = 5,66.$\mathbf{10^{14}}$, f = 6,32.$\mathbf{10^{14}}$, f = 6,67.$\mathbf{10^{14}}$, f = 7,50.$\mathbf{10^{14}}$.. $\boldsymbol{s^{-1}}$ E = 1,77.$\mathbf{10^{0}}$, E = 2,00.eV , E = 2,14.eV , E = 2,34.eV , E = 2,64.eV , E = 2,76 eV , E = 3,10.eV ,

From above is seen the small- large size of the energy difference.

Extending quantization of Space and Energy according to exponential formula for acceleration,

Planck's *Length* $\mathbf{L_S}$= $\mathbf{e^{-i.(-\pi+k\pi).b}}$= $e^{-i.\pi(k-1).10}$*, then* ,$\mathbf{e^{-(29{,}933606)}}$,

For base e = 2,71828 and base b = 10 then $\mathbf{e^{-(29{,}933606)}}$ = 1 .$\mathbf{10^{-13}}$ m *Particles length*

For base e = 2,71828 and k = 0 then$\mathbf{L_S}$= $\mathbf{e^{i.(-\pi).b}}$ = $e^{-i(-31,41593)}$ = 3,56237 . $\mathbf{10^{-14}}$ m

For base e = 2,71828 and base b = 10 then $\mathbf{e^{-(32{,}236191)}}$ = 1 .$\mathbf{10^{-14}}$ m *Particles length*

For base e = 2,71828 and base b = 10 then $\mathbf{e^{-(92{,}103404)}}$ = 1 .$\mathbf{10^{-27}}$ m *Particles length*

For base e = 2,71828 and k = 1 then$\mathbf{L_S}$= $\mathbf{e^{i.(-2\pi).b}}$ $e^{-i(-62,83185)}$ = 9,31289 . $\mathbf{10^{-28}}$ m

For base e = 2,71828 and base b = 10 then $\mathbf{e^{-(94{,}405989)}}$ = 1 .$\mathbf{10^{-28}}$ m *Particles length*

Minimum Acceleration happens for Particles in, *Cave* ≡ *Recession* ≡ *Wavelength*, where then Energy, Energy $\mathbf{E_a}$= $\frac{\mathbf{1{,}24}}{\mathbf{3{,}56237.10^{-14+6}}}$ = 3,481.$\mathbf{10^{7}}$ eV = 5,576.$\mathbf{10^{-10}}$ Joules, while Redshift Energy happens as

$$\mathbf{E_R}=\frac{\mathbf{1{,}24}}{\mathbf{0{,}7495}}= 1{,}6542\text{ eV} = 2{,}65.\mathbf{10^{-19}}\text{ Joules .} \qquad [31]$$

It was prior referred that, when Matter and Antimatter annihilate at rest or when Anti-space comes in contact with its regular Space counterpart, they mutually destroy each other and all of their Energy is converted to the *Three Breakages*

$$\rightarrow s^2 , -|\bar{\mathbf{v}}|^2, [2\bar{\mathbf{w}}].|s|\ |r|.\nabla i \leftarrow \text{ and for , } \bar{\mathbf{v}}\equiv s \equiv r = \text{the cave , then} \rightarrow s^2 , - s^2 ,\ 2[\bar{\mathbf{s}}]^2.\nabla i\leftarrow \qquad [58]$$

Because Pure energy happens at s = 0 then 2[$\bar{\mathbf{s}}$] ².∇i = 0 , i.e. ∇i = 0 or [∇i] ² = 0 , meaning that Energy as Matter is moving perpendicularly to Anti-matter without annihilate each other . Photon is a Particle in all Levels of

Energy-magnitudes , and thus traversing gaseous-media of any temperature is experiencing redshift without losing Energy. Star - light passing near the Sun is bending because of its refraction in the dense-Sun, and of Newton`s gravitation.

Since Storage r = n λ/2 is an EM -Energy-tank with n frequencies and, $\mathbf{f_n}$ the Electromagnetic Radiation E, B the conveyer, in case of *Conveyer-annihilation* then *Photon* is regenerated by the Intrinsic-store which is the intrinsic Electromagnetic wave E, H and is indistinguishable from the annihilated.

It was proved before that, either velocity ,c , or Golden-frequency $\mathbf{f_n}$, creates motion ≡ Energy.

In case of Redshift , Energy is squared as $\mathbf{E_a}^2 = \mathbf{E_R}$ or $[\,5{,}576.\mathbf{10^{-10}}\,]^2 = 31{,}09\ .\mathbf{10^{-20}} = \mathbf{E_R} = 3{,}109.\mathbf{10^{-19}}$ Jouls corresponding to aRedshift → f = 468THz. markos 11 / 2 / 2018.

8. *The Numeric - Length of Space-caves: [26 - 29]*

Why Rotational energy $\bar{\boldsymbol{\Lambda}}$ is Elastically damped in monad $\boldsymbol{\lambda_2} = \mathbf{10^{-35}}$m as → mass m, velocity $\bar{\mathbf{v}}$, angular velocity $\bar{\mathbf{w}}$, and finally as a Constant Frequency f, which is dissipated in the fundamental particles (Fermions and Bosons) by altering the two variables, velocity$\bar{\mathbf{v}}$and wavelength λ, only ??

Since monad ($\overline{\mathbf{AB}}$) = *quaternion* = $\bar{\mathbf{z}}$ and the, w, Spaces and ,1/w = $\mathbf{w^{-1}}$, Sub-spaces are monads in, w, powerand, $\mathbf{w^{-1}}$, the root which represent the Regular Circumscribed and the Regular Inscribed Polygons in monad $\overline{\mathbf{AB}}$ then quaternion $\mathbf{z^w} = \bar{\mathbf{z}} = s + \bar{\mathbf{v}} = s + \bar{\mathbf{v}}.i = s + [\,\mathbf{v_1} + \mathbf{v_2} + \mathbf{v_3}].\nabla i = s + \bar{\mathbf{v}}\nabla i$, where s = the Scalar part, and $(w^2\varphi+\varphi+2k\pi)$, $\frac{\mathbf{(w^2\varphi+\varphi+2k\pi)}}{w}$, $\mathbf{e}^{\mathbf{i}[\frac{(w^2\varphi+\varphi+2k\pi)}{w}]}$

$\bar{\mathbf{v}}$= [v1 + v2 + v3] the Imaginary part of it , equal to$\bar{\mathbf{v}}\nabla$i ...... [25] and then becomes

$\rightarrow \mathbf{z^w} = (\mathbf{s} + \bar{\mathbf{v}}\nabla\mathbf{i})^{\mathbf{w}} = [\,\mathbf{z_o}.(\cos\varphi + \mathbf{i}\ \sin\varphi)]^{\mathbf{w}} = |\mathbf{z_o}|^{\mathbf{w}}.(\cos \mathbf{w}\,\varphi + \boldsymbol{\varepsilon}.\sin \mathbf{w}\varphi) = |\mathbf{z_o}|^{\mathbf{w}}.\mathbf{e}^{\mathbf{i.w\varphi}}$, *where*

$\rightarrow |\mathbf{z_o}| = \sqrt{\mathbf{s^2 + v1^2 + v2^2 + v3^{\,2}}}$, ε=[v1.i + v2.j + v3.k] / $[\sqrt{\mathbf{v1^2 + v2^2 + v3^{\,2}}}\,]$,$\cos\varphi = \frac{s}{|\mathbf{z_o}|}$ s *and*

$\rightarrow \mathbf{z^{1/w}} = (\,\mathbf{s} + \bar{\mathbf{v}}\nabla\mathbf{i}\,)^{\mathbf{1/w}} = |\mathbf{z_o}|^{-\mathbf{w}}.[\cos(\varphi + 2\mathbf{k}\pi)/\mathbf{w} + \mathbf{i}.\sin(\varphi + 2\mathbf{k}\pi\,/\mathbf{w})] = |\mathbf{z_o}|^{-\mathbf{w}}.\mathbf{e}^{\mathbf{i.(\varphi+2k\pi)/w}}$

where $\mathbf{z^w}$= The Space , and $\mathbf{z^{1/w}}$ = The Anti-space of Monad ≡ Quaternion $\overline{\mathbf{AB}}$.

Above equations define the Wave-nature of monads in all Levels or Sub-levels.

Adding Space, Anti-space then $\mathbf{z^w} + \mathbf{z^{1/w}} = [\mathbf{z^w} + \mathbf{z^{1/w}}]\,/\,2 = A\ .\mathbf{\cos wt} = R.A\mathbf{e^{iwt}}$, where R stands for the real part of the quantity z.

Multiplying Space, Anti-space then $\mathbf{z^w} x \mathbf{z^{1/w}} = \mathbf{A_1}\ \ \mathbf{A_2}\ .\mathbf{e}^{\mathbf{i(\varphi1-\varphi2)}} = |\mathbf{z_o}|^{\mathbf{w}}\ \mathbf{e}^{\mathbf{i.w\varphi1}}] x [|\mathbf{z_o}|^{-\mathbf{w}}\ \mathbf{e}^{-\mathbf{i.w\varphi2}}\,] = 1$

The In-between Spaces $\mathbf{z^w}$and Anti-spaces $\mathbf{z^{1/w}}$ consists the *Absolute-Vacuum* of Spaces in all levels.

The Energy, Spaces $\mathbf{z^w}$andAnti-spaces$\mathbf{z^{1/w}}$, consists the *Granular-Vacuum* of Spaces in all levels.

Rotational Energy E = $\bar{\boldsymbol{\Lambda}}$= mv.r = (m$\bar{\mathbf{v}}$).λ/2 = (m.wλ/2).λ/2 = (mw).λ²/4 = (m.2πf).λ²/4 = f.[mπ.λ²/2]. *Total Energy* E in k2 = |$\bar{\boldsymbol{\Lambda}}$|λ = (m$\bar{\mathbf{v}}$).λ²/2 = (m.wλ²/2).λ/2 = (mw).λ³/4 = (m.2πf).λ³/4 = f [mπ.λ³/2].

From equation of Work = Energy E=Pd$\bar{\mathbf{s}}$= P.$\bar{\mathbf{v}}$ dT= P.$\bar{\mathbf{v}}$.(2π/w)=P.$\bar{\mathbf{v}}$.(2π/2π.λ)= P.$\bar{\mathbf{v}}$/λ= hf = h(v/L) i.e. during diffraction, d$\bar{\mathbf{s}}$, frequency, f, doesn't change and only the velocity, $\bar{\mathbf{v}}$, and wavelength, λ, changes

Diffraction d$\bar{\mathbf{s}}$, maybe on any Quantized Space-monad (*quaternion*) *and in Planck Length* Lp *but how*?

Work is embodied in the three perpendicular regions $\mathbf{k_1}$, $\mathbf{k_2}$,$\mathbf{k_3}$, as the *rotating Energy* $\bar{\boldsymbol{\Lambda}}$ on dipole $\overline{\mathbf{AB}}$ = A ↔B =d$\bar{\mathbf{s}}_1$,d$\bar{\mathbf{s}}_2$, d$\bar{\mathbf{s}}_3$, in the Configuration of co variants $\bar{\boldsymbol{\Lambda}}$, d$\bar{\mathbf{s}}$, with constant C=4.$\bar{\boldsymbol{\Lambda}}d\bar{\mathbf{s}}$/(πwλ²) *which exists simultaneously as the Equation of Quaternion*→ Spaced$\bar{\mathbf{s}}$ = $\bar{\mathbf{z}}$ = [s ±$\bar{\mathbf{v}}$.∇i] = [s ± $\bar{\mathbf{v}}$.i] = Work = Total Energy =

$$\text{TE} = [\,\Lambda\nabla + \bar{\boldsymbol{\Lambda}}x\nabla] = \sqrt{[\mathbf{m.v_E}^2]^2 + [\boldsymbol{\Lambda}.\mathbf{v_B} + \bar{\boldsymbol{\Lambda}}\,\mathbf{x}\,\mathbf{v_E}]^2} = \sqrt{[\mathbf{m.v_E}^2]^2 + \mathbf{T}^{\,2}} =$$

$$\sqrt{[\mathbf{m.v_E}^2]^2 + |\sqrt{\mathbf{p_1 v_{B1}}}|^2 + |\sqrt{\mathbf{p_2 v_{B2}}}|^2 + |\sqrt{\mathbf{p_3 v_{B3}}}|^2} = (\,\bar{\mathbf{z}}_\mathbf{o})^{\mathbf{w}} = (\,\boldsymbol{\lambda}\,,\boldsymbol{\Lambda}\nabla\mathbf{i}\,)^{\mathbf{w}} = (\bar{\mathbf{z}}_\mathbf{o})^{\mathbf{w}}.\mathbf{e}^{[\bar{\mathbf{v}}.\mathbf{w\theta}]} = (\bar{\mathbf{z}}_\mathbf{o})^{\mathbf{w}}.$$

$$\boldsymbol{e}^{[\,\bar{\boldsymbol{\Lambda}}\nabla\mathbf{i}\,/\sqrt{\ }\ \boldsymbol{\Lambda}`\,\bar{\boldsymbol{\Lambda}}\,[\mathbf{Arc\ Cos}(\frac{\mathbf{w}|\boldsymbol{\lambda}|}{2|\sqrt{\bar{\mathbf{z}}'\mathbf{o}.\bar{\mathbf{z}}\mathbf{o}}|}\,]} \quad \ldots\ldots\ldots\ldots\ldots \quad \text{(TW)}$$

Nature has not any < meter > to measure quantized quantities (of Space and Energy) except these of the Geometry constants, one of which is number, π,(Archimedes number π) so quantization of Points (λ) *follows geometry constant* (π) *and for Energy* $\mathbf{W_d}$*,which is the quantized Energy of the Quantity dissipated per cycle,[and this because monads follow sinusoidal oscillation on wavelength = monads as the w.th power and the n.th root of this monad where* w. n =1 *as above on and in the same monad*]*and which energy is*→ $\mathbf{W_d}$= (mw).λ²/4 = (2mπf).λ²/4 = (mπ.λ²/2).f = C.f= C.$[\frac{(1+\sqrt{5})}{2}]\frac{\boldsymbol{\sigma}}{4\pi r^3}$ = $\mathbf{W_d}$= C.$[\frac{(1+\sqrt{5})}{2}]\frac{\boldsymbol{\sigma}}{4\pi r^3}$= (m/2r).$[\frac{(1+\sqrt{5})}{2}]\frac{\boldsymbol{\sigma}}{4\pi r^3}$ = (m/λ).$[\frac{(1+\sqrt{5})}{2}]\frac{\boldsymbol{\sigma}}{4\pi r^3}$ → a Golden ratio pattern ,i.e.

From above monads $(\,\mathbf{s} + \bar{\mathbf{v}}\nabla\mathbf{i}\,)^{\mathbf{1/w}} = |\mathbf{z_o}|^{-\mathbf{w}}.\mathbf{e}^{-\,\mathbf{i.(\varphi+2k\pi).w}}$, where $\cos\varphi$ = s / |$\mathbf{z_o}$|, and for Rotated Energy case where s = 0 , and also $\cos\varphi$ = 0 exists for angle φ = π /2 , the quaternion $(\,\mathbf{s} + \bar{\mathbf{v}}\nabla\mathbf{i}\,)^{\mathbf{1/w}}$ *as dimension power*

$\rightarrow w = b \leftarrow$ *and for* $k = 1$ *above becomes* , $\mathbf{e}^{-\,\mathrm{i}.(\pi/2+2k\pi).\mathbf{w}} = \mathbf{e}^{-\,\mathrm{i}.(\pi/2+2k\pi).\mathbf{b}} = \mathbf{e}^{-\,\mathrm{i}.(5\pi/2).\mathbf{b}} = \mathbf{e}^{-\,\mathrm{i}.(5\pi/2).\mathbf{10}}$ *and for Planck length*

$$\mathbf{L}_{\,\mathbf{p}} = \mathbf{e}^{-\,\mathrm{i}.(5\pi/2).\mathbf{10}} \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (\mathbf{P}_{\,\mathbf{l}})$$

Equation ($\mathbf{P}_{\,\mathbf{l}}$), is thebasic Geometrical interpretation of the <*Planck scale meter*>based On the two *Geometry constantse*, π where $k = 1$, and *base* $b = 10$, and this from logarithm properties with different bases on the same base e as this is , $\mathbf{e}^{\mathbf{w}} = [\, b^{\log_b(e)} \,]^{\,w} = b^{w.\log_b(e)}$ and because $\sqrt[\mathbf{w}]{\mathbf{e}} = \mathbf{e}^{\mathbf{1/w}} = \mathbf{e}^{-\,\mathbf{w}} = x^{1/w.\log_b(e)}$ *which are monads in monads, and is therefore of Wave motion with angular velocity* $w = 4\mathbf{W_d}/(\pi.\mathbf{C_o}.\lambda^2)$, [5-4] i.e.

Space and Energy is quantized and measured on the two Constant and Natural numbers e, π.
where *for base* the natural logarithm, e, *and exponent* the decimal base, b = 10, then is→
For base e = 2,71828 and base b = 10 then$\boldsymbol{e}^{-\,(\mathbf{78{,}2879})} = 1$. $\mathbf{10^{-34}}$m *The answer*
For base e = 2,71828 and base b = 10 then$\boldsymbol{e}^{-(\mathbf{78{,}5398})} = 8{,}906$. $\mathbf{10^{-35}}$m *to the above*
For base e = 2,71828 and base b = 10 then$\boldsymbol{e}^{-(\mathbf{80{,}5905})} = 1$. $\mathbf{10^{-35}}$m *question.*

$\mathbf{L_p} = \mathbf{e}^{\mathrm{i}.\left(\frac{\pi}{2}+2\mathbf{k}\pi\right).\mathbf{b}} = \mathbf{e}^{-\mathrm{i}.\left(5\frac{\pi}{2}\right).\mathbf{b}} = \mathbf{e}^{\mathrm{i}.\left(-5\frac{\pi}{2}\right).\mathbf{10}} = \mathbf{e}^{-.(\mathbf{78{,}5398}).} = 8{,}906.\mathbf{10^{-35}}$ m $= \{\sqrt{\mathbf{3}}.\pi.\ 1{,}616199.\mathbf{10^{-35}}$ m$\}$

i.e. *Planck's Length*$\mathbf{L_p}$ *During Diffraction,* d$\bar{\mathbf{s}}$*, frequency* ,f, *doesn't change and only the velocity*, $\bar{\mathbf{v}}$, *and wavelength*, λ, *changes, or the Wave nature of Even function* f(Λ)*and of Odd* f(-Λ)≡[0,-∇xΛ.∴] *creates on Planck-Length* ,d$\bar{\mathbf{s}}$*, Fermions and Bosons* .This becomes from velocity relation v= w.r = 2πf.r = (2πr / T) = [2πr.c/λ], where velocity ,c, or Golden-frequency $\mathbf{f_n}$,creates Energy ≡ motion.

Again $\mathbf{z^{1/w}} = (\,\mathbf{s} + \bar{\mathbf{v}}\nabla\mathbf{i}\,)^{\mathbf{1/w}} = |\mathbf{z_o}|^{-\mathbf{w}}.[\mathbf{cos}\,(\boldsymbol{\varphi} + \mathbf{k\pi})/\mathbf{w} + \mathbf{i.sin}(\boldsymbol{\varphi} + \mathbf{k\pi}\,/\mathbf{w})] = |\mathbf{z_o}|^{-\mathbf{w}}.\mathbf{e}^{\mathbf{i}.(\boldsymbol{\varphi}+\mathbf{k\pi})/\mathbf{w}}$

For $\mathbf{cos}(\boldsymbol{\varphi} + \mathbf{k\pi})/\mathbf{w} = 0$ then exists only the Imaginary part of monad,($\bar{\mathbf{v}}$.∇i) ≠ 0 , where φ = π /2 and then, it is the *Diffraction Energy mechanism* for all Space Levels of quantization which are The Energy Particles only i.e. Energy particles $\mathbf{z^{1/w}} = |\mathbf{z_o}|^{-\mathbf{w}}.\ \mathbf{L_v}$ ≡ Energy Monads.

9. *The Energy conservation, due to any motion*

Since Medium-Field Material-Fragment → [± s²] = [MFMF] ≡*The Chaos*, is the base for all motions, *then issues for the Motion of Photons all issuing for the others motions*:
All motions create Work which is conserved.

1. When Motion presupposes a *Displacement-vector*$\bar{\mathbf{r}}$ and the small amount, $\mathbf{d}\bar{\mathbf{r}} = \bar{\mathbf{v}}$, with between angle θ , then the area dS, swept out by the two vectors is → $2.dS = r.dr.\mathbf{sin}\,\boldsymbol{\theta} = \bar{\mathbf{r}}\mathrm{x}\mathbf{d}\bar{\mathbf{r}} = \bar{\mathbf{r}}\mathrm{x}\dot{\bar{\mathbf{r}}}$ ....(1)
   By differentiating with respect to time becomes $\mathbf{2d\dot{S}} = \dot{\bar{\mathbf{r}}}\mathrm{x}\dot{\bar{\mathbf{r}}} + \bar{\mathbf{r}}\ \mathbf{x}\ \ddot{\bar{\mathbf{r}}}$ ....(2) i.e.
   The first term on the right hand side of (2) is zero because is the cross-product of a vector with itself.
   The second term is the cross-product of *Displacement-vector*$\bar{\mathbf{r}}$and *Acceleration-vector* $\ddot{\bar{\mathbf{r}}}$, which is directed to $\bar{\mathbf{r}}$, vector therefore is also Zero and $\mathbf{2d\dot{S}} = 0$, or, $\mathbf{d\dot{S}} = 0$, so, dS = constant = k ....(3)
2. When Motion presupposes *Velocity vector*$\bar{\mathbf{v}}$which , *when is in motion collides with other velocity Vectors*, creating a Constant Work k . Motion may be *Linear or Rotational* for any displacement r , so exists the Constant-work → $k = \bar{\mathbf{v}}\mathrm{x}\bar{\mathbf{v}}.\bar{\mathbf{r}} = v^2.r$ ← ....(4)
   or , $k = v^2.\ r = (wr)^2.r = [\frac{\mathbf{2\pi}}{\mathbf{T}}\mathbf{r}]^2.r = \frac{\mathbf{4\pi^2\ r^2}}{\mathbf{T^2}}\ r = \frac{\mathbf{4\pi^2\ r^3}}{\mathbf{T^2}} = 4\pi^2.r^3.\mathbf{f^2}_{\mathbf{p}}$ →

which is The Kepler Laws ,where for $\frac{\boldsymbol{4\pi^2}}{\boldsymbol{k}} = C$ then $1 = C\ r^3.\mathbf{f^2}_{\mathbf{p}}$ .... (4a)

Relation $1 = C\ r^3.\mathbf{f^2}_{\mathbf{p}} = [\,\frac{\boldsymbol{4\pi^2}}{\boldsymbol{k}}\,]\ r^3.\mathbf{f^2}_{\mathbf{p}}$, becomes either from *Displacement*, *Space*, or *Velocity*, *Anti-space*.

Remarks:

1. Since (1)denotes *Area*, (3) denotes *Acceleration* ≡ *Force* ≡ *Energy*, and, are equal and same, *so* The area Swept-out by a vector radius is, 2.dS = constant = k = $\bar{\mathbf{r}}$ x $\mathbf{d}\bar{\mathbf{r}}$ and *Energy is Stored into it*. Since Photon is Particle as [$\bar{\mathbf{v}} = \bar{\mathbf{c}}$= λf], then *Energy* ≡ *Work* produced in motion is stored into its, velocity - vector ≡ $\bar{\mathbf{c}}$= λf≡ $\mathbf{f_R}$ = [$\mathbf{B_P}$ ≡ $\mathbf{f_{1=N}}$, $\mathbf{f_2}$, $\mathbf{f_3}$,$\mathbf{f_R}$] ≡[E² + H²] = 2(2r).c.$\mathbf{sin\,2}$φ, *where* $\mathbf{f_R}$ ≡$\mathbf{f_N}$ and consists the moving Storage of Photon . *The carrier of Body* $\mathbf{B_P}$, is the *Outward*$\bar{\mathbf{c}}$= λf *Electromagnetic-Wave* →{[εE²+μB²] =2.λc.sin.2φ}
2. From(4)*Photon during Motion in* [MFMF] *Chaos collides with other* Photons*, by means of Cross-Product and produces a constant Work which is stored into the* Only-Four *Energy - Geometrical-Shapes, of the motion. The Interior motion is kept in its Wavelength-Tank* 2r = nλ, *and Linear motion is continued by the Propagating Electromagnetic-Wave* ≡ *The conveyer of the Storage.*

The mechanism of *Energy-transport through a Medium* involves the *Absorption and the Reemission* of the wave-energy by the atoms of the material . Since Quanta of Energy occupy a finite space λ = 2r, as motion then an electromagnetic wave impinging upon the atoms of a material, its energy is absorbed by the atoms of the material, and since Energy ≡ motion then occurs *Resonance*, and electrons within the atoms undergo vibrations . After a short period of vibrational-motion, the vibrating electrons create a *New Electromagnetic wave* with the same frequency as the first one and thus delay motion through the medium. Because energy is related to the content of wavelength λ, *Body* $\mathbf{B_P}$, then once the energy of EM-wave is reemitted then it travels through a small region of space between atoms and once it reaches the next atom the EM-wave is absorbed and transformed into electron vibrations and then reemitted as an Electromagnetic-wave. The actual *speed of an Electromagnetic-wave through a material-medium*, due to the Absorption and Reemission-process, is dependent upon the *optical-density* of the medium, or when their atoms are closely packed upon their, *material – density*. i.e.

Photon is an Energy-store r, in a Stationary-wave of wavelength n λ = 2r, consisted of n stationary lobes filled in λ with inner motion the Electromagnetic - Displacement-current, while is Outward Propagating with light speed as Energy-store λ = 2r / n, [+] Electric-field as Space, [-] Magnetic-field as Anti-space.

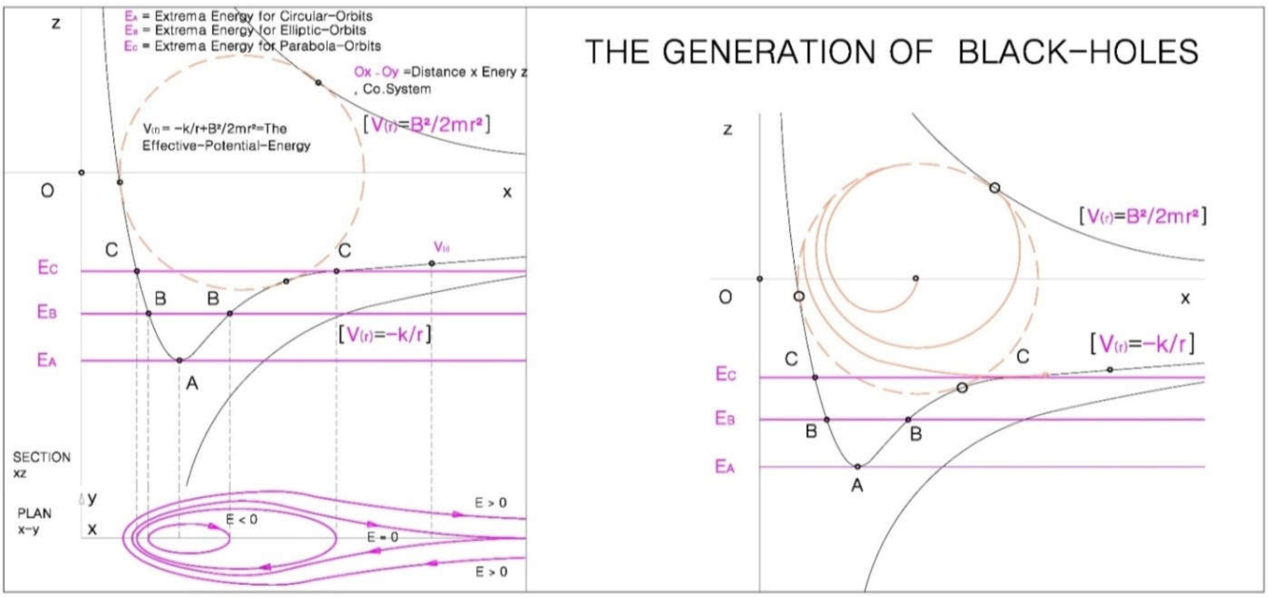


Figure 17: The Energy in Orbits and the *conditions for a Black-hole*[$\bar{\mathbf{v}}=\mathbf{n\pi\bar{c}}=\lambda\ .\mathbf{n\pi}$f]

1. In (1) is the Graph of *Effective-Potential-energy-Orbits* in a Central-motion becoming from Kepler constant

$$k = 4\pi^2.r^3.\mathbf{f_P}^2,\ \text{or}\ 1 = [\frac{4\pi^2}{k}]r^3.\mathbf{f_P}^2 \rightarrow 1 = c.\ r^3.\mathbf{f_P}^2, \ldots\ldots(4a)$$

where for r → 0 then $\mathbf{f}_{\ \mathbf{P}} \rightarrow \infty$

2. Because of the *Golden-ratio-frequency relation*$\mathbf{f}_{\ \mathbf{n}} = [\frac{(1+\sqrt{5})}{2}]\ \frac{\mathbf{n.\sigma}}{2\pi r}$, and from $\bar{\mathbf{v}} = \mathbf{n\pi\bar{c}} = \lambda.\mathbf{n\pi}$f, v = $\lambda.\mathbf{n\pi}.[\frac{(1+\sqrt{5})}{2}]\ \frac{\mathbf{n.\sigma}}{2\pi r} = \frac{\lambda.\mathbf{n}^2.\sigma}{2r}$ = n².σ, predicts the *Ubiquity of the Golden-ratio* in Nature from the microcosm to the macrocosm , *the macro scale*, and the when velocity $\bar{\mathbf{v}}$can enter a cave r.

Instead of it momentum B*, rotates into the Angular – Velocity–cone,* i.e. From equalities, acceleration g = $\frac{2\pi v}{T}$ and velocity v =$\frac{2\pi r}{T}$ then g =$\frac{4\pi^2.r}{T^2}$, Period T =$2\pi\sqrt{\frac{r}{g}}$or *frequency*$\mathbf{f_1} = \sqrt{\frac{g}{4\pi^2 r}}$……(4b)

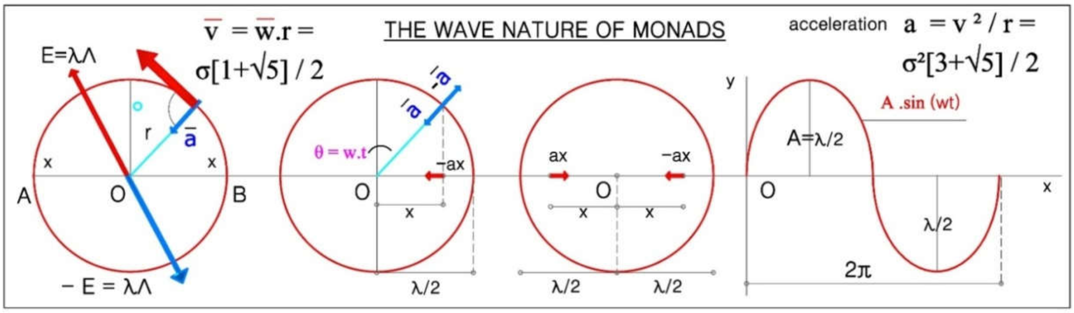
or from acceleration on orbits a = $\frac{2\pi v}{T} = \frac{v}{r}\ v = \frac{v^2}{r}$ and from force P = m $\frac{d\bar{v}}{dt} = \frac{d(m\bar{v})}{dt}$ = m.$\bar{\mathbf{a}}$….Fig-3.(2)

From C $r^3.\mathbf{f^2}_{\mathbf{P}}$ = 1, when cave, r, tends to zero, 0, then frequency $\mathbf{f_1}$is tending to infinite ∞ where then constant C = $\frac{4\pi^2}{GM_S}$= 5,9188.$\mathbf{10^{11}}$ Kg²/Nm²$\mathbf{M_S}$. Photon exists as an Angular-Momentum body $\mathbf{B_P}$rotating in Angular-velocity-coneas a Stationary wave

$$[\mathbf{B_P} \equiv \mathbf{f_{1=N}},\ \mathbf{f_2},\ \mathbf{f_3}\ ,\mathbf{f_{\ R}}] \equiv [E^2+H^2] = 2(2r).c.\mathbf{sin\ 2\varphi} \ldots\ldots(4c)$$

From (4a),(4b)and $\mathbf{f_1}$ when cave, r, tends to zero ,0, then frequency $\mathbf{f_1}$, is tending to infinite ∞, while from (4c), when $\mathbf{f_1}$ tends to ∞ then, r tends to zero, i.e. both are the cases of an Planar and an Atom-Black-hole. The How and When a Black-hole is formulated, in [73].

VII. The Electromagnetic - Fields E, P of Monads



(1) (2) (3) (4)

Figure 18: The Wave nature of the*Material-Point-Monad* AB

a) *The Wave nature of Monad* $\overline{\boldsymbol{AB}}$

In (1), are shown *Velocity* , $|\bar{\mathbf{v}}| = w.2r = \frac{2\pi}{T}.r = 4\pi r.\ f = [\frac{\sigma}{2}].(1+\sqrt{5})$,*Angular velocity* $|\bar{\mathbf{w}}| = \frac{\sigma}{2r}[\ 1+\sqrt{5}]$ And the *Golden-ratio-Frequency* f $= \frac{(1+\sqrt{5}\,]).\sigma}{4\pi r}$in cave, r.

In (2), are shown Centripetal, $\bar{\mathbf{a}} = v^2/r$, and Centrifugal, $-\bar{\mathbf{a}} = v^2/r$, acceleration in cave, r.

In (3), are shown the *Projections* on AB axis of Centripetal, $\bar{\mathbf{a}}_x$, and Centrifugal, $-\bar{\mathbf{a}}_x$acceleration in cave, 2r = λ. Note that Waves transfer Energy but not mass.

In (4) , is shown the *Sinusoidal - motion* of the Centripetal ,$\bar{\mathbf{a}}_x$, and Centrifugal,$-\bar{\mathbf{a}}_x$,acceleration in cave , r = λ/2 . Following Analysis in [33] then, Monad $|\overline{\mathbf{AB}}|$ = r = λ/2 is the ENTITY ≡ Space, and [A , B $-\bar{\mathbf{P}}_A$, $\bar{\mathbf{P}}_B$] is the CONTENT ≡the Energy which is the LAW, so Entities are embodied with the Laws. Entity is quaternion ∇i=[s $+\bar{\mathbf{v}}$∇i] with *Real* part |AB| =The length r = s = λ/2 between points A,B and *Imaginary* part the equal and opposite forces $\bar{\mathbf{P}}_A$, $\bar{\mathbf{P}}_B$such that$\bar{\mathbf{P}}_A + \bar{\mathbf{P}}_B$ = 0, and In Primary-Neutral Space [PNS] the Dipole $|\bar{\mathbf{A}}\circlearrowright\circlearrowleft\bar{\mathbf{B}}|$ = [λ , Λ] in [PNS] are composed of the two elements λ, Λ which are created from points A , B only , where *Real* part |AB| = λ /2 = wavelength (*dipoles*) and from the embodied Work $\bar{\mathbf{B}}\bar{\mathbf{w}}$= 2L , *where the Imaginary part*$\bar{\mathbf{B}}$= (r.dP) = $\bar{\mathbf{r}}$x$\bar{\mathbf{p}}$= I.w = [λ.p] = λ.Λ= $\bar{\mathbf{B}} = \frac{\mathbf{h}}{2\pi}$, the momentum Λ=$\bar{\mathbf{B}}$and the Forces dP =$\bar{\mathbf{P}}_B$ - $\bar{\mathbf{P}}_A$ are the stationary sources (*the excitation sources*) of the Space -Energy field . [22-23-25].

The moving charges is velocity, $\bar{\mathbf{v}}$, *created from the eternally rotated main stresses*, ± σ, forming the *dipole momentum vector,* ±$\bar{\mathbf{\Lambda}}$, *when is mapped on the perpendicular to* Λ*plane as* → $\bar{\mathbf{v}}$E || dP and $\bar{\mathbf{v}}$B⊥ dP). Since (dP ⊥ ± $\bar{\mathbf{\Lambda}}$) the work occurring from momentum $\bar{\mathbf{p}}$ is $\bar{\mathbf{p}}$ = m$\bar{\mathbf{v}}$= Λ acting on force dP , d$\bar{\mathbf{P}}$is zero, so *momentum* $\bar{\mathbf{\Lambda}}$= m$\bar{\mathbf{v}}$*only is exerting the velocity vector*$\bar{\mathbf{v}}$*, onto the dipole,* λ /2, with the generalized mass m (*the reaction to the change of velocity* $\bar{v}$) which creates the component forces, $\mathbf{F_E}$ || dP.$\bar{\mathbf{v}}$and $\mathbf{F_B}$⊥ dPx$\bar{\mathbf{v}}$. Magnitude |A|=r.$\mathbf{\sin\theta}$

Dipole momentum {Ω = (λ. Λ) = Spin} is the rotating total Energy on dipole $\overline{\mathbf{AB}}$ and mapped on the perpendicular toΛplane as*, velocity* $\bar{\mathbf{v}}$*, mass* m*, on radius,* r , to AB/2 = λ/2.

From (1) velocity $\bar{\mathbf{v}}$ is created from the Centrifugal force $\mathbf{F_f}$= - σ and from the equal and opposite to it Centripetal force $\mathbf{F_p}$= + σ with acceleration $\bar{\mathbf{a}}$, and the *meter* of x, component equal to a sinθ = a.(x/A) = (a/A).x . The equation of motion then becomes m.(d²x/dt²) = - (a/A). x with the general solution, x = $\mathbf{C_1}$ sinθ + $\mathbf{C_2}$ cosθ = $\mathbf{C_1}$ sin.wt + $\mathbf{C_2}$ cos.wt, *where* w² = (a/Am), $\mathbf{C_1}$, $\mathbf{C_2}$, constant and for θ = 0 then v = $\mathbf{v_o}$= w.r = w. λ / 2 = (wλ) / 2 and $\mathbf{x_o}$= A = λ/2, where A =The amplitude of oscillation, and when x = 0 then A = λ / 2 = r.

Above equations define the wave nature of Inner motion of monad AB.

The period of the Harmonic vibration is T = 2π$\sqrt{\mathbf{A/a}}$, and Displacement x, from the centre is

$$x = A.\mathbf{sin}[\sqrt{\left(\tfrac{\mathbf{A}}{\mathbf{a}}\right)}.\mathbf{t}] = A.\mathbf{sin}[\sqrt{\left(\tfrac{\mathbf{A}}{\boldsymbol{\sigma}}\right)}.\mathbf{t}] = A.\mathbf{sin(w\,t)}\ldots\ldots(1)$$

i.e. The Harmonic-Vibration is *Sinusoidal – motion with* w² $= \left(\frac{\mathbf{A}}{\boldsymbol{\sigma}}\right)$, where for material point acceleration a ≡ σ ≡ Principal-stress.

Considering motion from time t = 0 where motion passes through O, (x = 0) with velocity $\mathbf{v_o}$// Ox, *then Displacement*

$$x = \mathbf{v_o}.\mathbf{sin\,wt} = A\,.\sin[\sqrt{\mathbf{(a/Am).t}}+\pi/2] = A\,.\sin[\sqrt{(\boldsymbol{\sigma}\mathbf{/Am}).\mathbf{t}}+\pi/2]\ \textit{Velocity}\ \dot{\mathbf{x}} = dx/dt = \mathbf{v_o}.w.\ \mathbf{\sin wt + \pi/2} =$$

$$A.\sqrt{\mathbf{(a/Am)}}\,.\ \sin\,[\sqrt{\mathbf{(a/Am).t}}+\pi/2]\ \ldots\ldots\ (2)$$

Acceleration $\ddot{\mathbf{x}}$= d²x/dt² = -$\mathbf{v_o}$.w². $\mathbf{\sin wt + \pi}$ = (a/m). sin [$\sqrt{(\mathbf{a/Am}).\mathbf{t}}$+ π] = - (a/Am). x= - (2a/λm). x, or $\ddot{\mathbf{x}}$=-(2a/λm). x i.e. The amplitude of oscillation ($\mathbf{x}_{\mathbf{maximum}}$) is equal to the constant $\mathbf{v_o}$/ w while the period T of a complete oscillation to the constant 2π /w as,

w = 2π /T = 2π f = √(a/Am) where f = frequency and solving for, a, then acceleration a is

$$a = \sigma = (2\pi / T)^2. (Am) = w^2.(Am) = w^2.(\lambda m) / 2 , \quad \ldots\ldots (3)$$

And for the material point where, $m = \frac{\mathbf{2E}}{\boldsymbol{a_a}} = [\frac{\bar{\mathbf{B}}.\bar{\mathbf{w}}}{\bar{\mathbf{B}}\mathbf{x}\bar{\mathbf{w}}}]$.J then , $a = \sigma = w^2. [\frac{\bar{\mathbf{B}}.\bar{\mathbf{w}}}{\bar{\mathbf{B}}\mathbf{x}\bar{\mathbf{w}}}].\frac{\boldsymbol{\pi}\mathbf{r4}}{\mathbf{2}}$ ……………………..... (4)

i.e. Monads $|\overline{\mathbf{AB}}|$*are Waves* or *of Wave nature, with angular-velocity* w = $\sqrt{\left(\frac{\mathbf{A}}{\mathbf{a}}\right)} = \sqrt{\left(\frac{\mathbf{r}}{\mathbf{a}}\right)} = \sqrt{\left(\frac{\mathbf{r}}{\mathbf{g}}\right)} = \sqrt{\left(\frac{\mathbf{r}}{\boldsymbol{\sigma}}\right)}$

b) *Analysis of the Wave - System in monads*

Free vibration on monads AB = $\bar{\mathbf{q}}$ = [s+$\bar{\mathbf{v}}\nabla$i] oscillating under the action (thrust) inherent in itself, subject to *damping* because energy is dissipated by the *stiffness*, k, of monad and *constant of proportionality*, c, regarding motion of *mass*, m, when placed into motion, oscillation will take place at the natural frequency, $\mathbf{f_n}$, which is the property of monads tobe the only possible motion in caves.

The homogenous differential equation of motion is

$$m\ddot{\mathbf{x}}+c\dot{\mathbf{x}}+kx = 0 \quad \ldots\ldots (1)$$

corresponds physically to the free damped vibration, where is x = the displacement, $\dot{\mathbf{x}}$ = velocity of monad with general solution given by the equation → x = A . $\boldsymbol{e}^{\boldsymbol{s1.t}}$+ B.$\boldsymbol{e}^{\boldsymbol{s2.t}}$, where,

$$s1,2 = - [c/2m] \pm \sqrt{\left[\frac{c}{2m}\right]^2 - \left(\frac{k}{m}\right)} \text{ and } S = \sqrt{\left(\frac{k}{m}\right) - \left[\frac{c}{2m}\right]^2},$$

and for initial conditions x(0), $\dot{\mathbf{x}}$(0)→A, B then displacement x= $\mathbf{e}^{-\mathbf{i}.(\mathbf{c}/\mathbf{2m})\mathbf{t}}$.[A.$\boldsymbol{e}^{\boldsymbol{S}.\boldsymbol{t}}$+B.$\boldsymbol{e}^{-\boldsymbol{S}.\boldsymbol{t}}$] and oscillatory,

$$x = \boldsymbol{e}^{\pm i\sqrt{(\frac{k}{m} - [\frac{c}{2m}]^2)}\boldsymbol{t}} = \cos\sqrt{\left[\frac{c}{2m}\right]^2 - \left(\frac{k}{m}\right)} \pm i.\sin\sqrt{\left[\frac{c}{2m}\right]^2 - \left(\frac{k}{m}\right)} \quad \ldots\ldots (2)$$

where ,

For $[\frac{c}{2m}]^2 > [\frac{k}{m}]$ no oscillations are possible, *over-damped,*

For $[\frac{c}{2m}]^2 < [\frac{k}{m}]$ exponent becomes an imaginary number and terms are oscillatory, *under-damped,* and this because ↻For $[\frac{c}{2m}]^2 = [\frac{k}{m}]$ then oscillatory , non-oscillatory and radicalmotion is zero, *critical dumping*$\mathbf{C_c}$ = 2m√$[\frac{\mathbf{k}}{\mathbf{m}}]$ = 2m$\mathbf{w_n}$ = 2√km.

Equalization of mass m from pairs $\mathbf{C_c}$ = 2√km$\mathbf{C_c}^2$ = 4km, then m = $\boldsymbol{C_c}^2$/ 4k and from 2m√$[\frac{\boldsymbol{k}}{\boldsymbol{m}}]$ = 2m$\boldsymbol{w_n}$ → k = mw² andm = k/w² = $\mathbf{C_c}^2$/ 4k , or → 2k = $\mathbf{w.C_c}$=2π.$\mathbf{f.C_c}$, k = π.$\mathbf{f.C_c}$ a relation between linear stiffness , circular frequency and the transverse damping coefficient , *the critical mass* . Any damping can then be expressed in terms of the criticaldamping by the non-dimensional number

ζ = C/$\boldsymbol{C_c}$ and S in terms ofζ , $[\frac{\boldsymbol{C}}{\mathbf{2m}}]$ = ζ $[\frac{\boldsymbol{Cc}}{\boldsymbol{2m}}]$ = ζ$\boldsymbol{w_n}$,is S = [-ζ± √(ζ²-1)].$\boldsymbol{w_n}$ and differential equation of motion becomes $\ddot{\mathbf{x}}$+2ζ$\boldsymbol{w_n}\dot{\mathbf{x}}$+$\boldsymbol{w_n}^2$x = 0 ..(1a)and the general solution is given by the three equations

1. For ζ< 1 is the Oscillatory motion, *Under-damped case.*

$$x = \boldsymbol{e}^{-\zeta.wn.t}. [A.\boldsymbol{e}^{i\sqrt{(1-\zeta^2)}.wn.t} + B.\boldsymbol{e}^{-i\sqrt{(1-\zeta^2)}.wn.t} =$$

$$\boldsymbol{e}^{-\zeta.wn.t}.\{[(\dot{\mathbf{x}}(0)+\zeta.\boldsymbol{w_n}.x(0)).\sin\sqrt{(1-\zeta^2)}.\boldsymbol{w_n}.t] / [\boldsymbol{w_n}.\sqrt{(1-\zeta^2)}]\} + x(0).\cos\sqrt{(1-\zeta^2)}.\boldsymbol{w_n}.t \}\} \quad \ldots\ldots (3a)$$

which indicates that the frequency of the damped oscillation is equal to $\mathbf{w_d} = \frac{\mathbf{2\pi}}{\boldsymbol{\tau}\mathbf{d}} = \boldsymbol{w_n}.\sqrt{(1-\zeta^2)}$

The study of vibration is concerned with the oscillatory motion of monads and the forces associated with them. Since all monads are processing mass and elasticity are capable of vibration. Monads or structures experience vibration to some degree, so require consideration of their oscillatory behavior. The Principle of superposition holds for linear oscillatory Critical damping for all Primary particles in contrast to Compound tending to become nonlinear with increasing amplitude of oscillation.

2. For $\zeta > 1$ is the Non-oscillatory motion, *Over-damped case* with the two roots increasing and decreasing with general solution,

$$x = A.e^{[-\zeta+\sqrt{\zeta^2-1}].w_n.t} + B.e^{[-\zeta-\sqrt{\zeta^2-1}].w_n.t} \text{ where}$$

$$A = \{\dot{x}(0) + [\zeta+\sqrt{(\zeta^2-1)}].w_n.x(0)\}/ [2w_n.\sqrt{(\zeta^2-1)}]$$

$$B = \{-\dot{x}(0) - [\zeta-\sqrt{(\zeta^2-1)}].w_n.x(0)\}/ [2w_n.\sqrt{(\zeta^2-1)}] \quad \text{.............................. (3b)}$$

3. For $\zeta=1$ is the Internally Isochronal oscillatory motion, *The critical damped motion case* and the displacement, x, is as $\rightarrow$ $x = e^{-wn.t}.[A + B.t] = e^{-wn.t}.\{x(0) + [\dot{x}(0) + x(0).w_n].t\}$

i.e. a double root $S1 = S2 = -w_n$ which is according to the Newton`s second law, the deformation of the real part, |s|, which isk.|s| = - w = - mg, and frequency $f_n = (1/2\pi).\sqrt{g}/ |s| = 2\pi\sqrt{m/k}$ depending on the mass and stiffness of monad ,being its properties. The three types of Response with initial displacement
x(0) are dependent on velocity $\dot{x}(0)$ factor as ,$\dot{x}(0) > 0 \rightarrow$ for cycloidal motion in caves,
$\dot{x}(0) < 0 \rightarrow$ for cycloidal motion in caves,
$\dot{x}(0) = 0 \rightarrow$ for energy-tanks,

This critical damping occurs on monads , which is their inner motion. *The Natural-Frequency* is then *the Golden-ratio-frequency* $f_n = \frac{n.v}{4r} = \frac{n\sigma}{8r}[1+\sqrt{5}] = \frac{1}{2}[1+\sqrt{5}]\frac{n\sigma}{4r}$

For $\zeta = 0$ differential equation reduces to s1, 2 /$w_n = \pm i$, and the roots on the imaginary axis correspond to un-damped case.

Complex Numbers, Quaternion and Resonance:

Rotation of [⊕] constituent around [⊖] constituent in Material point is equivalent to a force $T = F_0$ Eternally and Sinusoidal acting on String [Figure - 5] , and is according to the differential equation,

$$m\ddot{x} + c\,\dot{x} + kx = F_0.\sin wt \quad \text{.. (1)}$$

where,
m = The mass of the [⊕] constituent related to acceleration,
c = A constant related to its velocity $\dot{x}$,
k = A constant related to its displacement, x,
w = The circular velocity of the [⊕] constituent related to the tension $T = \pm\sigma$
t = The time of rotation.
$w_n = \sqrt{k/m}$ = the natural frequency of undamped oscillation
$c_c = 2mw_n$ = critical damping
$\zeta = c / c_c$ = damping factor.

The Vector - Force - Polygon of equation (1) is consisted of force in different orientations, and if the force had been $\rightarrow$ $F_0.\cos wt$, instead of, $F_0.\sin wt$, the Vector- Force - Polygon would be unchanged and the terms of the equation then would have been the *Projections of the Vectors on the horizontal axis*.
Taking note of this , then could let the Harmonic - Force be represented by the equation,

$$F_0.(\cos wt + i.\sin wt) = F_0.e^{iwT} \text{..(2)}$$

This would be equivalent to multiplying the quantities along the vertical axis by $i = \sqrt{-1}$, and using complex vectors. The displacement can then be written as,

$$X = X.e^{i(wt-\varphi)} = [X.e^{-\varphi}] . e^{iwT} = \bar{X}.\, e^{iwT} \quad \text{.................................(3)}$$

where,

$\bar{X}$, is a complex displacement - vector equal to [$X.e^{-\varphi}$], and by substituting into the differential equation and cancelling from each side of the equation, then results to (- w² m + k w + k) $\bar{X} = F_0$ and

$$\bar{X} = \frac{F_0}{(k- w^2 m)+ i.(c\,w)} = \frac{F_0/k}{\left(1-(\frac{w}{w_n})^2 + i.[2\zeta\frac{w}{w_n}]\right)} \text{...(3a),}$$

and by introducing the complex
frequency response H(w) defined as the output divided by the input then becomes

$$H(w) = \frac{\bar{X}}{F_0} = \frac{1/k}{1-(\frac{w}{w_n})^2 + i.(2\zeta\frac{w}{w_n})} = \frac{1-[\frac{w}{w_n}]^2}{[1-(\frac{w}{w_n})^2]^2+[2\zeta\frac{w}{w_n}]^2} - i\,.\,\frac{2\zeta\frac{w}{w_n}}{[1-(\frac{w}{w_n})^2]^2+(2\zeta\frac{w}{w_n})^2} \quad \text{.................(4)}$$

Equation (4) shows that *at Resonance the Real - Part is Zero*, *and the Response is given by the*

Imaginary - Part which is → $H(w) = -i\,.\frac{1}{2\zeta}$, and *the Phase angle* is → $\tan\varphi = \frac{2\zeta\frac{w}{w_n}}{1-(\frac{w}{w_n})^2}$..............................(4a)

The general solution of equation (1) consists of two parts, *the complementary function*,
which is the solution of the *homogenous equation*, and the particular Integral, as

$$x = A.\sin(wt-\varphi) + e^{-\frac{c}{2m}t}\,[\,C_1\sin\theta t + C_2\cos\theta t] \qquad \text{where,}$$

$$\theta = (\sqrt{4mk-c^2})/m\ ,\tan\varphi = \frac{c\,w}{k-mw^2}\ ,\ A = \frac{F_0\cos\varphi}{k-mw^2} = \frac{F_0}{\sqrt{k^2+(c^2-2mk)w^2+m^2w4}} \equiv \frac{F_0}{(k-mw^2)\cos\varphi + cw\sin\varphi} \quad \text{......................(5)}$$

When the System is subjected to Harmonic excitation, it is forced to vibrate at the same natural

Frequencies as that of the excitation and then, *a condition of Resonance* is encountered and (5) is $x = A.\sin(wt-\varphi)$ i.e. an Harmonic vibration with the same Period $T = 2\pi/w$, but with time hysteresis $T_H = \frac{\varphi}{w}$, or a difference in Phase, angle φ.

For, c, very small then then angle φ is small near zero, and for $w = \sqrt{k/m}$ or, $k = mw^2 = 0$ then $\tan\varphi = \infty$ and $\varphi = 90\,^{\circ}$, and Force → $F_0.\sin wt$is vibrated with Period $T_R = 2\pi\sqrt{\frac{m}{k}}$, and amplitude $A = F_0 / c\,w$, tends to zero for infinite $c = \infty$.

i.e. *In Material – point, Complex - Frequency - Response,* H(w)*, which is an Energy-monad, is composed of the Real – part which represents the Granularity of Energy as Particle, and the Imaginary – part which represents,* at Response, *the Wave Energy - Pattern.*

The rotating axis, l = 2r = KK_1 *in Material–point, creates the* Linear vibration of string*, l , which is in String* K≡ [⊖] ↔ K_1≡ [⊕] *, and the Natural - frequency,* $f_n = \frac{(1+\sqrt{5}\,]).\sigma}{4\pi l}$ *in points* K, K_1 *or, the* Rotational vibration Plan Energy *which is, The Spin as* [K ≡ ⊖ s² ↻ ↺ K_1≡ ⨁s²] ≡ $\bar{B}$ **.**

Above relation of this Plane Work, is the Quantization in Geometry-Shapes, and becomes into the Plane – Stores of Anti-Space and, consists the Unification of Geometry – monads with those of the Energy monads, which Energy-monads is the Work in caves stored as Angular momentum $\bar{B}$*, and Angular velocity Ellipsoids* $\bar{w}$*. When* a *Frequency of Excitation coincides* with one of the *Natural - frequencies* of Material-Point then it is a condition of *Resonance* and encountered as above.

It was proved that Units = Monads, and they have their place in Spaces.

From the Second-order differential equation excited by a Harmonic external force , F_t sin wt, and is as,

$$m\frac{d^2x}{dt^2} + c\frac{dx}{dt} + k\,.\,x = F_t\sin wt$$

corresponds Physically to the free damped vibration , where x = the displacement , dx / dt = the velocity and d²x / dt² = the acceleration of monad, m, c, k constants, with the general solution given by the equation

$$x = A.e^{s1.t} + B.e^{s2.t} + X\sin(wt\text{-}\varphi) \quad \text{..(1)}$$

In Electromagnetism, *Change*, say a Space-monad is → *a Resonance which can occur in the RLC circuit*, where *Resistance* R, is the change in current amount *it is the converter of current*, *Inductance* L , is like mass or Inertia in Mechanical systems which store the Magnetic–energy and, *Capacitance* C, concentrates (±) charge which store the Electric–energy in much the same way that springs store mechanical energy *inverse spring constant*, is the analogous n Mechanics.

The differential equation excited by a Harmonic Electromotive force,E_t. **sin wt**, in an RLC circuit, oscillating at its natural frequency is as,

$$\text{Equation} \rightarrow\ L\frac{d^2q}{dt^2} + R\frac{dq}{dt} + \frac{1}{C}q = E_t\sin wt\ .$$

Corresponds physically to the free damped vibration, where Charge q = is the physical property of matter that causes it to experience a force which can be positive or negative, dq / dt = the least quantized amount of charge and d^2q / dt^2 = the space distribution of charge, and L, R, C Inductance, Resistance, Elasticity constants with general solution given by the equation

$$q = A.\boldsymbol{e}^{s1.t} + B.\boldsymbol{e}^{s2.t} + X \sin(wt\text{-}\varphi) \quad \ldots\ldots(2)$$

Equations (1) and (2) give the analogic relation of the *Classical mechanics* [Space position, x,] and the *Electromagnetism* [Quanta of energy ,q,] of *Storing and Removing of energy in Energy-Space* cosmos.

The distributed force is as $\mathbf{L_1}\text{-}\mathbf{L_2}$ = L (di/dt), $\mathbf{R_1}\text{-}\mathbf{R_2}$ = R . i, $\mathbf{C_1}\text{-}\mathbf{C_2}$ = q / C, respectively, showing the Identification of the Mechanical and Physical laws.

The way that *Potential-Energy is stored*, is that of Material-LRC-Circuit, which is for the Gravitational-Potential-Energy the *Material-Capacitor* or the →*Focus-Planet–Sector-Stores-change* ← which develop a voltage in response to that charge. The coil of wire is the infinite Stationary-Dipole-Spinning Material-Points of this → *Focus-Planet-Sector* ← which develops the back-emf, when the current through them changes.

Conservation of Energy in an, *Free-vibration Un-damped System,* Energy is partly kinetic T (*stored in the mass by virtue of its velocity and for mass-less in wavelength -velocity –vector* λ) and partly potential U, (*stored in the form of Strain-energy in Elastic Deformation of work done in a force field*),and is Quantized as the motion in λ, in n, lobes as frequencies

$$\mathbf{f_1} = \frac{(\mathbf{1}+\sqrt{\mathbf{5}}\,]\,).\boldsymbol{\sigma}}{\mathbf{4\pi r}} = \frac{\mathbf{E}}{\mathbf{h}} = \frac{\mathbf{W}}{\mathbf{h}},$$

Total Energy {*in*, λ, *massless* n *loops*}→ W = $[\frac{\mathbf{4\pi r^2 f1}}{\mathbf{3}}]$ .n.(n+1) where n = 1,2,3,4 .. n ... ∞

The principle of virtual work states that, in an equilibrium system under the action of a set of forces is given a virtual displacement, the virtual work done by the forces will be zero.

Coulomb damping results from the sliding of two dry surfaces where dumping force is equal to the product of the normal force and the coefficient of friction, μ, independent and opposite of the velocity valuing only for half-cycle intervals. Viscous damping force $\mathbf{F_d}$ determines an decay of amplitude $X_2\text{-}X_1$ = 4.$\mathbf{F_d}$/ k and the frequency of oscillation $\mathbf{w_n} = \sqrt{}$ k/m equal to that of the Un-damped system, and in case of two masses with stiffness k1, k2 then k = k1+k2.

From above implies that, *Vibration on a system taking place under the excitation of External-forces*, which *excitation is Oscillatory*, then the System is *Forced to vibrate at the excitation frequency*.

If the frequency of excitation coincides with one of *the Natural-frequencies* $\mathbf{f_{N=1}}$*of the System* S, then exists a condition of *Resonance*, i.e. Oscillatory-Excitation → $\mathbf{f_R}$ [S ≡ $\mathbf{f_{1=N}}$, $\mathbf{f_2}$, $\mathbf{f_3}$,$\mathbf{f_R}$] ← and $\mathbf{f_R} \equiv \mathbf{f_N}$.

For the Un-damped free-vibration, the System S, will vibrate at the Natural-frequency. However, in the N-DOF, the System not only vibrates at a certain natural-frequency but also with a certain natural-displacement –configuration. Moreover, there are as many Natural-frequencies and associated natural configurations as the number of DOF of the system, the natural modes of vibrations.

The equations of motion for the *Un-damped* N-DOF *System* is written as M.$\ddot{\mathbf{x}}$ (t) + K$\mathbf{x_{(t)}}$= 0 for initial conditions x(0) = $\mathbf{x_o}$ and$\dot{\mathbf{x}}$(0) =$\dot{\mathbf{x}}\mathbf{o}$, where x(t) is the Displacement-Vector, M is the Inertia-matrix , and K is the Stiffness-matrix and the general solution is of Eigenvalue-equation

$$[-w^2M + K]\ u.\mathbf{e}^{\mathbf{iwt}} = 0 \quad \ldots\ldots(m)$$

where u , is the constant scalar displacement-vector and w = 2πf, the frequency of the system.

The solution of the above equation determines the *Real or Complex numbers*, $\boldsymbol{\lambda_1}$, $\boldsymbol{\lambda_2}$, … $\boldsymbol{\lambda_n} = \mathbf{w}^2$, called *Eigenvalues*, which satisfy the *Characteristic equation* det K=[A-λI] x = [A-w²I] x = 0 where x, is the eigenvector associated with the eigenvalues λ = w² , and the corresponding Non-zero vectors.

Equation (m) when applied *in Material-point* where stiffness K = 0 then w²M ≠ 0 , is the complex mass equal to m = w²J = w².($\pi\mathbf{r^4}$/2) =(w²/2).π r²$\mathbf{v^2}$/w² = (π r²/2) $\mathbf{v^2}$ of the Vibrating cave r.

Remarks

1. In any material System S, *with any N-Net-Configuration* , in all levels is formed a Stationary equation containing the *M Inertial-matrix of Configuration*, and the *K Stiffness-matrix*.
2. The Characteristic matrix K = [A – λ I] and its Characteristic Determinant, det K = 0 produces a Characteristic polynomial with powers of, λup to $\boldsymbol{\lambda}^{\mathbf{n}}$, and therefore when it set equal to zero has , n , roots called eigenvalues, and factorized in the form (λ - $\boldsymbol{\lambda_1}$).(λ-$\boldsymbol{\lambda_2}$) … (λ-$\boldsymbol{\lambda_n}$) = 0 and for λ = 0 then → detA = $\boldsymbol{\lambda_1}$. $\boldsymbol{\lambda_2}$ … $\boldsymbol{\lambda_n}$= 0
3. The Operator associated with Energy is Euler`s or Lagrangian and the Operator on the Wave-function is Laplace or Lagrangian equation.

4. In case of an Energy-Rim issues the *Stability of Equilibrium*, $\frac{dy}{dx} = \frac{dv}{du}$, where x,y ≡ Space and u,v ≡ Energy ≡ motion and for very small velocities u, v then Characteristic matrix K = [A – λ I] and its Characteristic Determinant, det K = 0, which produces equations $u = \mathbf{u_1}.e^{\lambda 1.t} + \mathbf{u_2}.e^{\lambda 1.t}$, $v = \mathbf{v_1}.e^{\lambda 1.t} + \mathbf{v_2}.e^{\lambda 1.t}$ dependent on the one eigenvalue only , i.e.

In Energy-Rims motion is either Oscillatory or Aperiodic, for Stable –Systems. This happens in Atom and Orbit-Rims, in microcosm and macrocosm.

5. Since Material Point is quaternion composed of*the In-Box*, the Storage $\mathbf{B_P}$=ras[r ≡ cT≡ EM-R≡ $\mathbf{f_{1=N}}, \mathbf{f_2}, \mathbf{f_3}, \mathbf{f_D}, , \mathbf{f_n}$], *the Outer-Box*, as the Electromagnetic Radiation which is the Conveyer of energy-cave r, with the minimum Resonance-Golden-ratio-frequency $\mathbf{f_R} = \mathbf{f_1}$, when collides with another Material Point, *or with another Particle or particles*, then Produces another monad which is a New quaternion and the first continuous to be of the same Identity, *frequency* $\mathbf{f_n}$, as before i.e. Resonance occurs between the fundamental frequencies of the colliders and *is adjusted in Photon*.

The Frequency of Photon, embodied with the Golden-ratio-pattern Φ, Uses the Vibrating Physical Structures, *the Granular Material-Instruments*, *to Kick - Start current* through Storage $\mathbf{B_P}$.

Systems with N-DOF, Degrees of Freedom:

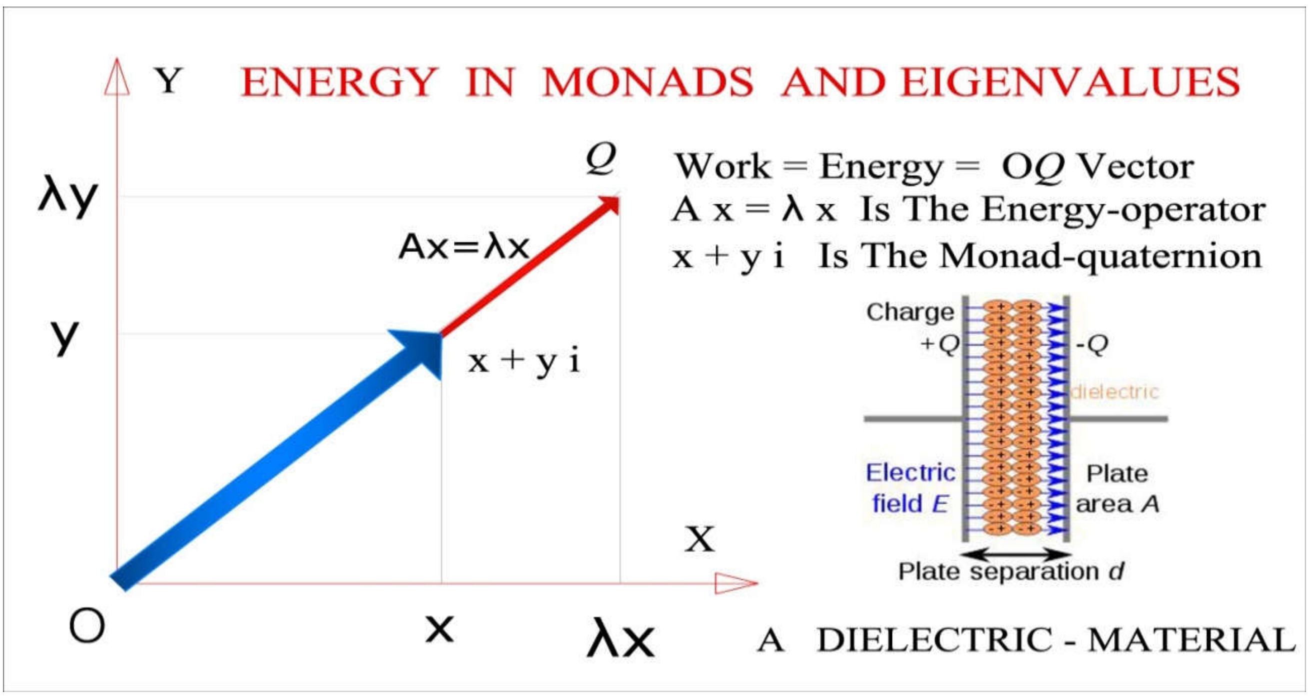


Figure 19: The Eigen values λ, in Energy monads

a. Monad is Quaternion [x + iy] and Energy the Vector $\mathbf{O\vec{Q}}$ = {Λ}.X
b. Energy is the Work produced in monads and equal to W =2L = $\bar{\mathbf{B}}.\bar{\mathbf{w}}$= J . w²
c. The Configuration of a Stationary-System is expressed by the matrices M.$\ddot{\mathbf{x}}$ (t) + K$\mathbf{x_{(t)}}$= 0
d. The Characteristic matrix K = [A – λ I] gives the, n , roots such that det. A = $\boldsymbol{\lambda_1}.\boldsymbol{\lambda_2}\,..\boldsymbol{\lambda_n}$= 0
e. Energy in Store 2λ= r = h/p ≡[$\mathbf{f_1}, \mathbf{f_2}, \mathbf{f_n}$≡ n lobes] follows the *Stationary-Wave-Nodes-Principle*.
f. Dielectric-medium is an Electric-Insulator that is Polarized by an , *applied or internal*, Electric-field.
g. Matrix A acts by stretching the vector X , *not changing its direction* , so X is an eigenvector of A.

Reorientation of Spin creates a New Nutation-Period $\mathbf{f_N}$ = n$\frac{(1+\sqrt{5})\sigma}{4\pi r}$=$\frac{n.\bar{B}}{4\pi r^2}$ and New wavelength $\boldsymbol{\lambda_N}$=$\frac{2\,r}{n}$

The Energy-method overcame the difficulties of the Vector-method , but in terms of physical-coordinates is limited to single-DOF Systems. The Virtual-work-method is a powerful tool for Systems of higher DOF, however it is not entirely a scalar procedure in that vector consideration of forces necessary in the determining the Virtual-work.

Lagrange`s formulation is an entirely Scalar procedure starting from the scalar quantities of the Kinetic energy T = T($\boldsymbol{q_1}, \boldsymbol{q_2}, \boldsymbol{q_N}$ ..$\dot{\mathbf{q}}_1$, $\dot{\mathbf{q}}_2$, $\dot{\mathbf{q}}_3$, Potential energy U($\boldsymbol{q_1}, \boldsymbol{q_2}, \boldsymbol{q_N}$) , and *Work expressed in terms of Generalized-coordinates* as Lagrange- equation,

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$$\frac{d}{dt}\left(\frac{\partial T}{\partial \dot{q}_i}\right) - \frac{\partial T}{\partial q_i} + \frac{\partial U}{\partial q_i} = \mathbf{Q_i} \quad \text{...(1)}$$

The left side of (1)

when summed for all the q_i, is a statement of the Principle of conservation of energy and is equivalent to d(T+U) = 0 . The right side of (1) results from dividing the work term in the dynamical relationship dT = dW into the work done by the potential and non-potential forces as is → dT = d$\mathbf{W_P}$ + d$\mathbf{W_{nP}}$ ← and thus Lagrange`s equation (1) is the q_i component of the energy equation d(T+U) = $\mathbf{\delta W_{nP}}$. The right side of this equation is as

$$\delta W = \sum \mathbf{Qi.\delta q_i} = \mathbf{Q_1 \delta q_1} + \mathbf{Q_2 \delta q_2} + \ldots.. ,$$

where$\mathbf{Q_i}$ is the Generalized-force .

Quantity $\mathbf{Q_i}$ can have Any-unit as, *Unit of forces, of Geometry, of Physical-coordinates*, *of motion,* and everything that can be considered as Work becoming from relation $\mathbf{Q_i \delta q_i}$.

In mechanics, the eigenvalues of a system are found from the roots of the polynomial equation obtained from the *Characteristic Determinant*. Each of the roots, *or eigenvalues*, is substituted, one at a time, into the equations of motion to determine the mode-shape, *or eigenvectors*, of the System . Fig-18

The Geometry and Physical Configuration-Structure of the Energy - Systems.

A. The Point-Line-Plane-Volume : E-Geometry : (1). (2).. (3)∴ ∴(4)
B. The Material-Point : M-Point : [⊕↻↺⊖] , | ⊖↔⊕ |
C. The Material-Point-Spaces : M-Geometry : $\mathbf{f_R}$ [S ≡ $\mathbf{f_{1=N}}$, $\mathbf{f_2}$, $\mathbf{f_2}$,$\mathbf{f_R}$] ← $\mathbf{f_R}$ ≡$\mathbf{f_N}$.
D. The Forced-Nodes -Structure : Mechanics : [-λ M + K] X= 0 , [$\overline{\mathbf{A}}$ – λ I] Y= 0 , λ = w²
E. The Valence-Bond-Particles : Chemistry : ® ® ® ⊙®® ☼⊙ ⊙θ ⊙⊙ ® θ® ® (® ® above; ® ® below)

In Euclidean-Geometry are shown the different Stationary-Shapes that Points maybe formatted.
The Points on Shapes are called *Vertices*. Fig-14.
In Material-Point are shown the two Stationary-Shapes that Material-Points maybe formatted.
The Points on Shapes are called *Spaces,* ⊕*, Anti-spaces,* ⊖, or (+), (-) charge. $\mathbf{B_P}$
In Material-Geometry are shown the different Stationary-Shapes that Material-Points maybe formatted.
The Points on Shapes are called *Spaces,* ⊕*, Anti-spaces,* ⊖, or (+), (-) charge and consist a system.

In Mechanics are shown the modes of Non-stationary-Shapes in General-coordinates equal in number to degrees of freedom of the system, and by using Energy-Equation of motion is converted to the Standard –eigen value-form. $\mathbf{f_R}$ [$\mathbf{B_P}$ ≡ $\mathbf{f_{1=N}}$, $\mathbf{f_2}$, $\mathbf{f_2}$,$\mathbf{f_n}$] ← and $\mathbf{f_R}$ ≡$\mathbf{f_N}$.

The Points on Shapes are characterized with the *Degrees of freedom,* which are, Loaded or Unloaded.

In Chemistry are shown the different, Stationary or Non-stationary-Shapes of Elementary-Particles Atoms, Ions, Molecules, Crystals, etc. and Compounds, placed with their Chemical-Bonds, that maybe formatted. The Points on mode-Shapes are in *each-State* the System of *Atoms-Ions-Molecules-etc.,* which are, Loaded or Unloaded.

All above Configuration-Structures Are *under a Common-Relationship, that of* Resonance. *i.e.*

a. On a System, z, which is Quaternion z ≡ $\mathbf{s} + \overline{\mathbf{v}}\nabla\mathbf{i}$, ACTING, another Quaternion z` ≡ $\mathbf{s}$` + $\overline{\mathbf{v}}\nabla\mathbf{i}$ with Real and Imaginary parts, OCCURS *a Relationship*, *a Resonance*, between them, and is described by their common *Natural-frequency* $\mathbf{f_N}$, while motion in response to *Imaginary parts*. *At Resonance the Real - Part is Zero, and the Response is given by the Imaginary – Part only.*
b. Since monads are of Quaternion and of Wave-nature-Pattern Resistance of change is the mass, i.e. a *Measure of any Reaction to motions* and of, *Real* and of *Imaginary Part* as $\mathbf{R_z} = \mathbf{R_s} + \mathbf{R_{\overline{v}}}$.

If the Reaction to motions $\mathbf{R_z}$ causes losses from cycle to cycle then is due to Damping.
Damping is of great importance in limiting the amplitude of oscillation at resonance.

Reaction to motion, In Mechanics and Physics, is the mass or the Inertia, In-Electricity is the Inductance in electric circuit, In Material-point m $= \frac{\mathbf{2}}{\mathbf{c}^2}$ (wr)³ = $\frac{\mathbf{h.w}}{\mathbf{2\pi.c}^2} \equiv \frac{\mathbf{2E}}{a_a} \equiv [\frac{\overline{\mathbf{B}}.\overline{\mathbf{w}}}{\overline{\mathbf{B}}\mathbf{x}\overline{\mathbf{w}}}]$.J= $[\frac{\mathbf{\pi r}^2}{\mathbf{2}}].\mathbf{v^2}$

Since also monads are internally as the, *Storage-modes* $\mathbf{f_n}$, therefore Systems are able to *Store* and easily to *Transfer* energy between two or more Storage-modes.

In Material-point, *M-Point - Resonance* occurs on Material-point when placed in a uniform Magnetic Field. Its energy E = W = $[\frac{\boldsymbol{4\pi r^2}}{\mathbf{3}}].\mathbf{f_n}$= n$\frac{\mathbf{(1+\sqrt{5}).\sigma r}}{\mathbf{3}}$= 2L = $\overline{\mathbf{B}}.\overline{\mathbf{w}}$= J.w² is split into the, n, finite numbers of Energy-lobes dependent on the angular-momentum-vector $\overline{\mathbf{B}}$ ≡ Spin. Reorientation of Spin creates a New Nutation-Period $\mathbf{f_N}$= n$\frac{\mathbf{(1+\sqrt{5})\sigma}}{\mathbf{4\pi r}}$ as in Fig-3. and a New wavelength $\boldsymbol{\lambda_N} = \frac{\mathbf{2\,r}}{\mathbf{n}}$, where λ = 2r.

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Since frequency $\mathbf{f_N}$= n$\frac{(1+\sqrt{5})\sigma}{4\pi r}$ =$\frac{\lambda_N}{c}$, then $\boldsymbol{\lambda_N}$=$\frac{n\sigma c\,(1+\sqrt{5})}{4\,\pi\,r}$= $\frac{3\,c}{nr\sigma\bar{B}}$which is the New wavelength.
If Material-point is ticked with a field of another frequency then is unlikely to transition only-when acquire a common frequency $\mathbf{f_T}$. This common Transition-frequency is the *M-Point-Resonance*.

In Mechanics, *Resonance* occurs in a Mechanical-System, under the EXCITATION of an Oscillatory-System. If the frequency of excitation coincides with one of the natural-frequencies of the system, a condition of Resonance is encountered. Vibrating Systems are all subject to damping because energy is dissipated by the resistances of motion.

In Physics, *Physical – Resonance* occurs in a Physical-System when another Vibrating - system or external forces DRIVE the System to oscillate with greater amplitude at specific frequencies called Resonance-frequencies. This property is found in Orbits either in Atoms, or in Universe.

In Electricity, *Electrical-Resonance* occurs in an Electric-circuit, Resistor [R], Inductor [L], Capacitor [C] at a particular, *Resonant – frequency*, when the Imaginary-parts of Impedance Z = R + i X of the circuit elements cancel each other.

In Medicine, *MRI-Medicine-Resonance* occurs between the Nucleus, *of the Two-Hydrogen-atoms in water-molecules*, consisted of a single Proton and when *excited by an Strong-Magnetic-field* then is twisting its orientation so that aligned with the field. Proton all by itself may absorb and reemit 900 MHz photons, but when it gets near other charges it gets twisted and distorted and its Resonance frequency is shifting to 906 MHz. This means that MRI Machine maybe used to generate Spectra corresponding to the amount of Resonance at various frequencies and which in turn reveals the details of the structure of molecules. Newton`s, First-Law states that, *Any change in vector*$\bar{\mathbf{v}}$*, to motion or direction* $\mathbf{d}\bar{\mathbf{v}}$*, involves acceleration* a=F/m =2S/t^2, or E=F.dS=(ma).d(at^2/2) = m.a^{2}t dt, i.e. *Resonance*$\mathbf{w^2_R}$ ≅*acceleration* $\bar{\mathbf{a}}_\mathbf{R}$

In Momentum-Paradox of light, MP-*Light-Resonance* occurs, when the Photon as a System, S, as {[$\mathbf{B_P}$ ≡ EM-R ≡ $\mathbf{f_{1=N}}$, $\mathbf{f_2}$,$\mathbf{f_3}$,$\mathbf{f_D}$,,$\mathbf{f_n}$] and $\boldsymbol{\lambda_N}$=$\frac{\sigma.(1+\sqrt{5})}{4\pi r}$ = $\frac{n.\bar{B}}{4\pi r^2}$}, *and which is a moving Energy-tank as EM-Radiation and,* DRIVES the System of the Dielectric-Medium [$\mathbf{S_D}$ ≡$\mathbf{f_D}$] to oscillate with a common amplitude, *the Dielectric-Polarization frequency* $\mathbf{f_D}$, with a → New-mass Density-Wave, becoming from *the Reaction to the New Reorientation of Spin*. It was proved that when Spin = $\bar{\mathbf{B}}$ vector changes direction, then frequency is between [$\mathbf{f_1}$,..,$\mathbf{f_n}$] and becomes another Particle.

A light-Pulse, Driven forward, in a sort of Optoelestic shock-wave, E.M-R ≡ $\mathbf{f_{1=N}}$, $\mathbf{f_2}$,$\mathbf{f_3}$,$\mathbf{f_R}$,,,,,,$\mathbf{f_n}$, *Electromagnetic-Radiation*, then Photon`s momentum $\bar{\mathbf{B}}$= $\frac{r\sigma.(1+\sqrt{5})}{n}$ = [$\frac{\sigma.(1+\sqrt{5})}{2}$] $\frac{2r}{n}$ =$\mathbf{v_R}$.$\frac{2r}{n}$=$\frac{2rc}{n.N_R}$ i.e. *Photon`s momentum* follows the Inverse-dependence of *Radiation-pressure* on the *Refractive-Index*, and since also Momentum $\bar{\mathbf{B}}$= $\frac{(1+\sqrt{5})}{2}$[$\frac{2\sigma r}{n}$], then follows the *Golden-ratio-Momentum* in all nature.

In Gravity which is a Potential-energy with binder Energy-Field [∇i], *the called Gravity force without Vibration but only local rotation*, *Gravity-Resonance* occurs in any Material-Point, *as the Photons is*, when collides with one of the { [± s^2] Spin-constituent in MFMF} – Field*, and say this is an Energy - Vector Resonance,* because happens axially on Spin-Vector.

In Orbits which are Negative – Energy-Rims with binder Energy the atraction between the opposite forces $\mathbf{P_A}$↔$\mathbf{P_B}$at points A,B, is created the Central motion where, *Orbital-Resonance*, are the Plane Surfaces, representing a Constant-Energy-Rim followingthe Celestial Kepler Laws, *and say this as an Plane-Energy-Resonance,* because happens in-Plane and on Energy-Field-vectors → the Spin $\bar{\mathbf{B}}$.

In Figure. 8-11- are shown the Ellipse-Orbits,1=c.$\mathbf{f_n}^2$.r^3, with their content which is The Spin-Field-vectors $\bar{\mathbf{B}}$ in all area *π*ab of MFMF field. During orbiting centripetal-acceleration $\bar{\mathbf{a}}_\mathbf{P}$ = σ= ±$\frac{4\pi r}{(1+\sqrt{5})}$.$\mathbf{f}$ i.e. *Orbit is subject to a Mechanical-stress, σ, becoming from the Centripetal-acceleration* $\bar{\mathbf{a}}_\mathbf{P}$, therefore *is appeared the* Piezoelectric-effect with Positive-charge *at the Nucleus* and Negative-charge *at the Planet* ≡ Material-point. The two faces at N, P *are connected by the in-between Gravity-field*[∇i] =[± s^2] in[MFMF] Field *so flows Current which is the Resonance on Orbit*. In the *Inverse* Piezoelectric-effect on Orbit , *when a voltage is applied across its opposite* faces at N,P becoming from the[⊕↔⊖] stretching then Orbit becomes mechanically stressed and *Deformed in Shape by the Resonance at* N,P.
From above, motion needs the Granular-Gravity-field [∇i]to make a circuit in Orbit tiny Battery.

In Atoms Negative-Energy-Rims are the *Energy-Plane-Field-vectors* the *Rims*, so that at focus the Proton and at Orbits the electron or electrons , *to follow the Central motion*, and motion conserved.

The Energy, *is motion*, is transformed into *velocity vectors*, *the moving Energy-tank in wavelength* $\boldsymbol{\lambda_N}$=$\frac{2\,r}{n}$, and the Velocity vector, $\bar{\mathbf{v}}\mathbf{i}$, to a *Field-Vector*,$\boldsymbol{\nabla}.\bar{\mathbf{v}}\mathbf{i}$, *which is the Stationary Surface of the Motion in Orbit*, because follows the *Extrem a Principle*, as Figures - 12 -17 - 18 -

c) The Energy Dissipated by Damping

Energy dissipated by damping, is the amount of loss of energy from the oscillatory system which results in the decay of amplitude of free vibration determined under conditions of cyclic oscillations.

It was shown before that Energy dissipated per cycle (x) in Material point is,

$\mathbf{W_d} = \oint \mathbf{c\acute{x}.dx} = \oint \mathbf{c\acute{x}^2.dt} =$ cw²x²$\oint \mathbf{c\acute{x}.dx} \int_0^{2\pi/w} \mathbf{cos^2(wt-\varphi)dt}$ where,

w $= \sqrt{\mathbf{k/m}}$ = the circular velocity per circle $\mathbf{sin^2(wt-\varphi)}$,

c = $2\zeta\sqrt{\mathbf{km}}$= the linear velocity per circle, and at Resonance

$$\mathbf{W_d} = 2\zeta\,\pi k x^2 \quad \text{……………………………………………………(a)}$$

Writing the velocity in the form $\mathbf{\acute{x}}$ = wX $\mathbf{cos(wt-\varphi)}$= ±wX $\sqrt{\mathbf{1-sin^2(wt-\varphi)}}$= ±w$\sqrt{\mathbf{X^2-x^2}}$ the damping force becomes

$$\mathbf{F_d} = c\mathbf{\acute{x}} = \pm w\sqrt{\mathbf{X^2-x^2}} \quad \text{…………………………………………(b)}$$

and by rearranging (b) then,

$$[\,\frac{\mathbf{F_d}}{\mathbf{cwx}}\,]^2 + [\,\frac{\mathbf{x}}{\mathbf{X}}\,]^2 = 1 \quad \text{……………………………………………(c)}$$

Equation (c) is an ellipse with $\mathbf{F_d}$ and x, plotted along the Vertical and Horizontal axis respectively and the Energy dissipated per cycle is the area enclosed by the ellipse.

In material point $\mathbf{W_d}$ = 2ζ πkx² = 8.kζ(πr²) = 8.kζ$\mathbf{A_c}$ where $\mathbf{A_c}$= The area of the cave, *Golden-ratio Energy* E = h.f = $\frac{\mathbf{h(1+\sqrt{5}\,])}}{\mathbf{4\pi}}$. $[\frac{\sigma}{r}]$ = $\mathbf{W_d}$ = 8.kζ$\mathbf{A_c}$, *where* h = Planck`s constant, k = Stiffness in N/m.

The force displacement curve, *the Stress-common-curve*, will enclose an area, *hysteresis loop*, that is proportional to the Energy lost per cycle. Considering the simplest case of energy dissipation, *that of a spring-mass system with viscous damping*, then is → Damping force

$$\mathbf{F_d} = c.\mathbf{\dot{x}} = \pm\ c.w.\sqrt{\mathbf{A^2-x^2}} \quad \text{……………………………………………(a)}$$

with steady-state displacement, x, and velocity $\mathbf{\dot{x}}$, natural frequency $\mathbf{w_n} = \sqrt{\mathbf{k/m}}$, and the constant c = 2ζ$\sqrt{\mathbf{k/m}}$= 2ζ$\mathbf{w_n}$,where ζ = the dumping ratio,

For A = maximum amplitude, then Dumping Force is graphically represented as [$\mathbf{F_d}$/ c.w.A]²+[x/A]² =1, i.e. an Ellipse with $\mathbf{F_d}$, x, plotted in vertical and horizontal axis of velocity vector and equal to the area enclosed by the ellipse, and if added to $\mathbf{F_d}$ the force, k.x, of the lossless spring (pressure) then the +hysteresis loop is rotated through $\mathbf{F_d}$ axis. (Voigt model). Quantized Energy is the enclosed by ellipse.

In Material point of cave r = λ/2 , and since $\mathbf{\dot{x}}$ = w.r → w = $\mathbf{\dot{x}}$/r then *Golden ratio Damping-Force* is,

$$\mathbf{F_d} = c.\mathbf{\dot{x}} = 1m.\mathbf{w_n}.\mathbf{\dot{x}} = 1.[\,(\pi r^2/2)\ \mathbf{v^2}].\ \frac{\dot{x}^2}{r} = [\frac{\mathbf{\pi r v^4}}{\mathbf{2}}] = g = \frac{2}{r}\,(\,\sigma\,[1+\sqrt{5}]\,)^2 = \frac{4\sigma^2}{r}[\,3+\sqrt{5}\,] \quad \text{……….. (b)}$$

This dissipation of energy is determined under conditions of cyclic oscillations, and dependent on Gluebond σ, and r, cave. Since r, is in denominator then for the very small caves, *the under Planck`s caves*, Damping-Force becomes infinite independently of Glue-bond. This may be considered as a type of *Black hole* as this happens in algebra inverse fractions. For Planck level r = 4,453.$\mathbf{10^{-35}}$ then *Damping – Force*

$$\mathbf{F_d} = \frac{4\sigma^2}{\mathbf{4{,}453.10^{-35}}}[3+\sqrt{5}\,] = 4{,}7.\mathbf{10^{\,35}}\ \text{N} = [\ \text{Kg.m/s}^2].$$

From relation $[\frac{\mathbf{\pi r v^4}}{\mathbf{2}}]$ = 4,7.$\mathbf{10^{\,35}}$results a velocity v = 2,8630656.$\mathbf{10^{\,17}}$ m/sec, squared that of light.

d) The Sharpness of Resonance

The sharpness of resonance is a quantity Q, related to damping and by assuming viscous damping then start with equation (3a) where for $\frac{w}{w_n}$ = 1, the Resonant amplitude is $\mathbf{X_{res}}$= ($\mathbf{F_o/k}$) / 2ζ.

We seek the two frequencies on either side of Resonance, *the sidebands*, where exist the half-power points [0,707$\boldsymbol{X_{res}}$]² = X². By squaring (3a) then → $\frac{1}{2}\,[\,\frac{1}{2\zeta}\,]^2 = \frac{1}{[\,1-(\frac{w}{w_n})^2\,]^2 + (\,2\zeta\frac{w}{w_n})^2}$, or equation $\left(\frac{w}{w_n}\right)^4$- 2(1-2ζ²)$\left(\frac{w}{w_n}\right)^2$ + (1-8ζ²) = 0 and by solving for $\left(\frac{w}{w_n}\right)^2$ then $\left(\frac{w}{w_n}\right)^2$= (1- 2ζ²) ± 2ζ.$\sqrt{\mathbf{1-\zeta^2}}$ and by assuming ζ< 1 and neglecting higher –order terms of ζ , then → $\left(\frac{w}{w_n}\right)^2$ = 1 ± 2ζ ……………………………………………………………………....(6)

Letting the two frequencies corresponding to the roots of equation (6) be $\mathbf{w_1}$ and $\mathbf{w_2}$ we obtain

$$4\zeta = \frac{\mathbf{w_2}^2 - \mathbf{w_1}^2}{\mathbf{w_n}^2} \equiv 2\left[\frac{\mathbf{w_2}-\mathbf{w_1}}{\mathbf{w_n}}\right] \text{ and quantity Q is defined as } \rightarrow Q = \frac{\mathbf{w_n}}{\mathbf{w_2}-\mathbf{w_1}} = \frac{\mathbf{f_n}}{\mathbf{f_2}-\mathbf{f_1}} = \frac{1}{2\zeta} \quad \text{.............................(7)}$$

Remarks:

1. Resonance is the phenomenon in which a *Vibrating-System* (1)*or External-force*, Drives *another-system* (2) to oscillate with greater amplitude at specific frequencies. This is a way of Energy-penetration in a system by using the *Golden ratio frequencies*.
2. It is the Mechanism by which virtually all Sinusoidal-Waves and Vibrations are generated. The Sounds we hear by strucking on, *metal glass or wood*, are caused by brief resonant vibrations in the object. *Light and other short wavelength Electromagnetic-Radiation* is produced by Resonance on an atomic scale such as electrons in atoms. *Photon*, which is, *Material Point*, and of the Eternal Rotation of (+) Opposite around (-) Opposite, due to Centifugal and Centripetal Glue-Bond Principal stresses ±σ, *creates in Primary and in caves which are Standing waves as Resonance phenomenon,* the *Golden-Angular-momentum-vector* being Identical to the Spin of Particles and which is trapped in caves`s loops always being in Phase with each other. Their amplitude of Oscillation varies from Zero at Nodes to maxima at Antinodes. In two dimensions reasoning antinodes, the six simple modes of vibration are of plus and minus signs, so shows the Phase of antinodes at a particular instant. The N *loops are*, the N, *Sub - Stores* created in the *Main-Store*, r, because Energy is this motion.
3. Increase of amplitude as damping decreases, and the frequency approaches Resonant - frequency of a driven damped simple harmonic oscillator.
4. When damping is small, the resonant frequency $\mathbf{f_r}$, is approximately equal to the natural frequency $\mathbf{f_n}$ of System $\mathbf{f_s}$ which is a frequency of unforced vibrations, or matches the system`s natural frequency. Energy is transferred by the wave-mechanism, *the Electromagnetic fields*, from one place to another, carrying, *the Energy-Storage*, the matter being transferred.
5. The sharpness of a Resonant System and of quantity Q, is dependent on amplitude $2\zeta = \mathbf{w_2} - \mathbf{w_1}$ *i.e. in all cavities* of *Mechanical-material-systems in all levels*, on *Longitudinal and Transverse* modes in *Electricity* and circuits, in Optical cavities, in all Formations which are forming standing waves, to Particles as → *Position and configuration* ← in *Atomic nucleus and Dipoles*, in *Chemical bonding*, molecules and Crystals and in *Material Points*.
6. Stationary Interference happens when two *Wave-Sources are coherent*, i.e. when these have a constant Phase different , the same frequency and the same wave-form.
7. It was proved that in Material-point of a cave r, issues $(\bar{\boldsymbol{\rho}})^2 + (\bar{\mathbf{a}})^2 = (\bar{\mathbf{M}} = \mathbf{J_a})^2$, where $[\bar{\boldsymbol{\rho}} =$ Energy-vector$]^2$ + $[\bar{\mathbf{a}} =$ Space-vector $]^2$ = [Mass-meter $]^2$ or $s^2 + (iv)^2 = 1$ or → $s^2 - v^2 = 1$ or [Work ≡ Energy ≡ Torsional-momentum]² = [Moving-Space-Energy]² + [Rest-Space-Energy]² or [The Energy-vector]² = [The Space-vector]² +[The Mass-meter]², which is the Ellipsoid of motion and *a Cone relation* on where Total-energy, *Kinetic and Potential* is conserved and for Particle Photon *Electromagnetic-radiation* is the *Kinetic-energy* and Velocity-vector *The-Energy-tank* the Potential. Cone is the one of the only Four-Shapes of the allowed Conic-sections.

Power of a Free force

The Power developed by a free force $F = \mathbf{F_o}.\mathbf{sin(wt+\varphi)}$ acting on a displacement $x = \mathbf{X_o}.\ \mathbf{sin(wt)}$ where Power P is the rate of doing work, which is the product of the force, F, and velocity, $\bar{\mathbf{v}}$ = w.r, is Power $P = F(dx/dt) = (w.\mathbf{X_o}.\mathbf{F_o}).\mathbf{sin(wt+\varphi)}.\mathbf{cos(wt)} = (w.\mathbf{X_o}\mathbf{F_o}).[\cos\varphi.\sin wt.\cos wt + \sin\varphi.\cos^2 wt]$
$P = w.\mathbf{X_o}.\mathbf{F_o}/2\ [\sin\varphi + \mathbf{sin(wt+2\varphi)}]$, where,

The first term is a constant, representing the steady flow of work per unit time.

The second term is a sine wave of twice the frequency which represents the fluctuation component of power, the average value of which is zero over any interval of time that is a multiple of the period.

The work W is found by the sinusoidal-equation → $W = \pi\ \mathbf{F_o}.\mathbf{X_o}.\mathbf{sin\,\varphi}$.

In a cave, as electron of 2r = 3,56237. $\mathbf{10^{-14}}$m the period is $T = \frac{\mathbf{2\pi r}}{\mathbf{c}} = \frac{\mathbf{2\pi.3{,}56237.10^{-14}}}{\mathbf{3.10^8}} = 7{,}468.\mathbf{10^{-22}}$ s and for a force $\mathbf{F_o}$ = 1 N , displacement $\mathbf{10^{-14}}$m , Phase φ = π/6 Period T as above and the work done for a complete circle is → W = 2.1.3,56237. $\mathbf{10^{-14}}.\mathbf{sin\,30^o}$ = 3,56237. $\mathbf{10^{-14}}$ N.m

Work in the second part is → $W = w.\mathbf{X_o}\mathbf{F_o}\ \boldsymbol{cos}\ \mathbf{30^o} \int_0^{\mathbf{T}} \mathbf{sin\,\pi t}.\mathbf{cos\,\pi t}$.

e) Lagrange`s Equations

In reviewing the method of virtual work, the equation is δW = Σi[Fi.$\boldsymbol{\delta}\bar{\mathbf{r}}$i] = 0 where Fi are applied forces excluding the constraint forces and internal forces of frictionless joints and $\boldsymbol{\delta}\bar{\mathbf{r}}$i are the virtual displacements. By including D`Alembert`s inertial forces – m.$\bar{\mathbf{r}}$i, the procedure is extended to dynamical and problems by the equation δW =Σi[Fi-m$\ddot{\mathbf{r}}$i].δ$\bar{\mathbf{r}}$i = 0.

This equation leads to Lagrange`s equation when the displacement,$\bar{\mathbf{r}}$, is expressed in terms of the generalized coordinates. The difference between, δ$\bar{\mathbf{r}}$i, and, d$\bar{\mathbf{r}}$i, takes place in the time, dt, whereas, δ$\bar{\mathbf{r}}$i, is an arbitrary number that maybe equal to, d$\bar{\mathbf{r}}$i, but is assigned instantaneously irrespective of time, ensuring compatibility of displacement.

For kinetic Energy, E, as a function of the generalized coordinates displacements, x, and the generalized velocity, $\dot{\mathbf{x}}$i , whereas Potential energy, U, is a function of, x, is, (d/dt)(∂E/∂$\dot{\mathbf{x}}$i) - (∂E/∂xi) + (∂U/∂xi) = 0 and fori =1 and for a system without potential (U=0) then,

$$(d/dt)(\partial E/\partial \dot{\mathbf{x}}i) - (\partial E/\partial x) = 0 \qquad \text{...................................(L1)}$$

Note: The elastic behavior of a system can be expressed in terms of stiffness, k, or the flexibility, $\mathbf{f}_{\boldsymbol{l}}$, as

Stiffness formulation:
Force, F = Stiffness, k, displacement ,x, and then F=k.x where[k=N/m]

Flexibility formulation:
Displacement, x, ={ Flexibility ,$\mathbf{f}_{\boldsymbol{l}}$ }. { force ,F,} → x = $\mathbf{f}_{\boldsymbol{l}}$.F and in measures [$\mathbf{f}_{\boldsymbol{l}}$ = m/N]

i. *Work*

Work ,W, by a force, F, exerted on an object which moves with distance times, dx, in the direction x-x of the force is W=F.dx, and in the special case of a constant force, the work maybe calculated by multiplying, the distance times dx . the component of force F.cosφ or W = (F.$\mathbf{cos\,\varphi}$).dx.

Since the component F.$\mathbf{cos\,\varphi}$ of force F when acting in the perpendicular direction y-y (dy⊥dx) of the motion x-x , produces zero work, therefore,

Work ,*as Kinetic Energy*, produced as *Stiffness,* k, in the dx Formulation , is stored in the perpendicular y-y direction as *Flexibility* ,$\mathbf{f}_{\boldsymbol{l}}$, in the, dy, Formulation.

The Analogues in Gravity

Work W by a constant force F=2(wr)², or by the constant velocity, c, exerted on an object [breakage (wr)²] which moves with a distance times dx = |(wr)²|, and because Surface is zero is calculated in two perpendicular Formulations (dx⊥dy) as,

Stiffness k = N/m → velocity vector$\mathbf{v}_{\mathbf{E}}$ → Electric field E
Flexibility af= m/N→ velocity vector$\mathbf{v}_{\mathbf{P}}$ → Magnetic field P

The why Energy, *the motion*, is transformed into velocity vector, *a moving wavelength* **λ**, and velocity to a field, *a Stationary Surface motion*, is explained through *Extrema Principle*.

f) The Extremes Principle or Extrema

All Principles are holding on any Point A. For two points A, B not coinciding, exists Principle of Inequality which consists another quality. Any two points exist in their Position under one Principle, *Equality of Stability*,(*Virtual displacement which presupposes Work in a Restrain System*).[16-17].
This Equilibrium presupposeshomogenous Space and Symmetrical Anti-Space.

For two points A , B which coincide, exists the *Principle of Superposition* which is a Steady State containing Extrema for each point separately.

Extrema, for a *point* A is the Point, for a *straight line* the infinite points on opposite line , either these coincide or not or these are in infinite, and for *a Plane* the opposite infinite lines and points with all combinations and Symmetrical ones,
i.e. all Properties of Euclidean geometry, compactly exist in Extreme opposite, Points, Lines, Planes, circles by following anode or descend sequence.

Since Extreme is holding on Points, lines, Surfaces, Volumes, bodies etc., therefore all their compact Properties(*Principles of Equality, Arithmetic and Scalar, Geometric Segments and Vectors, the Proportionality, Qualitative, Quantities, Inequality, Perspectivity etc.*), exist also in the common opposite context *magnitude to direction*, therefore in Superposition the magnitude AB is equal and constant in both directions, or any other direction ≠ 0 , [|A,B| – P$\overline{\mathbf{A}}$, P$\overline{\mathbf{B}}$] i.e.

Any Segment $\overline{\mathbf{AB}}$ between two points A,B consist a Vector, described by the magnitude, |AB|, and directions $\bar{\mathbf{A}}$B , B$\bar{\mathbf{A}}$and in case of Superposition $\bar{\mathbf{A}}$A, A$\bar{\mathbf{A}}$, whereProperties of Vectors, Proportionality, Symmetry, etc.exist either on edges A,B, or on segment AB as →

A quantity to Anti-quantity, *a monad to Anti-monad*, and since it is either a scalar or a vector and by their distinct definitions which is, Scalars, are quantities that are fully described by a magnitude or numerical value alone in *Anti-Scalars*. *Energy*, which is motion to Anti-motion, i.e. to the Anti-trajectory.

According to Thales theorem , Figure - 5. 3, if two intersecting lines PA, PB are intersected by a pair of Parallels AB//A′B′ , then ratios PA/AA′ , PB/ BB′, PA/PA′ , PB/ PB′ of lines, or ratios in similar triangles PAB, PA′B′ are equal or ratio λ = [PA / AA′] = [PB / BB′]. In case line A′ B′ coincides with AB, then AA′ = AA ,BB′ = BB , i.e. exist Extreme and thenλ = [PA/AA] = [PB/BB], (the Principle of Superposition), where property of scalar exists on common segment AB.

Vectors are Imaginary quantities that are fully described by a constant magnitude and change direction in order to keep their constant numerical value or move to *Anti -Space*.

Strain (ε) = change of length / length → It is the relative change in shape or size of an object due to externally-applied forces . Young modulus (E) = tensile stress / tensile Strain.

Stress (σ) = E. Strain = E.**ε**, Strain = Stress / E = **ε** = **ε**(u,v,w)

G = shear modulus = E.m2(m +1) where m= Poisson`s ratio = 1/μ = 10/3. [26-27]

In Elastic material Configuration, the Strain Energy is absorbed as Support Reactions and displacement field [∇**ε** $(\bar{\mathbf{u}},\bar{\mathbf{v}},\bar{\mathbf{w}})$] upon the deformed placement, (where these alterations of shape by pressure or stress is the equilibrium state of the Configuration [26] , then equations of Elasticity are [22-23], G.∇^2.**ε** + [m G/(m-2)].∇[∇.**ε**]= F) or in isotropic material [μ .∇^2.**ε** + (λ+μ).∇(∇.**ε**)] + F = 0].

In Central motion*, Extrema cases for Energy - Orbits are*,

From Ellipse to Parabola is as e → 1 where then *Energy from Negative becomes Zero*.

From Hyperbola to Parabola is as 1 ← e where then *Energy from Positive becomes Zero*.

From eccentricity e equation $e = \sqrt{1+2EL^2/G^2M^2m^3}$, $e^2 - 1 = \frac{2E\,L^2}{G^2M^2m^3} = \frac{E\,k^2\,L^2}{8\pi^4m^3} \equiv \frac{A\,L^2}{GMm^2} \equiv \frac{b^2}{a^2}$

During collision of Photon in [MFMF] with other Photons ,by means of Cross-Product is produced a constant Work , which is stored into the *Only-Four Geometrical-Energy-Shapes*, of the motion. The Geometrical energy shapes are the Plane-Orbits of Kepler-laws, denoting that *Macrocosm and Microcosm* Obey Newton`s Laws of motion in all Scales and consist the *Extreme-Energy-Shapes.*

For the Interior motion to be conserved, *is kept in its Wavelength-Tank* 2r = n **λ**, and for the Linear motion tobe conserved , *is kept in its Plane-Orbits* when continued by the Propagating Electromagnetic-Wave-conveyer .

Extrema Energy - Orbits help, The Moving-Energy-Stores*, to enter the Zero-energy-Caves.*

g) The Volume and Surface, Extreme Plane stresses

A material is said to be under Plane stress if the stress-vector is zero across a particular surface, i.e. σ3 = 0 or σz = $\boldsymbol{\tau_{yz}} = \boldsymbol{\tau_{xz}}$ = 0, a shearless case with Principal stresses only .

From mathematical theory of Elasticity a Surface ,S, under Pressure, p, due to a transverse force ,P, is p = P/S pervaded in all surface, and around surface and if force direction forms an angle θ, then the Principal stresses σ1,σ2 and Shear stresses $\boldsymbol{\tau_{12}}$areas,σ = $\sqrt{(\boldsymbol{\sigma 1 - \sigma 2})^2 + 4\,.\,\boldsymbol{\tau_{12}}}$,$\boldsymbol{\tau_{12}}$

$$\sigma 1{,}2 = (\sigma 1 + \sigma 2)/2 \pm (\tfrac{1}{2})\sqrt{(\boldsymbol{\sigma 1 - \sigma 2})^2 + 4\,\boldsymbol{\tau_{yz}}^2} \text{ and } \rightarrow \tan\theta = 2.\boldsymbol{\tau_{12}}/(\sigma 1 - \sigma 2) \qquad \text{.................. (a)}$$

When surface becomes a point [*This is the Extreme case where surface is interchanged as line or line-segment, it is the same as the infinite small, ds, in Calculus*], then σ2 = 0 and $\boldsymbol{\tau_{12}}$ is very small i.e. a type of vanishing-shear due to layers laterally shifted.

Since force P is a vector, then as in cross-product to a right–handled coordinate system where exists σ2 = 0 and $\boldsymbol{\tau_{12}}$ = σ1, equation (a) becomes as *the Golden ratio of stresses* as (b) or

$$\sigma 1{,}2 = \sigma 1/2 \pm (\tfrac{1}{2}).\sqrt{\boldsymbol{\sigma 1}^2 + \mathbf{4}.\boldsymbol{\sigma 1}^2} = \sigma 1.[1 \pm (\sqrt{5})]/2 \qquad \text{..............................(b)}$$

i.e. The Stress, σ, *on a Point* is manifested as **σ** = P / dS and as dS = 0 then is moving as → $\bar{\boldsymbol{\sigma}}$= P / [dS→0] and becomes $\bar{\boldsymbol{\sigma}}.\bar{\mathbf{v}}$ = *The Reaction to the motion*, as$\bar{\mathbf{v}}$ ≡*momentum* ≡m$\bar{\mathbf{v}}$.

Since Stationary force P exists independently of the acting area then for zero surface (*a point*) stresses P/S vanish, and *Stationary force* P becomes a *Moving force* $\bar{\mathbf{P}}$ and exists as momentum mv with m=1 (*Extreme hypothetical Reaction to the motion*), i.e. the velocity $\bar{\mathbf{v}}$at this point and which is decomposed in the two perpendicular velocities$\bar{\mathbf{v}}$1,$\bar{\mathbf{v}}$2, where then equation (b) is transformed as, σ1 =$\bar{v}$1=(σ1) /2 (1+ √5) and σ2 = $\bar{v}$2= (σ2) /2 (1 -v5) ……...................................(c)

σ = P /dS=0 → $\bar{P}$ = m.$\bar{a}$→$\bar{v}$ = {$\bar{v}$1 ⊥$\bar{v}$2}= {$\bar{\sigma}$1 ⊥$\bar{\sigma}$2}= Constant, where,
$\bar{v}$1 → represents the *Inward compressible* radial velocity and
$\bar{v}$2 = $\bar{v}$1 → represents the *Transverse Outward stretchable* radial velocity of point, *which is transformed into*,
σ1 ≠ 0→ representing the *Inward compressible* radial pressure
σ2= σ1 → representing the *Transverse Outward stretchable* radial pressure of material point,

Since Principal-stresses $\bar{\sigma}$1 ,$\bar{\sigma}$2and Principal-velocities $\bar{v}$1 ,$\bar{v}$2 are perpendicular each other and both follow the vector rule {$\bar{v}1^2+\bar{v}2^2$ } = { $\bar{\sigma}1^2+\bar{\sigma}2^2$ } = ±1 then for their between angle φ = 90º issues,

1. $\bar{\sigma}$1 ≠ 0, $\bar{\sigma}$2 = 0 and $\bar{\sigma}1^2$ =±1, $\bar{\sigma}$1 = 0, $\bar{\sigma}$2 ≠ 0 and $\bar{\sigma}2^2$ =±1
2. $\bar{v}$1 ≠ 0, $\bar{v}$2 = 0 and $\bar{v}1^2$ =±1, $\bar{v}$1 = 0, $\bar{v}$2 ≠ 0 and$\bar{v}2^2$ =±1 and since velocities in a medium can be expressed by their Stiffness $\mathbf{k_x, k_y}$ in solids, Permittivity-Permeability$\boldsymbol{\varepsilon_o, \mu_o}$ in Electromagnetism mass m in Newton`s change of velocity, Generalized mass and Stiffness M, Kin Eigenvector-Dynamics reaction to any motion $\mathbf{r_m}$in monads, then since $\bar{v}$= $\bar{v}$**1**/ε, $\bar{v}$= $\bar{v}$**2**/μ, and $\bar{v}.\bar{v}$= $\frac{\bar{v}1.\bar{v}2.}{\varepsilon\mu}$ = 1 → $\bar{v}$ = $\frac{1}{\sqrt{\varepsilon\mu}}$, which is the known formula of Maxwell`s EM-Propagating wave and, where

m = the reaction to the change of velocity motion (the mass),
$\bar{a}$= the change of velocity motion (the acceleration),i.e.

Force P, In a Material body *appears as Kinetic energy*, In an Elastic surface *is appearing* as *Principal and Shear stress*, In a Material line or segment as *Tension*, *in Euclid line becomes velocity on line or, a Free Velocity moving Line-Segment, or a moving Vector (quaternion ≡ monad), In-Particles as an Electromagnetic wave in cave* r = λ/2, *Out-Particles* as an system *S ≡ Electromagnetic-Radiation with* n, *frequencies in*$\boldsymbol{\lambda_N}$*as*{ [S ≡ $\mathbf{B_P}$≡ EM-R ≡ $\mathbf{f_{1=N}}$, $\mathbf{f_2}$,$\mathbf{f_3}$,$\mathbf{f_D}$,,$\mathbf{f_n}$] *and*$\boldsymbol{\lambda_N}$=$\frac{\mathbf{8.r\ c}}{\mathbf{n\sigma^2.(1+\sqrt{5})}}$ = $\frac{\mathbf{8\ r^2c}}{\mathbf{n\sigma\bar{B}}}$]}.

The *minimum Quantized Energy, the Quanta*=2s², is diffused through the *minimum Quantized Space, Quanta s²,* in all quantized spaces, which are all Particles, [MFMF] , moving Vectors, Free velocity monads, Material lines, Material Surfaces, *the Energy Rims*, and Bodies.

Since also it is a moving energy then diffusion (decomposition) of stored energy follows Pythagoras theorem in a New Configuration with Scalar and Vector magnitudes such that satisfy the principle of conservation of linear momentum.

Points in Space carry a priori the work W = ∫A↔B [P.ds]= 0, or∇^2ds = 0, where magnitudes, P, d$\bar{s}$, can be varied leaving work unaltered.

Using the work formulas of Elasticity then In and On Surface work W is,
W = [(σ1² + σ2²) / 2 - (σ1. σ2) / m] / ES and$\mathbf{W_v}$= [(σ1² + σ2² - σ1. σ2) / 6.GS] where,
σ1, σ2, Are the Principle stresses,
W, Is the work Inward radial surface,↔ ,
$\mathbf{W_v}$, Is the work Onward radial surface (*the Transverse*, ↻↺,)
Placing equation (c) in above work equations then become , W = [P² /4.EF ²] .(6+4/m)
$\mathbf{W_v}$ = [2P ² /3.GS ²] and for m= 4 and G=2E/5, W = (7/4).[P ² / ES ²], Wv = (5/3).[P ² / ES ²] ………………..….(d)

Remarks:

1. *Kinetic Energy*, *motion*, in Primary-Particles becoming *from Circular rotation* of ⊕ to ⊖ is,
   Total Energy in n loops →$\mathbf{W_{n(n+1)}}$ = [$\frac{\mathbf{4\pi r^2 f1}}{\mathbf{3}}$] . n.(n+1) where n = 1,2,3,4… n ...∞ and Mass → m ≡$\frac{\mathbf{2E}}{a_a}$≡ [$\frac{\mathbf{\bar{B}.\bar{w}}}{\mathbf{\bar{B}x\bar{w}}}$] . J ≡ W ≡ [$\frac{\mathbf{4\pi r^2 f1}}{\mathbf{3}}$] . n.(n+1) where$\mathbf{f_1}$ = [$\frac{(1+\sqrt{5}\,])}{2}$][$\frac{\sigma}{2\pi r}$] = $\frac{\mathbf{E}}{\mathbf{h}}$,

   Frequency $\mathbf{f_1}$, *is the Golden-ratio-pattern of stress* σ, *from the generation of frequency. At Resonance the Real-Part is Zero, and the Response is given by the Imaginary-Part only.*
2. *Kinetic Energy*, *motion*, in Primary-Particles becomes *from Cycloidal rotation* of ⊕ to ⊖ is, Total Energy is Spin≡$\bar{\mathbf{B}}$ =$[\mathbf{r.\sigma.(1+\sqrt{5})}]$=($\frac{\mathbf{8\ r^{\ \ 2}}}{n}$).$\mathbf{f_n}$≡[εE²+μH²]/2 = 2rc.sin.2φ, and $\mathbf{f_n}$ = ($\frac{\mathbf{n\sigma}}{\mathbf{8\ r^{\ \ 2}}}$).$\bar{\mathbf{B}}$ i.e. Stationary Energy-lobes are the Stationary Wave-Fringes and Broglie Mass m=$\frac{\mathbf{h.f}}{\mathbf{c^2}}\sqrt{\mathbf{1-\frac{v^2}{c^2}}}$
3. *Kinetic Energy*, *motion*, in Compound-Particles follows the, *Breakage-Principle*, which is (-)the Anti -Space as the Transverse -Electric-field, $\bar{\bar{\mathbf{E}}}$, (+) the Space as the Horizontal -Magnetic-field, $\bar{\bar{\mathbf{B}}}$, and (λ) the Energy-loop ≡ Energy-tank of particle. Motion in Primary-Particles is circular or cycloidal while in Compound Particles, *motion*, occurs by Symmetric [⊕←→⊖] or Antisymmetric [⊕→←⊖]Stretching and of Bending [⊕↻↺⊖]. By this way Energy is absorbed or emitted in the different caves.

4. *Kinetic Energy*, *motion*, in Orbits becomes from, *Piezoelectric-effect*, where Orbit is subject to a Mechanical-stress, σ, *becoming from the Centripetal-acceleration* $\bar{\mathbf{a}}_{\mathbf{P}}$, and is appeared Piezoelectric Effect with Positive-charge at the *Nucleus* and Negative-charge at the *Planet*.

The two faces at N, P are connected by the in-between Gravity-field $[\nabla i]=[\pm s^2]$ in[MFMF] Field.

h) The Relationship between Light and matter

Above relations happen between Electromagnetic radiation which can be described in terms of a *Stream of mass-less particles, the Photons*, each travelling in a wave - like pattern at light speed and containing a certain amount of Energy. As above referred Energy ≡ motion ≡ The rotation of ⊕ to ⊖ in Energy caves, or the Up-down vibration in lobes of particles` wavelength, λ is transferred as Propagation. As for a Greenhouse where gas is gas in an atmosphere that absorbs and emits radiant energy within the Thermal range < i.e. a regulating valve of Absorption and Emission of radial-energy >.

Waves transfer energy but not mass, meaning that mass is only a meter for measurements.

In atoms, *Stretching* occurs when atoms move in the same (←←) or opposite (←→) directions as the bonds shrink or stretch. *Bending* occurs when different (any two) atoms move Downward and Upward away from axis-lobe, thus causing an imbalance-Unbalanced in Electronegativity and change in polarity *the dipole-moment during a vibration*. This motion can result from the absorption of Infrared radiation.

Conclusion

Mass of Photon is the reaction to the Electromagnetic Spectrum which contains all known types of Electro-Magnetic Radiation, and which is Energy that travels and spreads out as it goes, and are for → Radio $\lambda=1.\mathbf{10^{3}}$ m, Microwave, Infrared, Visible, Ultraviolet, X-ray, Gamma-ray ≡ $\lambda=1{,}5.\mathbf{10^{-20}}$ m $\mathbf{M_1}$-ray ≡ $\lambda = 8{,}9.\mathbf{10^{-35}}$, $\mathbf{M_2}$-ray ≡ $\lambda = 2{,}3.\mathbf{10^{-48}}$,$\mathbf{M_7}$-ray ≡ $\lambda = 4{,}5.\mathbf{10^{-171}}$, $\mathbf{M_n}$-ray ≡ $\lambda = 1.\mathbf{10^{-n=\infty}}$, i.e. If *EM radiation with* , λ - $\mathbf{f}_{Ir}$, of the *molecule* cave [$\lambda=1.\mathbf{10^{-5}}$ m , $\mathbf{f}_{Ir}= 1.\mathbf{10^{12}}$ Hz =s/mm] and *of Infrared-radiation*[$\lambda= 1.\mathbf{10^{-8}}$ m, $\mathbf{f_m} = 1.\mathbf{10^{16}}$] *is absorbed by Stretching and Bending, by atoms of Ultraviolet–radiation, where then is caused an Unbalance in molecule Electronegativity, Resulting to the Emission of the travelling and spreading Energy of the Infrared – radiation*.

This means that Energy as Ultraviolet-radiation travels from cave $\lambda= 1.\mathbf{10^{-8}}$ to cave $\lambda= 1.\mathbf{10^{-5}}$*of Infrared - vibration by following the Breakage-Principle and because of Waves - Resonance, this consists one way of transportation of Energy . Mass is the Reaction-meter to the change of motion.*

Photon has a frequency $\mathbf{f_{Ph}} = 1{,}34.\mathbf{10^{21}}$ Hz *and mass* $\mathbf{m_{Ph}} = 4{,}868.\mathbf{10^{-33}}$ Kg .

The Wavelength $\lambda = c / \mathbf{f_{Ph}} = 2{,}00.\mathbf{10^{-13}}$ m *momentum* mv $=1{,}458.\mathbf{10^{-22}}$ Kg.m /s

For *Gravity- length- caver* $=3{,}969.\mathbf{10^{-62}}$mass $m=[\frac{\bar{\mathbf{B}}.\bar{\mathbf{w}}}{\bar{\mathbf{B}}\mathbf{x}\bar{\mathbf{w}}}].J = \frac{\mathbf{1}}{\mathbf{1}}J = \frac{\boldsymbol{\pi}\mathbf{r4}}{\mathbf{2}} = 248{,}156.\mathbf{10^{-248}}$ Kg.

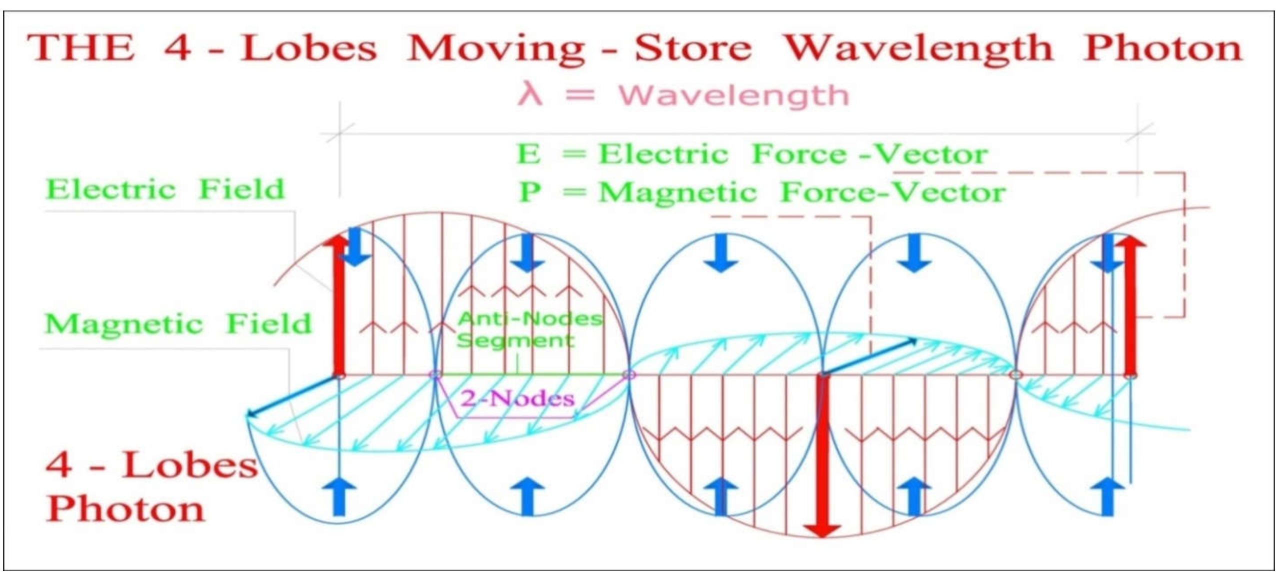

Figure 20: The Inner-Structure of a, 4-lobe, Stationary Wavelength $\lambda = 2\pi r = 2r / n$

Stationary Wavelength $\lambda = 2\pi r$ *is executing a Free vibration,* and under an Outward light motion as the Electromagnetic – radiation E ⊥P. The *Wavelength* λ, contains 3 all lobes plus 2 halve lobes and, *is the moving Energy-Storage* r, because of the Closed-end-Node of Material-Point-motion. *Work* W, *from the Wave-Energy-Pattern and with wavelengths* $\boldsymbol{\lambda_n}$, *created from all Points of the Periodic Oscillation in any Cave,* r , *is Stored into the,* n, *Integer and Energy-Lobes of cave* r.

Energy is the Work, the *motion* in One - Two and Three directions, which is conserved.

In order that *Motion is conserved* as *Displacement*, then must be *Quantized* in a *Finite Space*, differently is annihilated. In Mechanics the only-possible motion in *Finite-Space* is, *the Periodic excitation*, and *the Revolving motion.* It was shown before that,

For the Interior motion to be conserved, *motion is kept in its Wavelength-Tank* $2r = n\,\lambda$, and for the Linear motion tobe conserved, *motion is kept in its Plane-Orbits* and is continued by the Propagating Electromagnetic-Wave which is the conveyer of lobes [$\mathbf{B_P}$ ≡ EM-R ≡ $\mathbf{f_{1=N}}$, $\mathbf{f_2}$,$\mathbf{f_3}$,$\mathbf{f_D}$,,$\mathbf{f_n}$].

i) The Breakage Principle

When a Particle meets its Antiparticle, the two annihilate each other to form two Photos, *gamma rays consist the two Opposites and the Subatomic particles as Ionizing radiation, the Neutral part*, due to conservation of Momentum ,with sum total energy equivalent to the total mass-energy of both particles. Energy, *which is motion*, in Photons is conserved in their, *Neutral Energy lobes*. Photon following the Breakage-Principle, may produce another pair of particles and this because it is a composition of other Sub-monads which again annihilate each other and produce another energy particle and so on, until the *Primary Particles* which are the Material points of the caves. *i.e.*

Breakage Principle, *applied to any two Primary or and Compound Particles, is presented as any two Opposite matter* (+) *antimatter* (-) *, and energy part* 2L=$\mathbf{\overline{B}}.\mathbf{\overline{w}}$ *becoming from Spin or angular-velocity*

Since Atom is a New monad, so follows the *Breakage - rule* → [+] ,[-] , [+ ,-] ← and because

Atom is a composition of other monads then is, $\mathbf{L_T}$ = 1,887 .$\mathbf{10^{-7}}$m

Nucleus → [+] ≡ [+ cave] , *the minimum acceleration Planck`s cave* r <3,56237 .$\mathbf{10^{-14}}$m

Electron → [-] ≡ [- cave] , *the minimum acceleration Planck`s cave* r <3,56237 .$\mathbf{10^{-14}}$m

Orbitals → [+↔-] ≡ [± cave ≡ Material Point] *In mini-acceleration caver* >3,56237 .$\mathbf{10^{-14}}$m

From Math,[1nm =$\mathbf{10^{-9}}$m ,1$\mathbf{\dot{A}}$ =$\mathbf{10^{5}}$ fm, 1fm =$\mathbf{10^{-15}}$m , 1$\mathbf{\dot{A}}$= $\mathbf{10^{-10}}$m, 1amu = 1,66.$\mathbf{10^{-10}}$ Kg] due to conservation of Momentum, with sum total energy equivalent to the total mass-energy.

An Atom is characterized so because, is composed of a *Proton*⊕ an *Electron* ⊖ *Orbit* ≡ Energy Energy is transferred by the *Absorption or Emission of a Photon* while in Orbit via Piezoelectric-effect and of *Electromagnetic force* between *Nucleus-Planet* chain of the Stationary Material-points-Spins.

A Protonis so characterized because, is composed of a *Quark*⊕ an *Quark* ⊖and *Gluon*≡ Energy

Energy is transferred by the *Strong nuclear force of Photons* which is the Centripetal of Material-point Force = v²/ r =$\frac{\mathbf{(3+\sqrt{5}\,])\ \sigma^2}}{\mathbf{2r}}$ which is dependent on Glue-bond stress σ, and cave r.

Quarks are electrical-charged as 1/3, 2/3, n/3 of Spin $\mathbf{\overline{B}}$, meaning that rotation occurs on Small-circles. *Leptons* are electrical-charged as 1, -1, 0 of Spin $\mathbf{\overline{B}}$, meaning that rotation occurs on Great-circles.

For all cases issues the *Breakage Principle*, applied to any *two Primary* or and *Compound Particles*.

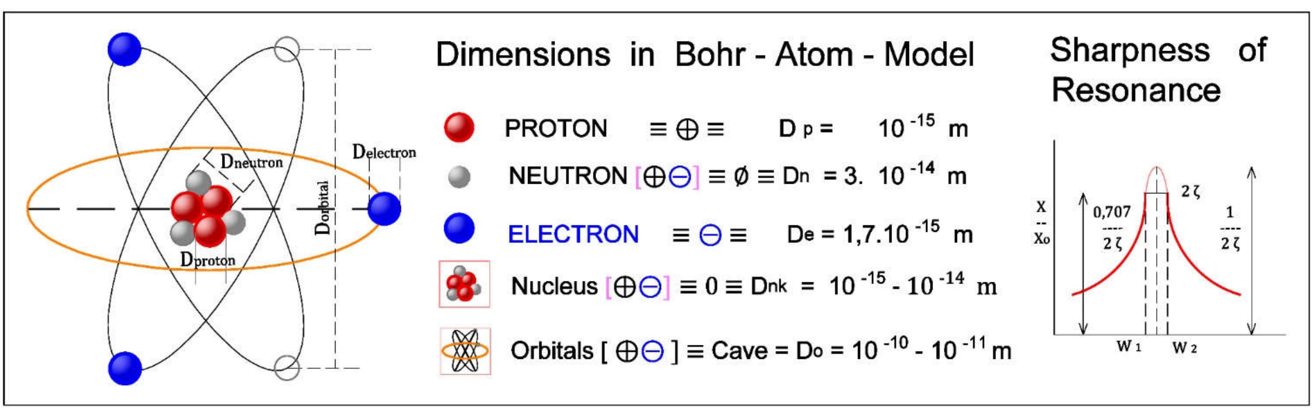

Figure 21: The Bohr-Atom-Model

Atom, Proton, Electron, Neutron, *Photons*, are Compound and Stable Wave-Energy-monads.

Proton is a Stable and Stationary Particle, *the Matter*, and consists the → [⊕] Positive Breakage of the three constituents of Atom monad,

Electron is a Stable and Moving Particle, *the Anti-Matter*, and consists the → [⊖]

Negative Breakage of the three constituents of Atom monad,

Neutron is a Stable and Stationary Granular lattice Energy, and consists the → [⊕↔⊖]

Neutral Breakage [∅] and are Orbitals and Nucleus structure of the three constituents,

Orbit, or, *Negative-Energy-Rim,* is the Stable and Stationary Granular–lattice –Energy-Disk, *which is kept in the Plane-Orbit of motionas Gravity-field*, and in a way *Opposite* to that which *follows the Central motion*, i.e. *Gravity force is packet into the Orbit-Rim as energy-conveyer for the interaction between, Nucleus and the orbiting object*, and consists the quanta, which is *the minimum constant energy*, of motion→ [⊕↻↺⊖]← *in monad atom*.
Neutral Breakage [∅] are Orbitals and Nucleus structure of the three constituents,

Proton is composed of three Fermions, Two up-quark = (+ $\frac{1}{3}$ e) + (+ $\frac{1}{3}$ e) = (+ $\frac{2}{3}$ e) and One down-quark = (- $\frac{1}{3}$ e). Constituents (+ $\frac{1}{3}$ e), (- $\frac{1}{3}$ e), consist *Matter* and *Anti-matter* of Proton-monad while the remaining (+ $\frac{1}{3}$ e) consists the, third *Strong-Energy-Breakage part*, showing that Decay of the Proton does not violate the conservation of baryon number.

Electron is the Negatively charged particle that makes Electricity by its flowing force and which consists the Anti-matter. Breakage Principle applied on Muon produces +Muon, - Muon, netrino and Electron. Because electron is a *Primary-Particle*, it is composed of the N energy tanks, the N loops in its Main-store λ=r= h/p ≡ [$\mathbf{f_1}$,$\mathbf{f_2}$,$\mathbf{f_n}$≡ n lobes] following the *Stationary-Wave-Nodes-Principle.*

Electron Decay from $\boldsymbol{n_2}$ to $\boldsymbol{n_1}$ orbital, causes an electron to jump to a lower energy level orbital, by releasing the extra energy in the form of light photon, *meaning that electron loses energy*. Instead of this, because electron is a *Stationary-Energy-Store*, Energy is complemented from its Main-store.

Neutron is composed of three Fermions, Two down-quark = (- $\frac{1}{3}$ e) + (- $\frac{1}{3}$ e) = (- $\frac{2}{3}$ e) and One up-quark = (+ $\frac{2}{3}$ e) . Constituents (+ $\frac{2}{3}$ e), (- $\frac{2}{3}$ e), consist *Matter* and *Anti-matter* of Neutron-monad consisting the (+) particle rotating around (-) particle of the *Neutron-Primary-Material- point*.

Photons are the Neutrally charged massless particle that make up light and are the Inner-force carriers for Electromagnetic force which consists the Matter. Electromagnetic force is composed of the Electric Field denoting, *the matter = Particle* and Magnetic field denoting *the Anti-matter= Anti-particle*.

Force carrier denotes the Energy-Storages of Photon which are, the N energy-lobes in its main store λ= r = h.c/ $\mathbf{E_{ph}}$ of Photon .*Photon Decay* causes a Photon to jump to a lower energy level, releasing the extra energy in the form of light photon from its Main-store λ= h/p. This issues because Photon is a, *Moving-Energy-Store*, in-where energy is conserved as frequency from formula E = h.f =$\frac{\mathbf{hc}}{\boldsymbol{\lambda}}$, or as increasing wavelength λ= r, i.e. *corresponds to an increase in light`s wavelength* λ, where, λ ≡ [$\mathbf{f_1}$, $\mathbf{f_2}$, $\mathbf{f_n}$≡ n loops≡the lobes which follow the *Stationary-Wave-Nodes Principle*].

Photon follows Cycloidal motion of Space Anti-space *on Stress-common-curve* of λ, so exists centrifugal acceleration and the Total-energy 2E = w B as Stationary Wave *Inward* the N lobes is thus producing the Skin-effect as, n, frequencies $\mathbf{f_n}$, and moving *Outward* as Electromagnetic Wave with light velocity.

j) The Total - Energy in loops

It was shown in [58] *that the maximum velocity in a closed system occurs in Common circle, when the two velocities,* $\bar{\mathbf{c}}$, $\bar{\mathbf{v}}$ *are perpendicular between them, and are not producing Work, from where then dispersion follows Pythagoras theorem and the resultant Quantized linear Space length, r, becomes, as the Resultant of Energy Vectors,* r = |($\bar{\mathbf{c}}$.T)| =$\sqrt{\mathbf{v}^2+\mathbf{c}^2}$*and by using Space Vector*$\bar{\mathbf{r}}$= |($\bar{\mathbf{c}}$.T)| =$\sqrt{\mathbf{v}^2+\mathbf{c}^2}$ *then, The total Rotating energy is* → ± $\bar{\boldsymbol{\Lambda}}$= $\bar{\mathbf{p}}$.r = (M.c).r = (M.c).$\sqrt{\mathbf{v}^2+\mathbf{c}^2}$ *and squaring both sites* [± $\bar{\boldsymbol{\Lambda}}$] ^{2} = p^2.r^2 = M ^{2}.c^2.(v^2+c^2) = (M^2.v^2).c^2 + M^2.$\mathbf{c^4}$= (p^2.c^2) + M ^{2}.$\mathbf{c^4}$ = [p.c] ^{2} + [$\mathbf{m_o}$.c^2] ^{2} or is $\mathbf{E_T}$ = $\mathbf{E_R}$+ $\mathbf{E_K}$ → Total - Energy of Elementary- particle = Intrinsic Rotational + Kinetic Energy,

The velocity of Elementary particles is the light velocity c = v = 2πr.$\mathbf{f_e}$and frequency → $\mathbf{f_e}$=$\frac{\mathbf{c}}{\mathbf{2\pi.r}}$……………………..(a)

Rotational Energy $\mathbf{E_R}$ =$\bar{\mathbf{B}}$.$\bar{\mathbf{w}}$= 2L= J.w^2 and → $\mathbf{E_R}$ = [$\frac{\boldsymbol{\pi r^4}}{\mathbf{8}}$].[$\frac{\mathbf{c^2}}{\mathbf{r}}$] = $\frac{\boldsymbol{\pi c^2}}{\mathbf{8}}$r^2 = 3,535.$\mathbf{10^{16}}$. r^2 ……...................................(b)

Energy and frequency of Elementary particles can be found from cave r , only since ,c, is constant .

Total - Energy→ $\mathbf{E_T}$ = $\mathbf{E_R}$+ $\mathbf{E_K}$ = $\frac{\boldsymbol{\pi c^2}}{\mathbf{8}}$r^2 + $\frac{\mathbf{1}}{\mathbf{2}}$m.v^2 = 3,535.$\mathbf{10^{16}}$. r^2 + $\frac{\mathbf{1}}{\mathbf{2}}$ m.v^2 ..…………………………………..…..(c)

Mass of elementary particles is m = $\frac{\mathbf{E}}{\mathbf{2r^2.w^2}}$ = $\frac{\mathbf{J.w^2}}{\mathbf{2}}$.$\frac{\mathbf{1}}{\mathbf{2r^2.w^2}}$ = $\frac{\mathbf{J}}{\mathbf{4.r^2}}$ = $\frac{\boldsymbol{\pi}.\mathbf{r^2}}{\mathbf{16}}$, i.e. dependent on radius of cave.

i. *Dot product and Cross product*

The *Dot-product* happens for interactions between *Similar dimensions*, while the *Cross-product* between *Different-dimensions*. Cross-product of two vectors $\bar{\mathbf{a}}$, $\bar{\mathbf{b}}$ is $\bar{\mathbf{a}}\times\bar{\mathbf{b}} = |\bar{\mathbf{a}}|.|\bar{\mathbf{b}}|\ \mathbf{sin\,\theta}.\bar{\mathbf{n}}$ and for $\bar{\mathbf{a}}=\bar{\mathbf{b}}$ and $\theta=90^o$ then $\bar{\mathbf{a}}\times\bar{\mathbf{a}} = \bar{\mathbf{a}}^{\,2}$, and for Quaternion, s, which performs the Work of rotating the one vector around the other →Work = $\bar{\mathbf{a}}\times\bar{\mathbf{a}} = \bar{\mathbf{a}}^{\,2}.\bar{\mathbf{r}}$, and for $\bar{\mathbf{a}}=\bar{\mathbf{v}}$ then, Work = $\bar{\mathbf{v}}^{\,2}.\bar{\mathbf{r}}=|\bar{\mathbf{v}}|.|\bar{\mathbf{v}}|.\bar{\mathbf{r}} = v^2.\,r.\bar{\mathbf{n}} = (wr)^2 r.\,\bar{\mathbf{n}} = (2\pi r/T)^2\bar{\mathbf{n}} = (4\pi^2 r^2/T^2).\,r.\,\bar{\mathbf{n}} = \frac{4\pi^2 r^3}{T^2}.\,\bar{\mathbf{n}}$ = W $= 4\pi^2.\frac{r^3}{T^2}.\,\bar{\mathbf{n}} = 4\pi^2.r^3.\mathbf{f}^2_{\mathbf{p}}.\bar{\mathbf{n}}$, is the Kepler celestial law for microcosm. Since in Mechanics issues $z^2 = s^2 - s^2 + 2.s.s = 1$, and from Unit-quaternion $s^2 + [iv]^2 = 1$ then is → $s^2 - v^2 = 1$ ….(d) Equation (d) is a *Cone relation* on where Total-energy, *Kinetic and Potential* is conserved and for Photon , Electromagnetic radiation is the Kinetic-energy and the Velocity-vector–energy-tank is the Potential .Photon is an Energy-store, r, in a Stationary-wave of wavelength n λ= 2r consisted of n stationary lobes filled in λ *with inner motion* the Electromagnetic-Displacement-current and Outward Propagating with light speed as Energy-store λ = 2r / n, {+ Electric-field,- Magnetic-field.

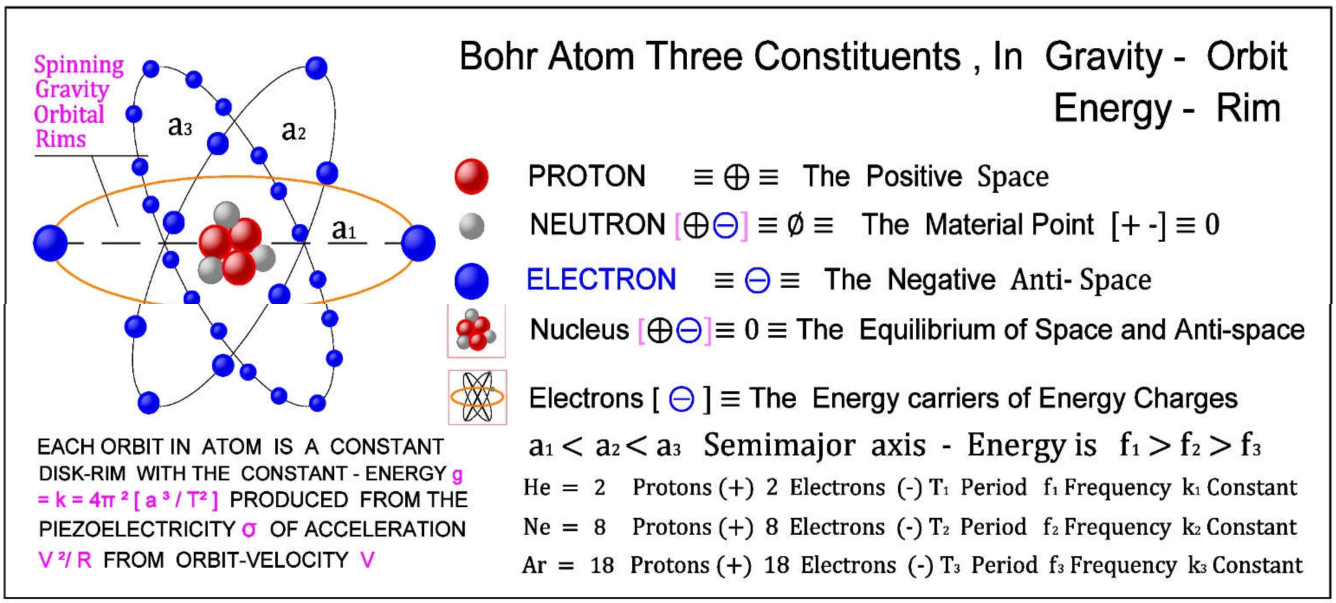

Figure 22: The three constituents in Bohr-atom and the *Spinning-Gravity* in Orbit *Energy-Rim*

Proton, in Bohr-model, consists the → Positive Breakage (+) of the three constituents,
Electron consists the → Negative Breakage (-) of the three constituents,
Neutron consists the → Equilibrium Material Point (+ -) of the Spaces and Anti-spaces.
Nucleus consists the → Equilibrium Positive Breakage Store , in Atom –Model.
Electron Orbits are the → Equilibrium Negative Breakage Store-Rims in Atom –Model.
Orbital Electron is the → Moving-Charge-carrier of Energy in Atom –Model.

Remark

It was prior referred that , when Matter and Antimatter annihilate at rest or when Anti-space comes in contact with its regular Space counterpart , they mutually destroy each other and all of their Energy is converted to the *Three Breakages* → s^2, $-|\bar{\mathbf{v}}|^2$, $[2\bar{\mathbf{w}}].|s|\ |r|.\nabla i$ ← where for, $\bar{\mathbf{v}}= s$ ≡ the cave,

$[\,s^2\,]$ → is the Real part , *Matter*, of the new monad , and is *a Positive Scalar magnitude*.
$-[\,s^2\,]$ → is the always Negative part, *Anti-matter*, which is always *a Negative Scalar magnitude*.
$2\,s^2.\nabla i$ → is the double Angular-Velocity Term, *The Energy Term*, and which is *a Vector magnitude.*

Since Photon is a Material-point in cave r, where its *Inner is Stationary*-Electromagnetic-Wave $[E^2+H^2] = 2(2r).c.\mathbf{sin\,2\varphi}$ with n Lobes representing the *Normal mode vibration* with frequencies $\mathbf{f_n} = n.\mathbf{f_1} = \frac{\mathbf{E}}{\mathbf{h}} = \frac{\mathbf{n.v}}{\mathbf{4r}} = \frac{\mathbf{n\sigma}}{\mathbf{8r}}[1+\sqrt{\mathbf{5}}]$, its *Outward as the Propagating Electromagnetic-Wave* → $\{[\varepsilon E^2 + \mu B^2] = 2.\lambda c.\sin.2\varphi\}$ ← *where* $2r = n\,\lambda$, Cave r, is the *Electromagnetic-Energy-Storage*, and Electromagnetic-Radiation E, B is *the conveyer*. Following above constituents of Photon then,

Since *Energy is motion* and the, *Total – Energy of Elementary - Particle* is equal to the → *Intrinsic Rotational+Kinetic Energy from velocity*, *then* according to the conservation law of Energy, *This Energy is stored into Neutral caves as Stationary Loops consisting the Lobes*, and thus producing the *Space and the Anti -Space Particles with velocity vector the remaining of the Energy Term*.

The Breakage - Principle, is the way of Energy conservation in all levels, *where Energy never annihilates and which is always reverted into* → the *two Opposites* {($\pm s^2$) or the Conveyers ≡ *Carriers* }*and an Neutral Part*2 .∇I which is the Energy-store ≡ Storage ≡ Energy-tank ← or as *Matter*($+s^2$) ,as *Antimatter* ($- s^2$) *and as Energy part*, 2L $= \bar{\mathbf{B}}.\bar{\mathbf{w}}$
In case of complex-structures is found their Energy-State and then the *Breakage-Principle-Constituents.*
Motion is obtained either by *Pushing* or *Attracting*.

Both cases presuppose *NOT the Continuity of points*, which points are nothing *But Discontinuity*, *the Discrete*, with the dimensional Units as filling as this was shown in Zenon Paradox [70], and *this because of their way of existence*, while their *Velocity - Vector,* is the rest part of Energy. *Pushing*, *Repulsion*, happens in Attractive Electric Fields where a Positive charge is dropped near another Positive charge or a Negative charge is dropped near another Negative charge.

Attractive, happens in Static - Electricity where there exists a Build-up of opposite charges on objects which are separated, *gathered and remaining at rest*, by an Insulator and balance the system out, OR an Electric field which is a large source of Negative charges that can propel electrons which Attractive Electric Fields will flow through a circuit towards positive charges. In Fig-21. Atoms exist in over Two hundred different forms as chemical elements like Hydrogen, Carbon, Oxygen Copper etc. [54-55].

Atoms of many types can combine to make molecules which built the Matter – Antimatter and energy (motion) we can physically see and touch. Atoms are tiny about 300 picometers long equal to $3.\mathbf{10^{-10}}$m An Atom is built with a combination of the three distinct particles , the Protons Neutrons and Electrons i.e. define Protons ≡ *The Space* , Neutrons ≡ *The Material point* , Electron ≡ *The Anti-space* , and as was seen before → *Energy* ≡ *Motion* ≡ *Space* + *Anti space* + *Kinetic Energy* , therefore the above combination is completed with a Structural–Lattice–Design, which is the Bohr Atom-model , i.e.

A core nucleus, of Protons and Electrons, surrounded by orbiting Electrons. Since the Structural design must be stable (*balanced state*) in all parts, therefore nucleus is combined of Protons and equal Neutrons determined the isotope of an atom, which define the equilibrium of *Space Anti-space*. The same also for Proton composed of Fermions, Electron which are primary particles and *Stress-common-curve* for Orbital.

The Kinetic Energy Part (Energy) is stored in Orbits as bounded orbiting electrons as below referred. In order that Energy, *motion*, is stored somewhere else then in the outer orbit of the atom, the Valence electrons with enough outside force may escape orbit of the atom and become free. These free electrons are the charge carriers (*Dimensional units as filling*) because Energy is motion and is quantified as the charges which these have. We refer that energy as charge is the same either for Space and Anti-space as this is [⊕↔⊖], therefore Protons and Electrons carry the same amount of charge and so in Bohr model for stability, *balanced state*, atoms have the same number of electrons and protons (*Breakage Principle*).

Potential energy, is the stored energy where then the Build-up of the opposites is at rest. The same also the Electric Potential Energy where a charge`s Electric potential Energy describes the how much stored energy it has when is set into motion and that energy is kinetic and charges can do Work . [67]

k) The Vibrations in Systems

For Orbits issues →W = $4\pi^2 . \frac{r^3}{T^2} . \bar{\mathbf{n}} = 4\pi^2.r^3.\mathbf{f^2_p} . \bar{\mathbf{n}}$ →which is Kepler celestial law for microcosm.

For the vibration of systems *of many degrees of freedom* and because an estimate of the Fundamental and a few of the lower modes is sufficient *Rayleigh`s method and Dunkerley`s equation*, are of great value and importance in the theory of *Resonance*.

For M and K, the Mass and Stiffness matrices and X the assumed Displacement vector for amplitude of vibration, then *for Harmonic motion*, the maximum Kinetic and Potential energies are written as $\mathbf{T_{max}} = \frac{1}{2}w^2. \mathbf{X^T}.M.X$ and $\mathbf{U_{max}} = \frac{1}{2}\mathbf{X^T}.K.X$ where, w, are the frequencies of the System.

By equating the two and solving for w^2 then $w^2 = \frac{\mathbf{X^T.K.X}}{\mathbf{X^T.M.X}}$ which is the lowest natural frequency from the high side and by expressing the assumed displacement curve, *wavelength* λ, in terms of the normal modes $\mathbf{X_i}$ as X $= \mathbf{X_1}+\mathbf{C_2X_2}+\mathbf{C_3X_3}$ + …. then by normalizing to the same number equation becomes,

$$w^2 = \mathbf{w^2_1}. [1+\mathbf{C}^2{}_\mathbf{2}(\frac{\mathbf{w^2_2}}{\mathbf{w^2_1}} -1) + …] \quad \text{.....(a)}$$

i.e. *a relation between the Fundamental frequency* $\mathbf{f_n} = \frac{\mathbf{w}}{\mathbf{2\pi}}$

which is found as the Natural-Frequency $\mathbf{f_n} = \frac{\mathbf{n.v}}{\mathbf{4r}} = \frac{\mathbf{n\sigma}}{\mathbf{8}r}[1+\sqrt{\mathbf{5}}] = [\frac{\mathbf{(1+\sqrt{5})}}{\mathbf{2}}] \frac{\mathbf{n\sigma}}{\mathbf{4}r}$, *and the other harmonics in any cave* r, *of the* n *lobes filled with the Golden-ratio-harmonics. Golden-ratio-frequency in any System is identified with the first harmonic* $\mathbf{w_n} = 2\pi.\mathbf{f_n}$

The plus and minus signs show the phase of the antinodes at a particular instant.

In Mechanics equation (a) is a regression method as the, *Least Squares*, to approximate the solution of over determined systems for angular velocity vector $\bar{\mathbf{w}}$. Because $\bar{\mathbf{w}}$is related to the Total work 2L=$\bar{\mathbf{B}}.\bar{\mathbf{w}}$ then w_1 = $2\pi.\mathbf{f_1}=\frac{(1+\sqrt{5}]).\sigma}{8\pi r}=\frac{[1+\sqrt{5}]\sigma}{4\ .\ r}$ i.e. dependent on cave, r, and Glue-Bond, σ. Moreover since in monads exist n, frequencies as equation of, Spin =$\bar{\mathbf{B}}$= $\mathbf{f_n}.(\frac{8\,r^2}{n\,\sigma})$ = Energy in n wave-node-loop where

$$\mathbf{f_n}= [\ \mathbf{n}\frac{\sigma(1+\sqrt{5})}{\pi\,(2r)^3}]\ ,\ \bar{\mathbf{B}}=[\mathbf{r}.\boldsymbol{\sigma}.(\mathbf{1}+\sqrt{\mathbf{5}})\ ]\ ,\text{ and } 2L = 2n(\mathbf{3}+\ \sqrt{\mathbf{5}}\ ][\ \frac{\sigma^2}{\pi r^2}\ ] \ldots\ldots\ldots [70]$$

Orbitals in an Atom are the three dimension standing waves because electrons are waves following the Breakage-Principle and consist the eigen values or and, the Eigen-frequencies. Since the wavelength λ, follows the sequence $\frac{1}{1},\frac{1}{2},\frac{1}{3},\frac{1}{4},\frac{1}{n}$,.. and frequency in, n, lobes the Odd and Even sequences 1, 2, 3, 4, 5, 6 … and 1, 3, 5, 7, 9, wavelength is fractionally quantized while Energy as whole numbers. Equation (a) shows the fundamental deflection *(or mode)* $\mathbf{X_1}$which is the greatest of all.

Since infinite large number in algebra, is what is called *Maxima* in Geometry, and Zero in the New *Material–Geometry* then article [65 -70] consists *The Energy- Beacon*, for understanding nature.

Laplace`s Orbital Angular-momentum

The Solid-Harmonics were homogeneous polynomial solution of the Laplace`s equation as equation $\frac{\partial\, u^2}{\partial x^2}+\frac{\partial\, u^2}{\partial y^2}+\frac{\partial\, u^2}{\partial z^2}=0$ and represent the Eigenvalues of the Torsional-momentum L, *as the classical Rayleigh`s Method* which is analytically presented in [70]. Spherical harmonics are the eigen functions of the Square of the orbital angular-momentum $\bar{\mathbf{B}}$ and for $\bar{\mathbf{B}}$=1 then unity-work is,

L = - $\mathbf{i}\bar{\mathbf{B}}$(Xx$\boldsymbol{\nabla}$) = $\bar{\mathbf{\imath}}\mathbf{L_x}+\bar{\mathbf{\jmath}}\mathbf{L_y}+\bar{\mathbf{k}}\mathbf{L_z}$ where $L^2 = \mathbf{L^2}_\mathbf{x}+\mathbf{L^2}_\mathbf{y}+\mathbf{L^2}_\mathbf{z}$. Because Spherical-coordinates are related to the Cartesians as , x = r.$\mathbf{\sin\vartheta\cos\varphi}$, y = r.$\mathbf{\sin\vartheta\sin\varphi}$, z = r.$\mathbf{\cos\vartheta}$, then after some Algebra

$\mathbf{L_x}$= -i.$\bar{\mathbf{B}}$(-$\mathbf{\sin\varphi}.\frac{\partial}{\partial\theta}$-$\mathbf{\cot\theta.\cos\varphi}.\frac{\partial}{\partial\varphi}$) , $\mathbf{L_y}$= -i$\bar{\mathbf{B}}$.($\mathbf{\cos\varphi}\frac{\partial}{\partial\theta}$ - $\mathbf{\cot\theta.\sin\varphi}.\frac{\partial}{\partial\varphi}$), $\mathbf{L_z}$= -i$\bar{\mathbf{B}}$.($\frac{\partial}{\partial\varphi}$) . Squared is

$L^2 = -\ \bar{\mathbf{B}}^2.[\frac{1}{\sin\vartheta}\frac{\partial}{\partial\theta}(\mathbf{\sin\vartheta}\frac{\partial}{\partial\theta})+\frac{1}{\sin^2\vartheta}.\frac{\partial^2}{\partial\varphi^2}]$ or $L^2 = -\ (r\boldsymbol{\nabla})^2+(r\frac{\partial}{\partial r}+1)r\frac{\partial}{\partial r} = -\frac{1}{\sin\vartheta}\frac{\partial}{\partial\theta}(\mathbf{\sin\vartheta}\frac{\partial}{\partial\theta})-\frac{1}{\sin^2\vartheta}.\frac{\partial^2}{\partial\varphi^2}$

Since in spherical coordinates $\mathbf{L_z}$depends Only on φ, we can denote its eigenvalue by , n $\bar{\mathbf{B}}$, and the corresponding eigen functions by $\boldsymbol{\Phi_n(\varphi)}$ thus these are,

$$\mathbf{L_z}= -i.[x\frac{\partial}{\partial y}-y\frac{\partial}{\partial x}] = -\ i.\frac{\partial}{\partial\varphi}\quad\text{or}\quad \mathbf{L_z}\boldsymbol{\Phi_n} = n\bar{\mathbf{B}}.\boldsymbol{\Phi_n(\varphi)}\ \text{ namely is- } i.\frac{\partial}{\partial\varphi}\boldsymbol{\Phi_n(\varphi)} = n.\boldsymbol{\Phi_n(\varphi)}\ \ldots\ldots (1)$$

The solutions to (1) are →

$$\boldsymbol{\Phi_n(\varphi)}=\frac{1}{\sqrt{2\pi}}\mathbf{e^{in\varphi}}\ldots\ldots (2)$$

This equation (2) is satisfied for any value of n , however physically the wave-function must be any quantized number differently is continuous, namely $\boldsymbol{\Phi_n(2\pi)}=\boldsymbol{\Phi_n(0)}$, *from which*

$$\mathbf{e^{i.2\pi n}} = 1\ \ldots\ldots (3)$$

This equation is satisfied for n = 0 , ±1, ±2 , ±3 , ..± n , which consist the eigenvalues of operator $\mathbf{L_z}$ *and agree with prior* $\mathbf{f_E}$ [$\mathbf{B_P}$≡$\mathbf{f_{1=N}}$,$\mathbf{f_2}$, $\mathbf{f_3}$,$\mathbf{f_E}$ = $\mathbf{w^2}$] [70-P61], λ ≡ [$\mathbf{f_1}$, $\mathbf{f_2}$,,, ,$\mathbf{f_n}$≡ the loops ≡ n lobes, or → $\mathbf{f_N}$ = n $\frac{(1+\sqrt{5})\sigma}{4\pi r}$= $\frac{n\sigma.\bar{B}}{8\,r^2}$, which is the Golden-ratio-Energy Stored in lobes of Material-points.

Since Waves transfer energy but not mass, interactions between Electrons ⊖ and Protons ⊕, *in Orbit Rims*, happen because of the enclosed *Gravity-force as packet in these Energy-Orbit-Rims*.

A Positive-charge *at the Nucleus* and a Negative-charge *at the Planet* ≡ Material-point is created due to Piezoelectric-effect. The two faces at N, P *are connected by the in-between Gravity-field*[∇i]=[± s²] dipole-Spins $\bar{\mathbf{B}}$, in[MFMF] Field, *so flows Current which is the Resonance on Orbit*.

l) Stress →Strain - Displacement–Deformation??? : Energy→ Kinetic–Potential

Stress: Stress is a Physical quantity that expresses the internal Forces that neighboring particles.

Strain: Strain is the Description of Deformation in terms of relative displacement of the Initial to the Final Configuration of a Body either [Solids, Liquids, Gases, Crystals, Molecules, Atoms Particles, Fields, Material-points] *in Euclidean-Geometry*.

Displacement: Displacement is a vector whose length is the shortest distance from the Initial to the Final Position of a point P, *in Euclidean-Geometry*.

Deformation: Deformation is the transformation of Body from a Reference-Configuration to a Current-Configuration, either for *Position or Direction*, *in Euclidean-Geometry.*

Energy: Energy is a Physical-Property that when transferred to an Object performs Work i.e. *motion On or In the Object*, producing [*Displacement, Strain, Deformation, any Changes*].

Kinetic-Energy: Kinetic-Energy is the Energy possessed On or In an Object, *when in motion*.

Potential-Energy: Potential-Energy is the Energy On or In an Object, because of its *State or position.*

- *Question*. How Energy ≡ Work ≡ Motion is penetrating matter ???

Given the External-Forces that are acting on a System, to determine the distribution of Internal-Stresses throughout the system. Explicitly is the Cauchy-stress-tensor at every point. In a Solid-object, *By Newton`s laws of motion where any external forces that act on a system must be balanced by internal reaction forces or cause the particles in the affected part to accelerate*, all particles must move substantially Resonated in order to keep overall the shape, so follows that any force applied to one part must give rise to internal reaction forces that propagate from particle to particle of the system.

All these internal forces are due to the very short-range intermolecular interactions, manifested as surface contact forces σ, between adjacent particles, which is what is said as Stress. *Since now*, the Work executed in the Elastic material Configuration as the Strain energy is absorbed as Support Reactions and displacement field in the three dimensions [$\nabla\varepsilon$ ($\bar{\mathbf{u}},\bar{\mathbf{v}},\bar{\mathbf{w}}$)] upon the deformed placement (these alterations of shape by pressure or stress is the *Euler`s-Lagrange Equilibrium-State* of the Configuration and is as

$$G.\ \nabla^2.\boldsymbol{\varepsilon} + [m.G / (m-2)]\ .\nabla\ [\ \nabla.\ \boldsymbol{\varepsilon}\ ] = F \quad \ldots\ldots(1)$$

where
E = Young modulus of elasticity. G = Shear modulus = E.m/2(m+1)
m = Poisson`s ratio = 1 / μ ≈ 10/3 σ = Stress = Force / Area.
$\boldsymbol{\varepsilon}$ = Strain = change of length / length . F = External forces.
In Electricity, the linear Electrical behavior, *Field and Strength*, of a Material point is $\check{D} = \boldsymbol{\varepsilon}\,\hat{E}$,
where $\check{D}$ = the Electric displacement field, $\hat{E}$ = the Inside Electric field strength and then according to Maxwell`s equations → $\nabla.\check{D} = 0$ , $\nabla x\hat{E} = 0$ and since in Elasticity, Hook`s law → $\boldsymbol{\varepsilon} = E.\sigma$ then
$\nabla.\ \sigma = 0$, $\boldsymbol{\varepsilon}=\frac{\nabla\mathbf{u}+\mathbf{u}\nabla}{2}$ *where* u = the displacement. All above when combined in *coupled equations then*

$$\boldsymbol{\varepsilon} = E\,.\sigma + \boldsymbol{\partial}\hat{E} \ \text{ and } \ \check{D} = \boldsymbol{\varepsilon}\,\hat{E} + \boldsymbol{\partial}\sigma \quad \ldots\ldots(2)$$

and since in Material-point $\sigma = 2(1+\sqrt{5}).\bar{\mathbf{v}}$ = constant,*and because*

v = w.r , then (1) becomes, $\boldsymbol{\varepsilon} = E\,.\ \sigma + \boldsymbol{\partial}\hat{E} = 2.E(\ 1+\sqrt{5}).\bar{\mathbf{v}} + \boldsymbol{\partial}\hat{E}$, $\check{D} = \boldsymbol{\varepsilon}\,\hat{E} + \boldsymbol{\partial}\sigma = \boldsymbol{\varepsilon}\,\hat{E} + 0 = \boldsymbol{\varepsilon}\,\hat{E}$ ……(3)

System (3) defines the Strain$\boldsymbol{\varepsilon}$, and the Electric displacement field $\hat{E}$ = [⊖] , in Material-point, which is the Work in a much deeper to stresses-level $dW = \frac{\boldsymbol{\sigma}^2}{2\mathbf{E}}(dx.dy.dz)$. *Work is always motion in three* dimensions dx, dy, dz and so *must be conserved in Storages,* in order that *these are transported*.

Motion which is kept in Storages is *a Stationary-Box* (which is moving with light velocity *and carried* by an Electromagnetic Radiation), *a wave created in this Stationary-Box*. This Electromagnetic wave is entering into the other Energy-structures ≡ matter, *penetrates into matter*, carrying always the Box = r In case that Electromagnetic wave EM-R is absorbed, *The Work produced in Stationary-Box becomes an Inward Electromagnetic wave of the Box and after leaves the Box*, as a New Electromagnetic wave from the *In-Box* to *Out-Box* ,which New E-M Radiation carries the Box further.

m) The Permeable Resonance-Path to a Common-motion

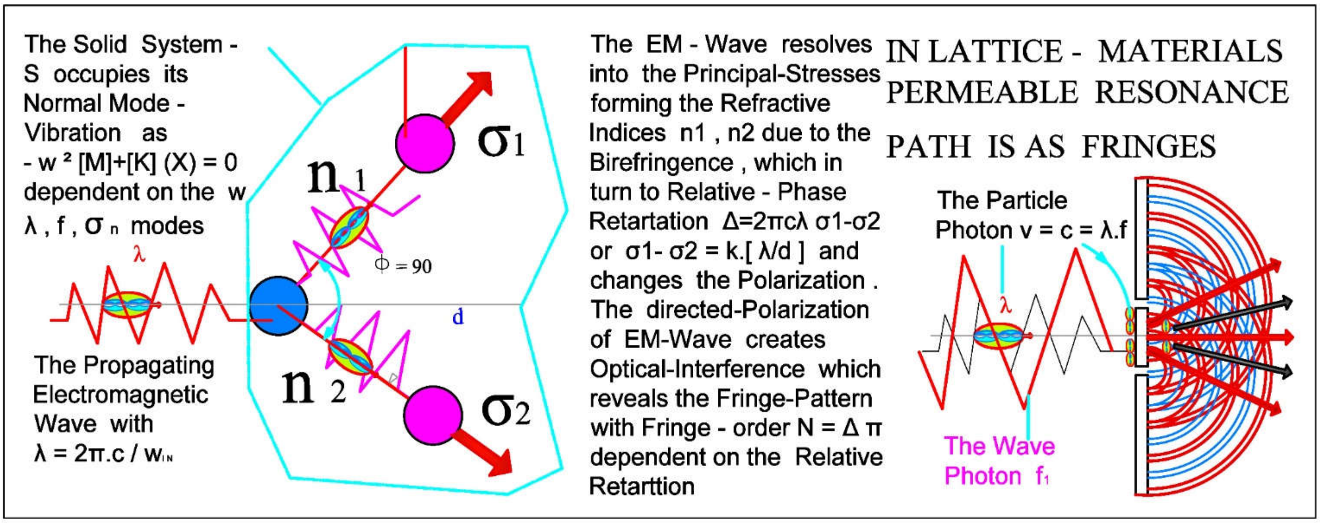

Figure 22: The Permeable *Resonance - Path* of Photon in *Lattice-Materials*

a) The Transmitted Electromagnetic Wave of wavelength $\lambda = 2\pi c/w \equiv c / f$ follows the Hook`s Elastic deformation and resolves into the Principal-Stresses-Pattern $\boldsymbol{\sigma_1}$,$\boldsymbol{\sigma_2}$.

b) The Permeable-Resonance-Path is always the *Resonance-frequency* and is for,

1) Solids → The Normal-mode-Vibration System $\{ - w^2 [M] + [K] (X) \} = 0$
2) Liquids → The Cauchy Stress-Tensor as Momentum equation $\boldsymbol{\nabla}.\sigma = - \nabla p + \boldsymbol{\nabla}.\tau$
3) Gases → The combined Avogadro`s Pressure-law $PV = n RT = n.mv^2/3$
4) Crystals → The Cauchy Ellipsoid-Stress-tensor where $E \perp B \perp r \equiv \boldsymbol{\sigma_1 \perp \sigma_2 \perp \sigma_3}$
5) Molecules → The Lattice - Crystal -Arrangement
6) Atoms → The Chemical Bonds relation
7) Particles → The Resultance One-Dimensional-Collision $\bar{\mathbf{v}}_{\mathbf{ij}} = \bar{\mathbf{v}}_{\mathbf{j}} - \bar{\mathbf{v}}_{\mathbf{i}} = \bar{\mathbf{w}}_{\mathbf{ij}}.\bar{\mathbf{r}}_{\mathbf{ij}}$
8) M-Points → The Resonance-frequencies $\mathbf{f_R}\ [\mathbf{B_P} \equiv \mathbf{f_{1=n}}, \mathbf{f_2}, \mathbf{f_3}, \mathbf{f_{R=}w^2}\ ] = \mathbf{f_n} = n\frac{(1+\sqrt{5})\sigma}{4\pi r} = \frac{n\sigma.\bar{B}}{8\, r^2}$
9) Cave-Orbit→ The Relation $c.\mathbf{L_s} = \mathbf{L_v}$,Light-velocity $3.\mathbf{10^8}$m/s*$1.\mathbf{10^{-42}}$m cave $=3.\mathbf{10^{-34}}$m²/s

Are the Cave-Energy-Plane-Rims, which are the Atom`s and Planet`s orbitals.

Remarks:

The Path Permeable to a common motion is following one of, w, f,$\boldsymbol{\sigma_n}$, quantities asbelow procedure,

1. A transmitted Electromagnetic wave with angular velocity vector $w = 2\pi f = 2\pi c/\lambda$ strikes on a Body.
2. The Electromagnetic wave entering into the Body follows Hook`s Elastic deformation, and resolves into the Principal Net-Stresses-Pattern.
3. Because of Principal-Stresses resolving, different Refractive-Indices are experienced on their perpendicular components due to the Birefringence.
4. The difference in the Refractive-Indices leads to a Relative-Phase –Retardation between the components given as

$$\Delta = (2\pi c/\lambda).k.(\boldsymbol{\sigma_1} - \boldsymbol{\sigma_2}) \text{ or } \boldsymbol{\sigma_1} - \boldsymbol{\sigma_2} = [\,\frac{\boldsymbol{\lambda}}{\mathbf{d}}\,] .\frac{\Delta}{\mathbf{2\pi c}} = k .[\,\frac{\boldsymbol{\lambda}}{\mathbf{d}}\,] \ldots\ldots\ldots \quad \text{(a)}$$

where

$\Delta =$ The Controlled Phase-Retardation from the transmitted Electromagnetic wave

$\Lambda = \frac{\mathbf{2\pi c}}{\mathbf{w}}$, is the vacuum wavelength dependent on light, and angular velocity.

d = The thickness of the Body or of Specimen

5. The Relative Phase Retardation changes the Polarization of the transmitted EM Wave, which changes also the Polarization of the Principal stresses, and thus many different waves are so produced. The Optical interference of the Waves Fringe-Pattern are revealed with Fringe-order $N = \Delta/2\pi$ dependent on Relative-Retardation.
6. *Photon is proved to be a Material-point embodied with the Golden-ratio-frequency*$\mathbf{f_P} = \Phi.\sigma/2\pi r$ and *when collides with another Particles*, *the Vibrating Physical Structures*, *occurs Resonance*(w) between the fundamental

frequencies of the colliders, *and then the Real-Part is Zero, and the Complex-Resonance is given by the Imaginary-Part only which is* → H(w) = - i .$\frac{1}{2\zeta}$,

7. Since Real-part is zero , then by Studying the Fringe-Pattern is determined the State of stresses at the points of materials and the General Permeable Paths of the Electromagnetic-State of the body.

In Figure-4.(3)is seen the Energy-Storage, p, which is transported by the Electromagnetic conveyer $\mathbf{f_n}$. *The Energy-Storages* r = n.[$\frac{\lambda}{2}$]≡$\mathbf{W_{n(n+1)}}$= [$\frac{4\pi r^2 f1}{3}$].n.(n+1), *are travelling through Bodies and follow*, *Lame Stress Ellipsoid*$\mathbf{n_1}^2$ + $\mathbf{n_2}^2$ +$\mathbf{n_3}^2$=$\frac{T_1^2}{\sigma_1^2}$ + $\frac{T_2^2}{\sigma_2^2}$ +$\frac{T_3^2}{\sigma_3^2}$ = 1, on principal stresses $\pm\sigma_1$,$\pm\sigma_2$,$\pm\sigma_3$, which *is the Passage* through which Forces (*The EM-Radiation*) travel in any Solid either in Motion or at Rest .

Laplace`s Orbital Angular-momentum $\mathbf{e^{i.2\pi n}}$= 1 and for n=0, ±1,±2, ±3,.±n ,consist the eigen values operator $\mathbf{L_z}$*which agree with prior* Resonance-frequencies $\mathbf{f_R}$ [$\mathbf{B_P}$≡ $\mathbf{f_{1=N}}$, $\mathbf{f_2}$, $\mathbf{f_3}$,$\mathbf{f_R}$ = $\mathbf{w^2}$] *as wavelengths* λ ≡ [$\mathbf{f_1}$, $\mathbf{f_2}$…$\mathbf{f_n}$= w²]≡*the* n *lobes*, or → $\mathbf{f_N}$ = n$\frac{(1+\sqrt{5})\sigma}{4\pi r}$= $\frac{n\sigma.\bar{B}}{8\,r^2}$, a Principal-Stresses σ , and a Resonance -frequencies $\mathbf{f_R}$ relation, which is the Energy stored in the MP-lobes. [70]

8. From the analysis of the Complex wave Systems (Page -55) is proved that , *The Complex frequency response* H(w) is composed of the Real and the Imaginary part.

At Resonance the Real part is zero and the *Response is* given by the *Imaginary part* H(w) = -i.[$\frac{1}{2\zeta}$] i.e. Energy transportation through *any Type of Material*, is independent of Collision, Impact or Adhesiveness between any two vectors, but from their *Common-frequency*, that of *Principal* or Fundamental mode $\mathbf{f_1}$of the Material, and that of the Incident Wave-frequency $\mathbf{f_n}$.

Physical Properties and Crystal-types:

The *Physical properties* of Crystals, depend on the *Kinds and Strengths of the Attractive forces* that hold the particles together in the Bodies [Solids, Liquids, Gases, Crystals etc.] while the *Types* depend upon the Kinds of Particles located at sites in the lattice-Material-geometry-formation.

An Ion is an Atom or Molecule in which the number of Electrons differs the number of Protons, or $\mathbf{E_n} \neq \mathbf{P_n}$, and if $\mathbf{E_n}>\mathbf{P_n}$ or $\mathbf{E_n}<\mathbf{P_n}$ then is *Negative or Positive Ion*.

Lattice-crystal is a Regular 3D geometrical arrangement of Atoms, Molecules or Ions in a crystal, which follows the Material–Geometry rules of Figure 6.

Lattice- energy is the Energy required to separate the Ions of an Ionic, with Atoms or Molecules Solid.
The mapping of Crystal-types is as below,

Type - Particles at sites- Type of Bounding-Force-Properties- EM-Radiation
Ionic : ⊕, ⊖ Ions - Electrostatic⊕↔⊖ - non-conductors - Infrared
Molecular : Atoms or Molecules - Dipole Attraction-Repulsion - non-conductors - Chemical-Bonds
Covalent : Atoms - Network-Bonds between Atoms -non-conductors - EM-Spectrum
Metallic : Atoms - Ions and Electrons Attraction -Conductors - E-conduction

The *Kinetic-Energy* $\mathbf{E_K}$ of a moving Material-point, *as this is the Photon*, is stored as motion in its Storage, r = [n.λ/2]with the, n frequencies $\mathbf{f_n}$ = n.$\mathbf{f_1}$, with n lobes and fundamental frequency $\mathbf{f_1}$.

From above is seen the *Passage and The-How EM-Radiation can travel in Crystals*and which are the Cauchy-stress-tensor where E⊥B⊥r ≡ $\sigma_1\perp\sigma_2\perp\sigma_3$, in-where Energy Propagatesalong Directions *without Birefringence*, and carries the Energy-Storage r, which is *The conveyer.*

Above procedure can be used in Cells, where cells are cases of an Birefringence material and the Resonance-Passage happens as the Force, *the EM-Radiation in Two directions can travel in Cell* through Cauchy-stress-tensor where the two Conveyers E ⊥ B ⊥ r ≡ $\sigma_1\perp\sigma_2\perp\sigma_3$, can carry the Energy-Storage*,* r, in Cell, and change the Inner-Structure of Cell to another desirable Property.

From Inner-velocity equation v = wr = (2π/T).r = 2π.$\mathbf{f_1}$ r , wavelength λ= cT = c/$\mathbf{f_1}$,cave r = n.[λ/2], then r = n.(c /2$\mathbf{f_1}$) and from

v = w.r = 2π.$\mathbf{f_1}$ [n.c/2$\mathbf{f_1}$] = n.π.c existsv = n.π.c ………………………………..…(4)

showing that velocities in lobes are, n.π, times velocity that of light and for n = 1 then v = π.c, more than three times faster of light velocity. Because of the above velocity v, an E field is produced, and which then produces the $\mathbf{\partial D/\partial t}$ field, which in turn produces the H field and which then produces the $\mathbf{\partial B/\partial t}$ field and which again produces the E field and so on ,i.e.

The total EM-field regenerates itself as it rotates, *a Phenomenon happening in a Propagating Plane Wave in Material-Points only*, and because the Work produced by any motion is stored in its Storage. From the above relation $v = \pi.c$is seen a possible way of entering the lobes and which is that of Black-holes. Permeable-Resonance-Path is impossible in an three-times stronger EM-field. Since Resonance happens between the Energy-frequencies of the Harmonic and Forced Excitation a new cave is needed.

VIII. THE ENERGY IN CAVES

a) The Energy in Atoms

The Electronic Structure of Atoms And Molecules, and Energy- Quantization:

a. As prior referred [54-55] for the First-Rotating-Monad, the common point on *Stress-common-curve* executes circular motion on the Positive breakage of radius, r. Wheel-Loop is a closed Stereo-Slate-Tube for Positive and Negative breakages, and Free to undergo transverse vibrations ,then this gives Odd-numbered harmonics only, and simultaneously as Open-Tube, gives both Odd-and-Even numbered harmonics.
b. Energy of loop or, Energy-Level, become from Rotational-Energy only , therefore issue Mechanical equations of motion, Independently of magnitude,
c. Rotational energy$\mathbf{E_R}$= r.m.v ….(1) where r = The radius of rotation, m = The mass of inner-motion of particle (it is the reaction to inner change of velocity vector),

v = The tangential velocity to inner central motion,

w = The angular velocity. f = The frequency of motion,

Velocity v = w r , w = $2\pi/T = 2\pi$ f and (1) becomes $\mathbf{E_R}$= (v/w).(mv) = v^2 m/w = $mv^2/2\pi f$ = mv^2 [$T/2\pi$] = v^2 [$mT/2\pi$] = v^2 [$h/2\pi$] → because mT = m/f = The stored energy in loop for the fundamental frequency$\mathbf{f_o}$= 1 , or T =1 and becomes from the relation λ = 2L of the Stationary Waves as this is →

$$\mathbf{f_o} = v\ .\ \lambda = v.2L$$

From the definition and the essence of motion, it is either *Displacement* ds = r , or Velocity-vector $\bar{\mathbf{v}}$. Motion may be *Linear or Rotational* for any displacement ,r, so exists a constant-work → k = $\bar{\mathbf{v}}$x$\bar{\mathbf{v}}$.$\bar{\mathbf{r}}$ = v^2.r. $\bar{\mathbf{n}}$. i.e. Constant-Work = k = v^2. r = $(wr)^2$.r = $[\frac{2\pi}{T}]^2$.r = $\frac{4\pi^2 r^2}{T^2}$. r = $\frac{4\pi^2 r^3}{T^2}$ = $4\pi^2$. $\frac{r^3}{T^2}$ = $4\pi^2.r^3.\mathbf{f^2_p}$ → or, A Photon during Motion in [MFMF] Chaos, collides with other Photons by means of Cross-Product and produces a constant Work which is stored into the Only-Four *Energy –Geometrical -Shapes*, of the motion which are the Conic-sections. The Interior motion is kept in its Wavelength-Tank 2r = n λ while the Linear motion is continued by the Propagating Electromagnetic-Wave Energy-conveyer.

i.e.

The stored energy in the loop is → $\mathbf{W_1}$ = v^2 $[\frac{h}{2\pi}]$ = $4\pi^2.r^3.\mathbf{f^2_p}$, is depending on velocity, v, and Planck`s constant h, or on loop, r , and frequency, $\mathbf{f_1}$. Atoms are compound elements, while atoms of many types combine and make molecules building matter. It was proofed that in Primary particles, *Energy in* n = 1 *loop is* $\mathbf{E_1} = [\frac{4\pi r^2}{3}].\mathbf{f_1}$

As prior referred the Planck length $\mathbf{L_P}$, i.e. *The minimum distance ≡ The Granular Space*, can be defined from the fundamental Physical constants, Speed of light, Planck constant, and the Gravitational constant $\mathbf{L_P} = \sqrt{\frac{hG}{2\pi c^3}}$=1,616229.$\mathbf{10^{-35}}$ m = *which agrees with one of the Energy - caves* $\mathbf{L_p} = \mathbf{e}^{i.(\frac{\pi}{2}+2k\pi).b}$ = $\mathbf{L_p} = \mathbf{e}^{i.(\frac{\pi}{2}+2k\pi).b}$= $\mathbf{e}^{-i.(5\frac{\pi}{2}).b}$ = $\mathbf{e}^{i.(-5\frac{\pi}{2}).10}$ = $\mathbf{e}^{-.(78,5398).}$ = 8,906.$\mathbf{10^{-35}}$m = {$\sqrt{\mathbf{3}}.\pi$. 1,616199.$\mathbf{10^{-35}}$m}. Planck length is one of the too many , *Cave - lengths* , that can be formed in our Energy nature in all levels as in [54-55]. [As 1nm =$\mathbf{10^{-9}}$ m, 1A° =$\mathbf{10^{-10}}$ m and $h/2\pi$ = 1,616.$\mathbf{10^{-35}}$ eVs, Velocity light is 2,9979.$\mathbf{10^{8}}$ m]

For a single photon of Red-light with λ = 700 nm = 700.$\mathbf{10^{-9}}$ m, then fundamental frequency $\mathbf{f_o}$ is, $\mathbf{f_o}$= v/λ = c / λ = 2,9979. $\mathbf{10^{8}}$ m / 7.$\mathbf{10^{-7}}$ m = 4,283.$\mathbf{10^{14}}$, and the Energy of the first loop (Total) is

$$\mathbf{E_1} = v^2\ [\ h / 2\pi\ ] = (2{,}9979)^2.\mathbf{10^{16}}.\ [\ 1{,}616.\ \mathbf{10^{-35}}] = 14\ ,\ 524\ eV.s\ \ldots\ldots\ldots\ldots\ldots\ldots(1)$$

The How many Negative breakages, *Units = Positions*, can be filled, is dependent on the Possible Repetitive Permutations of *Moulds= Orbitals* =$\mathbf{R_C}$, Positive ⊕ breakages, and Units which are 2 Units and is the maximum number in a Point, i.e. The Possible Repetitive Permutations for Moulds = Orbitals and Units which are 2.$\mathbf{Mould^{Units}}$ = 2.M^2, for every Mould = Space = Number of Non - coinciding Points , and the available Extrema Positions Units , for M = N = 4 , the Total Positions in Mould is → 2.4^2 = 32 Position - Units which are the Electrons in each orbital. All these happen because in Fig.14 *Atom - Orbitals, are the Equilibrium Negative Breakage Energy Stores, in Atom - Model*.

For Neutrons Units is 2N and for N-Mould, and for N = 4 is 2.4 = 8 Position-Units.

Energy of the first Slice-Wheel-Rim or Orbital is distributed to orbit Electron, while energy of the second Slice -Wheel-Rim to the couple of permitted Electrons (2e) of the orbital is as,

$\mathbf{E_1} = v^2 [h/2\pi] / \mathbf{R_1}^2 = 1^2 = 1$

$\mathbf{E_2} = v^2 [h/2\pi] / \mathbf{R_2}^2 = 2^2 = 4$, and for the, c, Space Number,

$\mathbf{E_C} = v^2 [h/2\pi] / Rc^2 = \mathbf{R_C} . \mathbf{R_C}$

Because any Next-Atom Energy, is equal to Prior + the distributed $[\frac{\mathbf{E1}}{\mathbf{Rc^2}} . \frac{\mathbf{1}}{\mathbf{2.Rc^2}}]$ then in, c, cave

Energy in, c, cave orbital is $\mathbf{E_c} = v^2 [\frac{\mathbf{h}}{\mathbf{2\pi}}] / \mathbf{R_c}^2$ where $\mathbf{R_C}$= Number of Spaces.

Energy of Hydrogen W-Rim.1 $\mathbf{E_1} = \frac{\mathbf{E1}}{\mathbf{1^2}} = 14 , 524$ eV.s

of Helium W-Rim..2 $\mathbf{E_2} = \mathbf{E_1} + [\frac{\mathbf{E1}}{\mathbf{1}} . \frac{\mathbf{1}}{\mathbf{1.2^2}}] = \mathbf{E_1} + \frac{\mathbf{E1}}{\mathbf{4}}$

of Lithium W-Rim..3$\mathbf{E_3} = \mathbf{E_1} + \frac{\mathbf{E1}}{\mathbf{4}} + [\frac{\mathbf{E1}}{\mathbf{2^2}} \frac{\mathbf{1}}{\mathbf{2.2^2}}] = \mathbf{E_1} + [\frac{\mathbf{E1}}{\mathbf{4}}] . \frac{\mathbf{1}}{\mathbf{8}}$ and so on .

For c, W-Rim $\mathbf{E_c} = \mathbf{E_{c-1}} + [\frac{\mathbf{E1}}{\mathbf{Rc^2}} . \frac{\mathbf{1}}{\mathbf{2.Rc^2}}]$ .... where, W-$\mathbf{R_C}$= 1,2, … c, Number of W-Rim.

Following above logic all Particles or Atoms are formulated in this Geometrical formula of Moulds, [Space – Anti space - Energy]≡[⊕↔⊖]-[$\bar{\mathbf{v}}$.∇i], *the Breakage Principle, without any Assumptions, or Axioms, or Exclusion Principles, or any other Starting Points.* [54 -55]

Using Energy in loop 1 → $\mathbf{E_1} = [\frac{4\pi r^2}{3}]\mathbf{f_1} = v^2 [\frac{\mathbf{h}}{\mathbf{2\pi}}]$ ← then $8\pi^2.r^2.\mathbf{f_1}=3v^2.h$, and $r^2 = \frac{\mathbf{3v^2h}}{\mathbf{8\pi^2f_1}}$, where for Planck Length $r^2 = \frac{\mathbf{3.3^2.6,626.10^{-34}.10^{16}}}{\mathbf{8.\pi^2.4,283.10^{14}}} = 2,2658.\mathbf{10^{-32}}$, the corresponding cave of Photon is, r = 1,505.$\mathbf{10^{-64}}$ m →*a cave beyond, in, Gravity length* →3,969.$\mathbf{10^{-62}}$ – 2,295.$\mathbf{10^{-48}}$m

d... Atoms Mould:

A -It is probably fake than true, that Matter and Antimatter annihilate at rest ,instead of that when Anti-space comes in contact with its regular Space counterpart ,they mutually destroy each other, *decay*, and all of their Energy is converted ,*transformed*, to the *Three Breakages*→ s² , -|$\bar{\mathbf{v}}$| ², [2$\bar{\mathbf{w}}$].|s| |r|.∇i ← and for$\bar{\mathbf{v}}$= s ≡ the cave

[s²] → is the Real part, *Matter*, of the new monad, and is *a Positive Scalar magnitude*.
- [s²] → is the always Negative part, *Anti-matter*, which is always *a Negative Scalar magnitude* .
2 s².∇i → is the double Angular-Velocity Term, *The Energy Term*, which is *a Vector magnitude.*

The Breakage – Principle, is the way of Energy conservation, *where Energy never annihilates and which is always reverted into* → the *two Opposites* (± w) *and an Neutral Part*2 .∇i← or as *Matter*(+ w =s²), as *Antimatter* (- w = s²) *and as Energy part*2L = $\bar{\mathbf{B}}.\bar{\mathbf{w}}$.

All above issue for Quaternion ≡ monads which follow the *Breakage Principle*

B–Stationary Fragments → [-s²+s²] = [MFMF] = *The Chaos*, is the base for all motions. Because Pure energy happens at s = 0 where then 2[$\bar{\mathbf{s}}$]².∇i = 0, i.e. ∇i≠ 0 or [∇i] ² ≠ 0, meaning that *Energy as motion* is as Electromagnetic wave only without the energy-store. In this case, *Matter,* looks like, is moving perpendicularly to *Energy vector as Anti-matter*, without annihilate each other.

Photon is a Wave and Particle in all Levels, of Energy-magnitudes, and thus traversing gaseous-media of any Temperature experiencing redshift without losing energy, *because Energy is stored in Photons lobes which are continuously filled*. Redshift happens because of the in staneous wavelength-amplitude happening by the excitation due to interactions where some lobes-resonances will be excited. Star-light passing near the Sun is bending because of its refraction in the dense-Sun, and of Newton`s gravitation, while Red-shift happens as low f and-Blue-shift, as high f being as Particle and Wave.

The base of motion [-s²+s²] = [MFMF] is of the Spin $\bar{\mathbf{B}}$ of the infinite Stationary-Pointy-Material-points. Because of the chains of Spins, is thus created a Magnetic field due to LRC-circuit and which is tuning to the critical Quantum-critical-State $\mathbf{g_G}$.The chains of Spins are pointy vibrating with their characteristic frequencies $\bar{\mathbf{w}}=2\pi f = \frac{\bar{\mathbf{v}}}{\mathbf{r}} = \frac{\boldsymbol{\sigma}}{\mathbf{2r}}[1+\sqrt{5}]$following the *Golden-ratio-Pattern on stresses* and then, Quantum energy $\mathbf{g_G}$ produced, is the State causing them to Magnetically-Resonate. The Back-Up Electromagnetic current is flowing in opposite direction by changing the Spin direction of the Sector-Material-Points.

C-*Energy is the motion of the* [⊖↔⊕]≡[Space ↔ Anti-space] charge, *as is the Electrostatic force*, in the N loops which *as Work can be stored in the,* n, *Energy loops of the Stationary Wave of cave,* r. The N loops are the Energy-Stores in M-P, and *mass the Reaction* to the *Up - Down oscillatory motion in Loop* of each wave Segment at frequency, $\mathbf{f_n}$, which describe each *mode* and characterized by a different λ and f. This happens because of charges alternation [+, - to - , +], i.e. (AC) which exists on Antinodes amplitude of this *Inverse* oscillation.
As prior referred frequency, $\mathbf{f_n}$, is the Golden ratio frequency creating the whole universe.

All monads can immediately be other monads with different frequency, f, by following the *Breakage rule* → $s^2 - |\bar{s}|^2 + 2|s|^2.\nabla i$ ← i.e. matter (+), antimatter (-), energy (+ -) or, *Material Point* A- $\mathbf{K_R}$ ≡ monad ≡ Dipole ≡ [⊕⊖] = ∅=$\mathbf{K_r}$ **A** $\mathbf{K_{R=r}}$*where* →{ $\mathbf{K_R}$≡ [⊕]}↔{ $\mathbf{K_r}$≡ [⊖] }→ ≡ 0 . i.e. *motion Kinetic - energy in stores*, *happens in antinodes-regions as vibrations or movement in lobes*.

From relation, c.$\mathbf{L_s}$ = $\mathbf{L_v}$ the *Light-velocity-moving-Store*3.$\mathbf{10^8}$m/sentering cave1.$\mathbf{10^{-42}}$m =3.$\mathbf{10^{-34}}$ m²/s *becomes the Cave-Energy-Rimi.e. the Energy-Storage of light as velocity,* v , *Enters in cave* 1.$\mathbf{10^{-42}}$m, *and becomes the Constant-Energy-velocity-Plane-cave* and equal to 3.$\mathbf{10^{-34}}$m²/s.

This quantity is constant in Planck`s scale cave $\mathbf{10^{-34}}$ m and exists, in Plane Rims, becoming from the continuous *Central - Rotation of masses* in scales. It is shown in, *Kepler`s third law*, that this constant is k = $[\frac{\mathbf{4\pi^2r^3}}{\mathbf{T^2}}]$ =4π².r³$\mathbf{f_e}$², where for the Sun-Earth-Rim Semi-major-axis, r = 15.$\mathbf{10^{10}}$ m, the period T=1year, then the Energy is in Plane-Sun-Earth Rim k = 3.$\mathbf{10^{-34}}$ m.

This result issues for the moving energy stores which enter in caves under the Planck`s level and create the Plane – Energy-Rims in all Energy-levels.

IX. Summary

a) *The Discrete Chaos*

1. Material points become from the Un-clashed Matter ⊕, and Anti-matter ⊖ through O, which is the Stationary [MFMF] ≡ [-$|\bar{s}|^2$, +$|\bar{s}|^2$] ≡ CHAOS, where the two opposite spaces , *come in contact*, according to the *Glue-Bond-Principle* and Not by *Forced-collision*, which happens in STPL mechanism.
2. The *Circular motion* of ⊕ space, to ⊖ anti-space creates in Material point, the Angular momentum vector $\bar{\mathbf{B}}$ and angular velocity vector $\bar{\mathbf{w}}$, related to the Total Work W, according to formula 2W = $\bar{\mathbf{B}}\bar{\mathbf{w}}$, and was proved that vector $\bar{\mathbf{B}}$is the Spin of particles [63]. Work W is the produced energy E in material point and it is the eternal motion of [⊕↻↺⊖] charge, which is trapped in the N lobes of the material point, *as the Up-Down oscillatory motion in loops*, of each Wave-Segment, at frequencies, $\mathbf{f_n}$,which describe each mode characterized by a different λ and f. Inward wavelength λ, Energy is stored as a stationary Energy - cave while Outward as the Spin of particles. The Work produced from this eternal motion is conserved in lobes and can be transferred anywhere and in case of absorption, is substituted by the in lobes motion.
3. The *Cycloidal rotation* of⊕ space, to ⊖ Anti-space creates in Material point as in circular motion *Spin* = *Vector* $\bar{\mathbf{B}}$≡ $\frac{\mathbf{2W}}{\bar{\mathbf{w}}}$, and *additionally* because of Centrifugal acceleration, is created the *Skin-effect*, which is the tendency of the alternating Electric current (AC) to become distributed within the material point at the *common-point-of-bonding*, and this because of *Principal-Stress* σ=ρ ,[59]. At the very high frequencies the thin layer of material point (λ= 0 → 3,969.$\mathbf{10^{-62}}$m) carries most of the Electromagnetic force as this is from Maxwell`s equations in complex form ∇ x E =- j.w. B and ∇ x H = J, and since, E = J/σ and H = B/μ, then ∇ x J = - jwσ. B , ∇ x B = μ J which give the Skin-depth d = $\sqrt{\frac{\mathbf{2}}{\mathbf{w\mu\sigma}}}$ Spin (m) So , *because of the Skin effect*, Kinetic-Energy moves *Outward the cave*, as an Electromagnetic Wave and this because is consisted of the → Space ≡ Electric Field , Anti-space ≡ Magnetic Field which are perpendicular each other and thus no Work is produced ,and of the Energy part which is *the Energy tank*, *the energy cave* λ , with zero conductivity ← and all Breakages travelling with light velocity. With this way are created the Photons and the other Energy Particles as Gauge Bosons and the exceeding the light velocity particles of [MFMF] field. In case of r <$\mathbf{L_p}$ = 1,616199.$\mathbf{10^{-35}}$m, Electromagnetic wave occupies the velocity of $\mathbf{C_c}$ = 3.$\mathbf{10^{10}}$m/s in order to exist the conservation Total Energy Principle. It was shown that from Inner-velocity equation v = wr = (2π/T).r = 2π.$\mathbf{f_1}$ r, wavelength λ= cT = c/$\mathbf{f_1}$, cave r = n.[λ/2] , then r = n.(c /2$\mathbf{f_1}$) and from

v = w.r = 2π.$\mathbf{f_1}$ [n.c/2$\mathbf{f_1}$] = n.π.c existsv = n.π.c ……………………………….....(4)

showing that velocities in lobes are, n.π, times velocity that of light and for n = 1 then v = π.c, more than three times faster of light velocity . i.e. Each , n, lobe in Material point occupies the velocityv = nπc =nπ (2rf)=n(2πr)f, *needing* n(2πr) *times energy to be zipped*, *with draw*.

4. For the circular rotation in wavelength λ, of the material points exists the stationary wave in loops with Spin $\overline{\mathbf{B}}$ which is getting Out the wavelength and is *locally-equilibrium* by this eternal - rotation. With this way are produced all Positive (+) and Negative (-) particles according to the Spin direction, as the Flavours and Leptons. For Primary particles under Planck`s length, the local-equilibrium of $\overline{\mathbf{B}}$ vector creates the ocean of [MFMF] ≡ Chaos in where exists the Gravity force.
5. In case of the Compound particles (*the Not Primary particles*) as the Bohr model of atoms, Breakage principle is still existing, *particularly* on each of the three Constituents and *on the all* Total formation as
Nucleus ≡ ⊕ ≡ The Space ≡ The matter → and the equal in charge counterpart
Electron ≡ ⊖ ≡ The Anti-Space ≡ The Anti-matter → and the Energy loop as,
Orbitals ≡ [⊕↔⊖] ≡ [∅] denoting the constant-Energy-tanks-Rims of atom following Kepler laws.

It was shown in [65] that frequency-equation $\sin\frac{w.l}{c} = \sin\frac{2rw}{v} = 0$ is satisfied by $\frac{2rw}{v} = \pi$, 2π, 3π, nπ, *Each,* n, *represents a Normal -Mode -Vibration* with natural frequency determined from equation, Natural frequency →

$$f_n = \frac{n}{2.l}c = \frac{n}{2.l}.\sqrt{\frac{T}{\rho}} = \frac{n}{2.l}\sqrt{\frac{\sigma}{\rho}} = \frac{n}{4r}\sqrt{\frac{\sigma}{\rho}} = \frac{n}{4r^3}.\sqrt{\frac{(1+\sqrt{5})^2\sigma^2}{4\pi^2 r4}} = [\,n\frac{\sigma(1+\sqrt{5})}{\pi\,(2r)^3}] \quad \ldots\ldots\ldots\ldots (9)$$

When n = 1 we have the fundamental mode $f_1 = [\frac{\sigma(1+\sqrt{5})}{\pi\,(2r)^3}] = [\frac{(1+\sqrt{5})}{2}]\,[\frac{\sigma}{8.r^3}]$, *a Golden ratio frequency* or from E = h f*the ubiquity Golden ratio Energy* in nature, when n = 2 we have the second mode $f_2 = 2.[\frac{\sigma(1+\sqrt{5})}{\pi\,(2r)^3}] = 2.f_1$, with a node at the center, when n =3 we have the third mode $f_3 = 3.[\frac{\sigma(1+\sqrt{5})}{\pi\,(2r)^3}] = 3.f_1$ with two nodes on both sides of the center etc. resulting to the Mode-Shape-Diagram. Above property and because motion in , *contour of equal heights loops*, is the Downward and Upward motion of opposites from axis-lobe, defines theWHY *Photon is an Endless Store of Energy*.

Energy in n = 1 *loop* → W = $[\frac{4\pi r^2}{3}].f_1$*and for the*$\mathbf{n^{th}}$→ W = $[\frac{4\pi r^2}{3}]\,.f_n = n\frac{(1+\sqrt{5}).\sigma r}{3}$ and *Total Energy in* n = n *loops*→ W = $[\frac{4\pi r^2 f1}{3}]$. n.(n+1) where n = 1,2,3,4… n .... ∞

The Work in n = 1 loop is $W = [\frac{4\pi r^2}{3}].f_1 = [\frac{4\pi r^2}{3}]\frac{(1+\sqrt{5}\,]).\sigma}{4\pi r} = \frac{(1+\sqrt{5}\,])\,r.\sigma}{3}$ which is only dependent on cave, r, and Glue-Bond ,σ, and for n = n loops $W = [\frac{(1+\sqrt{5}\,])\,r.\sigma}{3}]$ .n. ……………………………………………………….(w)

Above equation (w) defines the HOW, *conservation law of Energy in Photon is working, and it is an Index for future Energy-Sources-Technology attempt*.

It was proved that Energy of wave is , → E = m.$\dot{y}^2$ / 2 = (m/2).(-w)^2.$\mathbf{A_o}$, and $m = \frac{2.E}{r.w^2}$i.e.

Mass of cave, r, is → $m = \frac{2.E}{r.w^2} = \frac{2.\overline{B}}{r.w^2} = \frac{W}{r.w^2} = \frac{(1+\sqrt{5}\,])\,4r^2\sigma}{6r\sigma^2\,(1+\sqrt{5}\,)^2} = \frac{2\,r}{3\sigma\,(1+\sqrt{5}\,]} = [\frac{4\pi r^2}{3}].f_1$ ……………………………......(12)

Equation (w) *denotes Energy in all Volume while* (12) *in all Surface of the Material-point.*

The frequency of Photon with light velocity v = c = 2πr.f is → $f = \frac{v}{2\pi.r} = \frac{3.10^8}{2\pi.3{,}5610^{-14}}$= 1,34.$\mathbf{10^{21}}$ Hz . From Photon and (12), mass → $m = [\frac{4\pi r^2}{3}].f_1$= 4,18879.[86,73.$\mathbf{10^{-56}}$].(1,34.$\mathbf{10^{21}}$) = 4,868.$\mathbf{10^{-33}}$ Kg i.e. *Photon has a frequency*$\mathbf{f_{Ph}}$ = 1,34.$\mathbf{10^{21}}$ Hz *and mass*$\mathbf{m_{Ph}}$ = 4,868.$\mathbf{10^{-33}}$ Kg .

In *Gravity- length- caver* =3,969.$\mathbf{10^{-62}}$→mass is $m = [\frac{\overline{B}.\overline{w}}{\overline{B}x\overline{w}}].J = \frac{1}{1}J = \frac{\pi r4}{2}$ =248,156.$\mathbf{10^{-248}}$= 2,482.$\mathbf{10^{-246}}$ Kg andfrom Energy equation E = mv²/2 , velocity v² = 2E/m = $\frac{2.1{,}22910^{21}\,Joule.}{2{,}482.10^{-246}\,Kg}$ = 0,94.$\mathbf{10^{146+21=267}}$ $\frac{Kg.m^2}{Kg.s^2}$ =9,4.$\mathbf{10^{266}}$.(m/s)² , *and the velocity of Photon in Gravity- length-cave* is $\mathbf{v_G} = \sqrt{\mathbf{2E/m}}$ = 3,066.$\mathbf{10^{\,133}}\,\frac{m}{s}$, a velocity Sixteen times faster than that of light and,

$$\textit{Total - Energy}\rightarrow \mathbf{E_T} = \mathbf{E_R} + \mathbf{E_K} = \frac{\pi c^2}{8}r^2 + \frac{1}{2}m.v^2 = 3{,}535.\mathbf{10^{16}}.\,r^2 \;+\; 1{,}229.\mathbf{10^{21}}\,\textit{Joule} \ldots\ldots\ldots\ldots (c)$$

Mass of elementary particles is $m = \frac{E}{2r^2.w^2} = \frac{J.w^2}{2}.\frac{1}{2r^2.w^2} = \frac{J}{4.r^2} = \frac{\pi.r^2}{16}$, i.e. dependent on radius of cave.

From above, Energy is the Work, The motion in *Stationary-Waves-Lobes* , which consist the energy-stores of Particles, and in case of Photon is a *Moving-Energy-Lobes-Radiation-Wave*. markos 6/4/2016

6. Generation, ***Δημιουργία***, Transmission, ***Μεταφορά***, Emission, ***Εκπομπή***, Diffusion, ***Διάχυση***, and Absorption, ***Απορρόφηση***, of *Potential and Kinetic Energy.*Fig.4

Generation of Potential and Kinetic Energy:

Question ?? Where, How and of What is generated? Answer,

Energy, Spaces $\mathbf{q^w}$and Anti-spaces$\mathbf{q^{1/w}}$, consist the *Granular-Vacuum* of Spaces in all levels.

In-between, Spaces$\mathbf{q^w}$and Anti-spaces$\mathbf{q^{1/w}}$ consist the *Absolute-Vacuum* of Spaces in all levels.

The eternal rotation of the ⊕ constituent on the ⊖ constituent due to Glue-Bond, σ, and with the constant angular velocity$\overline{\mathbf{w}}=\frac{\bar{\mathbf{v}}}{\mathbf{r}}=\frac{\boldsymbol{\sigma}}{\mathbf{2r}}[1+\sqrt{5}]$ creates *Material-Point*$\boldsymbol{KK_1}$, which is the *first Energy-automobile-monad of this cosmos*. From the definition of Work, W = *Work* = *Force* x *Displacement* = *Energy,* results the where this Energy, *as Momentum Vector* $\overline{\mathbf{B}}$≡ *Spin* ≡ *Energy,* is stored. It is in the r, cave of $\mathbf{KK_1} = \bar{\mathbf{q}}$ = [s+$\bar{\mathbf{v}}$∇i] as *Potential Energy*. Cave, r, IS, *Inward a Stationary Wave*, with infinite Lobes = Stores ≡ The Frequencies$\mathbf{f_1}$....$\mathbf{f_n} \rightarrow \mathbf{f}_\infty$which follow the *Stationary–lobe-Principle* with Energy part, *The Potential Energy*, E = W= $[\frac{4\pi r^2}{3}]\ .\mathbf{f_n}$= n$\frac{(1+\sqrt{5}).\sigma r}{3}$, and which is the motion in lobes.

In case of *Cycloidal rotational motion*, which is Isochronous, the acceleration $\ddot{\mathbf{x}}$ = - w² $\dot{\mathbf{x}}$ where w = 2π/T, produces the *Skin-effect* at *common-point-of-bonding*, this because of *Principal-Stress* σ=ρ from the Up - Down Oscillatory motion in Lobes, and thus produced an Electromagnetic Wave in the Outer Cave ≡ Loop, and *Kinetic Energy as EM radiation*, is travelling with light velocity c.

Transmission of Potential and Kinetic Energy:

Question ?? What is, How and Where is transmitted ? Answer,

Energy which is *motion as frequencies* n = 1 … n, in lobes ≡ Stores of cave 2r = λ wavelength , *consists the Potential Energy* of monad λ, for the Stationary Primary-Particles, while *EM radiation* as Electromagnetic Wave , is the *Kinetic Energy* part, the transporter, the conveyer.

Electromagnetic Wave follows the *Breakage -Principle* as Electric-field ≡ *Space*⊥ Magnetic-field ≡ *Anti-Space* and *Energy-part*≡ E = $\frac{h.c}{\lambda}$for the PlanckScale and for $\mathbf{v_G}$>>c for Under-Planck-Gravity- Scale. Transmission as *EM radiation* occurs in the In-between Spaces$\mathbf{q^w}$andAnti space s$\mathbf{q^{1/w}}$consisting the *Absolute-Vacuum* of Spaces in all levels and as Diffusion inEnergy Spaces $\mathbf{q^w}$andAnti-spaces$\mathbf{q^{1/w}}$, consisting the *Granular-Vacuum* of Spaces in all levels also.

From mechanics, Energy as motion of Forces is Diffused → as below,

7. *To Elastic material Configuration*, as *Strain energy* and is absorbed as *Support Reactions* and Displacement field [∇ε ($\bar{\mathbf{u}}$,$\bar{\mathbf{v}}$, $\overline{\mathbf{w}}$)] upon the deformed-placement where these alterations of shape by Pressure or Stress is the equilibrium-state of the Configuration G.∇².ε+ [m.G / (m-2)] .∇ [∇. ε] = F, a relation between *Forces* (F) and *Displacement field* [∇ε ($\bar{\mathbf{u}}$,$\bar{\mathbf{v}}$, $\overline{\mathbf{w}}$)] *through Catalysts*, G, m, where G = shear-modulus = E.m/2(m+1), m = Poisson ratio = 1/μ ≈10/3, and Laplace symbol →
$\nabla^2 = \frac{\partial^2}{\partial x^2}+\frac{\partial^2}{\partial y^2}+\frac{\partial^2}{\partial z^2}$.In [25-27] are presented Cauchy equations and the Energy-Principles followed by the, *Math Theory of Elasticity*, concerning Work = Force x Displacement and the Stability as,
   1. The demand of conservation of stability between the exerted forces (and gravity F), and the tensions that are applied on an infinitesimal unit volume and satisfy the equilibrium equations.
   2. The conservation demand of the geometrical continuum (ρ = mass density) during the Elastic (E=Young modulus) Deformation and also the principle of conservation of the angular momentum.
   3. The Elastic constitutive equations, where Hookeℑs law represents the material behavior which relates the unknown stresses and strains (Cauchy-Navier equations of Virtual work for solids).
8. *To Solid material Configuration*, as *Kinetic* (*Energy of motion* $\bar{\mathbf{v}}$) and *Potential* (*Stored Energy*) energy by displacement (*the magnitude of a vector from initial to subsequent position)* and rotation, on the principal axis (*through center of mass of the Solid*) *as ellipsoid*, which is mapped out , by the nib of vector (δ$\bar{\mathbf{r}}$c) = [$\bar{\mathbf{v}}$ c + $\overline{\mathbf{w}}$.$\bar{\mathbf{r}}$. n] δt ,as the Inertia ellipsoid [*Poinsot's ellipsoid construction*] in (AF) which instantaneously rotates around vector axis $\overline{\mathbf{w}}$,φ with the constant polar distance $\overline{\mathbf{w}}$.Fe/|Fe| and the constant angles $\boldsymbol{\vartheta_s}$,$\boldsymbol{\vartheta_b}$, traced on, Reference (BF) cone and on (AF) cone ,which are rolling around the common axis of $\overline{\mathbf{w}}$, vector, *without slipping* , and if $\mathbf{F_e}$, is the Diagonal of the Energy Cuboid with dimensions a,b,c *which follow Pythagoras conservation law*, then the three magnitudes (J,E, B) of Energy-state follow Cuboidal, Plane, or Linear Diagonal direction, and if Potential Energy is zero then vector $\overline{\mathbf{w}}$ is on the surface of the Inertia Ellipsoid.

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Emission of Potential and Kinetic Energy:
Question ?? What, How and Where is Emitted ? Answer,
Potential Energy which is motion is trapped in caves or lobes, and needs a Mechanism, *a Medium*, between The A - Phase and B – Phase motion, i.e. is needed a Catalyst containing both Phases. How is this *Mechanism*, called Catalyst = C ?

Catalyst in Nature

Nature needs a Regulative valve for Programming the task which is the transformation of a substance of *Activation-Energy-monad-A-Phase*, to another substance, *Reactive-Energy-monad-B-Phase*, by changing Energy to another Energy consumption without alternating the Equilibrium-State as schema A ← C → R From above, Catalyst must contain what A and R contain independently of Energy-Level, as *Catalyst for*

1. Energy-caves *Is the Resonance* of EM-Radiations as Electromagnetic-Waves between the caves.
2. Material-Point *Is* the *Stress-common-curve* where exists $\sigma = \rho \cong f$.
3. Moving Primary Particles *Is the Resonance* of EM-Radiations of the moving Waves with the Fundamental Harmonic of the Energy-stores of the other moving or not Particles.
4. Sub-atomic and Atoms *Are* the → *Photo, Electro, Nano* ← Catalyst PLUS all priors.
5. Inorganic-Molecules *Are* the lattice → *Electric field, Magnetic field* ← Catalyst PLUS all priors
6. Organic-Molecules *Are* the → *Chemical Waves*, Homogenous ← Catalyst PLUS all priors.
7. Biochemical reactions *Are* the → *Enzymes*, Bio, Organo ← Catalyst PLUS all priors.
8. Compound Elements *Are* the lattice → *Crystal*, *Cells*, *Enzymes* ← Catalyst PLUS all priors etc.

while *EM radiation* as Electromagnetic Wave, is the *Kinetic Energy* part .Electromagnetic Wave follows the *Breakage-Principle* as Electric-field ≡ *Space*⊥ Magnetic-field ≡ *Anti-Space* and *Energy-part* ≡ $E = \frac{h.c}{\lambda}$ as work $W = 2L = \bar{\mathbf{B}}.\bar{\mathbf{w}} = J.w^2$, for the Planck Scale.

Sound is a vibration, a Signal, *linear as* K ≡ [⊖] ↔ $\mathbf{K_1}$≡ [⊕], that typically propagates following the *Breakage principle*, as *an audible wave of pressure converted to E-Voltage*, *conservation law of Energy* through a transmission medium, *material monads as composition of opposites or following the Breakage* Principle, such as gas, liquid or solid. The Signal is converted, transmitted to receiver and reconverted. A Digital Signal is a Signal that is constructed from a discrete set of wave forms of a physical quantity so as to represent a sequence of discrete values which is succeeded by a discrete space of a topological chart The Golden-ratio-frequency in Sound happens for *Resonant note* A at 432 Hz between the prior 267 Hz and 699 Hz frequencies of the Harmonic and the Forced Excitation.

Enzymes are *Catalysts*, i.e. *make the Chemical reactions go faster but not consumed.*

Enzymes are Proteins that act as Catalysts in the Biochemical reactions. They break molecules into smaller, absorb and combine (build up) molecules and Finally *release-energy* (ATP) . By changing molecules smaller or bigger or turn other molecules into another Finally *capture-energy*. i.e. *Nature changes energy by transforming a Substance into Another-Substance*, energy consumption.

By changing shape, Permanently or Temporary, can become Stores of Energy and be best working in an optimum Temperature, *a critical*, and also on PH.

9. *Diffusion of Potential and Kinetic Energy:*

Question ?? What, How is done and Where is Diffused ? Answer,

Motion in Spaces $\mathbf{q}^{\mathbf{w}}$and Anti-spaces $\mathbf{q}^{1/\mathbf{w}}$, consists the *Granular-Vacuum* of Spaces in all levels. *Motion* in Material-Points, *is as frequencies* $\mathbf{f_n}$and n = 1 ... n, are the first Energy-automobile-monads.

The Motion in Elastic material Configuration, as *Strain energy* is absorbed as *Support Reactions* and Displacement field [$\nabla\varepsilon$ ($\bar{\mathbf{u}}$,$\bar{\mathbf{v}}$, $\bar{\mathbf{w}}$)] upon the deformed placement where these alterations of shape by Pressure or Stress is the equilibrium-state of the Configuration $G.\nabla^2.\varepsilon + [mG / (m\text{-}2)] .\nabla [\nabla. \boldsymbol{\varepsilon}] = F$.

Motion to Solid material Configuration, as *Kinetic* (*Energy of motion* $\bar{\mathbf{v}}$) and *Potential* (*Stored Energy*) Energy by displacement (*the magnitude of a vector from initial to subsequent position)* and rotation, on the principal axis (*through center of mass of the Solid*) *as Ellipsoid*, which is mapped out , by the nib of vector $(\delta\bar{\mathbf{r}}c) = [\bar{\mathbf{v}}\, c + \bar{\mathbf{w}}.\bar{\mathbf{r}}.\, n]\, \delta t$, as the Inertia ellipsoid [Poinsot's ellipsoid construction]. i.e. *Motion in Spaces* is done by the three Breakage-Substances, that *of Matter* which is the Electric-field that *of Anti-Matter* which is the Magnetic-field, and that *of Energy-Part* which is the Energy-Store λ.

When a Part meets another moving substance then *Motion is continued* with the same velocity and by their in-between *Resonance*while their *Harmonic Energy part* is added. When a Part meets another obstacle in the way, then is Diffused as above.

Absorption of Potential and Kinetic Energy:

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Question ?? When, How is done and Which is Absorbed ? Answer,
Since Potential-Energy is *motion as frequencies* $\mathbf{f_n}$and n =1 … n, in lobes of wavelength, λ,
Absorption *as the opposite of transmission* , may occur only in Primary particles if λ, changes.

In compound Particles or molecules when exist *Refrigerator-system* where Heat energy travels in only one direction, from a warmer to a cooler, *or transferred by virtue of a difference in temperature*, object, substance or area. The Refrigeration-cycle is based on the known physical principle that of a liquid is expanding into a gas, extracts heat from the surrounding substance or area *or* as above referred*, the is odynamous Breakage-Principle*, where the two opposites follow the Expansion into gas and Energy Part the Absorption or Transmission energy, *transferred by virtue of a difference in temperature*, i.e. *Breakage-Principle*, is followed for Absorption of energy, and issues for all energy levels. *For travelling Waves*, the high and low points, *crests and troughs*, in the transverse case, OR in the longitudinal case where *points are compressed or stretched*, travel through the Medium which is their
wavelength λ = 2r .Waves transfer energy but not mass .

Because Energy in wavelength is as *Natural-frequencies*, that energy be fed into this system is the appropriate frequency condition, known as *Resonance* identified by increasing in amplitude. The Set of all possible standing waves are the harmonics of the Systems and simplest *Fundamental one*. Absorption occurs in a wave when the *Amplitude of the Standing wave* is much larger than the *Amplitude of another Disturbance diving it*. Accumulation into that with the greater energy is because follows *The Stationary-Wave-Nodes-Principle*. This ability to amplify a wave of one particular frequency over those of any other frequency, *Fundamental frequency plus its multiples*, has numerous applications in musical instruments and others, by amplifying which due to resonance of some selected frequencies. [65B]

b) Dark – Matter and , Dark – Energy: [43]

Dark-matter becoming from the center ,O, of Common-circle where there ,v = 0 , and is (± c.s²) moves with the constant light velocity, $\bar{\mathbf{c}}$, and is composed of the two opposite signed elements , (+cs²) , (-cs²) , and Dark - Energy [$\bar{\mathbf{c}}$.∇i] moves also with the same velocity of light, so is continually effecting *on the two* fragments separately and are slinging them further, formulating the attracting, *the mixture of the spherical opposite signed elements*, highlights, *while* dipole, form the heavy and massive invisible dark matter which repel, *the dipole energy blobby volumes as the* massive Dark – Fringes. The parallel motion of this mixture, *not parallel universes*, is the rolling on Gravity field as the Base *of expanding.* Using Kepler`s laws and Newton`s laws of motion is possible to define the What is Dark-matter and Dark-energy and Why these are so defined. A wide analysis of both and that of Black-holes in [73].
The [*Geometrically Rolling*, *Moved mixture* DM-DE] *Expansion* for the constructing universe. [56]

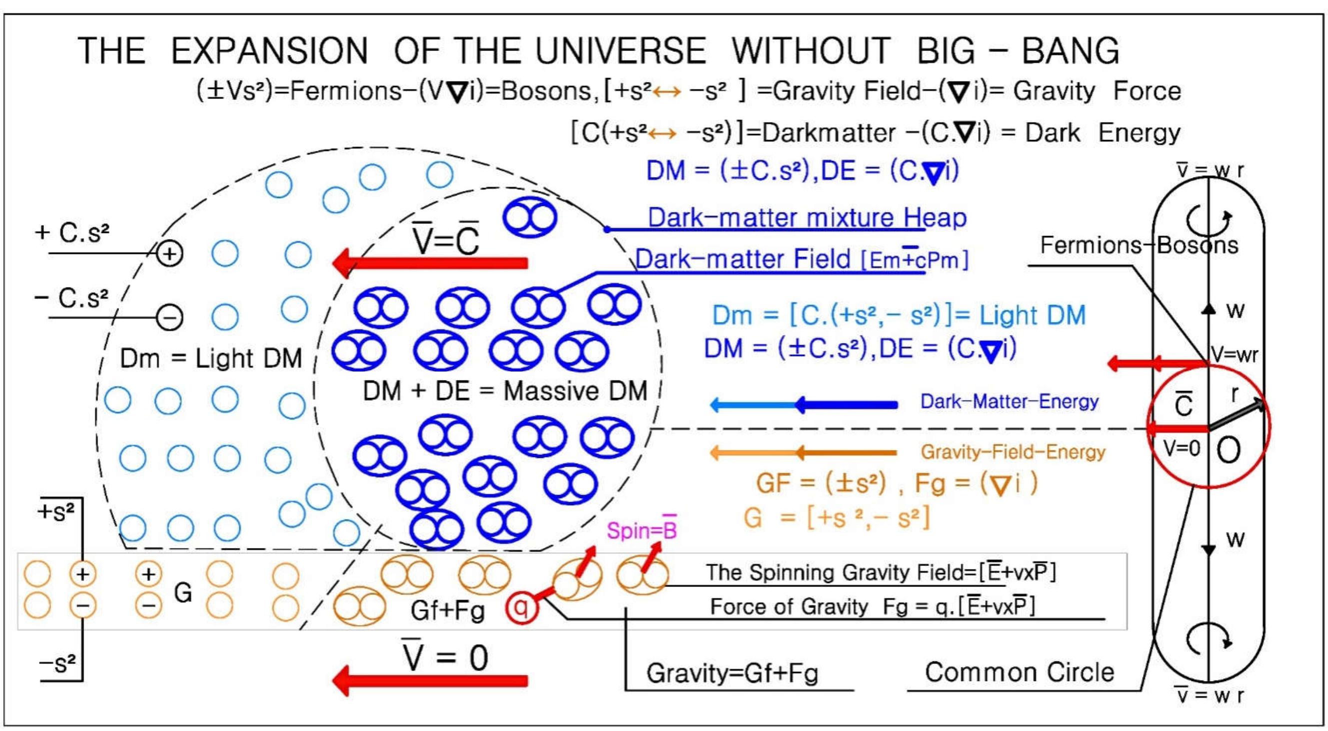

Figure 24: The Expansion of the Universe, without *Big-Bang*

The Cause Expansion of the Universe, is the continuous and simultaneous Rolling of mixture Heap [DE-DM], *The Fragments Heap*, on the Rest Gravity-field [$\mathbf{G_f}+\mathbf{F_g}$] as the Base of rolling.

The three properties of Dark-matter [DM] are → [(+c.s²),(-c.s²),(±c.s ²)] and Dark-energy [DE] →[$\bar{\mathbf{c}}$.∇i] Since [DM] = ±$\bar{\mathbf{c}}$.s², is of opposite signed (±), then consists the Dipole,[|+c.s²|↔|-c.s²|] = |λ| ≡ [|+c.($\bar{\mathbf{w}}$.r)²|↔|-c.($\bar{\mathbf{w}}$.r)²|] of Dark matter which is a more massive base than that of gravity, *and this because of* ,c, so issues DM field = [$\mathbf{E_m}+\bar{\mathbf{c}}.\mathbf{P_m}$] = [$\mathbf{c.E_g}+\bar{\mathbf{c}}^2.\mathbf{P_g}$] and as this is also a Stationary field then follows equation $\mathbf{E_m} = 2.A.c.\mathbf{sin}(\frac{2\pi}{\lambda}).\mathbf{cos\,wt}$ where $\mathbf{P_m}\perp\mathbf{E_m}$. Since also the tiny volume of wavelength |λ|≡[|+c.s²|↔|-c.s²|, consists a, *sink*, then DM attracts and it is an infinite ocean in all universe .

Since also Dark energy is effecting then, DE = q . [$\mathbf{E_m}+\bar{\mathbf{c}}.\mathbf{P_m}$] align with the field, so on [DM] dipole [$\mathbf{E_m}+\bar{\mathbf{c}}.\mathbf{P_m}$] exist also a torque (τ) and in this way [DE] repels.

Dark-energy [$\bar{\mathbf{c}}$.∇i] acting on the three constituents of [DM] = [(+c.s²) ,(-c.s²) ,(±c.s²)] separately and being also a non-uniform field, then is not canceled but is a pushing force, i.e. *DE is influencing as an expansion of the universe* . Because [DE] is a stationary force on [DM], so is exerting a very strong gravitational pull on gravity field (participates in gravity). Action of Dark matter, Dark Energy is, [DE] © [DM] ≡ [$\bar{\mathbf{c}}$.∇i] ©[DM] → [$\bar{\mathbf{c}}$.∇i].(+c.s²), [$\bar{\mathbf{c}}$.∇i].(-c.s²) , [$\bar{\mathbf{c}}$.∇i].|(±c.s²)| = [$\bar{\mathbf{c}}$.∇i].[|+c.s²|↔|-c.s²|] , and Results to,

1. DM → [|+c.s²|↔|-c.s²|] attracts and DE → [$\bar{\mathbf{c}}$.∇i]repels and not competing.
2. DE is exerting a pull and gravitational pull on all visible matter on the largest universe cosmic scale.
3. DE by exerting pull on DM → [$\bar{\mathbf{c}}$.∇i].(+c.s²) and on [$\bar{\mathbf{c}}$.∇i].(-c.s²) *highlights* , and on → [$\bar{\mathbf{c}}$.∇i].[|+c.s²|↔|-c.s²|] the Darkness which is the tiny energy volume consisting the dipole of dark matter, *and formulates the massive Dark Fringes and this because are not particles*.[41] Dark-matter becomes from the *Effective-Potential-energy* in a Central-motion and from Kepler constant k = 4π².r³.$\mathbf{f_P}$², or 1 = [$\frac{4\pi^2}{k}$]r³.$\mathbf{f_P}$² or → 1 = c. r³.$\mathbf{f_P}$² which is the dipole[|+c.s²|↔|-c.s²|] and attracts . *The Cause Expansion of the Universe, is the continuous and simultaneous effection of Dark-Energy* DE= [$\bar{\mathbf{c}}$.∇i] *on all Five Energy-Fragments with light velocity*$\bar{\mathbf{c}}$,*as* [$\bar{\mathbf{c}}$.∇i] →{(∇i),(+s²),(-s²),(+cs²),(-cs²)} *which is the rolling Heap . Energy Quantities* [∇i = 2(wr)²], *in the rolling Heap, acting on the dipole breakages* [± s²] *formulate the Gravity-Field and Gravity-Force while acting on dipole breakages* [±$\bar{\mathbf{c}}$.s²] *formulate Dark matter*, DM, *and Dark Energy* , DE, *respectively, while* DE acting on Baryons, *Leptons and Quarks Anti-Leptons and Anti - Quarks, Bosons, formulate the whole existing Material worlds*.
4. DM and DE are not visible because both travel with light velocity and so light is not interacting with them. Light, photon, *which is a particle and wave*, is interacting with the Rest Gravity field and all others with less velocity and so are detectable . Only velocities greater than that of light, *or a New simultaneity mechanism* , can make them visible. These velocities exist into Material points. From Inner-velocity equation v = wr = (2π/T).r = 2π.$\mathbf{f_1}$ r, wavelength λ= cT = c/$\mathbf{f_1}$, cave r = n.[λ/2], then r = n.(c /2$\mathbf{f_1}$) and from v = w.r = 2π.$\mathbf{f_1}$ [n.c/2$\mathbf{f_1}$] = n.π.c existsv = n.π.c showing that velocities in lobes are, n.π , times velocity that of light and for n = 1 then v = π.c, more than three times faster of light velocity . Becauseof the above velocity v, an E field is produced, and which then produces the $\boldsymbol{\partial D/\partial t}$ field , which in turn produces the H field and which then produces the $\boldsymbol{\partial B/\partial t}$ field and which again produces the E field and so on . Lobes [v = n.π.c] emit No-light, c, and cannot be seen. When Anti-matter annihilates with matter, gamma rays are produced , because Energy is converted to the *Three Breakages* → s², - s ², 2[$\bar{\mathbf{s}}$] ².∇i ← , *the Breakage Principle* ,and because in Energy- space continuum remains only the energy while DE acting on DM fragments|+c.s²|↔|-c.s²| ≡∅ formulates the massive compact spherical objects and massive compact anti-spherical Anti-objects.
5. Because of the DM and DE structure , which is breakages and force, collision of galaxies does not predict stars to be smashed into others. As above are created the, *gas clouds*, which are smashed into the other and get heated and so be a visible effect.
6. Because light is a particle with velocity, c, interacts with the REST gravity field by the Gravity force while DM, DE having the same velocity have a parallel motion, *not parallel universes* , which cannot see it. DE has exactly the same effect as that of a very small constant vacuum energy MFMF field. Energy density of the Rest base MFMF is that of gravity, $\mathbf{I_g}$, while of the Moving DE,DM is that of, c .$\mathbf{I_g}$, so in this way occurs expansion of the universe. GR being confined in Planck`s length $\mathbf{L_p}$,*could not* see the whole Energy- space beyond this length and the way and how could expansion occurs. Cosmological constant is the value of the energy density of the vacuum in the tiny space, without describing the how this tiny volume is expanded, so why to presume this as constant ..?.? The answer is that, this was then introduced just to surpass the problem. [41]
7. Because DM, DE consist a not homogeneous Heap of mass distribution (anomalous mass) and permeate the whole universe is causing what is said, the expansion of the universe to accelerate without any Big-Bang

explanation and any other mysteries force. The motion of this DM, DE, *mixture of the spherical opposite signed materials and dipole energy blobby volumes*, is not in contrary to gravity $\mathbf{F_g}$, because both have already passed from the center of STPL contracted mechanism.

Dark matter is the *Balancing of, Spinning-Momentum* of mass-energy in the Expanding universe . Gravity field is the Rest-Base of all universe which doesn`t exist apriori but is the Base, *the carpet* on which *the* DE-DM *Heap mixture*, with the same velocity ,c, is rolling*, expanding* , with the maximum constant velocity, c, and continually formulating the, *Zero → any Number,* the Discrete ≡ Granular*, → Infinite → Geometrical Universe,* Energy density of base.

8. *Black Holes are gravitational wells*, *caves*, in [MFMF] - Field ≡*The Energy - Chaos*, so any next constituent is dissipated or collapsed, swallowed. Following above analysis it is a kind of mechanism which is source of energy and because of conservation of energy law, Black-holes, *the quasars* exist in the centers of galaxies and are the beacons for astronomers and *consist the Recycled Space machines* of the Universe. DE, DM being also *constituents* are also recycled in Black-holes. The why are embedded in DM is a problem of stability and conservation of space and energy circle [STPL]→[DE,DM]→↻$\bar{\mathbf{\Lambda}}$↺
9. The principle of Virtual Work is the energy method for static procedure of interconnected Systems of material points or bodies of higher DOF and associated with the equilibrium of them and may be stated as follows, <If *a System in equilibrium under the action of a set of Forces is given a virtual displacement and the virtual Work done by the Forces will be zero*, and the opposite, *The virtual work done by the forces is zero for any equilibrium System under the Action of a set of forces* >. In case of two material points the static procedure is , *the Virtual work done by two forces is zero, for adual equilibrium system which results to the equality of opposite signed forces.*
10. It was shown that, *in the Rest base,* [MFMF]*field ,*± *s²,* *issue the Kepler - laws* , denoting that Macrocosm and Microcosm Obey, *Newton`s Laws of motion in all Scales*. Photon and the other Primary-Material-Points during Motion in [MFMF] Chaos, collide with the others, *by means of vector products,* and produce Work which is stored into the Only four Energy-Geometrical-Shapes of the motion . Evidently, the Rotation of the ⊕ = +s² around the ⊖ = - s² constituent , in any Material-Point executesa Circular motion on a circle of radius, r, where then the Total Energy E is Negative.

It was Prior shown that, Any moving Particle when is Tangentially-colliding with a Material-Point executing Circular motion, then the Total Energy Eis Negative ,and the Particle follows constant Elliptical – Energy - Orbits on the same semi major axis, and of the same constant Energy.

If the New Orbit *is of eccentricity*e = 0 *and Zero Total Energy, the Particle follows constant Circles*

If the New Orbit *is of eccentricity*e = 0*and Negative Total Energy , the Particle follows constant*
Elliptical – Energy - Orbits on the same semimajor axis, and of the same constant Energy.

If the New Orbit *is of eccentricity* 0 < e < 1 *and Negative Total Energy, the Particle follows constant*
Elliptical – Energy - Orbits on the same semimajor axis, and of the same constant Energy.

If the New Orbit *is of eccentricity*e = 1*, and Zero Total Energy the Particle follows constant*
Parabola – Energy - Orbits on the same semimajor axis, and of the same constant Energy.

If the New Orbit *is of eccentricity*e > 1*, and Positive Total Energy , the Particle follows constant*
Hyperbola – Energy - Orbits on the same semimajor axis, and of the same constant Energy.

If the New Orbit is of eccentricity e = 0 and Negative Total Energy , the Particle follows constant Elliptical-Energy-Orbits on the same semi major axis, and of the same constant Energy $\mathbf{f_P}^2$. From relation 1 = c. r³. $\mathbf{f_P}^2$, which is the attracting dipole[|+ n.π.c.s²|↔|- n.π.c.s²|] and because in lobes light-velocity is n.π.c times faster than that of light , No one velocity cexit can happen.

So all Planets move in this way, either in Atoms, *in microcosm*, or in Planetary - System, *in macrocosm* , obeying Newton`s equations of motion.

The New Creation Hypothesis is Summarized as follows F- 19:

a. From Nothing (*i.e. the Point*) to Existence (*i.e. tobe another Spherical Point*) issues the Zero Virtual work law, where zero Work is the equilibrium of two equal and opposite forces on points. Thus Space [S] is *the Point* and Anti-space [AS] is the *Other Point.* Infinite points are between, *the Point* and *Other Point* , and between the Infinite points also which consist the Primary Neutral Space [PNS] ≡ The Vacuum-space, as[∇i = 2(wr)²] x [± s²].
b. Work as, *Opposite forces*, exist on the infinite points between, *the Point,* and, *the Other Point*, which Opposite forces with different lever-arms exert the equal and opposite Angular Momentum $\bar{\mathbf{B}}$ which equilibrium, *as Work* $\mathbf{W_{n(n+1)}}$*, which is zero*.
c. Opposite Momentums are only in the Rest curl Energy volumes differently would not be rest. This inverse *Vortical motion*results to velocity vectors collision which are so crushed into three Energy-Fragments , and after clashed

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with the velocity vectors $\bar{\mathbf{v}},\bar{\mathbf{c}}$ are thrown OFF , *the curl Ellipsoid Energy volume* (*the Absolute System*), and through an Anti-diffused geometrical mechanism again in new Energy-Volume (*the Relative System are the parallel Inertial systems*).

d. This Anti-diffused mechanism drives all clashed fragments , either through the *Centre of the Common circle curl Ellipsoid forming the Rest Gravity Field - energy* [MFMF] *Chaos and the Movable Dark - Matter - Energy*, or through the Tangents on *Circumference of Common circle curl Ellipsoid and forming the Movable Particles – Antiparticles – Bosons,* to an Simultaneity Relative and cylindrical volume.

e. In this cylindrical volume , which are the parallel inertial systems, *is the Rest* Gravity-Energy - Field as the Base *carpet*, for *The Movable Dark* Matter-energy and for all Formation in *Rest or Movable*, *by Pulling and Repelling and also all* moving Particles–Antiparticles and Bosons, on where are applied laws of Chemistry and Physics.

11.. *Gravity-force and Force of gravity, g, in Black-Holes*

The principle of Virtual Work is the motion of a force, P, executed on a point A to reach point B, so A force acting on point A (*which is Nothing*) reaches point B (*which is also Nothing*), i.e. stability of the system A-B is obtained by the equal and opposite forces acting on points A , B . [|A|↔|B|]

On the infinite points between the two infinite and opposite forces are also acting on them resulting to a, *Whirling on a line*, perpendicular to A-B axis. Because of the Unbalance of Whirling, *it is a common source of vibration excitation*, the Rotating unbalanced*,* is represented by an angular velocity, w. The rest system of this opposite Whirling Energy, *vortices*, exists in the vibrating Ellipsoid volume which is a geometrical cave. This inverse vortical motion(w,- w), in cave results to *velocity vectors collision* which are crushed into fragments and after clashed with the velocity vectors are thrown, OFF *this curl Ellipsoid Energy volume (the Absolute System),* through an Anti-diffused geometrical mechanism to a new energy volume *(the rest Relative System)*. Fragments through, *The Centre* (where v=0) *of the Common circle Ellipsoid, form The Rest Gravity Field-energy* and the *Movable Dark Matter - Energy* , and through *The Tangent* (where v = v)on the *Circumference of the curl Ellipsoid circle , form the Movable Particles - Antiparticles – Bosons,* to an Simultaneity Relative cylindrical volume.

All movable elements are formulated, *by Pulling or Repelling and by Collision ,i.e.*

All moving Particles–Antiparticles and Bosons and all their producing`s, on where laws of Chemistry and Physics are applied, and the action of Energy[∇i] produces,

Dark Energy DE ≡ [$\bar{\mathbf{c}}$.∇i] (©) → Acting on the Five Constituents → [(∇i),(+s^2),(-s^2),(+cs^2),(-cs^2)]

[∇i].[± s^2] → MFMF Field [∇i].[±$\bar{\mathbf{c}}$.s^2] → DM-DE Field, of Dark matter and Anti-matter.

[∇i].[±$\bar{\mathbf{v}}$.s^2] → Fermions [∇i].[∇i] → $\mathbf{G_f}$ = Gravity-Force (- i) in DM-DE Field.

[∇i].[$\bar{\mathbf{v}}$.∇i] → Bosons, [∇i].[$\bar{\mathbf{c}}$.∇i] ≡ DE → Dark Energy.

c x (©)[. ∇i] → Gravity Force DE ≡ [$\bar{\mathbf{c}}$.∇i] =$\bar{\mathbf{c}}$[∇i] =The Travelling-Energy with c velocity and,

Regular Matter. → ⊖s^2 ≡ Electron, ⊕s^2 ≡ Proton , [⊖s^2 ↻↺⊕s^2] ≡ Neutron ↺

Anti - Matter → + ⊖ ≡ Positron, - ⊕≡ Anti-Proton ,[⊖s^2 ↺↻⊕s^2] ≡ Neutron ↻

Dark - Matter → [+$\bar{\mathbf{c}}$.s^2] ≡ Matter, [- $\bar{\mathbf{c}}$.s^2] ≡ Anti-Matter ,[$\bar{\mathbf{c}}$.⊖s^2 ↺↻$\bar{\mathbf{c}}$⊕s^2] ≡ ± Matter

Dark – Energy→ [+$\bar{\mathbf{c}}$.∇i] ≡ Energy, [-$\bar{\mathbf{c}}$.∇i] ≡ Anti-Energy ,[$\bar{\mathbf{c}}$.⊖∇i↺↻$\bar{\mathbf{c}}$.⊕∇i] ≡ ±Spin

Degenerate-Matter [+$\bar{\mathbf{v}}$.s^2] ≡ D-matter, [-$\bar{\mathbf{v}}$.s^2] ≡ D-Anti-Matter,[$\bar{\mathbf{v}}$⊖s^2 ↺↻$\bar{\mathbf{v}}$⊕s^2] ≡ ± D-matter

It was shown before that Atraction of opposite Forces $\mathbf{F_o}$↔ $\mathbf{F_P}$ at two different points , O , P creates the Central motion and Kepler`s laws where Orbits are Plane-curves representing a Constant-Energy becoming from the squared Periods T^2 , or Frequencies $\mathbf{f}^{2}{}_{\mathbf{p}}$,representing the Imaginary-Energy- Part and $\mathbf{r_n}^3$ representing the Real-Space-Part of monad $1 = C.\mathbf{f_n}^2.r^3$.

All these constants are the Quantized –Energy - Curve-Rims from which Galaxies are created .

Galaxies are accelerated and expanded as equation → $ds = \frac{\mathbf{F}}{\mathbf{2m}}[\frac{\mathbf{1}}{\mathbf{f}^2}] \equiv \frac{\mathbf{F=[\bar{c}.\nabla i]}}{\mathbf{2m}}[\frac{\mathbf{1}}{\mathbf{f}^2}] \equiv \frac{\mathbf{[\bar{c}.\nabla i]}}{\mathbf{2m}}[\frac{\mathbf{1}}{\mathbf{f}^2}]$ It was shown before that cavities, r, are *Inward a Stationary Wave* with infinite Frequencies $\mathbf{f_1}..\ \mathbf{f_n} \rightarrow \mathbf{f}_\infty$ and with Energy,

$$E = h.\mathbf{f_n} = \frac{\mathbf{h(1+\sqrt{5})}}{\mathbf{4\pi}}.\ [\frac{\sigma}{r}] = (\frac{\mathbf{n\sigma}}{\mathbf{8\,r^2}})\ .\bar{\mathbf{B}} = \mathbf{W_d} = v^2\ [\frac{\mathbf{h}}{\mathbf{2\pi}}],\ \text{or}\ \rightarrow\ r = \frac{\mathbf{n\pi}}{\mathbf{2h(1+\sqrt{5})}}\bar{\mathbf{B}} \ldots\ldots\ldots (r)$$

Equation (r) occupies a cave , r, in Space where *Glue-Bond pair of opposites*[⊖⊕], *Creates Rotation* and it is the *Material-point*, while *Collision of any two opposites*, ±$\bar{\mathbf{B}}$, annihilate each other.

This is the case of a *Black-hole* where issues *The Breakage-Principle, and which is the way of Energy conservation*, *where Energy* L =(B/2).w, *never annihilates and which is always reverted into* → the two Opposites (± w) *and an Neutral Part*2 .∇i← or as *Matter*(+w)*,* as *Antimatter*(- w) *and as Energy part*, 2L, *and always to its constituents, either to all or separate* following →L =(B/2).w.

Because Gravity-Force $\mathbf{F_G}$ becomes from the in-storages acceleration a = v²/r of MFMF material-points and force [∇i] is stationary because from the pointy-rotation [-s² ℧℧+s²], then for Planck length is, *Gravity force*

$$[\nabla i] \equiv \mathbf{F_G} \equiv \mathbf{m_G} g = g.\nabla[\frac{\sigma}{c^2}]^2.r = \mathbf{m_G}\frac{\mathbf{v}^2}{\mathbf{r}} = Jw^2.\mathbf{g_G} = [\frac{\pi r^4}{2}]\, w^2.\frac{\mathbf{v}^2}{\mathbf{r}} = \frac{\mathbf{v}^2}{\mathbf{r}}[\frac{\pi r^4}{2}]\frac{\mathbf{v}^2}{\mathbf{r}^2} = [\frac{\pi r v^4}{2}] \quad \ldots\ldots\ldots\ldots(s)$$

Substituting (r) in (s) and from relation, Spin S = $\frac{\mathbf{h}\sqrt{3}}{4\pi}$ then , $\mathbf{F_G} \equiv [\frac{\pi v^4}{2}]\frac{n\pi}{2h(1+\sqrt{5})}\overline{\mathbf{B}} = [\frac{n\pi^2}{4h(1+\sqrt{5})}]\overline{\mathbf{B}}\mathbf{v}^4$

Gravity-force → $\mathbf{F_G} \equiv \frac{n\pi\sqrt{3}}{16(1+\sqrt{5})}\mathbf{v}^4 = \frac{n\pi\sqrt{3}}{(1+\sqrt{5})}(\frac{v}{2})^4$, *which is the Black – hole - gravity - equation related to theInner velocity ,v, and to its,*n,*lobes* .

$\mathbf{g_G}$ = s$[\frac{\pi r v^4}{2}] = [\frac{3{,}1415926([\sqrt{5}+1].\sqrt[4]{2}.10^{-35}).(299793458)^4}{2}]\boldsymbol{e}^3$ = 6,044981.$\mathbf{10^{-35}}$.80,776078.$\mathbf{10^{32}}$.20,085536 =

$\mathbf{g_G}$ = 9,8076941, *where* 1 / $\mathbf{m_G}$ = s = mass-coefficient [√5+1] .$\sqrt[4]{\mathbf{2}}.\ \mathbf{e^3}$

The constant tensor $\mathbf{T_z}$ = Tensor (the length) of vector, z ≡ m, in Euclidean coordinates and which magnitude is, k = $\mathbf{T_z} = \sqrt{\mathbf{y_1}^2 + \mathbf{y_2}^2 + \mathbf{y_3}^2 + \mathbf{y_n}^2}$, denotes the Energy-Space relation From above the dimensionless coefficient of work W is , [v5+1] , for any Material-cave, r ,

The Unity-Plane-Quaternion coefficient is $\sqrt[2]{\sqrt[2]{\mathbf{2}}} = \sqrt[4]{\mathbf{2}},\overleftrightarrow{\mathbf{\imath} \perp \mathbf{\jmath} \equiv \sqrt{\mathbf{2}}} + \overleftrightarrow{\mathbf{k} \perp \sqrt{\mathbf{2}} \equiv \sqrt[2]{\sqrt[2]{\mathbf{2}}}} = \sqrt[4]{\mathbf{2}}$

The Three dimensions for the Rotation-System of Euler`s number is e . e . e =$\boldsymbol{e^3}$

All bodies produce gravity because are in MFMF field which is consisted of the stationary [∇i] = ± s² forces as Material points [⊕s²℧℧⊖s²] . By compressing it , the more intense of gravity is at its surface and this because of the principal stress-common-curve . By producing a body that *had such an intense gravity* , that even light could not escape from it , then this body would be called *Black-hole* .

It was shown that, ± *Energy in Orbits*, defines the Orbiting-path of Planet related to frequency f , and to the Semi-major axis a of the Conic. Plank`s formula for energy states that E = h .f .

From Kepler`s 2nd law the area , S , swept by any*Focus-Planet-Sector* ≡ FP is constant and equal to,

S² = $\frac{L^2T^2}{4m^2} = \pi^2 a^2[b = \pi a(\frac{L^2}{2mE})]$, or $\frac{T^2}{a^2} = \frac{4\pi^2 m}{2E} = \frac{4\pi^2}{2E/m} = \frac{4\pi^2 a}{GM}$ and → $\frac{T^2}{a^3} = \frac{4\pi^2}{GM}$ = k = $\frac{1}{f^2{}_n.a^3}$or→1= k.$\mathbf{f^2{}_n.a^3}$

Above equation 1= k.$\mathbf{f^2{}_n.a^3}$, denotes that by increasing of frequency f, a decreases since k = constant Semi major axis ,a, is related to energy as → a = GMm / 2E, i.e.

For very large Energies , semi major axis tents to a Negative-Energy-Point ,which is the beginning of the Black-hole in microcosm and macrocosm. *For axis* a → 0 , *then* $\mathbf{f_n}$ → ∞, which is Black-hole.

The Phase speed of a Photon is defined the moving velocity of its rotating phase as, v =λ/T =λf= w/k. As the cycloid occupies the, *Isochronous*, property for velocities the same for, *Congruency property*, are the Logarithm-Spirals which are *congruent to their Involutes, Evolutes, and the Pedal-curves*.

Logarithm-Spirals are in Polar-coordinates as r = a.$\mathbf{e^{b\theta}}$ or θ = $\frac{1}{b}\mathbf{ln}(\boldsymbol{r/a})$ and , x(t) = r(t) .$\mathbf{cos(t)}$ = a . $\mathbf{e^{bt}}.\mathbf{cos(t)}$,

$$y(t) = r(t)\ .\mathbf{sin(t)} = a.\mathbf{e^{bt}}.\ \mathbf{sin(t)} \ldots\ldots\ldots\ldots (1)$$

where

r = The distance from Initial point
e = The base of natural logarithm
a , b Arbitrary positive constants
For b = 0 then from (1) → θ = π / 2 Spiral is a circle
For θ = 0 then from (1) → limit b = ∞ and Spiral tends toward a straight-line
For a ≠ b ≠ 0 , then from (1) → θ ≠ π / 2 and Spiral is between an ellipse and a circle .

The constancy of , Tangential and Radial line angle, φ , for any point conserves the exponential properties of Euler`s complex exponential function r.cos [ r(θ),r`(θ)/{r(θ), r`(θ)}]=arc tan $\frac{1}{b}$ = φ and issue Euler`s equations,

$\frac{d}{dx}\mathbf{e^x} = \mathbf{e^x}.\mathbf{log_e\, e} = \mathbf{e^x}$, $\mathbf{e^{-i.\theta}} = \mathbf{cos\,\theta}$ + i.$\mathbf{sin\,\theta}$, r/$\mathbf{cos\,\varphi}$ = c .

All above Curves *occupy properties* that can carry the nature of Quaternion ≡ monads ≡ Vibrations in Spaces and Anti-spaces as the $\mathbf{z^w}$, $\mathbf{z^{1/w}}$ equations of monads in the Logarithm-Spirals as is,

$$\to \mathbf{z^w} = (\mathbf{s} + \bar{\mathbf{v}}\nabla\mathbf{i})^{\mathbf{w}} = |\mathbf{z_o}|^{\mathbf{w}}.\ [\mathbf{cos\ w\,\varphi + \varepsilon.sin\ w\varphi}] = |\mathbf{z_o}|^{\mathbf{w}}.\mathbf{e^{i.w\varphi}} \quad , \ \ldots\ldots\ldots\ldots(2)$$

$$\to \mathbf{z^{1/w}} = (\ \mathbf{s} + \bar{\mathbf{v}}\nabla\mathbf{i}\ )^{\mathbf{1/w}} = |\mathbf{z_o}|^{-\mathbf{w}}.[\mathbf{cos\ (\varphi + 2k\pi)/w + i.sin(\varphi + 2k\pi\,/w)}] = |\mathbf{z_o}|^{-\mathbf{w}}.\mathbf{e^{i.(\varphi+2k\pi)/w}}$$

Since a Black-hole is a Place in Space where Gravity (*a force due to an acceleration in the stationary Material-point*[⊕s²℧℧⊖s²]) pulls so much(nπ.c) that even light cannot get out, therefore are invisible.
The only way, is to see directly the effect of its strong gravity, on the stars and gases around it.

Question, How and Why exist the Black-holes ??

It was referred before that Dark matter is the *Balancing of the Spinning-Momentum* of mass-energy in the Expanding universe, Differently *Unbalance in the rotating Spinning - Momentum* will be one of the common source of *Vibration excitation*. This is the why Dark matter, Dark Energy exists.

A. Two *Physical-Systems are in Thermal-Equilibrium* if there is no net flow of Thermal-Energy between them , when they are connected by a *Path Permeable to Heat*. Thermal-equilibrium obeys the zeroth law of Thermodynamics, where the temperature within the System is, *Flowing Spatially and Temporally Uniform*.

B. Two *Physical-Systems are in Mechanical-Equilibrium*, it is the condition of the Systems when neither their *State of motion* nor their *Internal Energy-State* tends to change with time and motion. Equilibrium is established even if the *Gradient of the Potential-Energy* with respect to the generalized coordinates is zero.

C. The two existing *Physical-Systems, that of Gravity-force* $\nabla\mathbf{i}$,and that of *all others*{[∇i].[$\pm\bar{\mathbf{v}}$.s²]}, is the condition of the two Systems, *either Stationary or in Motion*, to react continuously either Internal or external and their *State of motion* either the *Internal Energy-State* or their *External Energy-State,* which tends to change between them, *to be connected by a Path Permeable to a common motion.*

Because *Gravity-force* $\nabla\mathbf{i}$, Stationary exists as Pointy-Spinning → $\mathbf{F_G} \equiv \frac{\mathbf{n\pi\sqrt{3}}}{\mathbf{16(1+\sqrt{5})}}\mathbf{v^4} = \frac{\mathbf{n\pi\sqrt{3}}}{\mathbf{(1+\sqrt{5})}}(\frac{\mathbf{v}}{\mathbf{2}})^{\mathbf{4}}$,and in the light-velocity moving *Rolling-Heap*, as the Travel-Spinning →$\bar{\mathbf{c}}\mathbf{F_G} \equiv \frac{\mathbf{c.n\pi\sqrt{3}}}{\mathbf{16(1+\sqrt{5})}}\mathbf{v^4} = \frac{\mathbf{c.n\pi\sqrt{3}}}{\mathbf{(1+\sqrt{5})}}(\frac{\mathbf{v}}{\mathbf{2}})^{\mathbf{4}}$, *and according to* [C.], The condition of the two Systems, *either Stationary or in Motion*, to react continuously either *Internal or External* and their *State of motion* either the *Internal Energy-State* or their *External Energy-State,* which tends to change between them, *is to be connected by a Path Permeable to a Common-motion.* Which is the Path and where this drives ??

This *Path is the Black-hole*, driving to the Common-motion *to the Rest Gravity Energy-Field-* [MFMF] In-where exist the, Pointy Stationary-Gravity-force $\nabla\mathbf{i}$, the Moving-Gravity-force [$\bar{\mathbf{c}}$.∇i], and that of All the others {[∇i].[$\pm\bar{\mathbf{v}}$.s²]} .

All stars are under the pressure of Gravity. This force is created from the continuous internal acceleration a = v²/r of Material-points [⊕s²↻↺⊖s²]in MFMF Gravity-field .The continuous pressure between them reach a point that they cannot be compressed any further , and the electrons degenerated pressure on a Neutron Star breaks-down under the force of Gravity and then, *Black holes are created* . In this way a NEW System *just the opposite* to [STPL] is generated and all {Regular Matter and Antimatter, Dark Matter, Energy, Degenerate matter, Stationary and travelling Gravity-force} are annihilated following *The Permeable Resonance - Path of Gravity-Material-Point* from the eternal motion of opposites.

D. Following Kepler laws then, *On any moving Particle when is Tangentially-colliding* or *under any angle* φ *with a Material-Point executing Circular motion*, then *the Total Energy* E *is Negative*, and the Particle follows *constant* Elliptical-Energy-Orbits on the same semi major axis as, k =1/c = $\mathbf{f_n}^2$.a³, and of the same constant Energy. Semi major axis, a, is related to energy as → a = GMm / 2E, i.e. for very large Energies semi major axis tents to a Negative-Energy-Point, which is the beginning of the Black hole in microcosm and macrocosm.

For axis a → 0 , *then* $\mathbf{f_n}$ → ∞, i.e. *for very small semi major axis a, frequency becomes infinite and Infinite-Negative-Energy also*, which is the Black-hole.

Resonance-Path happens as the Force, *EM-Radiation in Two directions*, can travel in any closed *System* through Cauchy-stress-tensor where the two Conveyers E ⊥ B ⊥ r ≡ $\boldsymbol{\sigma_1}\perp\boldsymbol{\sigma_2}\perp\boldsymbol{\sigma_3}$, can carry the *Energy Storage* r, in *System*, and change the Inner-Structure of System to another *Primary-Energy-System*.

From Inner-velocity equation → v = wr = (2π/T)r = 2π.$\mathbf{f_1}$ r , wavelength λ = cT = c / $\mathbf{f_1}$, cave r = n.[λ/2] and → r = n.(c /2$\mathbf{f_1}$) also v = 2π.$\mathbf{f_1}$ [n.c/2$\mathbf{f_1}$] = n.π.c *or* →v = n.π.c← and thus showing, velocities in lobes are, n.π , times that of light, and for n = 1 then v = π.ci.e. more than 3 times the light velocity.

The answer to the question < Why is the speed of light constant and magnitude c ? *and not* , it just does > is because as prior referred ,the Centrifugal velocity, $\bar{\mathbf{v}} = \bar{\mathbf{w}}$.r, is always a constant $\bar{\mathbf{c}}$, and this because acceleration [d$\bar{\mathbf{v}}$/ dt = d($\bar{\mathbf{w}}$r/dt)=0] is zero since $\bar{\mathbf{w}}$ is constant .[39]

X. Epilogus

The origin of Space[S] *becomes, through the Principle of Virtual Displacements W* = $\int_A^B \boldsymbol{P.ds}$= *0, from Primary Point* A, *which is the Space, to point* B *which is the Anti-space as the Inner distance of Space and Anti-Space in all Layers becoming as shown from STPL Mechanism.*

The origin of Energy becomes , through the same Principle because are co-related and is the Work, motion, executed by the displacement, ds, and *is conserved between points,* A and B, *and which never vanishes.*

This means that Universe is Energy-Space and nothing else, which follows the Glue-Bond – Principle in all Positions and Layers starting from The First Eternal< Self – Moving – Energy - Dipole > ≡ *The Quantum, of this*

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cosmos and transformed in every Energy Space level as the Golden ratio frequency. The Torsional oscillation of Caves (cleft, slit)*,* w*, is transformed as inner Wave-frequencies which in turn, to monads and moving Particles transforming Inward-Spin to the Outward-Spin and motion. All above are produced in and from STPL.*

Energy produced by Reference System $\{\mathbf{D_A}\text{-}\ \mathbf{P_A}\}\equiv$ [R] (x', y', z', t') *moves with velocity*, $\bar{\mathbf{v}}$, *parallel*, to x-x', *axis with respect to the fixed and Absolute System* $\{\mathbf{D_A}\text{-}\ \mathrm{O}\}\equiv$ [S](x,y,z, t) and is conserved.

Energy of the whole universe is defined as a whole, all at once, and not the Energy of different pieces. It was referred that Energy in Gravitational-Field is Torsional and Negative and always attractive. [27]

In General-Relativity is referred that Space time is giving energy to matter or absorbed it from matter, and thus the Total energy is not conserved. Here are not clarified the three Basic Quantities, Energy, Matter and Time. It was proved that the Basic Quantity is only the Energy → motion, while Matter is the Space where Energy is stored, and Time is the meter of changes in Energy.

The Argument < Energy is not conserved but it changes because Spacetime does >is the greatest –confusion for these magnitudes. In [31-36] and [39] was clarified that →

1) Because of Zero acceleration of rotational velocity $\bar{\mathbf{w}}$ in a cave, velocity $\bar{\mathbf{v}}$=wr is also constant , so thus GR failed *to explain the WHY speed of light is constant*, considering constancy of light as an axiom from which derived the rest of its theory.
2) For the reality of discrete monads, GR failed *to explain the WHY → Wave nature, is the Intrinsic Electromagnetic Wave of Particles* (Maxwell`s Displacement current) and speed of light is constant in a Stress-Strain System with (where Red-shift happens as low f and-Blue-shift, as high f) Photon to be as Particle and Wave also as above, but considering constancy of light as an axiom deriving theory. Here is referred that, Since the mass is equal to $m = \frac{2}{c^2}(wr)^3 = \frac{h.w}{2\pi.c^2}$, *analogous to Energy w*, → then *mass is a factor measuring energy magnitude only*,
3) GR, by Appealing space-time a Priori is *accepting the two elements, Space and Time, as the fundamental elements of universe* without any proof for it, and so anybody can say that this *Stay on air*. It has been proofed [22-26] that any space AB is composed of points A, B which are nothing and equilibrium by the opposite forces $\mathbf{P_{\bar{A}}} = -\mathbf{P_{\bar{B}}}$ following *Principle of Virtual Displacement*.
4) GR, by Presenting Time as element of universe *could not perceive that, Time (t) is the conversion factor between the conventional units (second) and length units (meter), and by considering the moving monads (particles etc. in space) at the speed of light pass also through Time ,this is an widely agreeable illusion*. *It was proved that Time is a meter, A simple number, measuring the alterations of Space concerning velocity and direction*.
5) GR by Presenting Space-Time universe *Becoming from Big Bang* is accepting Infinite priors. Euler-Savary equation of couple-curves is related to the Tangential and angular velocity from (Space, *Path*, Anti-space, *Evolute*) and is, *The Rolling-Glue-Bond of Space , Anti-space*, and which happens on the instaneous center of curvature by STPL line. [58]
6) The Energy - Space Genesis Mechanism:

Everything in this cosmos, is Done or Becomes, from a Mould where,
In Geometry Mould is the Monad, the discrete continuity AB from points,
In Mechanics-Physics Mould is the Recent Acquisition of Material - Geometry where,
Material-point = The discrete continuity$|\oplus+\ominus|$ = The Quantum = Energy distance,
In Plane Mould is number ,π, becoming from the Squaring of the circle as extrema case, In the Space, volume, Mould is the number $\sqrt[3]{2}$ becoming from the Duplication of the Cube [STPL] Geometrical Mechanism, is itself the Mould which produces and composite all opposite Spaces and Anti spaces Points, to Rest-Material-points which are the three Breakages $\{[s^2 = \pm(\bar{\mathbf{w}}.r)^2,\ [\nabla i] = 2(wr)^2]$ of [MFMF] Gravity, under thrust $\bar{\mathbf{v}} = \bar{\mathbf{c}}\ \}$, where become Fermions → $[\pm\bar{\mathbf{v}}.s^2\ ]$and Bosons → $[\bar{\mathbf{v}}.\nabla i = [\bar{\mathbf{v}}.2(\bar{\mathbf{w}}.r)^2] = [\bar{\mathbf{v}}.2s^2\ ]$.

Big Bang and GR *was the temporary solution to the weakness of what men-kind had to answer*. Nature cannot be described through infinite concepts, as this can happen in Algebra and values, because are devoid of any meaning in our Objective - Reality, or the Physical World, or the Nature , or the Cosmos. Solutions of geometric classification problems with moduli Spaces, and Algebraic geometry by giving a universal space of parameters for the problems, must follow the classical and dialectic logic of Geometry which exists in Objective reality.

And which is this logic ? This way of thinking is nothing else than the Dialectic way of thinking and which is able to solve the Geometrical problems and that of Mechanics.

Material Geometry is the Science and the Quantization-Quality of this Cosmos which joints the, infinite dimensionless and the meaningless Points, *which have only Position*, with those of Nature which are *Qualitative the, Positive - Negative - Zero Points and which have, Positions, infinite Directions and Magnitudes with infinite meanings*, which through the Physical laws are the language of them in itself.

One of the most important concept in geometry is, *distance*, which is the Quanta in geometry, while in Material-Geometry the composition of opposite, *the Material-point*, which is the Quanta in Chemistry and Physics. A wide analysis in Book [58]. The Work, *as Energy*, is the Essence of this deep connection of Material-Points, *The Space*, and through the Conservation-laws is making the

Material-Geometry from STPL mechanism. Extension of the Material - Geometry to the chemical-sector gives the possibility for new materials in a drained way of thinking. In summary, my personal confidence is that nature is produced from Euclidean Geometry moulds, *as Space only* from the two existing, *Energy opposites*, *by following the Principle of Virtual work*, and not any other logical starting point.

The essential difference between Euclidean and the non-Euclidean geometries has been attentive in the very specially written article [32] for the nature of the parallel lines, a unique Postulate directly connected to the physical world. [STPL] line (doubled cylinder in spatial CS) is the creation Mould for Particles, *Quanta*, which are created between all Space-Levels and which Spaces are directly connected. [58]

Particles and Forces consist the monads *i.e.*

The Vibrations caused by the varying lever arms, *the varying lengths between Cycloid and Anti –cycloid of inner structures of monads*, and which cause the *Inner Electromagnetic waves and Spin* of Energy caves create motion. This motion is conserved and transferred everywhere and in all levels. Vibrations are caused from the first Material point becoming from the eternal rolling of the |⊕| Space on⊖ Space producing the physical angular velocity, w, and dissipation under conditions of cyclic oscillations in monads. The Work produced by this eternal rotation in r cave is stored in the n, lobes of cave r, and is outward the *Golden ratio frequency* → $\mathbf{f_n} = (\frac{\mathbf{n\sigma}}{\mathbf{8\,r}^2}).\overline{\mathbf{B}} = \frac{\mathbf{n\sigma}}{\mathbf{8}r}[1+\sqrt{\mathbf{5}}]$ of electromagnetic wave. Inner, Spin and EM wave, is transformed to the Outer Electromagnetic Wave of Particles as this is in Photon. Their Inner Electric and Magnetic forces are related to gravity\`s forces, thus unify all physics. According to the Second law of Thermodynamics by considering the Material-point as a closed system this tends to equilibrium State, *on the contrary*, *Spin is the available energy to do Work* , i.e. *In Material point the second law of Thermodynamics is Violated*.

Moreover, the articles concerning the Ancient and Special unsolved till yesterday Greek problems of E-geometry argue , and defense on all the above referred. [44-49]-[52]

7) The How Enerrgy from Chaos becomes the First-Discrete-Material-Point:

Material-point was proved to be a System which has an Inner–Rotation - constrained, Due to the velocity vector, $\overline{\mathbf{v}} = \frac{\mathbf{d\psi}}{\mathbf{dt}}$ and Angular velocity, $\overline{\mathbf{w}}$, becoming from Stress, σ, of the two Opposite Constituents [⊕↔⊖], and which is the Force applied on lever-arm ,$\overline{\mathbf{r}}$, in space , on where External Forces and Moments are not existing.

The inner forces of this system, are the two equilibrium → Centripetal and Centrifugal Forces ← due to the Eternal, ± σ, Stresses of Opposites.

As in Algebra Zero ,0, is the *Master-key* number for all Positive and Negative numbers and this because their sum and multiplication becomes zero, *and the same* on any coordinate-system where ± axes pass from zero, *Exists also Apriori in Geometry the Material-Point* in where the Rolling of the Positive ⊕, constituent on the Negative ⊖, constituent, creates the Neutral Material point which Equilibrium , and consists the *First–Discrete - Energy-monad* which occupies, *Discrete Value and Direction*, in contradiction to the point which is, nothing, *Dimensionless* and *without any Direction*.

Material-point was proved to be the *First Energy monad* because occupies a Space, a cave, in where exists an Eternal intrinsic rotation with a constant Angular-velocity $\overline{\mathbf{w}}$andan Angular-momentum $\overline{\mathbf{B}}$.

This Angular - momentum is identical with Spin, which is trapped in caves\`s loops and which are in Phase with each other. The amplitude of Oscillation varies from Zero at Nodes to maxima at Antinodes.

8) The How and Where , Energy from Chaos Becomes Discrete – monads and Spin:

In Planck\`s cave [61A–64] is proved and shown,

The Angular-momentum Vector $\overline{\mathbf{B}}$ is identical to the Spin, S, and analogous to the Magnetic moment $\overline{\boldsymbol{\mu}} = \frac{\mathbf{4r.L}}{(\mathbf{1+}\sqrt{\mathbf{5}}\,])\,.\boldsymbol{\sigma}}$and vector $\overline{\mathbf{B}} = \frac{\boldsymbol{\pi}\mathbf{r}^3\boldsymbol{\sigma}}{\mathbf{8}}[1+\sqrt{\mathbf{5}}]$, both depended on Glue bond σ . The *Angular -Velocity Vector* $\overline{\mathbf{w}}$ is identical to The current-loop Torque and analogous to the charge $\overline{\mathbf{q}} = (\frac{\mathbf{m}.\overline{\mathbf{w}}.\overline{\boldsymbol{\mu}}}{\mathbf{Lg_s}}) =$ [r σ (1+√5)] a *Golden-ratio-charge* relation .

In Under-Planck cave [64] is proved and shown,

The Angular - momentum Vector$\overline{\mathbf{B}}$ is identical to Spin $\equiv \frac{\mathbf{E}}{\mathbf{w}} = \frac{\mathbf{h_m}}{\mathbf{2\pi}} = \overline{\mathbf{B}} = [\mathbf{r}.\boldsymbol{\sigma}.(\mathbf{1}+\sqrt{\mathbf{5}})\,]$ and analogous to *the Golden-ratio* of cave, r, and Glue-bond ± σ. The *Angular -Velocity Vector* $\overline{\mathbf{w}}$is analogous to the Principal Stress σ, as $|w| = \frac{\boldsymbol{\sigma}}{\mathbf{2r}}[\,1+\sqrt{\mathbf{5}}]$ and is a *Golden-ratio-angular velocity vector* relation causing the mass of monads, which is the meter of, *the reaction to the change of velocity vector*.[72]'

9) The Where Energy, produced through a Circular Removal of Space, is Stored:

In article [62] was shown the Geometrical construction of all the - Regular - Polygons in a circle and, for Odd, between the two sequent Even Polygons. Any two chords at the Ends of any diameter consist *the Space* and *Anti -*

Space monads which are Perpendicular each other and do not produce Work.

In case of a Removal from these two chords the *Work Produced* between them *is equal to the Central triangle* Surface, and consists the Quantization of the Work –Produced in Geometry- Monads,

Work, Either – in, Odd - Regular - Polygons and with their Angle, OR - in, Any - Shape of Area equal to the Space triangle, and are equal also to the, In Area of the Anti - Space triangle.

It was also proved that, By Scanning Any Space-Monad $\boldsymbol{K K_1}$ *to a Space –Monad* $\boldsymbol{K K_2}$ *of the circle, The Work produced is conserved in a Space - triangle in the circle, and in one of equal area out of the circle, which is the Anti-Space triangle, meaning that,*

The above relation of this Plane Work, is the Quantization in Geometry – Shapes, and becomes into the Plane – Stores of Anti-Space and, consists the Unification of Geometry – monads with those of the Energy monads, which Energy - monads is the Work in caves stored as Angular momentum and Angular velocity Ellipsoids, and which were analyzed and have all been fully described.

For Orbit or, Negative-Energy-Rim, which is the Stable and Stationary Granular-lattice-Energy-Disk, which is kept in the Plane-Orbit of motion, In the Ellipse area, πab, existing in Gravity-field, and in a way Opposite to that which follows the Central motion.

It was shown in [58] that the free rotation is so happening because of the eternal rotation of the ⊕ constituent on the ⊖ constituent in the two x, z, axis of rotation. Considering the distance of rotation be, the diameter of the cave, l = 2r , then velocities as angular velocity, w, and velocity, v, under the condition y(2r,0) = 0, then leads to the Energy-equation $\mathbf{sin}\frac{\mathbf{2rw}}{\mathbf{v}}= 0$, or $\mathbf{w_n}.\frac{\mathbf{2r}}{\mathbf{v}}=\frac{\mathbf{4\pi r}}{\boldsymbol{\lambda}}= n.\pi =\frac{\mathbf{4\pi rf}}{\mathbf{v}}$, where n = 1,2,3, and $\boldsymbol{\lambda}=\frac{\boldsymbol{c}}{\boldsymbol{f}}$ is the wavelength and, f, is the frequency of oscillation, *i.e.* Each, n, represents → *a Normal mode vibration* with natural frequency determined by the *Golden-ratio* equation →

$$\mathbf{f_n}=\frac{\mathbf{n.v}}{\mathbf{4r}}=\frac{\mathbf{n\sigma}}{\boldsymbol{8r}}[1+\sqrt{\mathbf{5}}] \qquad \text{...} \quad (n)$$

i.e. Normal mode vibration is an Energy - cave (the ∞ modes of $\mathbf{f_n}$) in where, Energy ≡ Spin is stored. Above relation (n) denotes the Energy-Storages in Material -point or Oscillations or and monads which are the Quantization of frequencies as the harmonics $\mathbf{f_1}$, $\mathbf{f_2}$,… ,$\mathbf{f_n}$ of cave, r = l , depended on, σ, only.

The rotating axis, l = 2r = K$\mathbf{K_1}$ *in Material – point, creates the* Linear vibration of string*, l, which is* K≡ [⊖] ↔ $\mathbf{K_1}$≡ [⊕] *and the Natural - frequency* $\mathbf{f_n}$*, in points,* K , $\mathbf{K_1}$ *, or the* Rotational vibration of string *which is* [K≡⊖ s² ↻↺ $\mathbf{K_1}$≡ ⊕s²].

In cave of radius, r, the correlation of → *Natural frequency*$\mathbf{f_n}$*, becoming from the Linear vibration of string*, and → *Spin equal to the Angular - momentum Vector* $\overline{\mathbf{B}}$*, becoming from the Rotational vibration of string*, Spin ≡ $\frac{\mathbf{E}}{\mathbf{w}}$= $\overline{\mathbf{B}}$=$[\mathbf{r.\sigma.(1+\sqrt{5})}]$ and Natural-Frequency $\mathbf{f_n}=\frac{\mathbf{n.v}}{\mathbf{4r}}=\frac{\mathbf{n\sigma}}{\boldsymbol{8r}}[1+\sqrt{\mathbf{5}}]$ is,

Spin ≡$\overline{\mathbf{B}}$=$[\mathbf{r.\sigma(1+\sqrt{5})}] = (\frac{\mathbf{8\,r^2}}{\boldsymbol{n}}).\mathbf{f_n}$and ,$\frac{\overline{\mathbf{B}}}{\mathbf{f_n}} = (\frac{\mathbf{8\,r^2}}{\boldsymbol{n\,\sigma}})$ = *Constant golden-ratio* for each cave ,and Frequency ≡ $\mathbf{f_n} = (\frac{\mathbf{n\sigma}}{\mathbf{8\,r^2}}).\overline{\mathbf{B}}$ → i.e. Energy-caves are Stationary Wave-Fringes.

In Material point*, and because of the Eternal rotation of the* [⊕] *constituent around* [⊖] *constituent*, *the Stretched - String Energy*$\overline{\mathbf{B}}$ *is not transmitted, but trapped in the,* N loops *, where loops are all in Phase with each other, and the amplitude of oscillation varies from zero, at the* N *nodes, to maxima at the antinodes. By considering rotation as a grating having* N *lines per,* r, *then maximum values of,* n, *is* n <$\frac{\mathbf{1}}{\mathbf{N\lambda}}$ *, i.e. the biggest whole number less than* $\frac{\mathbf{1}}{\mathbf{N\lambda}}$ *which is always integer .*

This is the Why Spin is , $\frac{\boldsymbol{l}}{\mathbf{2}},\frac{\boldsymbol{l}}{\mathbf{3}},\frac{\boldsymbol{l}}{\mathbf{4}},\frac{\boldsymbol{l}}{\mathbf{5}}$, …….$\frac{\mathbf{l}}{\mathbf{N}}$, *i.e.*

One, Half, Third …$\frac{\mathbf{1}}{\mathbf{N}}$. - Lengths →$[\frac{\boldsymbol{l}}{\mathbf{2}},\frac{\boldsymbol{l}}{\mathbf{2}}]$,$[\frac{\boldsymbol{l}}{\mathbf{3}},\frac{\boldsymbol{l}}{\mathbf{3}},\frac{\boldsymbol{l}}{\mathbf{3}}]$, , ,$[\frac{\boldsymbol{l}}{\boldsymbol{N}},\frac{\boldsymbol{l}}{\boldsymbol{N}}]$, with One, Two, Three ,,, N- *Wave-nodes.* Above is the, *Stationary - Wave - Nodes Principle* , in Material – point, and in all monads.

In article was proved that,*in Material Point* , the Eternal - Rotation of (+) Opposite around (-) Opposite , due to Centifugal and Centrifugal Glue-Bond Principal-stresses, ± σ, *creates in Primary and in caves which are Standing waves as Resonance phenomenon*, the Angular – Momentum being Identical to the Spin of Particles , and which is trapped in caves`s loops always being in Phase with each other.

Their amplitude of Oscillation varies from Zero at Nodes to maxima at Antinodes.

The N *loops are*, the N, *Sub - Stores* created in the *Main-Store*, r, and this because Energy Momentum vector ,$\overline{\mathbf{B}}$, follows the Stationary-Wave -Nodes Principle in Material – point only. From Inner-velocity equation v = wr = (2π/T)r = 2π.$\mathbf{f_1}$.r, wavelength λ = cT = c /$\mathbf{f_1}$, cave r = n.[λ/2] , then r = n.(c /2$\mathbf{f_1}$) and v = 2π.$\mathbf{f_1}$ [n.c/2$\mathbf{f_1}$] = n.π.c or v = n.π.c …(4) showing that velocities in lobes are, n.π, times that of light , i.e. in Material-points exist velocities multi-times that of light. .

It has been confirmed that, when Matter and Antimatter annihilate at rest or when Anti-space comes in contact with its regular Space counterpart, they mutually destroy each other and all of their Energy is converted to the *Three Breakages* $\rightarrow s^2$, $-|\bar{\mathbf{v}}|^2$, $[2\bar{\mathbf{w}}].|s|\ |r|.\nabla i \leftarrow$ where for, $\bar{\mathbf{v}} = s \equiv$ the cave,

$[s^2] \rightarrow$ is the Real part, *Matter*, of the new monad, and is *a Positive Scalar magnitude*.

$-[s^2] \rightarrow$ is the always Negative part, *Anti-matter*, which is always *a Negative Scalar magnitude*.

$2s^2.\nabla i \rightarrow$ is the double Angular-Velocity Term, *The Energy Term*, which is *a Vector magnitude,*
And since *Energy is motion* and, *Total – Energy of Elementary - Particle* is equal to the $\rightarrow$ *Intrinsic Rotational + Kinetic Energy from velocity*, *then* according to the conservation law of Energy, *This Energy is stored into Neutral caves as Stationary Loops*, and thus producing the *Space and the Anti - Space Particles with velocity vector the remaining of Energy Term*.

This is *The Breakage-Principle, which is the way of Energy conservation*, *where Energy never annihilates and which is always reverted into* $\rightarrow$ the *two Opposites* ($\pm$ w) *and an Neutral Part* $2\nabla i \leftarrow$ or as, *Matter* (+ w), as *Antimatter* (- w) *and as Energy part*, 2L, *and always to its constituents, either to all or separate* following $\rightarrow$ Total Energy as L = (B/2).w. Because Motion is obtained either by Pushing or Attracting, so both cases presuppose NOT the Continuity of points which points are nothing, But Discontinuity, *Discrete*, with the dimensional Units as filling as this was shown in Zenon Paradox (1), *i.e. through Granular Material-Space*. Advancing from Primary to compound elements as are Atoms, *Discrete Energy - monads*, *then by following above logic for, Primary Particles or Atoms, is formulated a Geometrical formula of all* *Moulds* [Space –Anti space - Energy] $\equiv[\oplus\leftrightarrow\ominus]-[\bar{\mathbf{v}}.\nabla i]$, *without any Assumptions, or Axioms, or Exclusion Principles, or any other Starting Points.*

In a few words Energy ≡ Motion ≡ Quantized constant-Quantity in Energy-lobes as the loops, and Exists because of Opposition or Charge. Is trapped in Energy - caves in case of Circular-motion ≡ {Stationary Waves ≡ The monads}, Is getting Out the cave in case of the Skin-effect ≡ { Formulated in the three Moulds of $\rightarrow$[Space – Anti space - Kinetic Energy]}, Never vanishes, But continuously changes to above three Moulds, formulating the Primary and Compound elements of this cosmos.

10. The Where Energy, *produced through a Removal of Space*, is Stored:

It was shown the Ellipse-Orbits, $1=c.\mathbf{f_n}^2.r^3$, with their content is The Spin-Field-vectors $\bar{\mathbf{B}}$ in all area πab of MFMF field. *During orbiting* centripetal-acceleration, $\bar{\mathbf{a}}_{\mathbf{P}} = \sigma = \pm\frac{4\pi r}{(1+\sqrt{5})}.\mathbf{f}$ and Because the *Orbit is subject to a Mechanical-stress* σ*,* becoming from the Centripetal-acceleration$\bar{\mathbf{a}}_{\mathbf{P}}$,*then is appearing the* Piezoelectric-effect with Positive-charge *at the Nucleus* and Negative-charge *at the Planet* ≡ Material point. The two faces at N, P are connected by the *In-between Gravity-field*$[\nabla i]=[\pm s^2]$ in [MFMF] Field *so flows Current which is the Resonance on Orbit,* the Gravity Force, g. For the *Inverse* Piezoelectric-effect on Orbit, *when a voltage is applied across its opposite* faces at N, P becoming from the$[\oplus\leftrightarrow\ominus]$ stretching ,then Orbit becomes mechanically stressed, *Deformed in Shape by the Resonance at* N *and* P. Motion is Kept, *is quantized,* as work $\rightarrow$ W =1= k ≡ $[\nabla i].[\pm s^2]$ ≡ MFMF Field $\leftarrow$ *in the Orbit-area* ,πab upon the Spin $\bar{\mathbf{B}}$ *Orientation of the Pointy-Material-points* $[\pm s^2]$. This Orientation of Spin becomes from the Energy in sinusoidal gravity-fields of orbit, created by the motion of oscillation of the M-P[⊕℧℧⊖] *Any Interaction* between this *Oriented-Energy Disk-Rim* and a *Body-Planet* creates disturbances in Disk and *Reorientation of Spin*$\bar{\mathbf{B}}$≡ Motion ≡ Work ≡ k = constant = quanta and transformed as ,*The Gravity Force in Disk-Rim* ,and this Energy is equal to the Gravity acceleration g, because *g = force* as g = F/m. Bodies produce *Work ≡ Gravity* g*,* on Dipole M-P≡$[\nabla i] \equiv \pm s^2$,equal to the Change of *Spin-direction.* Motion with velocity vector v, may be *Linear or Rotational* for all displacements r, and thus exists as constant-work

$$W = k = \bar{v}x\bar{v}.\bar{r} = v^2.r.\ \bar{n} = v^2.\ r = (wr)^2.r = [\frac{2\pi}{T}r]^2.r = \frac{4\pi^2 r^2}{T^2}.\ r = \frac{4\pi^2 r^3}{T^2} = 4\pi^2.\ \frac{r^3}{T^2} = 4\pi^2.r^3.\mathbf{f}^2{}_p$$

Because Gravity-Force $\mathrm{F_G}$ becomes from the in-storages acceleration a = v^2/r of the MFMF material points and force $[\nabla i]$ is Stationary, and this because from the pointy-rotated-dipole [-s²℧℧+s²], then for Planck length *Gravity force* $[\nabla i] \equiv \mathrm{F_G} \equiv \mathrm{m_G} g = g\nabla[\frac{\sigma}{c^2}]^2.r = \mathrm{m_G}\frac{v^2}{r} = Jw^2.\mathrm{g_G} = [\frac{\pi r^4}{2}]\ w^2\frac{v^2}{r} = \frac{v^2}{r}[\frac{\pi r^4}{2}]\frac{v^2}{r^2} = [\frac{\pi r v^4}{2}]$

For Gravity-Acceleration in Black-holes is $\mathrm{g_G} = s[\frac{\pi r v^4}{2}] = [\frac{3{,}1415926\left([\sqrt{5}+1].\sqrt[4]{2}.10^{-35}\right).(299793458)^4}{2}].e^3 = 6{,}044981.10^{-35}.80{,}776078.10^{32}.20{,}085536 = \mathrm{g_G} = \rightarrow 9{,}\ 8076941 \leftarrow$ the theoretical g, number which is near to that of measurements $= \mathrm{g_m} = \rightarrow\ 9{,}\ 8082382\frac{s^2}{m^3} = \frac{N}{Kg}$ markos 10/10/18.

Photon is the Quantum of lightened and is a *Wave-Packet, and* may lose its Conveyer which is the Outer Electromagnetic part or its E&M Radiation ,but conserve its Body which is the stationary wave in a cave r, with the bound energy-frequencies $[\mathrm{B_P} \equiv \mathrm{f_{1=n}}, \mathrm{f_2}, \mathrm{f_3}, \mathrm{f_{R=}} w^2]$. Photons eradicate themselves by losing E&M vectors, but they can still exist with their Body ,$\mathrm{B_P} \equiv \mathrm{f_{1=n}}, \mathrm{f_2}, \mathrm{f_3}, \mathrm{f_{R=}} w^2$, which can develop NEW E&M vectors and continue to travel. All comments are left to the Readers and for more, *Black-holes* [74].

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Markos Georgallides comes from Cyprus and currently resides in the city of Larnaca, after being expelled from his home town Famagusta by the Barbaric Turks in August 1974. He works as a consultant civil and architect engineer having his own business. He is also the author of numerous scholarly articles focusing on Euclidean and Material Geometry, and mathematical to physics related subjects.

He obtained his degree from the Athens, National Technical, Polytechnic University [NATUA] and subsequently studied in Germany, Math theory of Photoelasticity.

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Newton's Coulomb Laws

By Ordin S. V.
Ioffe Institute RAS

Abstract- On the example of the gravitational and electrostatic fields, the distribution of any equipotentials in with a uniform and accelerated particle motion is analyzed. It is shown that inertia is determined by the distortion of equipotentials. It is also shown that Einstein corrections to the mass and energy of a particle at about light speeds are also determined by the distortion of the equipotentials due to the delay time of the interaction of the particle with equipotentials. Potential waves, transverse with respect to the amplitude of the potential oscillations and longitudinal with respect to the amplitude, oscillations of force, which describe “gravitational waves” without any convolutions of space-time, are incomprehensible. The conclusion is made about the general character of Newton's laws for any potential fields, which makes it possible to combine methods of measuring gravitational and electric fields. A unified approach to the calculation of centrifugal and magnetic forces showed weakness / incompleteness of their definitions, which led to the emergence of a number of "theoretical" disasters.

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NEWTONSCOULOMBLAWS

Newton's Coulomb Laws

Ordin S.V.

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I. Introduction

The gravitational and electrostatic fields are canonical potential fields and, accordingly, have many strictly mathematically proved identical solutions[1]. But because of the huge difference of forces, or rather, the ratios of gravitational and electric forces used for physical theories, the solutions are different[2]. And when they are trying to build a Unified Field Theory, they are trying, in principle, to combine the almost incompatible - from two magnificent buildings to build a new, whole. But the transitions do not match, and sometimes the floors. So, in practice, this Single Construction has been reduced to over-tightening the rope. And it began this pulling, one might say, with Heviside's Electromagnetic Theory of Gravity. But then they dragged the rope in the direction of Einstein's Theory of Relativity. And then, adding quantum theory to electrodynamics, they began to try to incorporate the Theory of Relativity into Quantum Electrodynamics.

But in the foundations of basic physical models, there are many assumptions that are not rarely erroneous[3]. At the beginning of the last century, at the dawn of building the Theory of Relativity and Quantum Theory, the basic models were actively discussed, but then were canonized. And their further development was reduced only to more complex calculations, which, taking into account the assumptions, led to the fragmentation of all physics, and in theoretical physics to singularities, wormholes and particles of God. The fact is that the Unified Field Theory has a few self-consistent solutions only in the ten-dimensional space, whereas for the convolution and our geometric three-dimensional space, we have not yet found the fourth dimension. Therefore, cumbersome but illiterate experiments are being made and speculate on their results.

Attempts to eliminate internal contradictions in physics, I began with an analysis of the intersections of the phenomenologies of dispersed branches of physics, describing, in principle, the same, or similar phenomena. But after correcting and generalizing some phenomenologies[4-11], it came to the conclusion that Quantum Mechanics is built on a special case - based on primitive solutions of the Schrödinger equation, which, in principle, are not elementary for atoms more complicated than hydrogen[12]. And Einstein's formula: "Some equations of the classical mechanic allow rewriting in the quantum-mechanical form" showed the need to return to the basic classical models. In this regard, the gigantic distinction between gravitational and electric forces is an excellent tool for analyzing various sides, in principle, strictly mathematically similar phenomena.

II. Gravity-Charge Analogy and Potential Waves

In the simplest geometric case (and in vacuum), the force of interaction between the masses $m_{1,2}$(Fig. 1) is described by the universal gravitation law (1)

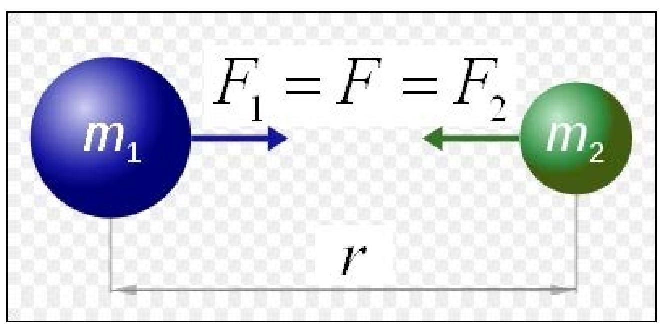

Рис.1.

$$F = G \cdot \frac{m_1 m_2}{r^2} \quad , \qquad (1)$$

where $G = k^m$ = 6,67408·10−11 m ^{3} / (kg · s^2) =6,67408·10−8 cm^3 g^{-1}s^{-2} - gravity constant (an inclination constant, according to Newton).

The Coulomb's law has a similar form, describing the force of interaction between charges $q_{1,2}$

Author: IoffeInstitute RAS. e-mail: stas_ordin@mail.ru

$$F = k^q \cdot \frac{q_1 q_2}{r^2} \text{,гдевСИ}\, k^q = \frac{1}{4\pi\varepsilon_0}, \qquad (2)$$

where $\varepsilon_0 \cong 8{,}8541878176210^{-12}\ F \cdot m^{-1}\ \left(C\ /\ (V \cdot m)\right)$- vacuum permittivity.

Proportionality coefficients in both laws are scaling ratios of different forces - reductions of both forces to usual to us to gravity force.

Usually, the analogy of these laws is associated only with their similar spatial distribution, with a quadratic decrease in the "density of static force" in both laws, corresponding to an increase in the surface of a sphere in three-dimensional space as its radius increases. The giant, by 42 orders of magnitude, the difference of these forces in absolute value, and the existence of two (accessible to measurements) charge marks led not only to different methods of measuring them, but also to theoretical isolation. Although the type of law itself indicates that they describe the power of the DIRECT (non-cross) interaction between EQUIVALENT particle measures μ.

$$F = k_\mu \cdot \frac{\mu_1 \mu_2}{r^2} = k_\mu \cdot F_\mu = k_\mu \cdot a_{\mu_1} \cdot \mu_2 \qquad (3)$$

where k_μ - a scaling ratio in force size, usual for us (now newton).

At the same time for all similar measures around a particle there is a field of their forces of direct interaction which can be measured by a trial particle with a unit measure and which can compare the potential field determined by integration of force from infinity to the coordinate particle r set relatively

$$\varphi_\mu = k_\mu \frac{\mu}{r}, \qquad (4)$$

And on the example of Newton's laws it is easy to see that there is a number of the general, the potential fields of the patterns which are not considered determined by existence neither for the charging field, nor for gravitational (for various reasons, but first of all, for the reasons determined by the different scale of forces).

And so, Newton's first law without "noise".

Inertia (as believed, solely for the masses).

Newton's first law postulates the existence of inertial reference systems. Therefore, it is also known as the law of inertia. Inertia (it is inertia) is the property of the body to maintain the speed of its movement unchanged in magnitude and direction when no forces act, and also the property of the body to resist a change in its speed. To change the speed of the body, it is necessary to apply some force, and the result of the action of the same force on different bodies will be different: the bodies have different inertia (inertness), the magnitude of which is characterized by their mass.

Or, modern wording

There are such reference systems, called inertial, with respect to which the material points, when no forces act on them (or mutually balanced forces act), are in a state of rest or uniform rectilinear motion.

And the second Newton's laws (also believe only for masses)

The second Newton's laws - the differential law of the movement describing interrelation between force applied to a material point and the acceleration of this point which is turning out from it. Actually, the second Newton's laws enters the weight as a measure of manifestation of inertness of a material point in the chosen inertial frame of reference (IFR).

The mass of a material point in this case is assumed to be constant in time and independent of any features of its movement and interaction with other bodies.

Or

In the inertial frame of reference, the acceleration that a material point with a constant mass receives is directly proportional to the resultant of all forces applied to it and inversely proportional to its mass.

In these first two laws of Newton, inertia is presented as a given, without any attempt to describe its nature. But having said "A" that inertia is a manifestation of external forces, they somehow did not dare to pronounce "B", which follows from the third law and the complementary concept of the first two. They did not dare because the subconsciously considered the field to be unreal, as if arising when a test particle was introduced into it.

Without going into casuistry of the type, whether there is a mountain, if a person has not "stepped in" on it, we simply accept as a given that the force of the particle's action (through the field) is equal to the force of its own field's opposition to it. Even the absence of the "Mountain" in the way of the waves excited by us in the medium does not cancel the necessity of applying force to the wave generator and the transfer of energy (waves) by this generator.

Only, at the same time, you should try not to allow twice taking into account the same impact - a member of the equation, as was often the case, for example, when calculating the potential Schottky barrier on the border of two media or in the Ioffe thermoelectric model, accounting for twice the same heat flux in thermal conductivity and in a change in entropy.

The denial of the materiality of a field is based on the denial of the Theory of Ether. But the recognition of the materiality of the field itself denies the primeval Ether - there is simply no "empty" vacuum not filled with the gravitational potential, but simply the presence or absence of particles in it. Moreover, the denial of the materiality of a field is simply a TABU for a deeper study of Nature, a ban on the existence, in particular, of the substructure of the field. Such a "prohibition" is akin to a ban on the existence of irrational numbers, without which, as it has been strictly mathematically proved, the number axis is not complete.

Then it is easy to show that when the Einstein finiteness is taken into account, the speed of transmission of the inertia effect is directly related to the particle field.

And so, in these first Newton laws, inertia is simply postulated as a reality, but without any attempt to describe its nature. Whereas it is not difficult to demonstrate how this property of a particle is directly related to the field of a particle.

If we construct equidistant equipotentials (Fig. 2, left), then when a particle moves at a constant speed, the equipotentials of its field do not distort (Fig. 2, right) (at least, such distortion has not yet been registered).

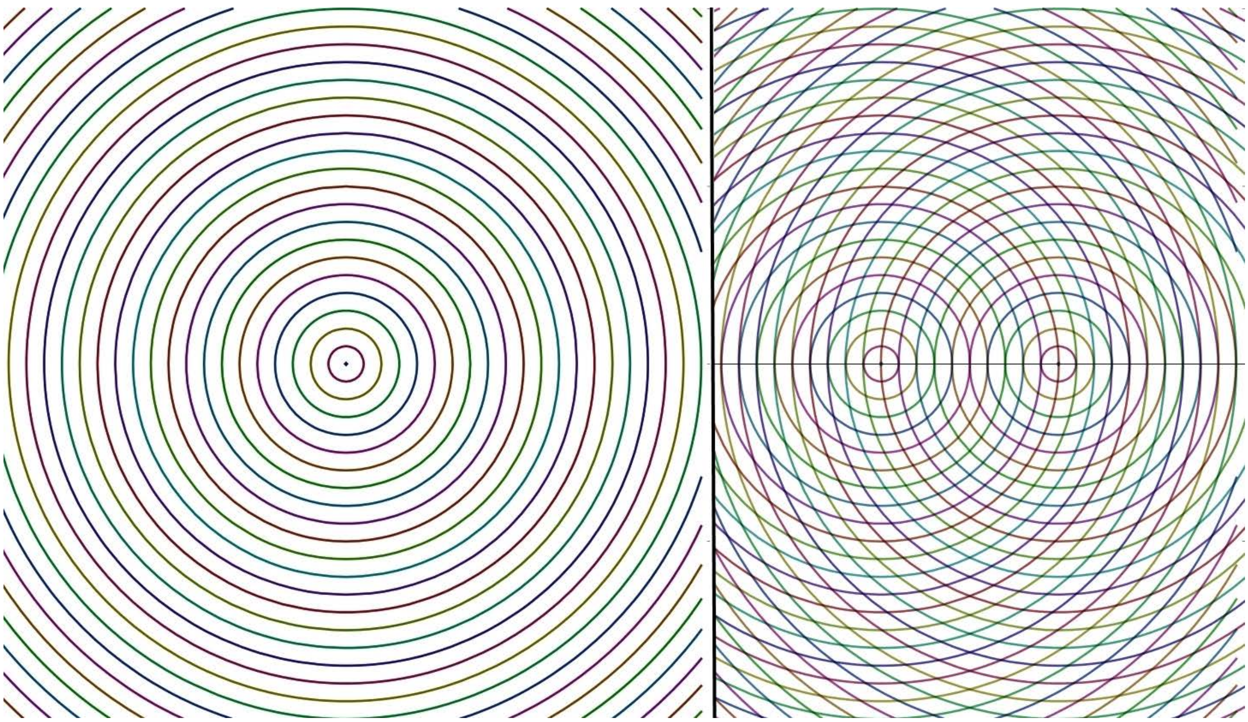

Fig. 2: Instant picture of the original equipotentials (left) and the imposition on them horizontally shifted to the right by ten distances between the equipotentials (right)

A more detailed transformation of equipotentials when a particle moves at low speeds is shown in Fig. 3 (the pictures depend on the angle of view on the drawing plane).

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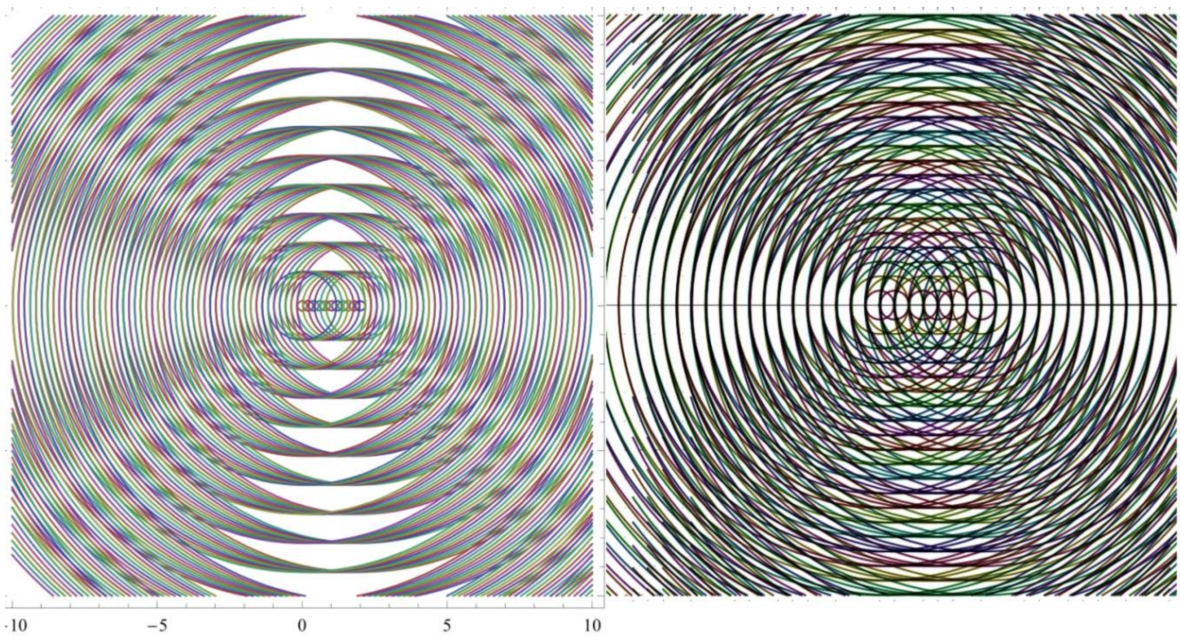

Fig. 3: Instant picture of the original equipotentials and the equipotentials horizontally shifted to the right superimposed on them: on the fraction of the step between the equipotentials (on the left) and the total steps (on the right)

On the other hand, when a particle moves with acceleration, on the contrary, there is no reason to assume that the change in the entire (to infinity) stationary field occurs instantaneously. Taking into account the finiteness of the transmission rate of the interaction of a particle with its own field gives a picture of the displacement of equipotentials, shown in Fig. 4, where it can be seen that after a fixed time interval, the further the equipotential is located from the particle, the less it is shifted.

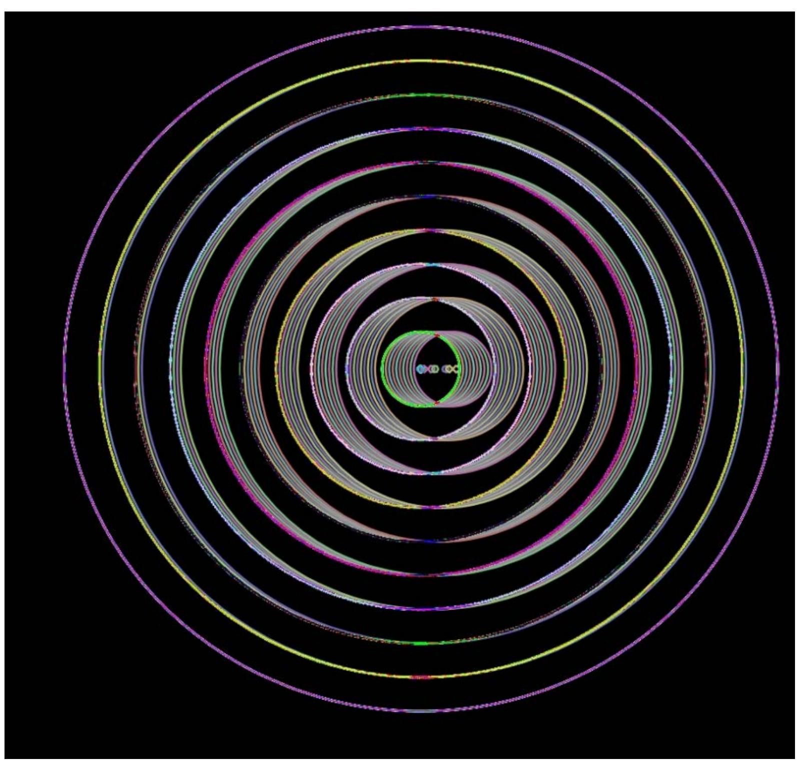

Fig. 4: The displacement of equipotentials with a horizontal displacement of the center of the particle to the right by one step, taking into account the delay time, the corresponding transmission of the interaction with the finite velocity through the time interval corresponding to the passage of ten steps

Assuming the charge and coefficient of proportionality equal to one, it is possible to calculate the spatial distribution of the potential in relative units when the particle is displaced by two steps (Fig. 5):
at stationary displacement without lag time

$$\frac{1}{r-2}, \quad \frac{1}{r+2} \tag{5}$$

taking into account the delay time shown in Fig.4

with impulse bias

$$\frac{1}{r-2\left(1-\frac{r}{10}\right)}, \quad \frac{1}{r+2\left(1-\frac{r}{10}\right)} \tag{6}$$

and with its harmonic oscillation

$$\frac{1}{r+2\cos\left(2\pi\frac{r}{10}\right)} \tag{7}$$

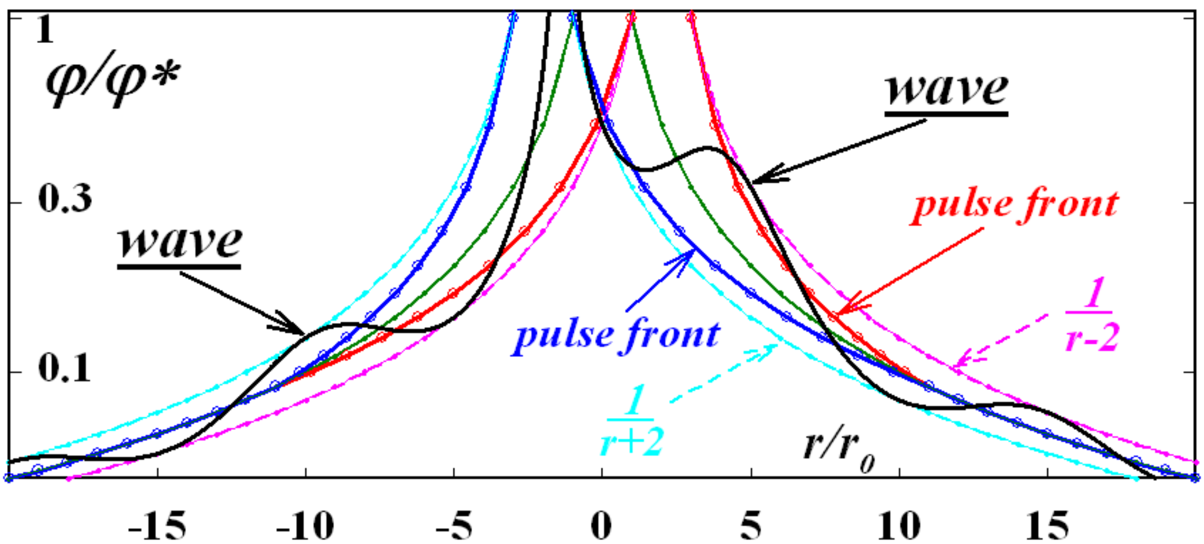

Fig. 5: The change in the spatial distribution of the potential during displacement / oscillation of a particle by two steps between equipotentials

The waves shown in Fig. 5 are potential and transverse with respect to their direction of propagation and amplitude of the potential oscillation. But in relation to force, they are longitudinal and not alternating, as are usual for us, transverse electromagnetic waves, the links with which we touch in the second paragraph. These potential waves, in fact, are similar to potential waves on the surface of the water, which, taking into account the principle of logarithmic relativity [13], will make it possible to look into the substructure of the field in the third paragraph.
So.

Summarizing the first law of Newton, one can say: if the potential field of a particle (even the mass, even the charge) is not distorted, then it moves uniformly at any speed.

Summarizing Newton's second law, we can say: if a particle's own field is distorted, then it (at least mass, even charge) gets acceleration proportional to the applied force and inversely proportional to the local measure of the particle (mass or charge).

And finally, the obtained longitudinal waves are for vacuum.

And for a medium, similar longitudinal Coulomb waves, in principle, have long been investigated — in plasma, in the form of longitudinal waves, fluctuations in the concentration of free electrons, and in polar crystals in the form of longitudinal polaritons — displacements of charges localized on ions. And these effects can be used to register longitudinal Coulomb waves in a vacuum, along with the charge of the nano-layer inside the sphere described in the article "Electrostatic propulsion 2" [14].

Recently identified with the help of an interferometer as gravitational waves specifically for vacuum, it is also possible to easily associate these longitudinal waves. But it requires the correct formulation of the experiment. Orientation of one axis of the interferometer vertically, even with a small length of it, will give a multiple increase in sensitivity. And most importantly, increasing the accuracy of interpretation without any convolutions of space-time[15].

III. Transverse Gravitational and Charge Effects

The modern, in my opinion, one-sided interpretation of the Theory of Relativity has led to some opposition of gravitational and charge effects. This was the reason for ignoring the Heaviside Electromagnetic Gravitational Theory. But I only remind you of this mathematical attempt of the Heaviside Single Description, but I will not engage in the analysis of this mathematical mind game, since physics is either built on invariants of reality, or they are isolated from reality. A charge and mass are independent characteristics of matter, and not different in indirect evidence. Here is an indirect, in my opinion, erroneously attributed difference between charge and mass, which modern theories give out as a matter of principle, and then they are fighting over its resolution, and I will try to eliminate it.

A fundamental difference is that the conservation law only works for charge. And for the masses of his allegedly, on the basis of the law of conservation of energy, abolished the Theory of Relativity. But the law of conservation of mass does not contradict the law of conservation of energy, if the energy associated with the Einstein additive to the mass at a speed close to the speed of light is associated with the same compression / discharge equipotentials shown in the first paragraph when the particle is accelerated. When a particle is accelerated, this compression directly follows, as was shown above, from the definition of inertia as an external influence on a particle of its own field. The compression of the medium and the excitation of waves in it when approaching the maximum transmission speed of exposure in the medium are also well known for environments with acoustic waves (sound barrier) and for the movement of ultrafast particles in the medium (the Vavilov-Cherenkov effect). So, the noted difference between gravitational effects and charge effects is not fundamental, but their description is repelled by different experiments and experimental conditions due to the gigantic quantitative difference of gravitational and Coulomb forces. Considering this gigantic, but quantitative difference, you need to build for your transverse effects your “Planck function” (which eliminated both your “ultraviolet” and your “infrared” catastrophes).

And so, in physics and in engineering, it has long been the norm to use transverse electromagnetic waves, but when they are emitted, even from wires, on long waves, even from dipoles, in the form of light, far exceeding their electrostatic fields are fully compensated (at sufficient distances). On the other hand, these transverse electric fields are generated by a giant Coulomb and, although weaker than it, by many orders of magnitude, but not by 42 orders of magnitude, like gravitational. And in order to observe gravitational transverse fields, at least in similar electromagnetic conditions, for experiments we would need a dipole of neutral particles and antiparticles, compressed by an additional force, which compensates for their repulsion. In the absence of this, two approaches to the description of transverse effects arose.

Considering the real experimental accessibility, it is required to analyze the differences of gravitational and charge effects. And Einstein's statement also led to the consideration of a concrete framework with a current from one electron: "Some equations of classical mechanics can be rewritten in a canting-mechanical form." And when the analysis of C & BN [10] led to the need to revise the atomic orbitals [11], and as a result, the revision of the Schrödinger equation [12], we had to return to the revision of the classical equations that Schrödinger wrote in an operator form (not without the help of Heaviside, who introduced the operators and vector analysis).

So. The standard charge approach allows us to estimate the transverse (magnetic) force acting on a single electron in a circular orbit. For a sufficiently accurate approximation, this force can be calculated as a force acting on the side of a square frame describing a circular orbit (Fig. 6).

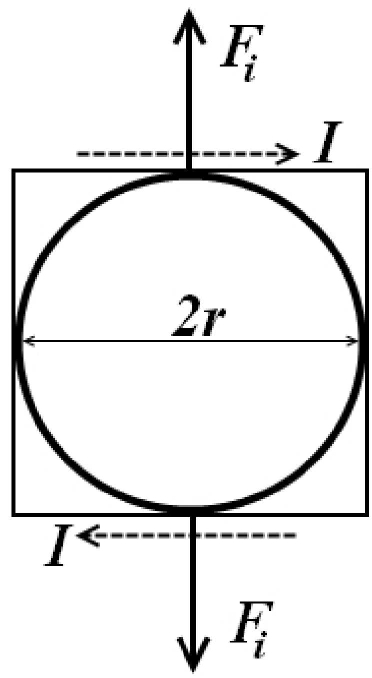

Fig. 6: The circular orbit of an electron and its equivalent frame with current

To do this, we use the formula for the force (called a magnetic) F_I pushing the wire at the counter currents in them. If the current is formed by one electron, then the formula for the current of one electron F_i takes the following form:

$$F_I = \frac{\mu_0}{4\pi} \cdot \frac{I^2}{d} l \to F_i = \frac{\mu_0}{4\pi} \cdot \frac{i^2}{2r} 2r = \frac{\mu_0}{4\pi} \cdot \left(\frac{e}{T}\right)^2 = \frac{\mu_0}{4\pi} \cdot \left(\frac{e}{2\pi r/v}\right)^2$$

$$\mu_0 \varepsilon_0 = c^{-2} \to F_i = \frac{1}{4\pi\varepsilon_0 c^2} \cdot \left(\frac{e}{2\pi r/v}\right)^2 = \frac{1}{4\pi\varepsilon_0} \cdot \left(\frac{v}{2\pi c}\right)^2 \cdot \frac{e^2}{r^2} \tag{7}$$

Strictly integrating projections from forces directed along arbitrary chords gives, of course, only an insignificant numerical correction. Therefore, a qualitative relationship between the electrostatic F_C^e and current F_i force can be obtained if a positive charge is placed in the center of the orbit, which is equal in magnitude to the electron:

$$F_i = \left(\frac{v}{2\pi c}\right)^2 \cdot \left(\frac{1}{4\pi\varepsilon_0} \cdot \frac{e^2}{r^2}\right) = \left(\frac{v}{2\pi c}\right)^2 \cdot F_C^e << F_C^e \tag{8}$$

It should be immediately noted that the original formula for current (magnetic) force was obtained for macroscopic objects. Therefore, it strictly describes the ratio of magnetic and electrostatic forces for macroscopics. At the same time, with the drift (current) velocities of electrons in the metal, fractions of cm / sec are weaker than the Coulomb forces of about 23 orders of magnitude, but at the same time, almost 20 orders of magnitude greater than the gravitational ones. Therefore, we can with a small magnet resist its gravitational attraction by the whole Earth. But this does not mean that the original formula works strictly on a microscopic scale. However, it is also used on a microscopic scale in electrodynamics. Whereas, as can be seen from formula 8, for any speed of motion of a charged particle in orbit, the centrifugal magnetic force will be less than the centripetal Coulomb. So, in addition to this force, it is necessary to take into account the presence on the micro scale of an additional force that repels the electron from the proton (otherwise the electron will fall on the nucleus).

This repulsive force was tied up with energy quanta, obtained from the Schrödinger equation, tied roughly, on the basis of a primitive model of the hydrogen atom. I tried to connect this centrosymmetric force with the empirical dependence of energy on distance $1/r^5$ [12]. And it is this additional force that determines the average minimum potential in a sphere of a certain radius, and the symmetry of the distribution of local minima over the sphere is determined by the number of external electrons. The dependence of the potential energy $1/r^5$, in principle, does not contradict the three-dimensionality of the geometric space, but allows for additional independent measurements in the space of subparticles that form the field.

The standard gravitational approach, of course, also developed for macroscopic conditions, but different, makes it possible, on the basis of formula 3, to calculate the centrifugal force of not only the mass, but also the charge of an electron $F^e_{\text{centrifugal}}$. And this centrifugal force can also be compared, when a positron is placed in the center of the orbit, with a centripetal Coulomb force F_C^e.

$$F^e_{\text{centrifugal}} = k^e \cdot a^e_{\text{centrifugal}} \cdot e = \frac{1}{4\pi\varepsilon_0} \cdot \frac{v^2}{r} \cdot e \rightleftharpoons \frac{1}{4\pi\varepsilon_0} \cdot \frac{e}{r^2} \cdot e = F_C^e \tag{9}$$

Formally, you can get your own "cosmic velocity" of an electron, rotating equivalent to it in the absolute value of a positive charge, say, around the positron:

$$v_1 = \sqrt{\frac{1}{4\pi\varepsilon_0} \cdot \frac{e}{r}}, \quad v_2 = \sqrt{2} v_1, \tag{10}$$

As can be seen from the formula 10, these speeds are higher, the smaller! radius of the orbit. But these velocity formulas are obtained for "particles" with a very large mass difference (by several orders of magnitude). And for equal measures with radii less than critical r^*, the centripetal force exceeds the centrifugal. And, on the contrary, when the radius of the orbit is greater than the critical one, the centrifugal force exceeds the centripetal force (Fig. 7).

$$r^* = \frac{e}{v^2} \tag{11}$$

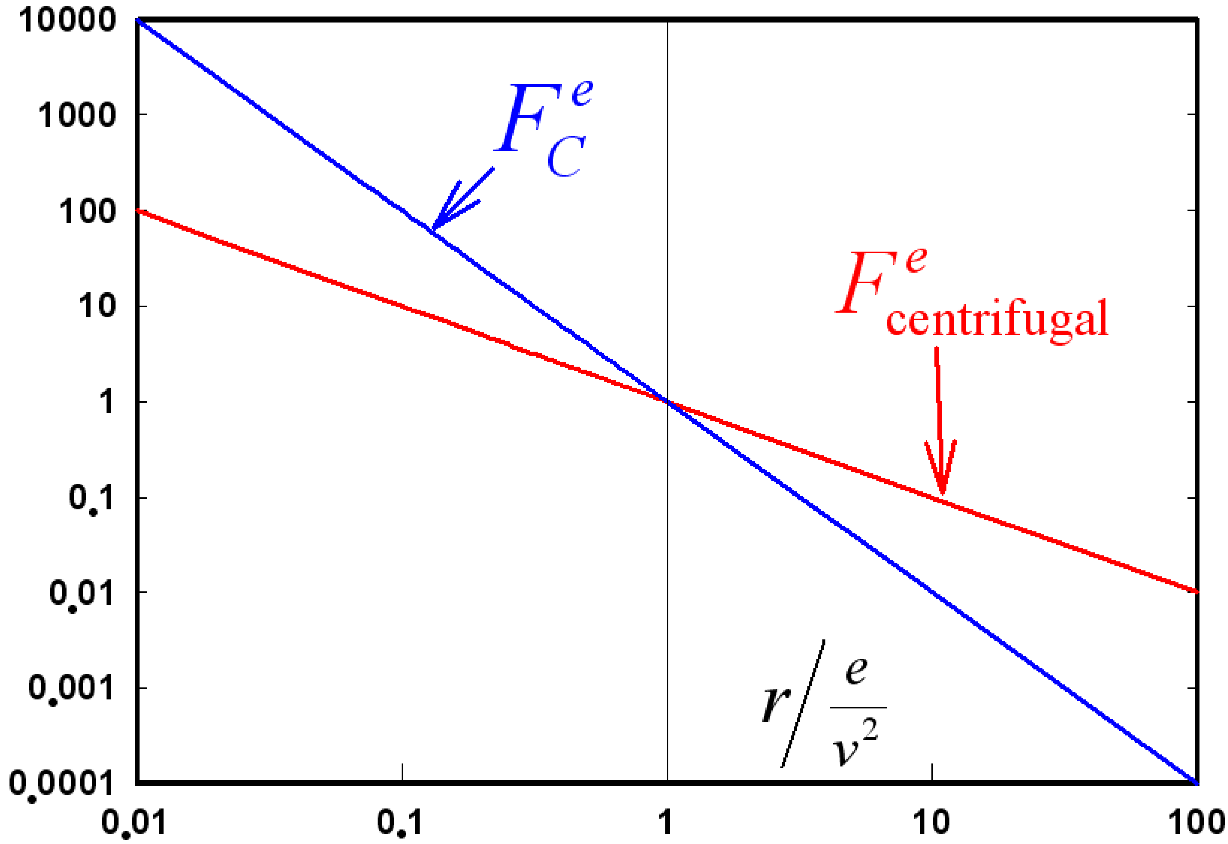

Fig. 7: Dependence of centrifugal and centripetal forces on the reduced radius

The presented elementary dependence of the critical radius is similar to the formula for the stability of a molecule or even a crystal, which, as is well known, falls apart at high speeds / temperatures. This indicates that the magnetic force (formula 8) at the microscopic level does not fully take into account centrifugal effects. Although, on the atomic scale, as noted above, the force inversely proportional to the first degree of the electron orbit radius is not enough for the stability of the electron orbit.

And, on the other hand, it is well known from the theory of gravity, for macroscopic mass and radius, that for equal small masses, their attraction is not enough to counteract this centrifugal force. The rotation of any ball around the equivalent will stretch the spring even at low speeds. Since if there are approximately flying stars that do not fly apart or rotate relative to each other, it would seem that it would be possible to assume that deviations about this formula for centrifugal force are possible only for very large masses. But integrating the centripetal force to infinity gives divergence for any masses. Therefore, to calculate the total potential of charges, we used the constraint at the level of 100 effective radii (Fig.8)

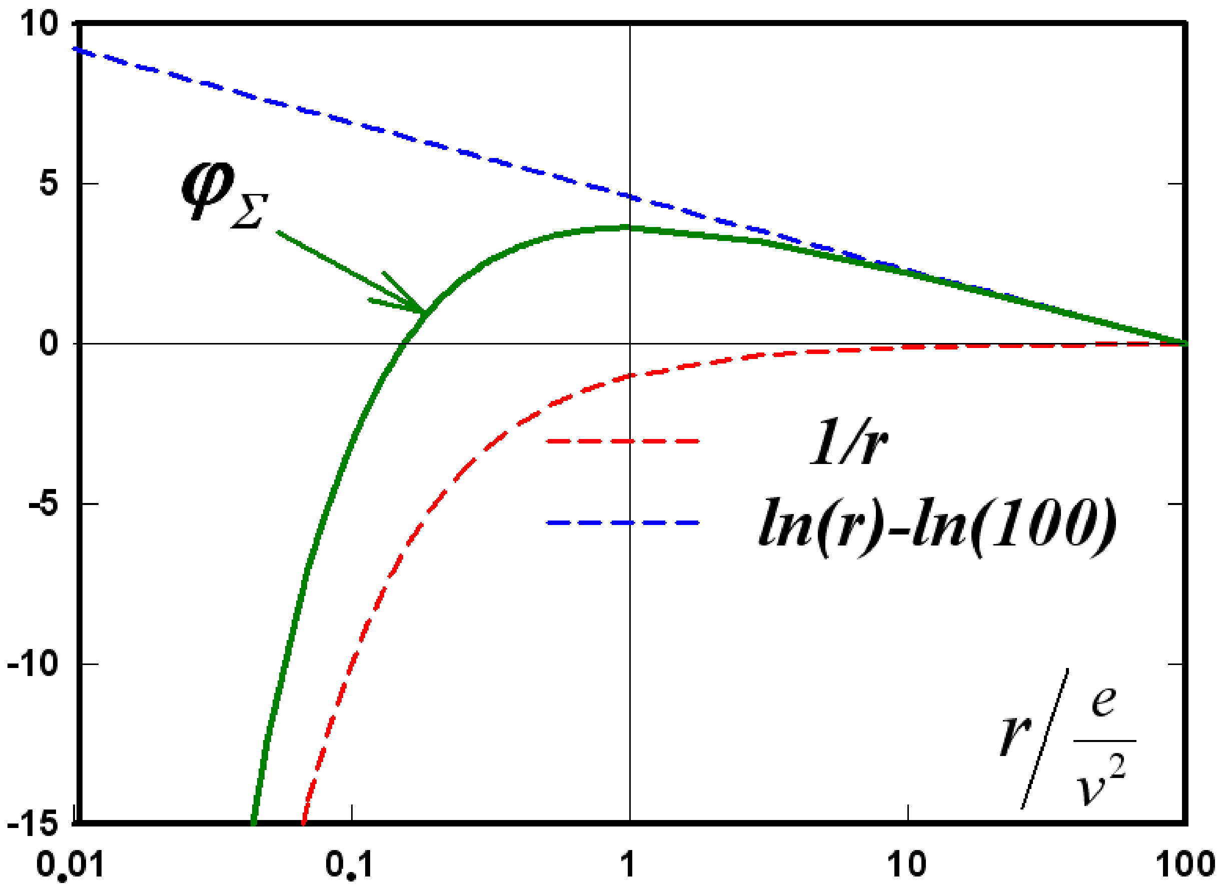

Fig. 8: Dependencies of centripetal, centrifugal and total potential on the reduced radius

The total potential presented in Fig. 8 for both masses and charges qualitatively demonstrates a point of unstable equilibrium with a distance between particles equal to the critical radius. But because of the potential used for the integration of a finite interval, this potential also contains the final support. The tendency of this support to infinity with increasing integration interval directly indicates that the centrifugal acceleration (formula 9) used is valid only where it is used: the satellite orbit radius does not exceed the Earth's radius much. And for the rotation of stars relative to each other, and for scattering of galaxies, especially, this formula is in principle not applicable. So no relativistic corrections will fix it, will not eliminate the divergence at infinity. And in general, not only for electrons in a crystal, but also for astronomical gravitational effects, it is necessary to take into account the potential formed by the environment (including an infinite medium). So it is likely that the stars, as well as the planets of our solar system, rotate in a gravitational potential well created by the space around us.

However, the influence of an unaccounted potential (and possibly an unaccounted particle measure) does not negate the fact that the gravitational formula contains an error, and the magnetic component confirms this additionally. In a more accurate formula, there must be a type factor $1\pm\frac{m}{M}$ that degenerates into a unit with a large difference in mass(measures) and a "magnetic" factor $\frac{v}{c}$.

But most importantly, the divergence is removed only for the force falling faster than the first degree

$$\int_x^\infty \frac{1}{x^{1+\Delta}}\,\mathrm{d}x = \frac{1}{\Delta\cdot x^\Delta} \qquad (12)$$

So even a simple geometric mean centrifugal and magnetic force removes a number of contradictions both in the theory of gravity and in electrodynamics.

$$F_\perp^e = \frac{v}{2\pi c}\sqrt{F_{\text{centrifugal}}^e \cdot F_C^e} \qquad (13)$$

And so, the formulas for the transverse "centrifugal" forces used by charge and mass differ radically (functionally).But this does not mean the fundamental difference between the gravitational and charge fields. This functional difference simply reflects the fact that in both traditional approaches we take into

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account only different parts / sides of the transverse effect. The principal difference is the scale difference between forces and distances, which can be seen from a comparison of these forces simply with the Coulomb one when placed in the center of the positron orbit. So the situation with the difference of gravitational and charge description of the centrifugal force is akin to resolved, for eliminating infrared and ultraviolet catastrophes, by Planck.

IV. Cross Effects

Phenomenological cross effects describe in a linear approximation a flux determined by a non-fundamental force indirect for a given flux. Thus, the temperature force or the electric heat flux in thermoelectric effects affects the electric current [6]. Similar considerations can be made for charged particles, which naturally have mass. And not only. So in a capacitor galvanometer electric, the recorded force accelerating mass of the movable plate of the capacitor is balanced by the force of elasticity of the spring. One can consider, without additional force, the total effect of the Coulomb force and gravity, say on the charged foil or currents in the atmosphere. The actual appearance of the charges themselves on the clouds is also determined by a similar cross-line effect, in this case, precisely in the flows of ion molecules in the atmosphere.

But some observable effects, and in a simple galvanic capacitor, when transverse, magnetic force works similarly to an electrostatic force, and when the light beam deflects when it passes near a massive star, we have a mass interaction with an electric field. Although, strictly speaking, the very holding on the particle and the mass and charge can also be considered as their interaction. Therefore, it is logical to assume that for different measures there is a cross-type force

$$F_{12} = k_{12} \cdot \frac{\mu_1 \mu_2}{r^2} \Leftrightarrow k_{qm} \cdot \frac{qm}{r^2} = F_{qm} \quad (14)$$

So a priori suppose that the cross coefficient is zero, there is no reason. And although, strictly speaking, there is also no reason, except for the three-dimensionality of geometric space, to assume that this force will be inversely proportional to the square of the distance, as in canonical laws. But the very presence of such an “unaccounted” force does not simply explain the possibility of a static attraction of a positron to a neutron or repulsion of an electron from it with the formation of a proton, but taking into account Newton's laws, it also allows to take into account the “unaccounted” dynamics under the influence of this force.

V. Substructure Fields

"Justification" of Coulomb's law by quantum electrodynamics using virtual photons (sometimes they are said to be bosons, but they all mean the same photons that are Bose particles) seems to me logically wrong, because and individual photons are the same waves, but not continuous - not coherent, like radio waves or laser radiation. And to use macroscopic wave trains to describe their internal structure and even for a static Coulomb field is a clear mistake.

When they talk about "discovery" (supposedly made by Einstein) that light consists of particles, they do not take into account that in the Einstein photoelectric effect particles are pieces (trains, quanta) of incoherent scattered light. And the particles from which the structure of the wave is built, even though the structure of the constant field has nothing to do with the trains, do not have electromagnetic quanta. The zugs themselves consist of these subparticles. But so far these are mythical (supposed) particles, the flow density of which is from a microparticle, due to the continuity of the total flow in a 3-dimensional space, and gives the laws of statics. But the flow is directly related to the departure (loss) of particles, which is not. So, if we discard the assumption of a solid, such as a crystalline substructure, we have rather a “gas” density distribution of these mythical particles “above the surface” of charge/mass. The characteristics of the medium of subparticles: pressure and density, are set by their own field acting on the subparticles, and the adiabatic index of the medium, which depends on the number of degrees of freedom of the subparticle, determines the limiting velocity of interaction in the medium.

This subfield and prevents them from scattering to infinity from the microparticles. And this is not a tautology, it is a manifestation of the principle of logarithmic relativity - some models, taking into account the scale factors work on different scales of the organization of matter. And the ancient Greeks, not knowing this formally, defined the atomic structure of matter correctly. And Lenin, saying that “an electron is also inexhaustible as an atom” also had in mind the previously known macroscopic “inexhaustibility” and the possibility of its large-scale translation to an “infinite” logarithmic zero. But the crisis of modern physics is evident in the fact that Lenin's formulation was understood literally and subparticles began to be sought in microparticles, while missing an important step - subparticles of the field. And they began to break down microparticles in the co-particles, and not the same light.

I personally was lucky to talk with Termen, who was able to translate the most abstract ideas into working devices, into the same termenvox. As he said, Einstein, when he came to him with a request to voice elementary geometric figures on his termenvox, tried not to lose the thread linking his calculations with reality [14, 15, 16].

The modern theory tends to distance itself from reality, moving into fictitious and experimentally unconfirmed ten-dimensional spaces. And the tighter dimension of the subspace of the field is not so difficult to estimate, relying on Newton's Coulomb laws and on the understanding that a continuous field without subparticles is as leaky as the number axis without irrational numbers. Experiments to study the structure of fields or to create virtual particles by a field (as described, for example, in [17]) will allow physics to return to the area of basic research related to reality, and not to particles of God.

VI. Conclusion

True Science is built on invariants, numerical and functional. And, as was shown, reliably established invariants of a potential field: Newton's laws and Coulomb's Law, allow us to describe a number of modern scientific "anomalies."

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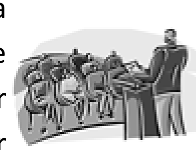

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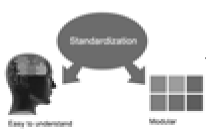

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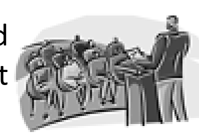

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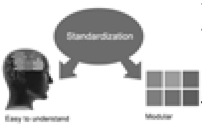

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Choice of the main keywords is the first tool of writing a research paper. Research paper writing is an art. Keyword search should be as strategic as possible.

One should start brainstorming lists of potential keywords before even beginning searching. Think about the most important concepts related to research work. Ask, "What words would a source have to include to be truly valuable in a research paper?" Then consider synonyms for the important words.

It may take the discovery of only one important paper to steer in the right keyword direction because, in most databases, the keywords under which a research paper is abstracted are listed with the paper.

Numerical Methods

Numerical methods used should be transparent and, where appropriate, supported by references.

Abbreviations

Authors must list all the abbreviations used in the paper at the end of the paper or in a separate table before using them.

Formulas and equations

Authors are advised to submit any mathematical equation using either MathJax, KaTeX, or LaTeX, or in a very high-quality image.

Tables, Figures, and Figure Legends

Tables: Tables should be cautiously designed, uncrowned, and include only essential data. Each must have an Arabic number, e.g., Table 4, a self-explanatory caption, and be on a separate sheet. Authors must submit tables in an editable format and not as images. References to these tables (if any) must be mentioned accurately.

Figures

Figures are supposed to be submitted as separate files. Always include a citation in the text for each figure using Arabic numbers, e.g., Fig. 4. Artwork must be submitted online in vector electronic form or by emailing it.

Preparation of Eletronic Figures for Publication

Although low-quality images are sufficient for review purposes, print publication requires high-quality images to prevent the final product being blurred or fuzzy. Submit (possibly by e-mail) EPS (line art) or TIFF (halftone/ photographs) files only. MS PowerPoint and Word Graphics are unsuitable for printed pictures. Avoid using pixel-oriented software. Scans (TIFF only) should have a resolution of at least 350 dpi (halftone) or 700 to 1100 dpi (line drawings). Please give the data for figures in black and white or submit a Color Work Agreement form. EPS files must be saved with fonts embedded (and with a TIFF preview, if possible).

For scanned images, the scanning resolution at final image size ought to be as follows to ensure good reproduction: line art: >650 dpi; halftones (including gel photographs): >350 dpi; figures containing both halftone and line images: >650 dpi.

Color charges: Authors are advised to pay the full cost for the reproduction of their color artwork. Hence, please note that if there is color artwork in your manuscript when it is accepted for publication, we would require you to complete and return a Color Work Agreement form before your paper can be published. Also, you can email your editor to remove the color fee after acceptance of the paper.

Tips for Writing a Good Quality Science Frontier Research Paper

Techniques for writing a good quality Science Frontier Research paper:

1. Choosing the topic: In most cases, the topic is selected by the interests of the author, but it can also be suggested by the guides. You can have several topics, and then judge which you are most comfortable with. This may be done by asking several questions of yourself, like "Will I be able to carry out a search in this area? Will I find all necessary resources to accomplish the search? Will I be able to find all information in this field area?" If the answer to this type of question is "yes," then you ought to choose that topic. In most cases, you may have to conduct surveys and visit several places. Also, you might have to do a lot of work to find all the rises and falls of the various data on that subject. Sometimes, detailed information plays a vital role, instead of short information. Evaluators are human: The first thing to remember is that evaluators are also human beings. They are not only meant for rejecting a paper. They are here to evaluate your paper. So present your best aspect.

2. Think like evaluators: If you are in confusion or getting demotivated because your paper may not be accepted by the evaluators, then think, and try to evaluate your paper like an evaluator. Try to understand what an evaluator wants in your research paper, and you will automatically have your answer. Make blueprints of paper: The outline is the plan or framework that will help you to arrange your thoughts. It will make your paper logical. But remember that all points of your outline must be related to the topic you have chosen.

3. Ask your guides: If you are having any difficulty with your research, then do not hesitate to share your difficulty with your guide (if you have one). They will surely help you out and resolve your doubts. If you can't clarify what exactly you require for your work, then ask your supervisor to help you with an alternative. He or she might also provide you with a list of essential readings.

4. Use of computer is recommended: As you are doing research in the field of science frontier then this point is quite obvious. Use right software: Always use good quality software packages. If you are not capable of judging good software, then you can lose the quality of your paper unknowingly. There are various programs available to help you which you can get through the internet.

5. Use the internet for help: An excellent start for your paper is using Google. It is a wondrous search engine, where you can have your doubts resolved. You may also read some answers for the frequent question of how to write your research paper or find a model research paper. You can download books from the internet. If you have all the required books, place importance on reading, selecting, and analyzing the specified information. Then sketch out your research paper. Use big pictures: You may use encyclopedias like Wikipedia to get pictures with the best resolution. At Global Journals, you should strictly follow here.

6. Bookmarks are useful: When you read any book or magazine, you generally use bookmarks, right? It is a good habit which helps to not lose your continuity. You should always use bookmarks while searching on the internet also, which will make your search easier.

7. Revise what you wrote: When you write anything, always read it, summarize it, and then finalize it.

8. Make every effort: Make every effort to mention what you are going to write in your paper. That means always have a good start. Try to mention everything in the introduction—what is the need for a particular research paper. Polish your work with good writing skills and always give an evaluator what he wants. Make backups: When you are going to do any important thing like making a research paper, you should always have backup copies of it either on your computer or on paper. This protects you from losing any portion of your important data.

9. Produce good diagrams of your own: Always try to include good charts or diagrams in your paper to improve quality. Using several unnecessary diagrams will degrade the quality of your paper by creating a hodgepodge. So always try to include diagrams which were made by you to improve the readability of your paper. Use of direct quotes: When you do research relevant to literature, history, or current affairs, then use of quotes becomes essential, but if the study is relevant to science, use of quotes is not preferable.

10. Use proper verb tense: Use proper verb tenses in your paper. Use past tense to present those events that have happened. Use present tense to indicate events that are going on. Use future tense to indicate events that will happen in the future. Use of wrong tenses will confuse the evaluator. Avoid sentences that are incomplete.

11. Pick a good study spot: Always try to pick a spot for your research which is quiet. Not every spot is good for studying.

12. Know what you know: Always try to know what you know by making objectives, otherwise you will be confused and unable to achieve your target.

13. Use good grammar: Always use good grammar and words that will have a positive impact on the evaluator; use of good vocabulary does not mean using tough words which the evaluator has to find in a dictionary. Do not fragment sentences. Eliminate one-word sentences. Do not ever use a big word when a smaller one would suffice.

Verbs have to be in agreement with their subjects. In a research paper, do not start sentences with conjunctions or finish them with prepositions. When writing formally, it is advisable to never split an infinitive because someone will (wrongly) complain. Avoid clichés like a disease. Always shun irritating alliteration. Use language which is simple and straightforward. Put together a neat summary.

14. Arrangement of information: Each section of the main body should start with an opening sentence, and there should be a changeover at the end of the section. Give only valid and powerful arguments for your topic. You may also maintain your arguments with records.

15. Never start at the last minute: Always allow enough time for research work. Leaving everything to the last minute will degrade your paper and spoil your work.

16. Multitasking in research is not good: Doing several things at the same time is a bad habit in the case of research activity. Research is an area where everything has a particular time slot. Divide your research work into parts, and do a particular part in a particular time slot.

17. Never copy others' work: Never copy others' work and give it your name because if the evaluator has seen it anywhere, you will be in trouble. Take proper rest and food: No matter how many hours you spend on your research activity, if you are not taking care of your health, then all your efforts will have been in vain. For quality research, take proper rest and food.

18. Go to seminars: Attend seminars if the topic is relevant to your research area. Utilize all your resources.

19. Refresh your mind after intervals: Try to give your mind a rest by listening to soft music or sleeping in intervals. This will also improve your memory. Acquire colleagues: Always try to acquire colleagues. No matter how sharp you are, if you acquire colleagues, they can give you ideas which will be helpful to your research.

20. Think technically: Always think technically. If anything happens, search for its reasons, benefits, and demerits. Think and then print: When you go to print your paper, check that tables are not split, headings are not detached from their descriptions, and page sequence is maintained.

21. Adding unnecessary information: Do not add unnecessary information like "I have used MS Excel to draw graphs." Irrelevant and inappropriate material is superfluous. Foreign terminology and phrases are not apropos. One should never take a broad view. Analogy is like feathers on a snake. Use words properly, regardless of how others use them. Remove quotations. Puns are for kids, not grunt readers. Never oversimplify: When adding material to your research paper, never go for oversimplification; this will definitely irritate the evaluator. Be specific. Never use rhythmic redundancies. Contractions shouldn't be used in a research paper. Comparisons are as terrible as clichés. Give up ampersands, abbreviations, and so on. Remove commas that are not necessary. Parenthetical words should be between brackets or commas. Understatement is always the best way to put forward earth-shaking thoughts. Give a detailed literary review.

22. Report concluded results: Use concluded results. From raw data, filter the results, and then conclude your studies based on measurements and observations taken. An appropriate number of decimal places should be used. Parenthetical remarks are prohibited here. Proofread carefully at the final stage. At the end, give an outline to your arguments. Spot perspectives of further study of the subject. Justify your conclusion at the bottom sufficiently, which will probably include examples.

23. Upon conclusion: Once you have concluded your research, the next most important step is to present your findings. Presentation is extremely important as it is the definite medium though which your research is going to be in print for the rest of the crowd. Care should be taken to categorize your thoughts well and present them in a logical and neat manner. A good quality research paper format is essential because it serves to highlight your research paper and bring to light all necessary aspects of your research.

Informal Guidelines of Research Paper Writing

Key points to remember:

- Submit all work in its final form.
- Write your paper in the form which is presented in the guidelines using the template.
- Please note the criteria peer reviewers will use for grading the final paper.

Final points:

One purpose of organizing a research paper is to let people interpret your efforts selectively. The journal requires the following sections, submitted in the order listed, with each section starting on a new page:

The introduction: This will be compiled from reference matter and reflect the design processes or outline of basis that directed you to make a study. As you carry out the process of study, the method and process section will be constructed like that. The results segment will show related statistics in nearly sequential order and direct reviewers to similar intellectual paths throughout the data that you gathered to carry out your study.

The discussion section:

This will provide understanding of the data and projections as to the implications of the results. The use of good quality references throughout the paper will give the effort trustworthiness by representing an alertness to prior workings.

Writing a research paper is not an easy job, no matter how trouble-free the actual research or concept. Practice, excellent preparation, and controlled record-keeping are the only means to make straightforward progression.

General style:

Specific editorial column necessities for compliance of a manuscript will always take over from directions in these general guidelines.

To make a paper clear: Adhere to recommended page limits.

Mistakes to avoid:

- Insertion of a title at the foot of a page with subsequent text on the next page.
- Separating a table, chart, or figure—confine each to a single page.
- Submitting a manuscript with pages out of sequence.
- In every section of your document, use standard writing style, including articles ("a" and "the").
- Keep paying attention to the topic of the paper.
- Use paragraphs to split each significant point (excluding the abstract).
- Align the primary line of each section.
- Present your points in sound order.
- Use present tense to report well-accepted matters.
- Use past tense to describe specific results.
- Do not use familiar wording; don't address the reviewer directly. Don't use slang or superlatives.
- Avoid use of extra pictures—include only those figures essential to presenting results.

Title page:

Choose a revealing title. It should be short and include the name(s) and address(es) of all authors. It should not have acronyms or abbreviations or exceed two printed lines.

Abstract: This summary should be two hundred words or less. It should clearly and briefly explain the key findings reported in the manuscript and must have precise statistics. It should not have acronyms or abbreviations. It should be logical in itself. Do not cite references at this point.

An abstract is a brief, distinct paragraph summary of finished work or work in development. In a minute or less, a reviewer can be taught the foundation behind the study, common approaches to the problem, relevant results, and significant conclusions or new questions.

Write your summary when your paper is completed because how can you write the summary of anything which is not yet written? Wealth of terminology is very essential in abstract. Use comprehensive sentences, and do not sacrifice readability for brevity; you can maintain it succinctly by phrasing sentences so that they provide more than a lone rationale. The author can at this moment go straight to shortening the outcome. Sum up the study with the subsequent elements in any summary. Try to limit the initial two items to no more than one line each.

Reason for writing the article—theory, overall issue, purpose.

- Fundamental goal.
- To-the-point depiction of the research.
- Consequences, including definite statistics—if the consequences are quantitative in nature, account for this; results of any numerical analysis should be reported. Significant conclusions or questions that emerge from the research.

Approach:

- o Single section and succinct.
- o An outline of the job done is always written in past tense.
- o Concentrate on shortening results—limit background information to a verdict or two.
- o Exact spelling, clarity of sentences and phrases, and appropriate reporting of quantities (proper units, important statistics) are just as significant in an abstract as they are anywhere else.

Introduction:

The introduction should "introduce" the manuscript. The reviewer should be presented with sufficient background information to be capable of comprehending and calculating the purpose of your study without having to refer to other works. The basis for the study should be offered. Give the most important references, but avoid making a comprehensive appraisal of the topic. Describe the problem visibly. If the problem is not acknowledged in a logical, reasonable way, the reviewer will give no attention to your results. Speak in common terms about techniques used to explain the problem, if needed, but do not present any particulars about the protocols here.

The following approach can create a valuable beginning:

- Explain the value (significance) of the study.
- Defend the model—why did you employ this particular system or method? What is its compensation? Remark upon its appropriateness from an abstract point of view as well as pointing out sensible reasons for using it.
- Present a justification. State your particular theory(-ies) or aim(s), and describe the logic that led you to choose them.
- Briefly explain the study's tentative purpose and how it meets the declared objectives.

Approach:

Use past tense except for when referring to recognized facts. After all, the manuscript will be submitted after the entire job is done. Sort out your thoughts; manufacture one key point for every section. If you make the four points listed above, you will need at least four paragraphs. Present surrounding information only when it is necessary to support a situation. The reviewer does not desire to read everything you know about a topic. Shape the theory specifically—do not take a broad view.

As always, give awareness to spelling, simplicity, and correctness of sentences and phrases.

Procedures (methods and materials):

This part is supposed to be the easiest to carve if you have good skills. A soundly written procedures segment allows a capable scientist to replicate your results. Present precise information about your supplies. The suppliers and clarity of reagents can be helpful bits of information. Present methods in sequential order, but linked methodologies can be grouped as a segment. Be concise when relating the protocols. Attempt to give the least amount of information that would permit another capable scientist to replicate your outcome, but be cautious that vital information is integrated. The use of subheadings is suggested and ought to be synchronized with the results section.

When a technique is used that has been well-described in another section, mention the specific item describing the way, but draw the basic principle while stating the situation. The purpose is to show all particular resources and broad procedures so that another person may use some or all of the methods in one more study or referee the scientific value of your work. It is not to be a step-by-step report of the whole thing you did, nor is a methods section a set of orders.

Materials:

Materials may be reported in part of a section or else they may be recognized along with your measures.

Methods:

- Report the method and not the particulars of each process that engaged the same methodology.
- Describe the method entirely.
- To be succinct, present methods under headings dedicated to specific dealings or groups of measures.
- Simplify—detail how procedures were completed, not how they were performed on a particular day.
- If well-known procedures were used, account for the procedure by name, possibly with a reference, and that's all.

Approach:

It is embarrassing to use vigorous voice when documenting methods without using first person, which would focus the reviewer's interest on the researcher rather than the job. As a result, when writing up the methods, most authors use third person passive voice.

Use standard style in this and every other part of the paper—avoid familiar lists, and use full sentences.

What to keep away from:

- Resources and methods are not a set of information.
- Skip all descriptive information and surroundings—save it for the argument.
- Leave out information that is immaterial to a third party.

Results:

The principle of a results segment is to present and demonstrate your conclusion. Create this part as entirely objective details of the outcome, and save all understanding for the discussion.

The page length of this segment is set by the sum and types of data to be reported. Use statistics and tables, if suitable, to present consequences most efficiently.

You must clearly differentiate material which would usually be incorporated in a study editorial from any unprocessed data or additional appendix matter that would not be available. In fact, such matters should not be submitted at all except if requested by the instructor.

Content:

- Sum up your conclusions in text and demonstrate them, if suitable, with figures and tables.
- In the manuscript, explain each of your consequences, and point the reader to remarks that are most appropriate.
- Present a background, such as by describing the question that was addressed by creation of an exacting study.
- Explain results of control experiments and give remarks that are not accessible in a prescribed figure or table, if appropriate.
- Examine your data, then prepare the analyzed (transformed) data in the form of a figure (graph), table, or manuscript.

What to stay away from:

- Do not discuss or infer your outcome, report surrounding information, or try to explain anything.
- Do not include raw data or intermediate calculations in a research manuscript.
- Do not present similar data more than once.
- A manuscript should complement any figures or tables, not duplicate information.
- Never confuse figures with tables—there is a difference.

Approach:

As always, use past tense when you submit your results, and put the whole thing in a reasonable order.

Put figures and tables, appropriately numbered, in order at the end of the report.

If you desire, you may place your figures and tables properly within the text of your results section.

Figures and tables:

If you put figures and tables at the end of some details, make certain that they are visibly distinguished from any attached appendix materials, such as raw facts. Whatever the position, each table must be titled, numbered one after the other, and include a heading. All figures and tables must be divided from the text.

Discussion:

The discussion is expected to be the trickiest segment to write. A lot of papers submitted to the journal are discarded based on problems with the discussion. There is no rule for how long an argument should be.

Position your understanding of the outcome visibly to lead the reviewer through your conclusions, and then finish the paper with a summing up of the implications of the study. The purpose here is to offer an understanding of your results and support all of your conclusions, using facts from your research and generally accepted information, if suitable. The implication of results should be fully described.

Infer your data in the conversation in suitable depth. This means that when you clarify an observable fact, you must explain mechanisms that may account for the observation. If your results vary from your prospect, make clear why that may have happened. If your results agree, then explain the theory that the proof supported. It is never suitable to just state that the data approved the prospect, and let it drop at that. Make a decision as to whether each premise is supported or discarded or if you cannot make a conclusion with assurance. Do not just dismiss a study or part of a study as "uncertain."

Research papers are not acknowledged if the work is imperfect. Draw what conclusions you can based upon the results that you have, and take care of the study as a finished work.

- You may propose future guidelines, such as how an experiment might be personalized to accomplish a new idea.
- Give details of all of your remarks as much as possible, focusing on mechanisms.
- Make a decision as to whether the tentative design sufficiently addressed the theory and whether or not it was correctly restricted. Try to present substitute explanations if they are sensible alternatives.
- One piece of research will not counter an overall question, so maintain the large picture in mind. Where do you go next? The best studies unlock new avenues of study. What questions remain?
- Recommendations for detailed papers will offer supplementary suggestions.

Approach:

When you refer to information, differentiate data generated by your own studies from other available information. Present work done by specific persons (including you) in past tense.

Describe generally acknowledged facts and main beliefs in present tense.

The Administration Rules

Administration Rules to Be Strictly Followed before Submitting Your Research Paper to Global Journals Inc.

Please read the following rules and regulations carefully before submitting your research paper to Global Journals Inc. to avoid rejection.

Segment draft and final research paper: You have to strictly follow the template of a research paper, failing which your paper may get rejected. You are expected to write each part of the paper wholly on your own. The peer reviewers need to identify your own perspective of the concepts in your own terms. Please do not extract straight from any other source, and do not rephrase someone else's analysis. Do not allow anyone else to proofread your manuscript.

Written material: You may discuss this with your guides and key sources. Do not copy anyone else's paper, even if this is only imitation, otherwise it will be rejected on the grounds of plagiarism, which is illegal. Various methods to avoid plagiarism are strictly applied by us to every paper, and, if found guilty, you may be blacklisted, which could affect your career adversely. To guard yourself and others from possible illegal use, please do not permit anyone to use or even read your paper and file.

Criterion for Grading a Research Paper (Compilation) by Global Journals

Please note that following table is only a Grading of "Paper Compilation" and not on "Performed/Stated Research" whose grading solely depends on Individual Assigned Peer Reviewer and Editorial Board Member. These can be available only on request and after decision of Paper. This report will be the property of Global Journals.

Topics	Grades		
	A-B	**C-D**	**E-F**
Abstract	Clear and concise with appropriate content, Correct format. 200 words or below	Unclear summary and no specific data, Incorrect form Above 200 words	No specific data with ambiguous information Above 250 words
Introduction	Containing all background details with clear goal and appropriate details, flow specification, no grammar and spelling mistake, well organized sentence and paragraph, reference cited	Unclear and confusing data, appropriate format, grammar and spelling errors with unorganized matter	Out of place depth and content, hazy format
Methods and Procedures	Clear and to the point with well arranged paragraph, precision and accuracy of facts and figures, well organized subheads	Difficult to comprehend with embarrassed text, too much explanation but completed	Incorrect and unorganized structure with hazy meaning
Result	Well organized, Clear and specific, Correct units with precision, correct data, well structuring of paragraph, no grammar and spelling mistake	Complete and embarrassed text, difficult to comprehend	Irregular format with wrong facts and figures
Discussion	Well organized, meaningful specification, sound conclusion, logical and concise explanation, highly structured paragraph reference cited	Wordy, unclear conclusion, spurious	Conclusion is not cited, unorganized, difficult to comprehend
References	Complete and correct format, well organized	Beside the point, Incomplete	Wrong format and structuring

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