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Theories of Physics, Cosmology

Noncommutative Quantum Gravity

Highlights

Theory of Quantum Gravity(TTQG)

Test and Research of Silicon Materials

Discovering Thoughts, Inventing Future

VOLUME 23 ISSUE 4 VERSION 1.0

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Physics & Space Science

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Particle Becomes Energy = Energy Becomes Mass

By Huu S. Tieu & Martin F. Loeffler

Golden Sunrise Nutraceutical, Inc.

Abstract- Each and every living thing on planet earth consists of at least one or more cells in their structure as an organism. A cell within each living thing has a chemical makeup that produces energy and is found in molecules that are supplied through its nutrition from the organism. This is considered the cell's food source. Energy is produced as the cell breaks down its nutritional source from the organism then, the cell can perform functions that it generally carries out. From the energy produced the cell has the ability to provide respiration, create hormones, enzymes, and perform other functions that the cell carries out. In energy transference a particle moves into a cell, as the cell increases in mass it increases in density as density increases and particles accumulate in the cell, the cell is forced to expand. As the cell expands energy is created from the particles and energy is released. When energy is created and released the cell divides into two cells then the process replicates itself as long as there are particles that are moving into the cell to create energy. After the cell divides, particles have lost their energy until new particles move into the cell and begin the process again. For a particle to move into the cell a vacuum may be created to pull the particle to the cell.

Keywords: life is quantum biology, tiêu equation, particle becomes energy, energy becomes mass, einstein equation, schrödinger equation.

GJSFR-A Classification: UDC code: 539.12

PARTICLEBECOMESENERGYENERGYBECOMESMASS

Strictly as per the compliance and regulations of:

Particle Becomes Energy = Energy Becomes Mass

Huu S. Tieu [α] & Martin F. Loeffler [σ]

Abstract- Each and every living thing on planet earth consists of at least one or more cells in their structure as an organism. A cell within each living thing has a chemical makeup that produces energy and is found in molecules that are supplied through its nutrition from the organism. This is considered the cell's food source. Energy is produced as the cell breaks down its nutritional source from the organism then, the cell can perform functions that it generally carries out. From the energy produced the cell has the ability to provide respiration, create hormones, enzymes, and perform other functions that the cell carries out. In energy transference a particle moves into a cell, as the cell increases in mass it increases in density as density increases and particles accumulate in the cell, the cell is forced to expand. As the cell expands energy is created from the particles and energy is released. When energy is created and released the cell divides into two cells then the process replicates itself as long as there are particles that are moving into the cell to create energy. After the cell divides, particles have lost their energy until new particles move into the cell and begin the process again. For a particle to move into the cell a vacuum may be created to pull the particle to the cell. For the particle to enter the cell Quantum tunneling must occur to penetrate the cell wall and enter the cell. Quantum tunneling may occur through a wavelike effect which disrupts the cell wall for the particle to enter the cell. The Schrödinger equation: $\hat{H}\Psi = i\hbar\frac{\partial}{\partial t}\Psi$ explains the waive function effects for Quantum Tunneling, the Tiêu equation: $E = \check{H}|\Psi\rangle\frac{P}{T}$ explains the waive function effects of particles and temperature in thermodynamics in Quantum Biology, and applying Einstein equation: $E = mc^2$ for energy, mass, and light for Quantum Mechanics.

Keywords: life is quantum biology, tiêu equation, particle becomes energy, energy becomes mass, einstein equation, schrödinger equation.

I. Introduction

In cellular function [1], the cell has more of a requirement for energy than basic survival. A cell needs to perform many tasks that will expend energy at a greater level than at inactivity and may depend on energy from the metabolism of food or from other alternatives [2]. In the quantum level, a particle must be absorbed or ingested into the cell for the cell to function [3]. As particles are absorbed the cell increases in density even after the metabolism of the cell has expended energy from the ingestion of particles to the cell, this makes the cell to become denser, heavier, and bigger. As density increases the cell grows larger and larger until the cell divides into two cells [4]. For the cell to divide there has to be energy to create the cell division. By introducing the Innovation the author had achieve a breakthrough cell division that allows the cell to grow as a fully functioning living cell [5]. During the release of energy there has to be a constant release energy, if the energy release is not a constant then the cell can be damaged during division. This constant is in line with the equation of physicist Albert Einstein's famous formula: $E = mc^2$ (Figure 3) where energy equals mass at the speed of light or in the case of an organism the metabolic effect [6] [7]. An unstable cell is a malfunctioning cell that has become unbalanced [8]. This cell has the inability to accept particles nutrition and other elements that allow proper function. To stabilize the cell a modulating factor must be introduced back into the cell. The modulating factor will then allow particles to move through the cell wall and accumulate and compress until the cell divides [9]. In the term before cell division proper nutrition for the cell may continue and other elements such as proteins hormones and enzymes may be taken in and released [10]. When particles penetrate into a cell, the cell becomes increased in density, heavy, and bigger. As a cell increases in density the cell becomes heavier and denser [11]. Quantum tunneling through a cell wall surface is required to penetrate the outer layer of the cell. This tunneling effect is accomplished in the crossing of the cell membrane and blood-brain barrier that separates the blood system from the nervous system. The Schrödinger equation has explained the effect of a Quantum Wave in particle distribution through nonsolid and solid structure [12]. It is believed that the Schrödinger effect produces a Quantum Wave from the particle and gives a pathway for nutrient intake [13]. The Schrödinger effect is that the cell may be penetrated through Quantum Tunneling.

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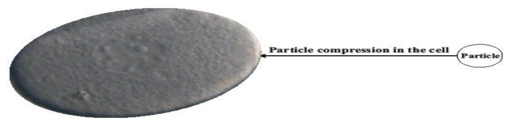

Figure 1: Particle accumulation and compression in the cell

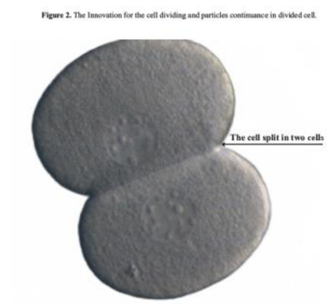

Figure 2: The Innovation for the cell dividing and particles continuance in divided cell. $E = mc^2$

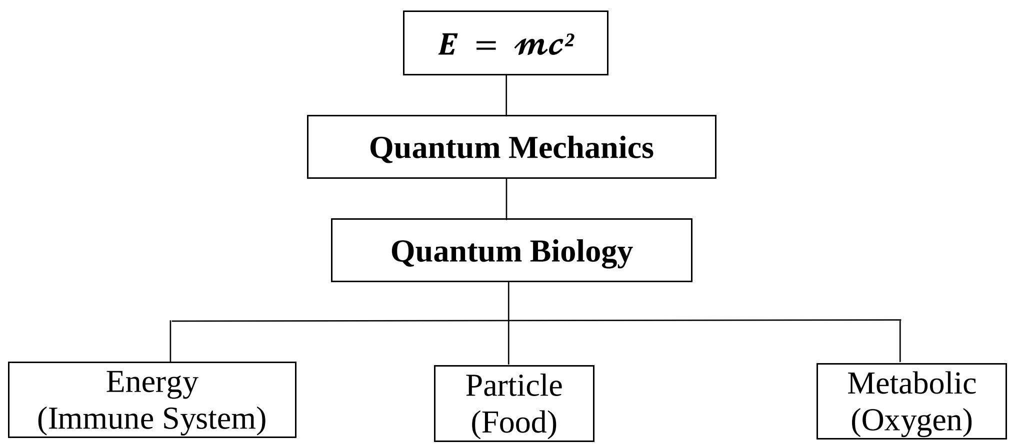

Figure 3: Quantum Biology: Energy (immune system), Particle (food), and Metabolic (oxygen).

II. Methodology

This unit of measurement had been replicated to show a consistent measurement relationship to the testing method. In observations and other testing methods, the patients overall health was shown to improve. Authors created a framework for evaluating the clinical benefit use of Real-World Evidence from U.S. Food and Drug Administration (FDA) guidance [14].

III. Results and Discussion – Real-World Evidence Patient Clinical Benefit [15]

The observations compiled by licensed physicians and specialists in the medical field were entered and compared. It was observed that using Innovation provokes a significant response, i.e., is a reduction in a variety of symptoms for patients with Serious or Life-threatening conditions or diseases that required monitoring for doses and reactions by both the attending licensed physician, registered nurse, or another specialist in the medical field [16]. The X-ray taken in (Figure 4) and (Figure 5) are of a 58-year-old male that required two teeth to be replaced. The subject had been taking Innovation products prior to the removal and replacement of the subject teeth. In (Figure 4) you will notice the replacement sockets inserted for the teeth without bone overgrowth. After six months when the replacement teeth were to be inserted, you will notice in (Figure 5) that there has been an overgrowth of bone which had to been removed before the insertion of the replacement teeth in (Figure 6). Evidence-Based Medicine is a set of principles and methods intended to ensure that to the greatest extent possible thru best clinical judgments or medical decisions are made [17]. To show the effects of the Schrödinger equation: for Quantum tunneling, comparing the Tiêu equation: for patient applications, and applying Einstein equation: for particle energy, it can be observed from patients suffering from Serious or Life-threatening illnesses [18] a Real-World Evidential effect on biologic organisms as referenced below.

a) *Patient with Thalassemia Major of Serum Iron Overload Aspartate Transferase (AST), Alanine Transaminase (ALT), and Alkaline Phosphatase*

J.C. is a 19-year-old male Asian that had been diagnosed with Thalassemia Major. His blood was so thick that it had trouble to move through his arteries. The subject had multiple sores on his skin and was constantly tired and had trouble getting out of bed even in the afternoon. The subject was almost incoherent and almost incoherent and had difficulty understanding commands.

Results: The subject began taking the Innovation substance and in a matter of hours the sores that were all over his body began to recede. After about a month the subject could get out of bed in the early morning and could function at work. The sores that had plagued him for a number of years were gone. The subject Platelet count also was greatly improved after in a matter of weeks. The subject was required to take blood transfusions on a weekly basis before taking the Innovation products. After taking the products for a month or so, the doctor lengthened the interval between transfusions as they were not needed with that frequency. The subject after taking the products improved his overall health.

Table 1: A chart the Innovation before and the Innovation after results

Date	ALK PHOS	AST (SGOT)	ALT (SGPT)
Before the Innovation: January; 2011	139	107	136
After the Innovation: February, 2011	137	67	93
March, 2011	135	76	85
April, 2011	119	69	78
May, 2011	121	60	73
June, 2011	133	58	75
July, 2011	123	68	74
August, 2011	106	57	63

b) *Patient with Liver Cancer*

T.B. is a 72-year-old male White that was diagnosed with stage four liver cancer. The subject complained of excruciating pain and could not find relief from any source of medication or treatment.

Results: The subject began taking the Innovation products and in a matter of days the pain had subsided.

Table 2: A chart the Innovation before and the Innovation after results

Date	ALK PHOS	AST (SGOT)	ALT (SGPT)
Before the Innovation: December; 2007	163	46	68
After the Innovation: February, 2008	195	39	43
March, 2008	132	44	45
July, 2008	131	41	45
August, 2008	120	31	35

c) *Patient with Dental Implants and Oral Surgery*

H.T. is a 58-year-old male Asian that required two replacement teeth.

Results: The subject began taking the Innovation to help with blood loss. When the dentist removed the teeth there was almost minimal blood loss and no pain medicine required. The healing process after teeth were removed was very fast with the doctor saying that the healing was that of a 20-year-old not a 58-year-old. When the dentist was ready to put new replacement teeth in he was shacked that the bone had grown over the screw shocked and that he had to scrape back the bone to insert the replacements. The doctor said that he had never seen such bone growth after a procedure.

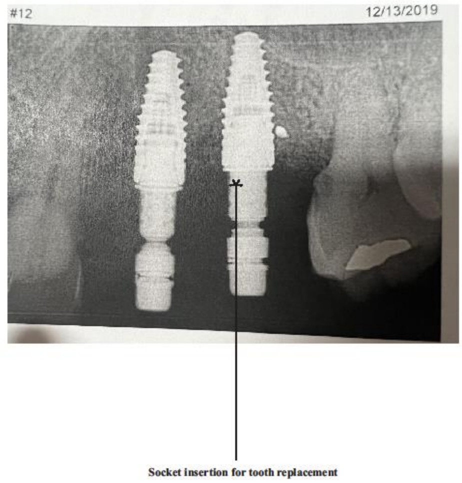

Figure 4: An X-ray photo of socket insertion for tooth replacement on December 13, 2019.

Figure 5: An X-ray photo six months after socket insertion of bone overgrowth on socket replacements on May 20, 2020

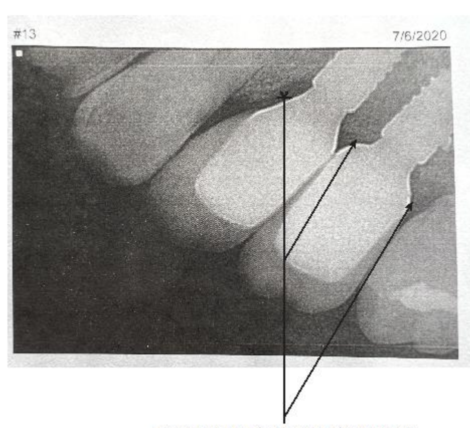

Figure 6: An X-ray shows the successful completion of the teeth replacements after bone scraping and final insertion of replacements on July 06, 2020.

The author have discovered that which is unlocking nature's secrets to the functioning of the living cell in quantum form. This breakthrough will move the future of science forward and transform science to find and create new discoveries and innovation [19]. In Quantum Biology, Quantum Mechanics, and Particle Physics, the Innovation is examined through equation and experimental data. The application can be performed on a diverse population of biological organisms. This means that the Innovation can be applied to humans, but also be used in the function of animals, and plant structures. This gives the Innovation a broad spectrum of uses for the vertebrae the invertebrate and the botanical kingdom to, and for the improvement of nature itself. The inclusion of all living things gives positivity to the quantum method. There is a belief that the Innovation has altered or produced a new particle or has created an unknown function for an existing particle that has eluded scientists in the past. This belief may further be followed where a particle can penetrate through cellular tissues in, and effect repair to damaged areas of the organism. To delineate particle transference, a particle may penetrate and move by potential energy from one side of a solid mass to another. If the particle cannot achieve complete penetration without exiting the mass then the particle becomes part of the mass. When this is viewed through a scientific equation the Tiêu Equation applies to particle penetration and movement. The Tiêu Equation merges wave function or Hamiltonian (Quantum Mechanics) [20] into temperature in thermodynamics [21] that excites particles to release energy for particle movement. This function describes the absorption or penetration that allows the Innovation to cross the blood-brain barrier. This penetration does not cause damage to the barrier but allows the Innovation into the nervous system by a possible layering effect. Penetration of the barrier may be done by only a vibration and vacuum fluctuations. This effect may be explained by the Theory of String that gives a detailed explanation of wave function in particles. Particle Entanglement is the measurement from the outcomes of an object state I Particle-A which is correlated with the measurement of outcomes from object state II Particle-B (two independents then events with solution, (then-*PA*(ƴ1) ⇋ event-*PB*(ƴ2)).

The Tiêu equation by the author accurately predicted the Innovation as defined for Real-World Evidence as pre-clinical data regarding the usage under 21st Century Cures Act (Cures Act) [22], or the potential benefits or risks, of a drug derived from sources other than traditional clinical trials.

IV. Conclusion

The Equations that demonstrate the effects of particle movement and cellular development are shown as successful through the experimental treatments of patients as Real-World Evidence to guide the use of the Innovation for future for the benefit of biological organisms. By showing particle accumulation and compression of the cell through Quantum Tunneling, Quantum Biology, and Quantum Mechanics can combine to learn and further its understanding of life and its function.

Acknowledgement

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Noncommutative Quantum Gravity and Dark Matter

By Gang Lee

Abstract- According to the theory of noncommutative quantum gravity[1][2], we calculate the self-interaction of gravitons in momentum space. It shows that the self-interaction of gravitons makes the gravitational field deviate from the inverse square law. By calculating the metric, it can be obtained that the stronger the gravitational source, the stronger the energy momentum of the excited gravitons, and the stronger the gravitational effect produced by the self-interaction of gravitons. Maybe be it can be used to explain dark matter and the Pioneer anomaly.

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NONCOMMUTATIVEQUANTUMGRAVITYANDDARKMATTER

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I. Introduction

In the paper 'A New Approach to Quantum Gravity'[1], we suggest a new theory of noncommutative quantum gravity, give the propagator of graviton, solve the difficulty of the Feynman integral divergence, and give evidence to prove that this theory is classical equivalent to the general theory of relativity. In the paper 'Noncommutative Quantum Gravity and Symmetry of Klein-Gordon Equation'[2], we discuss the multiple-graviton system with self-interaction and find the symmetry of Klein-Gordon equation related to noncommutative quantum gravity.

In section 2, we give a brief review of noncommutative quantum gravity theory suggested in the paper[1] and paper[2].

In section 3, from the theory of noncommutative quantum gravity, we calculate the metric of multiple-graviton system in momentum space, then find the deviation of metric from the inverse square law caused by self-interaction of gravitons. As an example, it can explain dark matter and the Pioneer anomaly.

II. A Brief Review of Quantum Gravitational Field with Self-Interaction

In this section, we briefly review the theory of noncommutative quantum gravity suggested in the paper 'A New Approach to Quantum Gravity'[1] and the theory of the multiple-graviton system with self-interaction suggested in the paper 'Noncommutative Quantum Gravity and Symmetry of Klein-Gordon Equation'[2].

Since the introduction of the uncertainty principle into the general theory of relativity, we get a wave packet $\xi^i(x,r)$ approximate to the Dirac δ-function. It can be explained as a semiclassical graviton. The free field equation is

$$\partial^\mu \partial_\mu \xi^i = 0 \tag{2.1}$$

From the free field equation, we obtain Green's function $\tilde{G}^i(k)$ as follows

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$$\tilde{G}^r(k) = -\frac{1}{(k^r)^2} \cdot \delta\Big(k^r - \frac{i}{l_P}\Big)$$

$$\tilde{G}^\theta(k) = -\frac{1}{(k^\theta)^2} \tag{2.2}$$

$$\tilde{G}^\phi(k) = -\frac{1}{(k^\phi)^2}$$

$$\tilde{G}^t(k) = -\frac{1}{\omega^2} \cdot \delta\Big(\omega - \frac{i}{t_P}\Big)$$

According to the properties of the Dirac δ-function, we just need to give singularity on the integral paths without calculating specific integrals when calculating the Feynman diagrams. So that the difficulty of divergence of the Feynman integral over large virtual momenta of graviton has been solved. By calculating the energy-momentum tensor of the gravitational field itself, we give strong evidence to prove that the quantum theory established in the paper[1] is classically equivalent to the general theory of relativity.

In the paper[2], we discuss the case of multiple-graviton. We used both two orthogonal coordinate systems x^μ and X^μ, then the local inertial system becomes

$$\xi^i(x,r) \to \xi^\alpha(x,X) = X + C^\alpha(x)\exp\Big(-\frac{|X|}{|L_P(x)|}\Big) \tag{2.3}$$

If there is no self-interaction of gravitons, the local inertial system at point x is

$$\lambda(\xi^\alpha) = \xi^\alpha(x,X)\big|_{X=0} \tag{2.4}$$

Due to the ductility of gravitons, gravitons elsewhere in a multi-graviton system will act on a point x together. The effect of the self-interaction of all other graviton on the point x is

$$\begin{aligned}\Delta\xi^\alpha =& X + \int d^4 l\, \xi^\alpha\big((x+l), |l|\big) \\ =& X + \int d^4 l\, \Big(C^\alpha(x+l)\cdot \exp\Big(-\Big|\frac{l}{L_P(x+l)}\Big|\Big)\Big)\end{aligned} \tag{2.5}$$

Then the true local inertial system at point x can be written as follows

$$\lambda(\xi^\alpha) = \xi^\alpha(x,X)\big|_{X=0} + \Delta\xi^\alpha \tag{2.6}$$

This is a brief review. More details can be found in the paper[1] and the paper[2].

III. Deviation of Metric from Inverse Square Law

If there is no self-interaction of gravitons, the local inertial system ξ^α is determined by the field $C^\mu(x)$. From Eq.(2.6) we can get the metric tensor $g_{\mu\nu}[\xi]$ of the gravitational field as follows

$$
\begin{aligned}
g_{\mu\nu}[\xi] &= \frac{\partial \xi^\alpha(x,X)}{\partial x^\mu}\Big|_{X=0} \cdot \frac{\partial \xi^\beta(x,X)}{\partial x^\nu}\Big|_{X=0} \cdot \eta_{\alpha\beta} \\
&= \int d^4k d^4k' \Big[-k_\mu k'_\nu \cdot \Big(C^\alpha(k)\exp\big(ikx\big) - (C^\alpha(k))^* \exp\big(-ikx\big)\Big) \\
&\qquad \cdot \Big(C_\alpha(k')\exp\big(ik'x\big) - (C_\alpha(k'))^* \exp\big(-ik'x\big)\Big)\Big] \qquad (3.1) \\
&= \int d^4k d^4k' \Big[-k_\mu k'_\nu \cdot \Big[C^\alpha(k) C_\alpha(k')\exp\big[i(k+k')x\big] + (C^\alpha(k))^* (C_\alpha(k'))^* \exp\big[-i(k+k')x\big] \\
&\qquad - C^\alpha(k)(C_\alpha(k'))^* \exp\big[i(k-k')x\big] - (C^\alpha(k))^* C_\alpha(k')\exp\big[-i(k-k')x\big]\Big]\Big]
\end{aligned}
$$

Due to the self-interaction of gravitons, the local inertial system $\lambda(\xi^\alpha)$ of any point in the gravitational field is Eq.(2.6). By the free field equation (3.1), we have

$$
\begin{aligned}
C^\alpha(x+l) &= \int d^4k \Big(C^\alpha(k)\exp\big(ik(x+l)\big) + (C^\alpha(k))^* \exp\big(-ik(x+l)\big)\Big) \\
&= \int d^4k \Big(C^\alpha(k)\exp(ikx)\exp(ikl) + (C^\alpha(k))^* \exp(-ikx)\exp(-ikl)\Big) \qquad (3.2)
\end{aligned}
$$

Then we get

$$
\begin{aligned}
\frac{\partial(\Delta\xi^\alpha)}{\partial x^\mu} &= \int d^4l\, d^4k \Big(ik_\mu C^\alpha(k)\exp(ikx)\exp(\frac{\pm ikL_P(k)-1}{|L_P(k)|}\cdot|l|) \\
&\qquad - ik_\mu (C^\alpha(k))^* \exp(-ikx)\exp(\frac{\mp ikL_P(k)-1}{|L_P(k)|}\cdot|l|)\Big) \qquad (3.3) \\
&= \int d^4k \Big(\frac{2|L_P|}{1\mp ikL_P} ik_\mu C^\alpha(k)\exp(ikx) - \frac{2|L_P|}{1\pm ikL_P} ik_\mu (C^\alpha(k))^* \exp(-ikx)\Big)
\end{aligned}
$$

For the true local inertial system $\lambda(\xi)$ in Eq.(2.6), the metric $g_{\mu\nu}[\lambda(\xi)]$ can be written as follows

$$
\begin{aligned}
g_{\mu\nu}[\lambda(\xi)] &= \frac{\partial\lambda(\xi^\alpha)}{\partial x^\mu}\frac{\partial\lambda(\xi^\beta)}{\partial x^\nu}\eta_{\alpha\beta} \\
&\equiv g_{\mu\nu}[\xi] + g^{(1)}_{\mu\nu} + g^{(2)}_{\mu\nu} \qquad (3.4)
\end{aligned}
$$

where $g_{\mu\nu}[\,\xi\,]$ is shown in Eq.(3.1), $g^{(1)}_{\mu\nu}$ is the first-order term of the Plank length-time L_P, $g^{(2)}_{\mu\nu}$ is the second-order term of L_P. $g^{(1)}_{\mu\nu}$ and $g^{(2)}_{\mu\nu}$ can be written as follows

$$
\begin{aligned}
g^{(1)}_{\mu\nu} = \int d^4k d^4k' \Big[-k_\mu k'_\nu \cdot \Big[\Big(\frac{2|L_P|}{1\mp ikL_P} + \frac{2|L_P|}{1\mp ik'L_P}\Big) C^\alpha(k) C_\alpha(k') \exp\big[i(k+k')x\big] \\
+ \Big(\frac{2|L_P|}{1\pm ikL_P} + \frac{2|L_P|}{1\pm ik'L_P}\Big) \left(C^\alpha(k)\right)^* \left(C_\alpha(k')\right)^* \exp\big[-i(k+k')x\big] \\
- \Big(\frac{2|L_P|}{1\mp ikL_P} + \frac{2|L_P|}{1\pm ik'L_P}\Big) C^\alpha(k) \left(C_\alpha(k')\right)^* \exp\big[i(k-k')x\big] \\
- \Big(\frac{2|L_P|}{1\pm ikL_P} + \frac{2|L_P|}{1\mp ik'L_P}\Big) \left(C^\alpha(k)\right)^* C_\alpha(k') \exp\big[-i(k-k')x\big]\Big]\Big] \\
g^{(2)}_{\mu\nu} = \int d^4k d^4k' \Big[-k_\mu k'_\nu \cdot \Big[\Big(\frac{2|L_P|}{1\mp ikL_P} \cdot \frac{2|L_P|}{1\mp ik'L_P}\Big) C^\alpha(k) C_\alpha(k') \exp\big[i(k+k')x\big] \\
+ \Big(\frac{2|L_P|}{1\pm ikL_P} \cdot \frac{2|L_P|}{1\pm ik'L_P}\Big) \left(C^\alpha(k)\right)^* \left(C_\alpha(k')\right)^* \exp\big[-i(k+k')x\big] \\
- \Big(\frac{2|L_P|}{1\mp ikL_P} \cdot \frac{2|L_P|}{1\pm ik'L_P}\Big) C^\alpha(k) \left(C_\alpha(k')\right)^* \exp\big[i(k-k')x\big] \\
- \Big(\frac{2|L_P|}{1\pm ikL_P} \cdot \frac{2|L_P|}{1\mp ik'L_P}\Big) \left(C^\alpha(k)\right)^* C_\alpha(k') \exp\big[-i(k-k')x\big]\Big]\Big]
\end{aligned}
\tag{3.5}
$$

The gravitational effect of self-interaction of gravitons can be as follows

$$
\begin{aligned}
\Delta g_{\mu\nu} &= g_{\mu\nu}[\,\lambda(\xi)\,] - g_{\mu\nu}[\,\xi\,] \\
&= g^{(1)}_{\mu\nu} + g^{(2)}_{\mu\nu}
\end{aligned}
\tag{3.6}
$$

From Eq.(3.5) we can see, if the gravitational source is very strong, the energy-momentum k^μ of the excited graviton is very strong, then the self-interaction effect of gravitons can not be ignored. If the gravitational source is weak, the effect of self-interaction of gravitons can be ignored compared with the inverse square law. This is similar to the development from Galilean transformation to Lorentz transformation: the stronger the gravitational source, the stronger the energy-momentum k^μ of the excited gravitons, and the stronger the gravitational effect of the self-interaction of gravitons. As we mentioned in paper[2], if the energy-momentum of the excited graviton reaches $k_\mu = \dfrac{1}{|L_P|}$, the gravitational effect of self-interaction is infinite, that is a black hole. It is another relativity theory related to the inverse square law of gravity. May be it can explain the Pioneer anomaly: the gravitational effect of self-interaction of gravitons pulls the probe towards the sun, although the gravitational effect is extremely weak.

Let's discuss dark matter. We know that there are extremely strong gravitational sources in galaxies, such as massive black holes, therefore, the gravitational field in the galaxy is formed by the graviton with extremely strong energy-momentum, so the self-interaction effect of gravitons can not be ignored. The gravitational effect generated by this self-interaction was previously explained to come from dark matter. There is no dark matter, and the gravitational effect of dark matter can be explained by the self-interaction of gravitons. This is actually a quantum effect. This is actually a quantum effect. When the gravitational source field is extremely strong, the energy-momentum of graviton is extremely strong, so this effect is also extremely strong. Therefore, in the past, we could only use the gravitational field of dark matter to explain this effect. To explain the gravitational effect of dark matter, we let that the gravitational effect of $\Delta g_{\mu\nu}$ is equivalent to the gravitational effect of dark matter. The quantity of dark matter is calculated according to its gravitational effect, but graviton can directly produce gravitational effect, therefore, as a candidate for dark matter, if the self-interaction of gravitons is required to produce the same gravitational effect as dark matter, its corresponding mass-energy is far less than that of dark matter used as the gravitational source.

IV. Conclusion

The viewpoint of this paper can be interpreted in this way: the metric $g_{\mu\nu}[\xi]$ shown in Eq.(3.1) corresponds to the inverse square law, but the true metric is $g_{\mu\nu}[\lambda(\xi)]$ shown in Eq.(3.4). It is different from the modify theory of gravity. The inverse square law is correct and does not require modification. It determines the gravitational field equation. The difference is that the inverse square law ignores the self-interaction of the gravitational field. The self-interaction of the gravitational field causes the additional gravitational effect that increases with the strength of the source field. For galaxies and even galaxy clusters with extremely strong gravitational source, compared with the inverse square law, the self-interaction effect of gravitons cannot be ignored. In fact, the gravitational effect of dark matter is equivalent to the gravitational effect produced by self-interaction of gravitons. The interpretation of the self-interaction of gravitons as dark matter is also consistent with current observations and experiments such as another cluster collision in what's called the Bullet Cluster, and graviton also conforms to all the known properties of dark matter. Therefore, the self-interaction of gravitons can replace the theory of dark matter. Deviation from Inverse Square Law is can also explain the Pioneer anomaly.

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The Newly Discovered Topological Theory of Quantum Gravity(TTQG) - A Multiblock Compatibilizer Cum Modifier of the Existing Theories of Physics, Cosmology, Quantum Mechanics and Quantum Computing

By C. Bhattacharya

Abstract- The recently discovered topological theory of quantum gravity (TTQG) is projected as a multi block theory having a core central block with multiple sub blocks grafted on the central block. Emerged out from the said central block, the sub blocks are spread all around multiple corners and they are connecting TTQG to most of the principal theories of physics and cosmology. While all the new concepts of TTQG are embedded in the core central block, the sub blocks truly play the role of 'compatibilizer'. In this article it has been shown straight forward that each and every sub block is compatibilizing one or the other streams like, e.g., quantum mechanics, the relativity theories, thermo-dynamics, cosmology, quantum computing. etc. and the others. Also, an altogether new 'spatial and topological interpretation of Quantum mechanics' have been given in regard to the operability of 'quantum mechanical operators' on the wave function Ψ.

The most of the principal theories of physics and cosmology are 'non-topological' and suffer from the serious problem of 'formlessness or shapelessness of the physical variables of the universe'.

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Abstract- The recently discovered topological theory of quantum gravity (TTQG) is projected as a multi block theory having a core central block with multiple sub blocks grafted on the central block. Emerged out from the said central block, the sub blocks are spread all around multiple corners and they are connecting TTQG to most of the principal theories of physics and cosmology. While all the new concepts of TTQG are embedded in the core central block, the sub blocks truly play the role of 'compatibilizer'. In this article it has been shown straight forward that each and every sub block is compatibilizing one or the other streams like, e.g., quantum mechanics, the relativity theories, thermo-dynamics, cosmology, quantum computing. etc. and the others. Also, an altogether new 'spatial and topological interpretation of Quantum mechanics' have been given in regard to the operability of 'quantum mechanical operators' on the wave function **Ψ**.

The most of the principal theories of physics and cosmology are 'non-topological' and suffer from the serious problem of 'formlessness or shapelessness of the physical variables of the universe'. In this research article it has been demonstrated that the TTQG apart from its 'compatibilizer' action on the other theories of physical science, also acts as a modifier of the said theories through its following inherent broad frame logic and philosophies:

1. The building blocks of the universe are the 'push forward' and the 'pull back' gravitons and those are originated from the singularity gravitons.
2. The phenomenon of gravitation is the superposition of space inversion fields and the said superposition gives birth to the ' singularity gravitons'
3. The physical variables 'time' (pull back graviton) and 'temperature' (push forward gravitons) are entangled to each other in the multiplicative inverse sense.
4. The exchange of forces or the interactions among the gravitons in the universe occur through the well defined quanta.
5. Entropy is a 'energy (E) -time (t)' interfering or hybrid concept and the 'Et' hybrid governs the 3 different laws of thermodynamics.
6. The parameter of quantum physics, the Planck's constant 'h' is basically the same as the 'thermodynamic parameter' 'S', 'degree of randomness' or 'entropy'
7. The Heisenberg's uncertainty principle is converging to the 2nd law of thermodynamics although the said laws have been presented in two entirely different ways.
8. The proper understanding of the phenomena of the mass-wave duality' is made through the TTQG depicted 'universal graviton cycle' and ' black body radiation'
9. The 'Qubits' or the 'Quantum bits' of 'Quantum computing' are the entangled 'color gravitons' of TTQG derived new theory of color physics.
10. The result of superposition, interference and entanglement of 'order' and 'mass gravitons' are the 'gravitational waves'.
11. The dimensionality of the universe is derived through the 'unification horizon of quantum mechanics and quantum gravity'.

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I. Introduction

In recent times the 'Topological Theory of Quantum Gravity' (TTQG)[98-104] has been discovered and proposed to the world scientific community and is attracting world wide attention and gaining popularity. Like a 'Multi block Co polymer' in the field of polymer science, whose action is to compatibilize a multi component homogeneous mixture of other different polymers (called polymer blend), the said TTQG has tied up the existing theories of physics (the Newtonian Physics, Quantum Physics, the theories of relativity , thermodynamics, the string theories, quantum mechanics …etc…and other theories) to the same source by its versatile compatibilizing characteristics. The schematic presentation of a what a multi block co

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polymer is and how is it compatibilizing a mixture of other polymers is in Figure 1 below:

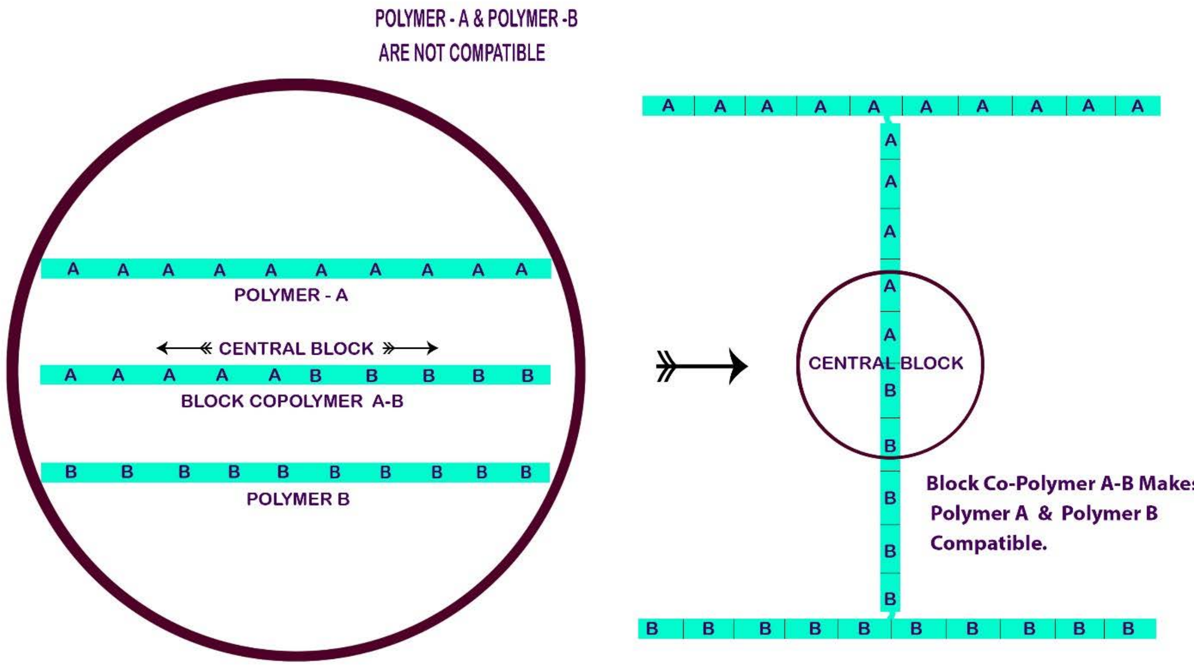

Figure 1: Compatibilizing Action of a block Co-polymer on an another Polymer Pair

As a matter of fact mixture of different polymers are incompatible from the stand point of thermo-dynamics owing to their vanishing small entropy of mixing. So this entropic disfavored situation is counter balanced by using block co-polymers.Following the physical chemistry dictum ‘ like dissolves like’ , the block co - polymers are tailor made which contains the basic ingredients of the polymer mixture distributed over the ‘different’ or the ‘multi’ blocks. Each block of the co-polymer is compatibilizing one or the other polymer of the polymer mixture on the ground of both of them being chemically identical. This way, as a whole the mixture of the ‘block co-polymer’ and the ‘polymer mixture’ become an integrated, homogeneous and a compatible entity.

The none of the existing theories of physics are ‘complete’ for their major shortfalls, the one or the other, and mostly are incompatible to each other as shown in Table 1 below:

Table 1: Incompleteness of the current theories of physics

Sl No.	Theory of Physics	Theory Based on	Shortfall
1.	Classical Or Newtonian Physics	Laws of motion and the law of Gravitation, Maxwell equations of electrodynamics, classical thermodynamics	Time space not considered. Geometry of mass. time and gravitation not offered. No topological or geometrical presen-tation of the laws of thermo-dynamics were given
2.	Theory Of Relativity	Space and time are different for different frames (with different velocities) of observation. Gravitation is the warp of the massive objects and space-time is distorted	Quantization of 'space -time' could not be explained. Geometry of mass. time and gravitation not offered.

			No explanation of the dark matter and dark energy of the universe presented.
3.	Quantum Physics	Energy is quantized in the form of 'photons' of different wavelengths. Photons are dual in nature and do behave both as a particle and an electromagnetic wave.	Energy and EM--wave are considered to be the same physical variable of the universe and which is fully illogical and unacceptable Geometry of mass, time and gravitation not offered. Topology of a photon not described. No explanation of dark energy and dark matter of the universe given.
			No Explanation Of Dark Matter And Dark Energy Of The Universe
4.	Quantum Mechanics	Heisenberg's uncertainty principle of position and momentum of microscopic particles. Dual nature of objects both as particle and wave. The trajectory of the microscopic particles are represented by wave functions and the existence of objects in the space are probabilistic. Properties such as position, speed , energies are discrete and are distributed in the form of packets. or quantum	Fully silent on the phenomenon of gravitation, the rheological and the thermodynamic properties of matter. The mystery of the dual nature of the objects could not be revealed. The wave function is a complex and non-observable quantity and its physical significance to a particle not described. While some observables are shown to be quantized , the 'time observable' is considered continuous and absolute.
5.	String Theory	All the particles (photons and quarks) are represented by one dimensional strings of length of similar degree of order to planck length. Brains of string theory are sheet like objects are capable of moving through space-time obeying the rules of quantum mechanics. Talks about extra 6 dimensional 'space-time' although no direct evidence proposed. A serious attempt had been taken to merge quantum mechanics and general relativity with limited success.	Cannot explain the quantum nature of the observables Cannot unify the other theories of physics and cosmology in a large frame. cannot offer the geometry of gravitation and 'time-space'. Cannot explain the dark energy and dark matter of the universe. Cannot explain the physical significance of the constants in physics like universal gas constant, Stefan-Boltzmann constant and others. Cannot explain the cold nuclear fusion phenomena of the universe.

All the said 'shortfalls' of the different theories as presented in Table 1 above have been overcome in TTQG, by the way of explaining the cosmic phenomena of the universe through the exchange, entanglement, interference and superposition of the multi various 'push forward' and 'pull back' quantum gravitons, and is being presented in this article.

In figure 2 below, the topologies of the gravitons of TTQG are shown. [99]

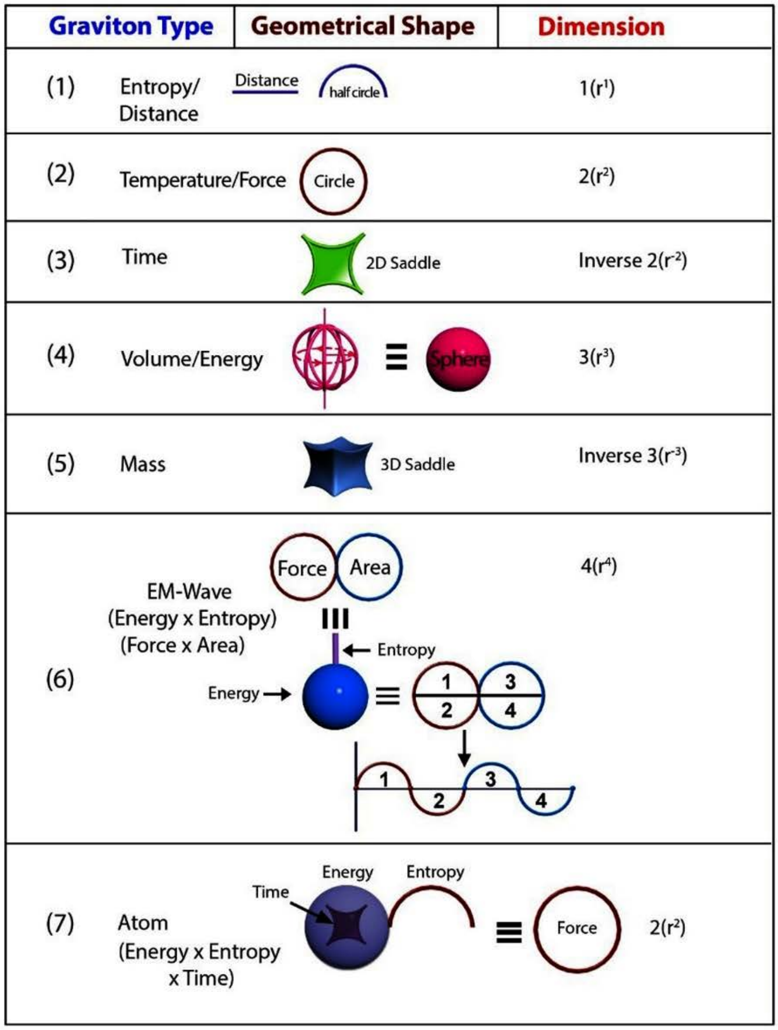

Figure 2: Geometrical shapes of the gravitons of TTQG

'THEORY OF EVERYTHING(TOE)', in context to the current need of physics and cosmology [1-97] , is a topic of much discussions now. As is playing in the minds of most of the first line scientists of physics and cosmology, that to fit in the model of TOE, a theory has to be very robust and versatile and the theory should be in a position to fully explain and connect all the happenings and aspects of the universe. In this regard to add here, that the said TOE has to be a multi block compatibilizing one (as explained above) and as well has to establish the fact that the theories of physics proposed so far, though have been presented in many forms but they are inherently identical by their origins or routes. The multi block compatibilizing characteristic of TTQG is schematically shown in Figure 3 below:

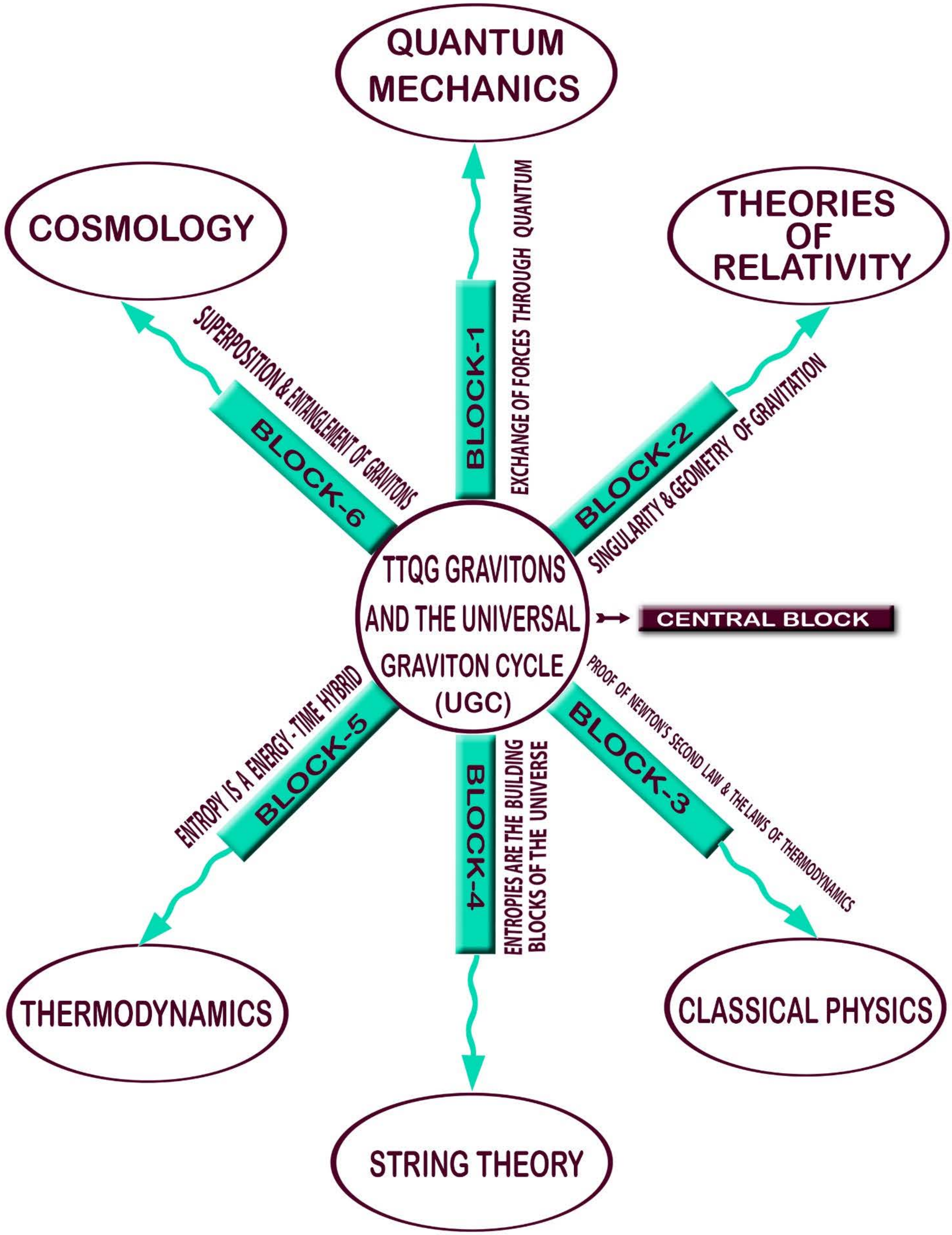

Figure 3: TTQG - Bridging and compatibilizing the existing theories of Physics & Cosmology

II. Planck's Constant h and Heisenberg's Uncertainty Principle

Planck constant h is related very much to the Heisenberg's uncertainty principle by the following equation

$$Et = h \text{ ....(1)}$$

Where E represents energy and t represents time. The above mentioned equation is obtained from the main hypothesis of Heisenberg (i.e $\Delta p \Delta x = h$, Δp and Δx stand for uncertainty in momentum and position respectively)) by doing some simple algebraic manipulation. However, since time is an 'abstract' variable so the product of E and t gives rise to an another abstract physical variable, h, being expressed in the unit 'energy. second'. It is the TTQG only , which for the first time in the history of physical science could topologically establish the identity of h being same to same to that of the thermodynamic parameter (or 'degree of randomness' parameter, S), entropy . This is shown diagrammatically in Figure 4 below:

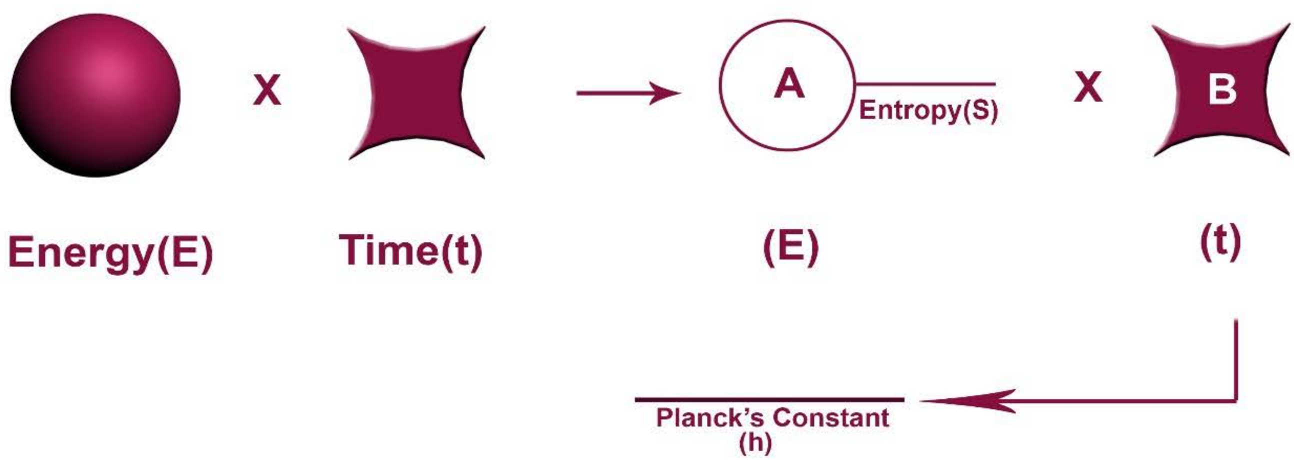

Figure 4: Topological presentation of 'E-t' or 'Energy-time' hybrid

In figure 4, the circle A and the 2D saddle B swallow each other (since their dimensions are inverse to each other) so what is left is a 'distance' S (represented by r in TTQG) and which is the entropy parameter of thermodynamics as established in TTQG. Mathematically this is being shown as below:

$$h = Et = (4\pi r^3) \times (3/4\pi r^2) = 3r \text{ ....(2)}$$

III. Energy Expression of Classical Physics VIS-A-VIS TTQG Expression of Energy and EM-Wave

The energy expression of classical physics is:

$$\text{Energy (E)} = \text{Force} \times \text{ Distance ....(3)}$$

Equation (3) can be rewritten in the form {keeping in mind that force = (pressure x area) and (area) x (distance) =volume}

$$E = \text{Pressure x area x distance}$$

$$= \text{Pressure(P) x Volume (V) ....(4)}$$

Neither from the equation(3) and nor from the equation(4) of classical physics one can evaluate the dimension of 'Energy'. The said situation is analyzed below:

i) In equation (3), the dimension of 'distance' is known. To determine the dimension of 'Force', one faces the problem of 'circularity of definition'.
ii) 'Force' is the product of 'Pressure' and 'Area' and while the dimension of 'Area' is known but in classical physics , 'Pressure' is expressed in regard to 'Energy' as 'Energy per unit volume' and 'Energy' in turn is expressed in regard to 'Pressure' as 'Pressure x volume'. This is what is called the 'problem of circularity' of definition.
iii) Obtaining the topology of energy in the 'Discrete' or 'Quantum' form is not possible without utilizing the topology of the physical variables as shown in Figure 3 above of TTQG and the new mathematical relation derived in the same, i.e., $E = 3V$, or the energy density of space is constant ($E/V = 3$).

The well known ideal gas equation is (for 1 mole of ideal gas):

$$PV = RT \text{ ....………. (5)}$$

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R is the 'Universal gas constant' and T is the temperature. Under the condition of equilibrium with the surroundings, P=1, and replacing V by (E/3) in equation (5), one gets

$$E = 3RT \quad \ldots\ldots\ldots\ldots(6)$$

Now utilizing the TTQG mathematical expression of E (= $4\pi r^3$) and T (= $4\pi r^2/3$), one gets from equation (6) above,

$$R = \text{universal gas constant} = (E/3T) = r \quad \ldots\ldots(7)$$

So energy, E, in classical physics can be represented in the form of 'quantum' by 3 numbers of 3D spheres of radius r each, such that the summation of three volumes (V) , gives the energy , E:

$$E = (4\pi r^3/3) + (4\pi r^3/3) + (4\pi r^3/3) = (V + V + V) = 3V$$

As shown in Figure (5) below [101] , when each of the above said 3D sphere is squeezed, either through x, y or z axis , they turn into a force circle and one of the radius's (r) emerge out of the 3D sphere. In such situation the energy 3D quantum takes the shape of hybrid of 'force' and 'distance'. In Figure 5 below, the form 'A' is 'integrated' form, 'B' is the 'transitory' form and form 'C' is the 'differential' form of the energy quantum.[101]

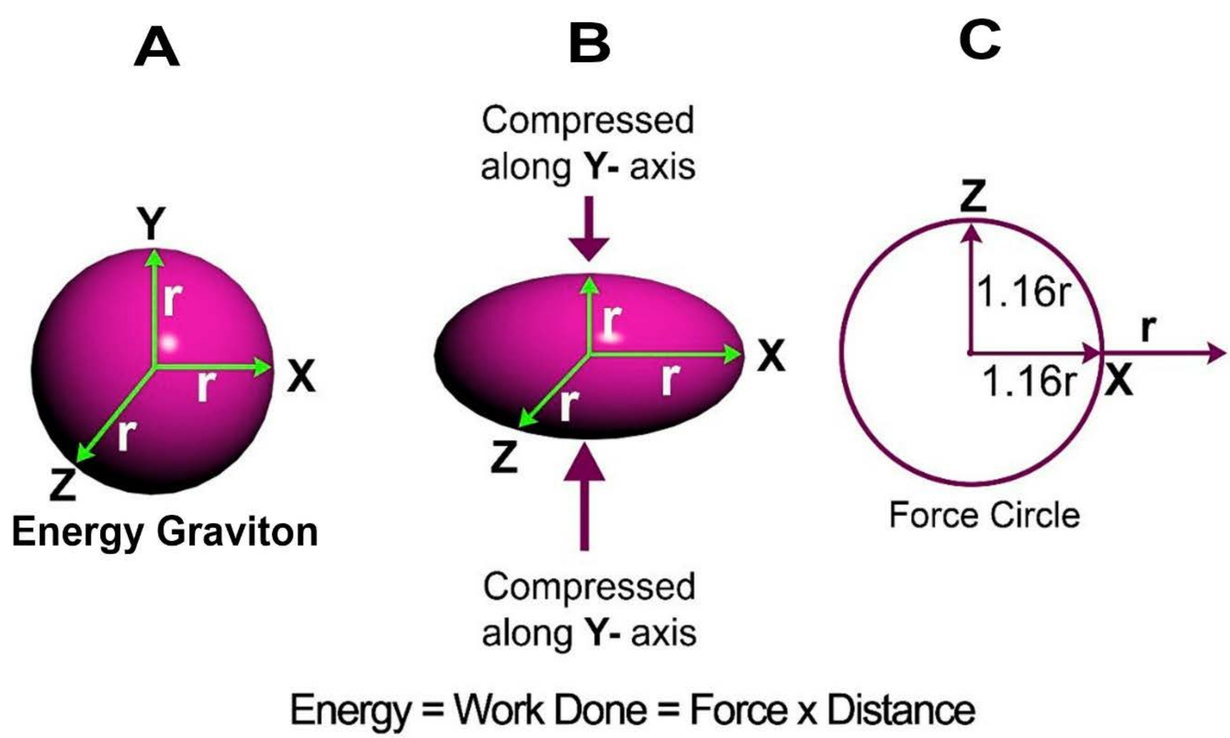

Figure 5: Energy Graviton (3D SPHERE) expressed as the hybrid of 'force' and 'distance' (r)

The mathematics of the transformation of the energy quantum from integrated form (A) to the differential form is shown below:

$$(4\pi r^3/3) = (4\pi r^2/3) \times r = \{\pi\,(1.16r)^2 \times r\} \quad \ldots\ldots\ldots(8)$$

From each 3D sphere one 'r' is emerged out and for 3 numbers of 3D spheres, the total distance becomes (r + r + r) = 3r and which is the value of the Planck constant 'h' as shown in equation 1. So it is firmly established that 'Planck constant', h, is purely en-tropic. So the energy expression in TTQG takes the following form (from equation 6 above)

$$\begin{aligned} \text{Energy (E)} &= 3RT = (\text{ entropy x temperature}) \\ &= \{ 3r \text{ x } (4\pi r^2/3)\} \\ &= 4\pi r^3 \\ &= (\text{ entropy x push forward force}) \quad \ldots(9) \end{aligned}$$

[In TTQG, 'temperature'(T) is a ' push forward force Graviton' and time (t) is a 'pull back force graviton' such that (Tt=1)]

In both classical physics and quantum physics, in one hand, at times, no distinction has been made between 'energy' and 'electromagnetic or EM wave' and very often the said two physical variables have been cited in the literature interchangeably in place of the other but on the other hand their definitions have been put in such a fashion that they appear to be different physical variables of the universe. Electromagnetic radiation, in classical physics, is the flow of energy at the speed of light through space or through a material medium in the form of electric and magnetic fields that make up EM waves such as radio waves, visible light, UV light, gamma rays…etc.

As per as the logic and philosophy of the TTQG is concerned[98], the 'energy' and 'EM-wave' are distinctly different physical variables of the universe having different dimensions and topology. While 'energy' is a quantum in the form of a integrated 3D sphere/ellipsoid, when it flows to the space, it has to acquire another new axis for its motion (in the form of distance or entropy) and it unfolds to the differential form. In other words, 'Energy' is the superposition of 'push forward force' and 'entropy' to form 'packets' or 'quanta' of a certain volume (equation 9 above), the 'EM-wave' is the superposition of 'energy' and 'entropy' and resulting to the further spread of the energy in the form of 'EM-wave packet or quanta' of higher volume than the 'energy quanta'.

$$\begin{aligned} \text{EM-wave} &= (\text{Energy x Entropy}) \\ &= (4\pi r^3 \text{ x } 4\pi r) \\ &= (4\pi r^2 \text{ x } 4\pi r^2) \\ &= (16\pi^2 r^4) \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (10) \end{aligned}$$

The difference between 'energy' and 'EM-wave' is shown below diagrammatically in Figure 6 below:

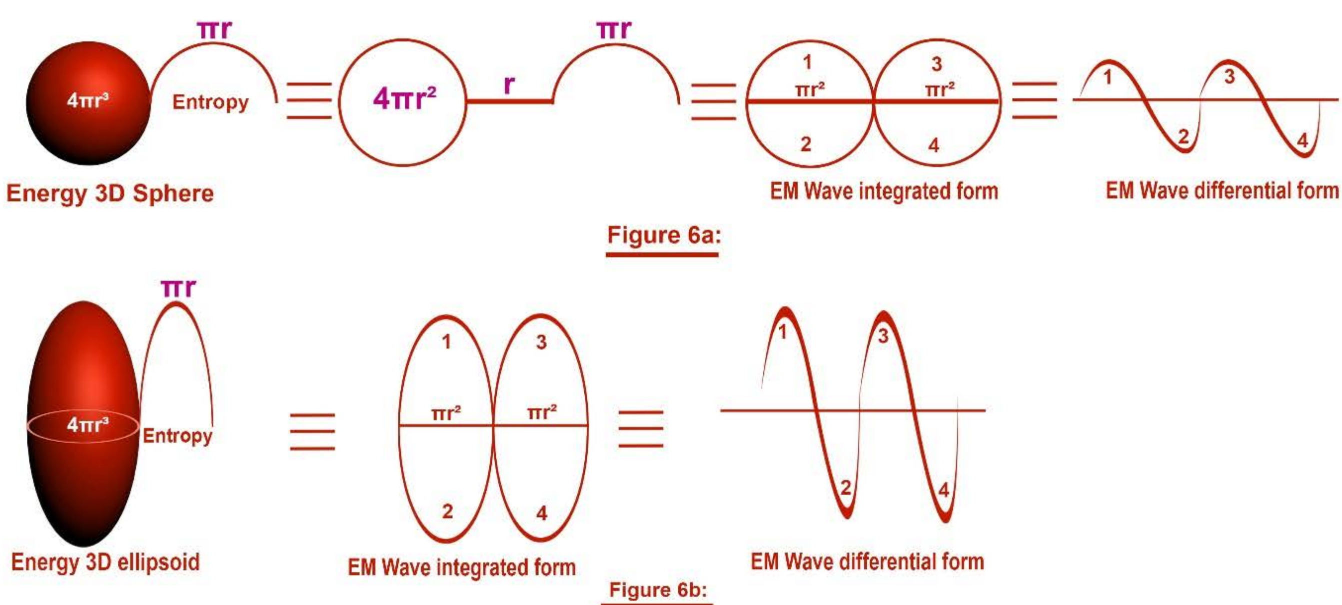

Figure 6a & 6b: Presentation of 'Energy' and 'EM Wave' as distinctly different physical variable of the universe

IV. TTQG Driven New Concept of Quantum Physics

At the beginning, the fact to remind the readers, that all the scientists (working from the very beginning in the field of physical science) had continued doing their valuable research work accepting the state of abstractness of the physical variable 'time'. It is TTQG only, which for the first time in the history of science gave the said physical variable a perceptible shape from the angles of physics, mathematics and geometry and as a result of that, the world science have encountered altogether a new turn around and the traditional stuff has emerged in a whole new form.

The subject 'quantum physics' start with the concept of 'photon', the expression of 'energy'(E) for the same was put forward by Max Planck as

$$E = h\mathbf{v} \qquad \ldots\ldots(11)$$

In equation 11, h is the Planck's constant and **v** is the frequency of the 'EM - wave' being expressed in Hertz or cycles per second. The **v** is related to the velocity of light (C) and wave length **λ** of the wave by the following equation

$$\mathbf{v} = (C/\lambda) \qquad \ldots\ldots(12)$$

So the ultimate expression of energy becomes

$$E = (hC/\lambda) \qquad \ldots\ldots(13)$$

Equation 13 shows an inverse relationship between E and **λ** (which is very much obvious) but the state of the affair is bit more complex than what it does apparently look alike. The said state of affair is revealed from the following dimensional break-up of equation 13: (using SI unit, for C = 3x 10^8 meter and **λ**, (for example) = 10^{-8} meter)

$$E = [\, h \times (\, 3\times 10^{8})\ \text{meter/ second}]/(\, 10^{-8}\ \text{meter})$$

$$= [\, h \times \{\, (\, 3\times 10^{16})]/(\text{sec})\}] \qquad \ldots\ldots(14)$$

[N.B. The dimension of wavelength get canceled between the numerator and the denominator of equation (14) and the 'inverse relationship between energy and wavelength' passes on to 'inverse relationship between energy and time']

In the above example, the number (3x 10^{16}) is the number of wave fronts passing through any point of the propagation path of the EM-wave per unit time. The constant, h, had been introduced by Max Planck very arbitrarily (the dimension being energy x sec) such that the 'sec' appearing in the denominator of equation (14) gets canceled and one is left with a 'energy' dimension only.

The energy expression of equation (14) can be written in the following form:

$$E = h \times (\text{number of wave fronts/time}) \qquad \ldots\ldots(15)$$

The energy expression of photons in the form of equation (15) becomes a decaying function of time and which is not acceptable. To make the energy expression free of time and to overcome the situation one needs to adhere to the definition of time as given in TTQG. In TTQG, 'time' is defined as an inverse 'force' or inverse 'area' (in the form of a pull back graviton, a 2D saddle), which is holding the universe.

Dimensionally, (Time) = (1/area)

So if this concept is utilized one can write in context to the equation (15):

(Time) = (1/ area of each wave front)

Then equation (15) takes the form

$$E = h \times (\text{number of wave fronts} \times \text{area of each wave front}) \qquad \ldots\ldots(16)$$

If in equation (16), the number of wave fronts (an integer) and the area of a wave front are represented by n and A respectively, the equation becomes:

$$E = nhA \qquad \ldots\ldots(\,17)$$

So area of the wave fronts are very important and on this said aspect, both Max Planck and Einstein were very silent else were not concerned at all. So 'energy', rather than maintaining the inverse relationship with 'wavelength', truly bears a direct proportionality to the area of the wave fronts. Higher the area of the wave fronts , higher would be the energy and the so called 'wavelength' of Planck is no way related to the energy.

Now utilizing equation (2) and equation (8) of the previous section, equation (17) converges to classical expression of energy [h=3r and A= ($4\pi r^2/3$)] as:

$$E = n \times (\text{ entropy} \times \text{area}) = n \times (\text{ distance} \times \text{force}) = n\times(3r) \times (\, 4\pi r^2/3) = (n\times 4\pi r^3) \qquad \ldots\ldots(18)$$

The geometrical shapes of the wave fronts (symmetric, longitudinal or lateral skewed, peak height to peak width ratio..etc..) and their area/volumes have been fully ignored in the quantum physics. In figure 7 below, two different types of wave fronts have been shown (but their so called Planck 'wavelengths' are the same).

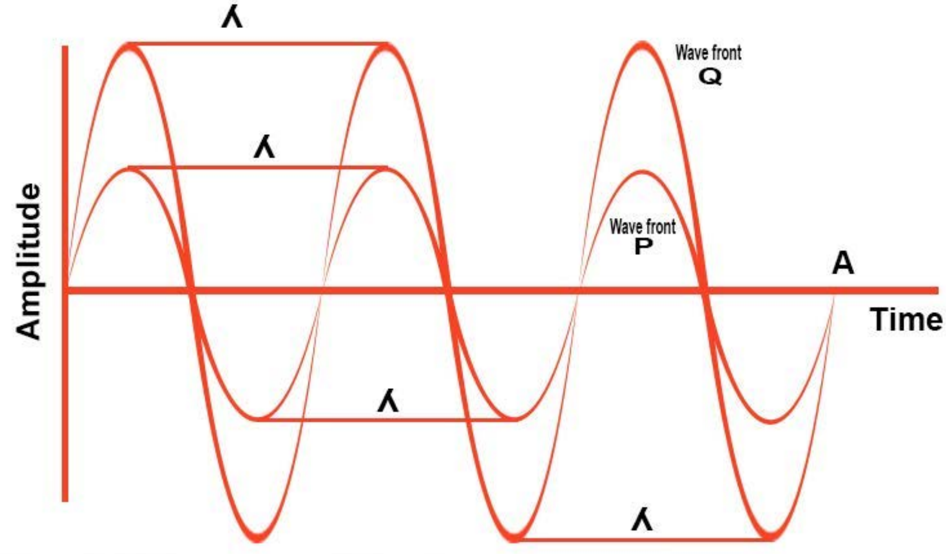

Figure 7: Different type of Wave fronts having the same wave length(λ)

It is quite easy to follow that between the two different types of wave fronts P, & Q, the former one has higher energy as per equation (16) since the area of the wave fronts of Q are higher than the other.

What the 'EM-waves' are, and how do they differ from 'energy' both dimension ally and topologically have already been presented in detail in the previous section. It is to conclude that the concept of 'photons' needs to be abandoned and it has to be replaced by the concept of 'EM wave gravitons' in the form of equation (10) and they are 4-dimensional wave packets or quantum. As far as the TTQG philosophy is concerned, the 'photon waves' are evolved out of the travelling of the swarm of photons through space and which gives rise to the familiar phenomena of 'space expansion' (the so called 'acceleration' of Newtonian Physics'). The 'EM-wave gravitons or quantums' are further expanded to form the said 'space expansion gravitons or quantums'. While the 'EM-wave gravitons' are formed out of the superposition of 'entropy' and 'Energy', it is the superposition of 'entropy' and 'EM-wave' (entropy x EM-wave), from which the 'space expansion gravitons or quantums' ($16\pi^2r^5/9$) are emerged and those are 5 dimensional (5D).

The space expansion gravitons can be represented as the superposition of 3D sphere and an encompassing circle {dimension-ally, $\pi^2r^5 = (\pi r^3 \times \pi r^2) = (\pi r^2 \times \pi r^2 \times r)$}. In figure 8 below the space expansion phenomena in the said 'superposition form of a sphere and a circle' and 'superposition of two circles and an entropy' (distance) are presented in Figure 8.

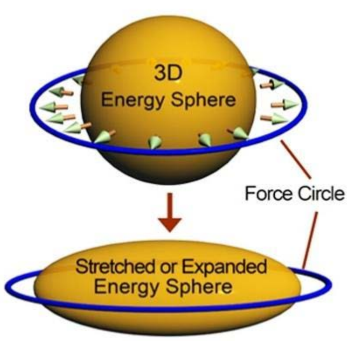

Figure 8a: Presentation of space expansion in the form of a 3D Sphere/Ellipsoid and a Circle

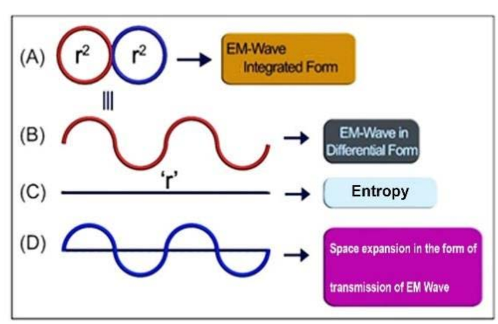

Figure 8a: Presentation of space expansion to the form of superposition of 2 circles and an Entropy Graviton

In figure 8a above, the 'space expansion' has been shown in the lateral fashion. The outside circle is stretching the sphere laterally such that the 3D space of the sphere increases and hence it is called the phenomenon of lateral space expansion. Such expansion may occur longitudinally too and in that case it will be 'longitudinal space expansion'.

In figure 8b, it is shown how the two numbers of circles are unfolded and on an entropy or distance axis

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the wave fronts do propagate leading to space expansion.

The phenomenon of ‘space expansion’ [98,101,103] being a 5D phenomena resembles the ‘energy transmission’ or ‘power ouput’ too. It is the happening out of the passage of the ‘EM-wave gravitons’ to the space. Power is ‘energy transmission per unit time’ and dimension-ally as per TTQG it is,

Power = (energy/time) = $[(r^3)/(1/r^2)] = (r^5)$ … (19)

So the ‘space expansion’ in the form of r^5 is power output too. Most interestingly, the said ‘space expansion gravitons’ are the so called photon waves of ‘quantum physics’. The shapes of the photon waves are shown in Figure 9 below.

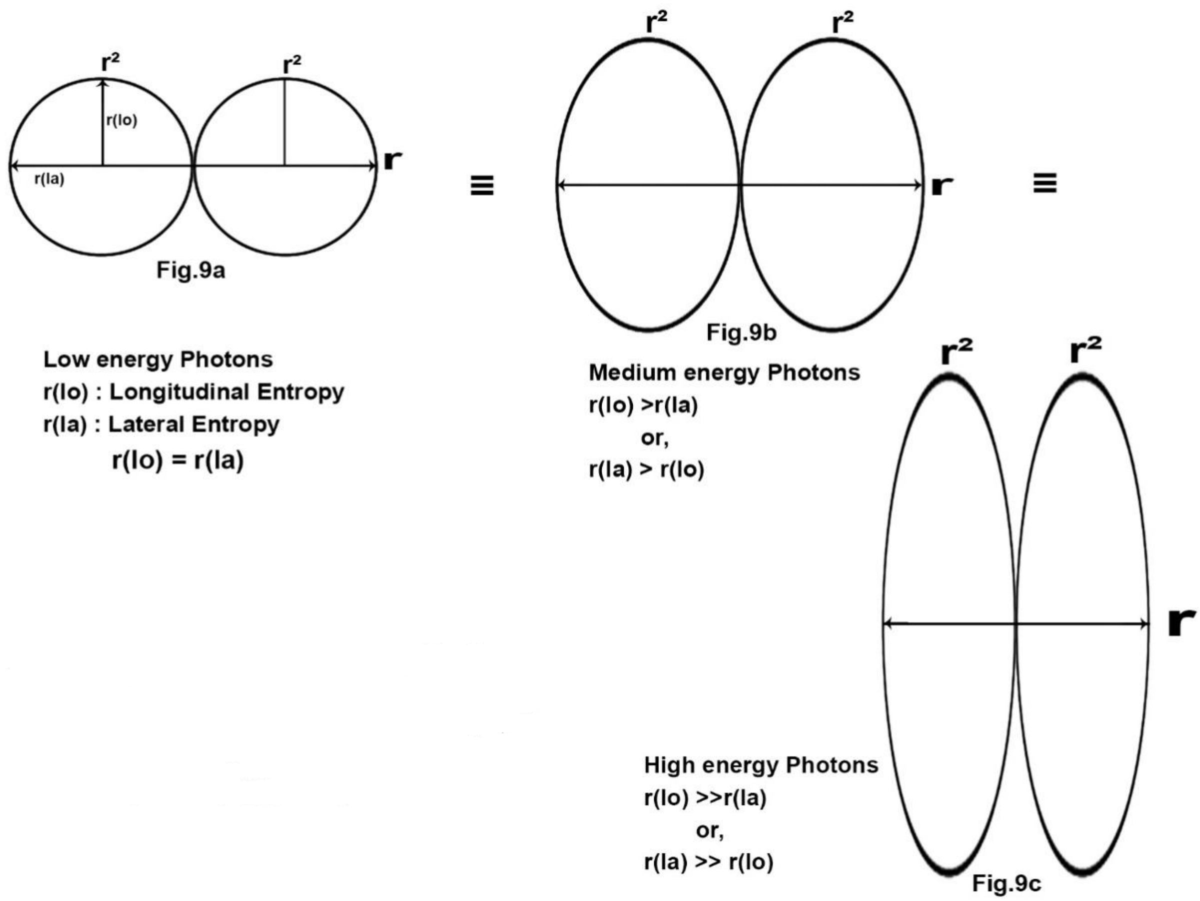

Figure 9: Geometrical shapes of the 'space expansion graviton' or the photons of lower to higher energy

As far as the logic and philosophy of the TTQG is concerned, the term ‘photon waves’ does not fit into its model since the term ‘photon’ is very abstract for the following obvious reasons there off

i) At times they are described as particles and a particle has to have a mass.
ii) On the other hand they are called mass less
iii) They are described sometimes as ‘energy packets’ and sometimes as ‘EM waves’. iv) No light had been shed on the size and shape of the photons (how do the photons look alike?).

So in TTQG, from now the term ‘photon’ will be replaced by a new term ‘SEG’ or ‘space expansion graviton’. From the above Figure 9, it is very clearly understood that the spread of the higher energy ‘SEG’ are more than the lower energy ones. While the lower energy ‘SEG’ are more or less isotropic (in regard to their longitude and latitude), the higher energy ones are either longitudinally or laterally skewed and are non-isotropic.

The energy level of the ‘SEG’ are directly proportional to the ratios of ‘longitudinal length/entropy (L_{lo}) to ‘lateral length/entropy (L_{la})’ as shown in figure 9 above. When the said ratio is higher the energies are higher and when it is 1:1, the energies are lower. One should be moving away from the dictum of ‘lower wavelength- higher energy’ and ‘higher wavelength-lower energy’. In figure 10 below the shapes of the SEG’s of the red light to violet light has been shown [in the differential form they are 5-dimensional, (πr^3-sphere/ellipsoid x πr^2-base) and in the integrated form they look like 3 dimensional)] as has been evaluated through the TTQG driven new theory of color physics.[104]

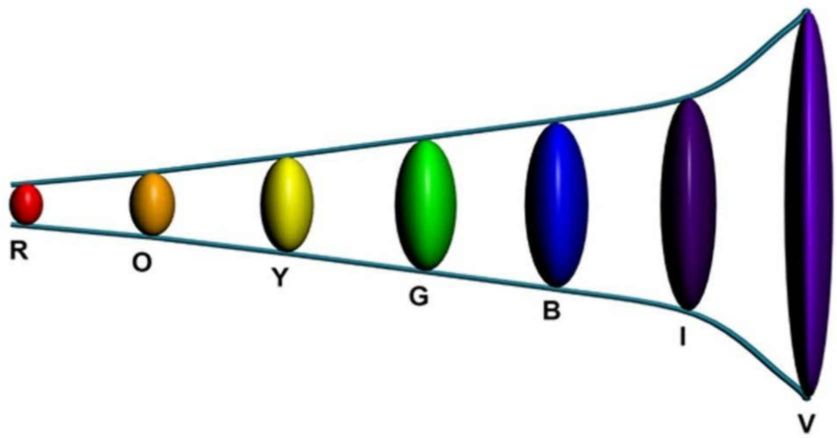

Figure 10: Shapes of all the 'VIBGYOR' EM-WAVE gravitons or the so called Photons of the Newton's Color Wheel from Red to Violet

From figure 10 it is observed that as one passes from the red to orange to yellow to green to blue to indigo to violet SEG, the volume of the gravitons/quanta increase and as well the above said to L_{lo} to L_{la} ratio increases. So the following two numbers of criteria are important to assess the level of energy of the SEG's:

i) Higher the volume of the SEG, higher would be its energy.
ii) Higher the L_{lo} to L_{la} ratio, higher would be the energy of the SEG's

The above said criteria (related to the magnitude of energy of SEG's) are matching to the large scale uniform, homogeneous and isotropic state of the universe but the Planck-Einstein concept of, energy being inversely proportional to the wavelength of the photons, does not match to the same. As per the Planck concept, when the energy level of the photons are higher the wavelengths are smaller and hence the wave fronts are narrower and the peaks are closely spaced one after the other. As a result, the volume swept by the wave fronts are lower. Hence the energy density of space for the swarm of high energy photons would be pretty high (since energy density is equal to the ratio of amount of energy to the amount of volume and energy is high and volume is low). For the lower energy photons, the wave fronts are wider and the peaks are relatively distantly placed one after the other and hence the wavelengths are higher and the volume swept by the wave fronts are higher. So energy density of space would be lower. If this be so, then al through the space of the universe, the gradient of energy density would have been developed and the universe would have lost its large scale homogeneous and isotropic character. But unfortunately this is not so.

If the TTQG depicted SEG's geometries and shapes are examined (Figure 10 above), it is found that starting from lower energy SEG, as one moves to higher energy SEG's (from Red to Orange to Yellow to Green to Blue to Indigo to Violet) , the volumes do increase as well. Since energy (E) remains directly proportional to volume (V) so the energy density has to remain constant. The criteria of the uniform spatial energy density of the universe is, when the energy is lower, volume has to be lower and when energy is higher, volume has to be higher (and the said increase and decrease of volume against the increase and decrease of energy has to be very much proportionate) and it has been proved in TTQG that, (E/V = 3). [98]

Surprising outcome are obtained upon the comparison of energy definition as given in 'classical physics', 'quantum physics' and 'thermodynamics'. But this surprising outcome or the findings make the foothold of TTQG very firm and affirmative as explained below.

CLASSICAL PHYSICS (CP) ENERGY = (PRESSURE X VOLUME)

= (ENERGY/VOLUME) X (VOLUME)

= [(ENERGY / (AREA X DISTANCE)] X (AREA X DISTANCE)

= [(ENERGY/AREA)] X (AREA)]

QUANTUM PHYSICS (QP) ENERGY = (PLANCK'S CONSTANT X FREQUENCY OF LIGHT WAVE)

= [(PLANCK'S CONSTANT X NUMBERS OF CYCLES/TIME)]

= [(ENERGY XTIME X N)/TIME]

= [N X (ENERGYXTIME) X (1/TIME)] [N= number of cycles]

THERMODYNAMICS (THDMS) ENERGY = (BOLTZMAN CONSTANT X TEMPERATURE)

= [(ENERGY/TEMPERATURE) X (TEMPERATURE)]

So if the definitions of 'Quantum physics' and 'Thermodynamics' are compared to each other, in the expression of the later, the time(t) variable of the former is being replaced by the reciprocal of temperature (T). So one can conclude that

$$T = (1/t) \text{ or } t = (1/T)$$

$$\text{So, } Tt = 1.0$$

If the definition of 'classical physics' is compared separately with the other two definitions as given above, the results one gets are:

CP & QP TIME = (1/AREA)

CP & THDMS TEMPERATURE = (AREA)

So the predictions of TTQG of the i) 'time-temperature' multiplicative inverse relationship, ii) the dimension of time (inverse area) and iii) the dimension of temperature (area) and the above said results are found to be the same and as well the hidden 'time-temperature entanglement' relationship of the conventional physics are unveiled.

De Broglie's wave length λ, associated with a particle is expressed in regard to its mass (m) and velocity(v) is in the following form (linked to the Planck's constant, h)

$$\lambda = (h/mv) \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (20)$$

So the wave associated with a massive particle would be lower in its wavelength and consequently the energy of the said wave would be pretty high as per the Planck's energy equation, E = hc/ λ. So for a moving train with a mass of the order of 10^6 gms and a velocity of the order of 10^5 cm/sec will have an associated wavelength would be in the order of 10^{-38}cm. The energy of such a small wavelength wave would be about 10^{30} times higher than ɤ ray having a wavelength of about 10^{-7}cm. So at the thrust of a moving train everything would have burned all out. But this is not happening so and one needs to re look the De Broglie's wave length equation in the light of TTQG.

In TTQG, it has been established that velocity v, converges to volume, V, and the product of mass and volume is constant (mV =3). So the equation (20) takes the form [considering h=3r, as shown in equation 2]

$$\lambda = r \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (21)$$

So Planck's energy expression of a photon would take the shape [the velocity of light would be in the form of a volume and in terms of r it will be, $(4\pi r^3/3)$] and in TTQG 'force/temperature' and 'entropy' are being expressed as $4\pi r^2$ and r respectively].

$$E = (hC/\lambda) = [3r \times (4\pi r^3/3)/r) = 4\pi r^3 = (4\pi r^2 \times r) = (\text{force} \times \text{entropy}) = (\text{temperature} \times \text{entropy}) \quad \ldots\ldots\ldots (22)$$

So one should move away from the traditional concept of tracing the 'energy' in inverse relationship to 'wave length' (λ) and should adhere to the following new concepts:

i) The wave length λ of Planck's equation in fact represents 'entropy'.
ii) In the language of TTQG, 'energy' is the superposition of 'area' and 'entropy' or 'force' and 'entropy' or 'temperature' and 'entropy'.
iii) When the 'area/force/temperature' remains constant, the energy is directly proportional to 'entropy'. As the entropy increases, the energy increases and vice versa,
iv) When the 'entropy' remains constant, the 'energy' is directly proportional to 'area/force/temperature'. As the 'area/force/temperature' increases, the energy increases and vice versa.

The arguments and the mathematical equations put forward by Albert Einstein to explain the familiar phenomenon of photo electricity suffers from the problems of ambiguity and self contradiction as described below:

i) The phenomenon of photo electricity has been referred to as the event of 'interaction of light wave and matter' but the photons are considered as 'particles' striking the metal surface. The geometry or the shape of the particles, though very important but were not at all thought of. Such mix-up of concepts (between particle and wave) are illogical and are not acceptable.

ii) The proposition that 'the photons are dual in nature and sometimes they behave as waves and sometimes as particles' is fictitious since no attempt was taken to link the said proposition and itself the phenomenon of photo electricity, to any of the very important aspects of 'quantum to quantum interaction' like the phenomena of 'entanglement', 'superposition', 'exchange' and 'interference'.

iii) The subject of 'failure of the low energy photons to eject the electrons from the surface of matter even when their intensities are higher' had been linked to the event of inability of the light waves to add up the energies of the photons (due to the discrete or discontinuous nature of the energy packets or the photons). It is a matter of common experience that the pressure of a gas (which is originated from the collision of the molecules with the walls of the container) increases if a certain fixed amount of a gas is transferred to a smaller size container from a higher size container, keeping the temperature the same, the number of collisions of the molecules with the walls increase per unit area per unit time (increase of intensity of collision). As a result the pressure increases although the average kinetic energy of the molecules remain the same since the temperature is the same. If the energies can add up in the case of discrete gas molecules, why it cannot happen for the photons considered as particles ? So the argument of Einstein is not an acceptable version.

iv) The phenomenon of photo electricity is a quantum phenomena as proposed by Einstein. But his very famous mathematical equation of the photoelectric effect is a subtractive model. He proposed that the energy of the photons (while striking the metal), are fully subtracted and the same passes on to the metal. The thrust of the said energy unbound the electrons from their orbits. As discussed above, the interaction of the quantum forces with each other rests on the principles of 'entanglement', 'superposition', 'interference' and 'exchange' of the said quantums. Hence any 'subtractive' model is not compatible with the logic and philosophy of quantized 'space-time' of the universe.

The TTQG model of the photoelectric effect vis-a-vis the Einstein's typical model (as shown in the standard text books of physics) are shown schematically in figure 11a and 11b respectively.

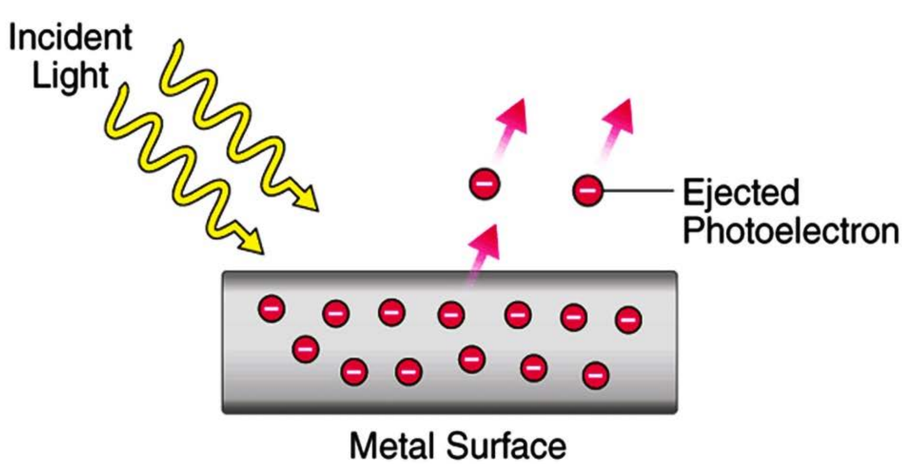

Figure 11a: Schematic presentation of the Photo-electric Phenomena in regard to Einstein,s Photo-electric equation

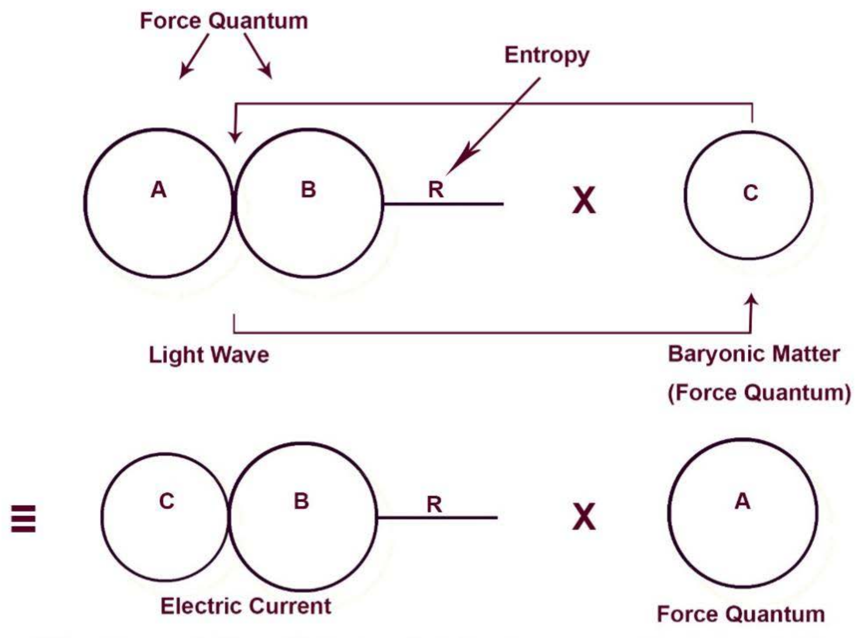

Figure 11b: Presentation of Photo-electric phenomena in regard to the exchange of Quantum forces between the light wave and the Baryonic matter

While the mechanism of quantum interaction of the 'light wave' with the metal could not been shown by Einstein (Figure 11 a), it is TTQG which shows very clearly how through the exchange of quantum forces (between EM-wave and the substrate) the charge quantums are generated from the metal as is shon in Figure 11b.

The inability of the 'low energy photons (SEG)' to eject the electrons is related to their geometrical shapes. As shown in Figure 10, the low energy SEG's are spherically more symmetrical than the high energy SEG's which are more sharper (either at the their longitudinal or their lateral edges) at one of their two ends. As a result of this sharper geometrical shapes of the later , their penetrating powers are much higher. So Einstein's explanation of the said happening, based on the discrete energy levels of the energy packets (photons), is not appropriate, due to the following main reasons:

i) The photo electric phenomena is not 'subtractive' but is based on the exchange of forces through quanta
ii) The temperature remaining constant, for a fixed quantity of a gas, the pressure of the gas is a function of, the number of gas molecules striking the wall of the container per unit area per unit time. Higher the number of impacts on the wall, higher is the pressure.
iii) The penetrating power of the the quantums is related very much to their geometrical shapes and the said factor was not considered at all.

V. True Significance of the Term 'Relativity' in the Special and General Theory of Relativity as Derived through TTQG

Einstein's theory of relativity, why it is called relativity, is more or less known to the scientific community. The very common explanation of the word 'relativity' is 'how different observers can have different measurements of space and time, depending on their 'relative motions'. While with an extraordinary power of intuition, Einstein could predict that space and time are interwoven to each other, he in fact could not express his thoughts in the right way. His predictions of special and general theory of relativity were in fact 'quasi-true' on the following grounds:

i) The interrelation between 'space-time' and velocity as was made in the special theory of relativity is very fragile since when one considers the physical reality of the universe (the dimension of 'time' and 'temperature' as revealed through TTQG), the physical variable 'velocity' does merge to the concept of 'volume'. The cup of tea indeed is the 'volume' not the 'velocity'. The 'space-time' is quantized and the universe appearing before us is being originated from the entanglement, superposition and interference of the 'push-forward' and 'pull-back' gravitons.
ii) The very famous equation of special theory of relativity relating energy (E) to the mass (m) in the form of $E=mc^2$ (c, the velocity of light) is again

non-appropriate since he tried to link energy to velocity. However, in TTQG, it has been very firmly established that this equation in fact converges to the TTQG derived equation, E = 3V, (V being a 'volume' graviton') which means that the energy density of space is constant.

iii) The GTR of Einstein talks about 'gravity' and the prediction is, it is the 'gravity' only, which affects the shape of 'space-time'. Einstein put forward his 'field equations', popularly known as Einstein Field.

Equations (EFE's), which are fictitious and difficult to comprehend. Over and above, neither in STR nor in GTR, the 'time', 'mass' and 'gravitational attractive force' was tried to be traced to the 'molecular level interactions' among the astronomical objects or matters of the universe.

As far as the logic and philosophies of the TTQG is concerned, the actual meaning of the term 'relativity' in realm to the cosmological physics of the universe is, how one is fixing up the sizes (distance, area and volume and their inverses) of the single units of a entropy graviton, an area/force /temperature graviton and a volume/energy graviton vis-a-vis the entangled order graviton, time graviton and mass graviton. In Figure 12 below this subject is clearly shown.

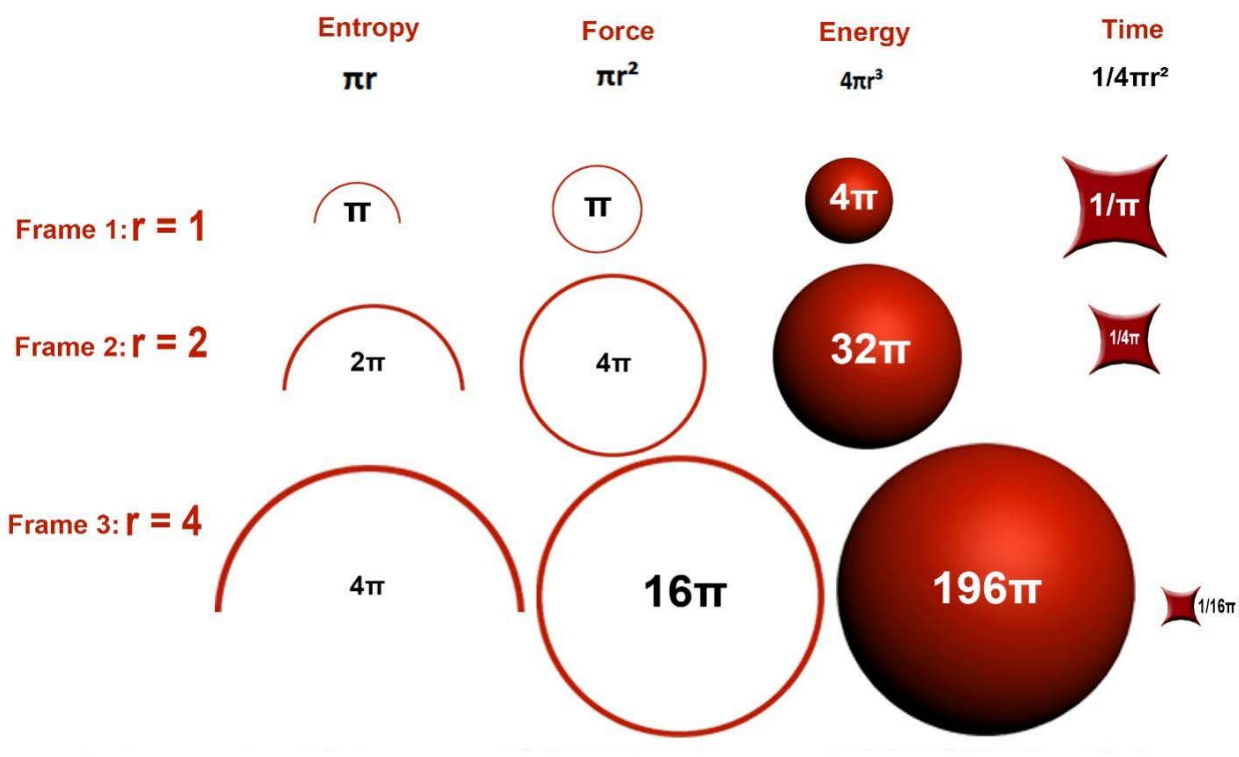

Figure 12: The real significance of the special theory of relativity of Albert Einstein

In Figure 12, if the three different frames (frame -1, frame -2 and frame -3) are compared to each other one would led to conclude that the single units of entropy graviton, force graviton, time graviton and volume graviton in frame -3 corresponds to 4 units, 16 units, 49 units and 4 units of entropy, force, energy and time gravitons respectively of frame-1. Similar type of correlations would be valid for any pair of the said three numbers of frames. This is what is called 'relativity' in the language of Einstein of the different zones/frames of the universe. However, this so called 'relativity' is not creating any gradient of energy distribution in the space since the 'energy -density' of all the frames are constant [the mathematical expression of the same is , (E/V) =3, as explained above] and the universe remains homogeneous, uniform and isotropic.

VI. TTQG Interpretation of the Quantum Mechanical Concepts of 'Superposition', 'Entanglement', 'and' Exchange of Forces'

The push forward and pull back gravitons in TTQG are all in the form of 'packets' or 'quanta' in the normal and inverse dimensionality as is shown in Figure 2. The act of superposition, i.e, placing of one thing on the top of another, leads to different types of outcome depending on the geometrical shapes of the involved things [98,101]. In Figure 13 below, three different types of quantum superposition are shown:

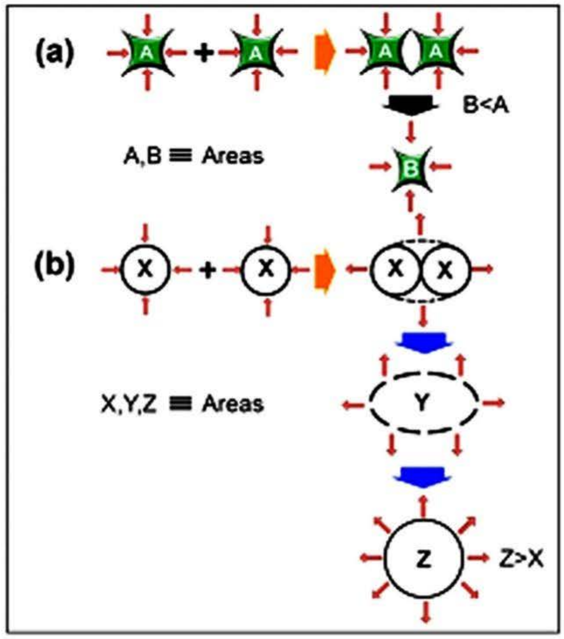

Figure 13a: **Superposition of two pull back gravitons to form a new Quantum state.**

Figure 13b: **Superposition of two push forward gravitons to form a new Quantum state.**

Figure 13b (interaction of two numbers of push forward gravitons, PFG) and Figure 13a (interaction of two numbers of pull back gravitons, PBG) correspond to the principle of quantum mechanics, i.e, additions of the two quantum states yield another valid quantum state. However, in case of two numbers of PFG, the newly generated quantum state is higher in area than the individual PFG'S because of their dispersive characters. However, in case of two numbers of PBG's, since they are squeezing type, the resulting quantum state is smaller in area.

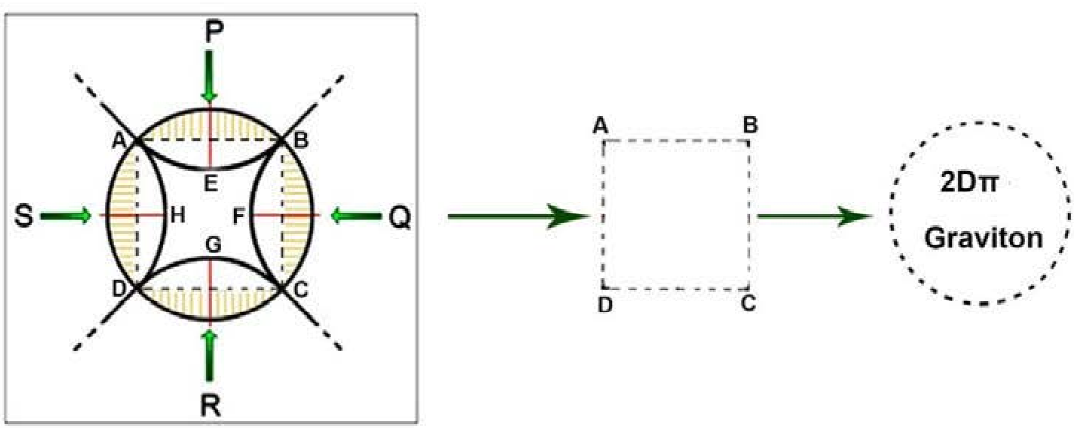

Figure 13 c: Entanglement of push forward and pull back gravitons to form Vaccum space Π -gravitons

The superposition as shown in Figure 13c[98] (the interaction of a PFG & a PBG) rightly reflects the 'SCHRODINGER'S CAT PARADOX'.As shown in Figure 13c, the inverse curvatures of the segments of the circle and a 2D saddle swallow each other (APB & AEB), (BQC & BFC), (RCD & DGC) and (RCD & DGC) produces the 4 numbers of equal length empty space straight lines AB,BC,CD & AD to form the vacuum square space ABCD. However the said vacuum square space homogenizes to a circle to attain minimum circumference and which is called as a 'vacuum space 2D π-graviton' or simply '2D π-graviton'. Similarly the interaction of a 3D sphere and a 3D saddle generates '3D π-graviton'. In the state of superposition of 'force' (circle) and 'time' (2D saddle), in Figure 13 c, the following statements stand logical:

i) No 'time' and no 'force' does exist at all in the universe.
ii) The 'time' and 'force' do co-exist with each other in the universe.
iii) From the state of a vacuum space of zero dimensionality, 'time' and 'force' gravitons or quanta are auto generated, which are inverse to each other in their dimensions such that the dimensionality of one cancels the dimensionality of the other such that the net dimensionality is zero. This way new dimensionality are continuously created in space.

The 'SCHRODINGER'S CAT PARADOX' as cited above, as such, is much difficult to comprehend and he could not express his thought in the right way. The paradox is , a cat is put in a box which contains a bowl of poison and the box is closed. When the box is opened after some time, the cat would be found either alive or dead. Schrodinger put the argument that though apparently the cat is found either alive or dead after opening the box but the physical reality of the universe is , the cat is both alive and dead simultaneously or in state of superposition of the two. He could not put forward any quantum description of the superposition phenomena.

However, in continuation with the discussions of the previous paragraph, if the 'force' graviton and the 'time' graviton, for example, represents the 'state of alive' and 'the state of death' respectively, one may conclude that none of the so-called living species in the universe are neither fully alive nor fully death. In a state of superposition with each other, they are both alive and dead simultaneously. The very broad frame essence of the discussion made above (against Figure 13c) is, the universe belongs to a state of superposition of 'existence' and 'non-existence'. Philosophically one might say 'Yes, the universe does exist very much but at the same time it does not exist too'.

The phenomenon of 'entanglement' or 'quantum entanglement' is very much related to the concepts of mathematical 'integration' and 'differentiation'. Mathematically, If the smallest segment of distance/length (which is a physical variable), for example, is being represented by dx, then its integration gives x (considering the dimensional part only not the constant part) and the further integration of x gives x^2. The integration of x^2 gives x^3. In the language of TTQG, integration is a physical process through which a physical variable does spread itself more and more in the space and its entity becomes the 'part and parcel' of the space. In the example cited above, the linear translations of the small distance segment (dx, which can be considered as a point) in space gives rise to straight line, which is x. Then the translation of the said line segment in a 2D space (in either of the 2 mutually perpendicular directions) to a distance of its own length x, gives a square of dimension x^2. Finally the translation of the said square (in any of the three mutually perpendicular directions) to a length of x gives a homogeneous cube of dimension x^3. So integrating a physical variable is to move (both rotation and translation) it in space such that the physical variable gets more and more 'hybridized' with the space. Differentiation is just the reverse of integration. While in case of integration, the build up of dimensions take place one after another, in the case of differentiation what happens is the chronological collapse of the dimensions. For example from x^3 it passes on to x^2 and from x^2 to x and finally from x to dx. In other words, the dimensions collapse from 3D to 2D to 1D to zero dimension (a geometrical point is of zero dimension) in case of differentiation.

The said two terms, i.e, 'hybridization and 'integration' are the key words of the two different subjects (the former one is of chemistry and the later one is of mathematics) but they are virtually the same and carries the same significance altogether. The actual meaning of the statement made above, 'physical variable does spread itself…….of the space' needs to be elaborated at this juncture and is described below:

i) If, for example, one talks about 'entropy' (which is being represented by a 1 dimensional line of length 'r' in TTQG), then its passing on to higher dimensions one after another (from 1 dimensional line to 2 dimensional circle to a 3D sphere or from r to r^2 to r^3), are considered to be 'integration' or 'hybridization. A 2D circle represents force and a 3D sphere represents energy and so the said transition takes place from entropy to force to energy.
ii) If, for example, one talks about 'force' (which is being represented by a 2D circle in TTQG), then its increase in size is also considered as 'integration' or 'hybridization.

So for any physical variable, either its 'dimensional step-up' or its 'increase in size without changing the dimension' both belong to the process of 'integration' or 'hybridization'. Similarly for any physical variable, either its 'dimensional step-down' or its 'decrease in size without changing the dimension' both belong to the process of 'differentiation' or 'dehybridization'.

The 'differentiation/dehybridization' and 'integration/hybridization' are simultaneous events. This has got a very good analogy with the processes of 'oxidation' and 'reduction' in chemistry. When a chemical reaction takes place, if there is an oxidation occurring therein, a reduction has to inevitably occur too. The real concept of physics is, whenever there is a differentiation or dehybridization taking place, somewhere in the space, a simultaneous integration or hybridization has to take place to maintain the dimensions of the universe constant. The concept of 'entanglement' of physical variables is resting on the following three physical aspects,

i) An equilibrium has to exist between the concerned 'entangled' physical variables.
ii) When one of the variables get integrated (hybridized), the other one will differentiate itself (at whatever distance it lies from the other) such that the net dimensions remain constant.
iii) The 'simultaneous integration - differentiation' does take place through the mechanism of exchange of quantum between the concerned physical variables.

Suppose there are two entangled physical variables r^2 and r^3 existing in equilibrium with each other [The net dimensionality is (2+3) =5, the constant of proportionality which does exist in such types of equilibrium is not shown]

$$r^2 \leftrightharpoons r^3$$

Now if the LHS physical variable is being integrated and the RHS is differentiated (only considering the dimensional part), the above equilibrium takes the following form and the net dimensionality '5' is being retained.

$$r^3 \leftrightharpoons r^2$$

Suppose there are 6 numbers of entangled physical variables (serial number 1,2,3,4,5 & 6) are existing in chronological equilibrium with each other in the following manner:

$$r^1(1) \leftrightharpoons r^2(2) \leftrightharpoons r^3(3) \leftrightharpoons r^4(4) \leftrightharpoons r^5(5) \leftrightharpoons r^6(6) \text{ [Net dimensionality is (1+2+3+4+5+6) = 21]}$$

Now if one starts from the right most side of the above shown equilibrium and 6th one is integrated, 5th one has to be differentiated, 4th to be integrated, 3rd to be differentiated, 2nd to be integrated and finally the 1st one to be differentiated. If all these are done, the above equilibrium takes the following shape,

$$r^0(1) \leftrightharpoons r^3(2) \leftrightharpoons r^2(3) \leftrightharpoons r^5(4) \leftrightharpoons r^4(5) \leftrightharpoons r^7(6) \text{ [Net dimensionality is (0+3+2+5+4+7) = 21]}$$

The 'hybridization' and the 'dehybridization' of the entangled physical variables of the universe take place in the above shown manner such that the net dimensionality of the universe remains constant. The distance of one physical variable from the other is not at all a factor of concern for the validity of the occurrence of the said 'hybridization' and the 'dehybridization'. From one angle of view, this said constancy of the dimensions of the physical variables is a consequence of the following four numbers of (TTQG derived equations) entanglement equilibrium of the different gravitons or quanta and from an another angle of view, the said following entanglements are the consequence of the above said simultaneous ' hybridisation' and 'dehybridisation' concept.

mV= 3 m= mass , V = volume - 'conservation of momentum'

Tt = 1 T = temperature/force t= time - 'Time and temperature are multiplicative inverse to each other

mE = 9 m= mass , E = energy - 'mass energy equivalence of the universe'

E = 3V E = energy , V = volume - 'Energy density of space is constant'

The said simultaneous 'hybridisation' and 'dehybridisation' concept is also valid for two physical variables in equilibrium with each other and are multiplicative inverse to each other.
The entanglement of 'time' ($1/r^2$) and 'force/temperature' in TTQG is represented in the following way:

$$r^2 = (1/r^2)$$

Now, in such type of entanglement, the net dimensionality is zero. The said simultaneous 'hybridisation' and 'dehybridisation' concept is also valid here. If the LHS of the above equation is integrated and the RHS is differentiated, one gets (only the dimensional part, not constant part)

$$r^3 = (1/r^3)$$

So the net dimensionality remains zero out of this simultaneous ' hybridisation' and 'dehybridisation'.

The above said simultaneous 'hybridisation' and 'dehybridisation' can also be represented in the form of exchange of quantum between the RHS and LHS of an entangled equilibrium. An equilibrium is shown below between two numbers of physical variables

$$\pi^2 r^4 \leftrightharpoons \pi^2 r^5$$

The LHS of the above said equilibrium can be represented by two numbers of circles of radius r each. The RHS of the above equilibrium can be represented as the product of two numbers of circles of radius r each and a distance r. The break up form of the said equilibrium can be represented as,

$$(\pi r^2) \times (\pi r^2) \leftrightharpoons (\pi r) \times (r^2) \times (\pi r^2) \text{ - BREAK UP FORM}$$

If the LHS and the RHS of the above equilibrium are differentiated and integrated respectively, it takes the following form,

$\pi(\pi r^2) \times (r) \leftrightharpoons [(\pi r^3) \times (\pi r^3)]$ - MUTUAL DIFFERENTIATION- INTEGRATION FORM OF LHS & RHS

One can arrive the above shown 'MUTUAL DIFFERENTIATION- INTEGRATION FORM OF LHS & RHS' without doing any differentiation and integration of the LHS & RHS respectively. If in the 'BREAK UP FORM' as shown above one just makes the following exchange of 'graviton' or 'quantum' between the LHS & RHS:

Exchanging the entropy graviton 'πr' of RHS with one of the force gravitons '$\pi r^{2'}$ of the LHS, the same MUTUAL DIFFERENTIATION- INTEGRATION FORM OF LHS & RHS is obtained dimension ally, as shown below

$$\pi\ (\ \pi r^2)\times(\ r)\leftrightharpoons[\ (\ \pi r^3)\times(\ \pi r^3)\ ]$$

In the space innumerable 'mutual interactions' of the physical variables take place and those can be viewed and understood in the light of the quantum mechanical phenomenon of 'exchange of forces through quantum'. To illustrate this, for example, if the event of interaction of 'force' and 'space expansion' gravitons or quanta (mathematically expressed as πr^2 and $\pi^2 R^5$ respectively, where r and R are the radiuses of the force circle and space expansion graviton circle) are considered, how the magnitudes of the 'force' and 'space expansion graviton' would remain correlated to each other before and after of the interaction taking place is shown below:

INTERACTION (EXPRESSED AS A PRODUCT OF TWO VARIABLES) = (Force graviton) x (space expansion graviton)

$$= (\pi r^2)\times(\pi^2R^5) = (\pi r^2)\times[(\pi R^2)\times(\pi R^3)]$$

Case I: when r= R and an exchange of quantum takes place [(πr^2) and (πR^2) in the 3rd bracket of the above equation interchanges their position) between the variables and after the interaction, the above equation can be written as,

$(\pi R^2)\times[(\pi r^2)\times(\pi R^3)]$ = (New force graviton) x [New space expansion graviton]

This is based on the equilibrium of the following type ,

{(original force graviton) x (original space expansion graviton)} = {(new force graviton formed) x (new space expansion graviton formed)}

Now since r=R, inspite of the exchange of quantums between the two, the magnitudes of the force gravition and the space expansion graviton remain the same before and after the interaction.

Case II: When r>R, then due to the above type of exchange, the following correlation will hold true

Magintude of 'force' graviton before interaction > Magnitude of the new 'force' graviton formed after interaction

Magnitude of 'space expansion graviton' before interaction < Magnitude of the new 'space expansion graviton'

Case III: When r<R, then due to the above type of exchange, the following correlation will hold true

Magintude of 'force' graviton before interaction < Magnitude of the new 'force' graviton formed after interaction

Magnitude of 'space expansion graviton' before interaction > Magnitude of the new 'space expansion graviton'

All the above discussions made are being shown diagrammatically in Figure 14a, 14b and 14c respectively.

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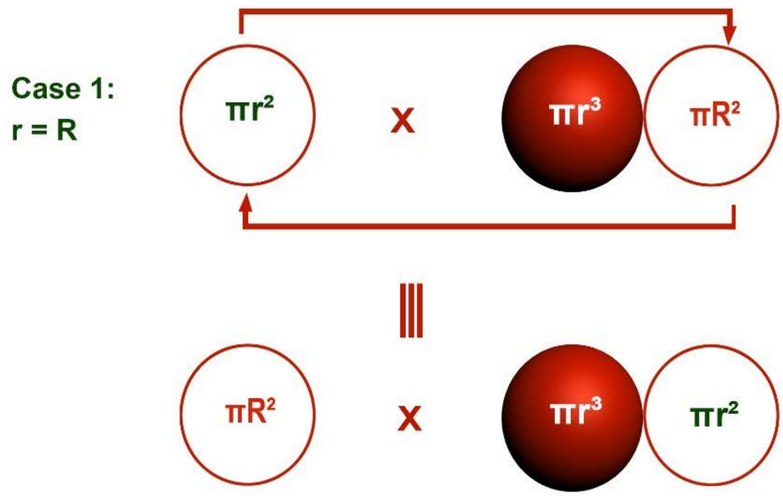

Figure 14 a: Exchange of quantum forces between a force graviton and a space expansion graviton

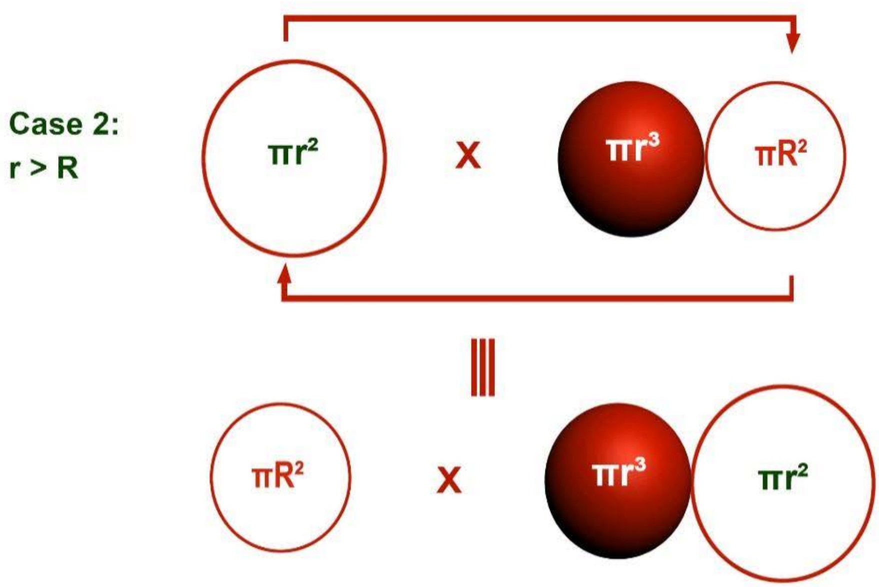

Figure 14 b: Exchange of quantum forces between a force graviton and a space expansion graviton

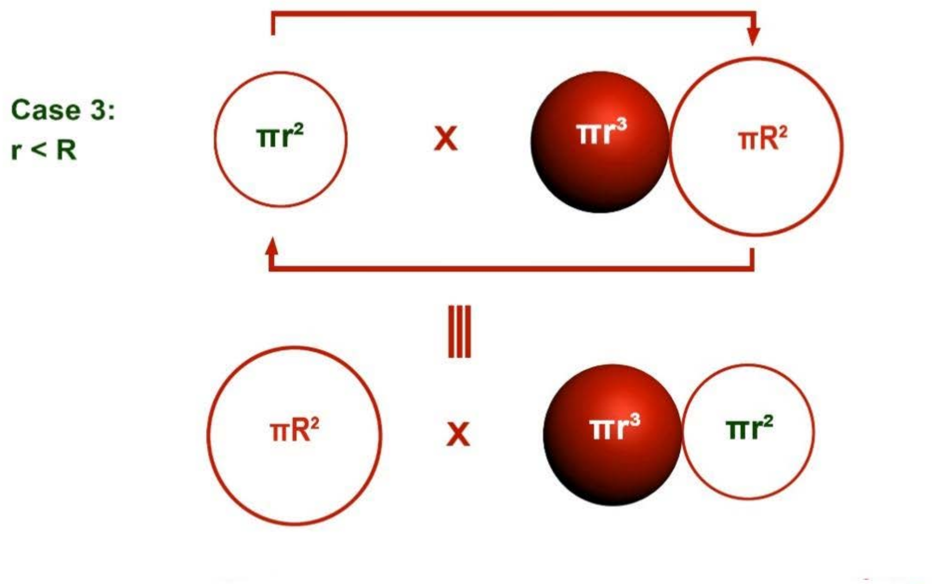

Figure 14 c: Exchange of quantum forces between a force graviton and a space expansion graviton

The TTQG depicted 'universal graviton cycle' [98,104] is shown in Figure 15 below. A 'singularity graviton' decays and as a result of that twelve numbers of different entanglement equilibrium are originated and which is shown in Table 2 below:

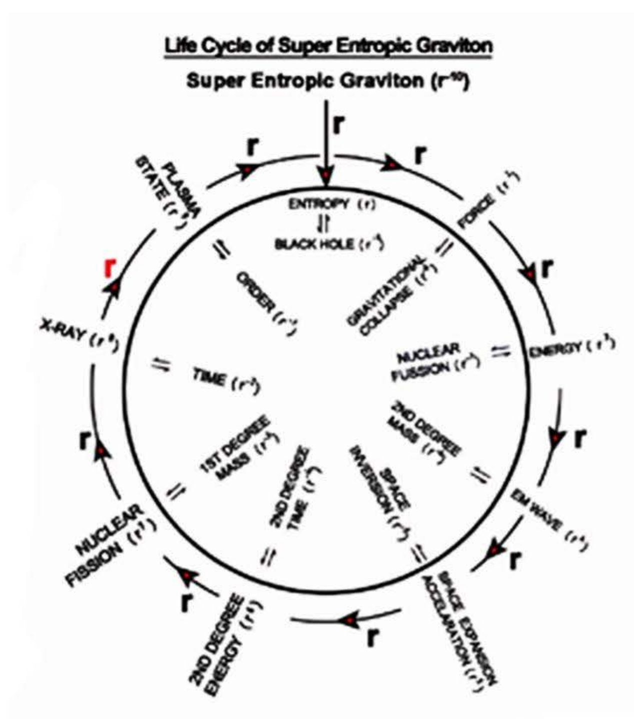

Figure 15: UNIVERSAL GRAVITON CYCLE

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Table 2: Stepwise decay of the singularity graviton and emerging of the twelve numbers of entanglement

STEP NO.	STATE OF GRAVITON	EMISSION FROM THE GRAVITON	EQULIBRIUM BETWEEN PUSH FORWARD AND PULL BACK GRAVITONS	OBSERVABLE PHYSICAL VARIABLES IN EQILIBRIUM WITH EACH OTHER
1.	$\frac{1}{f^2} = \frac{81}{256\pi^4 r^{10}}$	π	$\frac{81}{256\pi^3 r^{10}} \leftrightharpoons \pi$	Empty space π-graviton or space hole graviton and super entropic graviton
2.	$\frac{81}{256\pi^3 r^{10}}$	r	$\frac{81}{256\pi^3 r^9} \leftrightharpoons \pi r$	Entropy graviton and Black-hole graviton
3.	$\frac{81}{256\pi^3 r^9}$	r	$\frac{27}{64\pi^3 r^8} \leftrightharpoons \frac{4}{3}\pi r^2$	Fourth degree time graviton and push forward /temperature/force graviton
4.	$\frac{27}{64\pi^3 r^8}$	r	$\frac{81}{64\pi^3 r^7} \leftrightharpoons 4\pi r^3$	Nuclear fusion graviton and first degree energy graviton
5.	$\frac{81}{64\pi^3 r^7}$	π r	$\frac{81}{16\pi^2 r^6} \leftrightharpoons 16\pi^2 r^4$	EM-wave graviton and 2nd degree mass graviton
6.	$\frac{81}{16\pi^2 r^6}$	r	$\frac{9}{16\pi^2 r^5} \leftrightharpoons \frac{16\pi^2 r^5}{9}$	Space inversion-space expansion, color graviton of object,and color graviton of EM wave
7.	$\frac{9}{16\pi^2 r^5}$	r	$\frac{9}{16\pi^2 r^4} \leftrightharpoons \frac{16\pi^2 r^6}{9}$	2nd order time graviton or 2nd order force or temperature graviton
8.	$\frac{9}{16\pi^2 r^4}$	π r	$\frac{9}{4\pi^2 r^3} \leftrightharpoons \frac{64\pi^3 r^7}{9}$	1st order mass and nuclear fission graviton
9.	$\frac{1}{4\pi r^3}$	r	$\frac{3}{4\pi r^2} \leftrightharpoons \frac{64\pi^3 r^8}{27}$	Time graviton and X-ray, gamma ray graviton
10.	$\frac{3}{4\pi r^2}$	r	$\frac{1}{\pi r} \leftrightharpoons \frac{256\pi^3 r^9}{81}$	Plasma state graviton and order graviton
11.	$\frac{1}{\pi r}$	π	$\frac{1}{r} \leftrightharpoons \pi$	Order graviton and π graviton
12.	1	r	$1 \leftrightharpoons \pi r$	Enlarged singularity and entropy graviton

It is to note from Table 2 (from the mechanism of stepwise decay of the singularity gravitons in the different steps) that the all the twelve numbers of different entanglement equilibrium are very much connected to each other. So any change in the magnitude of any of the graviton of any of the steps, will affect the magnitude of the all other gravitons (irrespective of how far they are positioned in the space from each other) since all the twelve steps exist in chronological equilibrium or entanglement with each other. Table 3 below shows the entanglements of the 'conjugate graviton-antigraviton' pairs of the universe.

Table 3: Graviton – Anti-Graviton Conjugate Pairs

Sl. No.	Type of Anti-Graviton		Type of Graviton
1.	DISTANCE COLLAPSING GRAVITON OR ORDER GRAVITON (r^{-1})	⇋	ENTROPY GRAVITON, INDEX OF RANDOMNESS, VOLTAGE/POTENTIAL DIFFERENCE (r^{1})
2.	TIME GRAVITON, VISCOSITY, MAGNETIC POTENTIAL (r^{-2})	⇋	FORCE, TEMPERATURE, CHARGE (r^{2})
3.	MASS GRAVITON (r^{-3})	⇋	ENERGY GRAVITON, INTENSITY, VOLUME (r^{3})
4.	INVERSE MAGNETIC FIELD (r^{-4})	⇋	EM WAVE GRAVITON/SO CALLED PHOTONS (r^{4})
5.	SPACE INVERSION, INDUCTANCE, MASS LOCALISATION, COLOR GRAVITON OF OBJECT IN MASS FORM $(r^{-5})*$	⇋	SPACE EXPANSIOIN, DELOCALISATION OF MASS, COLOR GRAVITON IN EM WAVE FORM $(r^{5})*$
6.	CONDENSED STATE MASS GRAVITON OR SECOND DEGREE MASS GRAVITON (r^{-6})	⇋	2ND DEGREE ENERGY GRAVITON, PHOTO-ELECTRICITY (r^{6})
7.	NUCLEAR FUSION GRAVITON (r^{-7})	⇋	NUCLEAR FISSION GRAVITON (r^{7})
8.	GRAVITATIONAL COLLAPSE GRAVITON (r^{-8})	⇋	X-RAY, GAMMA RAY GRAVITON (r^{8})
9.	BLACK HOLE GRAVITON (r^{-9})	⇋	3RD ORDER ENERGY, PLASMA STATE GRAVITON (r^{-9})
10.	SUPERENTROPIC/SINGULARITY GRAVITON (r^{-10})	⇋	ANTI-GRAVITY OR SUPERNOVA (r^{-10})

Sir Isaac Newton had expressed his 3rd law of motion as 'To every action, there is an equal but opposite reaction'. However, he could not explain why there is an opposite reaction always. After the discovery of TTQG, one finds the logic behind it. The entanglement of push forward and pull back gravitons is responsible for the evolution of the opposite force since the pull back gravitons of the universe are always trying to swallow or neutralize the effect of the push forward gravitons and vice versa.

VII. The Physical Significance of the Quantum Mechanical, 'Wave Function' and 'Operators' Revealed through TTQG

The subject of quantum mechanics started with the hypothesis of 'wave - particle duality'. Till date no full proof definition of particle has been given in physics or chemistry. It is the TTQG which for the first time in the history of science put forward the tripartite definition (based on physics, mathematics and geometry) of particles or masses. Through the 'universal graviton cycle', the several entanglement equilibrium and the 'graviton-antigraviton' conjugate pairs, TTQG, has firmly demonstrated that in fact the 'wave particle duality' is in

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fact the equilibrium of push forward gravitons (those are in the form of EM-wave) and the pull back gravitons (those are in the form of the masses of 1st degree, 2nd degree, 3rd degree ..etc..) as shown in Table 3 above. So one should move away from the notion of 'wave -particle duality' and the word 'duality' should be deleted from it and the same to be renamed as 'entanglement of wave and particle' or 'wave- particle entanglement'.

TTQG, however, has developed, '3 in 1 type' pictorial presentation, of the 3 different types of 'quantum entanglements' as shown below in Figure 16 and Figure 17. As shown in the said figures the three numbers of physical variables, i.e., i) 'π gravitons', ii) 'force gravitons' and iii) 'EM-wave constituent gravitons' are all represented by circles (so the term '3 in 1 type' has been used) and another three numbers of physical variables, i.e., i) 'anti-π gravitons' ii) 'time gravitons' and iii) 'particle constituent gravitons are all represented by 2D saddles.

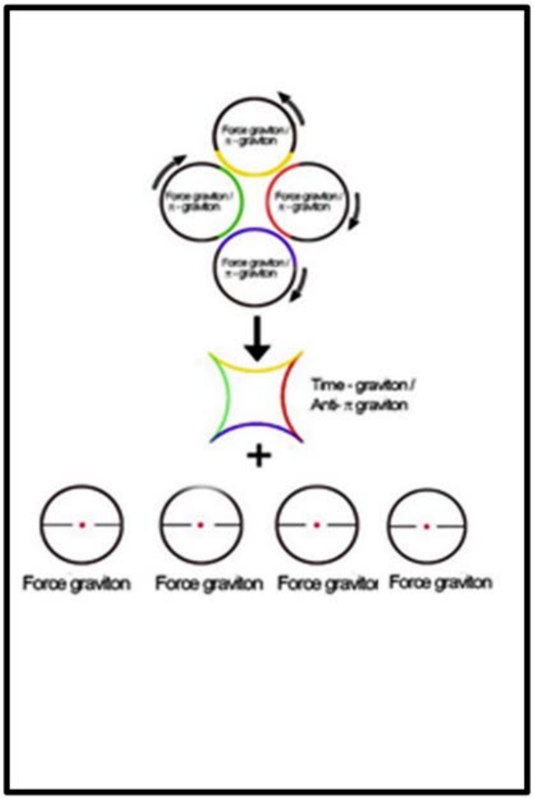


Figure 16: **Formation of 'Time' Graviton from the closely interacting of 4 nos. of 'Force Gravitons'. The direction of rotation of the force gravitons are shown by arrow. On the figure, the similar fashion an anti-π graviton is formed from 4 nos. of rotating π gravitons and a particle constituent is formed from 4 nos. of wave constituent**

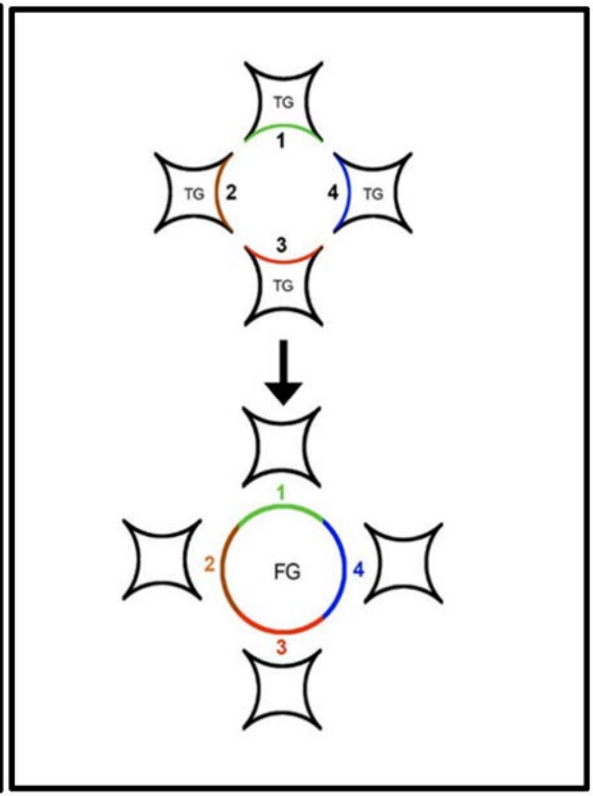


Figure 17: **Formation of a Force Graviton (FG) from 4 nos. of Time Gravitons (TG) or formation of a π Gravitons from 4 nos. of anti-π Gravitons. a wave constituent is formed from 4 nos. of particle constituent**

Figure 16 represents the following entanglements:

i) Wave to particle
ii) 'π gravitons' to ' anti π gravitons'
iii) 'Force graviton to time graviton'

Figure 17 represents the following entanglements:

i) Particle to wave
ii) 'anti π gravitons' to 'π gravitons'
iii) 'time graviton' to 'force graviton'

The physical significance of 'wave function' of quantum mechanics could not be put forward as yet. It is often told that the wave function is a complex and non-observable quantity. This means that the wave function is something abstract but TTQG has offered a very distinctly visible shape of the wave function, explained the physics of its formation, and provided a mathematical expression of the same.

A bicycle or a motor cycle contains two wheels (of circular geometry) and operations like balancing, steering, braking, accelerating, …etc…are acted upon the wheels. Similarly, the brains of the human being and the living animals send signals to the muscles of the different organs (like for examples fingers, hands, legs, limbs…etc…, having some or the other geometrical shapes) to perform the following day to day life activities as and when required:

i) Walking
ii) Running
iii) Balancing and standing on one leg
iv) Dancing
v) Skating
vi) Changing direction while walking or running
vii) Scrolling
viii) Vibrating or shaking hands

In the examples as cited above for the wheels of the bicycles or the organs of human being, all are conserved, i.e, the wheels or the organs go back to their resting positions, once the said activities are completed. This is to note that in the above examples of several activities, the pattern of the movements of the organs or the pattern of the forces playing part vary widely from each other and the outputs are different too. When the activity is 'running', the output is the creation of kinetic energy, walking downhill is creation of space expansion (the so called acceleration), walking uphill is gaining potential energy, walking along a straight line is linear momentum generation, running or walking through a circular orbit is generation of angular momentum, ….etc…..

The wave function Ψ in quantum mechanics, is same to same as that of the 'EM- gravitons' of TTQG and which is bearing a typical geometrical shape. The different quantum mechanics 'operator'(like the different signals of the brains as discussed above), are acting on the same wave function differently to yield different physical variables, as for example, the' potential energy', the 'kinetic energy', the 'linear momentum', the 'angular momentum', the 'force', the 'space expansion'…etc… The physics, mathematics and the topology of the convergence of the quantum mechanics Ψ to that of the 'EM-wave gravitons' of TTQG is explained below.

From the quantum physics concept of Niel's Bohr, the electrons are rotating around a nucleus in different electronic orbits. The waves are generated from the movement of the electrons (the so called concept of 'wave-particle' duality and De Broglie's hypothesis of, a moving particle is always carrying a wave associated with it). An orbit has the following characteristics:

i) It has a specific energy level
ii) It has its angular momentum called 'orbital angular momentum', L

The energy expression of TTQG is ($4\pi r^3$) and the angular momentum, L is expressed through the following mathematical expression,

$$L = (2\pi \times M \times f \times r^2) \text{ …………………..(23)}$$

[M =mass, f = frequency of rotation = (number of cycles / time), r = radius of the orbit]

The above equation (23) takes the form:

$L = (2\pi \times M \times n \times r^2)/t$ [n = integer = numbers of cycles and t= time]…………………………………………...(24)

Now putting the TTQG expressions of mass and time [($9/(4\pi r^3)$) and ($3/(4\pi r^2)$) respectively for mass and time] , one gets

$$L = [2\pi \times (9/(4\pi r^3)) \times n \times ((4\pi r^2)/3]$$

$$L = 6\pi r \text{ …………..........…..……………(25)}$$

(the integral multiple n is not considered)

Since L is a vector quantity in physics and so 'angular momentum' is a 'directional entropy' of TTQG. In a 3D sphere by applying the right hand thumb rule (the movement of the particle and the positioning of angular momentum vector), one can find the six numbers of angular momentum. (2 numbers in each of the mutually perpendicular x,y and z directions)

Now, it is very logical to conclude that the creation of wave or the wave function Ψ, is a superposition of 'energy' and 'angular momentum' or 'the directional entropy',

So the wave function

$$\Psi = (\text{energy} \times \text{angular momentum})$$

$$= (4\pi r^3 \times 6\pi r)$$

$$\Psi = (24\,\pi^2 r^4) \text{ ……………….…………….(26)}$$

From equation (26) one can conclude that the wave function Ψ can be represented geometrically as, i) the hybrid of 2 numbers of circles or ii) hybrid of a 3D sphere and a half circle or iii) four numbers of half circles.

The Schrodinger 'time independent' wave equation is functionally equivalent to the Newton's second law derived expression of force, i.e.,

$$\text{Force} = (\text{mass}) \times (\text{acceleration})$$

Or in the language of TTQG,

$$\text{Force} = (\text{mass}) \times (\text{space expansion})$$

The 'time independent' Schrodinger wave equation is,

$$\nabla^2 + \frac{8\pi^2 m}{h^2}(E - V)\Psi = 0 \text{ …………….(27)}$$

In the above equation, ∇^2, m, h, E, and V stand for the Laplacian operator (second derivative of the wave function Ψ (that is $d^2\,\Psi/dx^2$)), mass, Planck's constant, energy and potential energy respectively. The definition of the Laplacian operator is

$$-\nabla^2 = \left(\frac{d^2}{dx^2} + \frac{d^2}{dy^2} + \frac{d^2}{dz^2}\right)\Psi \qquad \ldots\ldots\ldots\ldots(28)$$

So the dimension of equation (28) has to be the same as that of [$8\pi^2 m/h^2$ (E-V) Ψ].

The dimensional break-up of [$8\pi^2 m/h^2$ (E-V)Ψ] turns out to be in regard to TTQG, [considering the expression of m =($9/4\pi r^3$), h= πr, E and V = πr^3 and Ψ = $\pi^2 r^4$], is,

[$8\pi^2 m/h^2$ (E-V) Ψ] = [π^2 x mass (m) x energy (E-V) x πr^4 (Ψ)]/r^2] ($r^2 = h^2$)

= [mass x $\pi^2 r^5$] [In TTQG, $\pi^2 r^5$ stands for space expansion

(acceleration of Newtonian physics]

= (mass x spaceexpansion)……… ……………………..……..……..(29)

The (d^2 Ψ/dx^2) is in the form (πr^2) and which stands for 'force' in TTQG. So the equation (27), the famous Schrodinger's equation converges to the very primitive equation of classical/Newtonian physics, i.e.,

Force = (mass) x (acceleration)

Or in the language of TTQG, Force = (mass) x (space expansion)

The origin of force as the 'superposition' of mass and space expansion is shown below diagrammatically in Figure 18 below.

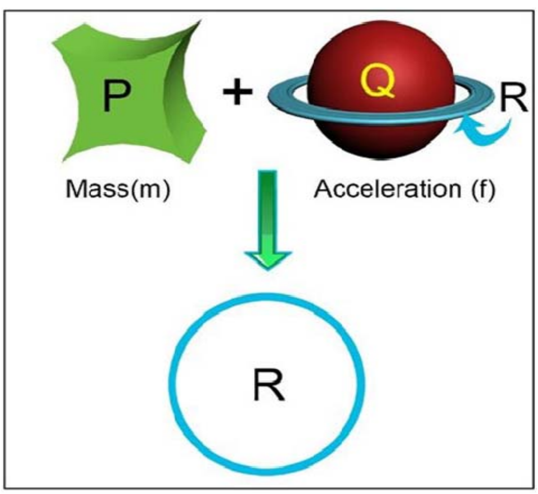


Figure 18a: Mass and Space expansion (Acceleration) interaction to produce force

Schrodinger's time dependent equation, however, has no validity as explained below. The time dependent equation is,

$$\Psi = A.e^{-i\omega t} \qquad \ldots\ldots\ldots\ldots\ldots\ldots\ldots(30)$$

Ψ is the wave function, $\hbar$ is the reduced Planck constant, A is the proportionately constant, t is time and ω is the angular frequency

Now angular frequency is (number of cycles)/(sec) and as per unified theory it has a dimension of $1/(1/r^2)=r^2$.So, when the value of is put into equation (30), it takes the form

$$\Psi = A.e^{-i}\omega t = A.e^{-i}.r^2\frac{1}{r^2} = A.e^{-i} \ldots\ldots(31)$$

So, the time part is totally eliminated from the time-dependent form of wave function Ψ.

So, the time-dependent wave equation proposed by Schrodinger has no real significance.

The action of the quantum mechanical operators on the wave function is a dual phenomena of 'exchange of quantum' and a 'simultaneous hybridization-dehybridization' process and this takes place in four numbers of different steps, which are explained below:

i) In step I, the system (the wave function Ψ) is dehybrized to lower dimensions (from 4 to 3 to 2…etc.) by operating the differential operators (1st derivative d/dx or second derivative, d^2/dx^2, ….etc..) on the wave function.
ii) In step II, the obtained dehybrized dimensions (those are lost by the wave function) in step 1 are transferred to the surroundings.
iii) Step III, is a step of 'integration' or 'hybridization' where the lost dimensions of the wave function are being returned back to the system (the left out

differential form of the wave function) such that the wave function is rebuilt and retained. However, the return of the dimensions does not take place directly. The support is taken of an another physical variable (like entropy, force, energy, space expansion..etc..), which in fact transfers the lost dimensions of the wave function back to it.

iv) In step 4, the lost dimensions of the above said physical variable of step III , is compensated by the surroundings (which the surroundings had received in step I from the system).

[To simplify the understanding of the functioning of the quantum mechanical operators on the wave function, the term 'system' and 'surroundings' have been used. In the following sections to come it has been shown that in this universe such sharp demarcation between 'system' and 'surroundings' is not possible and it does not carry any significance too]

The above said four numbers of steps is shown diagrammatically in Figure 18b below:

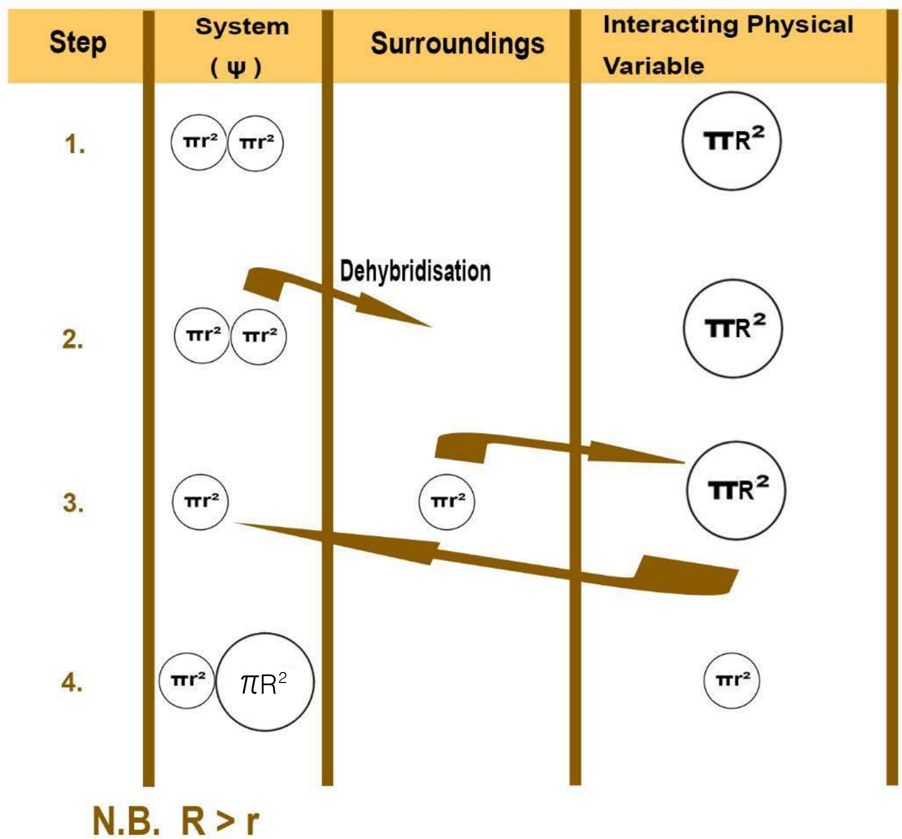


Figure 18b: Topological Presentation of the operatibility of the Quantum mechanical operators

The above said steps are now being explained with an example, e.g., by considering the event of operability of kinetic energy operator, $(h^2/2m)\ d^2/dx^2$, on the wave function Ψ. The parameter, $(h^2/2m)$, is dimensionally a space expansion graviton [since h=r and m = $(1/\pi r^3)$ such that, $(h^2/2m)$ = (πr^5)] and the interaction between the wave function and the said operator can be represented as:

$$(h^2/2m)\ d^2/dx^2\,(\Psi) = (\pi r^5) x d^2/dr^2\,(\pi^2 r^4) = (\pi r^5) \text{ x } (\pi^2 r^2) = (\pi r^3 \text{x } r^2) \text{ x } (\pi^2 r^2) = (\pi r^3) \text{ x } (\pi^2 r^2 \text{ x} r^2) = (\pi r^3) \text{ x } (\pi^2 r^4) = (\text{ energy}) \text{ x } (\text{wave function}) = (E\Psi) \quad \ldots\ldots(32)$$

When the different operators do act on the wave function Ψ, the one or the other output are obtained but the wave function is retained. The diagrammatic presentations of the operability of three different operators, i.e., momentum, kinetic energy and angular momentum on the wave function Ψ are given in figure 19a, 19b and 19c respectively. It is to note that any quantum mechanical operator represents one or the other a physical variable and the actions of such operators on Ψ can be described as:

$$i\hbar\nabla = i \times r/\pi \times d/dr\,[\psi]$$

Dehybridization

$$= i \times r/\pi \times d/dr\,[\pi^2 r^4]$$

$$= i \times r/\pi \times \pi^2 r^3$$

$$= i/\pi \times \pi r \times \pi r^2 \times r$$

$$= i/\pi \times \pi r \times \pi r^2 \times r$$

hybridization

$$= i/\pi \times \pi r^2 \times \pi r^2$$

$$= i/\pi \times \psi$$

Figure 19a: Topological Presentation of momentum operator in Quantum mechanics

$$r \times i\hbar\nabla = r \times i/\pi \times r \times d/dr\,[\psi]$$ **Dehybridization**

Angular momentum operator $= r \times i/\pi \times r \times d/dr\,[\pi^2 r^4]$

$$= r \times i/\pi \times r \times \pi^2 r^3$$ **hybridization**

$$= r \times i/\pi \times [\pi^2 r^3 \times r]$$

$$= r \times i/\pi\,[\pi^2 r^4]$$

$$= r \times i/\pi \times \pi r^2\ \pi r^2$$

$$= i/\pi \,.\, r \,.\, \psi$$

Figure 19b: Topological Presentation of Angular momentum Operator in Quantum mechanics

$$(\hbar^2/2m)/\nabla^2 = 1/\pi^2.\ r^2.\ \pi r^3\ d^2/dr^2[\psi]$$ **Dehybridization**

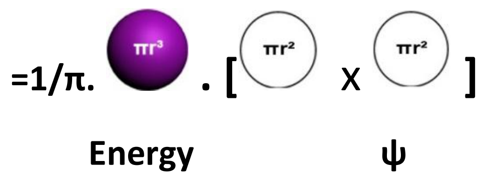
Kinetic energy operator

$$=1/\pi^2.\ r^2.\ \pi r^3.\ d^2/dr^2[\pi^2 r^4]$$

$$=1/\pi^2.\ r^2.\ \pi r^3\ [\pi^2 r^2]$$

$$=\pi/\pi^2 \, . \, \pi r^3 . \, \pi r^2 \, [\pi r^2]$$

Hybridization



$$\equiv E\psi$$

Figure 19c: Topological Presentation of Kinetic Energy Operator in Quantum Mechanics

The wave function Ψ takes different shapes as and when required for balancing the forces between the two force circles. The said balancing of forces are illustrated in Figure 20 below.

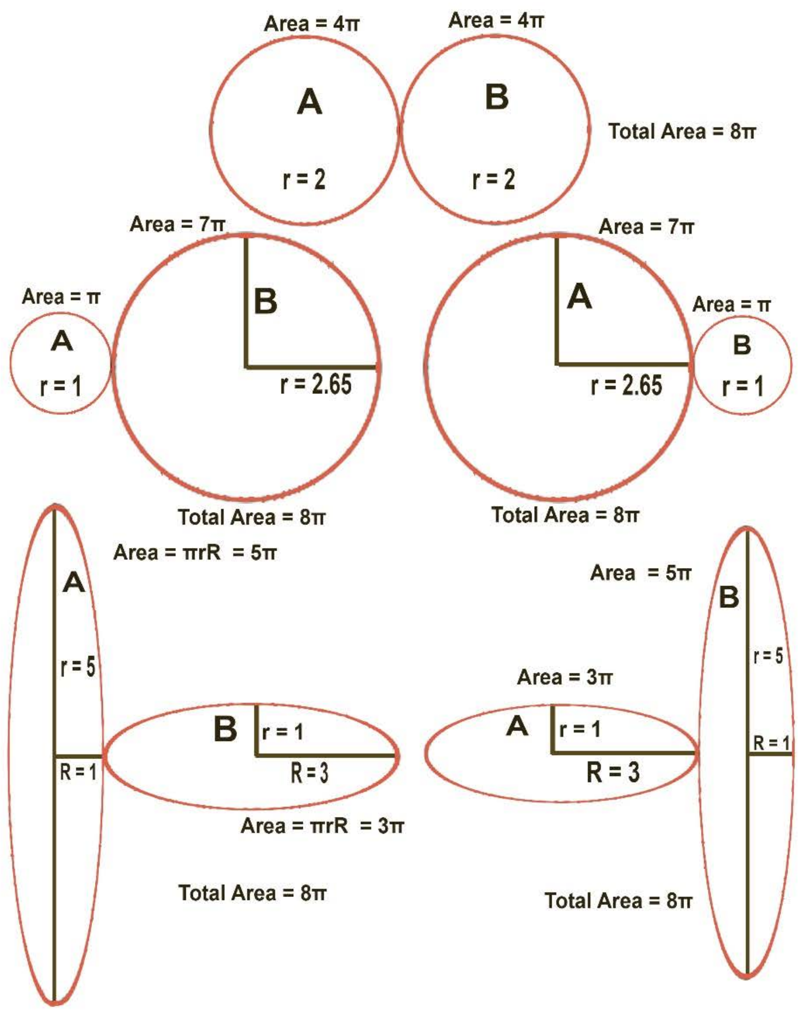


Figure 20: Different isomeric or topological forms of wave function(ψ)

As is found from the above figure 20 that due to the balancing of forces, the different isomeric or topological forms do evolve of the wave function. When one of the force circles increase in size, the size of the other force circle decreases. When one of the force circles is longitudinally more expanded (than its lateral spread width), the other force circle is expanded laterally more to balance it and the vice versa. However, one thing to note here that the sum of the areas of the two circles remain to be constant always as has been clearly shown in Figure 20. [98]

The 'exchange of force circles' between two energy gravitons is shown diagrammatically in Figure 21 below.

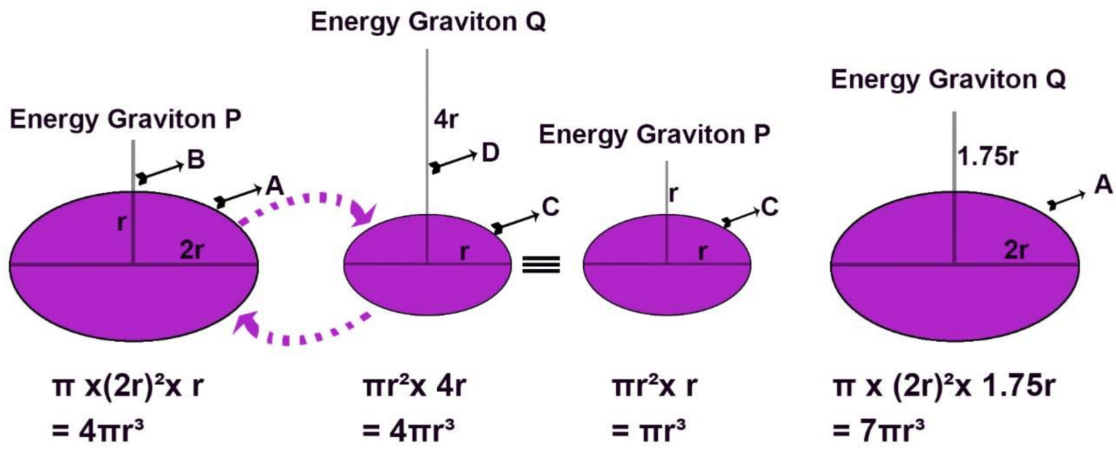


Figure 21: Topological presentation of exchange of forces through quantum (Base circle A & Base circle C have radius 2r & r respectively)

The figure 21 clearly demonstrates how the 'force quantum' are exchanged between two energy gravitons keeping the sum total of the energies of the two gravitons constant.

The 'law of conservation of energy' and the 'law of conservation of mass' are the two principal laws of science but the none of the said laws have been described topologically in the history of science. The said two law are geometrically presented in figure 22a and 22b below and those are self explanatory. [in calculation of the volume of the sphere/ellipsoid in the said figures, the factor, (4/3) has not been considered since it a common factor for all and what is done, is the comparisons of the volumes . The volume of a sphere or a ellipsoid is obtained through a formula, (4π x a x b x c)/3, where a, b & c represents the length, breadth and height respectively].

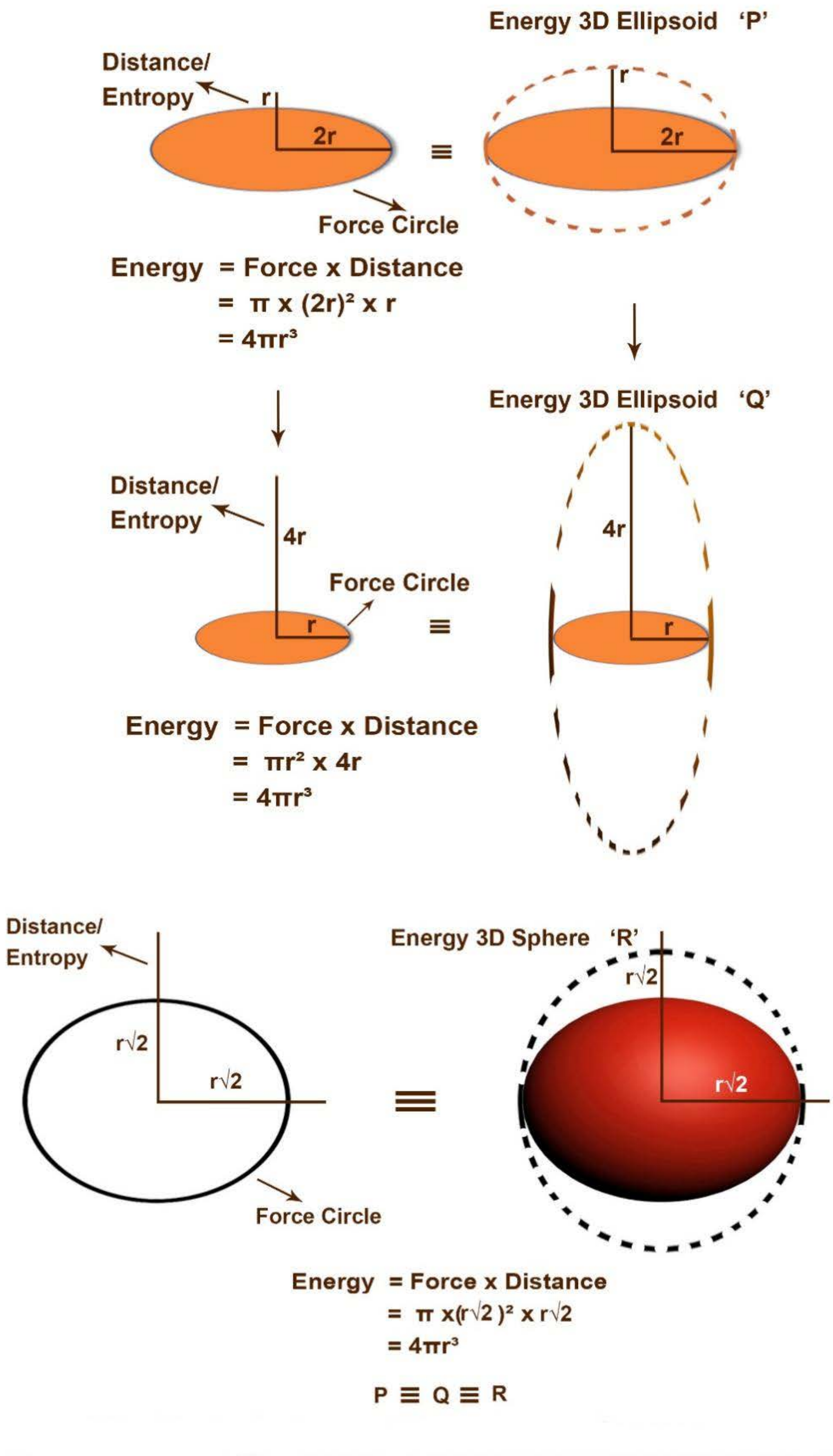


Figure 22a: Topological presentation of laws of conservation of energy

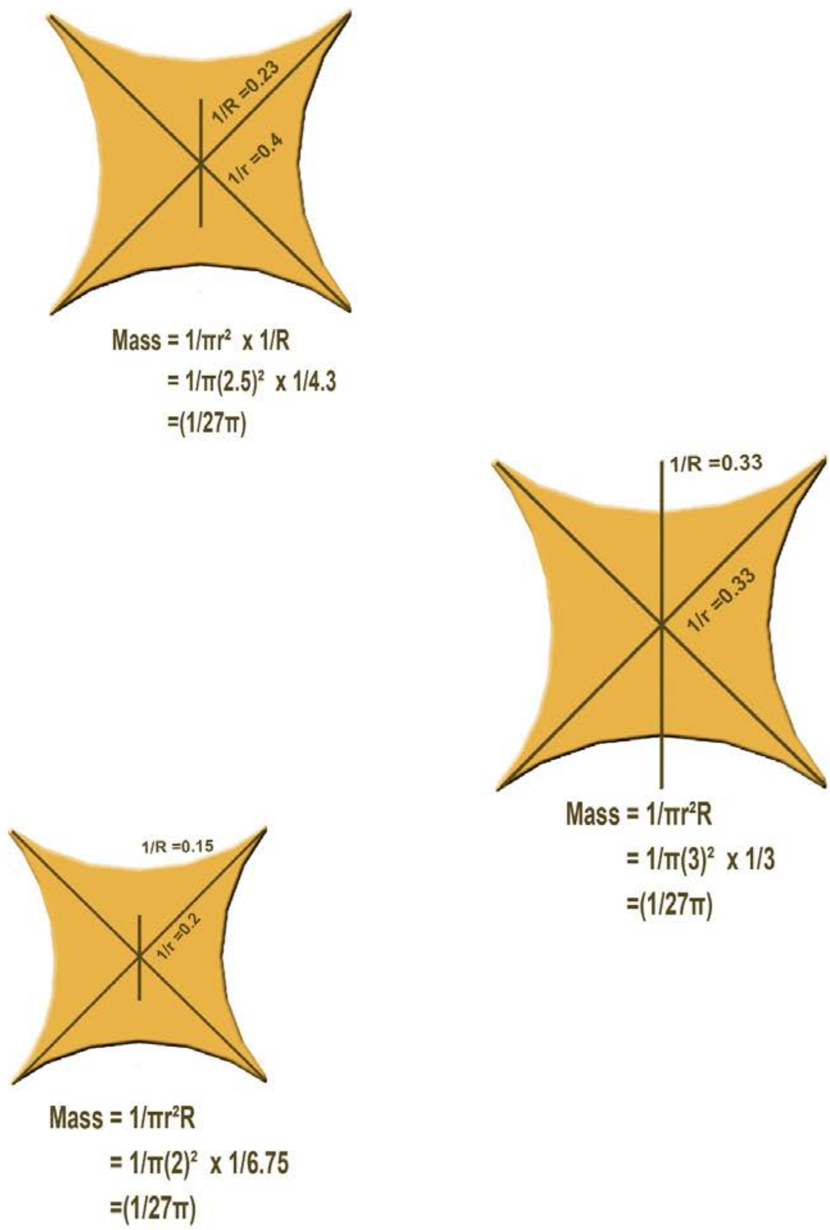


Figure 22b: Topological presentation of Conservation of Mass

The salient features of the principle of conservation of energy are: (in context to figure 22a)

i) The ‘energy graviton’ is the superposition of a ‘force graviton’ (represented by a circle) and an ‘entropy graviton’ (a distance, represented by a straight line).
ii) When the area of the force circle increases, the length of the adjoined straight line decreases and when the area of the force circle decreases , the said length increases such that the product of the two remain constant. This inverse relationship between force and entropy has a much bigger implication on the large scale structure of the universe. Since the total energy of the universe is constant, as the universe expands , the more and more entropy are generated but the universe from a spherically symmetrical shape does pass on to more and more flatter geometry.
iii) The universe does expand longitudinally, reaches out to a maximum point, and the universe essentially becomes flat or linear (as if the only longitudinal entropy line is existing with a vanishing small force circle). However, after reaching to the state of highest longitudinal expanded state, the longitudinal entropy does start decreasing. Then the lateral entropy start increasing and the universe does go on expanding laterally and reaches out to a state of highest possible lateral expanded state. Then again the longitudinal expansion does begin. The said cycles are repeated time and again. The

total space occupied by the universe remains constant even though the universe does always remain in the state of expansion either longitudinal or the lateral. In figure 23, the said periodic 'longitudinal and lateral expansion' of the universe is shown:

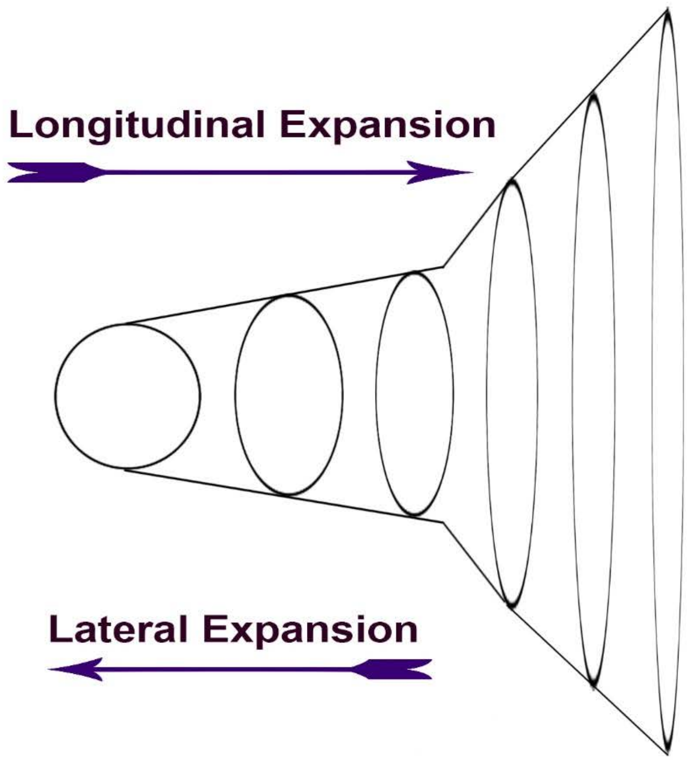


Figure 23: Periodic longtudinal & lateral expansion of the universe and the conservation of the total space (The area of the ellipsoid/circle are the same)

Between the two entropy parameters (the longitudinal entropy and the lateral entropy), the either of the two always remain in the increasing mode and the following conditions do always hold:

VIII. Longitudinal or the Lateral Expansion of the Universe

(CHANGE IN LONGITUDINAL ENTROPY) + (CHANGE IN LATERAL ENTROPY) >0

$$: (\Delta S)_{long} + (\Delta S)_{lat} > 0$$

When the universe expands longitudinally, $(\Delta S)_{long} > (\Delta S)_{lat}$ [$(\Delta S)_{long}$ is positive, $(\Delta S)_{lat}$ is negative but the modulus of the former is higher than the later]

When the universe expands laterally, $(\Delta S)_{long} < (\Delta S)_{lat}$ [$(\Delta S)_{long}$ is negative, $(\Delta S)_{lat}$ is positive but the modulus of the former is lesser than the later]

In the literature there does exist numerous definitions of the second law of thermodynamics and one of them is, (which is much important and much discussed topic of physics/physical chemistry):

For a spontaneous process the sum total of the 'change in entropy of system' (ΔS_{sys}) and the 'change in entropy of surroundings' (ΔS_{sur}) is always greater than equal to zero and which is mathematically expressed as:

$$(\Delta S_{sys}) + (\Delta S_{sur}) >= 0$$

However, the proof of the above theorem or postulate of thermodynamics (as is being found in the standard books of physics/physical chemistry) is obscure and abstract and which is much difficult to understand. When one considers the occurrence of the expansion of the universe (which is a spontaneous one), the question arises which is the 'system' and which is the 'surroundings'? The universe itself is the 'system' and the 'surroundings' too. Actually there does not exist anything like system and surroundings separately. In the universe the innumerable physical variables do exist in the form of quantum (having a particular geometrical shape or the other) and there are superposition, entanglement and exchange of forces taking place among themselves. Rather than 'system' or surroundings' what is more important is the change in geometries of the physical variables and attainment of new quantum state during a change. In the incidence of the longitudinal expansion of the universe, the lateral entropy quantum are passed on to the longitudinal entropy and as a result of that the later is surpassing the other and sum of the change in longitudinal entropy and the lateral entropy is always positive. The reverse will be true in case of the lateral expansion of the universe. The following exercise will help one to understand the above said topic in a more distinct fashion and some other notions of modern cosmology.

In this exercise for simplification, a circle is considered having a radius of 5 (in any arbitrary scale of measurement) and which starts expanding longitudinally (contracting laterally) first in the different stages and attains almost a flat geometry. Then the process is reversed and the lateral expansion takes place and the geometry is back to the circle again. The Table 4 shows the expansion in difference stages. At the start both r and R (longitudinal radius/entropy and lateral radius /entropy respectively) are the same but they start differing from each other but, πRr, the area of the 2D ellipsoid remain to be constant.

Table 4: The periodic longitudinal and the lateral expansion of the universe

STAGES	r (longitudinal entropy)	R (lateral entropy)	**Δr** (change in longitudinal entropy) (Final - initial)	**ΔR** (change in lateral entropy) (Final - initial)	(r/R) (ratio of longitudinal to lateral entropy)	(πRr) (Area of the circle/2D ellipsoid)	(**Δr** + **ΔR**) (sum total of the change in longitudinal entropy and the lateral entropy)
START	5	5	-	-	1.00	25π	
STAGE 1	6.7	3.7	1.7	-1.3	1.8 : 1	25π	0.4
STAGE 2	8.9	2.9	2.2	-0.8	3.2 :1	25π	1.4
STAGE 3	11.9	2.1	3.0	-0.8	5.6 :1	25π	2.2
STAGE 4	15.6	1.6	3.7	-0.5	9.75:1	25π	3.2
STAGE 5	20.8	1.2	5.2	-0.4	17.3 :1	25π	4.8
STAGE 6	27.7	0.9	6.9	-0.3	30 :1	25π	6.6
STAGE 7	37	0.67	9.3	- 0.23	55 :1	25π	9.07
STAGE 8	50	0.5	13	- 0.17	100 :1	25π	12.5

Figure. 24 and Figure. 25 below show, the plots of (r/R) and [(Δr + ΔR)] vis-a-vis the different stages (stage 1, stage 2, …etc.. and along the x-axix, the eight numbers of steps are being equally spaced) as per the data given in Table 4 above.

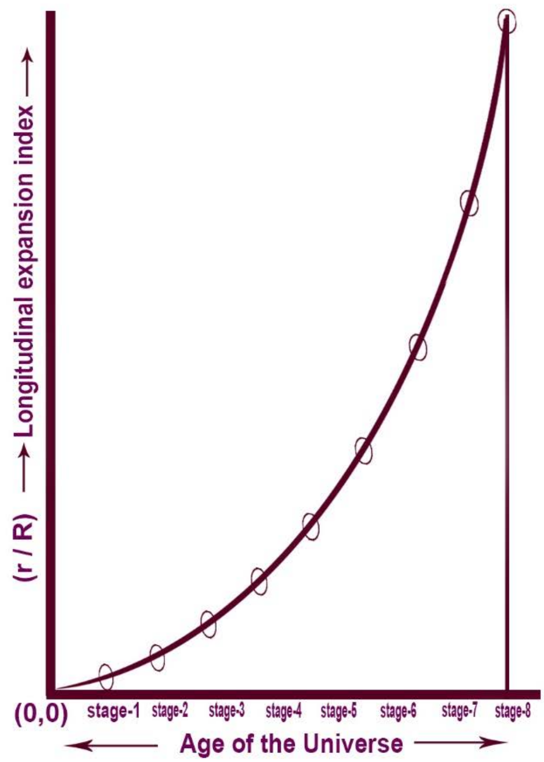


Figure 24: Space expansion of the Universe as a Function of age of the Universe

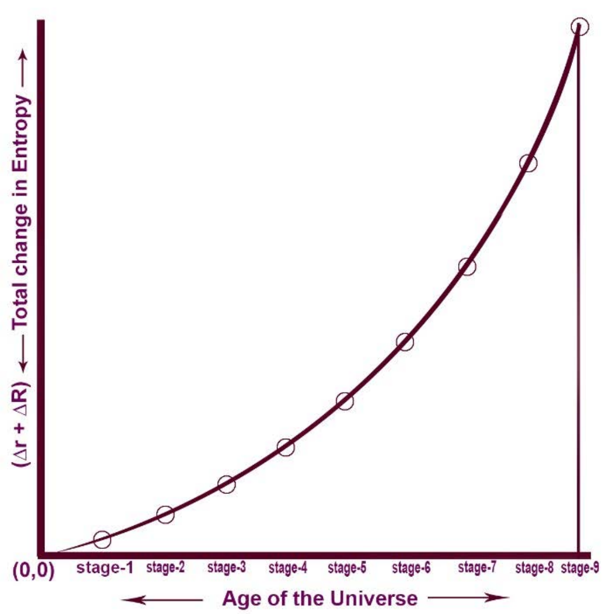


Figure 25: Presentation of net increase of entropy of the Universe as a function of the age of the Universe

From the above said figures one would conclude that:

i) From figure 24 it is seen that the space expansion (or acceleration) is taking place in the universe at a very high rate and the said expansion is in a ever rising path. This matches fully with the modern cosmological concept of accelerating universe, which says that our universe is not only accelerating but it is accelerating more and more with time.

ii) From figure 24, it is also found that the universe with the progress of its expansion is attaining more and more flat geometry and which is the concept of the current day cosmology too.

iii) From figure 25 it is clearly revealed that the 'change in entropy of the universe' is always a rising function of the expansion of the universe. Though the one of the principal postulates of the subject of thermodynamics is, the entropy of the universe is increasing and going towards maximum, but this postulate could not be presented in the right way in the history of the development of thermodynamics. For the first time through the concepts of TTQG, the topology of the said concept is revealed. There does not exist any such thing as entropy of the system and the entropy of the surroundings. What is true is the distribution of randomness over the longitudinal and the lateral directions and in spontaneous physical and chemical processes, the said two entropy parameters is changing in opposite directions and the modulus of either of the two surpasses the other such that the net change in entropy is positive or there is always a net gain in entropy of the universe. From the data presented in Table 4 and the graph of the Figure 24, one would be very much tempted to conclude that our universe itself is an entropy generating machine.

IX. TTQG Drived New Theory of Color Physics - A New Horizon in Physics

TTQG driven new theory of color physics have been recently offered[89, 90,98,104]. The said new theory, in one hand has revealed many mysteries of the cosmological physics and on the other hand could rightly explain the black body radiation and their associated phenomena. The topology of the baryonic matters of the universe (as discovered in the new theory of color physics) is shown in Figure 26a and 26b below:

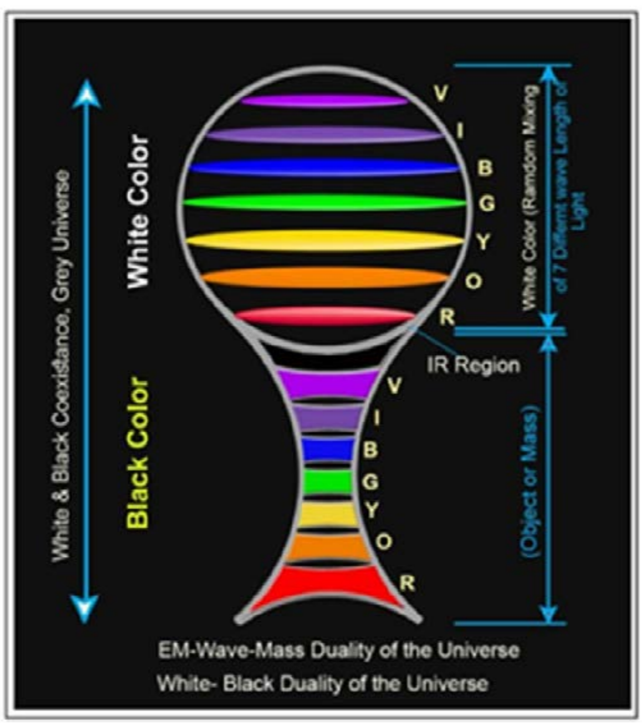


Figure 26a: The Topology of the Baryonic matters of the Universe.

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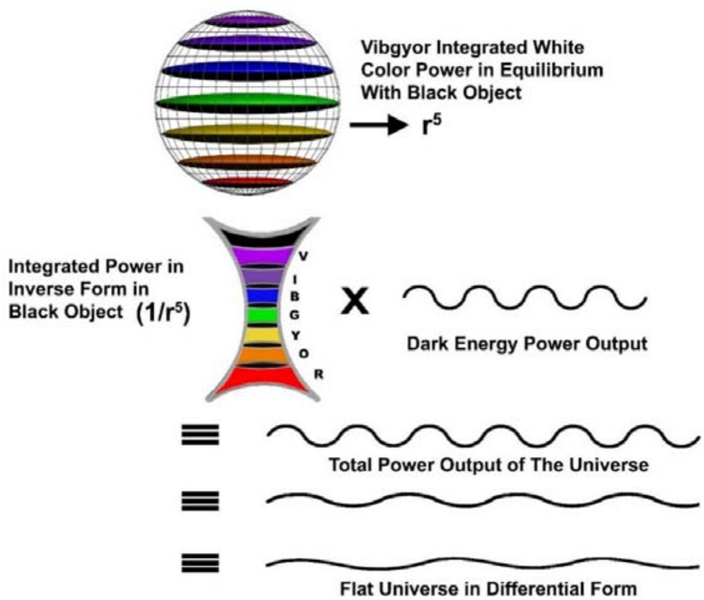

Figure 26b: Presentation of the dark energy and dark matter of the universe

The new theory of color physics considers the baryonic matter as the outcome of the incidence of superposition of 'COLOR HYBRID FUNCTION OF LIGHT, CHFL' and 'COLOR HYBRID FUNCTION OF OBJECT, CHFO'. Figure 26a as shown above is the geometry of the superposition of the said, 'CHFL' AND 'CHFO' THE figure makes us understand the following phenomena of the universe:

i) The upper spherical part of the said figure is multi faceted and it represents the following
   a. This represents a 'qubit' or a 'quantum bit' of the wave transmission/teleportation of modern quantum computing system.
   b. This also represents the 5D color space of the light wave of the universe.
   c. This represents the origin of the 7 different colors of 'VIBGYOR', which no other theory of physics could establish.
   d. d. This represents the 'wave' part of the 'wave- particle entanglement' of the universe.
   e. e. This represents the white color of the universe
   f. f. This represents the ' dark energy' of the universe
   g. g. This also describes the 'spectral power distribution' of the 'Black Body Radiation' or the sun's energy spectrum.

ii) The lower 3D -saddle part of the said figure is also multi -faceted and it represents the following
   a. This represents a particle or mass 'qubit' or a ' mass quantum bit' and could become the potential tools for the mass transfer from one place to the other.
   b. This also represents the inverse 5D color space of the objects or particles of the universe.
   c. This represents the origin of the 7 different object colors of 'VIBGYOR' , which no other theory of physics could establish.
   d. This represents the 'particle or mass' part of the 'wave- particle/mass entanglement' of the universe
   e. This represents the Black color of the universe
   f. This represents the ' dark matter' of the universe
   g. This also describes the 'inverse spectral distribution' of the 'Black Body mass' or the Black Hole.

So the upper spherical part and the lower saddle part together represents an entangled quantum pair of the baryonic matters of our universe. The upper white color part and the lower black color part makes the universe grey since the combination of white color and black color make a grey color.

The entanglement of 'quantum bits' are shown in the literature as shown in the following Figure 27. However, how such apparent 3D looking quantum (with the inscribed circles) are originated has never been discussed in the literature. The TTQG driven new theory of color physics, however, reveals this mystery too.

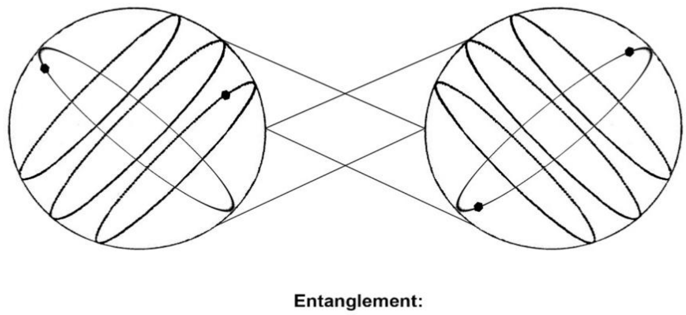

Figure 27: Typical presentation of quantum entanglement

As explained in the previous section of quantum mechanics, how the entropy is continuously being generated in the universe. Now this generated entropy in sequence by the way of the phenomena of superposition, generates the following

Entropy to force to energy to EM-wave to 5D power propagation, and could be represented as,

5D power generation = (entropy) x (EM-wave) = (entropy) x (entropy) x (energy) = (entropy) x (entropy) x (entropy) x (force) = (entropy) x (entropy) x (entropy) x (entropy) x (entropy) = $(\text{entropy})^5$.

The 5D power generation as shown above in fact has been diagnosed as the 'dark energy' of the universe. So the universe continuously does go on producing dark energy and this way the dark energy stock of the universe is rising. Some people have opined that the it is the parameter 'dark energy 'which is responsible for the expansion of the universe. The present article firmly establishes that the 'entropy' is the cause and the 'dark energy' is the manifestation of it. So the actual candidate is the 'entropy', which is responsible for the expansion of the universe.

The point to highlight here (in context to the Figure 26) that the upper wave part and the lower mass part are 5D and inverse 5D respectively and they are the idols of the 'dark energy' and the so called 'dark matter 'or the 'dark mass' of the universe. When they are separated from each other (breaking their entanglement to each other) by some means or the other and they reside separately, they represent the 'dark energy' and 'dark matter' respectively.

X. The TTQG Driven Topological Presentation of the Three Laws of Thermodynamics

The said presentation are given below in Figure 28, Figure 29 and Figure 30 respectively and those are self explanatory.[101].

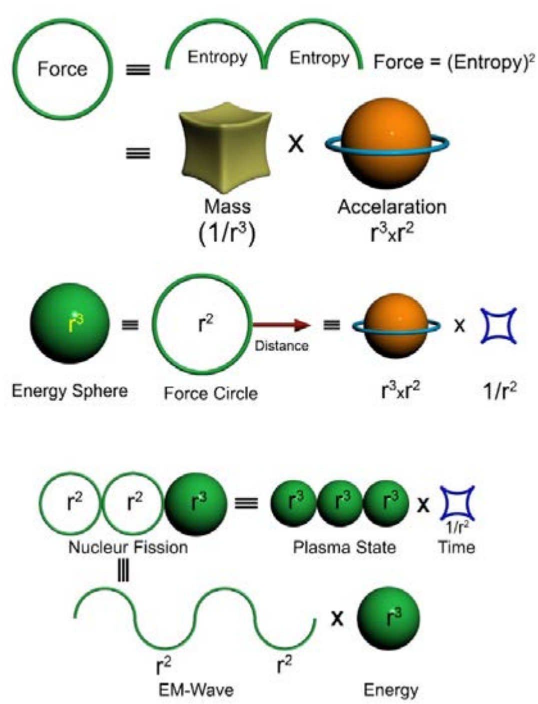

Figure 28: Quantum gravity theory driven geometrical presentation of 1st law of thermodynamics

From the above geometrical presentation in Figure 28, it is being very clearly understood that energy can be represented by numerous other permutations and combinations in the hybrid form of 'push forward' and 'pull back gravitons'.

Coming out of the very specific physical variable 'energy', of the first law of thermodynamics, one can put the first law of thermodynamics in a very broad frame in altogether a different fashion as

"Any physical variable of the universe could be observable either in the form of a push-forward or pull back graviton or in numerous permutation-combination hybrid forms of the different gravitons, retaining the magnitude of the physical variable being unchanged."

The above statement of first law of thermodynamics stands to be the most updated statement as far as the newly discovered TQG is being concerned or taken into account.

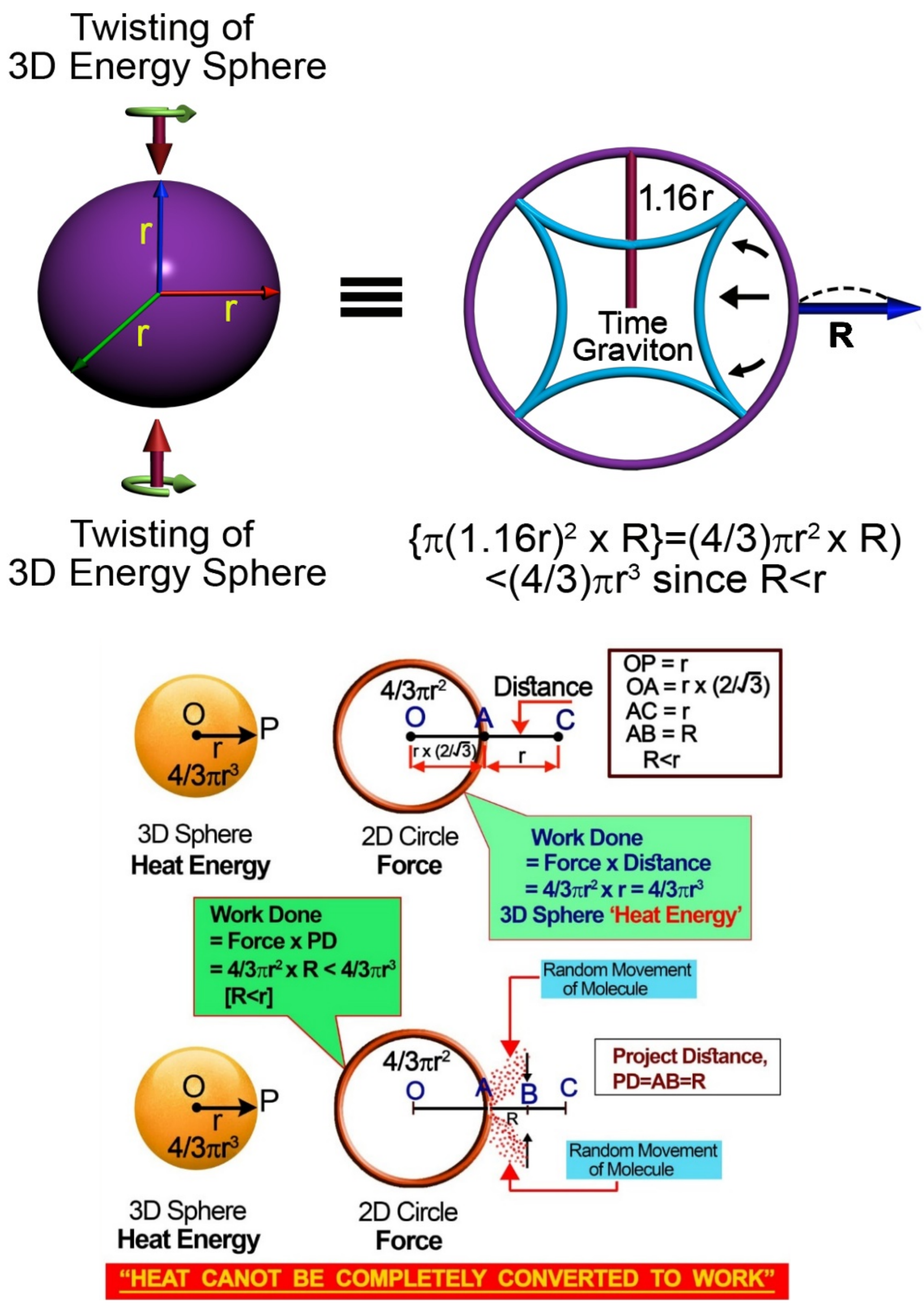

Figure 29: Quantum gravity theory driven geometrical presentation of second law of Thermodynamics.

The time graviton being intrinsically a sort of 'attractive cage' enforces the development of a curvature (randomness) to the emerged 'directional entropy', which is being shown in figure 29 too. The randomness part is being ultimately merged with the 2D force circle and become an integral part of it as combinatorial entropy. The net result is the length of the directional entropy diminishes and it attains a value of 'R' (as shown in figure 5) and this makes 'R<r'. So the work done (W)(in the form of force x distance) is less than the magnitude of energy (E) 3D sphere. So both the 'combinatorial' and 'non-combinatorial' parts of entropy be responsible for not allowing the energy to be fully converted to work. However, apparently the entropy is the responsible for W<E but the real responsible physical variable is the 'time graviton'. The 'time graviton' is the cause and the 'entropy graviton' is the effect as the TTQG very clearly is revealing above.

There does exist so many statements of the second law of thermodynamics but the main essence is "Energy cannot be completely converted to wok due to the existence of randomness or entropy". The second law of thermodynamics as has been proved above geometrically driven by TQG, leaves a scope to modify the second law of thermodynamics as "Energy cannot be completely converted to work due to the presence of time graviton or time attractive cage in an atom of a baryonic matter".

The TQG being in the hand of the global scientific community, a more explicit and much broader version of the second law of thermodynamics is the need of the day as is being felt and which should not only talk about heat and work only. It has to be very broad one such that the 'directional to multidirectional' or 'multidirectional to directional' phenomena of the entire universe would come under its periphery. Such a version could be stated as

"To pass on to a state of directionality from a multidirectional state, one has to adopt the route of generating as much energy (E), as possible, and then operate the same on time graviton (t) to dilute the unfavorable time attractive force (acting in opposition to generate directionality) such that the hybrid of the two, Et, results into directional entropy".

As per TQG, the hybrid of E and t is,

$$E \times t = (4\pi r^3) \times (3/4\pi r^2) = 3r = \text{Entropy} \qquad (2.1)$$

One of the derived phenomena of the universe from Heisenberg's uncertainty principle is, (energy x time) = Planck's constant, h. In TQG, it has been proved that 'h' is in fact a physical variable same to same as 'entropy'.

All the above discussion as made above regarding the second law of thermodynamics leads one to very justifiably conclude that the second law of thermodynamics and Heisenberg's uncertainty principle are virtually the same though the said two laws/principle, apparently look to be dissimilar or have no link to each other.

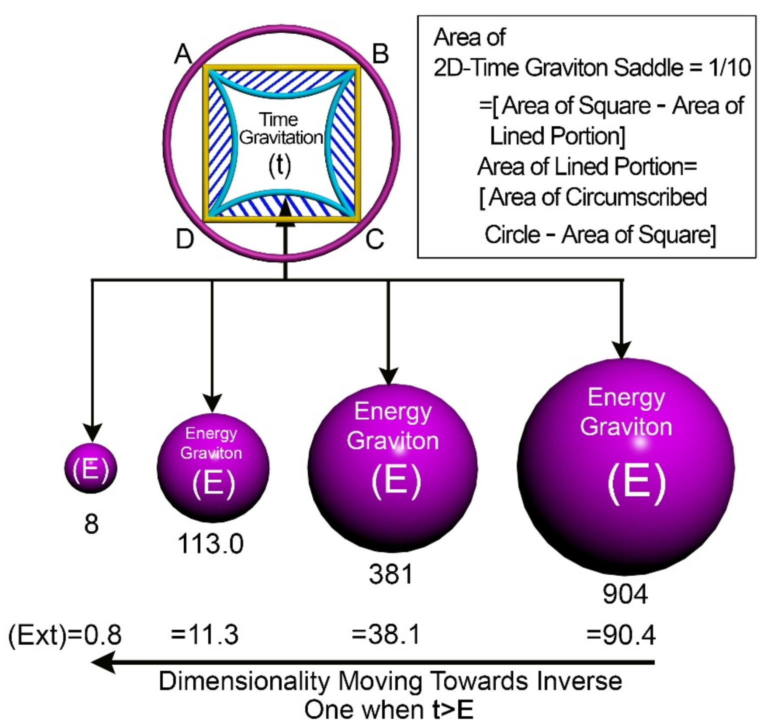

Figure 30: Quantum Gravity theory driven geometrical presentation of 3rd law of thermodynamics

XI. Third Law of Thermodynamics

The third law of thermodynamics and the concept of entropy are very much related to each other. Continuing with the concept of Et=r= entropy and tT=1 of TQG as is being shown in the following figure 30, as soon as the temperature (T) is lowered, time (t) becomes more and more stronger being the multiplicative inverse of T. This inverse dimensional stronger force insists the Et hybrid or the entropy 'r' to pass on to inverse dimensionality in the form of 'order graviton' of TQG. The said order graviton or inverse entropy graviton does asymptotically approaches zero although it cannot become exactly be zero.

The TQG showered definition or statement of third law of thermodynamics needs to be put as

"There does exist an inverse dimensionality (which remains in the form of order graviton or inverse entropy graviton) of the universe arising out of the hybridization of energy and time graviton when the time graviton is much stronger than the magnitude of the energy graviton and the said inverse dimensionality approaches asymptotically the state of perfect order or zero.

XII. Summing up of TQG Definition of the Laws of Thermodynamics

In a very nutshell, all the three laws of thermodynamics are the consequences of energy (E) and time (t) interacting with each other. The sum-up of the above said definitions are as under:

i) The first law of thermodynamics is suited to any range of domain of E and t or any phenomena of the universe.
ii) The second law of thermodynamics is suited in the domain of the universe when E > t (in the multiplicative inverse sense) from energy/work to EM-wave/dark energy flow to space expansion to photo-electric phenomena to nuclear fission to X-ray, gamma ray to plasma state to dark energy.
iii) The third law of thermodynamics is suited in the domain of the universe when t > E (in the multiplicative inverse sense) from order to mass to gravitational lensing to space inversion to nuclear fusion to black hole to dark matter or dark mass.

XIII. Conclusions

In this article the following theories of physics have been presented altogether in new modified forms:

1. *Cosmology*

All the cosmic phenomena of the universe have been tied up to the same source by the discovery of 'universal graviton cycle'(UGC). The UGC is originated from the superposition and entanglements of the different push forward and pull back gravitons. All the gravitons are in the form of quantum.

2. *Theories of relativity*

While presenting the theories of relativity (the special and general ones) Einstein talked about distorted 'time-space', 'singularity', 'geometry of gravitation', 'cosmological constant' …etc…and so on but he could shape none of them properly and the said theories were incomprehensible to many people. In TTQG, by constructing the geometry of gravitation and shaping up the concept of singularity, the relativity theories have come up in a newer simplified way in front of people. The very famous equation of Einstein, $E = mC^2$, has been shown to converge to one of the major findings of TTQG and which is the constancy of the energy density of the space of the universe.

3. *Quantum Mechanics*

The roots of the subject of Quantum mechanics are 'Heisenberg's uncertainty principle' and the 'wave-particle duality'. However , both the said phenomena carry different significance than the way they were presented to the scientific community. In TTQG, It has been shown for the first time in the history of science that Hiesenberg's uncertainty principle is basically the generation of entropy of the universe and the wave particle duality is a phenomenon of entanglement of mass and EM-wave.

The famous Schrodinger's equations were developed from the classical equation of mechanical wave of particles and from the TTQG point of view no new value addition was made to physics by proposing the said equation. It has been shown in this article that the 'time-independent' equation of Schrodinger had just converged to the Newton's second law of motion which is omnipresent in physics in the form of, (Force = mass x acceleration). Though the Newton's said equation is correct dimension-ally but the physical variable 'acceleration' is ambiguous and TTQG rightly labeled 'acceleration' in regard to 'space- time' concept as (Force = mass x space expansion).

Quantum mechanics did never offer the topology and the physical significance of the wave function, Ψ. The topology of the wave function, Ψ, was first provided by TTQG and its physical significance was explained in the form of 'balancing of forces of the universe' by its bi circular hybrid geometrical shape. Through the concept of 'mutual hybridization - dehybridization' of TTQG, the actual physical process occurring during the operability of quantum mechanical operators on the wave function have been diagnosed and presented topologically.

4. *Quantum Physics*

The subject of quantum physics is resting on the hypothesis put forward by Max Planck of 'discrete photons' and the 'energy equation' (with inverse dependency on the wavelength of light). However, it has been shown that that photons are 'EM-wave gravitons' and the energy is a 3D quantum of dimension 4 and 3 respectively. The Planck's constant in the energy equation of Planck represents 'entropy'. The inverse relationship of energy with wavelength, as shown by Planck, is apparent and energy is inversely proportional to 'time', which is of inverse area dimension and hence energy is being directly proportional to the area or volume of the wave fronts. The idea of energy of Quantum physics (inverse function of the wavelength of light) has been fully reversed in TTQG and the photo-electric phenomena has been shown to be a phenomena of 'exchange of force quantum' between the light wave and the baryonic matter rather than the subtractive model of the same as offered by Albert Einstein.

The 'black body radiation' phenomena, the 'Stefan-Boltzman law' and the 'spectral power distribution of Black body radiation or sun's energy spectrum could not be explained by the subject of Quantum Physics. Planck had to do some tedious mathematics to explain the typical black body radiation curves but which is again an incomprehensible one. However, in TTQG through the 'new theory of color physics' and the concept of ' constancy of the energy density of space', the 'black body radiation', 'Stefan-Boltzman law' and 'spectral power distribution' have been clearly interpreted without doing any tedious mathematical exercise.

5. *Classical Physics and Thermodynamics*

The major shortfall of classical physics was the ignoring of the 'time-space' of the universe and the most of the physical variables were presented shapeless. TTQG has filled the said incompleteness of the clsassical physics and thermodynamics as well. TTQG has shown that the so called 'acceleration' of Newtonian physics is in fact a 'time-space' phenomena in the form of 'space expansion'. When there is a longitudinal space expansion, the increase in longitudinal entropy surpass the decrease in lateral entropy and in case of lateral space expansion, the reverse is true. The net change in entropy (the longitudinal and the lateral) is always positive during the spontaneous expansion of the universe and the so called acceleration and the said entropy always remain in the rising path and tending towards maximum.

The world scientific community needs to realize the fact that the representation of force in the form of (Force = mass x acceleration), is one of the representations of force out of the possible innumerable superposition equations which could be fabricated through TTQG as shown below:

Force = $(\text{entropy})^2$, Force = (mass x entropy x EM-wave), Force = $(\text{Nuclear fission x mass})^{1/2}$, Force = (Nuclear fusion x EM-wave x space expansion), Force = $(\text{EM-wave})^{1/2}$….. so many. In the language of chemistry one may say that all these forms of force are the isomeric forms of force and based on this concept, the first law of thermodynamics has been reshaped by TTQG and presented in this article.

For the first time in the history of science, the TTQG came up with the geometrical proof of the second law of Newton and all the three laws of thermodynamics. The most updated versions of the three laws of thermodynamics have been given.

6. *String theory*

String theory is based on the idea of microscopic strings (of lengths of the order of Planck length) spread all around the universe and are considered to be the 'building blocks' of the universe. As a matter of fact the string theory could not shape up itself properly mainly on ground of ignoring the topology of 'time- space'. As a result of that it failed to explain the geometry of the gravitation and though talked about the multidimensional universe but could not prove it. The line of thinking or the postulates of the string theory needs to be diverted towards the TTQG postulates and is required to be restructured.

The topology of the dark matter and dark energy had been kept at total dark in the string theory. TTQG has shown in a very straight forward fashion the physics of the formation of dark matter and dark energy, their geometrical shapes and the mathematical expression through the presentation of TTQG driven new theory of color physics.

To end, this is to say that based on the altogether many new findings, discoveries and the successful interpretation of the physics and cosmology of the universe by TTQG, the basic and the advanced text books of physics and physical chemistry (especially the chapters of thermodynamics, chemical kinetics and chemical equilibrium..) needs to be re-written immediately to update our knowledge and recognize the cosmos in a new way altogether.

Dedication: Dedicated to my beloved late parents (Mr K P bhattacharya and Mrs Aruna Bhattacharya) and my dearest friend and colleague late Mr Sajal Kumar Roy (of Austin Paints & Chemicals Private Limited, Kolkata).

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I acknowledge my daughter Ms Sulagna Bhattacharya, my wife Mrs Chandana Bhattacharya, the senior technician Mr Debabrata Chatterjee and CEO, Mr Bijoy Sarkar of Austin Paints & Chemicals Private Limited for their constant inspiration and encouragement. Special thanks are due to Mr Debabrata Chatterjee for drawing the critical figures of this manuscript.

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Test and Research of Silicon Materials in Integrated Device Engineering

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Abstract- It is of great practical significance to test and analyze the quality of silicon materials used in integrated devices and their changes in planar thermal process. This paper summarizes the international test, analysis and research results. The contents include polycrystal preparation, single crystal growth and its crystal defects, wafer cutting, grinding and polishing, wafer tracking observation and analysis in plane thermal process, generation control and elimination of induced dislocations, etc.

Keywords: polycrystalline and monocrystal silicon, crystal defects, induced slip dislocations, induced dislocations and their relationship with device quality and yield.

GJSFR-A Classification: *LCC: TK7871.15.S5*

TESTANDRESEARCHOFSILICONMATERIALSININTEGRATEDDEVICEENGINEERING

Strictly as per the compliance and regulations of:

Test and Research of Silicon Materials in Integrated Device Engineering

Chuan-Zheng Yang

Abstract- **It is of great practical significance to test and analyze the quality of silicon materials used in integrated devices and their changes in planar thermal process. This paper summarizes the international test, analysis and research results. The contents include polycrystal preparation, single crystal growth and its crystal defects, wafer cutting, grinding and polishing, wafer tracking observation and analysis in plane thermal process, generation control and elimination of induced dislocations, etc.**

Keywords: polycrystalline and monocrystal silicon, crystal defects, induced slip dislocations, induced dislocations and their relationship with device quality and yield.

I. Introduction

Nowadays, there is a very fashionable term "chip" and "chip engineering". Their essence is to prepare semiconductor devices on silicon wafers, such as diodes (P-N junctions, rectifiers), transistors (P-N-P or N-P-N), integrated circuits, including large-scale integrated circuits and super-large-scale integrated circuits. The so-called circuit is to integrate the diodes-transistors-resistors-capacitors with different parameters into a single circuit according to the purpose and needs of use, and then fabricate it on the silicon wafer by the method of planar process. The so-called "planar process" is produced by repeatedly arranging individual circuits into an array on a silicon wafer. Therefore, after the completion of the plane process for the production of integrated circuits, it is necessary to use an integrated device dicing machine to split out a single integrated circuit, that is, a silicon chip, and test each chip under a high-power magnifying glass, and then place the qualified silicon chip into an exquisite packaging box. after it is fixed, it is also connected, that is, to connect the output input point of the silicon chip with the input and output connector of the packaging box, and finally add the cover package to get the chip needed by the user. Please note that the pre-process and post-process of chip production are carried out in a highly clean purification room.

The planar process for the preparation of integrated circuits is quite complicated. the first step is to produce qualified silicon single crystals, including large-diameter and super-large diameter silicon single crystals, the purity of silicon single crystals, N-type/P-type impurity concentration, and crystal perfect have very strict requirements; the second is to cut the wafers with a certain orientation and thickness according to the requirements of different devices, and the wafers that can meet the requirements of the devices after strict grinding and polishing. The prepared wafer must also have a strictly required reference chip in order to arrange the chip pattern and ensure the yield of the final device.

After entering the thermal process, it becomes more complex, including oxidation-lithography, selective diffusion, epitaxy, re-oxidation-re-lithography, re-selective diffusion and so on. There is not only plane arrangement, but also the problem of multi-layer intersection. For example, the scale of lithography has now reached the nanometer and sub-nanometer scale, so the plane scale of selected diffusion also reaches the nanometer scale; there are also phosphorus (N-type) diffusion and boron (P-type) diffusion, as well as the concentration of diffusion doping. The cross-overlap between layers and the problem of diffusion depth and concentration distribution can form a P-N junction or P-N-P or N-P-N junction that meets the design requirements, as well as the parameters of resistance and capacitance, as well as the wiring of these diodes, transistors, resistors and capacitors, input and output wiring, and so on. For lithography, first apply photoresist, under the cover of the lithography mask, use the lithography machine to expose the selected area, etch the selected area, and remove the photoresist. It can be seen that lithography is very important in the chip plane process, in which the lithography machine is the most critical equipment. At present, there are ASML of the Netherlands, Nikon and Canon of Japan, and Shanghai Microelectronics of China.

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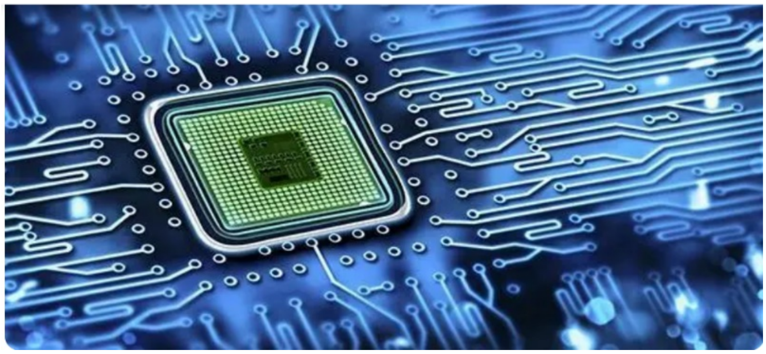

Fig. 1: Advertising map of an integrated circuit (or chip) after high magnification

An integrated circuit (or chip) after high magnification is shown in figure 1. Why it is used, what kind of integrated circuit to design, this is the task of the integrated circuit (chip) designer, how to use the plane process to produce qualified chips, this is the process designer of the plane process engineer and the art of the operators on the production line. What we are concerned with here is the problem of silicon materials in the process of silicon and its devices. The so-called material problems include the purification and ultra-purity analysis of polycrystals, the preparation of monocrystal silicon and crystal defects, and the preparation of silicon wafers (orientation of reference edges, directional cutting, grinding and polishing). As well as the generation control of crystal defects in the thermal process and the best thermal process and other material problems. We will discuss it in sections below.

II. Preparation and Purification of Polycrystal Silicon

The preparation of polycrystal silicon is the use of the most common raw material quartz sand (also known as silica) on earth, which refers to silicon dioxide. Polysilicon is obtained by refining, and then a series of chemical and physical purification processes can be used to produce polysilicon with semiconductor purity. Some people say that the purity of electronic grade polysilicon can reach 11N, that is, 11- 9s, that is 99.999999999%.

a) *Smelting of quartz sand and purification of crude silicon [5]*

i. *Smelting of quartz sand*

Smelting uses charcoal or other carbon-containing substances such as coal and tar to reduce quartz sand to obtain silicon with a content of 98-99%, which becomes metallurgical grade silicon and crude silicon or ferrosilicon. The chemical reaction is

$$SiO_2 + 2C \longrightarrow Si + 2CO$$

The main impurities in crude silicon are Fe, Al, C, B, P and Cu, which need to be further purified.

ii. *Purification of crude silicon*

Silicon is insoluble in acid, so the preliminary purification of crude silicon is soaked with HCl, H_2SO_4, aqua regia, HF and other mixed acid to 99.7% Si content. The chemical reaction formula is.

$$Si + 3HCl \longrightarrow SiHCl_3 + H_2$$

$$Si + 2Cl_2 \longrightarrow SiCl_4$$

b) *Acquisition of ultra-pure polysilicon*

The principle of further purification is to make use of the different boiling point of the substance and purify it by distillation in the distillation column. Because the boiling points of $SiHCl_3$ and $SiCl_4$ are 31.5 ℃ and 57.6 ℃ respectively, both $SiHCl_3$ and $SiCl_4$ are liquid at room temperature. High purity $SiHCl_3$ or $SiCl_4$ is obtained by distillation in a distillation column. Hydrogen is easy to purify and has very low solubility in Si, so the silicon obtained by reducing $SiHCl_3$ and $SiCl_4$ with H_2 is semiconductor pure polysilicon. The decomposition reaction is as follows:

$$SiCl_4 + 2H_2 \longrightarrow Si + 4HCl$$

$$SiHCl_3 + H_2 \longrightarrow Si + 3HCl$$

The purity of the intermediate products obtained in each stage of purification can only be known by ultra-purity analysis, reaching several 9. For ultra-pure analysis, mass spectrometry, polarography and neutron activation are often used for statistical analysis. if trace or ultra-pure analysis is to be carried out, secondary ion mass spectrometry is a suitable method.

III. Preparation and Test Analysis of Silicon Single Crystal

Up to now, silicon single crystals are mostly prepared by gas phase growth method, Czochralski method and floating zone growth method.

a) *Preparation of Silicon single Crystal*

Silicon materials have been developed in two ways: one is to provide higher quality crystals (including the control and extraction of impurity distribution).

The second is to develop cheap silicon crystals of certain quality, which are mainly used to make silicon solar cells used on the ground, and the vapor phase silicon single crystals are simple in process, and the cost can be greatly reduced. The crystal quality meets the requirements of making solar cells.

Using chemical vapor deposition (CVD) method, using $SiHCl_3$ or $SiCl_4$ as raw materials, the silicon single crystal was reduced by H_2, and the silicon single crystal was grown by vapor phase method using seed crystals with specified orientation (such as [110,111,112 and 115]) as silicon core, then grew freely in vapor phase $SiCl_4+H_2$ environment and temperature 1150~1160ºC, its length remained unchanged, while lateral free growth [2].

The Czochralski method is to heat the polysilicon through the thermal field, melt it into a melting state, control the liquid surface temperature at the critical point of crystallization by controlling the thermal field, and pull up from the liquid surface through the single crystal seed crystal above the liquid surface. with the rising of the seed crystal, the molten silicon grows into a cylindrical silicon single crystal according to the direction of the seed crystal.

Silicon single crystals are grown by this method with [111] and [100] orientations.

The floating zone method melts the polysilicon by local heating, moves the heating zone, and the melting part begins to crystallize. If the seed is placed at one end of the polysilicon material, the crystal will form a single crystal in the seed direction, and finally all the materials will be converted into single crystals. The principle is that the soluble impurities of raw materials are controlled or reformulated by generating a temperature gradient near the growth interface, so it has the function of purification.

The floating zone method is divided into horizontal zone melting method and suspension zone melting method. The growth process is as follows: (I) the crystalline material is made into an ingot in the crucible, the seed crystal is at the leftmost end of the crucible (horizontal zone melting method), and the seed crystal is at the top end of the suspension zone melting method; (ii) one end of the crucible is moved to the high temperature zone to form a melt; (iii) the crucible continues to move, the melt from the high temperature zone is formed, and the ingot entering the high temperature zone is melted; (iv) the other end of the crucible is moved out of the high temperature zone, and the growth ends.

b) Observation and analysis of the shape of silicon single crystals [6, 7, 8]

Figure 2 shows the cross-sectional views of vapor phase grown single crystals with three orientations of $< 111 >$, $< 112 >$ and $< 115 >$.

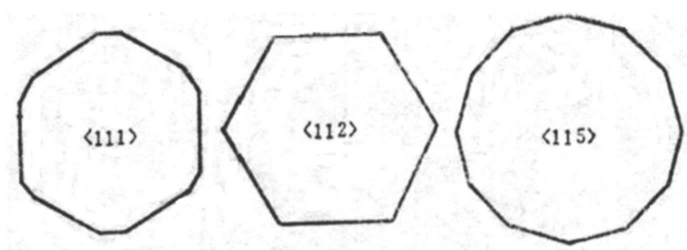

Fig. 2: Cross-sectional view of vapor phase single crystals with three orientations of $< 111 >$, $< 112 >$ and $< 115 >$

The external shape of vapor grown silicon single crystal follows the principle that the total surface energy of all external surfaces is the minimum, and the normal growth rate of these planes is slower, and the surface energy is lower, which is generally a low index crystal plane [2]. The $< 111 >$ oriented gas phase silicon single crystal is nearly hexagonal, with six $\{11\bar{2}\}$ faces and six edges as narrow planes $\{\bar{1}10\}$, and the $< 115 >$ orientation is twelve prisms and two $\{1\bar{1}0\}$ faces, Four $\{\bar{4}11\}$ faces, four $\{\bar{6}11\}$ faces, two $\{\bar{5}52\}$ faces, the four plane areas are not much different; the orientation is $< 112 >$ there are four $\{\bar{3}11\}$ faces and two $\{\bar{1}11\}$ nearly hexagonal prisms [1]. From these analyses, it is concluded that the crystal plane with the fastest growth rate in the normal direction is easy to disappear, and the crystal plane with the slowest growth rate is the slowest. From the point of view of the crystal structure, $< 110 >$ with the highest linear atomic density grows the slowest, and it is the easiest to reveal. The $< 110 >$ oriented gas phase silicon single crystal is almost tetragonal prism, and the surface is a pair of {100} faces and $\{\bar{1}10\}$ faces, which $\{\bar{1}10\}$ is much wider than {100}. The $< 100 >$ orientation should be square column, and all four cylinders are {110}.

The silicon single crystal grown by Czochralski method and suspension zone melting method is cylindrical in shape. The surface of [111]-oriented single crystal shows three growth edges with cubic symmetrical distribution, and the surface of [100]-oriented single crystal shows four growth edges with four symmetrical distribution. Their orientation relations are given by polar diagram analysis and experimental observation [4]. This gives the fabrication orientation of the reference plane of the (111) and (100) wafers, that is, the reference plane of the cylindrical single crystal with < 111 > orientation should be parallel to the line between the two edges of the vertical cross section, and the reference edge of the (111) wafer is in the < 110 > direction. The reference plane of the < 100 > oriented cylindrical single crystal should be parallel to the diagonal of the four growth edges, so that the reference edge of the (100) wafer is also < 110 > direction. It is also pointed out that when making integrated circuits with (111) chips, the long side of the rectangular chip should be strictly parallel to the reference edge in the < 110 > direction when laying out the circuit graphics for the first time. It is also pointed out that when slicing with a dicing machine, the first knife should be parallel to the reference edge, and after the second knife perpendicular to the first knife is completed, the wafer should be rolled along the vertical direction of the reference edge, so as to ensure that the wafer breaks along the {111} solution tilted to the wafer surface. For the fabrication of integrated circuits with {100} oriented wafers, it is only required that either side of the rectangle or square should be parallel to the reference edge of the wafer when laying out the circuit for the first time. In this way, the best slicing yield of integrated circuits can be guaranteed, which is completely based on theory.

IV. Observation of Several Phenomena in the Growth of Dislocation-Free Silicon Single Crystals by X-Ray Topography [1, 9]

Although some devices require uniform distribution of low-dislocation wafers, dislocation-free silicon single crystals are still the most widely used materials. It is of practical significance to study and summarize the problems in the growth of dislocation-free silicon single crystals.

a) *Generation, extension and elimination of weld surface defects*

Dislocation-free silicon single crystals grown by Czochralski method, zone melting method or pedestal method should be induced by single crystal seeds with a certain crystal orientation. After baking, the directional growth of the new crystal begins when the seed crystal is in contact with the melt. The interface between the seed and the new crystal is called the fusion surface. The seed which is cold or hot to a few hundred degrees will instantly come into contact with the melt above 1420℃, which will produce great thermal fluctuation and thermal stress, so a large number of dislocations will be introduced into the seed end of the fusion face. on the one hand, these dislocations will return to the seed, on the other hand, they will move and extend in the new crystal. From this point of view, it does not matter whether the seed crystals grow dislocation-free single crystals or not.

In order to prevent the dislocation produced by the weld surface from extending into the crystal, 1956, The necking-thinning technology proposed by Dash [6] is very effective. A simplified diagram of the motion and extension of the dislocation in the thin neck is shown in figure 3. The silicon crystal has a diamond cubic structure, and the dislocations mainly lie on the {111} slip plane. The orientations of edge dislocations and screw dislocations are<112> and <110>, respectively.

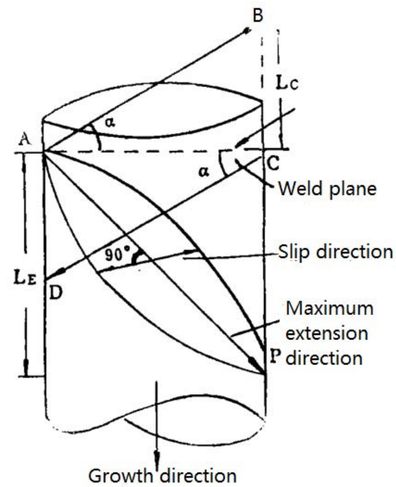

Fig. 3: Schematic diagram of the movement and extension of dislocations in a thin neck

The extension direction of the dislocation line is the direction of the dislocation line, the climbing direction of the edge dislocation is <111>, the slip direction is <110>, and the screw dislocation can slip on any crystal plane including the dislocation line and the Bell vector. We consider that the projection of the maximum climb, slip and extension distance of a dislocation on the {111} plane at an angle to the growth axis is L_{Cmax}, L_{Gmax} and L_{Emax}, respectively, which can be expressed as follows:

$$L_{Cmax}=D\text{tg}\,\alpha$$

$$L_{Gmax}=0$$

$$L_{Emax}=D\text{ctg}\,\alpha$$

The α, L_{Cmax} and L_{Emax} of the single crystals grown in the <111>, <110>, <100> direction are listed in Table 1 for reference.

Table 1: α, L_{Cmax} and L_{Emax} in the thin neck of <111>, <110>, <100> orientation

	α	Climbing	Extension	
		L_{Cmax}	L_{Emax}	hkl
<111>	19.47	0.354D	2.821D	<112>
	90	The length of a thin neck	0	
<110>	54.73	0.413D	0.708D	<112>
	0	D	The length of a thin neck	<110>
<100>	27	0.707D	0.413D	<112>

Table 2: Thin neck process data with almost the same casting speed

	Seed diameter D_0/mm	Thin neck diameter D/mm	Length of dislocation elimination in place of weld plane	D/D_0	D_0 x tgα mm	D x ctg α mm
Corresponding to the Fig.4(a)	3.7	4	24.7	1.08	10.5	11.3
Corresponding to the Fig.4(b)	5	3.3	10	0.66	14.2	9.4

An effective and intuitive way to study this problem is to take the X-ray topography of the longitudinally cut wafer along the growth axis.

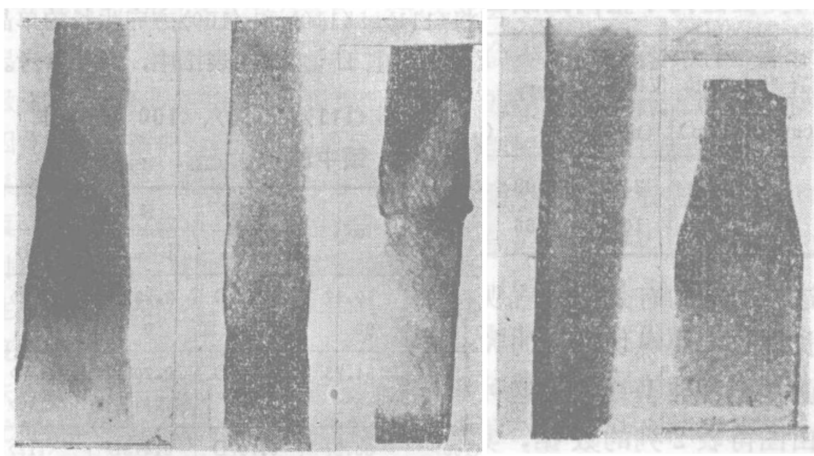

Fig. 4: The distribution of dislocations in the two shapes of thin necks.
(a)The neck is slightly larger than the seed crystal
(b) stretch neck-thin neck

Figure 4 is the projection topographies of two typical thin-necked wafers. From the data in Table 1, where D_0 is the seed diameter and D is the radius of the thin neck, it can be seen that when the fine neck diameter is smaller than that of the seed, the distance of error elimination at the fusion surface is consistent with the maximum extended projection distance. When $D>D_0$, L is about 2 times of L_{Emax} d, which may be related to the proliferation of dislocations (see figure 4a) and the fluctuation of thin neck diameter, but it can also be inferred that not pulling the neck is disadvantageous to the exclusion of dislocations.

From the simple analysis of figure 3, it can be seen that the dislocation slip on the inclined {111} plane can make the L_{Emax} smaller, while climbing along the CD direction will increase the L_{Emax}, and climbing along the DC direction will make the L_{Emax} smaller.

Sometimes dislocations can be eliminated without pulling neck-thin neck slowly. Schwuttke believes that the crystal drawing speed is fast enough so that the supersaturated vacancy concentration is very high, and the dislocation climbs outward, which means that the dislocation climbs to the direction of DC, which indicates that the vacancy moves towards the melt. In recent years, it has been found that the extension and elimination of dislocations in thin necks are also related to the type and concentration of doped elements.

b) Facet growth of dislocation-free Silicon single Crystal

It is generally believed that silicon single crystal is grown by the mechanism of two-dimensional surface nucleation and lateral layered growth. When there is a dislocation outcrop on the two-dimensional surface, especially the screw dislocation outcrop, they become the main center of the two-dimensional surface nucleation, which requires less undercooling, while the two-dimensional surface nucleation without dislocation outcrop requires a larger undercooling. What we are concerned about now is what the two-dimensional surfaces are and their distribution on solid-liquid interfaces of different shapes.

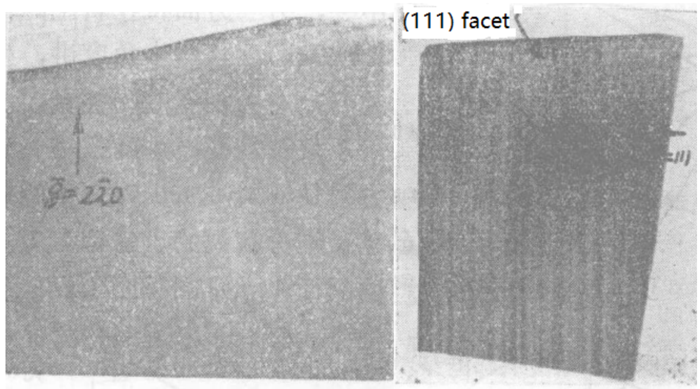

Fig. 5: X-ray projection topography of (11-2) wafer including bract region cut from dislocation-free silicon single crystal deviating from long bract, MoK radiation

Figure 5 shows a projection topography of a dislocation-free silicon single crystal that deviates from the growth of [111], including the "bud" region (11-2). As can be seen from the diagram, the "bud" region has no contrast in the (2-20) phase diagram. however, it has a strong contrast in the (111) phase diagram, due to the value of $\vec{g}$ 、$\vec{s}$ is

[111]/3 · [111] = 1 maximum contrast.

[111]/3 · [2-20] = 0 No contrast

According to this contrast change, it can be concluded that the stripe in the "bud" region is parallel to the (111) plane, and its maximum strain direction is [111], in other words, the facet is (111) plane. The highest point of the intersection between the plane and the cylinder is farthest from the high temperature, and the degree of undercooling is the highest. The two-dimensional surface nucleation occurs preferentially here, advances along the (111) plane, and then continues to form a step-like growth front along the solid-liquid interface.

c) *Destruction of dislocation-free silicon single crystal growth [9]*

In the process of dislocation-free silicon crystal growth, dislocations are often caused and multiplied for some reasons. this phenomenon is called the destruction of dislocation-free silicon single crystal growth. In practice, several phenomena of "Lepao", "parabola" and "crystal transformation" are often observed, which are briefly discussed below.

i. *"Lebao"*

It is pointed out that when the single crystal deviates from the orientation, it is found that the "Grow out of bao" phenomenon may begin to appear in the fine neck when the dislocation density is reduced to the order of $10^2/cm^2$, so the "Grow out of bao" is regarded as a representation of dislocation-free ($< 10^2/cm^2$) in silicon single crystal or at least in a certain region of single crystal. On the contrary, in the process of dislocation-free single crystal growth, due to some gradual factor. For example, the small fluctuation of the thermal field leads to the introduction of dislocations in the crystal growth process. It gradually increases, and when the dislocation density increases to more than 10^3, the "bao" will disappear again, which is called the "retrenchment" phenomenon in some production plants, indicating the destruction of the growth of dislocation-free silicon single crystals. In practice, we have observed that the slag consumption in the Czochralski method and the discharge ignition in the zone melting will introduce a large number of dislocations, resulting in "strangulation", and the introduced dislocations will return to the original dislocation-free part, which is obviously a sudden reason.

Whether it is the cause of sudden or gradual change, the observation results of the phenomenon of "lashing the bract" (disappearance of the bract region) all show the end of the small plane growth process, which further shows that the facet growth of silicon single crystal is related to dislocation-free and low-dislocation ($< 5x10^2/cm^2$).

ii. *"Parabola" and "crystal transformation"*

Twinning may occur in the inclined {111} plane during crystal growth. If the twinning of the inclined {111} plane occurs, an elliptic curve appears on the surface of the crystal rod, which is called "parabola" in some factories. After the oblique [111] twinning occurs in the < 111 >, < 110 > and < 100 > oriented rods, the orientation of the twin rods is < 115 >, < 114 > and < 221 >, respectively. Because the orientation of the twin is different from that of the main crystal, the requirements for thermal field and other conditions for

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crystal growth are different, so the defects of the crystal after tilting {111} twin are much larger.

In other words, the growth of dislocation-free bodies is destroyed and fewer dislocations become multiple dislocations. Figure 5 shows the projection topography of a < 111 > oriented silicon single crystal including the host crystal and the crystal cut wafer after (11-1) twinning. Due to the use of (11-1) reflection, both the main crystal of [111] orientation and the twins of [115] orientation participate in diffraction. It can be seen that the integrity of the crystal is much worse than that of the main crystal.

If the inclined twins occur one after another, especially when several groups of inclined {111} planes occur, the thermal field is not suitable for the single crystal.

The growth of, therefore, the emergence of polycrystal, this is commonly known as the so-called "crystallization" phenomenon.

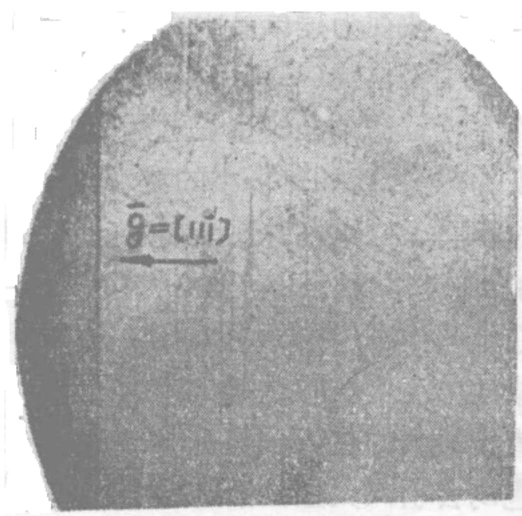

Fig. 5: Shows the projected topography of the two crystals with different integrity after the "parabola".

iii. *Edge exchange and dislocations on twins*

In the growth of (111)-oriented silicon single crystals, there is sometimes a sudden position change of 180o in the long edges, and it is obvious that there are two crystals, commonly known as "edge exchange". We cut the (11-2) wafer with two parts of the crystal and take a series of reflection phase diagrams of (333) mt, (202) t and (202) m. According to the analysis, it is concluded that the mechanism of "prismatic exchange" is a twin of a nearly horizontal (111) plane. In terms of its atomic model, the crystal on both sides of the twin plane moves a fraction of the distance between atoms in the direction of the twin. In terms of orientation relation, it rotates 180^{o} relative to the line of the twin plane. The orientation relation is shown in figure 6(d), which is also proved by Laue orientation. After face exchange, the growth direction of the twin is the same as that of the main crystal. Under the same growth conditions, the two crystals can be dislocation-free or dislocation-free, indicating that "edge exchange" does not necessarily destroy the growth of fault-free silicon single crystals.

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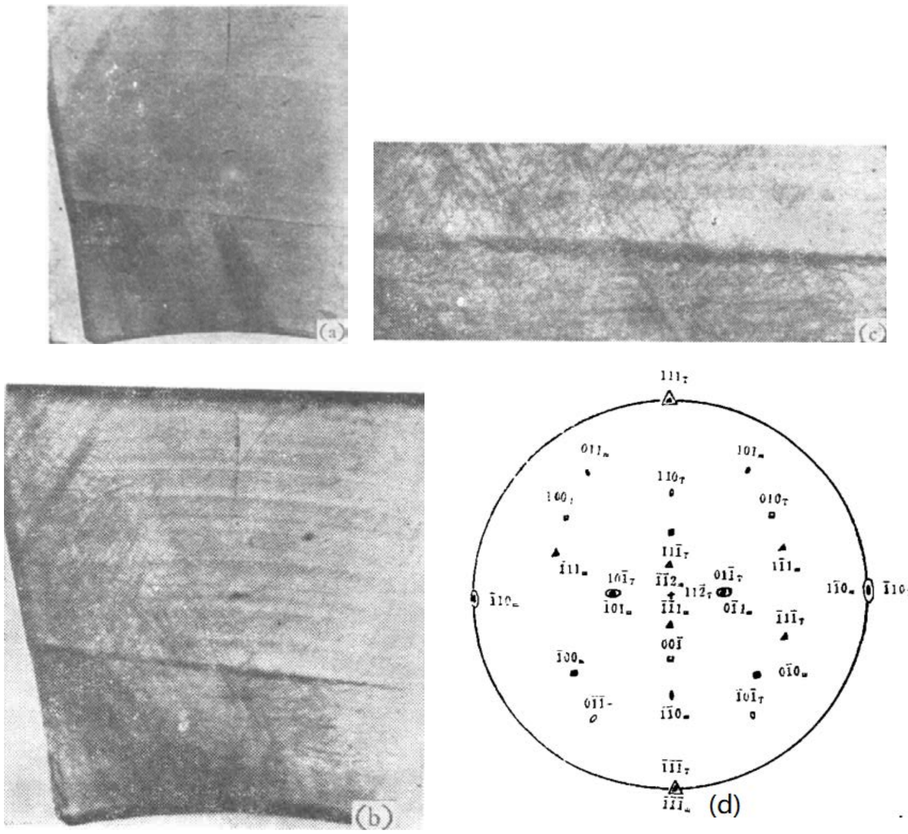

Fig. 6: The projected topographies of the "edge exchange" chip. (a) (111) reflection, (b) (333) reflection, (c) is the amplification of (b); (d) orientation relationship between main crystals and twins

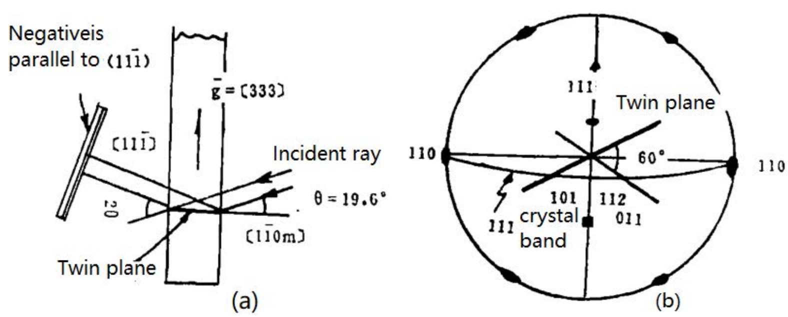

Fig. 7: Analysis of the dislocation configuration on the crystal plane in figure 6.

(a) Spatial relationship, (b) Polar graph analysis

Two groups of dislocation lines are observed on the twin band of figure 6 (a). The angle between them is about 60° and is divided equally by the [1-10] direction. According to the relationship between the diffraction geometry and the crystal orientation (see 36.7a), the direction of the third-order diffraction (333) of the used (111) is almost parallel to the(11-1) plane, while the twin plane (111) is perpendicular to the(11-2) wafer surface. The dislocation line direction are [10-1] and [01-1] on the (111) plane, they are projected into 60° on the (11-1)plane. And it is divided equally, as shown in figure 6b, it can be seen that the trends of the two groups of dislocation lines are[10-1] and[01-1] respectively.

d) *Dislocation return and closing process*

As mentioned earlier, when dislocations are suddenly introduced during crystal growth, these dislocations will return (or reverse extend to the dislocation-free crystal). If twinning occurs, the return of the dislocation in the twin will terminate at the twin plane, as shown in figure 8.

Even if the dislocation-free silicon single crystal grows to the tail, the rapid cooling of the crystal from the melt and the rapid crystallization of the droplet melt bonded with the tail will cause great thermal stress, resulting in a large number of dislocations and slip dislocation bands in the crystal. As shown in figure 8 A, this kind of dislocation will also return to the adjacent dislocation-free single crystals, reducing the yield of dislocation-free single crystals. Similar to the dislocation extension considered previously, the way to overcome this problem is to control the small tail or imitate the tapered ending process of zone melting, which is shown in Fig. 9(a) and (b) respectively. The latter has been successful in the process. For crystals with < 111,110 > and < 100 > orientations, the angles are less than 39 °, 109 ° and 91°, respectively.

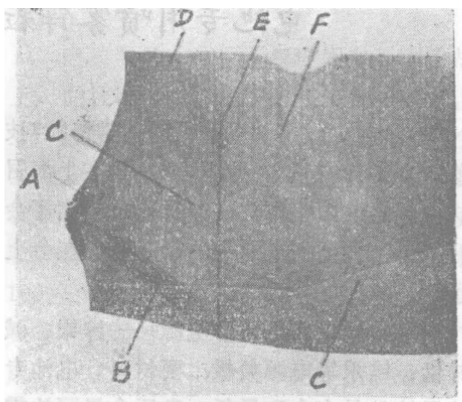

Fig. 8: X-ray projection topography returned by the error at the end of the crystal;

A is the long-range stress field caused by the rapid crystallization of the final melt.

B is the introduced slip dislocation band. In addition, it also shows that the curved dislocation C;

D is a stacking fault, the twin interface E and the growth band F

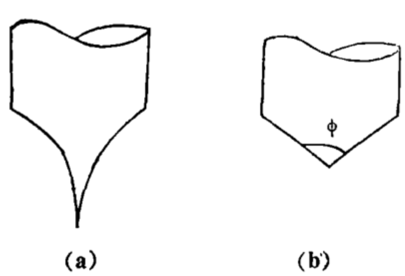

Fig. 9: Two finishing processes for overcoming the error return of single crystal tail

The above study is only for < 111 > oriented Czochralski silicon. In fact, for < 100 > oriented Czochralski silicon, the thin neck process and ending process are similar. The failure of dislocation-free single crystals also has "Lepao" and "parabola" phenomena, and the probability of parabola phenomenon is 25% higher than that of <111> orientation, this is because there are four {111} planes with 54.5° with (100) faces. However, there will be no "edge exchange".

V. Observation and Analysis of Defects in Floating Zone Silicon Single Crystals [10~14]

a) Defects in grown crystals

The growth of silicon single crystals by floating zone method is mostly carried out in argon-hydrogen mixed atmosphere. In the crystal drawing process, the content of hydrogen in the atmosphere is a very important parameter, so it is necessary to study this problem.

The X-ray appearance of the zone fused silicon (111) wafer grown in argon-hydrogen mixed atmosphere is shown in figure 10. Three types of defect images can be seen, namely, rod pair A, flake B and point pair C. most of the axes of the first two defects are parallel to the intersection line between the {111} plane and the wafer surface, and other orientations are also observed. as shown in figure 10, they are the projection of < 112 > direction on the {111} plane.

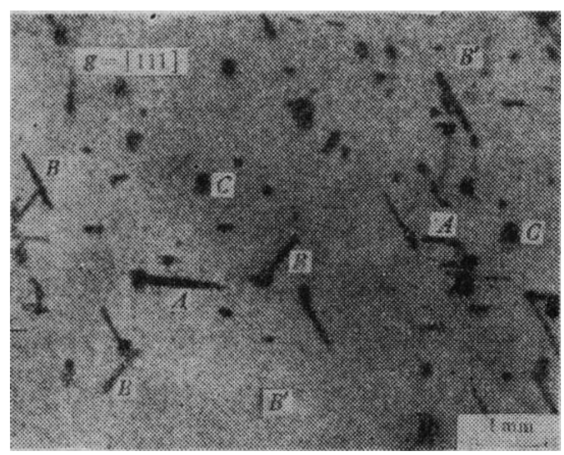

Fig. 10: X-ray topography of single crystal wafers containing 25% hydrogen in atmosphere, MoK α

In order to study the effect of hydrogen content in atmosphere, under the condition that other growth conditions are basically the same, a series of oriented single crystals are prepared by changing the flow rate of argon and hydrogen, and the 15mm-length segments and 400um wafers are cut in the same part of the single crystal. After grinding and cleaning, the former is polished in the same container, and the pit density is measured sideways. The dislocation pair density of the wafer was observed after mechanochemical polishing and selective etching, and the projection phase diagram was taken to observe the total bulk density of the three kinds of defects. the relationship between the results and the hydrogen content in the atmosphere is drawn in figure 11. it can be seen that there is a maximum value on the curve, and the peak position is almost all at the hydrogen content of about 10%. When the hydrogen content is less than 10%, the defect density increases rapidly with the increase of hydrogen content. When the hydrogen content is 10%, the defect degree decreases slowly with the increase of hydrogen content. When the hydrogen content is more than 50%, there is almost no such defect.

b) Heat treatment effect of Silicon single Crystal in hydrogen-Argon mixed atmosphere

Fig. 12 shows the X-ray topography of the polished wafer with a thickness of about 400um before and after heat treatment. the comparative observation shows that after annealing at 1200 ℃, the contrast of the flake defect image almost disappears, while the rod still has a weak contrast to the defect image. however, almost all the point-to-defects are retained, and the image is dispersed, which seems to correspond to the outward movement of dislocation pairs during processing.

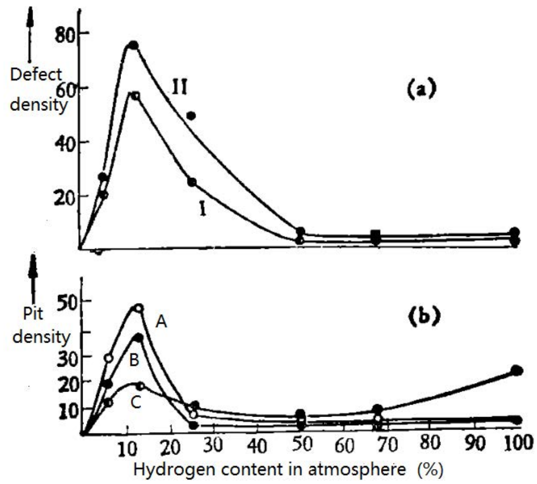

Fig. 11: The relationship between the defect density and the hydrogen content in the growth atmosphere (a) the dislocation alignment I (pair/cm^2) of the grown crystal and the defect II (/cm^3) in the phase diagram; (b) the pit density cm^2); A-represents the growth state, and B and C represent the near-surface and bulk defect density of the crystal segment annealed at 1200 ℃ for 11 hours, respectively.

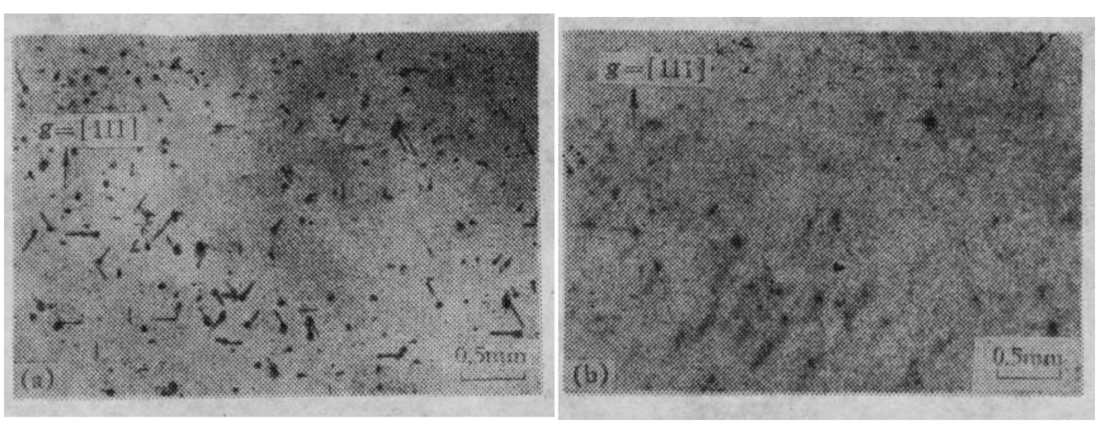

Fig. 12: X-ray topography of the same wafer with 1 before annealing (a) and 6 hours after 1200°C annealing

The aforementioned crystal section was annealed at 1200°C for 11 hours after grinding and cleaning, then cooled to 600°C with the furnace, the oxide layer was removed and polished, the chemical polishing was carried out, the pit density near the surface layer was observed, and then the crystal segment was cut off at half the length, and then the pit density in the body was measured by grinding and chemistry. the results are also shown in figure 11. C three curves show that the pit density near the surface layer is lower than that in the growth state, and the peak position of the maximum value remains unchanged. However, in the body, when the hydrogen content is less than 25%, the pit density is lower than that in the growth state, but when the hydrogen content is more than 25%, the pit density in the body is generally higher than that in the growth state, and a maximum occurs when the hydrogen content is 100%. The results of the research on such defects are described below.

c) *Defects in Silicon single crystals grown in Pure hydrogen atmosphere*

i. *X-ray topographic observation*

Figure 13 shows the X-ray topography of (111) wafer in pure hydrogen zone melting single crystal after annealing at 1000℃ for 1 hour. rod pairs, single rod and point defects are obtained , rod defect point to<1-10> direction and quite long scale are also observed. they have strong contrast in the topography of {2-20}symmetric diffraction geometry or{11-1} asymmetric diffraction, indicating that they do not have, <11-2> or <1-10> strain vectors.

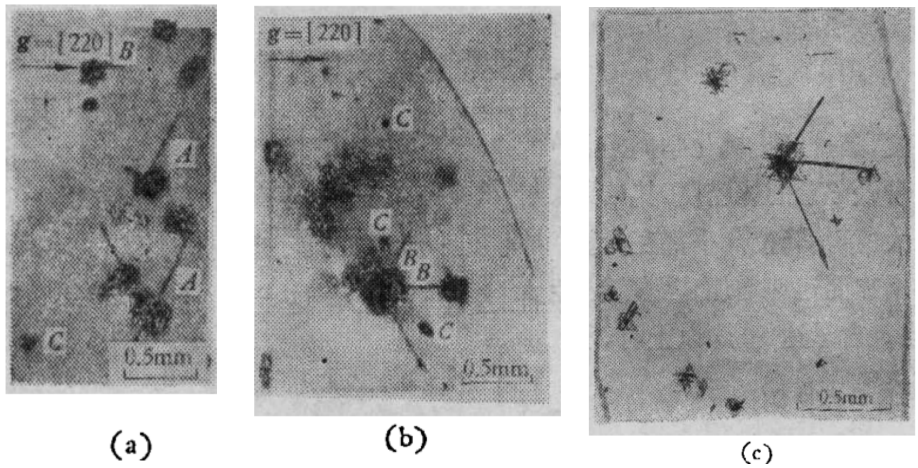

Fig. 13: X-ray topography (a) (b), (c) optical micrographs of single crystals grown in pure hydrogen after annealing at 900 ℃ for 1 hour

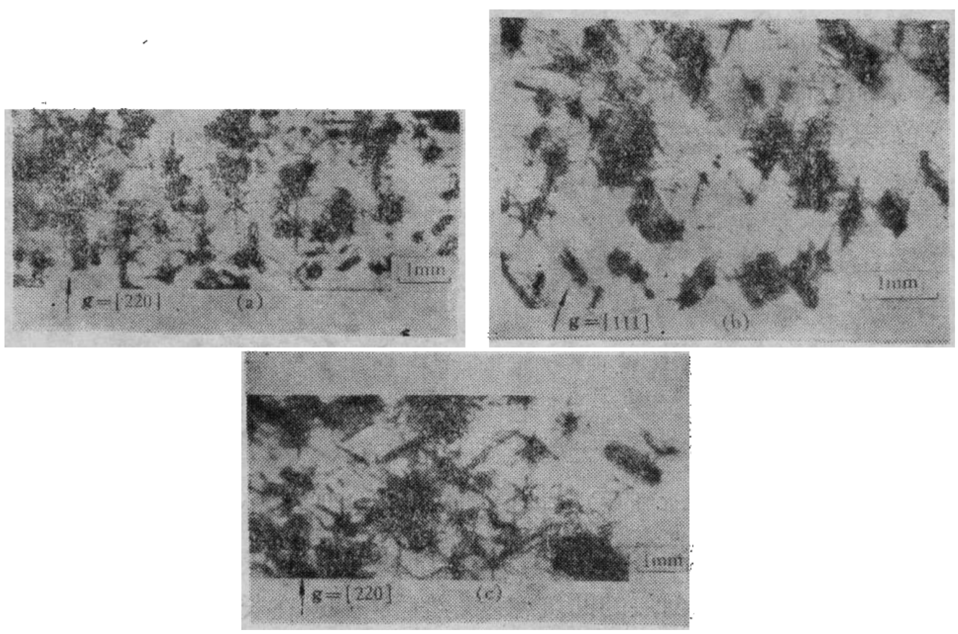

Fig. 14: X-ray topographies of single wafer annealed at 1000℃ for 1 hour in pure hydrogen atmosphere

Fig. 14 shows the topographies of the(001),(1-10) and (111) wafer cut from the same single crystal after being treated at 1000 ℃ for 1 hour, and the image of "rose knot" defect emitted from a strain center can be observed. In the topography of the (001) wafer, see figure 14 (a). In addition to the two groups of intersecting marks (1-10) and [110] parallel to the {111} plane and the surface, we can also see two groups with 45^{o}.

In the topography of the (111) wafer, in addition to the[1-10],[01-1] and [10-1] three groups, we can also see the three groups that form 30^{o}. See figure 13 (c) synthesize the projection relationship of the "rose knot"-like defects in the three kinds of chip projection phase diagrams, it can be inferred that a complete "rose knot" defect is composed of twelve rose petals in the < 112 > direction. From the picture with higher magnification, 14b, you can see. A rose petal consists of a row of dislocation loops, and there is a complex structure of multiple central rings near the strain center.

In order to determine the Boolean vector of the dislocation ring array, a series of symmetrical and asymmetric transmission geometric diagrams of the (111) wafer are photographed. According to the law of image elimination, it is found that the dislocation ring array has a Burgers vector parallel to its petal axis <110>, which is consistent with the results of Cui Shufan et al.

ii. *Secondary annealing effect*

The topographies of the wafer cut on the wafer annealed at 900 ℃ for 1 hour before and after secondary annealing is shown in figure 15, which is obviously different from that shown in figure 12, indicating that secondary annealing can not reduce and eliminate the defects produced during the first annealing.

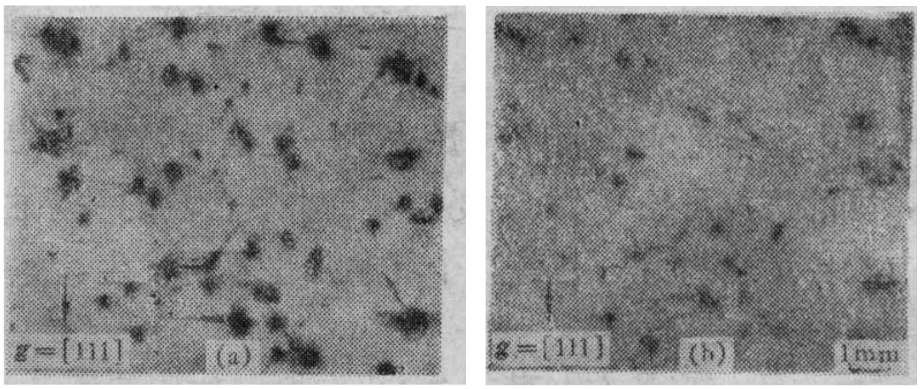

Fig. 15 (a): The topography of the wafer cut from the hourly segment annealed at 900C; (b) the topography of the same wafer annealed at 1100 ℃ for 4 hours

d) *Precipitation of hydrogen in single crystals and the mechanism of hydrogen-induced defects*

From the above experimental results, the existence of these hydrogen-induced defects is closely related to the state of hydrogen in single crystals. The solubility of hydrogen in melt silicon is large, and the hydrogen entering into freshly grown silicon through the melt is of the order of $2x10^{19}/cm^3$, while the solubility in solid silicon is very small, as shown in Table 1. except for the partial outward diffusion during the cooling process of crystal growth, if the cooling rate of the crystal is fast enough, then the rest of hydrogen is dissolved in the crystal by interstitial supersaturation, which is proved by the infrared absorption spectrum of silicon single crystal in floating zone in pure hydrogen atmosphere. If the crystal is cooled slowly enough, or if the crystal is cooled fast enough, the supersaturated solid solution hydrogen will dissolve and precipitate. Jiang Bolin et al. [9] studied the floating zone silicon single crystal treated by 500~1000ºC at different temperatures for 1 hour by X-ray face center method. It is considered that it is first the decomposition of Si-H bond, then nucleation and growth by diffusion, and the precipitate changes from spherical to elliptical disk, and the precipitate is parallel to {111} plane. When the stress at the interface between the precipitate and the matrix exceeds the yield stress of the silicon at the treatment temperature, the dislocation ring is emitted in its favorable direction, as can be seen in figures 14 and 15, the multi-center dislocation ring of the complex structure near the high contrast region of the core and the dislocation ring far from the core.

Table 1: Solubility of hydrogen in silicon at different temperatures [10]

temperatures (ºC)		Two kinds of calculation results	
	%	Atoms/cm³	Atoms/cm³
500			$3.4x10^9$
1000	3.6x10-6	$1.8x10^{14}$	$2.0x10^{14}$
1200	4.0x10-6	$1.8x10^{15}$	$2.4x10^{15}$
1300	1.7x10-5	$8.5x10^{15}$	$4.8x10^{15}$
1400	5.3x10-5	$2.7x10^{16}$	$1.2x10^{16}$
1420 (liquid state)	0.45x10-1	$2.3x10^{19}$	$1.3x10^{16}$

The emission mechanism of the dislocation ring is shown in figure 16. A group of flake precipitates on the {111} plane can emit the dislocation ring by prism stamping in three favorable < 110 > directions. The primitive ring consists of two pairs of dislocations parallel to each other, each on a set of parallel slip planes, and the direction of the dislocation is < 112>.The two pairs of dislocation lines have the same Burgers vector and are parallel to the intersection of the two slip planes. The size of the initial dislocation ring is closely related to the projection scale of the precipitate in the emission direction. If the precipitates are on several groups of {111} planes at the same time, or when the precipitates are almost spherical, the dislocation rings can be emitted to 12 <110> directions to form a "star" dislocation ring array, as shown in figure 14. At high temperature, under the action of continuous emission stress, the dislocations of the dislocation rings move along the common slip direction on their respective slip planes, and the emission core slip continues one after another, so that the dislocation rings are arranged in strings along the emission direction. the dissonance of the slip of dislocation rings on each plane and the interaction of climbing nuclei make the dislocation rings of different sizes on one row distorted. As a result, multiple central dislocation loops with complex configurations are formed near the core.

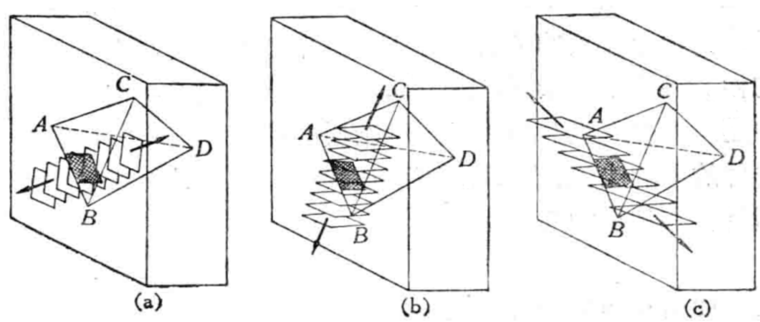

Fig. 16: A schematic diagram of the dislocation ring emitted by a flake hydrogen precipitate.
ABCD is a regular tetrahedron composed of {111} faces. if the precipitate is parallel to ABD, the emission direction of the dislocation ring is (a) AC direction; (b) BC direction; (c) CD direction.

The experimental results show that all crystals with this defect, especially those with high defect density, can not produce qualified devices, and serious local breakdown will occur. However, it is worth mentioning that when the floating zone silicon single crystal grown in pure hydrogen atmosphere is cut into 700 μm thick wafers and heat treated as mentioned earlier, there are no defects such as hydrogen precipitated nucleus dislocation ring array. this may be due to the outward diffusion of hydrogen during heat treatment rather than the accumulation and precipitation in the wafer.

VI. Microdefects and Vortex Defects in Dislocation-Free Silicon Single Crystals [15,18]

Practice shows that although the scale of vortex defects is small, silicon wafers are very easy to cause oxidation stacking faults due to the influence of stress field in the process of thermal oxidation, which has an important impact on silicon devices, so it is necessary to study this problem.

The methods of observing and studying microdefects and behavior defects in dislocation-free silicon single crystals are as follows: one is the etching method for polishing wafers, and the commonly used etching agent is HF:33%CrO3=1:1. The practice shows that the etching effect of cutting and polishing wafers for growing crystals is not good, and it is often necessary to carry out 1100oC wet oxygen oxidation and then etch them. Similarly, the effect of direct observation of growing crystals by X-ray appearance method is not good, and it generally needs to be decorated with copper before the effect is observed

There are micro defects in dislocation-free silicon single crystal, which are thermal vacancy, interstitial atoms and chemical impurity atoms will be supersaturated under certain conditions and will be condensed into point defect clusters, which are called micro defects. Vortex defects are micro-defects in the macroscopic distribution of vortex. Microscopically, vortex defects and dislocations also form triangular corrosion pits, the difference is that the micro-defects are triangular shallow flat-bottomed corrosion pits with a white core under the microscope and a small scale. The dislocation is a deep sharp-bottomed etching pit, which shows a black triangle under the microscope, as shown in figure 17.

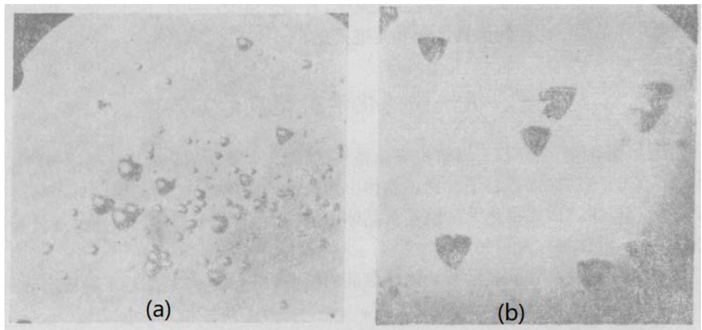

Fig. 17: Etching pits for microdefects (a) and dislocations (b)

Macroscopically, the micro-defects show vortex stripes, as shown in figure 18, and are often decorated with carbon and heavy metal impurities, which are similar to resistivity stripes, but their mechanisms and micro-morphologies are different. The difference is that the essence and formation mechanism are different, the vortex defects are formed by the aggregation of hot spot defects, and the resistivity fringes are caused by the segregation fluctuation of doping elements. Microscopically, the micro-defects are triangular flat-bottomed corrosion pits or Xiaoqiu, the resistivity fringes are micro-corrosion pits, and the corrosion surface is mirror.

The distribution of vortex defects is as follows: there are two shallow etch pits, namely A defect and B defect, An is a large etch pit or mound (3 μm), B is a small etch pit(~1μm).

The distribution of A defect is two orders of magnitude less than that of B defect, both of them are striped, but the position of distribution is different. B defect is distributed around the wafer, the center is less, and A defect is distributed in the center of the crystal.

The transverse and longitudinal distribution characteristics of the vortex defects are that when the cutting plane is perpendicular to the growth axis, several levels of corrosion pits are displayed at the same time, forming the vortex stripes shown in figure 19 (b). When the cutting surface is not perpendicular to the growth axis, the cutting surface intersects several levels of the vortex defects, showing each level and an arc segment, as shown in figure 19 (c).

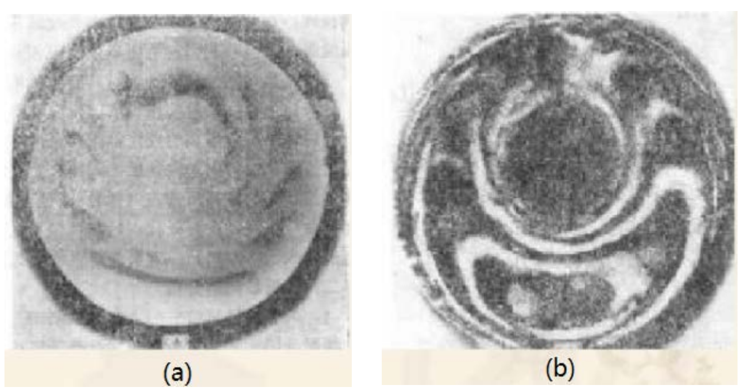

Fig. 18: Vortex distribution of microdefects

There is no vortex defect in the dislocation-free silicon single crystal, but this behavior defect exists in the dislocation-free silicon single crystal, and the concentration of microdefects is low in the 1~2cm range of the crystal surface.

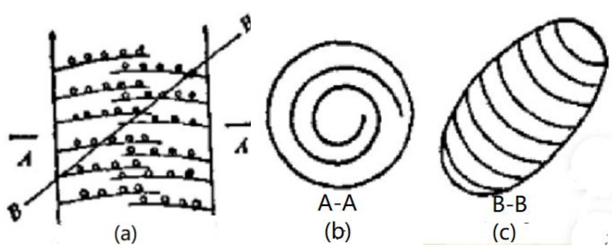

Fig. 19: Silicon Wafer cutting, Grinding and polishing observation and Analysis

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The formation of vortex defects is related to single crystal growth stripes, thermal field symmetry and crystal remelting during growth, so crystal remelting can be avoided by adjusting crystal growth parameters, such as melting temperature, crystal diameter, casting speed and rotation speed, etc. while using a higher casting speed, keep the flat and concave growth interface, so that the vortex defects can be reduced and eliminated.

The problem is that when crystals with such vortex defects are annealed by 1350°C and come out of the furnace quickly (such as falling to room temperature within 20 seconds), the wafers are oxidized by 1200°C for 3 hours, and it is found that in addition to the circular stacking faults of the raw materials, half-ring dislocations are also found, as shown in figures 20 and 21. These paired dislocation loops are divided into two categories, which are represented by A and B. For the (001) wafer, the two A-type semirings are located on the two inclined {111} where the surface intersection marks are parallel to each other, and their spatial configuration and projection on the (001) plane are shown in figure 22 (a). The B-type hexagonal dislocation ring is located on two {111} planes perpendicular to the surface intersection marks, and its spatial configuration and projection on the (001) plane are shown in figure 22 (b). The projection of the development of the two dislocation rings on the (001) plane is shown in Fig. 23 (a) and (b), respectively. The type A semicircle dislocation is a process of climbing, sliding and cross-slip, while the type B is initially due to the precipitation of the climbing word to emit a circular dislocation ring parallel to the surface, and then transformed into a square ring in the "110" direction. Under the action of decomposition shear stress, a pair of flat dislocations slip in the opposite direction, thus developing into a hexagonal dislocation ring [36].

Similar half-ring dislocations are also found for (111) wafers [37].

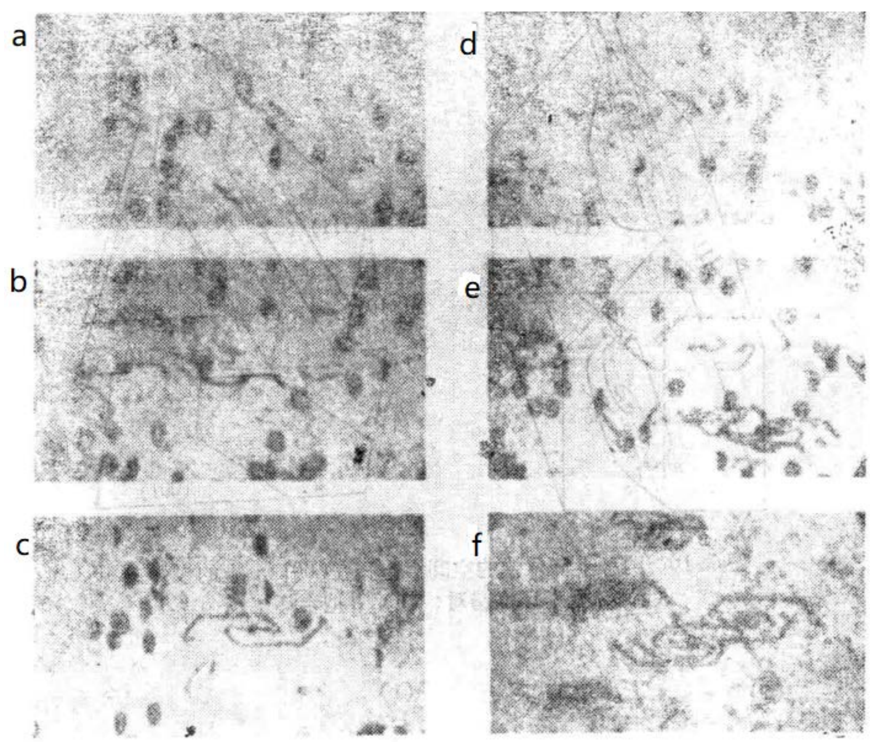

Fig. 20: The circular stacking faults and half-ring dislocations A & B along the vortex defects and show the different stages of the development of half-ring dislocations.

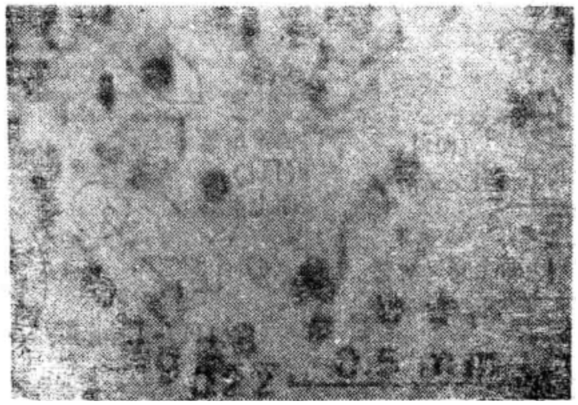

Fig. 21: The circular stacking fault along the vortex defect and the semi-dislocation ring B, (111) wafer on the (111) plane perpendicular to the surface intersection mark

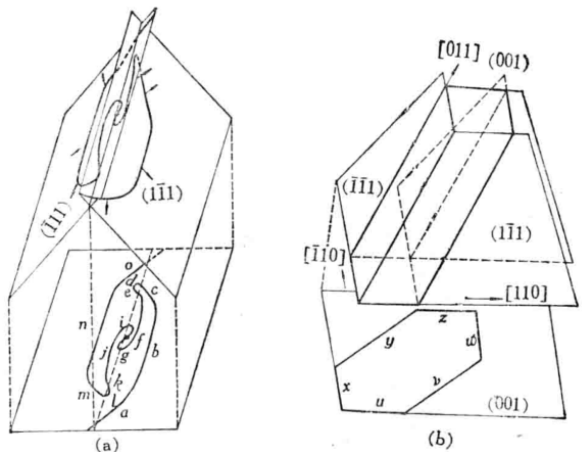

Fig. 22: Spatial configuration of two kinds of semi-dislocation rings and projection on (001) plane. (a) A-type semi-dislocation ring pair (b) B-type semi-dislocation ring

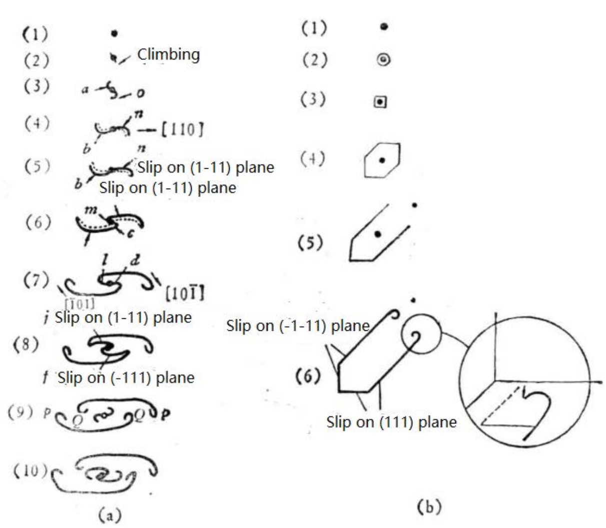

Fig. 23: Projection of dislocation configurations in the formation, development and multiplication of two semi-dislocation rings A (a) and B (b) on the (001) plane

VII. Test and Analysis of Directional Cutting and Polishing Process of Wafer

The first step in the process is to make a reference surface. In the early days, the first step was to circle the grown silicon single crystal which was close to the cylinder, so that the wafer cut perpendicular to the growth axis was an ideal circle. From a modern point of view, this is necessary and wrong, because the rolling circle loses the reference of the crystal orientation relation, which makes it difficult to make the reference plane. Secondly, the rolling circle inevitably leaves residual stress on the crystal surface, resulting in some kind of stress concentration. It makes the wafer easy to slip dislocation in the later thermal process, which affects the yield and yield of the device. The round rolling process can be completely discarded.

The growing crystal bought by the device maker may be an entire ingot or an ingot that has been cut into segments. Whether it is < 100 > orientation or < 111 > orientation, the end face needs to be ground with thicker sand for optical orientation. the light reflection patterns of the three oriented crystals are shown in figure 24, which shows that they are four times, three times and two times symmetrical. Referring to this pattern, or referring to the growth edge of the ingot surface to make the reference plane, is to grind a certain orientation plane on the crystal surface. The method is:

(1) For the crystal end of <100> orientation, the reference plane should be strictly parallel to the line of the diagonal edge, or parallel to the cross line of reflected light.
(2) For the < 111 > oriented crystal segment, the reference plane should be strictly parallel to the line of two growth edges or parallel to the line of three light spots. If you think about it, the method of reference growing edges is more accurate.

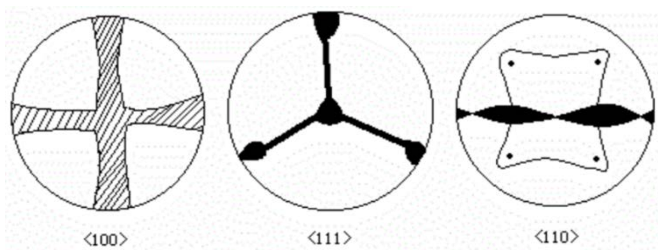

Fig. 24: Cross-sectional light reflection images of crystals with three orientations: <100>, <11 > and <110 >

The second step is directional cutting, which is to install the crystal segment on a special fixture with three-degree rotation for orientation, and carefully adjust the three-degree rotation to make the strictly symmetrical reflected light pattern appear to start cutting. For general requirements, this is fine. However, some requirements are not roughly < 100 > or < 111 > oriented wafers, but wafers that deviate several degrees from a specific orientation, so it is necessary to cut out a piece and then proofread it with an X-ray orientator. determine how to adjust in order to achieve the required adjustment parameters, according to this adjustment parameter and then carefully adjust before cutting. The cut wafer not only has a clear reference edge, but also can see the growth edge of the wafer edge.

The third step is the strict and meticulous grinding and polishing of the wafer. Polishing generally leads to the use of mechanochemical polishing. We are concerned about the test and analysis of grinding damage here to determine whether polishing has removed the grinding damage. The testing methods are as follows:

i. *The method of measuring diffraction intensity*

The sample to be measured is processed into a strip as shown in figure 21 (a). The new cutting surface is chemically polished to remove the surface damage, and the relative intensity of the transmitted diffraction line is measured according to the diffraction geometry shown in figure 25 (a). Because of the damage on the machined surface, the diffraction intensity distribution shown in figure 25 (b) can be obtained. when the diffraction intensity decreases to a constant value, the distance to the machined surface is the thickness of the damage layer.

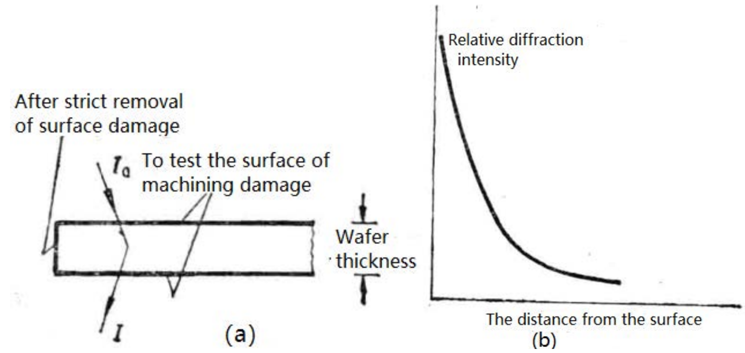

Fig. 25: Diffraction intensity method for measuring damage of silicon wafers

ii. *Take the appearance diagram of the cleavage plane*

In order to avoid the treatment of new cutting, the desired sample can be obtained by cleavage, and the projection phase diagram can be taken, which can be determined by observing the contrast change from the machined surface to the interior of the crystal.

iii. *The half width method of the double crystal swing curve*

It has known that when the dislocation density of the crystal is greater than that of $10^3/cm^2$, the half width of the double crystal swing curve increases with the increase of the dislocation density, which indicates that the half width of the double crystal swing curve is sensitive to the damage to the wafer. In one method, the half width of double crystal swing curve obtained by different processing methods of the same batch of wafers is observed for qualitative comparison; in another method, the half width of double crystal swing curve is observed after etching and delamination in different time, and the relation curve between half peak width and delamination depth (or corrosion time) is obtained. when the half peak width reaches a constant value, it is the thickness of the damage layer. Table 2. A typical measurement result is given.

Table 2: Determination of damage layer of Silicon {111} {100} Wafer cut in Grinding

	{111}wafer, (111) diffraction		{100}wafer, (400) diffraction	
	Outermost half width / second	Depth of damage layer / μm	Outermost half width / second	Depth of damage layer / μm
Cut wafer	146.6	18~20	64.4	18~26
Grinding wafer	91.2	~6	30.4	~5

VIII. Study on Oxidation Process

Oxidation is a very important process for silicon integrated devices, especially the first oxidation, which is not only a test of wafer processing quality, but also a method to explore a better oxidation process. It was the 1970s, when China was in the midst of a chaotic cultural revolution, when several of us young people carried out an exploration of silicon wafer oxidation process behind our backs. After the establishment of the oxidation stacking fault display by etching method, we began to explore the process to reduce the oxidation stacking fault. For this reason, the following comparative experiments were carried out. That is, the same polished silicon wafer is oxidized by different methods. 1) direct wet oxidation; 2) vacuum (or protective atmosphere) annealing for 0.5 hours at the same temperature, and then wet oxygen oxidation for the same time; 3) dry oxygen oxidation for half an hour and then wet oxygen oxidation. And keep the oxide thickness of the three kinds of silicon wafers roughly the same.

After the oxidation stacking fault measurement, it is concluded that the oxide stacking fault density of direct wet oxygen oxidation is the highest, followed by dry oxygen oxidation followed by wet oxygen oxidation, and the oxide stacking fault density of first annealing followed by wet oxygen oxidation is the lowest. This shows that the polishing damage of annealed wafers can be eliminated to a certain extent.

In order to confirm the nature of the oxide stacking fault, the oxide stacking fault was deliberately grown, and then studied by X-ray diffraction. The results show that the stacking fault plane is {111} plane which is inclined to the wafer, the stacking fault vector Renz1max 3 <111>, and the boundary of the stacking fault is a prismatic dislocation ring. Therefore, there are three groups of oxide faults forming 120° each other on the {111} wafer, which are respectively located on the {111} plane of 70.5° with (111), and on the second (100) wafer, there are two groups of oxide faults of 90o each other, which are respectively located on the four {111} planes of 54.5° with (100).

IX. Epitaxial Pattern Distortion [20~23]

Drum and Clark [20] found that when the orientation deviation is less than 0.5o, the epitaxial pattern of the wafer is seriously distorted and diffuse, which makes it difficult to carry out the subsequent lithography. Bean et al. [21] proposed that the deviation from 2～4° to the nearest (110) can minimize the distortion. In practice, we find that when the reference plane of the wafer is (1-10) and the wafer orientation (110) deviates from 2～4°, the lines perpendicular to the reference in the buried pattern become wider obviously. therefore, we study the relationship between the pattern micro-distortion and the deviation orientation in this deviation range.

Taking the growth edge of silicon single crystal as the reference plane (1-10), the X-ray Laue directional cutting is used to cut the wafer {100} and the nearest {110} to the wafer which deviates from 2～4°, see figure 26. according to the general bipolar circuit turn-on isolation process, the pre-epitaxial processes are completed, and the lithography patterns are arranged parallel to the reference edge and 60° with the reference edge, and then 1200 ℃.

The epitaxial growth is made, and the thickness is about 4 microns. Finally, it is observed by interference contrast microscope. The results are as follows:

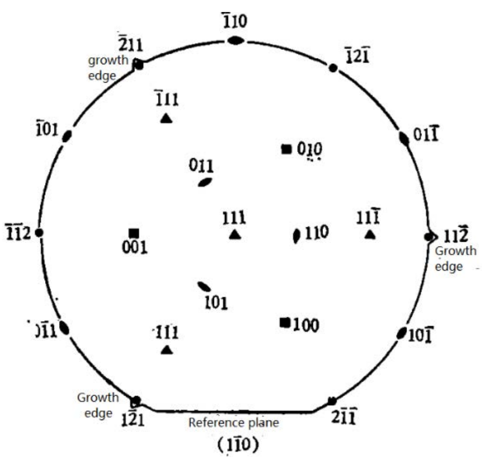

Fig. 26: A simplified stereographic projection of the orientation relationship of the wafer, and shows the reference plane and growth edge

i. *Wafers deviated from (110) and (001)*

When the figure is arranged parallel to the reference edge, the line perpendicular to the reference edge is obviously asymmetrically broadened, and its relative width reaches ～ 66%, as shown in figure 27 (a) (b). For the wafer deviated from (110), if the figure is 60o with the reference edge, the scale of the two lines perpendicular to each other is almost unchanged, only chamfering occurs at the intersection of them.

ii. *Wafer deviated from (011) or (101).*

In order to further prove the phenomenon of Cookie change of wafer patterns deviated from (110), similar experiments have been carried out on wafers deviated from (011) or (101). The results show that when the patterns are arranged parallel to the reference edges, the scales of the two lines perpendicular to each other are almost unchanged, as shown in figure 27 (b). When the figure is 60o with the reference edge, only the lines perpendicular to the projection of the normal of (011) or (101) appear broadening [23].

iii. *Wafer deviated from (100) or (010)*

When the graphics are arranged parallel to each other, the two lines perpendicular to each other are obviously narrowed, as shown in figure 27 (d).

To sum up, it can be seen that the degree of pattern distortion is closely related to the orientation of lithography steps, which may be due to the epitaxial growth of lithography steps. Two-dimensional nucleation plays an important role in lateral growth, and the anisotropy of lateral growth rate is the cause of pattern distortion.

In order to minimize the micro-distortion of the epitaxial pattern, the (111) wafer should not deviate 4° from the nearest (110) when the reference plane is. Instead, it should deviate 2 °～4° from the nearest (011) or (101), that is, not around the axis perpendicular to the reference edge (110).

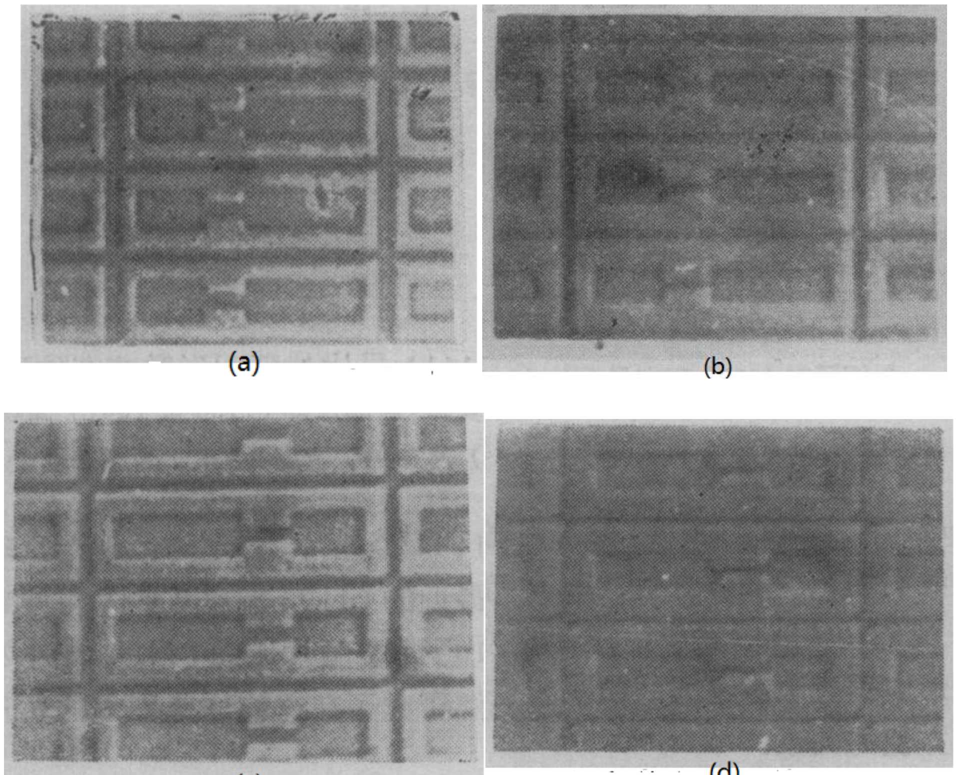

Fig. 27: Interference contrast micrograph of micro-distortion of Eagle (111) wafer during epitaxy [23], the pattern is arranged parallel to the reference edge [112]. (a) deviate from 2° to (110); (b) deviate from 4° to (100); (c) deviate from 4° to (101); (d) deviate from 4° to (010)

Deviate, but should deviate from the axis (011) or (101) of the reference edge 30°. This process has been used in the development of ECL-1K and TTL-K bipolar large-scale integrated circuits with good results.

It should be noted that the reference plane (1-10) should not be, but should be (11-2), that is, the <1-10> direction, which ensures the highest wafer yield. However, it is no problem to deviate from 2～4° to the nearest (011) or (101), or even to the nearest (110). However, the long edge of the circuit graph should be parallel to the reference edge, that is, along the [1-10] direction.

X. X-ray Topographic Observation and Study on Thermal Process Tracking of Silicon Integrated Devices

Practice has proved that a certain crystal defect and density can reduce the breakdown voltage of semiconductor devices, increase the leakage current and produce excessive noise, thus reducing the yield of semiconductor devices. Because of the non-destructive and area-reaching imaging advantages of X-ray topography method, useful results can be obtained in studying the relationship between induced defects and device yield, as well as the generation and elimination of induced defects and improving the device process. At that time, in order to take X-ray appearance pictures of large-diameter wafers, the author, in cooperation with mechanical designers, designed and manufactured a remote-controlled X-ray projection camera capable of shooting two-inch-diameter wafers, and later won the Shanghai third-class Science and Technology Progress Award.

The relationship between the induced defects and the yield can be established by taking the appearance phase diagram of the silicon after wiring and alloying and comparing the distribution of the qualified chips. Fairfied and Schwuttke [24] found that 90% of diodes have hard breakdown in dislocation-free regions and only 20% in dislocation-free regions. Authier et al. [25] found the relationship between dislocations and Zener diode failure. Jungbluth and Wang [26] found an one-to-one relationship between induced slip dislocation bands and the yield of high-power transistors. Schwuttke [27] studied the relationship between large-scale integrated circuits and slip dislocation bands, and obtained the corresponding relationship as shown in figure 28. As can be seen from the figure, the internal yield of the middle region of the wafer without slip dislocation is up to 70%, while the unqualified units are clustered in the area with high slip dislocation density, but not all the units there are bad, in which the bad devices may play the role of absorbing impurities. So that some units around it are still qualified, so there is only a statistical corresponding relationship between the induced slip dislocation and the yield. Schwuttke et al. [28] studied N-channel insulated gate field effect transistor devices by the same method and found that there is a good corresponding relationship between the leakage current distribution and the induced stacking fault density. They specify that the leakage current of qualified devices is below 1nA, and the distribution of unqualified devices due to leakage current corresponds to the area of oxide fault contrast in the X-ray topography.

The author has also carried out a "study on the X-ray appearance of device process tracking wafers", that is, each step of the thermal process in the fabrication process of large-scale integrated circuits, such as epitaxy, oxidation, diffusion, etc., carries out a completely non-destructive inspection of the wafers one by one. In this way, the generation and development process of induced defects in wafers can be observed and discovered, thus revealing the causes of induced defects. Finally, the defect distribution in the appearance phase diagram of the wafer is compared with the distribution of the yield on the wafer. Figure 28 also shows.

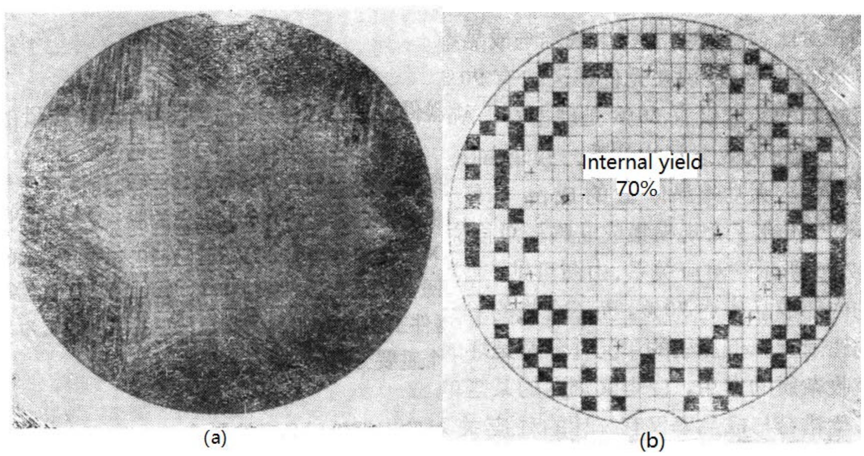

Fig. 28: The corresponding relationship between slip dislocation band and yield of large-scale integrated circuits. (a) The topography after alloying shows the origin. A strong dislocation band at the edge of the wafer; (b) the yield distribution map, and the black square is a substandard device

It is found that there is a good corresponding relationship between the distribution of finished product rate and the distribution of induced slip dislocation zone, which is consistent with the above-mentioned foreign research results.

So ask, why are there still so many qualified devices around the chip? It can be explained as follows that when the device in the slip dislocation zone with precipitated impurities is unqualified due to large leakage, while the device in the dislocation zone without precipitated impurities is qualified.

It is also found that the slip dislocation band starts from the long-range stress field at the edge of the wafer and gradually develops to the center of the wafer, and is related to the large temperature gradient in and out of the thermal process. As a result, three principles for the best thermal process are put forward: 1) after the wafer is cut and round, after the reference edge is made, the long-range stress field should be eliminated by corrosion method before polishing; 2) the wafer should be slowly into and out of the furnace; 3) the wafer should be placed vertically as far as possible in the high temperature furnace. Flatness of the wafer boat should also be paid attention to to avoid large radius wafer bending in the thermal process as far as possible.

XI. Test and Analysis of Wafer Bending in Silicon Device Process

In the thermal process of silicon devices and integrated circuits, they are generally very thin (~ 300 microns) and large diameter (2 inches or larger) wafers. Bending occurs due to different surface forces; in the high temperature cycle, due to improper placement of the wafer, such as warping of the quartz boat when the wafer is standing or flat, bending is caused by self-weight; or when the wafer comes out of the furnace, the temperature gradient difference between the edge and the center will also cause the wafer to bend; in addition, the epitaxial or diffusion layer mismatch between the substrate will also lead to wafer bending. Because the bending radius of this kind of bending is very large, many quantitative measurement methods fail, and the X-ray profile and double crystal diffractometer methods are very effective, non-contact, non-destructive, and can follow the process for quantitative analysis.

If the wafer curved crankshaft is vertical, that is, parallel to the vertical linear incident ray, then two diffractive contrast images will appear in the projection topography, as shown in figure 29(a) if the recorder is scanned synchronously with the crystal, the two

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diffraction transmission peaks are recorded, as shown in figure 29 (b) as shown, they correspond to the diffraction at A and B of the same set of crystal planes of the wafer in the incident $K_{\alpha 1}, K_{\alpha 2}$ beam, whose diffraction geometry is shown in figure 30 It is shown that the angle between the two crystal planes at A and B is 2δ, the distance is S, and their diffraction angles are θ_1 and θ_2, respectively.

$$S/2 = \rho \mathrm{Sin}\delta \tag{4}$$

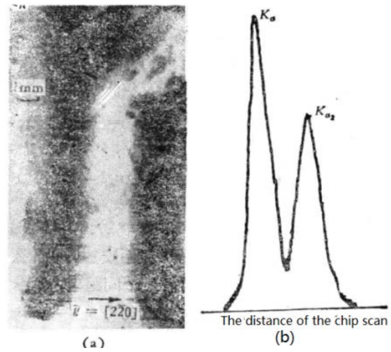
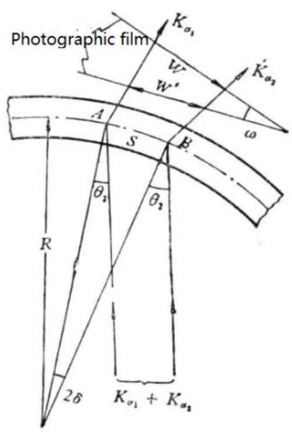


Fig. 29: The projection topography (a) of curved silicon wafers and the intensity distribution of parallel scanning of wafers (b). Both pictures show the diffraction band.

Since $2\delta = \theta_2 - \theta_1 = \Delta\theta_{2\text{-}1}$, it can be obtained from the differential Bragg formula, that is,

$$\Delta\theta_{2\text{-}1} = (\Delta\lambda/2) \tan\theta \tag{5}$$



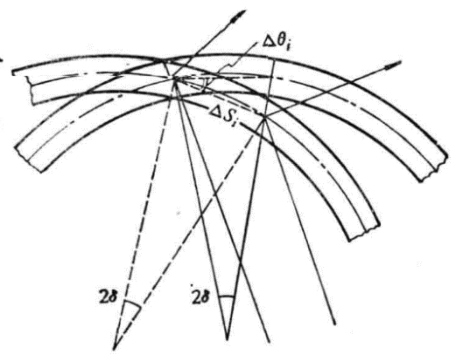


Fig. 30: Diffraction Geometry of uniaxial *Fig. 31:* The derivation of the relation of $\Delta\theta_i = 2\delta_i$ bending Wafer.

Among them, $\Delta\lambda = \lambda_{K\alpha 2} - \lambda_{K\alpha 1}$, $\lambda = (1/3) \mathrm{x} (2\lambda_{K\alpha 2} + \lambda_{K\alpha 1})$, When the photographic film is placed parallel to the surface of the wafer, then the distance between the diffraction bands of $\lambda K_{\alpha 2}$ and $\lambda K_{\alpha 1}$ is t = S, so the radius of curvature R is

$$R = t/[2\sin(\Delta\theta_{2\text{-}1})/2] \tag{6}$$

Because $\Delta\theta_{2\text{-}1}$ is very small, $\sin(\Delta\theta_{2\text{-}1}/2) = \Delta\theta_{2\text{-}1}/2$, Therefore, there are

$$R = \omega/\Delta\theta_{2\text{-}1} \tag{7}$$

Therefore, according to the time distance t between the two diffraction bands on the photographic film or the recording paper, the bending radius R can be obtained. If the negative is placed perpendicular to the diffraction line,

$$S = t/\cos\omega \tag{8}$$

Where ω is the angle of the negative on the surface of the wafer (see figure 31). For symmetrical transmission Laue geometry, ω = θ, so the formula (7) can be written as

$$R = \omega/(\Delta\theta_{2\text{-}1} \mathrm{x} \cos\theta) \tag{9}$$

In addition, the bending radius can be calculated according to the width of the diffraction band or the base width of the single diffraction peak.

$$R = L/2\varphi \tag{10}$$

Where φ is the horizontal divergence of the incident beam.

The aforementioned method either needs to take the appearance phase diagram, or record the scanning intensity curve when rotating the scanning wafer, and assume that the radius of curvature between $K\alpha_1$ and $K\alpha_2$ diffraction bands is constant, and the result is the average value in the range of inter-band distance. The author has developed a simple and convenient method for direct measurement. Its diffraction geometry is shown in figure 30. Suppose a certain scanning distance of the wafer is ΔS_i, and the corresponding diffraction angle difference is $\Delta\theta_i$. According to the derivation of figure 31, $\Delta\theta_i=2\delta_i$, the formula can be written as

$$R = \Delta S_i / \Delta\theta_i.$$

The direction of the bending of the wafer can also be observed by using the X-ray phase diagram, which is not detailed here.

XII. Study on Ion Implantation Doping of Silicon Wafer

Ion doping and impurity absorption by ion bombardment have been widely used in the manufacture of silicon devices. X-ray topography is one of the effective methods to study the injection-annealing behavior of injected atoms and damage.

Kishino and Noda [29] studied boron and phosphorus (1x10^{16} atom/cm^3) implanted into 100keV with a double crystal diffractometer. They found that the wafer bending after implantation is convex and has nothing to do with the type of implanted reason. The implanted ions are generally in the interstitial position, and the implanted wafers are annealed at different temperatures. It is found that within a certain range of problems, the bending radius and lattice parameters of the implanted boron wafers become larger, indicating that the interstitial atomic fraction of boron increases. On the other hand, the bending radius of the implanted phosphorus wafer becomes smaller and the lattice parameters become larger, which indicates that the part of the interstitial position occupied by phosphorus is smaller, and then the transition occurs. According to the change of the square resistance with the annealing temperature, the turning temperature of boron implanted is 700°C, that of phosphorus is 600°C, and the annealing below this temperature is called "reverse annealing". When annealed above this temperature, the lattice parameters of boron implanted wafers become smaller, the resistance becomes smaller, and boron occupies the substitute position. Play the role of electrical activity.

Lecrosnier et al. [30] implanted boron at the energy of 500keV and the dose of 1x1015 atom/cm^3. The distance between the main peak and the subpeak was measured by double crystal diffraction. The relationship between the diffraction intensity and half width of the main peak and the annealing temperature is shown in figure 32(a) (b). The most obvious feature is that the diffraction intensity and half width of the main peak of 500oC are close to that of the complete crystal, while the subpeak is still very sharp, indicating that the layer between the surface and the implanted layer (about 0.8um thick) is completely restored during 500°C annealing, and there is still a lattice strain in the crystal which is larger than the distance between the crystal planes of the substrate. After 600oC annealing, the double crystal layer disappears. This kind of lattice strain is released by producing secondary defects, and the half width of the matrix increases during 600°C due to the increase of dislocation density.

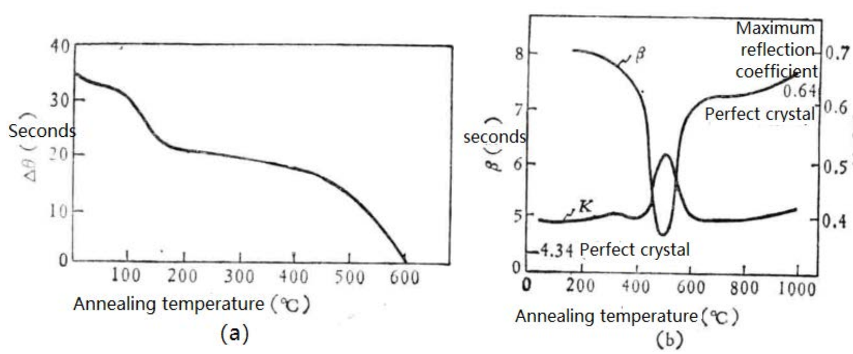


Fig. 32: The results of double crystal diffraction of ion implanted (100) silicon wafers [27].

(a) the relationship between the angular distance between the main peak and subpeak and the annealing temperature; (b) the relationship between the half width of the main peak and the maximum reflection coefficient and the annealing temperature. The unimplanted samples are 4.34 seconds and 0.64 seconds, respectively.

From the backscattering of ion implantation damage, it is found that the serious damage is not on the surface of the crystal, but at a certain depth below the surface. If the energy of implanted ions is more than 1MeV, an amorphous layer is formed at a certain depth on the wafer surface, and the crystal part containing the amorphous layer becomes a strictly parallel double wafer. When taking the appearance phase diagram of this kind of wafer, just like the highly parallel double wafer, it can produce X-ray water pattern interference fringes with visible spacing. Figure 33 A group of topography of silicon wafers bombarded by 2MeV energy N + ions are given. In the picture, we can see the three regions with different contrast shown by the symbol 1, 2, and 3, which is the result of the inhomogeneity of the ion beam. Region 1 is the un-implanted area blocked by the mask, and area 2 is the area under bombardment. Region 3 is bombarded with the highest ion density, that is, the highest dose, and obvious stripes patterns can be seen. When the Mo target is replaced by the Cu target, the reflection fringe density is higher (see figure 33 (a) the illustration on the upper right.

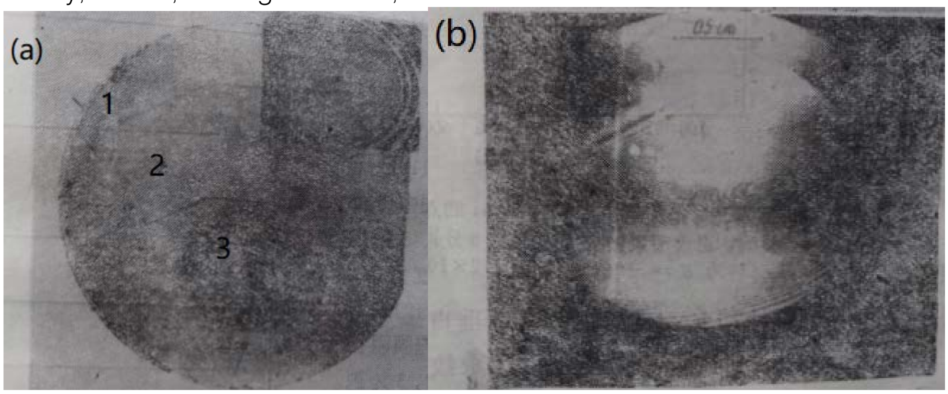


Fig. 33: X-ray topography of 2MeV N^+ ion bombardment wafer [27]. Area 1 is blocked by mask, area 2 is bombarded. (a) Mo target, 11-1 reflection transmission phase diagram, the upper right corner illustration shows Cu target radiation, 115 reflection corresponding to region 3; (b) Cu radiation of the same wafer, 333 reflection appearance diagram

The model of wafer damage after heavy ion bombardment is shown in figure As shown, it includes five areas, namely, the power of the injection layer. The school district, the sports district, the power district and the sports district in the bulk crystal, and the amorphous region surrounded by two sports districts. The dynamic region suffered only some minor injuries; the sports district contained varying degrees of severe damage, but remained single crystal. The volume of the amorphous region is 10% larger than that of the crystalline region, so the atoms move along the boundary of the region to the un-bombarded region.

This displacement |C| is schematically shown in figure 34(b) in the figure, the damage profile along the Z axis is shown by the shifted atomic concentration N_i.

(C) it can be seen that the damage changes continuously in the direction of z-axis, in the same area and from one area to another.

The amorphous region shows a maximum value.

Schwuttke et al have studied the change of the transmission phase diagram of the sample annealed after bombardment with this kind of high energy ion, and found that. The contrast of the bombardment-un-bombarded boundary changes obviously, indicating that the lattice expansion of the bombardment zone is relaxed and increases with the annealing temperature.

With the extension of the addition time, the lattice of the bombarded region continues to relax until it is stable, when the amorphous region is transformed into non-quasicrystals.

The lattice damage and recovery of the implanted samples are also confirmed in the study of low energy implanted samples.

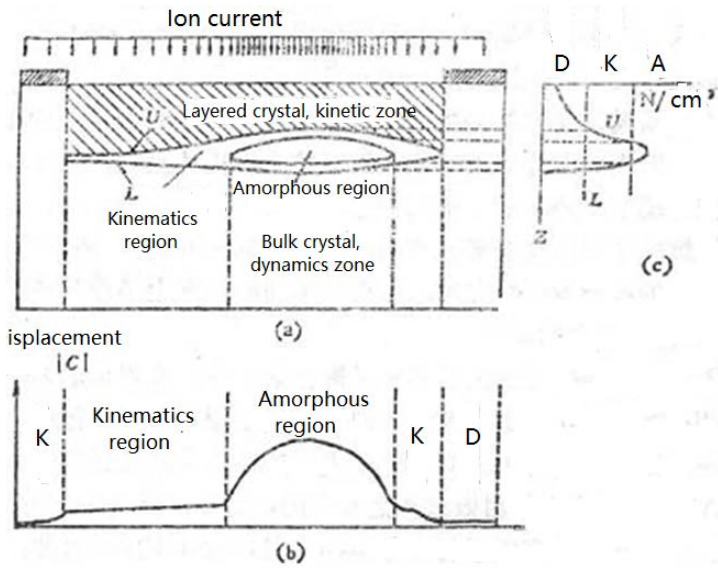


Fig. 34: Radiation damage model in silicon wafers after ion implantation.

(a) the cross section of the bombarded wafer, (b) the outline of the atomic displacement of the bombarded wafer, and (c) the degree of damage of the bombarded wafer.

D, K and A. represent separately Dynamic, Kinematics and Amorphous region

XIII. Generation and Elimination of Induced Dislocations

From the above, it can be seen that to avoid the generation of induced defects in order to establish a reasonable and optimal thermal process is an urgent problem for integrated device manufacturers to solve, and to study the generation and elimination of induced dislocations is for this purpose. The generation of induced dislocations is a very complex problem, which involves many technological factors. We synthesize the existing research results according to the stress-strain point of view.

a) Introducing dislocations by internal stress

When the device is fabricated, the lattice parameters of the diffusion layer are different from the matrix, and there is a mismatch stress due to the lattice mismatch. When the internal stress reaches a certain value, the mismatch dislocation will be introduced. To parameter mismatch dislocations a minimum diffuser concentration Q_{min} is necessary. Q_{min}1.13CsDt where the C_s, D, t is the surface concentration, diffusion coefficient and diffusion time, respectively. For phosphorus in silicon, the lowest concentration is Cs $\approx 5 \times 10^{20} \times$ cm^3, while that of boron is 1×10^{20}/cm^3. Dislocations are introduced beyond this concentration, and an example is shown in figure 35.

In order to overcome the introduction of dislocation caused by mismatch stress, Yeh [38] proposed a method of stress compensation, that is, when diffusing P, B, Sn is diffused at the same time. The effective method to study the diffusion stress and stress compensation is to observe the swing curve of double crystal diffraction and satellite reflection.

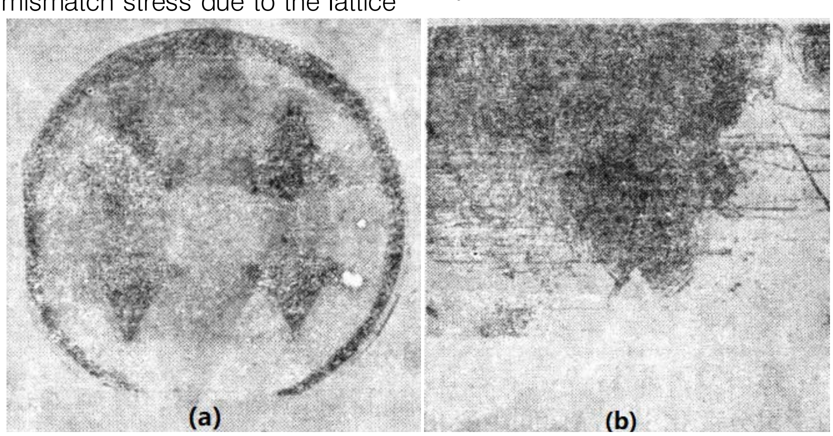


Fig. 35: Shows the X-ray topographies of the dislocation introduced by the edge of the diffusion zone

Mismatch dislocations will also be introduced between the epitaxial layer and the substrate due to lattice mismatch. Sugita and Tamura [39] X-ray double crystal diffractometer using B-doped substrate P-P^{+} epitaxial growth found that the mismatch dislocation is also related to the resistivity of the substrate. The dislocation caused by the mismatch between the epitaxial layer and the substrate is particularly prominent in the heteroepitaxy of compound semiconductors.

b) Introducing dislocations by external stress

The external stress that can introduce dislocations into the high temperature process of silicon integrated devices includes mechanical damage, such as heavy scratches, etching marks and gaps on the edge of the wafer, cracks, damage of the reference edge, excessive temperature gradient or thermal stress caused by rapid cooling and heating, etc.

i. Dislocation caused by mechanical damage

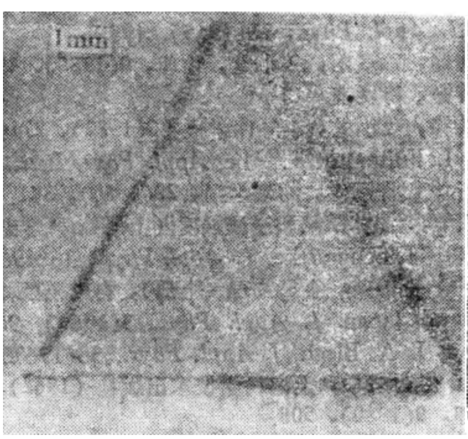
At a certain temperature, if the stress of mechanical damage exceeds the yield limit of silicon single crystal at this temperature, slip dislocation will be introduced. Obviously, whether mechanical damage can produce dislocation is related to the degree of mechanical damage, the temperature of treatment and whether there is a temperature gradient. Figure 36.

In the case of the dislocation introduced by the "△" mark after 6 hours of 1200°C treatment, it can be seen that the lighter scratches hardly introduce dislocations, while the heavy and thick scratches produce a large number of dislocations.

Figure 37 shows the dislocation at the crack tip at the edge of the silicon wafer. This induced dislocation will also be added and extended in the following high temperature cycle. It can be seen that the mechanical damage such as edge collapse and notch at the edge of the wafer is the potential source of dislocation, so these damages should be avoided as far as possible.

ii. Dislocation is introduced by wafer bending

Wafer bending will directly affect the alignment of lithography patterns, and dislocations will be introduced in the following high temperature cycle. Huff et al. [40] found that if there is warping of dozens of μ m caused by machining in 50mm wafers, it is sufficient to produce dislocations in 1200°C. If the curved substrate is concave on one side of the epitaxial growth, only the center is at high temperature, so there is compressive stress, resulting in a large number of dislocations due to normal deformation near the center of the wafer [41]. If the local bending of the wafer is large enough (the radius of curvature is small enough), a large number of dislocations can be introduced due to multilateralization during annealing.



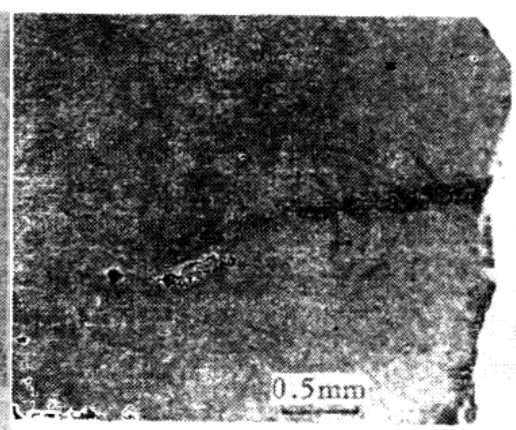


Fig. 36: Transmission topography of silicon wafer. There are Fig. 37 shows the X-ray topography scratches on the back of the wafer. After 1200°C annealing of edge cracks and dislocation for 6 hours, there are a large number of induced dislocations increment in silicon wafers, MoKα radiation. (2-20) reflection. MoKα radiation, (2-20) reflection

iii. Dislocation is introduced by thermal stress

In the fabrication of silicon devices, dislocations will be introduced due to thermal stress. Figure 38 shows the phase diagram of the two wafers in 20 seconds (a) and 5 minutes (b). It can be seen that the introduction of the former from the edge of the wafer is much more serious. In order to restrain the completion of thermal stress introduction, special attention should be paid to the heating and cooling rate higher than that of 900oC. Hear et al. [42] used capped quartz boat and further improved quartz boat to achieve good results.

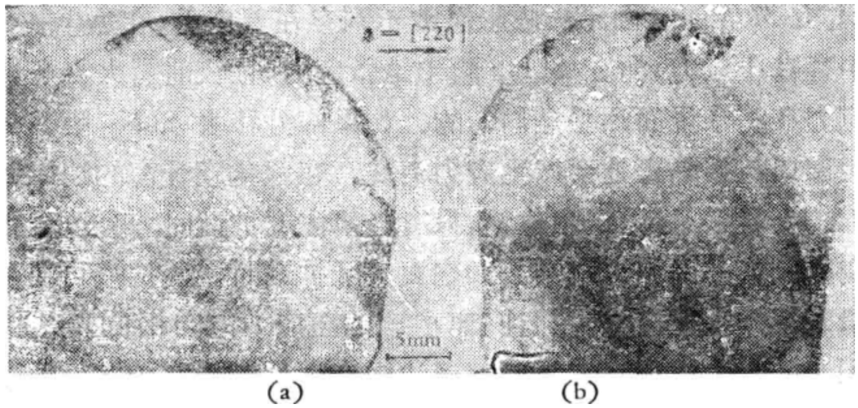


Fig. 38: Effect of wafer speed on induced dislocations. (a) in and out of the furnace within 20 seconds. (b) 5 minutes into the oven and 10 minutes out of the oven

iv. *Introducing dislocations by stress abrupt change*

After oxidation or nitriding, there is stress on the interface of SiO_2-Si, Si_3N_4-Si due to the difference of thermal expansion coefficient. There is a compressive stress in the thermally grown SiO_2 film and a tensile stress in the Si_3N_4 film, which is much larger than the former, and the stress is almost uniform at the whole interface. If the Si_3N_4 film is partially removed, abrupt stress changes will occur in places such as diffusion windows, cracks, etc. There is elastic distortion at the edge of the oxide film window, but it is not enough to produce dislocations. Only when there is a high concentration of diffusion will the state of the image distortion region be changed and dislocations will be introduced. For example, when diffusing in the emitter region, phosphorus diffusion can produce compressive stress near the edge of the window, and the compressive stress direction of the SiO_2 film is the same. The stress mutation caused by this strain can produce dislocations at the edge of the diffusion window, which is called emitter edge (EE) dislocation. This EE dislocation has an obvious effect on the gain β of the device. Schwuttke and Fairfield [43] have observed that dislocations occur under the edge of the oxide window after boron diffusion and extend from the diffusion zone to the non-diffusion zone. As shown in figure 35.

XIV. The Summary

The above 13 sections are the contents and results of modern test analysis and research of silicon materials in integrated device engineering. Let's sum it up.

(1) *The purity of polycrystalline silicon*, the raw material for growing silicon, must reach the semiconductor level, and in modern terms, it is necessary to meet the requirement of 11N, that is, 11 9s, that is to say, 9 9s after 99%.

(2) Because {111} or {100} wafers are often used in silicon integrated devices, especially large-scale integrated circuits or ultra-large-scale integrated circuits, single crystals with <111> or <100> orientation are required. Single crystals with this orientation must be prepared by Czochralski or floating zone method. The process of growing this oriented silicon single crystal is complex and fastidious. The process and crystal defects are discussed in sections 3 and 4. But the question of resistivity is involved.

Most of the high-purity polysilicon materials are neutral and fail to reflect N-type or P-type. However, single crystals must be N-type or P-type, and require a certain resistivity. It is necessary to doping the fused polysilicon (N-type or P-type) when preparing the single crystal, and control the doping concentration to make the finished single crystal achieve the required resistivity.

(3) *The preparation stage of the wafer*

In the development (production) unit of integrated devices, the required silicon single crystals are generally segments, and the silicon single crystals grown by Czochralski and floating zone methods are cylindrical in shape. the growth edges of the cylinder surface are symmetrically distributed three times (<111> orientation) and four times (<100> orientation).

➢ *Preparation of rolling circle and reference plane*

Previously, the circle has been discarded, because the circle will cause damage to the crystal surface. Cutting the wafer with this round crystal will inevitably leave damage around the wafer, and this mechanical damage will become the source of slip dislocation in the subsequent thermal process. Now the first step is to make the reference plane (edge). For <100> oriented crystals, the reference plane should be parallel to the line of diagonal growth edges, while for <111> oriented crystals, the reference plane should be parallel to the line of two growth edges. It is generally prepared by mechanical grinding. It is worth noting that after the reference surface is prepared, chemical methods are used to corrode the grinding surface to minimize mechanical damage.

- *Directional cutting*

Generally, optical orientations are used to observe the appearance of third (or fourth) symmetrical reflectors.

Fine adjustment of the crystal is the best image symmetry, which can be mechanically cut, so that it can meet the process requirements in general. However, for the {111} wafers to be epitaxially grown, the accurate {111} is not needed, which causes a deviation of 2~ 4° degrees from the nearest <110>. At this time, after obtaining the best cubic symmetrical light emission image, if the spot is directly above the observation screen, the crystal should be tilted upward by 2~ 4° degrees; if the best cubic symmetrical spot is directly below the observation screen, it should be bent down by 2~4 ° degrees. There's nothing wrong with it.

- *Grinding and polishing of wafers*

Generally, it should be ground on both sides, preferably mechanochemical grinding, to reduce cutting damage. One-sided mechanochemical polishing can not only meet the requirements of wafer surface flatness and finish, but also minimize grinding damage.

(4) *Enter the thermal process*

- The first thermal process is generally oxidation. It is suggested that wet oxygen oxidation should not be carried out directly, but should be annealed for 30 minutes and then with wet oxygen in order to reduce the occurrence of oxidation stacking faults. Similarly, if the first thermal process is epitaxial, the wafer should be annealed for a certain period of time before epitaxial growth, in order to reduce epitaxial growth stacking faults.
- In the first lithography, it is necessary to pay special attention to the long edge of the chip diagram and the reference edge of the chip, so as to ensure the highest yield at the end of the chip.

(5) *The best thermal process*

In this chapter, we spend a lot of space to study the law of induced defects, and we know that they are all related to the mechanical damage and thermal process around the surface of the wafer. Therefore, it is summarized as "the best hot process":

- In the process of wafer preparation, such as the preparation, cutting, grinding and polishing of the reference surface, we should try our best to reduce the mechanical damage around and on the surface of the wafer.
- In and out of the high temperature furnace must be slow to reduce the thermal stress caused by thermal shock. Never fast in and out.
- The quartz boat where the wafer is placed must be flat, and the wafer cannot be placed vertically or tilted to avoid bending or warping of the wafer at high temperature. It is best to put a lid on the quartz boat after placing the chip.

(6) *Chip segmentation*

Because the cleavage plane of the silicon crystal is {111}, there are strict requirements for the arrangement of the chip pattern, so a reference edge is made on the wafer, which is the intersection of the inclined {111} plane and the wafer surface. Therefore, the long edge of the chip pattern should be parallel to the reference edge. After the completion of the planar process of chip fabrication, the process of chip segmentation should be carried out sequentially. For the {100} wafer, as long as the direction of the blade is parallel to the reference edge, both directions can be split along the cleavage plane, while for the {111} wafer, the first knife must be parallel to the reference edge, and after the scribing in this direction is completed, then make a vertical scribing. The direction of rolling the wafer must be perpendicular to the reference edge so that the chip can split along the {111} cleavage plane, but the direction perpendicular to the reference edge is not split.

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Alternatively, you can download our basic template from https://globaljournals.org/Template.zip

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Unless specified in the notification, the Editorial Board's decision on publication of the paper is final and cannot be appealed before making the major change in the manuscript.

Acknowledgments

Contributors to the research other than authors credited should be mentioned in Acknowledgments. The source of funding for the research can be included. Suppliers of resources may be mentioned along with their addresses.

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The following is the official style and template developed for publication of a research paper. Authors are not required to follow this style during the submission of the paper. It is just for reference purposes.

Manuscript Style Instruction (Optional)

- Microsoft Word Document Setting Instructions.
- Font type of all text should be Swis721 Lt BT.
- Page size: 8.27" x 11'", left margin: 0.65, right margin: 0.65, bottom margin: 0.75.
- Paper title should be in one column of font size 24.
- Author name in font size of 11 in one column.
- Abstract: font size 9 with the word "Abstract" in bold italics.
- Main text: font size 10 with two justified columns.
- Two columns with equal column width of 3.38 and spacing of 0.2.
- First character must be three lines drop-capped.
- The paragraph before spacing of 1 pt and after of 0 pt.
- Line spacing of 1 pt.
- Large images must be in one column.
- The names of first main headings (Heading 1) must be in Roman font, capital letters, and font size of 10.
- The names of second main headings (Heading 2) must not include numbers and must be in italics with a font size of 10.

Structure and Format of Manuscript

The recommended size of an original research paper is under 15,000 words and review papers under 7,000 words. Research articles should be less than 10,000 words. Research papers are usually longer than review papers. Review papers are reports of significant research (typically less than 7,000 words, including tables, figures, and references)

A research paper must include:

a) A title which should be relevant to the theme of the paper.
b) A summary, known as an abstract (less than 150 words), containing the major results and conclusions.
c) Up to 10 keywords that precisely identify the paper's subject, purpose, and focus.
d) An introduction, giving fundamental background objectives.
e) Resources and techniques with sufficient complete experimental details (wherever possible by reference) to permit repetition, sources of information must be given, and numerical methods must be specified by reference.
f) Results which should be presented concisely by well-designed tables and figures.
g) Suitable statistical data should also be given.
h) All data must have been gathered with attention to numerical detail in the planning stage.

Design has been recognized to be essential to experiments for a considerable time, and the editor has decided that any paper that appears not to have adequate numerical treatments of the data will be returned unrefereed.

i) Discussion should cover implications and consequences and not just recapitulate the results; conclusions should also be summarized.
j) There should be brief acknowledgments.
k) There ought to be references in the conventional format. Global Journals recommends APA format.

Authors should carefully consider the preparation of papers to ensure that they communicate effectively. Papers are much more likely to be accepted if they are carefully designed and laid out, contain few or no errors, are summarizing, and follow instructions. They will also be published with much fewer delays than those that require much technical and editorial correction.

The Editorial Board reserves the right to make literary corrections and suggestions to improve brevity.

Format Structure

It is necessary that authors take care in submitting a manuscript that is written in simple language and adheres to published guidelines.

All manuscripts submitted to Global Journals should include:

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The title page must carry an informative title that reflects the content, a running title (less than 45 characters together with spaces), names of the authors and co-authors, and the place(s) where the work was carried out.

Author details

The full postal address of any related author(s) must be specified.

Abstract

The abstract is the foundation of the research paper. It should be clear and concise and must contain the objective of the paper and inferences drawn. It is advised to not include big mathematical equations or complicated jargon.

Many researchers searching for information online will use search engines such as Google, Yahoo or others. By optimizing your paper for search engines, you will amplify the chance of someone finding it. In turn, this will make it more likely to be viewed and cited in further works. Global Journals has compiled these guidelines to facilitate you to maximize the web-friendliness of the most public part of your paper.

Keywords

A major lynchpin of research work for the writing of research papers is the keyword search, which one will employ to find both library and internet resources. Up to eleven keywords or very brief phrases have to be given to help data retrieval, mining, and indexing.

One must be persistent and creative in using keywords. An effective keyword search requires a strategy: planning of a list of possible keywords and phrases to try.

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).

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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.

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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:

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- 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.

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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.

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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.

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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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