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Global Journal of Science Frontier Research: A

Physics and Space Science

Physics of the Universe (1)

Hydrodynamics of Underwater

Highlights

Underwater Physical Explosion

Interaction of Electromagnetic Wave

Discovering Thoughts, Inventing Future

VOLUME 20 ISSUE 12 VERSION 1.0

Global Journal of Science Frontier Research: A
Physics & Space Science

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Physics of the Universe(1)

By Prince Jessii

Abstract- The Physics of the Universe series emerges from the discovery of the Grand Unification Theory (Theory of Everything). It starts from (1) and counting. The last revolution of physics begins from this paper (1). See Introduction for more details.

[La serie Physics of the Universe emerge dalla scoperta della Teoria della Grande Unificazione (Teoria del Tutto). Inizia da (1) e conta. L'ultima rivoluzione della fisicainizia da questo articolo (1). Vedere Introduzione per maggiori dettagli.]

Keywords: universe; space-time; dark energy; energy; matter; physics.

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PHYSICSOFTHEUNIVERSE1

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[La série Physique de l'Univers émerge de la découverte de la Théorie de la Grande Unification (Théorie du Tout). Il commence à partir de (1) et compte. La dernière révolution de la physique commence à partir de cet article (1). Voir Introduction pour plus de details.]

[Die Reihe "Physik des Universums" gehtaus der Entdeckung der Theorie der großen Vereinigung (Theorie von allem) hervor. Es beginntbei (1) und zählt. Die letzte Revolution der Physik beginnt mit dieser Arbeit (1). Weitere Informationen finden Sie in der Einführung.]

[Universets fysikserie framgår av upptäckten av Grand Unification Theory (Theory of Everything). Detbörjarfrån (1) ochräknar. Den sista fysikrevolutionen börjar från denna uppsats (1). Se Introduktion förmer information.]

[宇宙物理學系列是從大統一理論（萬物理論）的發現中產生的。它從（1）開始計數。物理學的最後一場革命從本文開始（1）。有關更多詳細信息，請參見簡介]

Keywords: universe; space-time; dark energy; energy; matter; physics.

I. Introduction

Imagine a scenario where a guide or handbook of this Universe was given as the first human was born into the world, or before the subject "Physics" existed; it would have changed the way physics was/is being studied or presented. That Scenario didn't happen, instead humans had to figure things out and studied physics from one discovery to another without initially knowing anything about the Universe.

Now, we've come this far and the major pillars of physics are unified to give us an understanding of our universe but the job hasn't yet been completed. It's true that brilliant minds in physics existed and they presented theories backed up with experiments and observations. However, there is need to go back to the root of physics and move through once again to this present point but this time we do it while having the handbook of this universe in our hands, the result will be a very unique and different physics that'll also involve the dark dimension. This is the last revolution of physics and I'll take the responsibility of doing that, contributions from other scientists/physicists are very welcomed. I begin from this chapter (1) – Physics of the Universe.

Note; if you're reading this paper and you've not read and understood the "Theory of Everything"[3], this paper might appear strange to you. Go to princejessii.academia.edu to download any of my papers free.

I proceed. The result of the Grand Unification Theory [3] is generally represented with an equation;

The Universe $(P_c) = Sc^2h/k$

The equation Sc^2h/k has several meanings. I presented the first meaning in my previous paper and this is the general meaning;

Do you know that; there is an original version of the universe where the dark entities (dark energy and dark matter) would be visible to our eyes. If that happens, the equation Sc^2h/k will completely change, that's what P_o represent. For the sake of your understanding, I'll bring back its derivation from [3].

a) Equation Derivation for Unification

First Equation Derivation;

$$(\text{Superior Light})/(\text{Inferior Light}) = P_c \quad \text{....(1)}$$

$$(\text{Dark Energy})/(\text{Energy}) = P_c \quad \text{....(2)}$$

$$(S \times c)/(k/hc) = P_c \quad \text{....(3)}$$

$$(S \times c^2 \times h)/(k) = P_c \quad \text{....(4)}$$

$$Sc^2h/k = P_c \quad \text{.... (5)}$$

The above equation (5) will have a duplicate which will represent the merging of both light dimensions. Merging means that energy will become the form/value of dark energy i.e. energy photons will change to dark energy photons.

Second Equation Derivation (Energy becomes Dark Energy);

$$(\text{Superior Light})/(\text{Inferior Light} \times 100) = P_o \quad \text{....(6)}$$

$$(\text{Dark Energy})/(\text{Energy} \times 100) = P_o \quad \text{....(7)}$$

$$(S \times c)/(k/hc \times 100) = P_o \quad \text{....(8)}$$

$$(S \times c^2 \times h)/(k \times 100) = P_o \quad \text{....(9)}$$

$$Sc^2h/k \times 100 = P_o \quad \text{....(10)}$$

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b) *Mathematical Test*

We have two equations;

1.) $Sc^2h/k = P_c$

2.) $Sc^2h/(k \times 100) = P_o$

Test with the first equation;

$$Sc^2h/k = P_c$$

Inserting Parameters

$$[(1.50 \text{ x } 10^{10}) \times (3 \text{ x } 10^8)^2 \text{ x } (6.6 \text{ x } 10^{-16})]/ (8.9 \text{ x } 10^9) = P_c$$

$$P_c = 100.$$

Test with the second equation;

$$Sc^2h/(k \times 100) = P_o$$

Inserting Parameters

$$[1.50 \text{ x } 10^{10} \times (3 \text{ x } 10^8)^2 \text{x } (6.6 \text{ x } 10^{-16})]/[(8.9 \text{ x } 10^9) \text{ x } (100)] = P_o$$

$$P_o = 1.$$

From the test, it is seen that P_o and P_c are constants as 1 and 100 respectively. When both light dimensions merge, they become one as the value (1) - P_o which is the original value of the universe signifying unity but presently, both light dimensions are not merged and differ by 100 as P_c (current value)

The dark entities (dark energy and dark matter) are superior to energy and matter. Dark energy and dark matter cannot become (merge) energy and matter, rather it's the other way; energy and matter can become dark energy and dark matter. The original version of the Universe is with the dark entities (dark energy and dark matter) visible, this means that energy and matter will exist (merge) as the form of dark energy and dark matter. However, the present version of the Universe is with energy and matter visible and the dark entities invisible. This whole explanation implies that; the dark entities are superior and are supposed to be the only entities existing as the inferior entities will take its form.

From the above calculation; although P_o as 1 from the second derivation implies that energy and matter are now merged with the dark entities, when this happens, the equation will flip its form/face representing the fact that energy and matter will no more exist. Its flipped face will be;

$$P_o = Sc /(M_d \text{ x } c^2)\text{…….…………}(11)$$

Inserting parameters;

$$1.50 \text{ x } 10^{10} \text{ x } (3 \text{ x } 10^8)/ (50 \text{ x } [3 \text{ x } 10^8]^2) = 1$$

$$P_o = 1$$

Can you see the difference as explained? With equation 10 and 11, P_o first face is the mathematical merging of energy and matter with the dark entities but when energy and matter becomes the form of the dark entities, energy and matter will no longer exist, they'll exist as dark energy and dark matter. Therefore, equation (10) as P_o will flip its face to equation (11). If you check, you can't get matter and energy from the breakdown of equation (11), but you can get dark energy and dark matter from the breakdown of equation 10. I hope you understand. Thus, there are two versions of this universe;

Stable Universe: Dark energy and Dark Matter are visible i.e. all matter and energy are merged with the existing dark energy and dark matter.

$$P_o = Sc /(M_dc^2)$$

Unstable universe: Energy and Matter are visible, dark energy and dark matter are invisible. Both light dimensions not merged.

$$P_c = Sc^2h/k$$

See section V for more explanation.

The major discovery that led to the Unification is all about space-time, It has has different natures, It is originally a very thick entity but can change as a reduction of its thickness.

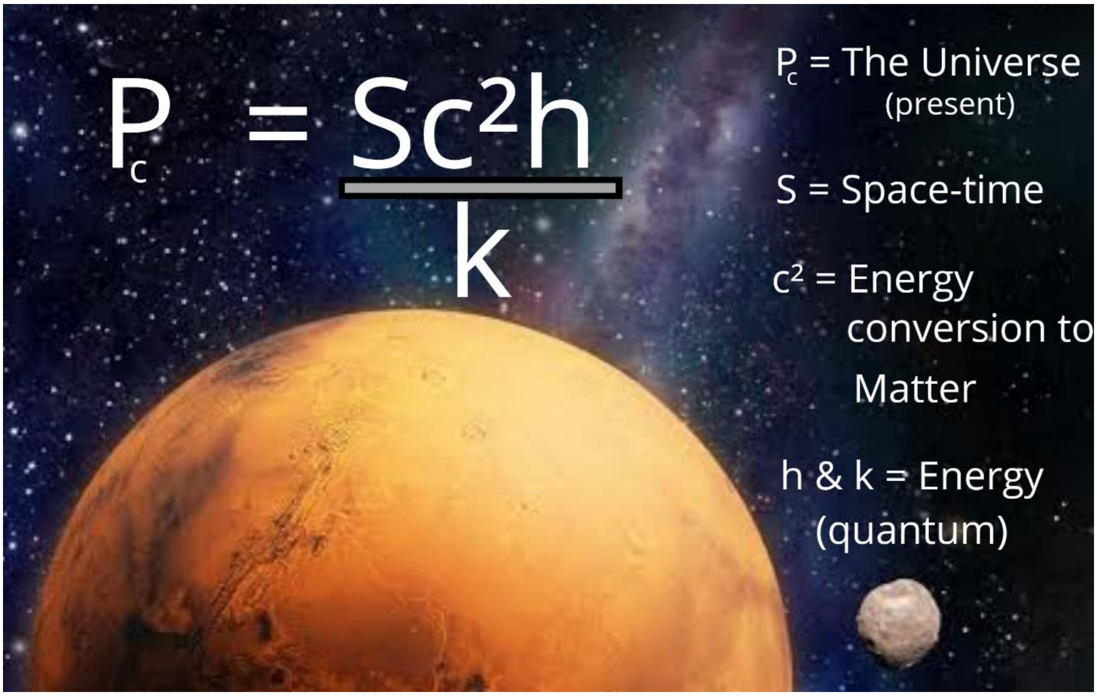

Figure 1

Now, the general meaning of the equation $P_c = Sc^2h/k$ is; When studying Physics which is the science of the interactions of matter/energy in space-time (figure 1), we should study the universe (physics) with the different natures of space-time and acknowledge the importance of space-time (S) in the Universe because space-time was being neglected and regarded as nothing at the early stage of physics, whereas it is the most important entity in the Universe.

Studying the interactions of matter/energy in different natures of space-time and acknowledging the importance of space-time is exactly what the series – Physics of the Universe is all about.

In the physics of the Universe, I move through physics (from the root) while identifying the different natures of space-time and to check for new developments that might arise due to the discovery of the Grand Unification Theory.

II. Foundation

How the universe was formed is now an old story [3] and [5] (Figure 2 and 3). Once again, presenting the entities that formed the universe.

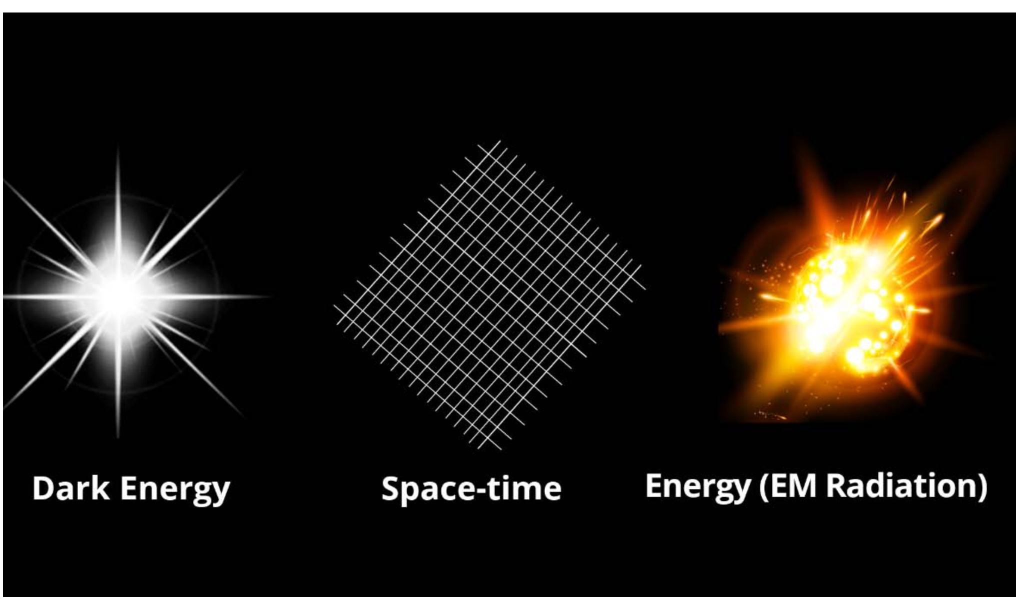

Figure 2

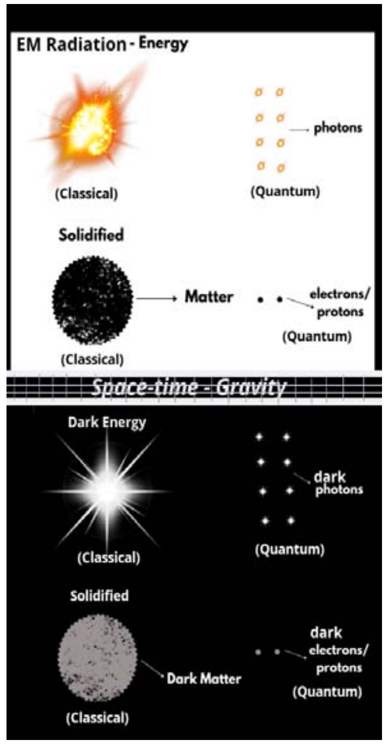

Figure 3

In this revolution, there's only one entity that's of great interest and that's space-time. The equation $P_c = Sc^2h/k$ simply defines physics as the science of matter and energy, its motion/interaction and behavior through space-time.

This new development/revolution is straight and simple. Nothing is changing, rather there are additional developments. All our lives, we studied physics without emphasis on the nature of space-time as to which a certain matter interacts in.

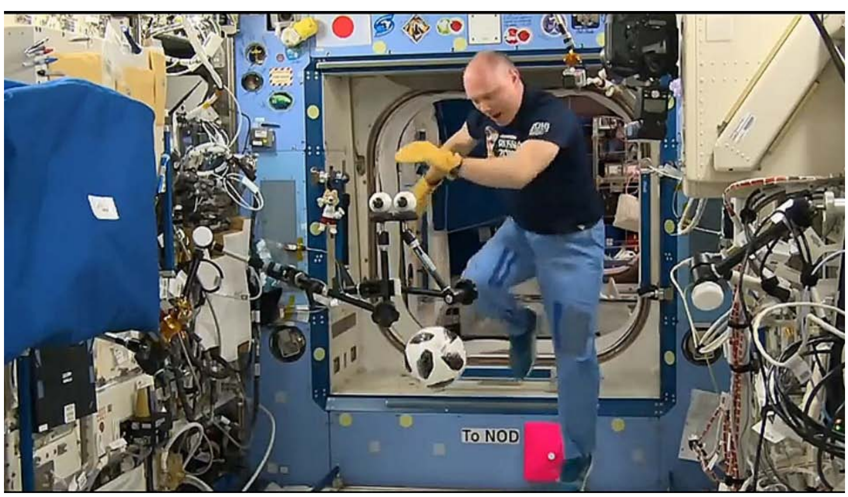

Figure 4

If you're reading this paper, you might have watched some videos of astronauts on the International Space Station (ISS). When you watch videos of ISS, you see how objects move and you also notice that their movements is not the same as being on earth. Yes, the previous understanding before the discovery of the Grand Unification Theory is that; it is due to low gravity/gravitational effect in that area. However, I made it clear that the extent of gravity/gravitational effect in an area will determine the nature of space-time in that area. Thus, if there is no gravity in an area, expect the nature of space-time in that area to be thick, objects will float. If there's little gravity/gravitational effect in an area, expect the space-time of that area to be still thick but not as thick as where there is no gravitational effect. The reduction of the thickness of space-time is by the increase in gravitational effect. Now, in a place like earth where there is a high gravitational effect, the nature of space-time will be free, and so on. In my previous paper [3], I presented how the different natures of space-time are formed. See section VI for more info.

Now, imagine a scenario where you migrate from earth to ISS and you kick a ball on ISS, in your mind you intend to apply much force to enable the ball to go far but this is the result; The force will be applied to the ball through the leg to kick the ball. A restriction comes in due to the thickness of space-time around you resulting into not kicking the ball with the force you intend to apply. Now, the force is eventually applied to the ball but once again the restriction comes in this time on the ball and the mass (ball) doesn't move far as required. If you take the mass of the ball and its acceleration, you'll get the force that was applied on the ball, but do you know?

> "If you apply that same force on the same ball with the same mass on earth, the ball will accelerate fast and cover more distance than on ISS".

This is part of the new development/revolution that the Physics of the Universe presents. The fact that we have values that represent a space-time in an area means that we can calculate how matter interacts in a different environment of space-time, using earth as a reference point.

III. Units and Measurements

Measurement is a very vital aspect of Physics and other sciences. No fact or theory in science is accepted unless it can be exactly measured and quantified. There's a new development which I'll present.

The three most important basic quantities in physics are length, mass and time and these are their definition.

Length is defined as the extent of distance in space-time.

Mass is defined as a quantity of matter resting on space-time.

Time is the indefinite continued and irreversible progress of events that occur in space, now known as space-time.

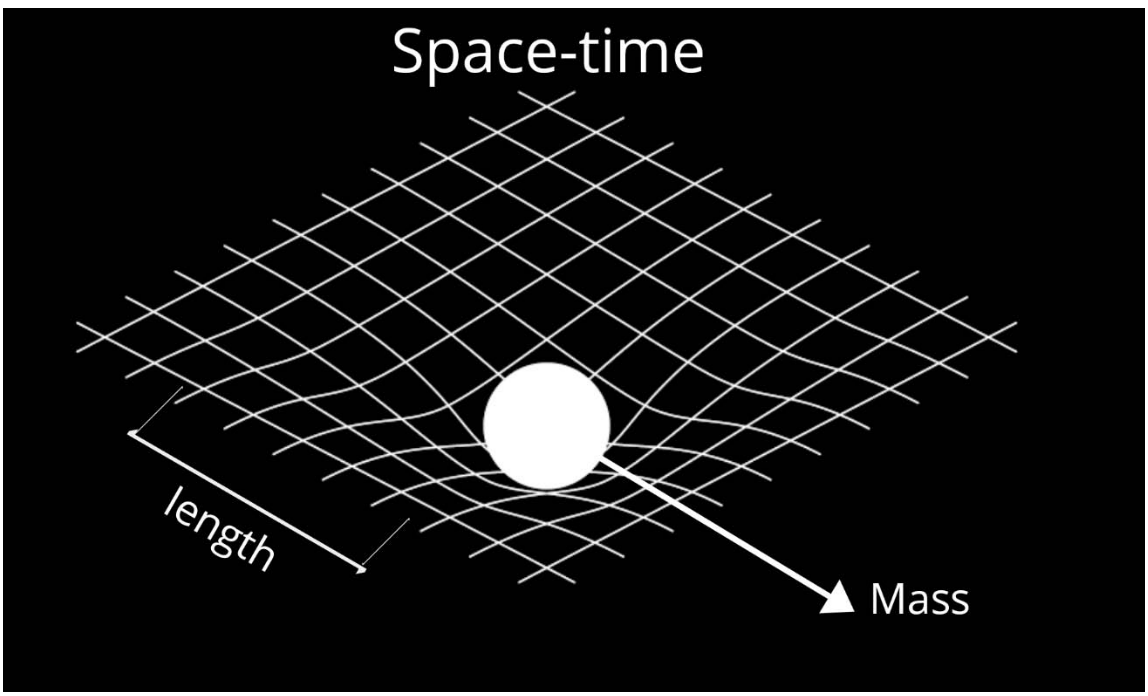

Figure 5

Look closely, there's something common between these three basic quantities and that's space-time (Figure 5).

[New Development]

Space-time is an ultimate entity, it has a light attached to it (dark-energy), its light can also be solidified (dark-matter), and space-time is where gravity emerges from.

Now, from my previous paper, I said that the constants (S, G, c, E_d, M_d) are ultimate constants, I take that back because of a clear fact; accessing Sc^2h/k and $Sc\ /M_dc^2$. It is seen that S and c are present in both equations of the Universe. This implies that S and c are the Ultimate constants while (G, E_d, M_d) are sub-ultimate constants. This is the reason;

Ultimate Constants: These are constants that represent in both versions of the Universe (S,c)

Sub-Ultimate Constants: These are constants that can be gotten directly from one ultimate constant or the combination of both.

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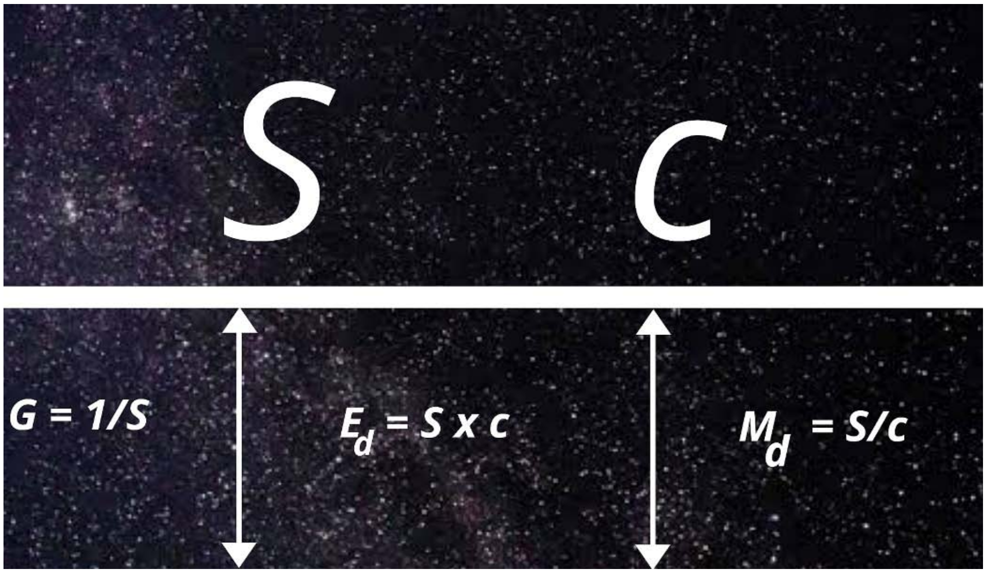

Figure 6

From figure 6, we can see clearly how the sub-ultimate constants are gotten. However, not the constants this time, when describing an ultimate entity, we say that space-time is an ultimate entity and light in general (energy or dark energy) represented by its speed (c) is also an ultimate entity.

Therefore;

	Ultimate Entity	Ultimate Constant
1	Space-time	S
2	Light	c
	Sub-Ultimate Entity	**Sub-Ultimate constant**
1	Gravity	G
2	Dark- Energy	E_d
3	Dark-Matter	M_d

The reason why I had to split into ultimate and Sub-Ultimate is to help in a better understanding of the new developments throughout this journey.

As you know, the fundamental and derived quantities/units remains the same alongside the fundamental constants (figure 7 and 8).

Fundamental Quantities

No.	Quantities	unit
1.	Length	meter [m]
2.	Mass	kilogram [kg]
3.	Time	second [s]
4.	Electric current	ampere [A]
5.	Temperature	kelvin [K]
6.	Amount of substance	mole [mol]
7.	Luminous intensity	candela { cd }

Figure 7

Derived quantity	Symbol	Formula	Derived Unit
Area	A	$length \times length$	m^2
Volume	V	$length \times length \times length$	m^3
Density	ρ	$\frac{mass}{volume}$	kgm^{-3}
Speed	v	$\frac{length}{time}$	ms^{-1}
Acceleration	a	$acceleration = \frac{change\ in\ velocity}{time\ taken}$	ms^{-2}
Force	F	$Force = mass \times acceleration$	$kgms^{-2}$ or $newton(N)$
Pressure	P	$pressure = \frac{force}{area}$	Nm^{-2} or Pascal (Pa)
Work	W	$work = force \times displacement$	Nm or joule (J)
Power	P	$power = \frac{work}{time}$	Js^{-1} or $watt(W)$
Electric charge	Q	$charge = current \times time$	Coulomb (C)
Voltage	V	$voltage = \frac{work}{charge}$	Volt (V)
Capacitance	C	$capacitance = \frac{charge}{volt}$	Farad (F)

Figure 8

Among the fundamental and derived quantities, the quantity that is of great interest is time, due to its direct involvement with space.

[New Development]

Time is an important quantity in this new revolution. In fact, time is the major reason I had to go back to the root of Physics. Time is the indefinite continued and irreversible progress (seconds to seconds) that occur in space, now known as space-time. There are differences between natures of space-time which causes differences in time between these different natures of space-time.

Using the explanation of kicking a ball on ISS, some might think that the nature of space-time directly affects the interaction by the person or the ball but this is the explanation;

I'll split space and time just for this explanation.

Space directly affects time, this is why physics combine both as space-time. Therefore, the slightly thick nature of space on ISS which produces the restriction to cause the ball to not move as required, doesn't directly affect the ball. This is what happens; the thick nature of the space on ISS offers a restriction, its aim is to reduce the time it'll take for the ball to interact than in other free natures of space-time. As an attempt to reduce the time, it affects the motion of the ball which involves its acceleration, velocity etc. Same with the leg which applies the force, the thick space aim is to reduce the time it'll take for the leg to interact with the ball. As an attempt to reduce the time, it affects the motion of the leg which will lead to a lower force applied.

Thus, space directly affects time (space-time) and indirectly affects "what time affects". Time affects the condition of matter and the interactions (motion). This is why I had to present the fundamental and derived quantity table; when I say "what time affects", I mean this way;

You can know what time affects i.e. what space indirectly affects by the derived quantities. Any derived quantity that includes time in its expression/formula is "what time affects". For example;

Velocity is displacement/time. Check, time affects velocity.

Now, momentum is mass x velocity. Check, since time affects velocity, it also affects momentum because we can break it down to momentum = mass x displacement/time.

There are many more that time affects, I'm just showing how to know.

Don't forget, I separated space and time. Now, since space directly affects time and indirectly affects "what time affects", it means that the combine word as "space-time" directly affects "what time affects". Therefore, the nature of space-time in an area will determine the velocity, acceleration, momentum, force, pressure, impulse etc. of an object, insert when you discover more.

Here comes the reason why I had to present space-time and light as both ultimate entities, which the equations of the universe also gave as a clue. When I say "light" as an ultimate entity, I mean the general way, I'm not specifically referring to electromagnetic radiation or dark energy, I'm referring generally to anything that moves with the speed of light (c). It is the constant "c" as the speed that resulted into categorizing the entity (light) as an ultimate entity and this is the reason;

The nature of space-time in an area will determine how the motion (interaction) of matter will be. A space-time that gives a restriction (a space-time that appears to show some thickness) like the one on ISS will make an object to move slowly and space-time will be like;

Space-time: "It's not really my fault, you don't move with the speed of my fellow colleague (c), so I have to restrict you"

The above statement is to say that if a matter magically moves with the speed of light, the thickest space-time cannot restrict it and this is the reason why a photon will move with the speed of light in any nature of space-time, even in a thick space-time. Once the speed of an object reaches the speed of light (c), it is above the law. Any speed less than that, the nature of space-time in that area will be responsible for the object's motion.

Now, this is a proof that S and c are ultimate constants. Mathematics doesn't lie.

Back to the main point and I proceed. I've put emphasis on the fact that time is not based on the rotation and revolution of a planet around the sun, this is the confusion;

As we know, the distance between the sun and a planet in our solar system will determine how long it'll take for that planet to complete 1rev around the sun. Planets far away from the sun than earth will take a longer time to complete 1rev than earth.

For example; Mercury completes 1rev around the sun in 87.97 earth days. Earth is 365.26 earth days and Jupiter is 4,332.82 earth days.

Now, people do think that the fact that it takes Jupiter a longer time to complete 1rev than earth means that time is slow on Jupiter, without knowing that the space-time on Jupiter is freer than on earth.

The only issue we have is when people say that time is ahead in one country than the other and how people say that a person is older in another planet far away from the sun than earth. No

To stop all the confusion and give the main fact, I'll have to present time as it is.

To make this simple, the bottom line is; regardless of the sunrise in a place and sunset in another place, even in another planet, anywhere you are, time moves this way in its unit;

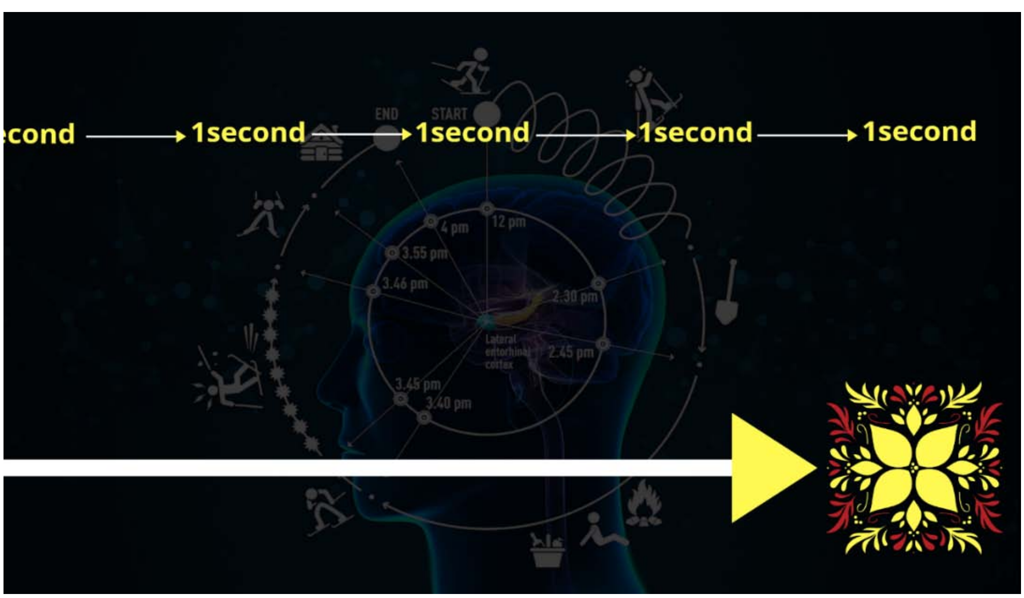

Figure 9

1s -1s -1s -1s -1s -1s -1s -1s -1s -1s (Figure 9)

Time passes from one second to another. It's day time in China (6am) and night in Nigeria (11pm), the time in china is ahead. No, that's not time, it's the sun's effect, that's all. Time passes from 1s to another, put that on your mind.

Also, do not confuse yourself in the fact that what we know as "It takes Venus 224.70 days to complete 1rev is in earth days", we do this because no one has been to all these other planets in our solar system.

However, let's say humans migrate to Venus, we would have to form a Venusian calendar living in Venus; we take a clock and measure a full day, (sunrise) to the start of another day and then group it in hours and in minutes and in seconds, once Venus completes one rev around the sun; we check the total days recorded and group them equally to form the months. Also, since earth is the default planet, we would have to make contact, once it's Christmas on earth, we record the date on Venus and use that as our Christmas, same with other important holidays. Now, we have our time in Venus, time moves from 1s to 1s still. There's no problem because we are just in our business in Venus and what happens in another planet is not our concern.
How long a year is in a planet and how short is not what determines the differences, it doesn't matter being in a planet with a longer year because time moves from seconds to seconds but here comes the real deal I've been talking about; the differences.

The explanation of space directly affects time and time affects motion (interaction), is the key. From my understanding, using an analog clock is the only way to effectively measure differences in time because an analog clock involves motion (interaction with space-time) via the short, long and longer hand. Any other device or form of time measurement are all computations and programming, these other devices won't interact with space-time to display the time.

[Experimental Test]

On Earth, we provide two analog clocks set properly. To ensure accuracy; we set both clocks at 12:00pm and ensure that both gets to 1:00pm together. Put off both clocks, keep one on earth and take the other to the moon. Start both clocks at the same time. The clock on earth will get to 2:00pm faster than the clock on moon.

Now, time is time but the differences between the natures of space is the real deal. When you'll know that time is different is when you try to get involved with another planet. If not, you wouldn't notice.

The nature of the space-time on the moon will restrict the hands of the clock to move as required. Thus, if the clock on earth gets to 2:00pm, the clock on the moon will be at;

[Mathematical Test]

Before calculations, I present the table from my previous paper which I formed for calculating differences in time between different natures of space-time below;

Table 1

Body	$S_{stretched}$ for planets	$P_E = S_{stretched}(\text{planet}) / S_{stretched}(\text{Earth})$
Sun	0.00365	0.035805
Mercury	0.27855	2.732489
Venus	0.11274	1.105944
Earth	0.10194	1
Moon	0.61728	6.055327
Mars	0.26525	2.602021
Jupiter	0.03854	0.378066
Saturn	0.09025	0.885325
Uranus	0.09372	0.919364
Neptune	0.07107	0.697175

Table 2

Body	P_E	Time(t) $[t/_{PE}]$
Sun	0.035805	t/0.035805
Mercury	2.732489	t/2.732489
Venus	1.105944	t/1.105944
Earth	1	t/1
Moon	6.055327	t/6.055327
Mars	2.602021	t/ 2.602021
Jupiter	0.378066	t/0.378066
Saturn	0.885325	t/0.885325
Uranus	0.919364	t/0.919364
Neptune	0.697175	t/0.697175

Calculations;

From 1:00pm to 2:00pm is 1hr. 1hr is 3600sec on earth,

From table 2, for moon we have t/6.055327.

3600/6.055327 = 594.52sec

594.52/60 = 10min

Therefore, the clock on moon will be on 1:10pm.

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Now we have a new experiment to try by the next mission to the moon (Clock Experiment). I should have tried it with ISS but I'll need to determine the value that represents the nature of its space-time by calculation, ISS has an irregular shape (not spherical), it'll be difficult to get the exact value.

However, let's try the same situation on Venus and Mars.

From 1:00pm to 2:00pm is 1hr. 1hr is 3600sec on earth

From table 2, for Venus we have t/1.105944.

3600/1.105944 = 3255.14sec

3255.14/60 = 54min

Therefore, the clock on Venus will be on 1:54pm.

For Mars,

From 1:00pm to 2:00pm is 1hr. 1hr is 3600sec on earth

From table 2, for mars we have t/2.602021.

3600/2.602021 = 1383.54sec

1383.54/60 = 23min

Therefore, the clock on mars will display 1:23pm.

One more to prove my Jupiter statement;

For Jupiter,

From 1:00pm to 2:00pm is 1hr. 1hr is 3600sec on earth

From table 2, for Jupiter we have t/0.378066.

3600/0.378066 = 9522.14sec

9522.17/60 = 159min

Therefore, the clock on Jupiter will display 3:39pm, while the clock on earth will display 2:00pm.

The Clock experiment is up for grabs by any astronaut. This should be included in the next mission to a planet. When the clock on earth gets to 2:00pm from 1:00pm, the other clocks in other mentioned planet will be at; See Figure 10

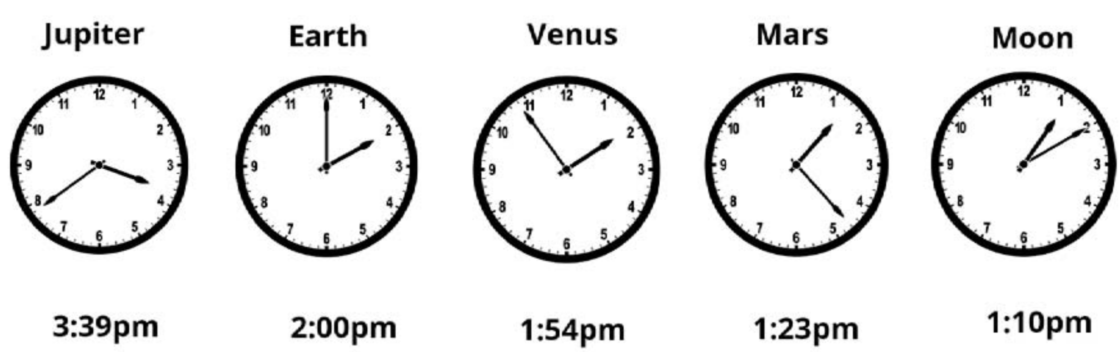

Figure 10

IV. Motion

Figure 11

Motion involves a change of position of a body with time. Time affects the motion of matter. Don't be confused, when I say time it means space-time.

We have the types of motion; random, translational, rotational, vibratory motion.

All you know about motion in basic physics remains the same but I'm using earth as a reference point to show the world how the motion of matter will be in other natures of space-time.

Note; The laws/theories/formulas of motion remains the same. In any nature of space-time, the formulas can be used while recording the event in that same nature.

[New development]

This is recording an event that happened in a different nature of space-time while being in an environment of another different nature i.e. recording an event of motion on Venus from Earth. This is how to know the interaction of matter in other natures of space-time by calculation with the different values representing different natures of space-time.

Read my previous papers (princejessii.academia.edu) if you don't know how to use table 1 and table 2. I proceed immediately with the calculations to show how matter interacts using four natures of space-time which will be Jupiter, Earth, Venus, Moon respectively arranged in the order of increase in thickness of space-time nature (Figure 12).

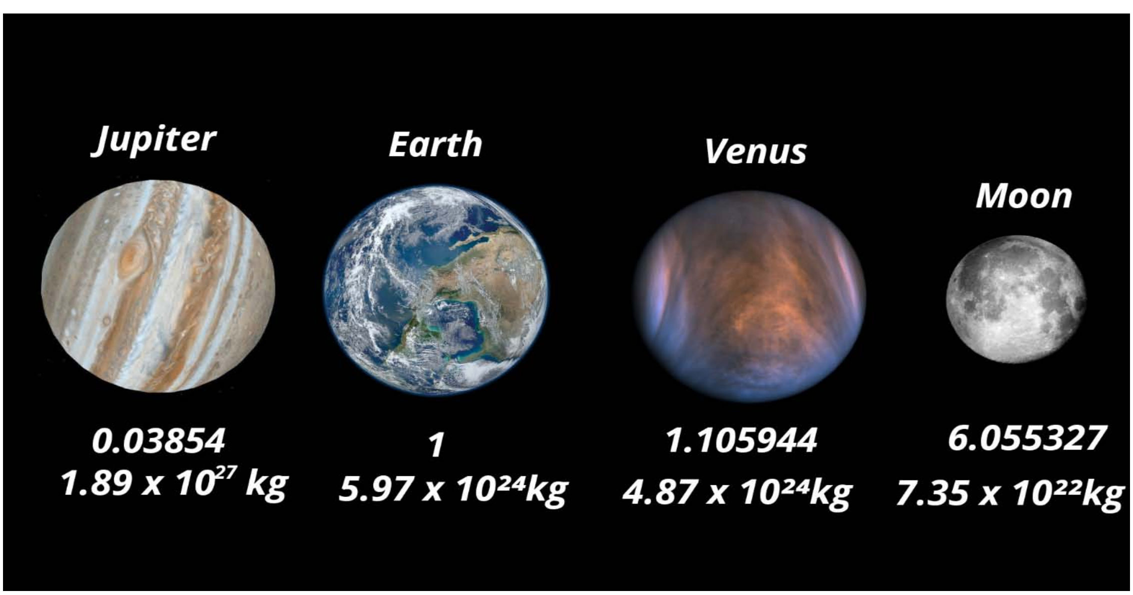

Figure 12

Calculations; Using values of the mentioned planets under t/P_E in table 2

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a) Distance

A car travels at a constant speed of 100m/s^{-1}. What distance does it cover in 5seconds?

1) Event on Earth, recorded on Earth; speed = distance/time, distance = speed x time
   100 x 5/1 = 500m
2) Event on Venus, recorded on Earth; speed = distance/time, distance = speed x time
   100 x 5/1.105944 = 452m
3) Event on Moon, recorded on Earth; speed = distance/time, distance = speed x time
   100 x 5/6.055327 = 82.57m
4) Event on Jupiter, recorded on Earth; speed = distance/time, distance = speed x time
   100 x 5/0.378066 = 1322m

Conclusion: Comparing the four calculations, it is seen that "the freer a nature of space-time is, the more distance an object is likely to cover with the same speed in the same time."

Arranging the four planets in the order of increase in the thickness of space-time;

[Jupiter – Earth – Venus – Moon]

[1322m- 500m – 452m – 82.57m]

I hope you understand.

b) Speed

A bus covers a distance of 1000m in 60sec, at what speed does the bus moves with?

a) Event on Earth, recorded on Earth; Speed = distance/time
   1000/ (60/1) = 16.67ms^{-1}
b) Event on Venus, recorded on Earth; Speed = distance/time
   1000/ (60/1.105944) = 18.43ms^{-1}
c) Event on Moon, recorded on Earth; Speed = distance/time
   1000/ (60/6.055327) = 100.92ms^{-1}
d) Event on Jupiter, recorded on Earth; Speed = distance/time
   1000/ (60/0.378066) = 6.30ms^{-1}

Conclusion: In this situation where the speed is unknown and a distance is given with time, it is seen that in a free space-time, an object can use a slight amount of speed to cover a distance than in a thick space-time.
Arranging the four planets in the order of increase in the thickness of space-time;

[Jupiter – Earth – Venus – Moon]

[6.30 – 16.67 – 18.43 – 100.92] in ms^{-1}

c) Force

A force of 10N is applied to a ball with a mass of 10kg, the ball is displaced in a certain direction. What distance does the ball cover in 10sec?

1) Event on Earth, recorded on Earth; Force = mass x acceleration, acceleration = velocity/time, velocity = distance/time. Distance = Force x time^2 / mass
   10 x 10^2 / 10 x 1 = 100m
2) Event on Venus, recorded on Earth; Force = mass x acceleration, acceleration = velocity/time, velocity = distance/time. Distance = Force x time^2 / mass
   10 x 10^2 / 10 x 1.105944 = 90.42m
3) Event on Moon, recorded on Earth; Force = mass x acceleration, acceleration = velocity/time, velocity = distance/time. Distance = Force x time^2 / mass
   10 x 10^2 / 10 x 6.055327 = 16.51m
4) Event on Jupiter, recorded on Earth; Force = mass x acceleration, acceleration = velocity/time, velocity = distance/time. Distance = Force x time^2 / mass
   10 x 10^2 / 10 x 0.378066 = 264.50m

Conclusion: These calculations are the mathematical prove of what I explained about the situation of kicking a ball on ISS. With the same force on the same mass of an object, the object will cover more distance in a free nature of space-time than a thick one.
Arranging the four planets in the order of increase in the thickness of space-time;

[Jupiter – Earth – Venus – Moon]

[264.50m – 100m – 90.42m – 16.51m]

General Conclusion: This is the theoretical/mathematical way of showing how matter moves in other areas of space-time. It is simply staying on earth and recording an object's movement on another planet with a clock in your hands, if you record for a certain period (time) and compare all your recordings for the different planets, you'll observe that the object's movement is different in all recordings. However, you can continue with the calculations with other quantities that space-time can affect by using table 2.

Instructions

1) The values under t/P_E in Table 2 is only applied with time (t). Do not use it with any other quantity apart from time. If time cannot be gotten from the breakdown of a formula, it means that the differences in the nature of space-time doesn't affect that quantity. For example; Volume = l x b x h. Time is not present in the formula/expression. Therefore, volume of an object cannot be affected in a different nature of space-time. Remember, the aim of any space-time nature is to affect the time related to any interaction of an object.
2) Do not use values under t/P_E in table 2 for a quantity that represents an entity moving with the speed of light (c)

d) Condition of Matter

What I mean by "Condition of Matter" is simply based on the inferior nature of matter.

Like you know, a house built yesterday will not be in the same condition in 100years to come. Yes you can paint it to deceive the eyes but deep down the condition of the house is far from fresh. Same with other matter. A man/woman is fresh and young but in 80years to come, its condition changes, close to fading. This is the nature of matter, if it moves from day to day or it stays stable and still for many years, its condition must change. This is the issue that comes with matter, it's inferior. This is what I mean by "Condition of Matter."

If an object is manufactured and split into four, the first part stays on earth, the second is taken to the Jupiter, the third is on Venus and the fourth is on Moon. After 80years on earth, the part on earth is definitely 80years old and its condition is very bad, its appearance is worn off.

To check the condition of the other three which are in a different nature of space-time, we use table 2 also.

1) 80/0.378066 = 211years (the object's condition on earth at 211years)
2) 80/1.105944 = 72years (the object's condition on earth at 72years)
3) 80/6.055327 = 13years (the object's condition on earth at 13years)

Perhaps, if the condition of the first part that stayed on earth was being detected and recorded at 13years, 72years and 211years; that will be the condition of the other three parts once the part on earth reaches 80years.
All these is what I mean by "Condition of Matter." (Figure 13)

Figure 13

V. Dark Energy and Dark Matter Theory

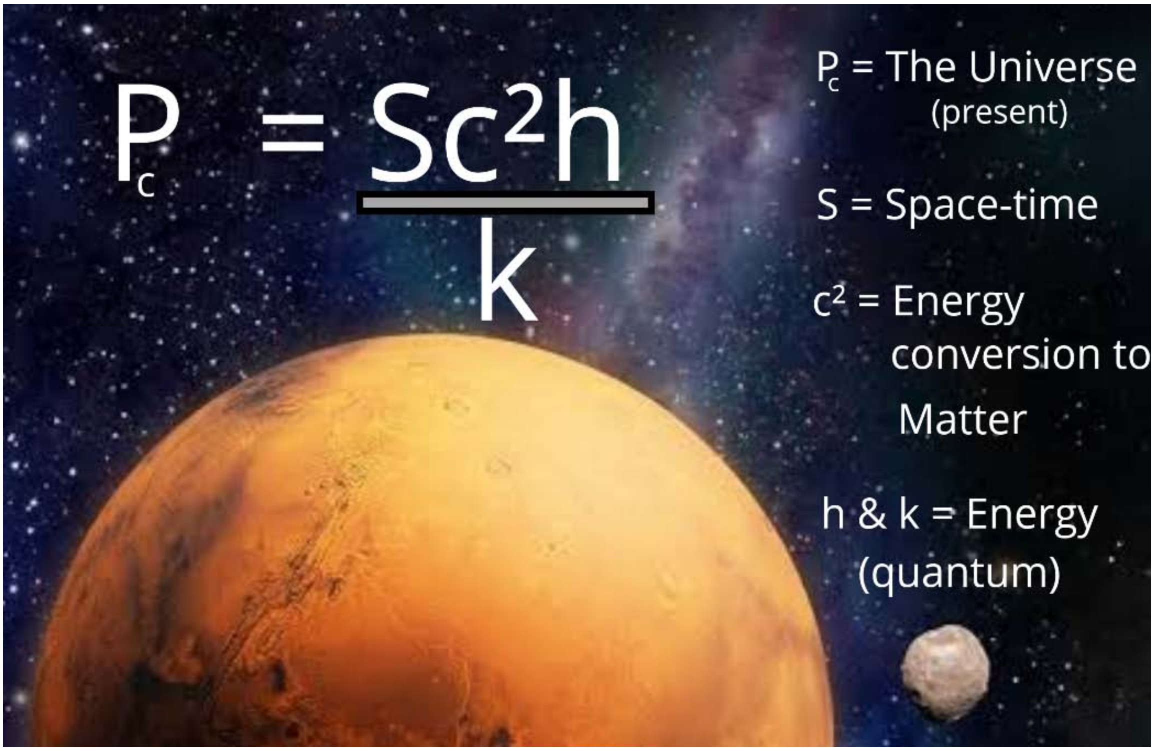

Figure 14

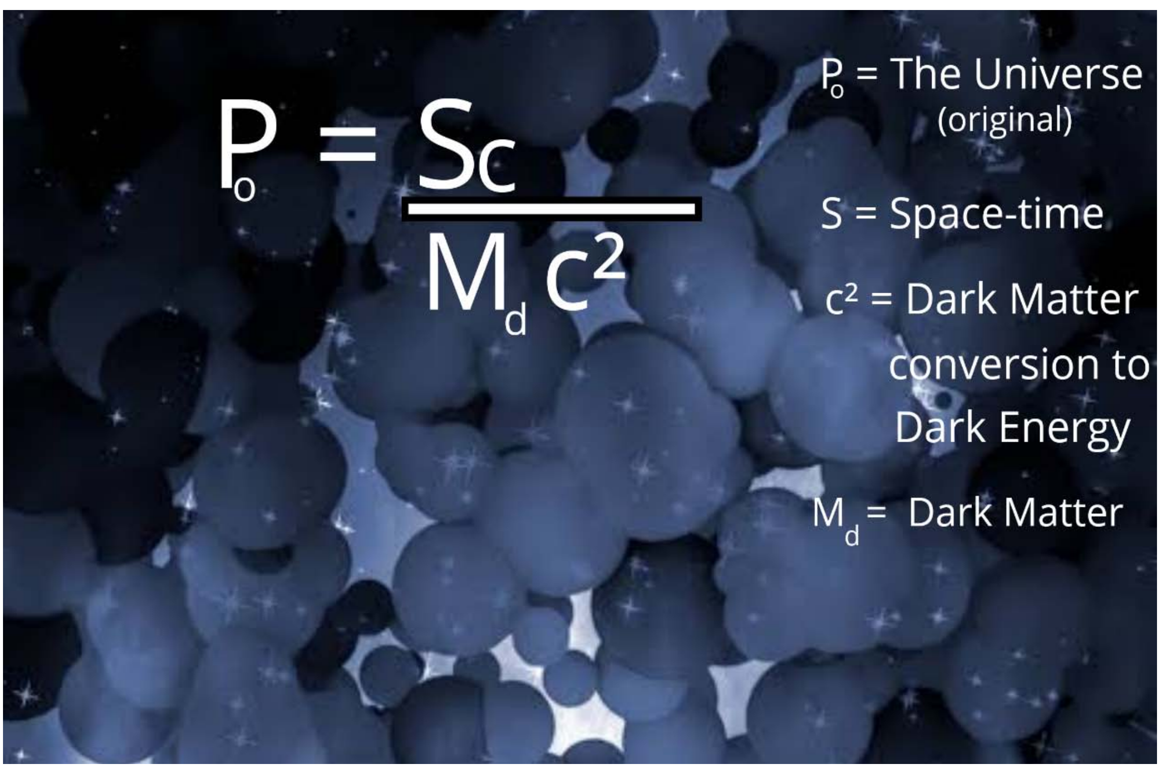

Figure 15

Physics: The natural science that studies matter and energy, its motion/interaction and behavior through space-time. $P_c = Sc^2h/k$ (Figure 14)

Dark-Physics: The natural science that studies dark matter and dark energy, its motion/interaction and behavior through space-time. $P_o = Sc/M_d c^2$ (Figure 15)

I present the name "Dark Physics" as the physics of the dark dimension and this is the reason; the interactions and behavior of the dark entities is completely different. In fact, it'll render the laws of physics invalid. If the four entities (Dark energy, Dark matter, Matter, Energy) are joined as one subject as "Physics" and in future; scientists fully realize how the dark dimension fully works, all the theories backed up by experiments in physics will seem like an error/failure in the eyes of our coming generations.

Presently, there are situations that defies the laws of physics but we don't see what happens on the other side; if shown to a physicists, he/she will be speechless and have nothing correct to offer.

"Matter behaves entirely different when combined with dark-matter"

For example; if a dark-matter is present in your room but you don't see it, and it eventually interacts/reacts with a matter in the room like a table, let's say it causes the table to levitate, you see that the table is levitating but don't know why and you get scared without knowing that a dark-matter piece has reacted with it. Now, with your eyes you can't explain what you just saw and you might probably not live in that house again. A physicist will have nothing to say about that.

For future sake, let physics be physics and let the physics of the dark-dimension be "dark physics". If the dark entities are understood properly in future by observations, the physics of the dark entities can be presented as dark physics according to the equation derivation (equation 11). The reason is to avoid going back to the root of physics again because of the fact that things would change. I'm not saying this as a prediction but by getting two formulas/expressions that defines two versions of physics.

I'll just give an introduction to dark physics until a good observational/experimental discovery relating to the dark entities has been presented then I can continue. To bring that discovery to reality, I have to give a clue.

From my mathematical presentation of the Universe [3], the default dark matter is represented by a unique value "50" as a constant. The value of the mass of dark matter as (50) depends on the default space-time. This means that its mass must have deviated from 50 presently. From my understanding; at the opposite dimension, it was the mass of matter but wasn't constant. Therefore, the resulting description of this value is;

"All single dark-matter in the Universe will have the same (equal) mass/weight in space-time at all positions"

Cosmologists/astronomers should use this as a clue for quick discovery of the mass of dark-matter and should be put at the frontline of attempts. If there's a mission to know more about dark matter, its mass should be the first finding. There's another clue after the statement below;

The theoretical aspect of physics is meant to see things through so as help cosmologists/astronomers know what they are dealing with, but some physicists in the past and nowadays physicists write their theories from experiments/observations that had already been done. What makes me wonder is that; yes, a clear observation/experiment has been done about a particular situation, some physicists will ignorantly use unknown variables/constants to form their theories, in some cases it might require using calculus and matrices to solve, in extreme cases some might proceed to use programs and compute just to prove an idea. In most cases, physicists will try to predict and predict just in case one of their predictions happen to be correct when proven by an experiment/observation in future and all credit goes to them. Yes, there's an idea which results into predictions, the prediction is then proven by an experiment/observation but if the theoretical aspect with calculations is not presented reasonably, what happens; their theories will deceive other generations to come just because of the fact that the corresponding prediction was observed. Deceit is what caused the delay in discovering a unification theory. It's not a physicist's intention to deceive but that is what a wrong theoretical presentation does because of the fact that people will always refer to a theory for answers to problems that are associated to that particular theory. They forget that all aspects of physics are linked, if a part is not presented well, it might affect another. Thanks to the few physicists that did things the right way.

What am I saying; entities have a constant/parameter/value that represents them (e.g. matter- electron – 1.60×10^{-19}) either by measurement or calculation. Entities in this universe are linked to one another, one way or the other. Any situation that can be proven observationally/experimentally can be also proven theoretically. Proving the situation theoretically means that one must prove it mathematically else it's a prediction and it means that; it is what the physicist thinks, that's what he/she publishes in the paper and not what the math says. Math doesn't tell lies, math I mean using the values/constants that represent entities for a general representation. Math I mean a reasonable math that can prove a situation. The reason I'm saying this is the fact that I want physics researchers and coming generations to follow the technique I use in my theories which is linking entities from their default states to get answers in any part of physics, you'll surely find that answer.

Here's another dark matter clue.

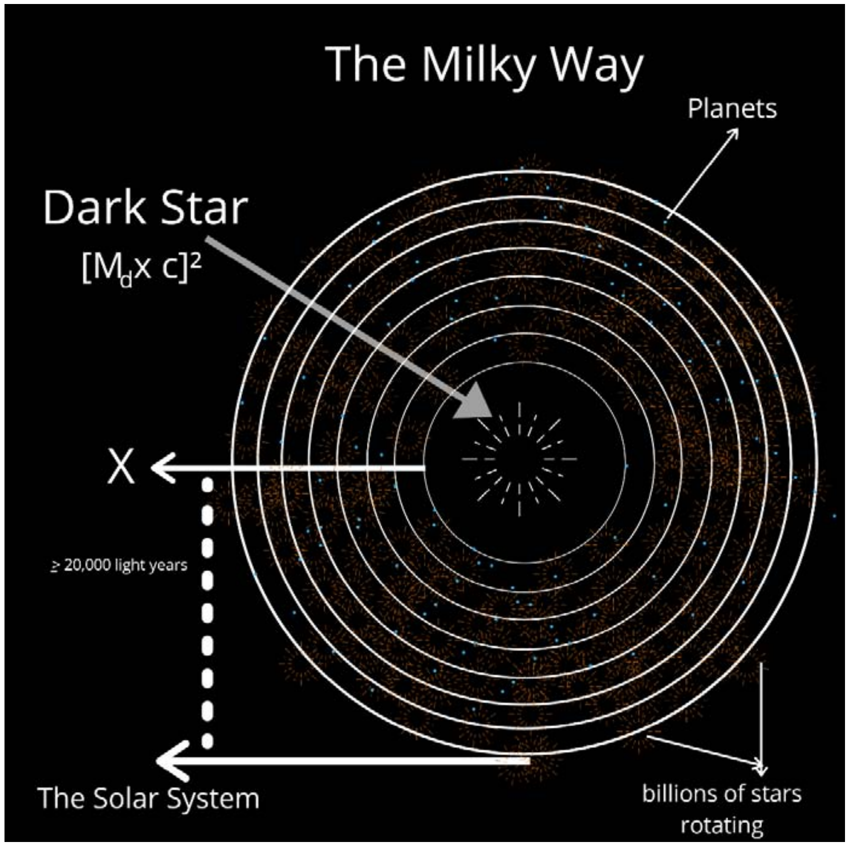

Figure Y

From my mathematical presentation of the universe; gravity as the constant (G) is directly gotten as 1/S.

$1/S = 1/1.50 \times 10^{10} = 6.66 \times 10^{-11}$

The formula (1/S) is simply saying that gravity is the Alta-ego of space-time, whenever a mass applies pressure on space-time to cause a curvature, gravity (G) arises from space-time (S) or we can say that space-time releases its alternate form (gravity). However, this is another expression that leads to (G);

$S/(M_d \times c)^2 = G$

Remember, S is space-time, c is the speed of light and M_d is dark matter
Inserting Parameters;

$1.50 \times 10^{10}/(50 \times 3 \times 10^8)^2 = 6.66 \times 10^{-11}$ (G)

That is the gravitational constant and the expression is simply saying that;

"Dark matter which is on space-time will cause a very strong gravitational effect regardless of the fact that it would distort space-time", but the dark matter that causes this strong gravitational effect is no ordinary dark-matter. A planet is matter, a star is also matter but unlike planets, they possess electromagnetic radiation i.e. they possess energy. This kind of dark matter that causes a strong gravitational effect is similar to a star, it is a star in the dark dimension, I want you to imagine a star that you can't see but this time the star is not matter possessing energy, rather this star is dark matter possessing dark energy (Dark Star - father of all stars) [figure Y]. Planets rotate around their star but what will the stars in a galaxy be attracted to? (See section VI).

Check back at my mathematical illustration of the universe in [3] to see the expression I gave as a star in the dark dimension.

Dark matter causes a gravitational effect, astronomers/cosmologists should note this clue. However, any point at the outer space where a strong gravitational effect is present but a planet is not present, the point seems to not be occupied by anything matter or energy but a strong (very high) gravitational effect is present from a point, just know that a dark matter is present in that point, it is a unique dark matter that possess its own light (dark energy) - a dark star which is not visible (See section VI for more info)

If I go deep into dark physics, it'll blow your mind. Remember, this is just an intro.

Dark-Physics: The natural science that studies dark matter and dark energy, its motion/interaction and behavior through space-time. $P_o = Sc/(M_d c^2)$

The answer to the nature of dark energy and dark matter should no more be an unsolved problem in physics. The GUT got us covered.

Again, I don't predict rather I do the math which brings out the reality.

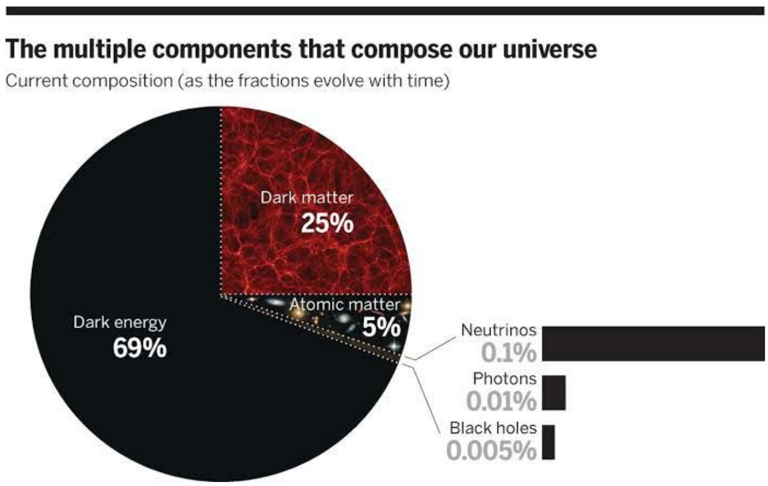

Figure 16

From figure 16, the universe is composed of 69% of dark energy (changes with time). It exists as the light attached to space-time. Space-time is everywhere, dark-energy is everywhere. It is said that dark energy doesn't interact with light (electromagnetic radiation), simply saying that it's invisible. However, dark energy is another light on its own. Dark energy is the reason for the expansion of space-time at the outer space, these are the major findings about dark energy.

From figure 16, the universe is composed of 25% of dark matter (changes with time). it is said that dark matter neither absorbs or emits light also, just like dark energy, dark matter cannot be seen directly (invisible), However, dark matter is another form of matter on its own.

To have the understanding that I have about the role of dark energy and dark matter in this unstable universe, think of this simple game.

The game is a 16th century game of lighting up a dark large room with candles i.e. to make the room bright and visible with candles. The more lit candles you put in the room, the brighter the room becomes. Also, the only way to light the candles is by putting them in a fire outside the room. So the game is simply fetch and put. Just think of this game and get any meaning you can get from it, it's just to prepare your mind.

Now, like I've always said in my previous papers; the dark entities (dark energy and dark matter) are superior to energy and matter. I've always emphasized on the fact that energy and matter are inferior. In fact, the presence of space-time hides 50% of the reality of matter and energy being inferior. Even with the presence of space-time, energy and matter still display their inferior nature. Inferior I mean they are capable of fading. Just like the saying "Energy can neither be created nor destroyed", that's the deceit that space-time brings. Energy can very well be destroyed if you imagine a universe where there is no space-time. Once again, one of the major properties of the dark entities is "indestructible", they are here to stay and they are invisible for a reason.

Do you think that the uncountable planets and stars we have in our universe is a decoration? Do you think that our creator wants humans to be born today and fade the next day? Think.

Einstein made it clear that energy and matter are two forms of the same thing meaning matter is the solidified form of energy (pack-photon forming into an electron). Same with the dark entities, dark energy and dark matter are two forms of the same thing. Dark matter is the solidified form of dark energy.

Now, I've always said that matter can become dark matter and energy can become dark energy. Why, it's an offer that allows matter/energy to change to its indestructible mode by the same space-time that tries to hide its inferior nature. The only way to change to that mode is by merging with the existing dark entity which is the reason for the existence of black-holes. (section VI)

The universe is of two versions;

Stable Universe: Dark energy and Dark Matter are visible i.e. all matter and energy are merged with the existing dark energy and dark matter. $P_o = Sc/(M_d c^2)$

Unstable universe: Energy and Matter are visible, dark energy and dark matter are invisible. $P_c = Sc^2h/k$

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VI. Black Hole Theory

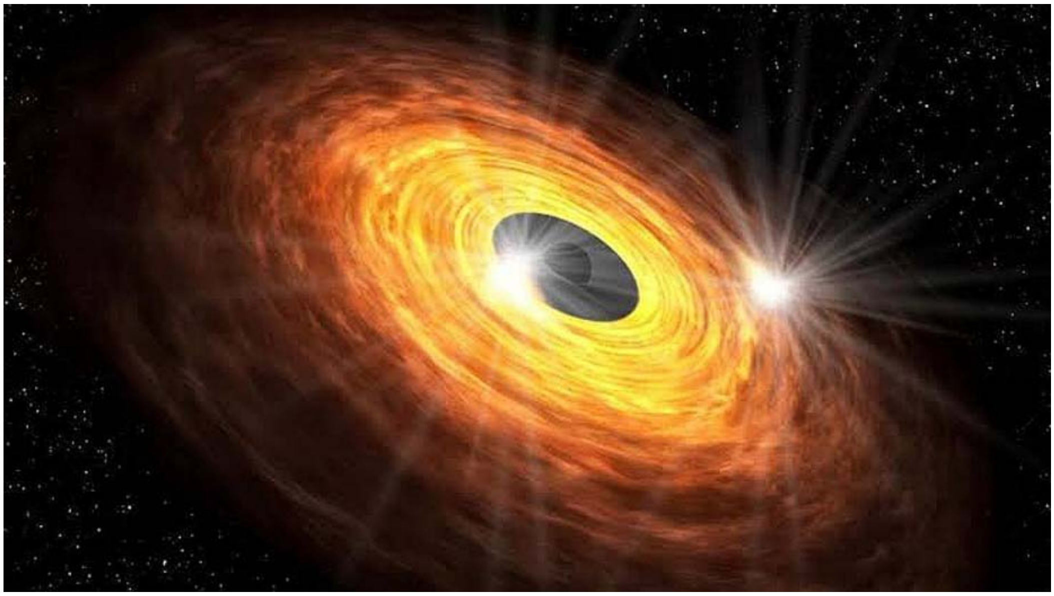

Figure 17

A black hole is a region of space-time where gravity is so strong that nothing, no particles or even electromagnetic radiation can escape from it (Figure 17). Black holes can absorb to gain mass from its surroundings.

If you understand the "GUT", you'll understand the existence of black holes.

Also, if you know the real definition of gravity, you'll understand the existence of black holes.

Therefore, the existence of black holes should not be a surprise. This is the real definition of gravity; Gravity is an effect that arises from a mass applying pressure/stress on space-time (curvature), once the pressure/stress is applied, this effect (gravity) stretches the space-time at the line of pressure.

I presented the calculations showing the effect of gravity to form a new space-time nature in my previous paper [3]. Again, using figures I designed for a better understanding, a detailed explanation of the link between (space-time, dark-energy, gravity, black-holes and the inferior entities) is as follows;

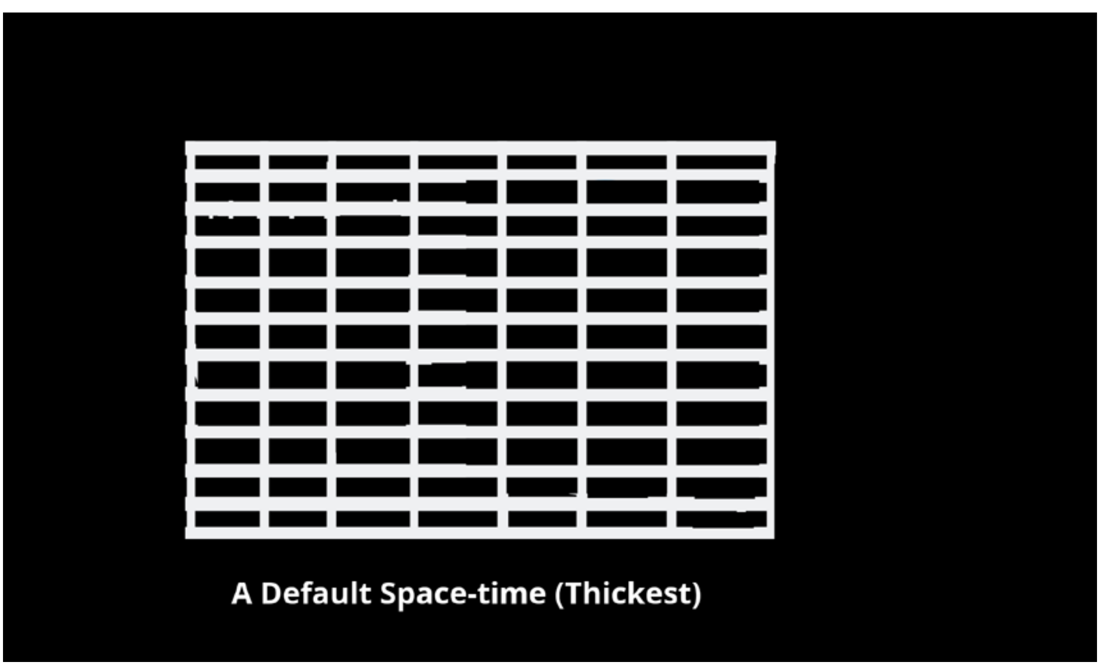

Figure 18

First, the formation of a new space-time nature is based on the default space-time (1.50 x 10^{10}). All planets/planetary bodies that apply pressure on space-time where all formed at creation. At creation, this default space-time which is the thickest was everywhere (Figure 18), it also existed with an energy (dark-energy)

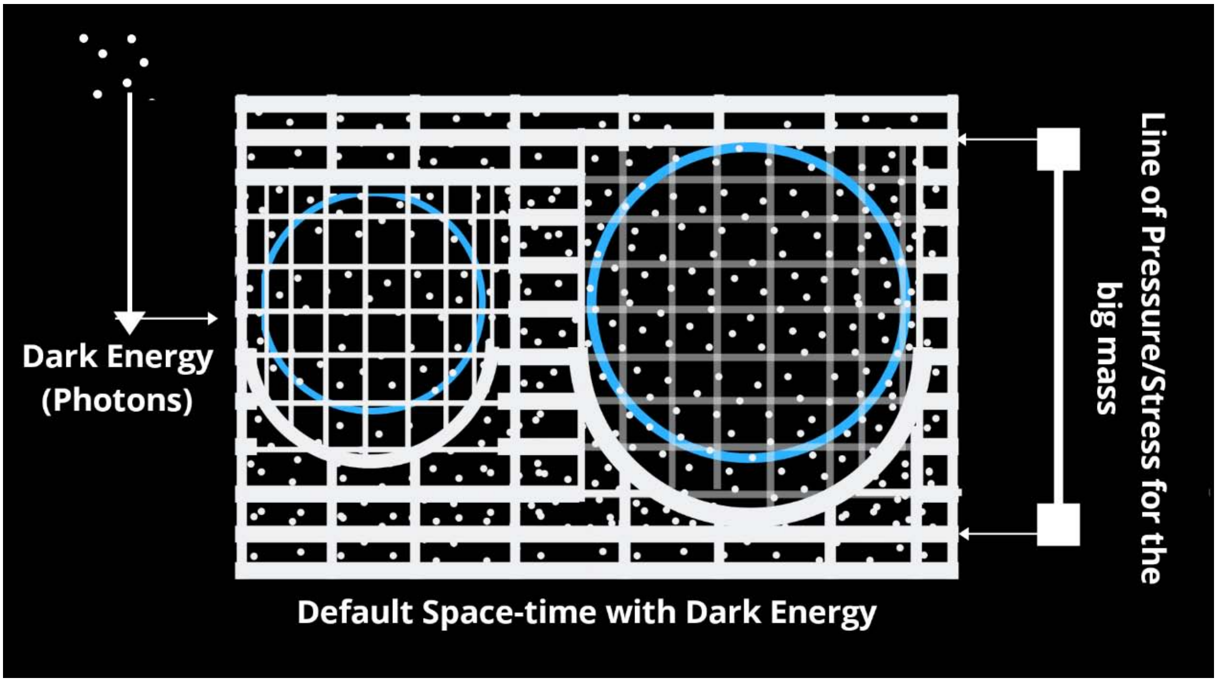

Figure 19

Secondly; once a planet/planetary body was formed at creation, they immediately applied pressure on this default space-time. The pressure/stress causes a curvature resulting to gravity. The gravitational effect stretches/reduces the thickness of the default space-time at the line of pressure to result into a new space-time nature.

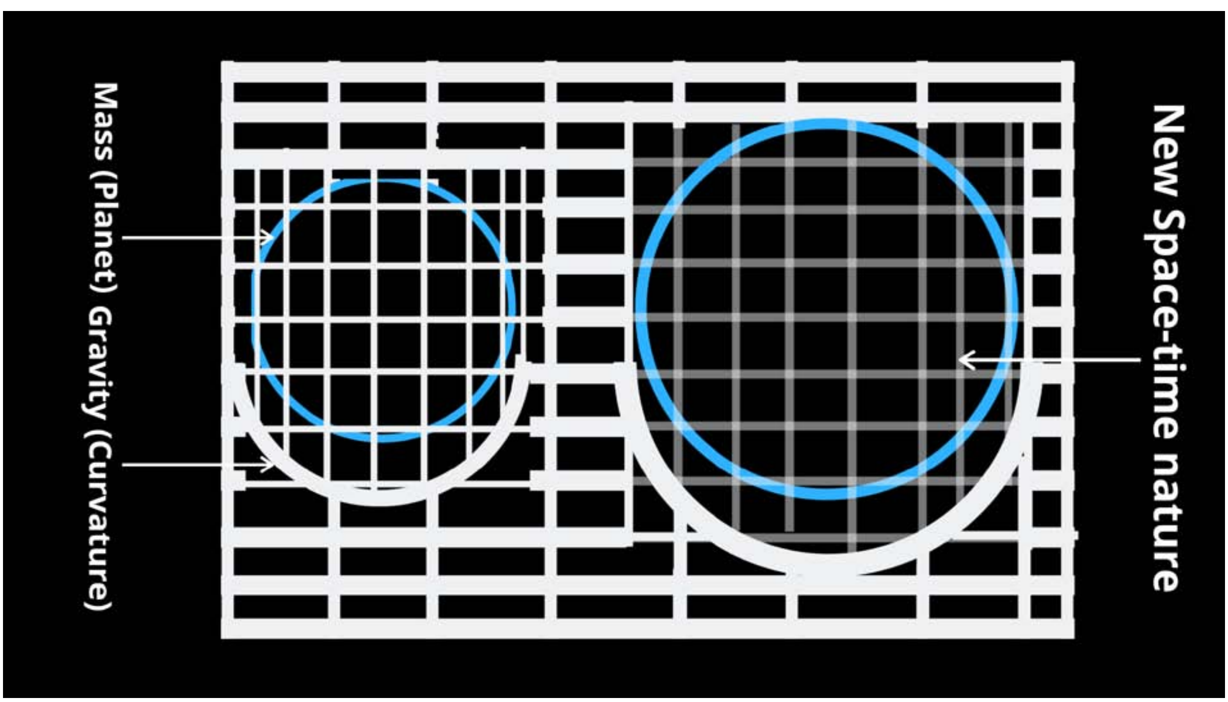

Figure 20

Next; from figure 20, it is seen that a new space-time nature is formed at the line of pressure. This line of pressure starts from the point of curvature area upwards to the top of the planet. A bigger mass will apply a bigger pressure, a smaller mass will apply a smaller pressure. The more pressure/stress applied by a mass, the more the default space-time at the line of pressure is stretched by gravity, the more free the new nature will be. From figure 20, it is seen that the thick lines around the line of pressure which represent the default space-time are now thin lines representing a new nature. Between the small and big mass, the lines of the bigger mass is not as thick as the lines of the smaller mass. However, these planets rotate around which means they apply pressure at different points in space-time but the main fact is that; once a new nature is formed inside a planet/planetary body, the new nature cannot be reversed back to its original nature (a contained space-time) unless a curvature is not present, also it cannot be stretched/reduced further unless a particular situation happens which I'll explain later. Thus, leaving the new nature permanent inside the planet. This is to say that; each planet/planetary body at the outer space contains a different nature of space-time based on the explanation from figure 20, unless two planets had the same mass at creation, they can both have similar nature of space-time. The function of gravity to stretch and reduce the space-time at the line of pressure happens when a mass applies pressure on space-time but if that mass has a new nature already other than the nature of space-time as to which it applies pressure, gravity won't stretch it rather it'll will protect it. Example, using earth;

1) Earth was formed long ago at creation when the default space-time (1.50×10^{10}) was everywhere, once earth was formed on the default space-time, it applied pressure on the same space-time to cause (gravity-curvature).
2) The gravitational effect from the default space-time stretched the same nature at the line of pressure which includes inside the planet. A new nature is formed and contained inside earth.
3) Presently, billions of years has passed. The nature of space-time at the outer space is not the default nature as it used to be at creation. Therefore, as earth applies pressure as it rotates at different points, gravity will always arise, it'll only stretch at the line of pressure but this time, excluding inside the planet. This is why an object close to the surface of a planet is attracted by falling with a certain speed but once it enters the planet, it falls with a faster speed. Detailed explanation goes this way;

Gravity is Gravity, but the function of the gravitational effect that arises from a space-time of 1.50×10^{10} is different from the gravitational effect that would arise from a lesser space-time. The gravitational effect that arises from a space-time of 1.50×10^{10} will only stretch/reduce the same space-time of 1.50×10^{10} at the line of pressure, any other nature apart from that won't be stretch by it, rather the gravitational effect will protect and maintain the new nature in the planet as it keeps rotating in different points. A gravitational effect from a lesser space-time can only stretch the same lesser space-time.

Can this irreversible nature of space-time inside a planet still be reduced further to a newer nature? The answer is yes and it is near impossible but it's the understanding of "Quantum Gravity"

a) Quantum Gravity Theory

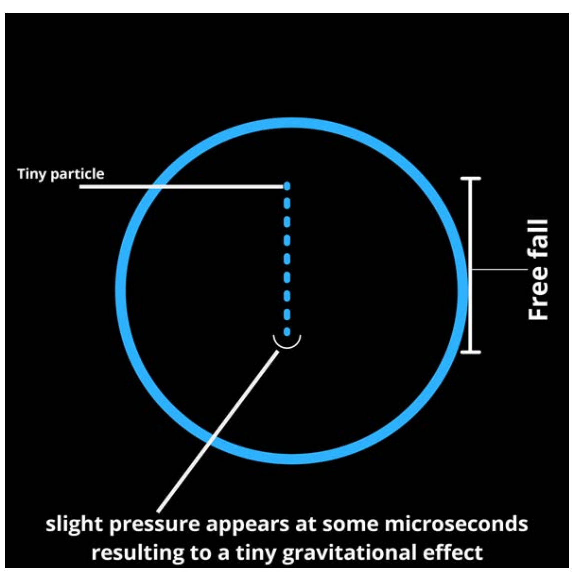

Figure 21

The new nature can very well be reduced. Just like the planets applied pressure on the default space-time at creation to cause gravity which will then reduce the thickness of the default space-time to give a new nature, this time the new nature inside the planet does not have enough thickness to keep objects floating to apply pressure rather the new space-time offers free fall. Therefore, objects won't be able to apply pressure but do you know that; in a new space-time nature like on earth, an object in free fall seems like it can't apply pressure due to the free nature, this is where the quantum realm comes in play. A tiny particle in free fall can have the mass that can match the free space-time nature to produce an applied pressure for some microseconds or nanoseconds depending on the nature, to cause a quantum curvature resulting to a very tiny gravitational effect(Figure 21). All these happens in less than a second and disappears. However, it means that a newly formed space-time inside a planet can be reduced further but it will take billions x billions of tiny particles for billions x billions of years to create a new nature all round inside the planet. There can be new creation of a new nature of space-time But reversal can only happen if planets are not suspended under gravity anymore, otherwise no reversal.

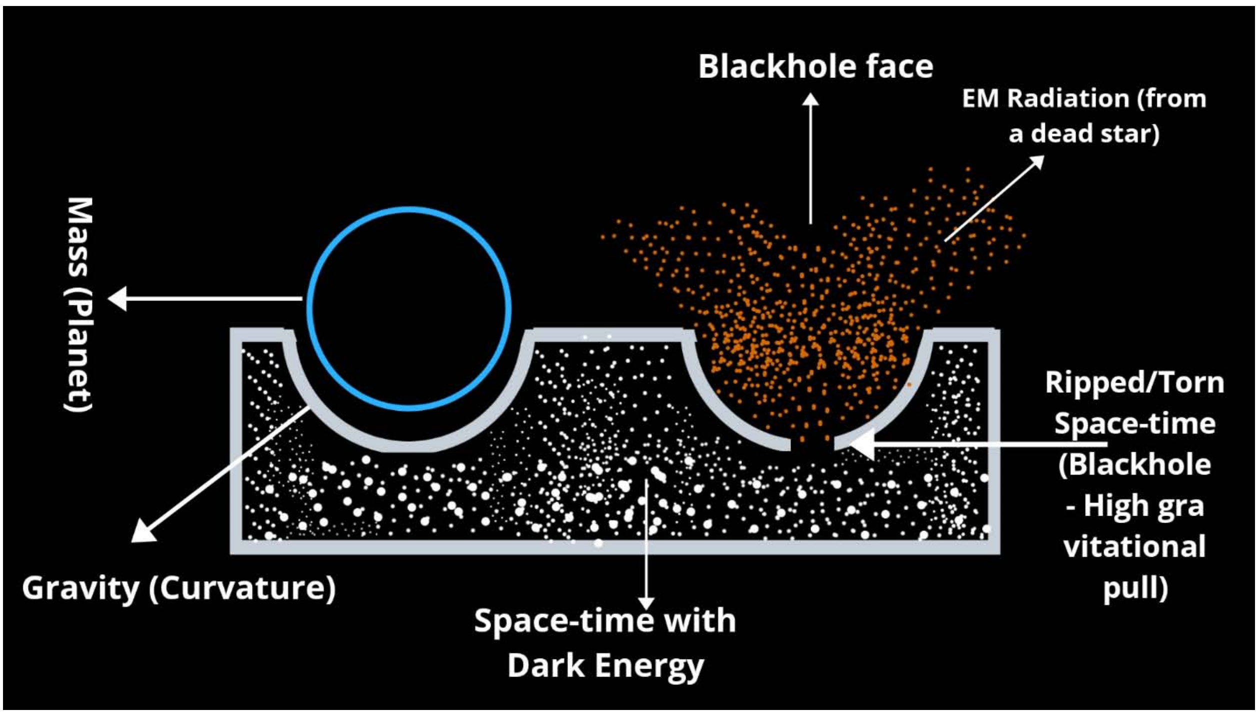

Figure 22

Next; Figure 22 is a view from a different angle to show space-time. Figure 22 is the difference between a mass applying pressure on space-time and energy (EM Radiation) applying pressure on space-time. The difference is; mass applies pressure/stress to curve space-time and energy applies pressure to tear/rip space-time.

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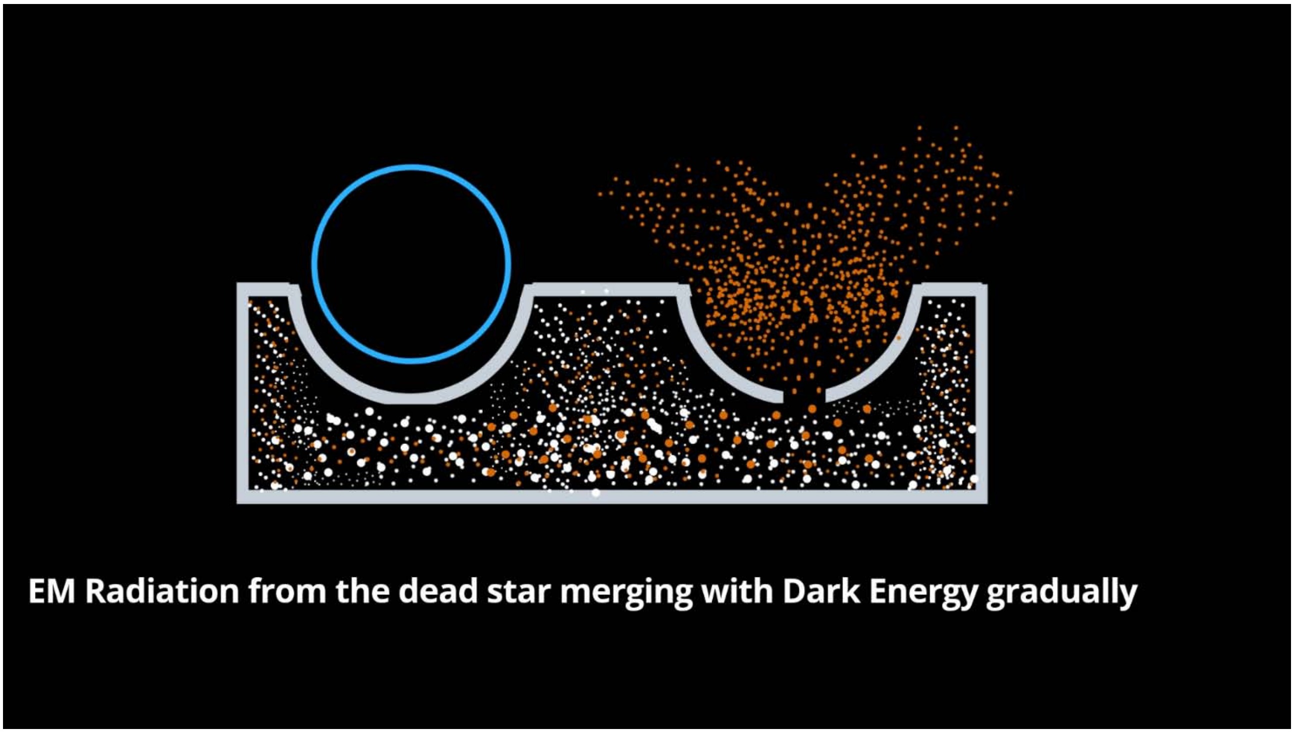

Figure 23

A torn space-time is a pull from gravity. It's like a situation where you puncture a small hole in a balloon, the air gets expelled gradually and if you create a big hole, the air comes out at quickly. However, the reason why energy is allowed to tear space-time and not matter (mass) is solely because of dark-energy. A black-hole is an event on space-time that allows energy to change to its indestructible mode (dark energy) by merging with the photons of dark energy, the spinning of the radiations by gravity is what results into the transformation to dark energy photons. This you don't see.

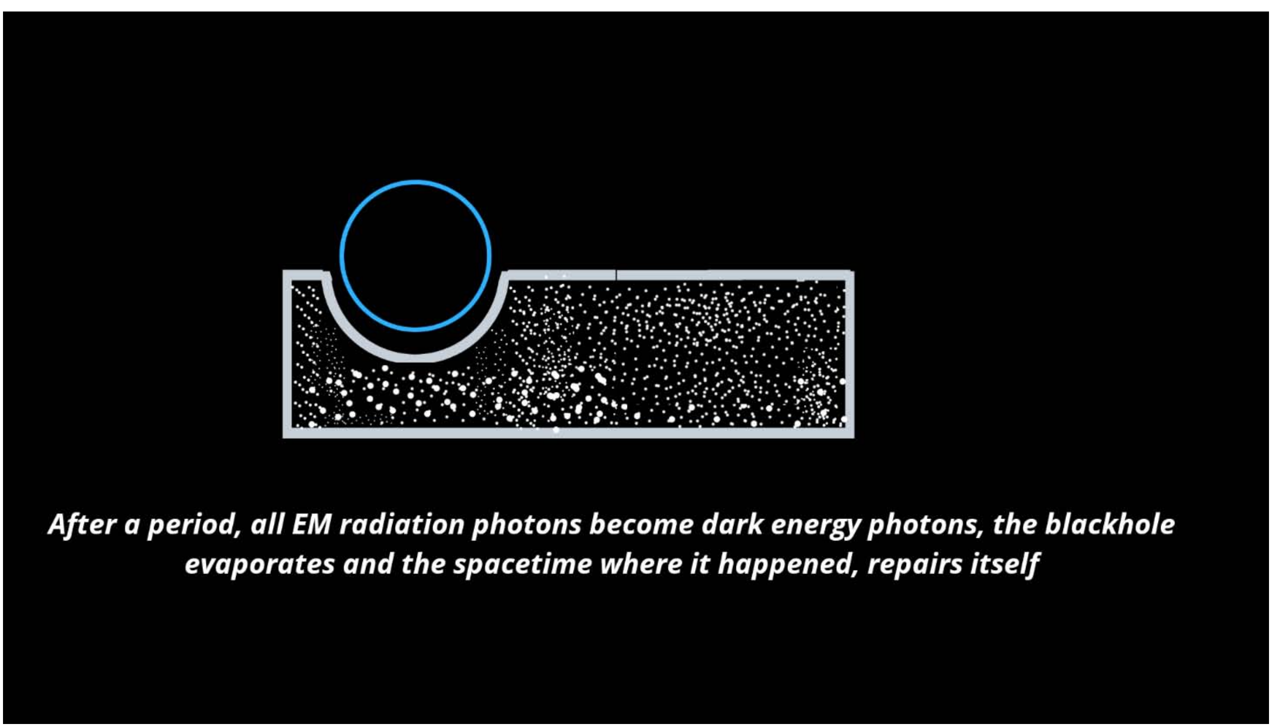

Figure 24

After a certain long time, we just observe a radiation that suddenly disappears and we wonder where they went. Remember, we can't see or observe dark energy, why should we see the merging of energy photons with dark energy photons.

After some time, the black-hole evaporates after all energy photons have changed to dark-energy photons, the space-time where the black-hole occurred repairs itself like nothing happened there (Figure 24).

Matter can be reversed back to energy, this means that; as a matter can apply pressure/stress on space-time, energy can equally apply pressure/stress on space-time. There are planets and there are stars, the difference is that unlike ordinary planets, stars possess energy (electromagnetic magnetic radiation). Stars are still matter that possess energy but when they die and collapse at the end of their life-span, all their matter part becomes radiation. I want you to think this through.

Also, I want you to think through as far as you can else you won't understand the existence of black-holes.

Energy is the default state of matter i.e. there was nothing like matter at the creation of this universe, energy is what solidified to form matter. Now, matter (mass) is not allowed to tear/rip space-time until it becomes energy totally. If it becomes energy, it can now tear/rip space-time. This is another view; there's an energy (dark energy) that exists with space-time and this is the reason why energy is allowed to tear space-time. Energy (radiation) tears space-time to form a black-hole for the sole purpose of merging with dark energy that you don't see i.e. energy is changing to its indestructible form (dark energy), it's a slow process. When the energy from a black-hole evaporates suddenly after some time, we ask; "where does the radiation go". You know the answer. Think this through, I wish I could transfer my understanding automatically to you.

There are two things involved in black hole theory/calculation

1) The Energy (radiation) from a black hole
2) The Gravitational effect (pull) from the black hole

Straight up from the "Theory of Everything", the energy from a black-hole is the energy of a dead star.
When a star dies, its matter part is transformed into energy (radiation).

This is why I presented the total energy of a star as $E_{star} = [M \times c]^2$

Therefore, the energy from a black-hole is given as $E_{blackhole} = [M \times c]^2$

If a star with a present mass of 1.99×10^{30} reaches its lifespan and collapses to cause a black-hole on space-time, the energy from that black-hole will be;

$$E_{blackhole} = [M \times c]^2 = [1.99 \times 10^{30} \times (3 \times 10^8)]^2$$

$$E_{blackhole} = 3.56 \times 10^{77} J$$

Note: This energy value is for a newly formed black-hole. As time passes, the energy from a black-hole changes.

However, this energy value of this black-hole will play a role in determining its gravitational pull.

Before presenting its gravitational pull, let me quickly discuss the meaning of the gravitational constant (G).

As you know, G is the inverse of S. I've said that; the main function of gravity is to reduce the thickness of space-time at the line of pressure whenever a mass applies pressure on space-time, and also as an attractive force/effect. G is the constant that represents that function. Gravity is weak, G is 6.67×10^{-11}. Now, this time; an energy is applying pressure to rip space-time. G has given us a hint that the value that'll represent the gravitational pull of a black-hole will be 10^{-x} to show the nature of gravity. However, once space-time is torn/ripped, G becomes $G_{black\text{-}hole}$ to show its strong gravitational pull.

It's straight, the formula used for determining the value of a stretched space-time by the effect of gravity is;

$$(S_{default} \times r^2)/ M = s_{stretched}$$

Remember, it is energy applying pressure not mass (matter). Also, the pressure by energy caused space-time to tear/rip.

Therefore, $S_{stretched}$ will change to $G_{black\text{-}hole}$ and M and r^2 will be replaced by the energy from the dead star ($E_{black\text{-}hole}$).

The gravitational pull from a black-hole is given as $S_{default}/E_{blackhole}$

With S as 1.50×10^{10} and $E_{blackhole}$ as 3.56×10^{77}J from the example,

The gravitational pull of the black-hole formed is;

$$1.50 \times 10^{10}/3.56 \times 10^{77} = 4.21 \times 10^{-68}$$

Also, I've made emphasis on the fact that the value 1.50×10^{10} represents the default space-time that was present at the big bang. Dark energy has been stretching the space-time (Expansion of the Universe) at the outer-space, this means that the nature of space-time present at the outer-space is not as thick as it used to be long ago at the creation of this universe.

Therefore, the value representing that space-time is no more 1.50×10^{10}, its value should be lesser but not too far from 1.50×10^{10}. So when calculating for the gravitational pull from a black-hole, have in mind that the value is not accurate due to the expansion of the universe that resulted into the stretching of $S_{default}$. If the formula is used for a black-hole that was formed at a period where the universe was <100years old, then it's accurate. I hope you understand.

From the black hole calculation above, a black-hole formula/expression is generally as $S/[M \times c]^2 = G_{blackhole}$

Now, linking entities from their default states is key to linking the puzzle of the universe, how do you want to know more about what you can't see and observe except this way?

Back on the dark star explanation, this should be taken seriously for a quick observational discovery.

Equation (12)	Equation (13)
$S/[M_d \times c]^2 = G$ S = Space-time, M_d = Mass of dark matter c = speed of light, G = Gravitational constant	$S/[M \times c]^2 = G_{blackhole}$ S = Space-time, M = Mass of matter c = speed of light, $G_{blackhole}$ = Gravitational constant as a pull from a black hole

When I say "default states", I mean their states/values at the Big Bang of the Universe, some will change and some will not but I presented their default states as ultimate and sub-ultimate constants to aid more linkage and further calculations to solve problems of this universe.

Accessing equation (12) and Equation (13) above; you can see that they are both similar. A statement can be this way; "If equation (13) is a black-hole equation, then equation (12) is also a black-hole equation."

If a statement should be that way, I'll agree with it, it's as simple as "they are both black-hole equations". Perhaps having the ability to read the puzzles of the universe was how I discovered the GUT/TOE and I'll give an answer to you from the comparison of both equations. Linking entities for equation (12) will definitely result to G because the default constants are involved, you'll expect the result to be a constant also, and you don't expect the result to be $G_{blackhole}$ to show that its gravitational pull is actually as strong as a black-hole. Therefore, there's a meaning.

The dark entities are indestructible, this is how the universe is meant to be – with the dark entities only. Also, all energy stars could be attracted to a dark star, this is to say that a dark star will be at the center of a galaxy (Figure Y). Now, the explanation;

The meaning of equation (12) and (13) by their comparison is; the death of a star (energy star) in the visible dimension will result to a black-hole and at the dark dimension, the presence of a dark star will result to a black-hole. Can you see the difference?

Thus, a star in the dark dimension (dark star) resting on space-time will cause a black-hole on space-time and a dead energy star in the visible dimension resting on space-time will cause a black hole on space-time. So, either way it's a star, dead or not dead, it must be a star resulting to a black hole. Dead for energy stars, not dead (active) for a dark star.

That's the story that equation (12) and (13) is telling. So yes, if a statement goes that way, I'll agree 100%. All these means that a black hole should be expected at the center of each galaxy and a dark star might not be observed because of its invisibility but it is present also at the black hole point.

Hence, the discovery of a dark star and detection of a gravitational effect by dark matter awaits.

a) Fate of the Universe

Figure 25

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The situation I just explained about the default nature of space-time at the outer-space being stretched by dark energy explains the fate of this universe. Space-time is a very thick entity represented by the value (1.50 x 10^{10}), its thickness is responsible for holding the planetary bodies floating. Although the nature of space-time at the outer-space is still thick enough to hold the planets floating but the present thickness is not as thick as it used to be. In Figure 26, (a) is the default nature during creation, its present nature could be b, c, d or even less than d but I know for sure that it's still thick to keep the planets floating. The fact that is still thick enough to keep the planets floating is the reason we don't notice the reduction of its thickness observationally. As dark energy stretches the space-time, it results into an increase in area of the universe (space-time) and also a decrease in thickness of space-time. Not concerned about the area but thickness this time.

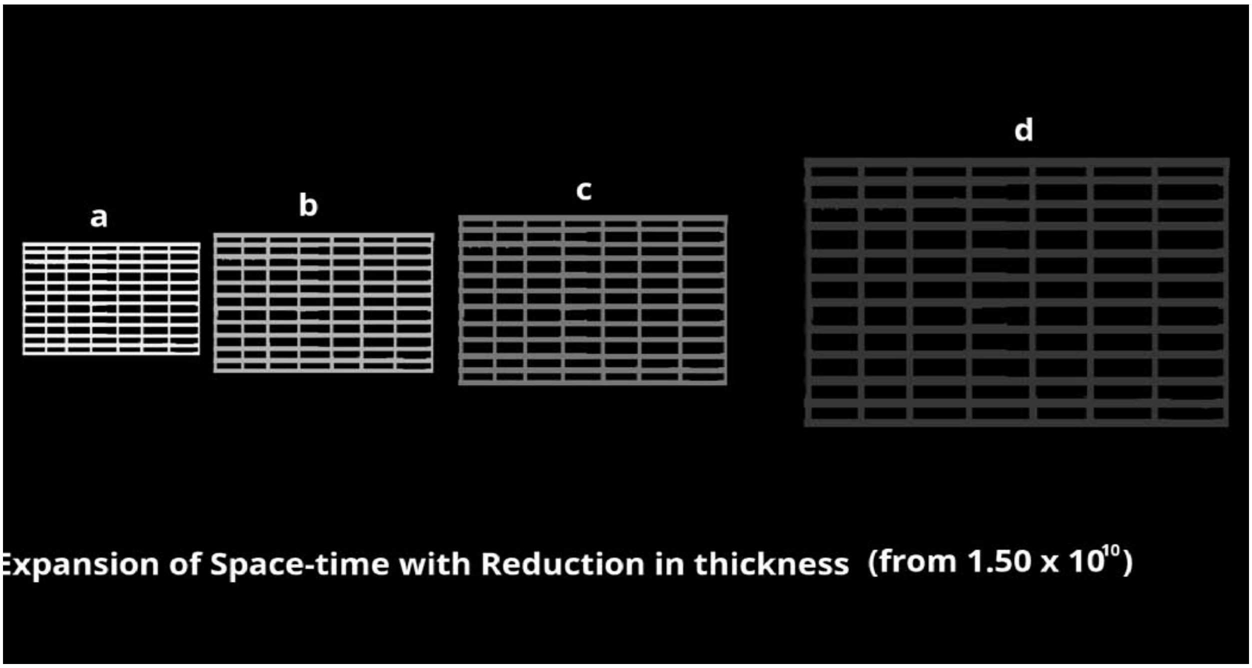

Figure 26

We can observe that it's still thick but it was thicker some centuries back. This is the situation/problem of the Universe; it's not only dark energy that stretches space-time, the same effect is observe from gravity; it stretches/reduces the thickness of space-time at the line of pressure due to pressure by mass on space-time. An example of the new (stretched/reduced space-time) by gravity is the nature on earth, we can see that the nature of space-time on earth is very free, not showing sign of thickness.

Although, gravity stretches space-time at a fast rate and dark energy does it at a slow rate compared to gravity, this whole situation means that the present thickness of space-time at the outer-space will eventually reduce/stretch to a very free space by dark energy. Let's do a swap between the present nature of space-time at the outer-space and the nature of space-time on earth. This is what happens; you can observe that on earth, objects don't float rather they fall to the ground; this is the fate of the universe.

All planets at the outer-space will fall and crash on another, imagine crashing with a star, the energy from a star can consume several planets. Note, the nature of space-time at the outer-space won't be like the nature on earth before planets start crashing, at a certain thickness that can't keep them floating, they will start crashing on one another. The situation of a black-hole gaining mass from its nearby environment will be the case that time. The energy (radiation) from the stars will keep gaining mass as they consume planets. At last, all planets (matter) in this universe will become radiation and proceed to merge with dark energy just like they united at the big bang. Hence, this visible part of universe will be destroyed completely but do you know? If that happens, our creator won't lose a single strand of particle of the entities he used to create the universe. The exact quantity of the entities that formed this universe is the exact that will be present at its demise. Hence, he'll just create another universe with the same "Omni".

Note; Dark energy causes the expansion of the universe i.e. stretches the space-time at the outer space. The more energy photons that become dark energy photons, the more the universe keeps expanding, the more the thickness of the space-time at the outer-space keeps reducing/stretching. This is to say that; "The more black-holes formed by energy stars, the faster the rate at which the universe keeps

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expanding, the closer we get to the demise of the Universe".

At the early years of the universe, energy stars won't die because they are still fresh, the universe will expand at a slow rate. As time goes on, centuries keep passing, stars will start collapsing/dying, black-holes will keep forming, energy photons will keep becoming dark energy photons to increase the amount of dark energy in the universe. As dark energy keeps increasing in amount, the rate of expansion of the universe increases. Wow, "black-holes".

Note; The constants S (space-time), M_d (dark matter) E_d (dark energy) are all the default states of the entities at the creation of this universe. I presented their default states as constants but the entities as time passed are not constants. Space-time will expand and reduce in value, dark energy will increase in amount and value, all from their default states. Presenting the default values of the entities as constants and checking the link between them, is the only way to theoretically get correct answers to unsolved problems in our universe.

S is the default space-time by its magnitude of thickness, its default state is presented as a constant (1.50×10^{10}) but can be stretched/expanded/reduced to a lower value indicating a reduction in thickness. S – by Prince Jessii

E_d is the default dark energy by its amount of energy associated with the default space-time of (1.50×10^{10}), its default state is presented as a constant (4.5×10^{18}) but can be increased to a higher value indicating an increase in amount, this increase is done as energy photons changes to dark energy photons through a black-hole, it stretches space-time and spread smoothly as it increases. E_d– by Prince Jessii

M_d is the default dark matter by its mass value as a constant (50) which is based on the default space-time, as the default space-time expands/reduces in thickness, this mass of dark matter increases. M_d– by Prince Jessii

G is the gravitational constant by its effect associated with space-time, it relates gravity to masses applying pressure on space-time and separation of particles, and these masses applying pressure were formed at creation where the default space-time was present. G – by Sir Isaac Newton

c is the speed of light as a constant, the minimum speed an object must move with to avoid differences in interactions at different natures of space-time (above the law). c – by Ole Roemer, Albert Einstein

Summary; the universe is unstable, this is the reason why dark energy stretches space-time. Why would dark energy stretch its attachment [space-time (S x c)] for no reason at all? The reason why it does that is the fact that the universe is in an "incorrect state", the dark entities are meant to be visible and be the only entities existing, rather the inferior entities are the ones visible. Why is the universe 69% composed of an invisible energy that we can't observe/see? At this time, it's 69%, isn't that fact alone making any sense? The equations of this universe speaks for itself. If I say that; Sc/M_dc^2 is the equation of the universe, will you believe me? I don't think so, because you can't get the inferior entities from the breakdown or the surface of the equation. Perhaps, if I say that Sc^2h/k is the equation of the universe, you would believe me because all observable entities that makes up this universe generally can be found at the surface, the breakdown of the equation presents the dark entities.

The dark entities can be gotten from the breakdown of the equation but they are not at the surface, meaning they are indeed hidden, but if we mathematically convert energy photons to dark energy photons because of the fact that EM radiations (energy) were also used to create this universe and were merged with dark energy at creation but both entities later separated to form two major dimensions, we see that the equation Sc^2h/k changes to Sc/M_dc^2 indicating that the inferior entities are not supposed to exist on their own, they are meant to be in the form of the dark entities. This implies that; as far as space-time has not been stretched to the limit which it can't hold planets anymore, it means that there's still time for the universe to be stable again. Once dark energy and dark matter becomes visible to our eyes, just know that the universe is stable again, Sc^2h/k which is the present form of the universe will change to Sc/M_dc^2,dark energy won't stretch space-time, and the inferior entities will change to their indestructible form.

Whose job is it to make the universe stable again? How can that be done? (See Section VII)

VII. Conclusion

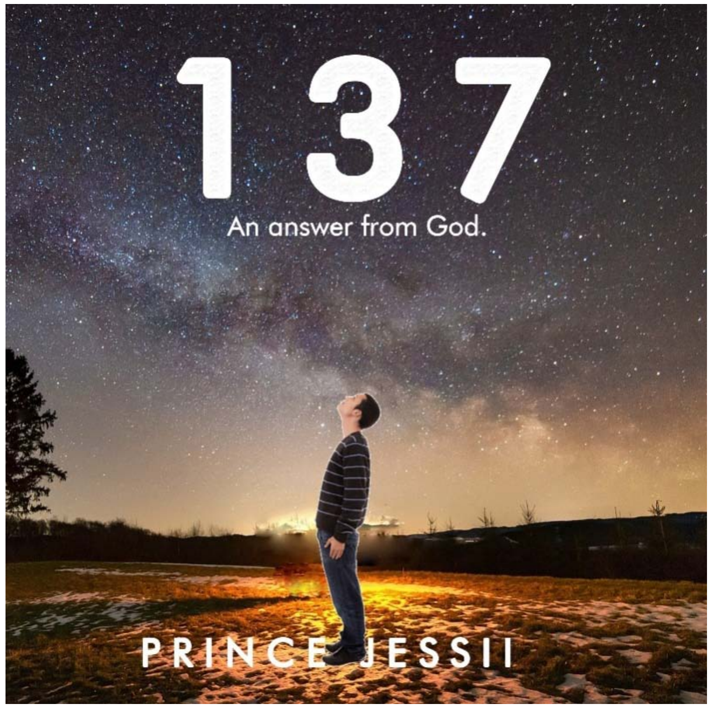

Figure 27

Since 2018, I Prince Jessii (Prince C Igboejesi) has tried to pass an understanding to the world by discovering the GUT (Theory of Everything) but a lot of people are still not aware of this. It seems there's a difficulty from the physics community in recognizing breakthroughs or maybe I need an "Eddington" to the rescue. The earlier the better I'm just saying, please do well to pass this paper to those you think might need it.

Finally, the wisdom of man is foolishness in the eyes our creator. Think, do you think that the billions of planets and stars at the outer space are a form of decoration? No is the answer to that question. If all matter changes to its indestructible form (dark matter), it means that humans would be immortals. Therefore, the billions of planets would contain as many. Think, I keep saying that "this universe is a game." If you understand the significance of the 16th century game I presented earlier then you'll realize the only way this unstable universe can become stable again. It is how matter can change to its indestructible mode (dark-matter). Not all things is presented as physics, read the book [5] (Figure 27)

It's all about the discovery of the Grand Unification Theory (GUT), its discovery resulted into new developments in physics, we just have to move through and identify. So far, the "Theory of Everything" has contributed a lot in physics. I present all achievements in physics brought about by the GUT.

Amongst other minor achievements, I present seven major.

S/N	Achievements in Physics by (GUT/TOE)	Experimental/Observational Confirmation
1	Unification of General Relativity with Quantum Mechanics alongside gravity	Measurement of the fine-structure Detection of gravitational waves Detection of a Pack-Photon (pending) Space-time Curvature: rotation and revolution of planets around their star
2	Perfect Understanding of our Universe (Theoretical and Mathematical)	Existence of black-holes Existence of dark matter and dark energy Detection of Gravitational waves Gravitational lensing Expansion of the Universe Detection of a Pack-Photon (pending) Gravitational effect by dark matter (pending)
3	Confirmed mathematical validation of gravitational theory; space-time model (Description of the different natures of space-time with their values)	Clock Experiment on different planets (pending) Observations on Moon and ISS Acceleration due to gravity
4	Theoretical/Mathematical description of the differences in time	Clock Experiment (pending)
5	Theoretical/Mathematical Presentation of how matter interacts differently in other natures of space-time	Clock Experiment (pending) Observations on Moon and ISS
6	Dark Energy and Dark Matter Theory Black Hole Theory	Existence of black-holes Discovery of equal mass of dark matter (pending) Discovery of a Dark Star (pending) Expansion of the Universe Gravitational effect by Dark Matter (pending)
7	Further Understanding on Electromagnetism; main description of the fine structure constant	Detection of a Pack-Photon (pending)

All theories/calculations and results in this paper are novel and proposed by Prince Jessii.

See more solutions to unsolved problems in science, Physics of the Universe (2) coming soon (2021).

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Hydrodynamics of Underwater «Physical Explosion»

By Gulenko Vladimir Ivanovich & Zakharchenko Evgenia Ivanovna
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Abstract- The modern scientific and technological revolution has led to profound changes in the technique and technology of marine seismic research, ensuring an increase in labor productivity, a significant increase in the volume of work, as well as an increase in their efficiency. At the same time, along with the use of floating piezoelectric seismograph, digital recording equipment, modern electronic computing equipment and more accurate satellite navigation systems, one of the important factors that contributed to improving the efficiency of seismic exploration was the introduction of a new generation of seismic signal excitation devices – non-explosive sources – into the practice of marine seismic research. Of these, the most widely used in seismic exploration in water areas around the world are pneumatic sources, in which elastic waves are excited by underwater exhaust of compressed air.

Keywords: pneumatic source, physical explosion, hydrodynamics of anoscillating bubble, pressure field of anoscillating bubble, rayleigh equation, herring equation, keller-kolodner equation, kirkwood-be the approximation.

GJSFR-A Classification: FOR Code: 249999

Hydrodynamics of Underwater «Physical Explosion»

Gulenko Vladimir Ivanovich [α] & Zakharchenko Evgenia Ivanovna [σ]

Abstract- The modern scientific and technological revolution has led to profound changes in the technique and technology of marine seismic research, ensuring an increase in labor productivity, a significant increase in the volume of work, as well as an increase in their efficiency. At the same time, along with the use of floating piezoelectric seismograph, digital recording equipment, modern electronic computing equipment and more accurate satellite navigation systems, one of the important factors that contributed to improving the efficiency of seismic exploration was the introduction of a new generation of seismic signal excitation devices – non-explosive sources – into the practice of marine seismic research. Of these, the most widely used in seismic exploration in water areas around the world are pneumatic sources, in which elastic waves are excited by underwater exhaust of compressed air.

The purpose of this work is to select and justify a theoretical model that adequately describes the process of pulsation in the water of the air cavity, as well as its acoustic radiation. The model chosen as a result can be used for mathematical modeling of new designs of pneumatic sources that are being developed.

Keywords: pneumatic source, physical explosion, hydrodynamics of anoscillating bubble, pressure field of anoscillating bubble, rayleigh equation, herring equation, keller-kolodner equation, kirkwood-be the approximation.

I. Equations of Motion in a Liquid of Spherical Gaseous Cavity. Pressure Field of The Oscillating Bubble. Basic Quantitative Ratios

From the point of view of hydrodynamics, a pneumatic source belongs to the class of sources of the «oscillating bubble» type. In the theory of sound radiation of a oscillating bubble in an unlimited extent of water, the main problem is the description of its motion. A significant number of works related to the study of acoustic cavitation [1, 2, 14], the calculation of the pressure field from the explosion of condensed explosives [8, 9, 15], from electric discharges in water [10, 11], from the exhaust of compressed air into water by a pneumatic source are devoted to this issue[4, 12, 13, 16, 20].

In the study of the problem of describing the motion of a cavity, the classical solution of the problem of collapse of a spherical cavity in an unlimited volume of a non-viscous incondensable and devoid of surface tension liquid under the influence of constant pressure, given by Rayleigh [9], became fundamental. All further decisions are essentially reduced to analyzing the influence of Rayleigh's assumptions and taking into account the actual properties of the liquid.

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Several types of approximations can be used to describe the motion of the cavity. All of them take into account the compressibility of the liquid in different ways, and each of them leads to a certain nonlinear differential equation of motion of the cavity interface.

a) Zero-order approximation (Rayleigh`s equation)

Assuming the fluid is incompressible ($\rho_0 = const$), it is easy to show that the motion of the interface is described by a second-order nonlinear differential equation [8]:

$$R'' + \frac{3}{2}\cdot\frac{R'^2}{R} = \frac{1}{\rho_0 R}\left(P - P_0\right), \qquad (1)$$

where $R(t)$– the radius of the cavity; ρ_0– the density of the liquid; $P(t)$ – the pressure in the liquid at the interface; P_0– the hydrostatic pressure.

If it is necessary to study the sound radiation of the cavity, the incompressibility condition must be modified so that the speed of sound in the liquid is finite. In cases where the speed of expansion of the sphere is small compared to the speed of sound in a divergent medium, the density perturbations caused by the expansion of the sphere will also be small. Therefore, for such processes, the propagation of a divergent wave can be described by a solution of linear acoustics that satisfies the boundary condition of velocity continuity on the surface of a sphere. Then the pressure distribution in the liquid is given by the equation [9, 11]:

$$p(r,t) - P_0 = \rho_0\frac{R^2R'' + 2R'^2R}{r} - \rho_0\frac{R'^2}{2}\frac{R^4}{r^4}, \qquad (2)$$

Or excluding R'' using the equation(2.1),

$$p(r,t) - P_0 = \rho_0\frac{R}{r}\left(\frac{P-P_0}{\rho_0} + \frac{1}{2}R'^2\right) - \rho_0\frac{R'^2}{2}\frac{R^4}{r^4}, \qquad (3)$$

where r – radial coordinate.

Denoting $V = 4/3\ \pi\ R^3$– the volume of the sphere, we get from (2)

$$p(r,t)-P_0=\rho_0\frac{V''}{4\pi r}-\frac{1}{2}\frac{V'^2}{(4\pi)^2 r^4}.$$

In the wave zone, the second term on the right side of this formula is negligible, so we can write down

$$p(r,t)-P_0=\rho_0\frac{V''}{4\pi r}.$$

This shows that *the pressure in the liquid is proportional to the volume acceleration of the gas bubble*. The maximum acceleration will be at the minimum volume of the bubble. Thus, in the process of cavity pulsations, repeated pressure pulses are emitted at each minimum volume.

Differential equation (1) does not allow us to take into account the energy emitted by the compression wave, and is a zero-order approximation in which all terms of the order R'/c are ignored (where c is the speed of sound in a liquid). The elastic modulus is assumed to be infinitely large and, consequently, the speed of sound in water is infinitely large as well.

Solution of the Rayleigh equation, Rayleigh-Willis formula

Considering the collapse of a spherical cavity having at the initial moment the radius R_{Max} and the pressure P inside, significantly less than the hydrostatic $P0$, and taking into account that this pressure ratio persists for most of the period of pulsations, Rayleigh obtained a simple solution to the equation (1) [14]:

$$R'^2=\frac{2(P_0-P)}{3\rho_0}\left(\frac{R_{\max}^3}{R^3}-1\right)\approx\frac{2}{3}\frac{P_0}{\rho_0}\left(\frac{R_{\max}^3}{R^3}-1\right). \quad (4)$$

This solution describes the collapse of the Rayleigh cavity. Based on it, Rayleigh determined the time t_{max}, required for complete collapse of the cavity under the condition $R_0 << R_{max}$:

$$t_{\max}=\sqrt{\frac{3\rho_0}{2P_0}}\int_{R_0}^{R_{\max}}\frac{dR}{\sqrt{\left(\frac{R_{\max}}{R}\right)^3-1}}.$$

For $R_0 = 0$ this integral can be taken using Γ-function:

$$t_{\max}=0{,}915R_{\max}\left(\frac{\rho_0}{P_0}\right)^{1/2}.$$

This time is approximately equal to half the period of pulsation of the cavity. Hence

$$T\approx 2t_{\max}=1{,}83R_{\max}\left(\frac{\rho_0}{P_0}\right)^{1/2}. \quad (5)$$

Expressing the maximum radius in terms of the total energy of the pulsating bubble, Willis obtained [9, 11, 18]:

$$T=1{,}14\rho_0^{1/2}\frac{E^{1/3}}{P_0^{5/6}}. \quad (6)$$

Formula (6) is often called the Rayleigh-Willis formula. It is very useful for estimating the relative energy and acoustic characteristics of various types of marine seismic sources. As can be seen from the Rayleigh-Willis formula, the pulsation period increases in proportion to the cube root of the total energy and decreases in proportion to the hydrostatic pressure in the power of 5/6. For processes accompanied by the formation of spherical gas bubbles in water (explosions of condensed explosives, underwater gas explosions, electric discharge, exhaust of compressed gas), this dependence is in better agreement with the experiment, the greater the depth of immersion of the source and the less heat exchange between the gas in the bubble and the surrounding liquid. Note, however, that formula (6) does not apply if the pulsating bubble is located near the liquid boundary due to a change in the nature of the spreading flows.

b) *First-order approximation: Herring and Keller-Kolodner equations*

The assumption that the speed of sound in water is permanent (and in this case the elastic modulus is considered as a constant and there is a linear dependence of pressure on density) leads to a first-order approximation, which contains terms of the order R'/c. Acoustic approximation allows us to take into account the energy loss due to radiation in this case.

The transformations performed by Herring [14] under the assumption $c = c_0 = = const$, give the equation:

$$\left(1-\frac{2R'}{c_0}\right)R''+\frac{3}{2}\left(1-\frac{4}{3}\frac{R'}{c_0}\right)\frac{R'^2}{R}=\frac{1}{\rho_0 R}\left[P-P_0+\frac{R}{c_0}\left(1-\frac{R'}{c_0}\right)P'\right]. \quad (7)$$

Compatible equation was obtained by Keller and Kolodner [17]:

$$(R'-c_0)\left(RR''+\frac{3}{2}R'^2-H_0\right)-R'^3+2R'H_0+RH_0'=0, \quad (8)$$

where $H_0 = \dfrac{P - P_0}{\rho_0}$.

For the case of an incompressible fluid ($c_0 \to \infty$), equations (7) and (8) are transformed into the Rayleigh equation (1).

The expression for the pressure field around the oscillating bubbleis obtained in [17] (or equation (13.333) from [8]):

$$\frac{p(r,t) - P_0}{\rho_0} = -\frac{f'(t_1)}{r} - \frac{f^2(t_1)}{2r^4} - \frac{1}{2c_0}\left[\frac{f'^2(t_1)}{c_0 r^2} + \frac{2f(t_1)f'(t_1)}{r^3}\right], \quad (9)$$

where$t_1 = t - r/c_0$; f and f' are given by the equations

$$f = -R^2R' + \frac{R^2}{c_0}\left(\frac{P - P_0}{\rho_0} + \frac{R'^2}{2}\right), \qquad f' = -R\left(\frac{P - P_0}{\rho_0} + \frac{R'^2}{2}\right). \quad (10)$$

In equation (9), Keller and Kolodner left the first two terms and omitted the second two, without examining their relative values [17]. In [21], an attempt was made to prove that the second term in equation (9) is not related to linear elastic theory and Newton's second law. Indeed, in deriving equation (9), Keller and Kolodner began their analysis with the wave equation, which applies only to a linearly compressible fluid with a constant speed of sound, when the particle velocity is sufficiently small. Then they linked the particle velocity to pressure via the Bernoulli equation, which has a much broader application than the wave equation. The authors of [21] correctly pointed out the incompatibility of the wave equation and the Bernoulli equation and the appearance of terms in equation (9) that are not related to linear elastic theory. However, in their analysis, they also omitted terms that are significant for linear theory when calculating the pressure field in the near zone.

Since the particle velocity in a linearly compressible fluid is quite small, we transform equation (9), by omitting the terms of the order$(R'/c)^2$. In the end we get:

$$p(r,t) - P_0 = \rho_0 \frac{R}{r}\left(\frac{P - P_0}{\rho_0} + \frac{R'^2}{2}\right)\left[1 - \frac{R'}{c_0}\frac{R^2}{r^2}\left(1 - \frac{R}{r}\right)\right] - \rho_0 \frac{R'^2}{2}\frac{R^4}{r^4}. \quad (11)$$

If in (9) we neglect the term of the order R'/c_0, we get equation (3).

c) *Second-order approximation (approximation of Kirkwood-Bethe)*

For the case when the rate of expansion of the cavity in the liquid is high and the density perturbations caused by the expansion of the cavity are significant, the Kirkwood-Bethe approximation is applicable [8, 9]. This method, developed in the study of underwater explosions, consists in determining the invariant of motion, which is taken as the function

$$\Phi = r(h + u^2/2),$$

where h –specific enthalpy of the liquid; u –particle velocity.

The value of Φ propagates at a constant speed equal to $u + c$ (where c is the local speed of sound). Under this condition, the equation of motion of the interface takes the form:

$$\left(1 - \frac{R'}{c}\right)R'' + \frac{3}{2}\left(1 - \frac{R'}{3c}\right)\frac{R'^2}{R} = \left(1 + \frac{R'}{c}\right)\frac{H}{R} + \left(1 - \frac{R'}{c}\right)\frac{H'}{c}, \quad (12)$$

where $H(t)$ and $c(t)$ are the specific enthalpy and speed of sound in the liquid at the interface, respectively. Both of these functions depend on the pressure $p(t)$. Equation (12) was first obtained by Gilmore [8, 9]. The relationship between pressure and enthalpy is found from the experimental dependence of pressure on density under isentropic compression, which is described by the formula [11]:

$$\frac{p + B}{P_0 + B} = \left(\frac{\rho}{\rho_0}\right)^n, \quad (13)$$

where B and n –constants that depend on the type of liquid; for water $B = 2\,500$ atm, $n = 8$ [20], or $B = 3\,000$ atm, $n = 7$ [11]. Using the equation (13),

weget $c^2 = \dfrac{dp}{d\rho} = \dfrac{n(p+B)}{\rho} = \dfrac{n(p+B)}{\rho_0}\left(\dfrac{p+B}{P_0+B}\right)^{-\frac{1}{n}}$,

hence

$$c = c_0\left(\frac{p + B}{P_0 + B}\right)^{\frac{n-1}{2n}}, \quad (14)$$

where c_0–speed of sound propagation in an undisturbed liquid.

$$h(p)=\int_{P_0}^{p}\frac{dp}{d\rho}=\int_{P_0}^{p}\left(\frac{p+B}{P_0+B}\right)^{-\frac{1}{n}}\frac{dp}{\rho_0}=\frac{n(P_0+B)}{(n-1)\rho_0}\left[\left(\frac{p+B}{P_0+B}\right)^{\frac{n-1}{n}}-1\right]. \tag{15}$$

On the surface of the sphere $h=H,\ c=C,\ p=P$, and from equations (14) and (15) we obtain:

$$C=c_0\left(\frac{P+B}{P_0+B}\right)^{\frac{n-1}{2n}}, \tag{16}$$

$$H=\frac{n(P_0+B)}{(n-1)\rho_0}\left[\left(\frac{P+B}{P_0+B}\right)^{\frac{n-1}{n}}-1\right]. \tag{17}$$

To compare equation (12) with equations (7) and (8), transform equation (16)

$$c=c_0\left(\frac{P+B}{P_0+B}\right)^{\frac{n-1}{2n}}=c_0\left(1+\frac{P-P_0}{P_0+B}\right)^{\frac{n-1}{2n}}=c_0\left[1+\frac{n-1}{2n}\frac{P-P_0}{P_0+B}-\frac{n^2-1}{(2n)^2 n!}\left(\frac{P-P_0}{P_0+B}\right)^2+O\left(\left(\frac{P-P_0}{P_0+B}\right)^3\right)\right]$$

and determine the order of value

$$\frac{P-P_0}{P_0+B}=\frac{\dfrac{P-P_0}{\rho_0}}{\dfrac{P_0+B}{\rho_0}}=\frac{\dfrac{P-P_0}{\rho_0}}{\dfrac{c_0^2}{n}}.$$

According to the approximate solution of equation (1) given by Rayleigh [9], the value $\dfrac{P-P_0}{\rho_0}$ is proportional to R'^2. Therefore, the expression $\dfrac{P-P_0}{P_0+B}$ has the order $(R'/c_0)^2$. Thus, up to terms of order $(R'/c_0)^2$

$$C=c_0. \tag{18}$$

Similarly, we can show that, neglecting the terms of order $(R'/c)^2$, for the enthalpy H we get

$$H=\frac{P-P_0}{\rho_0}. \tag{19}$$

Substituting the expressions (18) and (19) in equation (12) and neglecting the term $\dfrac{R'}{\rho c_0^2}P'$, having an order $(R'/c_0)^2$, we get the Keller and Kolodner equation (8).

We now transform equation (12) by multiplying each of its terms by c:

$$[(c+R')-2R']R''+\frac{3}{2}\left[(c+R')-\frac{4}{3}R'\right]\frac{R'^2}{R}=(c+R')\frac{H}{R}+[(c+R')-2R']\frac{H'}{c}.$$

Dividing each term of this equation by $c+R'$ and neglecting the terms of order $(R'/c)^2$, we arrive at the equation

$$\left(1-2\frac{R'}{c_0}\right)R''+\frac{3}{2}\left(1-\frac{4}{3}\frac{R'}{c_0}\right)\frac{R'^2}{R}=\frac{1}{\rho_0 R}\left(P-P_0+\frac{R}{c_0}P'\right), \tag{20}$$

which is accurate to the term $\frac{R'}{\rho c_0^2}P'$, having an order$(R'/c)^2$, coincides with the Herring equation (7).

Thus, the Kirkwood-Bethe approximation allows us to take into account terms of order$(R'/c)^2$and is a second-order approximation. It can be considered proved that the Herring (7) and Keller-Kolodner (8) equations coincide with each other up to terms of order $(R'/c)^2$.

Taking into account the terms of the order$(R'/c)^2$ the pressure field of the oscillating bubbleis calculated using the formulas [20]:

$$p(r,t)-P_0=\rho_0\left(\frac{y}{r}-\frac{u^2}{2}\right)+\frac{\rho_0}{2c_0^2}\left(\frac{y}{r}-\frac{u^2}{2}\right)^2, \tag{21}$$

where $y=R\left(H+\frac{R'^2}{2}\right)$;

$$u=\frac{y}{c_0 r}+\frac{k_3 y^2}{c_0^3 r^2}\left(1-\frac{y}{c_0^2 r}+\frac{k_3^2 y^4}{2c_0^8 r^4}\right); \tag{22}$$

$$k_3=\frac{c_0^3 R^2 R'}{y^2}\left(1-\frac{R'^2}{2c_0^2}\right)-\frac{c_0^2 R}{y}\left(1-\frac{R'}{c_0}\right).$$

It is easy to show that, ignoring the terms of order $(R'/c)^2$, we find an expression for the pressure field from (21) that coincides with equation (11).

II. Results of Numerical Solution of Equations of the Motion of Spherical Cavity. Analysis of the Assumptions made in Relation to the Underwater Exhaust of Compressed Air

a) Comparison of results of numerical solution of equations of the motion of a spherical gas cavity in a liquid

So, to describe the motion of a pulsating spherical bubble in a liquid, we can apply three different differential equations, depending on the order to which the terms R'/c are taken into account. The assumption of incompressibility of the fluid leads to the differential equation (1), in which all terms of the order R'/c are ignored – this is an approximation of the zero order. The pressure field in a liquid is described by equation (3).

The assumption that the speed of sound in a liquid is constant leads to equation (7) or (8), which take into account the terms of the order R'/c and which coincide with each other up to the terms of the order $(R'/c)^2$. This is a first-order approximation. The pressure field is given by equation (11). Finally, the Kirkwood-Bethe approximation leads to differential equation (12), which takes into account second-order terms with respect to R'/c. This is a second-order approximation. The pressure field is given by equation (21).

Let's assume that a sphere with radius R_0 (initial volume of the sphere $V_{01}=(4/3)\pi R_0^3$) with gas pressure inside P_{01} exceeding the hydrostatic pressure is placed in an unlimited extent of liquid with densityρ_0 and hydrostatic pressure P_0. At the initial moment, the shell of the sphere is instantly removed and the bubble expands with acceleration under the influence of the pressure difference in the bubble and in the surrounding liquid. In this case, an acoustic signal is emitted, the maximum pressure of which is observed at $t = 0$. Assuming that the change in the state of the gas in the bubble occurs according to the adiabatic law, the pressure in the bubble as a function of its radius is described by the dependence

$$P=P_{01}\left(\frac{V_{01}}{V}\right)^{\gamma}=P_{01}\left(\frac{R_0}{R}\right)^{3\gamma}, \tag{23}$$

where γ–is the adiabatic exponent (for air $\gamma = 1{,}4$). Knowing the pressure in the bubble, we can solve differential equations (1), (7) (or (8)) and (12) by setting the following initial conditions:

$$R(0)=R_0,\quad R'(0)=0,\text{при этом } P(0)=P_{01}. \tag{24}$$

Numerical solutions of these equations performed in MathCAD by the fourth-order Runge-Kutta-Gill method at$P_{01} = 12$ *МПа*, $P_0 = 0{,}2$ *МПа*, $R_0 = 0{,}089$ *м* ($V_{01} = 3$ *дм*^{3}), are shown in Fig. 1. The solutions of equations (7), (8), representing the first-order approximation, and equation (12), describing the second-order approximation, as well as the pressure in the liquid, calculated respectively from equations (11) and (21), completely coincide and are represented by a single curve. Fig. 1 (a) shows the change in the bubble radius as a function of time. Fig. 1 (b) shows acoustic pressure signals in the far zone, reduced to a distance of 1 m from the emitter. As can be seen from figure 1, equation (1) gives a sustained solution. Equations (7), (8), and (12), which take into account the compressibility of the liquid, allow for energy losses due to radiation. In this case, along with the attenuation of the amplitude, the period of pulsations also decreases.

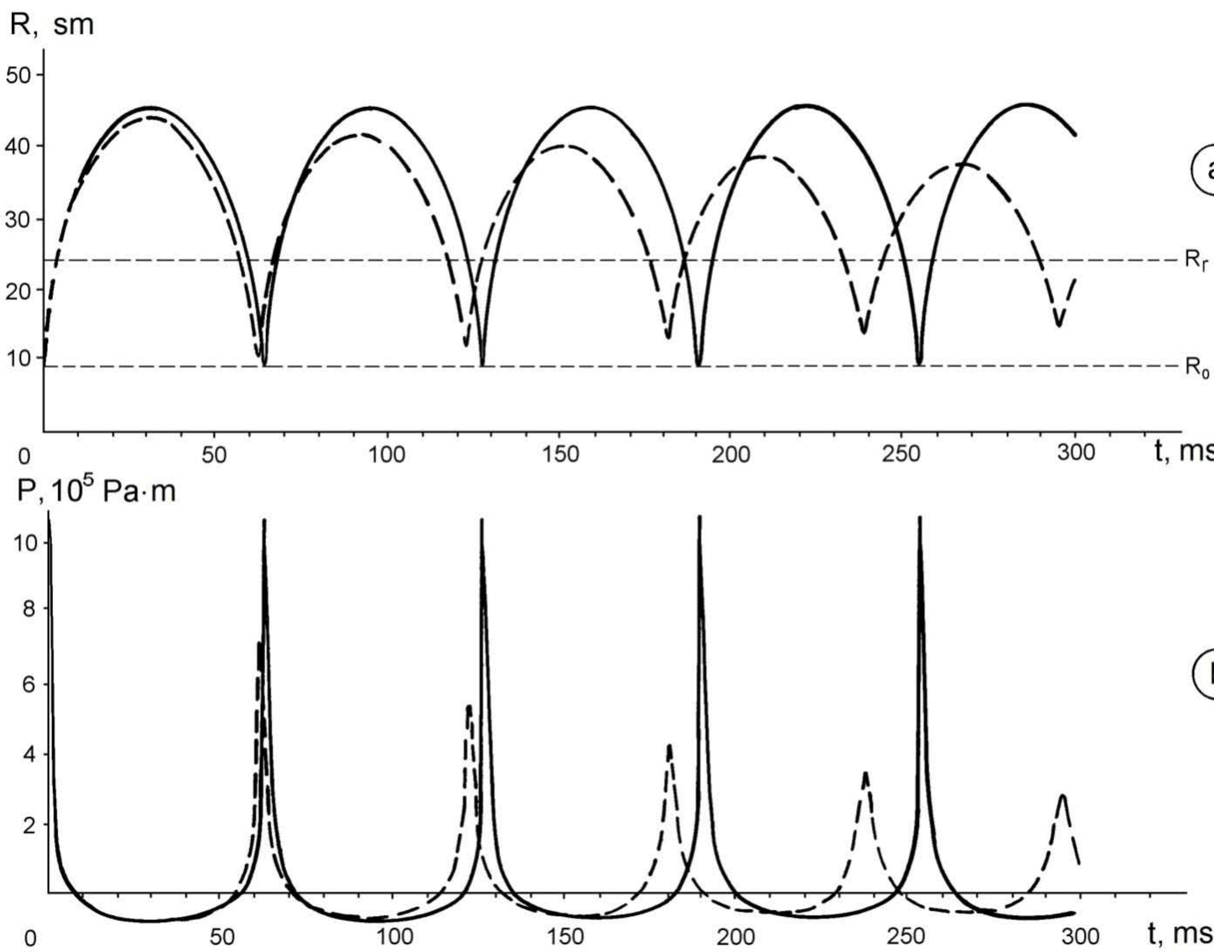

Fig. 1: Numerical solution of equations (1), (7), (8) and (12) at P_{01} = 12 *MPa*, P_0 = 0,2 *MPa*, R_0 = 0,089 *m*; (*a*) – dependence of the bubble radius on time; (*b*) – pressure in the compression wave; ______ equation (1); _ _ _ _ equations (7), (8) and (12)

Numerical analysis of the equations of motion of the cavity shows that at an initial pressure P_{01} = 10 ÷ 15*MPa* for volumes V_{01} = 0, 1÷10 dm^3 (namely, at such pressures and volumes of operating chambers, pneumatic sources are used), approximations of the first and second orders give the same results. Since the vibrations of a free bubble represent an idealized case for a pneumatic source, when the energy losses associated with the flow of air through the exhaust windows of the source are ignored, the expansion rate of real bubbles will be at least no greater than the expansion rate calculated for free bubbles. Hence, we conclude that the rate of expansion of bubbles generated by pneumatic emitters is small and there is no need to use a second-order approximation.

The zero – order approximation – equation (1) – is the roughest approach to the problem of acoustic radiation and is mainly used to obtain semi-quantitative information about the oscillating bubble.

The first-order approximation remains, which leads to equations (7) and (8). In our opinion, the use of these equations is most advantageous, since with the same accuracy of the solution as equation (12), these equations are simpler. Since equations (7) and (8) coincide up to second-order terms with respect to R'/c, any of these equations can be used to describe the motion of a bubble formed by an underwater exhaust of compressed gas. The Keller-Kolodner equation (8) is most often used in the literature devoted to the theoretical study of underwater compressed air exhaust.

b) Analysis of the effect of viscosity and surface tension

When a fluid moves radially, viscosity and surface tension are not included in the equation of motion, but they appear under boundary conditions. If we assume that the radial stress in the liquid and the pressure in the cavity must be continuous at the interface, we get [2, 14, 20]:

$$P(t) = P_g + P_v - \frac{2\sigma}{R} - \frac{4\mu R'}{R}, \quad (25)$$

where P_g и P_v–partial pressures of gas and water vapor, respectively; σ– surface tension; μ– shear viscosity. For water, the value is: $\sigma = 72{,}5 \cdot 10^{-3} N/m$, $\mu = 10^{-3} kg/m \cdot s$.

The effect of surface tension and viscosity can be significant only for a very small radius of the bubble and a high speed of its surface movement, which is observed, for example, in acoustic cavitation [2, 14, 19]. For bubbles generated by pneumatic sources with operating chamber volumes from 0.1 to 10.0 dm^3, according to calculations, we obtain the following order of values: $R \approx 10^{-1} m$, $R \approx 10\ m/s$. Thus, the order of magnitude of the stress that occurs under the action of surface tension and viscosity is:

$$\frac{2\sigma}{R} + \frac{4\mu R'}{R} \approx 1{,}85\, N/m^2.$$

Since the minimum value of the gas pressure in the bubble, reached at $R = R_{max}$, has an order $P_{g\ min} = 0{,}2\ atm = 2 \cdot 10^4 N/m^2$, which is 4 orders of magnitude greater $\left(\frac{2\sigma}{R} + \frac{4\mu R'}{R}\right)$, the effect of surface tension and viscosity in this process can be ignored. Thus,

$$P = P_g + P_v.$$

The water vapor pressure in the bubble P_v will reach its maximum when the bubble expands to its maximum volume and the gas pressure of the P_g becomes minimal ($P_g = 0{,}2\ atm$). The partial pressure of water vapor never exceeds 10% of the P_g value [20], so $P_{v\ max} = 0{,}02\ atm$, i.e. this value can be ignored. As a result, we get

$$P = P_g, \quad (26)$$

that is, the pressure inside the bubble is caused only by the air pressure.

c) Physical models of pneumatic sources

i. *Model in the form of a spherical gas layer*

In some works (Schulze-Gattermann R. [22]; Gribanov A.M., Akentyev L. G.[13]), theoretical estimates of the parameters of the pressure signal emitted by a pneumatic source were achieved. Physical model of the source is a spherical layer with compressed gas containing an absolutely rigid sphere. This model is somewhat closer to reality and takes into account the influence of the source body on the expansion of the cavity, but the description of the dynamics of the process, and especially the acoustic radiation at the initial stage of the exhaust, is also approximate and differs from the experimental data.

ii. *The Schulze-Gattermann model*

In contrast to the spherical layer model considered by Gribanov A.M. and Akentiev L.G. based on the Rayleigh equation for adiabatic changes in the state of gas in a bubble, the Schulze-Gattermann spherical layer model is based on the Keller-Kolodner equation under the assumption of isothermality of the process of changing the state of air in a bubble during its pulsation in water.

Some people calculated characteristics obtained for the Schulze-Gattermann model are somewhat closer to the experimental ones (the period of pulsations), but other indicators (the amplitude and shape of the signal) differ from the characteristics of the real process.

iii. *The Safar model*

In contrast to all other models in which the pneumatic source is modeled as an air sphere with an initial volume equal to the volume of the operating chamber, in the theoretical model of Safar (Safar M. H. [16]), it is proposed to approximate the shape of the bubble at the initial stage of the process with an equivalent sphere, surface area of which is equal to the total area of the exhaust windows of the source. In addition, it is assumed that the first pulse of the emitted acoustic signal reaches a peak value when the exhaust port is fully opened, and the movement of the movable piston occurs under constant pressure.

The calculated characteristics of the underwater exhaust process obtained using the Safar model allow us to more accurately estimate not only the amplitude, steepness, and shape of the first pressure peak of the emitted signal, but also the period of its pulsation. However, the main parameters that characterize the dynamics of the emitter itself are determined in the Safar model either too approximately or not at all.

iv. *The Maksakov-Roy Model*

An important step in the study of the process of underwater exhaust of compressed air was the work (Maksakov A. A., Roy N. A. [3]), which considers a system of differential equations describing the impulse flow of gas into water through a hole, cross-sectional area of which changes in time according to any predetermined law. The air pressures in a constant volume chamber and in a bubble are expressed from the law of conservation of energy and from the equation of state and conservation of mass of gas as it flows from the chamber to the bubble. The flow rate of gas into the bubble during an isentropic flow is given by the Saint-Venant and Wantzel formula, in which the area of the hole was set to vary linearly over time, and the Rayleigh equation was used to describe the movement of the bubble walls.

This model already allows us to quantify the effect of the opening speed of the exhaust port, its maximum area and the initial gas pressure on the acoustic efficiency of the underwater exhaust process. However, in real designs of pneumatic sources, the exhaust area is a complex function of both the design parameters and the gas parameters in the operating and control chambers and in the cavity, and does not change in time according to a linear law.

v. *Model of sources«Signal»*

The most adequate description of the underwater exhaust process can be constructed only taking into account the dynamics of the moving element of the pneumatic source. This model was presented in the work (Gulenko V. I. [4], Gulenko V. I., Karpenko V. D. [5, etc.]).

This model is implemented as a system of ten differential equations that depend on very many parameters, and is a further development of the idea laid down in the Maksakov-Roy model. An experimental study of the dynamic and acoustic characteristics of pneumatic sources of the «Signal» series [6] has showed a very good agreement with the theory.

III. Conclusion

1. The Rayleigh differential equation, which describes the simplest model of a pneumatic source in the form of a gas cavity, does not take into account the compressibility of water, the presence of a source, and the influence of processes occurring in it. Therefore, this model can be used only in the first approximation as a purely qualitative illustration of the process of pulsation in the liquid of an air bubble.
2. In the model described by the Keller-Kolodner equation, energy losses due to acoustic radiation are taken into account, so its solution is decaying and non-periodic. However, it also does not take into account the presence of the source and the influence of processes occurring in it, as well as the heat exchange between the air in the cavity and the surrounding liquid.
3. The Kirkwood-Bethe approximation was developed for underwater explosions of condensed explosives characterized by very high explosion product pressures and, consequently, high bubble expansion rates comparable to the speed of sound in water.

   In addition, calculations show that the solution of the Gilmore equation completely coincides with the solution of the Keller-Kolodner equation to describe the free vibrations of an air bubble in a compressible liquid for the initial parameters of the problem corresponding to the typical parameters of an underwater pneumatic explosion, so the use of the Kirkwood-Bethe approximation for solving this class of problems is not justified.
4. The most adequate description of the process of underwater exhaust of compressed air can be built on the basis of the Keller-Kolodner equation, but with mandatory consideration of the dynamics of the moving element of the pneumatic source, which determines the mode of air flow from the operating chamber to the expanding cavity.

IV. Annotation

The piece of work is devoted to the selection and justification of a theoretical model of a pneumatic source that adequately describes the process of pulsation in the water of an air cavity, as well as its acoustic radiation.

The classical solution of this problem given by Rayleigh for an incompressible liquid, the Herring and Keller-Kolodner differential equations obtained for a compressible fluid, and the Kirkwood-Bethe approximation developed for underwater explosions of condensed explosives are considered as possible approximations of this process.

It is shown that for those modes of expansion of the cavity that are typical for underwater exhaust of compressed air by a pneumatic source, the most adequate description of the pulsation process is the description of the pulsation process of the air cavity in a compressible liquid – the Keller-Kolodner differential equation. It is also shown that the influence of water viscosity and surface tension on the walls of the cavity can be ignored.

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Parameters of a High-Frequency Source Located in the Tropopause

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Abstract- A model of a transionospheric pulse pair, previously obtained experimentally and not having a satisfactory explanation, is proposed. The physical parameters of the emitting object in the form of a flat ionized structure, the electron density in it, and the electron temperature are considered. Two estimates are given for each of these parameters, where $n = 10^7 cm^{-3}$, and T_e is in the range from 600 K to 3000 K.

Keywords: transionospheric pulse pair, nonlinear plasma-waveguide model, tropopause, ordinary and extraordinary waves.

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PARAMETERSOFAHIGHFREQUENCYSOURCELOCATEDINTHETROPOPAUSE

Strictly as per the compliance and regulations of:

Parameters of a High-Frequency Source Located in the Tropopause

G. V. Sklizkov[α] & A. V. Shelobolin[σ]

Abstract- A model of a transionospheric pulse pair, previously obtained experimentally and not having a satisfactory explanation, is proposed. The physical parameters of the emitting object in the form of a flat ionized structure, the electron density in it, and the electron temperature are considered. Two estimates are given for each of these parameters, where $n = 10^7 cm^{-3}$, and T_e is in the range from 600 K to 3000 K.

Keywords: transionospheric pulse pair, nonlinear plasma-waveguide model, tropopause, ordinary and extraordinary waves.

I. Introduction

In [1], from the analysis of the spatial structure of giant jets recorded in [2, 3], it was found that there is a coherent source of HF radiation in the tropopause. However, the parameters of the source remained unexplored. In this work proposed below, an attempt is made, on the basis of the analysis of transionospheric pulse pairs [4, 5] (TIPP) to estimate the spatial dimensions, energy parameters, frequency spectrum, and divergence of a similar source.

Transionospheric pulse pairs of electromagnetic pulses in the atmosphere (TIPP) were recorded in [4], and then analyzed in [5]. The indicated registration was carried out from a satellite in orbit close to circular with height over Earth surface from 800 to 1725 km. The TIPPs themselves were a double electromagnetic pulse in the frequency range 28 - 80 MC, which corresponded to a wavelength range from 3.8 to 11 m and critical electron densities from $9.7 \cdot 10^6 cm^{-3}$ to 810^7 cm^{-3}. The duration of each pulse was from 0.5 μs to 20 μs, with an average duration of 5 μs with intervals between them from 10 μs to 100 μs with an average value of 50 μs. In addition, it was recorded that their power was significantly higher than the power expected and observed for HF radio emission from ordinary lightning at all stages of its development, and the temporary structure of the TIPP was not found anywhere in atmospheric discharges. Solar radiation did not play a decisive role on the effect of TIPP, since the maximum frequency of observations of this phenomenon occurred both at midnight and at noon.

The main observations were carried out in equatorial regions at latitudes of $\pm 8^0$ with a field of view of $\pm 35^0$ (a circle of 8000 km) both in latitude and longitude (though some of the TIPP observations had been made in the mid-latitudes). In approximately 1% of cases, only one impulse was observed. Equally rarely, the second impulse was superior in intensity to the first. In the remaining cases, the former was more powerful, although there was no significant difference in their amplitudes. An analysis of the signal dispersion during the passage of the ionosphere made by the authors of [4, 5] gave a qualitative coincidence of the time – frequency characteristic with the same characteristic for a calibration pulse from the ground. However, if the calibration pulse was linearly polarized and therefore produced a noticeable splitting associated with birefringence near the lower boundary of the frequency range, then a similar splitting for the studied pulse was visible not in all the spectrograms presented, but only in one recorded at latitude 6^0. Was it due to the lack of polarization in individual experiments or it was insufficient frequency-time resolution of the equipment, had been unclear from [4, 5].

An attempt made in [5] to identify the nature of these pulses has not yet been successful. The main attention of the authors [5] was focused on determining the nature of the pairing of these pulses. Although the authors were inclined to believe that the second pulse was a reflection of the first one from the surface of the earth, a number of contradictions did not allow them to confirm it. Below we will try, using the previously proposed nonlinear plasma-waveguide model of electric gas breakdown (NPWM) [6-8], and the results of [9 - 12] to build a general model of the process leading to TIPP, and to analyze on its basis the contradictions noted in [5].

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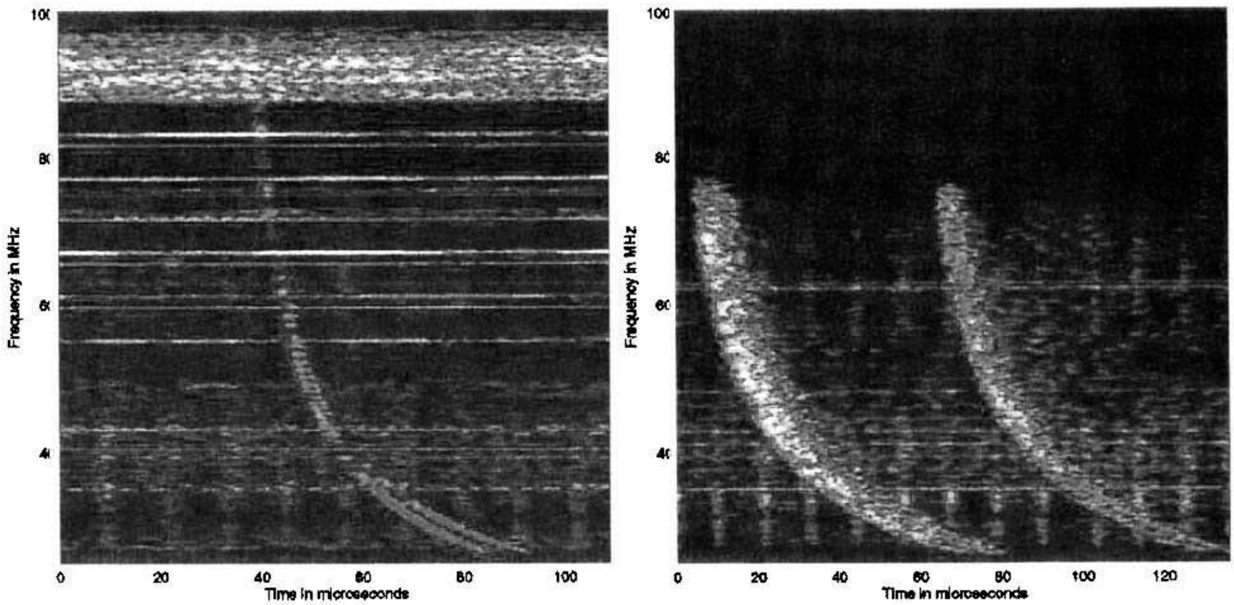


a) b)

Fig. 1: Calibration pulse from the ground (a) and transionospheric pulse pair (b) obtained at latitude 6^0 [4].

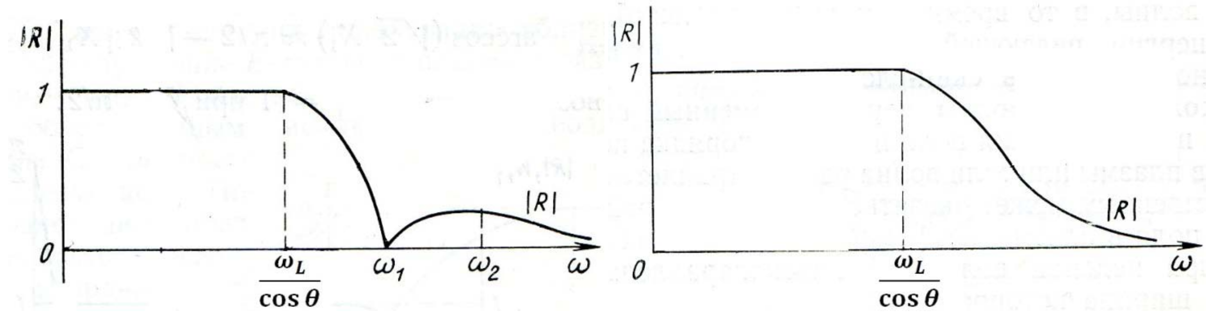
II. Diagnostics of the Plasma of the Object and the Frequency Resolution of the Equipment

The need for such a diagnostics is connected with the fact that the authors' desire [4, 5] to link the resulting dispersion picture with the influence of the ionosphere on the detected radiation is doubtful. Let us try first qualitative, and then quantitative to show that the influence of the ionosphere on the dispersion characteristic of an object is negligible. In this case, we also try to determine the electron density in the studied object. Then, we determine quantity the difference in the refractive indices of the object plasma for the ordinary and extraordinary waves at a frequency of 56 MC, where according to the spectrograms the corresponding lines merge. If for the ionosphere this difference is less than indicated, this will mean that its influence on the recorded signal is negligible. Then it will be possible to make a hypothesis for the structure of the object and determining its necessary geometric parameters and the temperature of the plasma electrons.

First of all, we will give a qualitative understanding of such a TIPP parameter as the frequency range of the process. In this case, as is customary in plasma physics, we will operate with the concept of a cyclic frequency, which is related to the frequency f by the expression $\omega = 2\pi f$, and the corresponding resonant electron density n will be determined from the expression $\omega_L = (4\pi e^2 n/m)^{0.5}$, where e is the elementary charge, m - the electron mass, and ω_L-Langmuir frequency. The lower frequency boundary f = 28 MC will correspond to the resonant electron density $n = 9.7 \cdot 10^6$ cm^{-3}. It should be compared with the electron density in the upper F_2-layer of the ionosphere, reference data for the daily maximum of which give $n \approx 5 \cdot 10^5$ cm^{-3}, which corresponds to the critical frequency f = 6.3 MC. This qualitatively means that the frequency range chosen in [4, 5] assumed an almost complete passage of the investigated radiation through the ionosphere with insignificant dispersion.

To explain the observed dispersion of electromagnetic radiation, it is necessary to analyze the process of polarization of this radiation at the plasma boundary, which has its own characteristics in comparison with this process in the optics of solid transparent bodies. Figure 2 shows the dependence of the reflection coefficient R on the frequency ω and the angle of incidence θ, taken from [14]. In this case the waves of two polarizations are distinguished: s-polarization, or H-wave, and p-polarization, or E-wave. For the H-wave, the vector of its electric field has no projection onto the plane of incidence, but for the E-wave it has.

As shown in Fig. 2, R (ω) decreases monotonically for all frequencies, ω satisfying the condition $\omega > \omega_L / \cos\theta$, which occurs for the H-wave for any θ and for the E-wave for $\theta > 0.25\pi$. If $\theta < 0.25\pi$, then for the E-wave there are two singular points $\omega_1$and ω_2. For $\omega = \omega_1$, the E-wave passes almost completely into the plasma, and the corresponding angle of incidence θ is called the Brewster angle θ_B, and $tg^2\theta_B = \varepsilon = N^2 = 1-(\omega_L / \omega)^2$. Here ε is the dielectric constant of the plasma, N is its refractive index. If θ_B is small, then the H-wave is almost completely reflected, and the E-wave passes almost completely into the plasma without reflection. This allows us to calculate the plasma frequency ω_L for such an inclusion and the electron density n in it. Assuming that the Brewster angle is $\theta_B = 6^0$, i.e., it is equal to the geographic latitude of the experiment, we obtain $\omega_L = \omega\ (1\text{-}tg^2 6^0)^{0.5} = 1.76 \cdot 10^8\ s^{-1}$, and $n = 1.1 \cdot 10^7\ cm^{-3}$. These values are close to the values of the lower boundary of the experimental frequency range [1], estimated above.



a) b)

Fig. 2: The dependence of the plasma reflection coefficient on the frequency for the E-wave (a) and the H-wave (b) [14].

According to the estimate given in [1], at $n \geq 10^7\ cm^{-3}$, the air at altitudes of 15 km and more becomes amplifying, since in it the temperature of the electronic subsystem is detached from the temperature of the neutral subsystem and the elastic scattering of electrons by neutral particles can provide spontaneous emission in the frequency range studied. In addition, the presence of the TIPP polarization indicates that the lower and upper horizontal boundaries of the plasma inclusion are the planes up to the wavelength at the lower boundary of the frequency range of the experiment. Finally, another consequence arising from the polarization of TIPP is the almost one-pass operation of the generator, since there is almost no reflection at the layer boundaries.

We calculate the refractive indices of the plasma for the ordinary and extraordinary waves, based on the expression [11, 12]:

$$N_{1,2}^2 = 1 - \frac{2v(1-v)}{2(1-v) - u\sin^2\alpha \pm \sqrt{u^2\sin^4\alpha + 4u(1-v)^2\cos^2\alpha}} \quad (1)$$

The upper sign in the denominator (1) corresponds to an ordinary wave, and the lower one to an extraordinary one. Here $\alpha = 0.5\pi - \Theta$, $v = (\omega_L / \omega)^2$, $u = (\omega_H / \omega)^2$, $\omega_H = eH / mc$ is the gyromagnetic rotation frequency. At the equator, with a magnetic field strength $H = 0.34$ G, $\omega_H = 5.98 \cdot 10^6 c^{-1}$ for all frequencies of the considered range and all experiments. Calculating by (1) the values of the refractive indices of the plasma with increased accuracy of calculation, we obtain:

$$N_1^2\ (56\ MC) = 0.75316,\ N_2^2\ (56\ MC) = 0.75227,\ \Delta N_{1.2}\ (56\ MC) = 5.1 \cdot 10^{-4}.$$

$$N_1^2\ (F_2\ layer) = 0.94878,\ N_2^2\ (F_2\ layer) = 0.94844,\ \Delta N_{1.2}\ (F_2\ layer,\ 28\ MC) = 1.8 \cdot 10^{-4}.$$

The value $\Delta N_{1,2}$ (56 MC) reflects the threshold for detecting wave decay into ordinary and extraordinary. The value $\Delta N_{1,2}$ (F_2 layer, 28 MC) shows that the dispersion of the considered signal is not significant in the ionosphere as compared to the threshold for recording satellite equipment at 56 MC.

III. The Analysis of the Pairing of Pulses and the Scheme of the Phenomenon

We consider three models of pulse pairing, two of which were close to the models [4, 5] and were not unconditionally accepted as the basis for studies. The third model we propose is based on the NPWM [6-8], analysis of the observation of giant jets [1], and the analysis of ionosphere studies [9–12]. The basic prerequisites for these models and their brief analysis are as follows:

1. One-pulse source can migrate vertically. The second pulse is a mirror reflection of the first from the earth with a reflection coefficient close to 1. The atmosphere is neutral.

The disadvantage of this hypothesis is the need to introduce a vertical source migration process, which we added to the hypothesis [4, 5] in order to explain qualitatively the spectrum of delays between pulses. The second drawback of this hypothesis is the assumption that the momentum reflection coefficient from the earth is close to 1, which contradicts both the reference data on this issue and the presence of experimental results

[4,5], where the second pulse is more powerful than the first one.

2. A two-pulse source does not change its vertical coordinate, but changes the delay between pulses. The atmosphere is neutral. There is no reflection from the earth.

The disadvantage of this hypothesis is that two questions about the delay and the nature of the source are combined into one, which has no answer as well. Formally, such atransition is not prohibited, but it does not bring a solution to the whole problem. In addition, the radiation of such a source should have been observed from the ground, which is not confirmed by the available experimental data.

3. The source is one-pulse. Both the source and the atmosphere are piecewise ionized, that is, separated by horizontal layers and random vertical boundaries. There are no reflections from the earth, but there are reflections from individual ionized layers.

This hypothesis was expressed quite a long time ago [13] and was experimentally confirmed in [1] when analyzing the structure of a giant jet spot on the ionosphere. There, in the open resonator formed by the flat upper layer of a thundercloud and the concave surface of the lower ionosphere, a transverse structure of the jet channels appeared, similar to the transverse structure in hemispherical laser resonators. In this case, the central imprints on the ionosphere were surrounded by a wide, weak imprint. Such an imprint appears only when there are opaque scattering centers inside the resonator whose dimensions are smaller than the working wavelength, which in [1] was 300 m. In studies of the ionosphere, such areas were called sporadic and were obtained both theoretically and experimentally [9, 10,12].

The presence of such sites between the thundercloud and the ionosphere was confirmed in [1]. Our hypothesis suggests that they exist in the interval from the earth to a thundercloud. Moreover, for TIPP, the upper layers of a thundercloud represent a generator with a wide range of frequencies, and the lower layers are a set of parallel mirrors reflecting this radiation. This separation is related to the dependence of the generation threshold on the height of the plasma object, which is the case of the upper ionized layer only. The threshold for the generation of electromagnetic oscillations in air is determined in [1] by the equality of the frequencies of the elastic electron–electron interaction ν_{ee} and the effective electron-neutral interaction ($\nu_{ea}\cdot 2m/M$) in the absence of ionization, i.e. $0.5M/m\cdot \nu_{ee}/\nu_{ea}\geq 1$, where M is the mass of a neutral particle, atom or molecule. Substitution of air parameters into this condition and taking into account the barometric formula [1] give the condition $(1\text{-}2)\cdot 10^{-8}\, n\exp(h/F)\geq 1$, where F = 7.5 -8 km is the reduced height and h is the height above sea level. This formula at $h\approx 2F$ = 15 km shows that at an electron density of $n\approx 10^7$ cm^{-3}, the bremsstrahlung of electrons during elastic interaction with neutral particles can enhance the electromagnetic radiation of the megahertz range, and in the presence of feedback, create lasing.

To illustrate this scheme, we take from [5] a histogram of delays between pulses, expand it vertically and put a height calibration next to the delay time calibration (see Fig.3). In this case, we will assume that the height of the upper boundary of the layer h is related to the delay τ by the relation h = 15-0.5cτ, where $c = 3\cdot 10^5$ km/s. In this case the histogram can be treated as the probability of the distribution of the reflecting layers vertically with the source at its upper coordinate. It should be noted that at these altitudes there is a maximum electron density arising from cosmic radiation, which, however, would not provide the necessary electron density $n = 10^7$ cm^{-3}.

We can draw the following conclusions:

a) Reflection from the earth or from the ocean surface cannot provide differences in the difference in the path of the rays by 15 km or 100 μs, i.e., the delay between the first and second pulses in all experiments should be constant.

b) When reflecting from the ocean surface, the reflection coefficient for all frequencies of the indicated range should be close to 1. In this regard, such reflection cannot give noticeable difference in the amplitudes in individual sections of the experimentally obtained dependence. On the contrary, reflection from the earth's surface should give a significant difference in the intensity of the first and second pulses.

c) If reflection is provided by plasma inclusions, then their concentration is maximal at an altitude of 7.5 km, which corresponds to the lower boundary of the thunderstorm region for tropical latitudes, where measurements were taken.

d) The upper boundary of the graph, i.e., 15 km, practically coincides with the upper boundary of a thundercloud participating in the formation of the transverse mode structure of a giant jet, as described in [1], for tropical latitudes as well.

e) In [4, 5] it was shown that the energy of the first pulse is almost always greater than the energy of the second pulse, and only in some cases the energy of the second pulse exceeded the energy of the first pulse. In the framework of the model under consideration, this means that the electron concentration in plasma inclusions is nonzero and lower than 15 km, but remains below the generation threshold. This suggests that the second reflected pulse can pass with amplification only through the upper layer. The ratio of the powers of the first and second pulses is determined by the reflection coefficient of the lower mirror and the gain of the upper plasma layer, and depending of the fact whether the reflected pulse passed through a medium with an inversion weakened by the first pulse.

f) In [5], rare (~ 1%) recordings of single pulses were also reported, which is consistent with the proposed model, assuming that the reflected pulse did not encounter plasma inclusions on its way to the ground, where it had been absorbed or scattered.

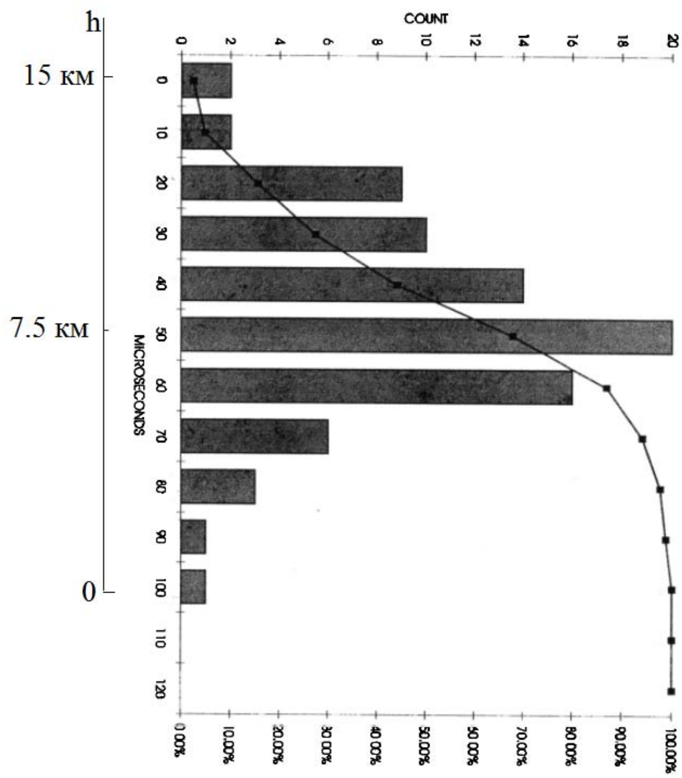


Fig. 3: The probability of vertical distribution of the reflecting plasma planes

In our model, it is assumed that the TIPP radiation is close to parallel, similar to the one emanating from the laser, which can explain qualitatively the increased TIPP intensity at the antenna of the satellite receiving device.

For theoretical verification of the proposed model and for its subsequent experimental verification, it is necessary to make several estimates that can be refined after additional experimental information. In this case, the main attention will be paid to the operation of the generator located at an altitude of 15 km, since the work of the reflecting layers is trivial. Firstly, it is necessary to make another frequency estimate for the frequency of electron-atom collisions ν_{ea}. A standard calculation of this value at an altitude of 15 km is $\nu_{ea} = 4.7{\cdot}10^{10}s^{-1}$. In order to obtain the effective energy frequency of electron-atom collisions, which ensures the process of pumping the medium, the obtained value should be divided by 2m/M. Then we get $\nu_{ea}^{eff} = 4.4{\cdot}10^{5}s^{-1}$. The inverse value will give a characteristic pump time $\tau^{eff} = 2.3{\cdot}10^{-6}$ s, which is close to the average TIPP pulse duration. Thus, the estimates showed that the electromagnetic radiation of the frequency range selected in [4, 5] freely passes through the generator layer, and the duration of a single pulse is almost equal to the duration of pumping by the radiation of electrons from the medium. You can also specify the number of passes of radiation in the generator as from one to four passes.

In optical generator circuits, there are two restrictions diffraction and geometric for divergence of the received radiation, diffraction and geometric. The diffraction restriction is reduced to the condition $\lambda_{max} \leq d$, where λ_{max} = 11 m is the maximum wavelength for radiation of the frequency range under consideration, d is the transverse horizontal dimension of the plasma inclusion. The geometric divergence is d/L, where L is the distance between the plasma mirrors in the plasma generator. For generators with a small number of passes, the maximum quality factor of the wave in the generator will be achieved when the diffraction divergence is approximately equal to the geometric divergence, i.e., λ_{max} / d≈d / L. From here we can estimate the horizontal size of the plasma inclusion as d≈ $(\lambda_{max}{\cdot}L)^{0.5}$. Assuming λ_{max} = 11 m, and from the delay histogram estimating L≈750 m, we obtain d≈90 m.

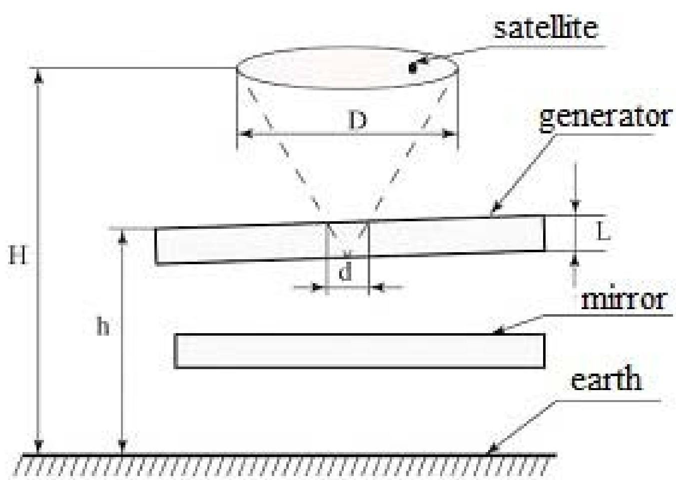


Fig. 4: The geometric design of the experiment

In order to estimate the temperature of the electron of the generator, we consider the geometric scheme of the experiment (see Fig.4). If the satellite is at a height H, and the upper end of the generator at a height h, then the ratio of the spot diameters on the satellite D and the diameter of the generator end face d will be D / d = (H-h + L) / L≈H / L. Then for further estimates, you can take D ≈ 100km.

The histogram of received energy at the satellite's antenna presented in [5] can be interpreted as the shape of the radiation spot in the plane of the satellite's passage, scanned by the satellite's antenna in various experiments, and therefore it can be approximated as a spot in the far zone of the generator through a dependence of the type F (r) = A exp[- $(r/a)^2$]. Such an approximation at parameter values A = $40 \cdot 10^{-9}$nJ / m and a = 40 km gives a satisfactory coincidence with the histogram. Integrating F (r) over the radius and azimuth, we can obtain the total energy in the spot W_H = 4 m J.

This allows a rough estimate of the electron temperature. At the same time, it must be remembered that the concept of temperature is strictly applicable to equilibrium systems only obeying the Planck distribution. That is why, in the presence of an experimental amplitude-frequency characteristic of radiation, comparing it with the Planck distribution, one can rigorously determine the temperature of plasma electrons. Since the experiment [4, 5] does not give such a characteristic, the electron temperature introduced below is only an estimated measure of the generator energy and the generation process.

The balance of energy in the generator's volume, provided that the energy at the generator's end face and the energy in the spot in the region of the satellite's span W_H = W_h is written as $0.25\pi\eta nLd^2 1.5k(Te-T_0) = W_H$, where T_0=200K is the temperature of the neutral component, k is the Boltzmann constant, and η is the generator efficiency. Hence, the electron temperature T_e will be determined from the condition:

$$T_e - T_0 = \frac{8W_H}{3\pi\eta knLd^2} \tag{2}$$

Calculations by (2) give T_e-T_0 = 1 / η·4.1 K. The sharp leading edge of each pulse in the pair, as well as the shape of the spot in the far zone of the generator, suggests that the radiation from the generator should be coherent. Such radiation can be obtained only with the help of a wave developing in the volume of the generator. The closest analogue of such a device is a traveling wave maser [15].

According to [16], masers have η in the range from 0.01 to 0.1, depending on the level of their technical optimization. Moreover, the lower value of η corresponds to the inversion threshold. That is why, as the first very rough estimate of the electron temperature in the layer under consideration, we can take η = 0.01, T_e-T_0 = 400 K, and T_e = 600 K. A detailed discussion of the wave transformation in a plasma generator goes far beyond the scope of this work, and therefore we only mention that in the ionosphere at lower n the electron temperature can reach 1000–2000 K [9, 10]. This is also an estimate by analogy, which at best gives an upper bound on the electron temperature in the generator in question.

Another estimate can be taken from a consideration of the evolution of plasma in a tube of diameter d and length L [17]. If the condition L >> d is satisfied, then the diffusion of all plasma elements in the tube is radial in nature, then in the stationary state the condition is satisfied:

$$\frac{T_e}{E_i} = \left[\ln\left(\frac{\Lambda^2}{\lambda_{ea}\lambda_{ia}} \cdot \frac{M_i}{m} \cdot \frac{\nu_{ia}}{\nu_{ea}} \right) \right]^{-1} \tag{3}$$

Here, λ_{ea} and λ_{ia} are the mean free path in electron-atom collisions and the characteristic ionization length, ν_{ia} and ν_{ea} are the collision frequencies in ion-atom and electron-atom collisions, M_i / m is the ratio of the mass of the ion to the mass of the electron, Λ is the diffusion length, which is determined from ratios Λ = 0.5d / 2.405, E_i is the ionization potential of the neutral component. In the calculations, we take $\Lambda = 2.7 \cdot 10^3$ cm, $\lambda_{ea} = 6.9 \cdot 10^{-9}$ cm, $\lambda_{ia} = 2.4 \cdot 10^{-2}$ cm, $\nu_{ea} = 4.7 \cdot 10^{10}$ s^{-1}, $\nu_{ia} = 1.2 10^{9}$ s^{-1}, M_i / m = 5.5 10 ^{4}. In this case, we obtain T_e / E_i = 0.023, which, taking into account the dispersion of air components in ionization potentials, will give T_e from 3000 K to 3500 K. These values may seem overestimated in comparison with theT_e ionosphere. However, it should be kept in mind that the radiation of the sun and cosmic radiation are the sources of ionization of the ionosphere. Here, an additional action of the electric field and the corresponding currents are assumed.

IV. Conclusion

The analysis allows us to explain the TIPP phenomenon on the basis of the generation of a plasma layer located at an altitude of 15 km, a thickness of 750 m, a diameter of 90 m with an electron density of 10^7 cm^{-3} in the electron temperature range from 600 K to 3000 K and the energy of a pair of pulses is about 4 mJ. In addition, as follows from experiment [4, 5], the frequency range of the detected radiation is from 28 MC to 80 MC. In this case, the lower limit of this range is determined not by the physics of the phenomenon, but by the characteristics features of the experiment.

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Interaction of Electromagnetic Wave and Metamaterial with Inductive Type Chiral Inclusions

By A. N. Volobuev

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Abstract- The principle of calculation of a plate from a metamaterial with inductive type chiral inclusions is submitted. It is shown that distribution of an electromagnetic wave in such substance can be investigated with the help of using of a chiral parameter and on the basis of a detailed method of calculation. With the help of a detailed method the nonlinear differential equation for potential on the chiral plate is found. It is shown that this equation has multiwave solutions as traveling solitary waves and standing waves but not traveling sine waves. The analysis of the received solutions of the nonlinear equation is carried out. Transition from the multiwave solution to the solution as standing waves is graphically shown at reduction of distance between the chiral elements.

Keywords: metamaterial, chiral parameter, inductive inclusions, multiwave solution, standing waves.

GJSFR-A Classification: *FOR Code: 260203*

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Keywords: *metamaterial, chiral parameter, inductive inclusions, multiwave solution, standing waves.*

I. Introduction

Now the materials (Greek. "meta" outside), i.e. composite materials with the various inclusions distributed both chaotically, and periodically are widely applied in particular in a radio engineering, at designing of space devices, in medicine, etc., [1, 2, 3, 4]. Due to these inclusions the received materials have many useful physical, electric, optical and other properties which are not present at natural substances. Among metamaterials are allocated the substances with chiral properties [5] which are capable to rotate a plane of polarization of electromagnetic waves. In optics as analogue of similar substances are the optical active substances, for example, quartz, a glucose solution etc.

However methods of calculation of metamaterials are enough limited [6]. Basically all calculations are based on the solving of the Maxwell's equations and the material equations selected according to a problem.

The existing method has restrictions since average characteristics of metamaterials are usually used only, for example, a chiral parameter.

In the present work attempt of more detailed approach to properties of chiral inclusions into metamaterials is made; the analysis of influence of these properties on interaction of chiral elements with the electromagnetic wave falling on a plate from a metamaterial is carried out.

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II. Standard Method of Calculation of a Metamaterial with an Electromagnetic Wave Interaction

At research of metamaterials with chiral inclusions on the basis of the Maxwell's equations usually use the material equations including so-called chiral parameter χ. In [5, 6, 7] the material equations in the following kind are offered:

$$\mathbf{D} = \varepsilon_a \mathbf{E} \mp i\frac{\chi}{V}\mathbf{H} , \quad (1)$$

$$\mathbf{B} = \mu_a \mathbf{H} \pm i\frac{\chi}{V}\mathbf{E} , \quad (2)$$

where *D* and *B* there are an induction of electric and magnetic fields in the electromagnetic wave propagating in a chiral medium, *E* and *H* – strength of the electric and magnetic components in wave, ε_a and μ_a - absolute electric and magnetic permeability of a chiral medium, *V* – velocity of an electromagnetic wave in a chiral medium, χ - a chiral parameter, in this case dimensionless size.

In [7] it is shown that the material equations (1) and (2) can be written down in more simple kind:

$$\mathbf{D} = (1 \pm \chi)\varepsilon_a \mathbf{E} , \quad (3)$$

$$\mathbf{B} = (1 \pm \chi)\mu_a \mathbf{H} . \quad (4)$$

In formulas (1) - (4) top signs define the right-turning chiral element, bottom signs – left-turning.

Using (3) and (4) it is possible to show [7] that if a chiral medium has only reactive resistance, the electromagnetic wave in it submits to the wave equations:

$$\Delta \mathbf{D} = \left(\frac{1 \pm \chi}{V}\right)^2 \frac{\partial^2 \mathbf{D}}{\partial t^2} , \quad (5)$$

$$\Delta \mathbf{B} = \left(\frac{1 \pm \chi}{V}\right)^2 \frac{\partial^2 \mathbf{B}}{\partial t^2} , \quad (6)$$

where *t* there is time.

III. Detailed Method of Calculation of Metamaterial with Electromagnetic Wave Interaction

Let's consider a plate of the metamaterial with chiral inclusions of the inductive type. The plate consist of the dielectric in which are included the current-carrying chiral elements as spirals which axis is directed across a plate. The chiral elements are distributed periodically.

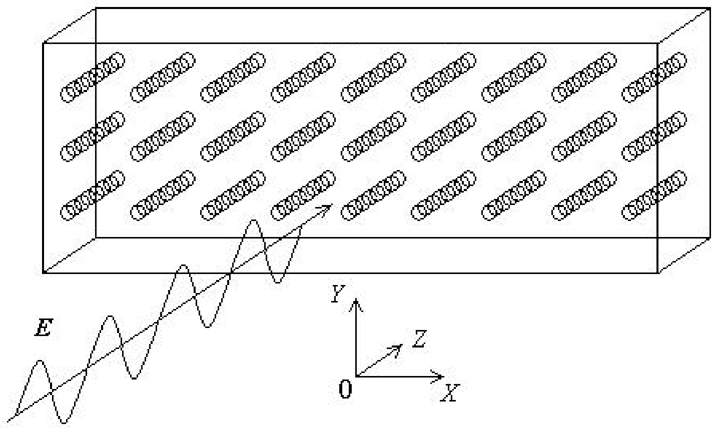

Figure 1: The plate of metamaterials irradiated by an electromagnetic wave

On fig. 1 the irradiation of a plate by an electromagnetic wave is shown. We assumed that chiral inclusions have no active resistance. The chiral element completely penetrates a plate.

Feature of a plate is the capacity distributed on its surfaces at dot inductive inclusions. Therefore to examine the interaction of separate chiral element having inductance and capacity with an electromagnetic wave is incorrectly.

Let's consider a plate consisting of chiral elements one lines, fig. 2.

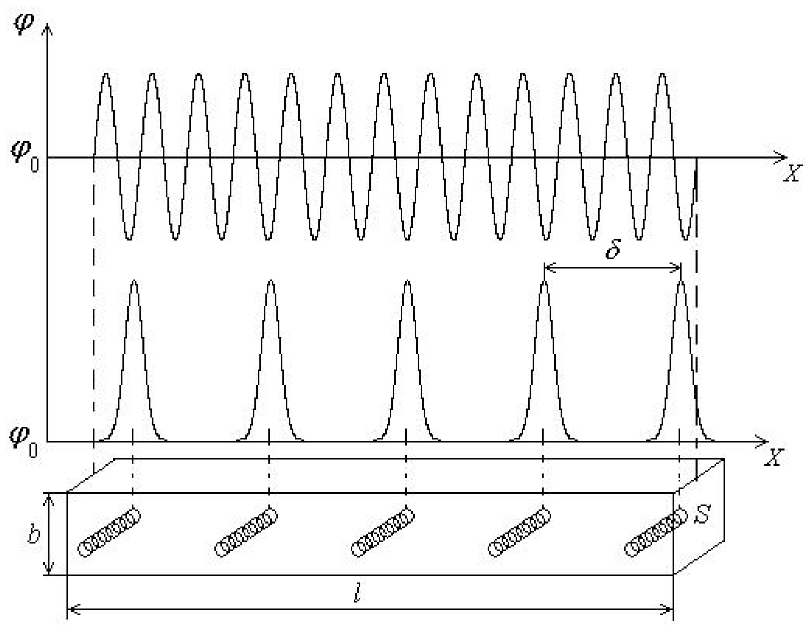

Figure 2: The single-row chiral plate

In [8] it has been shown that the potential φ on a plate submits to the nonlinear differential equation:

$$V^2(\varphi-\varphi_0)\frac{\partial^2\varphi}{\partial X^2}=\left(\frac{\partial\varphi}{\partial t}\right)^2-(\varphi-\varphi_0)^2\omega_0^2. \tag{7}$$

where φ_0 there is an origin of potential, *V* – a velocity of an electromagnetic field along a plate, ω_0 - natural frequency of the chiral system.

Let's notice that the nonlinear equation similar (7) arises at research of a self-induced transparency in substance [9].

IV. The Solution as Solitary Waves

The nonlinear equation (7) has solution as a solitary traveling wave:

$$\varphi - \varphi_0 = \varphi_{\max} \exp\left(- \frac{\left(k_0\left(X - X_0\right) \pm \omega_0\left(t - t_0\right)\right)^2}{2} \right). \quad (8)$$

where $k_0 = \dfrac{\omega_0}{V}$ there is a wave number of a natural traveling wave in the chiral medium, $\varphi_{\max}$ - a peak value of potential $\varphi - \varphi_0$, X_0 - coordinate of the chiral element center, and accordingly a maximum (center) of a wave impulse, t_0 - a time of achievement of this maximum. The sign a minus concerns to a wave spreading from left to right, and sign plus from right to left.

Growth of potential above chiral inclusions, fig. 2, is caused by proportionality of the chiral inclusions reactance their inductivities.

From the analysis of both curves it is possible to conclude that the top curve, fig. 2, concern to often enough inclusions of the chiral elements in a plate, and bottom to more rare. Therefore into the solution (8) to enter a chiral parameter it is irrational.

Obviously for the nonlinear equation (7) there should be a multiwave solution. Multiwave solutions are found for very much limited circle of the nonlinear wave equations [10, 11]. The multiwave solution should depend on concentration of the chiral elements in a plate. Only with its help it is possible to understand under what conditions it is possible is proved to enter the chiral parameter, i.e. to understand borders of the material equations (1) - (4) applicability.

The equation (7) supposes the multiwave solution as:

$$\varphi = \varphi_0 + \varphi_{\max} \sum_{n=1}^{N} \exp\left(- \frac{\left(k_0\left(X - X_{0n}\right) - \omega_0\left(t - t_{0n}\right)\right)^2}{2} \right), \quad (9)$$

where *N* there are quantity of the waves-impulses kept within a length *l* of a plate, fig. 2, equal to number of the chiral elements, *n* - current number of an impulse, X_{0n} - coordinates of waves-impulses maxima, t_{0n} - times of these maxima achievement.

Substituting (9) in (7) we shall find:

$$V^2\left(\frac{\partial^2 \varphi}{\partial X^2}\right)\sum_{n=1}^{N}\varphi_n + \omega_0^2\left(\sum_{n=1}^{N}\varphi_n\right)^2 = \left(\frac{\partial \varphi}{\partial t}\right)^2. \quad (10)$$

where it is designated:

$$\varphi_n = \exp\left(- \frac{\left(k_0\left(X - X_{0n}\right) - \omega_0\left(t - t_{0n}\right)\right)^2}{2} \right). \quad (11)$$

Finding the derivatives on coordinate *X*:

$$\frac{\partial^2 \varphi}{\partial X^2} = \sum_{n=1}^{N}\left(\varphi_n\left(k_0\left(X - X_{0n}\right) - \omega_0\left(t - t_{0n}\right)\right)^2 k_0^2 + \varphi_n k_0^2\right) =$$

$$= k_0^2 \sum_{n=1}^{N} \varphi_n\left(k_0\left(X - X_{0n}\right) - \omega_0\left(t - t_{0n}\right)\right)^2 + k_0^2 \sum_{n=1}^{N}\varphi_n, \quad (12)$$

and on time *t*:

$$\frac{\partial \varphi}{\partial t} = -\omega_0 \sum_{n=1}^{N} \varphi_n\left(k_0\left(X - X_{0n}\right) - \omega_0\left(t - t_{0n}\right)\right), \quad (13)$$

we substitute (12) and (13) in the equation (10) and taking into account $k_0 V = \omega_0$ we have:

$$\left(\sum_{n=1}^{N}\varphi_n\left(k_0\left(X-X_{0n}\right)-\omega_0\left(t-t_{0n}\right)\right)^2+\sum_{n=1}^{N}\varphi_n\right)\sum_{n=1}^{N}\varphi_n=$$

$$=\left(\sum_{n=1}^{N}\varphi_n\right)^2+\left(\sum_{n=1}^{N}\varphi_n\left(k_0\left(X-X_{0n}\right)-\omega_0\left(t-t_{0n}\right)\right)\right)^2 . \quad (14)$$

Reducing in the left and right parts (14) the identical addends $\left(\sum_{n=1}^{N}\varphi_n\right)^2$ we shall find:

$$\sum_{n=1}^{N}\varphi_n\sum_{n=1}^{N}\varphi_n\left(k_0\left(X-X_{0n}\right)-\omega_0\left(t-t_{0n}\right)\right)^2=$$

$$=\left(\sum_{n=1}^{N}\varphi_n\left(k_0\left(X-X_{0n}\right)-\omega_0\left(t-t_{0n}\right)\right)\right)^2, \quad (15)$$

Let's consider two one after the other going the identical impulses $n=1,2$. Writing down for this case the formula (15) we shall find:

$$\left(\varphi_1+\varphi_2\right)\left(\varphi_1\left(k_0\left(X-X_{01}\right)-\omega_0\left(t-t_{01}\right)\right)^2+\varphi_2\left(k_0\left(X-X_{02}\right)-\omega_0\left(t-t_{02}\right)\right)^2\right)=$$

$$=\left(\varphi_1\left(k_0\left(X-X_{01}\right)-\omega_0\left(t-t_{01}\right)\right)+\varphi_2\left(k_0\left(X-X_{02}\right)-\omega_0\left(t-t_{02}\right)\right)\right)^2. \quad (16)$$

Transforming the formula (16) we shall receive:

$$k_0\left(X_{02}-X_{01}\right)-\omega_0\left(t_{02}-t_{01}\right)=0 . \quad (17)$$

The formula (17) shows that distance between chiral elements $\delta=\left(X_{02}-X_{01}\right)$, fig. 2, an electromagnetic impulse propagates in time $\left(t_{02}-t_{01}\right)$ with a speed $V=\frac{\omega_0}{k_0}$. The size $\frac{1}{\delta}$ characterizes linear concentration of the chiral elements in a plate.

Using in (15) $t_{0n}=\frac{X_{0n}}{V}=\frac{k_0X_{0n}}{\omega_0}$, we receive that expressions in brackets $\left(k_0\left(X-X_{0n}\right)-\omega_0\left(t-t_{0n}\right)\right)^2=\left(k_0\left(X\right)-\left(\omega_0t\right)\right)^2$ do not depend from *n* they can be taken out for a symbol of the sum and to reduce. In result (15) turns to identity.

Hence (9) is the multiwave solution of the nonlinear equation (7).

The most simple kind the multiwave solution (9) has in occasion of identical distance between all impulses and accordingly between of the chiral elements. In this case coordinates of maxima of impulses are $X_{0n}=n\delta$, and times of achievement of maxima $t_{0n}=\frac{k_0X_{0n}}{\omega_0}=\frac{k_0n\delta}{\omega_0}$.

On fig. 3 for an illustration the some impulses following one after another plotted under the formula (9) are shown under conditions of the dimensionless sizes: $V=0$ - absence of dependence on time (the figure fixed in time) $\varphi_0=0$, $\varphi_{max}=1$, $k_0=2$, $\delta=4$.

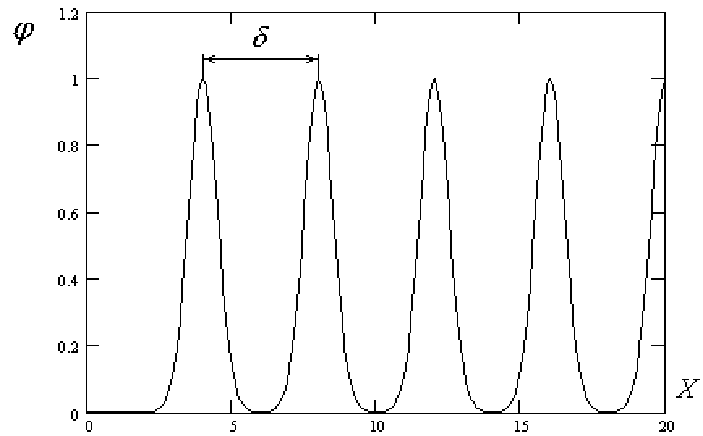

Figure 3: The impulses following one after another in the multiwave solution

Thus the formula (9) under condition of uniform distribution of identical impulses is the multiwave periodic solution of the nonlinear equation (7).

V. The Solution as Standing Waves

Let's consider in more detail another kind of the wave arising on single-row chiral plate at falling on it of an electromagnetic wave.

Standing waves are formed in linear systems as a result of superposition (interference) of the direct and reflected traveling waves more often. However it is known that standing waves can arise in nonlinear systems [12]. Many physical processes have essentially nonlinear character and process of standing waves occurrence in such systems is nontrivial. We shall examine an opportunity of standing waves occurrence in researched chiral medium.

The nonlinear equation (7) can be solved by a method of the Fourier variables division [13]. We search the solution of the equation (7) as:

$$\varphi-\varphi_0=\varphi(X)T(t). \qquad (18)$$

where $\varphi(X)$ there is function only coordinates *X*, $T(t)$ - a function only time *t*.
Having substituted (18) in (7) we shall find:

$$V^2\varphi(X)T^2(t)\frac{\partial^2\varphi(X)}{\partial X^2}=\left(\varphi(X)\frac{\partial T(t)}{\partial t}\right)^2-\varphi^2(X)T^2(t)\omega_0^2. \qquad (19)$$

Let's divide both parts of the equation on $\varphi^2(X)T^2(t)$. In result we shall receive:

$$V^2\frac{1}{\varphi(X)}\frac{\partial^2\varphi(X)}{\partial X^2}+\omega_0^2=\left(\frac{1}{T(t)}\frac{\partial T(t)}{\partial t}\right)^2=-\omega^2. \qquad (20)$$

where ω there is a constant.

The equation (20) breaks up to two independent equations. The equation dependent on *X* looks like:

$$\frac{\partial^2\varphi(X)}{\partial X^2}+\left(k_0^2+\frac{\alpha^2}{V^2}\right)\varphi(X)=0. \qquad (21)$$

Designating $k_S^2=k_0^2+\dfrac{\omega^2}{V^2}$ the solution of the equation (21) we shall write down as:

$$\varphi(X)=\varphi(0)\exp(ik_S X). \qquad (22)$$

where $\varphi(0)$ there is value of function $\varphi(X)$ in the beginning of coordinates.
The second equation of equality (20) looks like:

$$\frac{\partial T(t)}{\partial t}=i\omega T(t). \qquad (23)$$

Solving this equation we shall find:

$$T(t)=T(0)\exp(i\omega t), \qquad (24)$$

where $T(0)$ there is initial value of function $T(t)$.

Using (18), (22) and (24) we shall find the solution of the equation (7) as:

$$\varphi-\varphi_0=\varphi_A\exp(i\omega t)\exp(ik_S X), \qquad (25)$$

where it is designated $\varphi_A=T(0)\varphi(0)$ there is a peak value of potential $\varphi-\varphi_0$ on a plate.

The function $\varphi-\varphi_0$ should not have imaginary addends, the potential is real size. Use an exponents with imaginary parameters is entered for convenience of transformations. Really in these exponents it is necessary to take into account only real items. Therefore the formula (25) describes the solution of the equation (7) as standing waves:

$$\varphi-\varphi_0=\varphi_A\cos\omega t\cos k_S X=\varphi_A\cos\omega t\cos\frac{2\pi X}{\delta}, \qquad (26)$$

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where φ_A there is a peak value of standing waves, δ - length of a wave.

Condition of the nodes occurrence in a standing wave $X_{ns} = \pm(2n+1)\frac{\delta}{4}$, where $n = 0, 1, 2, \ldots$.

On the ends of the single-row chiral plate, fig. 2, should be nodes of a standing wave. If excitation of a wave occurs in the center of a plate the number of the maximal distant node from a center of a plate can be found under the formula $\pm\frac{l}{2} = \pm(2n_{\max}+1)\frac{\delta}{4}$ or $n_{\max} = \left(\frac{l}{\delta} - \frac{1}{2}\right)$.

It is necessary to note that running waves $\varphi - \varphi_0 = \frac{\varphi_A}{2}\cos(k_S X \pm \omega t)$ with account $k_S^2 = \frac{\omega_0^2 + \omega^2}{V^2}$ are not the solution of the equation (7) therefore the formula (26) from the physical point of view cannot be presented as a sum of the direct, and reflected from borders plate waves though mathematical this procedure is simple for making. It is consequence of the equation (7) nonlinearity.

It is interesting to track graphically a transition of the multiwave solution (9) in the solution as standing waves (26). This transition is carried out at rapprochement of impulses, fig. 2, 3, i.e. at reduction of size δ.

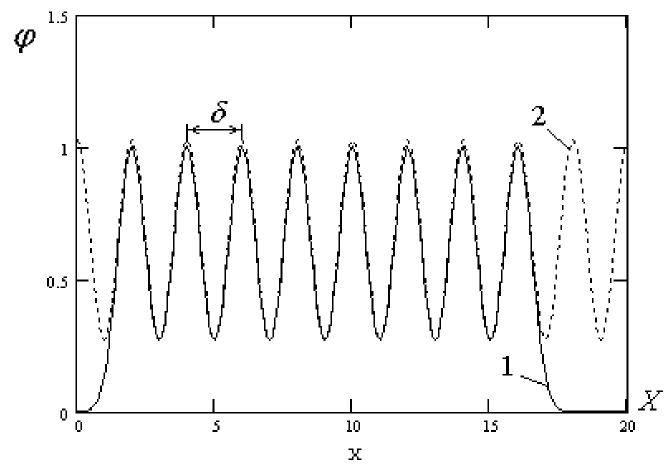

Figure 4: Transition of the multiwave solution in the solution as a standing wave: 1 - the multiwave solution, 2 - a standing wave

On fig. 4 the two curves are shown. Curve 1 is plotted under the formula (9) under conditions: $V = 0$, $\varphi_0 = 0$, $\varphi_{\max} = 1$, $k_0 = 2$, $\delta = 2$ for $N = 8$ impulses. Curve 2 is plotted (dotted line) under the formula (26) under conditions $\varphi_0 = 0{,}65$ and $\varphi_A \cos \omega t = 0{,}38$ for some moment of time *t*.

VI. Conclusion

Distribution of potential to a plate from a metamaterial with inductive chiral inclusions is investigated as with use of the material equations together with the Maxwell's equations, and on the basis of a detailed method of calculation of the chiral elements and an electromagnetic wave interaction. Comparison of two approaches has allowed to find out that introduction of the chiral parameter is correct only at enough high concentration of the chiral inclusions. At use of a detailed method of calculation the nonlinear equation for the potential having solutions as standing waves and solitary waves is received. Traveling waves are not the solution of this equation. Existence of the multiwave solution of the nonlinear equation is shown. At reduction of distance between chiral elements the process of transition of the multiwave solution of the nonlinear equation in the solution as a standing wave is investigated.

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Comments on "Einstein's Miraculous Year" by John Stachel

By C. Y. Lo
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Abstract- Einstein revolutionized physics, but some of his ideas are only partially correct. For example, $E = mc^2$ is not always correct, although the photonic energy is equivalent to mass. Although he successfully challenged the wave theory of light, he did not know that the photons' energy includes electromagnetic wave energy and related gravitational wave energy. Einstein does not understand that massless particles' energy is incompatible with the electromagnetic energ-stress tensor in Maxwell's theory. Moreover, the related Einstein equation must be modified with additional photonic energy sources having an anti-gravitational coupling. The proof that massless particles can represent the photonic energy is a remarkable achievement of general relativity. Moreover, to accommodate repulsive gravitation, general relativity must be extended to a five-dimensional theory. However, important experiments related to the repulsive gravitation have been essentially ignored by the American Physical Society, who is interested in only big projects.

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I. Introduction

It is true that after 1905, physics would never be the same again [1]. However, being a human, Einstein's interpret-ation is not perfect. His "A New Determination of Molecular Dimensions" indeed gives a correct method, and "*On the Motion of Small Particles Suspended in Liquids at Best Required by the Molecular-Kinetic Theory of Heat*" gives the mean free path of such particles. His theory of special relativity is almost perfect. However, his conclusion of $E = mc^2$ is not valid, and his notion of photons is only partially true. We will discuss these in this paper.

II. The Conditional Validity of E = MC²

The formula $E = mc^2$ appears in special relativity, but this only means that mass can be converted into energy. Einstein wants to have new content, $m = E/c^2$, i.e., any energy can be equivalent to mass. However, Einstein failed, although he made a great effort to prove this in 1905- 1909 [1].

The truth is that, for the electromagnetic energy E, $E = mc^2$ is inconsistent with the Einstein equation [2, 3],

$$G_{\mu\nu} \equiv R_{\mu\nu} - (1/2)g_{\mu\nu} R = - K T_{\mu\nu} , \qquad (1)$$

where $G_{\mu\nu}$ is the Einstein tensor, $R_{\mu\nu}$ is the Ricci tensor, $R = R_{\mu\nu}g^{\mu\nu}$ is the Ricci curvature, $T_{\mu\nu}$ is the sum of energy-stress tensor, and K is the coupling constant. Then, we have

$$R = KT_{\mu\nu}g^{\mu\nu}. \qquad (2)$$

Note that eq. (2) is completely general.

For the case of electromagnetic energy E, the trace of the electromagnetic stress tensor $T(E)_{\mu\nu}$ is zero, i.e., $g^{\mu\nu} T(E)_{\mu\nu} = 0$. Thus, it cannot influent the Ricci curvature. However, the mass m can since the trace for the massive energy-stress tensor is non-zero. Thus, electromagnetic energy and mass are not equivalent.

One might argue that Einstein [4] has shown that the radiative energy L emitted from a body could be equivalent to mass. We shall show that this photonic energy is different from electromagnetic energy. It also includes the gravitational wave energy (see section 5).

III. Experimental Verification on the Invalidity of E = MC²

A theoretical conclusion may not be valid unless experiments support it because, in physics, implicit assumptions could be used without knowing it. For example, an implicit assumption in the space-time singularity theorems is that all the coupling constants have the same sign. This assumption has recently been proven invalid [5, 6, 7].

Einstein claimed that $E = mc^2$ means that a piece of heated-up metal would have an increment of weight [8]. He reasoned if an increment of energy for matter implies an increment of mass, this will result in the increment of weight. Therefore, $E = mc^2$ would be invalid if one can show that an increment of energy would reduce weight.

However, Dmitriev, Nikushchenko, & Snegov [9] showed in 2003 that a piece of heated-up brass has reduced weight. Their results can be shown in the following figures.

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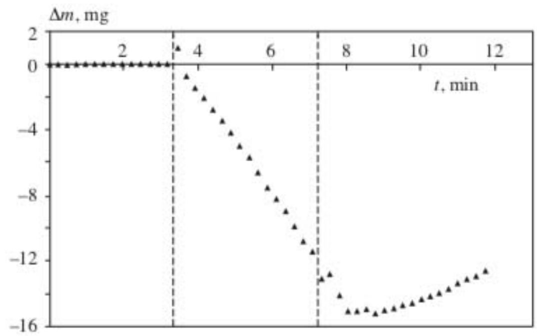

Fig. 1: Change in mass of a brass rod mounted in an open holder. Ultrasound frequency 131.25 kHz. The deshed lines indicate the moments when the ultrasound was switched on and off

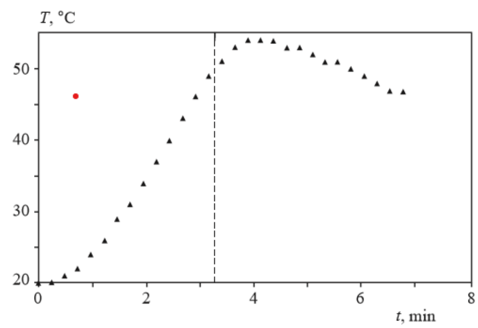

Fig. 2: Time dependence of the temperature of a part of the surface of an ultrasonically heated brass rod (open holder). Ultrasound frequency 13 l.28 kHz. The dashed line indicates the moment when the ultrasound was switched off

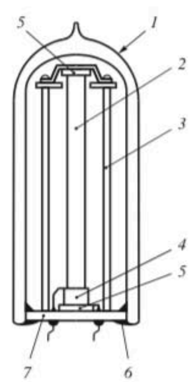

Fig. 3: Arrangement of the air-tight container: 1) Dewar vessel; 2) metal Road; 3) holder pillar (tcxtolite cloth-bored laminate); piezoelectric transducer 5) foam plastic specers 6) coold weld; 7) holder base (ebonitc),

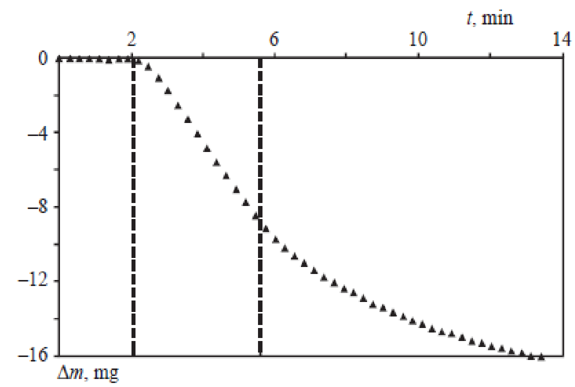

Fig. 4: Change in mass of a brass rod mounted in a closed Dewar vessel. Ultrasound frequency 131.27 kHz. The dashed lines indicate the moments when the ultrasound was switched on and off

Figure 1 shows the change of weight for the brass rod mounted in an open holder. Figure 2 shows the time dependence of the temperature of a part of the surface of an ultrasonically heated brass rod (open holder). Figure 3 shows the arrangement in an air-tight container. Figure 4 shows the change of weight for the brass rod in a closed Dewar vessel. It separates the influence of outside heat. The brass rod weighs 58.5 g before heating, with a length of 140.0 mm, and a diameter of 8.0 mm. These figures show that the Dewar vessel is not essential for the weight reduction experiment.

Dmitriev et al. [9] pointed out, "It is well known that the temperature regimes play an important role when weighing with high accuracy. The basic reasons for temperature influencing the results of such measurements are thermal expansion of the bodies, temperature changes in the magnetization of the weighed sample, adsorption of moisture by the surface of the sample (a change in the buoyancy), thermal convection of the air near the surface of the sample, the influence of the heated sample on the balance mechanism (through thermal radiation, heat conduction, or convection). These factors are quite well known in modern measurement technology and their contribution to the results of measuring the mass of samples can be estimated quantitatively." So, they are confident that their measured result of a reduction of weight as temperature increased is correct.

It should also be noted that the temperature dependence of gravity also depends on the metal involved. They have measured such dependencies for the Lead, Copper, Brass, and Duralumin, and find they are different. It would be interesting to find out the detailed rules on such dependencies. And Fan, Feng Jinsong, & Liu [10] also showed with an electronic scale in 2010 that six kinds of metal have reduced weight after heating-up. Moreover, recently it has been verified by Lo [11] with a torsion balance scale that the lead balls have reduced gravitation after heated-up.

Besides, a charged capacitor and or a charged metal ball also have reduced weight [12]. Thus, it is clear that an increase in electromagnetic energy need not mean an increase in mass.

IV. Einstein's Incomplete Proof of E = MC²

Einstein [2] has shown that the electromagnetic radiation energy L emitted from a body is equivalent to the mass L/c^2, where c is the light speed. In his approach, the energy L is due to two waves W1 and W2, in the opposite directions, each with energy (1/2)L. His motivation is to assume the two waves as two groups of massless particles. Because these two waves are in opposite directions, their momentums cancel each other, and thus what remains is the sum of the energies of the massless particles, i.e., L. Then, he shows the energy L is equivalent to a mass L/c^2.

However, his proof is inconsistent with electromagnetism as follows: 1) the electromagnetic energy-stress tensor $T(E)_{\mu\nu}$ has a zero trace. 2) The sum of two electromagnetic energy-stress tensors is still an electromagnetic energy-stress tensor with zero traces. However, an energy-stress tensor of trace zero cannot be related to a mass whose energy-stress tensor has a non-zero trace. Thus, Einstein's proof is inconsistent with electromagnetism. 1)

Einstein [4] claimed, without proof, that the relation between the energy l for a wave measured in the co-ordinate (x, y, z) and the energy l^* for the same wave measured in a new co-ordinate system (ξ, η, ζ) is

$$l^* = l\frac{1-(v/c)\cos\phi}{\sqrt{1-v^2/c^2}}, \qquad (3)$$

where v is the relative velocity between these two coordinate systems, and φ is the angle between the propagating direction of the wave and the relative velocity v. He [4] also claimed that "The principle of the constancy of the velocity of light is of course contained in Maxwell's equations." However, we have just shown that the results being derived from eq. (3) are inconsistent with Maxwell's theory.

Note that the energy of massless particles is inconsistent with the electromagnetic energy-stress tensor related to an electromagnetic wave, although the energy-stress tensor of a massless particle is also traceless. On the other hand, Einstein's notion of photons that are quantized electromagnetic energy has successfully met all the experimental tests. In fact, Einstein obtained a Nobel Prize for his explanation of the photo-electric effects, instead of general relativity that many had expected.

Although $E = mc^2$ has been demonstrated with the conversion of mass to energy in nuclear physics, for instance, the atomic bomb [13], the reverse conversion of energy to mass has never been proved. In fact, Einstein failed to show the mass-energy equivalence in his intense efforts from 1905 to 1909 [1]. Thus, the equivalence of mass and energy is still a question. The radiation energy L [4], being the photons' energy, is Einstein's assumption whose validity must be proved. Thus, Einstein's proof is at least incomplete.

However, the fact is that *Einstein* [4] *did not know that the electromagnetic energy-momentum tensor alone is incompatible with the energy of the massless particles* [6]. In other words, Einstein had used the energy-momentum tensor of massless particles for the photons without necessary proof, although such proof is needed as shown by Lo [6] in 2006. The omission of such proof shows that *Einstein does not understand Maxwell's theory.*

Nevertheless, Einstein's invalid derivation on the loss of mass L/c^2 was accepted without any question since it has been known from special relativity that $E = m_0c^2$, where m_0 is the rest mass of a particle. Note that the energy-momentum tensor of the photons is compatible with the energy-momentum tensor of the mass [6, 7]. However, many just did not understand electromagnetism and gravity well enough to know the difference between the radiation L and electromagnetic energy. Thus, Einstein does not know that E/c^2 as mass may not always be valid.

Note that in 1912 Einstein invalidly changed the letter L to E in the formula to represent general energy [14]. Then, Einstein's proof for $E = mc^2$ is not only incomplete but also invalid.

V. The Notion of the Photons and the Remarkable Achievement of General Relativity

Since the equivalence of energy and mass has never been generally verified [1], one may suspect that $E = mc^2$ may not be valid for the electromagnetic case. On the other hand, however, the equivalence between the photonic energy L and mass not only has been verified theoretically by Einstein [4] (although with an unverified assumption), but also is supported by the experimental fact that a π_0 meson can decay into two photons. This paradox can be solved only if the photons also contain other energy in addition to the electromagnetic energy. This would mean that Einstein's proposal on the notion of photon [15] is only partially correct.

It is well-known that the verification of the bending of light rays makes Einstein famous. Here, it will be shown that the bending of light also exposed the shortcomings of Einstein's theory and the necessary modifications. However, most of the followers of Einstein were not aware of this.

Einstein's calculation implicitly assumed that the gravity created by an electromagnetic wave is negligible. Since Einstein also claimed that any energy-momentum tensor could be a source of his equation, one should obtain a gravitational solution for the electromagnetic wave. Since such gravity is physically very weak, journals such as the Chinese Physics B and Physical Review D, in agreement with Einstein, believed that such gravity could be calculated with the perturbation approach, although they did not do it. 2)

Mathematically, for a perturbation approach to be valid, a necessary condition is, however, that this problem has a bounded solution. This compatibility between mathematics and physics is crucial for the validity of a theory in physics.3) Thus, it is natural for Einstein [16] to believe that his equation could be used for such a case. Although Einstein claimed that his equation is valid for any energy-momentum tensor, he has not solved it for many cases [3, 17, 18]. Nevertheless, Einstein insists only on his Einstein tensor G_{ab}, but allows otherwise modification.

However, explicit calculation shows that it is impossible to have a bounded solution for the gravity of an electromagnetic wave. In order for Einstein's theory of general relativity to make sense, the related Einstein equation with an electromagnetic wave as the source must include a photonic energy-stress tensor with the anti-gravity coupling [6, 7]. For this case, the related modified Einstein equation is the following:

$$G_{ab} \equiv R_{ab} - (1/2)g_{ab}R = - K[T(w)_{ab} - T(p)_{ab}], \qquad (4)$$

and

$$T_{ab} = - T(g)_{ab} = T(w)_{ab} - T(p)_{ab}, \qquad (5)$$

where $T(w)_{ab}$ and $T(p)_{ab}$ are the energy-stress tensors for the electromagnetic wave and the related photons, which are massless particles. *Thus the photonic energy must also include the energy of its gravitational-wave component.*

For monochromatic plane-waves, a gravitational wave solution has the polarization matching that of the electromagnetic wave, while their frequency ratio is two

[19]. The existence of a distinct energy tensor for photons clarifies and explains further i) the meaning of duality, and ii) the behavior of radiative electromagnetic energy. Then, the bending of light is self-consistently calculated, and we also establish the theoretical proof for the existence of gravitational waves. Hawking and Penrose follow mathematics blindly, but not physics.

Now, the energy-related to an electromagnetic wave is clearly beyond special relativity. Also, the implicit assumption of the unique sign for all coupling constants in the space-time singularity theorems is invalid. Thus, the claim of Hawking and Penrose on general relativity being not suitable for microscopic phenomena is just nonsense.

Thus, Einstein failed to see the need for an anti-gravity coupling in this case, in addition to a massive dynamic Einstein equation [5]. 4) Note that Einstein [4] uses the massless particles to represent the photons, but from eq. (4) it is clear that this cannot be done without the gravitational wave [6]. Thus, Einstein failed to recognize that this energy problem is beyond special relativity. Note that this is also clear since Einstein failed to show the general validity of $E = mc^2$ in 1905-1909 [1].5) This failure to see the need for the anti-gravity coupling provides the basis for the space-time singularity theorems, which are based on the implicit assumption of a unique coupling sign [20].

If the photons consist of only electromagnetic energy, there is a conflict since the photonic energy can be equivalent to mass, but the electromagnetic energy is not. Now, this conflict is resolved since the photonic energy is the sum of electromagnetic energy and gravitational energy, and thus it is established that $E = mc^2$ can be invalid.

The proof of the photonic energy being of massless particles is a remarkable achievement of general relativity.

The claim of Hawking that general relativity is unsuitable for microscopic phenomena is incorrect.

VI. The Inertial Mass and Einstein's Invalid Gravitational Mass

Although Dmitriev et al. [9] and Fan et al. [10] have shown that a piece of heated-up brass has reduced weight, they have mistaken instead that these experiments [9, 10] show the reduction of mass. However, it has been firmly established that mass is equivalent to the energy from the atomic bomb [13]. Therefore, they must explain where the loss mass had become. Thus, their results were incorrectly rejected by many as errors.

Since physics is based on experiments, we must be able to explain the experiments consistently. Although heat would increase energy, the increase of energy need not mean the increase of gravity, according to experiments [21]. Apparently, they do not understand that if the repulsive gravitation is present, to measure mass through gravitation is no longer valid [22]. Thus, $E = mc^2$ is not generally valid. Since David Gross won his Nobel Prize based on the general validity of $E = mc^2$ [23], their proof for asymptotic freedom for the strong interaction is at least incomplete.

As Einstein pointed out, the inertial mass is related to the resistance to acceleration, and gravitational mass is related to the attraction to a mass. Thus, acceleration mass and gravitational mass should be distinguishable.6)

However, Einstein was able to identify them because *the existence of repulsive gravity has not been recognized* [24]. Einstein's notion of gravitational mass is a misconception created by a failure to recognize repulsive gravity.

Unfortunately, the invalid notion of gravitational mass is very popularly used currently on the scale. Although, as Einstein points out that the notion of inertial mass is different from the notion of weight (gravitational mass), many theorists still cannot distinguish the difference between mass and weight. Nevertheless, the mass and gravity can be distinguished with the first approximation of a formula for the period T of a pendulum as follows [25]:

$$T \approx 2\pi\sqrt{\frac{l}{g}}, \qquad (6)$$

where l is the length of the pendulum and g is the gravitational acceleration.7) Thus, the change of mass of the pendulum would not change the pendulum period, but if the g changes, the period T of the pendulum will be changed.8), 9) Since a piece of metal is a solid, a reduction of its mass or gravity can be distinguished by using it as a pendulum. Apparently, Dmitriev et al. [9] and Fan et al. [10] did not measure the changes of the period T.

In fact, it has been verified by Liu [26] that the mass is essentially the same as Einstein [8] and Lo [22] predicted, but the period is extended after heating-up.10) Thus, from the above weight reduction experiments [9, 10], the repulsive gravitational force must exist. Moreover, it has been verified by Lo [11] with a torsion balance scale that the lead balls have reduced gravitation after heated-up.x)

Thus, measuring the mass through gravity is no longer reliable, and the repulsive gravitation must exist.11)

VII. The REpulsive Gravitation and the Necessary Extension of General Relativity

In fact, a charge-mass repulsive force has been derived from the Reissner-Nordstrom metric in 1916 for a particle with charge q and mass M [17] as follows:

$$ds^2 = \left(1 - \frac{2M}{r} + \frac{q^2}{r^2}\right)dt^2 - \left(1 - \frac{2M}{r} + \frac{q^2}{r^2}\right)^{-1} dr^2 - r^2 d\Omega^2 \qquad (7)$$

(with c = 1) where r is the radial distance (in terms of the Euclidean-like structure [27]) from the particle center.[12)] In metric (7), the gravity components generated by electricity have not only a very different radial coordinate dependence but also a different sign that makes it a new repulsive gravity [24]. This repulsion implies that the assumption [13)] of gravity being always attractive is invalid, and general relativity must be extended. [14)]

For an elementary charged particle, the repulsive force would be very small. However, a similar metric can be derived for a charged ball. The only changes are that r becomes R, the distance from the center of the ball, and q becomes Q, the total charge of the ball [28]. Thus, since the repulsive force mQ^2/R^3 for a test particle with mass m is proportional to Q^2, a charged ball with a sufficient large Q, the repulsive gravitational force can be macroscopically observed.[15)] However, nothing has been derived from this metric until 1997 [29].

Tsipenyuk and Andreev [30] discovered that a charged metal ball becomes lighter in weight,[16)] but they did not know why because repulsive gravitation was not included in general relativity. Moreover, theorists such as Herrera, Santos, & Skea [31] argued that M in metric (7) involves electric energy. Then they obtained a metric that would imply a charged ball would increase its weight as the charge q increased [24], in disagreement with experiments [30]. Nevertheless, 't Hooft [32] [17)] and Wilczek [23] [18)] also have mistaken that m = E/c^2 was universally true.

On the other hand, if the mass M is the inertial mass of the particle, the weight of a charged metal ball would be reduced [24]. Thus, experiments on two metal balls [30] support that the mass M in metric (7) does not include electric energy since a charged ball has a reduced weight. Based on the principle of causality, it will be shown that such a force leads to the necessity to extend the theoretical framework of general relativity.

To see the necessity of extending general relativity,[8)] we consider the force on a test particle with mass m, and

$$\frac{d^2x^\mu}{ds^2} + \Gamma^\mu{}_{\alpha\beta}\frac{dx^\mu}{ds}\frac{dx^\nu}{ds} = 0,$$

where $$\Gamma^\mu{}_{\alpha\beta} = (\partial_\alpha g_{\nu\beta} + \partial_\beta g_{\nu\alpha} - \partial_\nu g_{\alpha\beta})g^{\mu\nu}/2 \qquad (8)$$

and $ds^2 = g_{\mu\nu}dx^\mu dx^\nu$ [2, 3]. Note, the gauge affects only the second-order approximation of g_{tt} [33].

Let us consider only the static case. For a test particle p with mass m at **r**, the force on p is

$$-m\frac{M}{r^2} + m\frac{q^2}{r^3} \qquad (9a)$$

in the first-order approximation because of $g^{rr} \cong -1$. Thus, the second term is a repulsive force.

If the particles are at rest, then the force acting on the charged particle P has the same magnitude

$$(m\frac{M}{r^2} - m\frac{q^2}{r^3})\,\hat{r}, \text{ where } \hat{r} \text{ is a unit vector} \qquad (9b)$$

since the action and reaction forces are equal but in opposite directions. However, for the motion of the charged particle with mass M, if one calculates the metric according to the particle p of mass m, we have only the first term.

Then, it is necessary to have a repulsive force with the coupling q^2 to the charged particle P in a gravitational field generated by mass m. Thus, force (9b) to P is beyond the framework of electromagnetism + gravitation. As predicted by Lo, Goldstein, & Napier [34], general relativity would lead to the necessity of its extension.

The repulsive force mq^2/r^3 comes from electric energy in metric (7) [24]. Thus, the charge-mass interaction is crucial for the unification of gravity and electromagnetism. An immediate question would be whether such a charge-mass repulsive force mq^2/r^3 is subjected to electromagnetic screening. This force, being independent of a charge sign, should not be subjected to such screening.

Note that this force can be considered as a result of q^2 interacting with a field created by the mass m. Thus such a field is independent of electromagnetism and is beyond general relativity, and the need for unification is established.[19)] To test such a possibility, one can measure whether there is such a repulsive force outside a charged capacitor. Thus, to include the repulsive force, general relativity must be extended to a five-dimensional space.

A necessary step to test general relativity is to measure the force (9a). For a sufficiently large charge Q, the force

$$-m\frac{M}{R^2} + m\frac{Q^2}{R^3} \qquad (10)$$

should be verifiable experimentally. However, no experiment on this has been performed so far. Thus, general relativity has not been properly tested. It seems the followers of Einstein are interested in only expensive projects.

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VIII. Einstein's Conjecture of Unification and the Five-Dimensional Relativity

The coupling with q^2 leads to a five-dimensional space of Lo et al. [34] since such coupling does not exist in a four-dimensional theory, the five-dimensional theories of Kaluza [35] or Einstein & Pauli [36].

Now let us give a brief introduction of the five-dimensional relativity. The five dimensional geodesic of a particle is

$$\frac{d}{ds}\left(g_{ik}\frac{dx^k}{ds}\right)=\frac{1}{2}\frac{\partial g_{kl}}{\partial x^i}\frac{dx^k}{ds}\frac{dx^l}{ds}+\left(\frac{\partial g_{5k}}{\partial x^i}-\frac{\partial g_{5i}}{\partial x^k}\right)\frac{dx^5}{ds}\frac{dx^k}{ds}-\Gamma_{i,55}\frac{dx^5}{ds}\frac{dx^5}{ds}-g_{i5}\frac{d^2x^5}{ds^2}\quad, \tag{11a}$$

$$\frac{d}{ds}\left(g_{5k}\frac{dx^k}{ds}+\frac{1}{2}g_{55}\frac{dx^5}{ds}\right)=\Gamma_{k,55}\frac{dx^5}{ds}\frac{dx^k}{ds}-\frac{1}{2}g_{55}\frac{d^2x^5}{ds^2}+\frac{1}{2}\frac{\partial g_{kl}}{\partial x^5}\frac{dx^l}{ds}\frac{dx^k}{ds}, \tag{11b}$$

where $ds^2=g_{\mu\nu}dx^\mu dx^\nu$, μ, ν = 0, 1, 2, 3, 5 ($d\tau^2=g_{kl}dx^k dx^l$; *k, l* = 0, 1, 2, 3) .

If instead of *ds*, $d\tau$ is used in (11), for a test particle with charge q and mass M, the Lorentz force suggests

$$\frac{q}{Mc^2}\left(\frac{\partial A_i}{\partial x^k}-\frac{\partial A_k}{\partial x^i}\right)=\left(\frac{\partial g_{i5}}{\partial x^k}-\frac{\partial g_{k5}}{\partial x^i}\right)\frac{dx^5}{d\tau}. \tag{12a}$$

Thus,

$$\frac{dx^5}{d\tau}=\frac{q}{Mc^2}\frac{1}{K},\qquad K\left(\frac{\partial A_i}{\partial x^k}-\frac{\partial A_k}{\partial x^i}\right)=\left(\frac{\partial g_{i5}}{\partial x^k}-\frac{\partial g_{k5}}{\partial x^i}\right)\text{ and }\qquad \frac{d^2x^5}{d\tau^2}=0 \tag{12b}$$

where *K* is a constant. It thus follows that (11) is reduced to

$$\frac{d}{d\tau}\left(g_{ik}\frac{dx^k}{d\tau}\right)=\frac{1}{2}\frac{\partial g_{kl}}{\partial x^i}\frac{dx^k}{d\tau}\frac{dx^l}{d\tau}+\left(\frac{\partial A_k}{\partial x^i}-\frac{\partial A_i}{\partial x^k}\right)\frac{q}{Mc^2}\frac{dx^k}{d\tau}-\Gamma_{i,55}\left(\frac{q}{Mc^2}\right)^2\frac{1}{K^2}, \tag{13a}$$

$$\frac{d}{d\tau}\left(g_{5k}\frac{dx^k}{d\tau}+\frac{1}{2}g_{55}\frac{q}{KMc^2}\right)=\Gamma_{k,55}\frac{q}{KMc^2}\frac{dx^k}{d\tau}+\frac{1}{2}\frac{\partial g_{kl}}{\partial x^5}\frac{dx^l}{d\tau}\frac{dx^k}{d\tau}. \tag{13b}$$

One may ask what the physical meaning of the fifth dimension is. Our position is that the meaning of the fifth dimension is not yet very clear [34], except some physical meaning is given in the equation, $dx^5/d\tau = q/Mc^2K$ where M and q are respectively the mass and charge of a test particle, and *K* is a constant. We shall denote the fifth axis as the w-axis. Our approach is to find out the full physical meaning of the w-axis as our understanding gets deeper.

For a static case, we have the forces on the charged particle *P* in the ρ -direction

$$-\frac{mM}{\rho^2}\approx\frac{Mc^2}{2}\frac{\partial g_{tt}}{\partial\rho}\frac{dct}{d\tau}\frac{dct}{d\tau}g^{\rho\rho},\qquad\text{and}\qquad\frac{mq^2}{\rho^3}\approx-\Gamma_{\rho,55}\frac{1}{K^2}\frac{q^2}{Mc^2}g^{\rho\rho} \tag{14a}$$

and

$$\Gamma_{k,55}\frac{q}{KMc^2}\frac{dx^k}{d\tau}=0,\qquad\text{where}\qquad\Gamma_{k,55}\equiv\frac{\partial g_{k5}}{\partial x^5}-\frac{1}{2}\frac{\partial g_{55}}{\partial x^k}=-\frac{1}{2}\frac{\partial g_{55}}{\partial x^k} \tag{14b}$$

in the *(-r)*-direction. The meaning of (14b) is the energy-momentum conservation. Thus,

$$g_{tt}=1-\frac{2m}{\rho c^2},\quad\text{and}\qquad g_{55}=\frac{mMc^2}{\rho^2}K^2+\text{constant}\quad\left(\text{or}\quad\frac{1}{MK^2c^2}g_{55}=\frac{m}{\rho^2}+\text{constant.}\right) \tag{15}$$

In other words, g_{55} is a repulsive potential, and g_{55}/M is also a function of a distance mass m. Because g_{55} is independent of q, this force would penetrate electromagnetic screening. However, because *p* is neutral, there is no charge-mass repulsion force (from $\Gamma_{k,55}$) on *p*.

Thus, general relativity must be extended to accommodate the charge-mass interaction. For this, five-dimensional relativity is a natural candidate. According to Lo et al. [34], the charge-mass interaction would penetrate a charged capacitor. To verify the five-dimensional theory, one can simply test the repulsive force on a charged capacitor. This has been experimentally confirmed [24].

However, journals such as the Physical Review and Proceedings of the Royal Society A still have not recognized these important experiments due to inadequacy in nonlinear mathematics and blind faith toward Einstein.

IX. The Oversights of Maxwell and Einstein

In the experiment of photon-electric effect, it was assumed that the photons consist entirely of electromagnetic energy. However, there is no evidence that the photons consist of electromagnetic energy alone. In fact, it would be natural to conjecture that the photons also consist of gravitational wave energy since all charged particles are massive. Historically, the formula $E = mc^2$ was proposed by Einstein in 1912 [14], before the publication of general relativity in 1916. Understandably, Einstein did not include the gravitational energy in the photons.

Moreover, that the light is also an electromagnetic wave was claimed by Maxwell because the light and the electromagnetic wave have the same speed, but Maxwell did not conceive that light could contain anything else because there was nothing that can have the speed of light. Thus, it was natural for Einstein to follow Maxwell.

Einstein did not rectify his proposal because he was not sure that the gravitation wave exists, although it could have the speed of light. He [37, 38] was puzzled by that the Einstein equation $R_{\mu\nu} - (1/2)g_{\mu\nu} R = - KT(m)_{\mu\nu}$ implies no gravitational wave although the linearized equation shows its existence. In fact, Einstein concluded his talk on gravitational waves at Princeton University by saying [39] "If you ask me whether there are gravitational waves or not, I must answer that I do not know. But it is a highly interesting problem." Thus, Einstein's last words on this subject were that "I do not know."

Recently LIGO announced that the gravitational wave had been detected. However, the exact equation that produces the gravitational wave remains to be investigated.[20)] Although the Lorentz-Levi-Einstein equation $R_{\mu\nu} - (1/2)g_{\mu\nu}R = - K[T(m)_{\mu\nu} - t(g)_{\mu\nu}]$, can produce the gravitational wave approximately [5], the exact gravitational energy-stress tensor $t(g)_{\mu\nu}$ remains to be investigated. However, Einstein rejected such a modification because he believed [16] that his equation was correct for the dynamic cases [2, 3] although mathematics shows otherwise.[21)]

In Einstein's derivation of the Planck's constant *h,* he started [15] with the black body radiation formula, instead of Maxwell's theory. Thus, his quanta $h\nu$, where ν, is the frequency, is related to the light quanta in Planck's theory but not a quantum related to Maxwell's theory. Currently, most physicists incorrectly considered $h\nu$ as the quantum in Maxwell's theory.

Apparently, Einstein and Maxwell did not see such differences. Now. since we have known that photons' energy is the sum of the energy of the related electromagnetic wave and the energy of the related gravitational wave, such a difference is clear.

X. Conclusions and Discussions

In 1905, Einstein represented the energy of photons with the energy of massless particles without necessary proof [4]. Apparently, he did not know that the energy-momentum tensor of massless particles is incompatible with the electromagnetic energy-stress tensor in Maxwell's theory. Since Einstein proposed general relativity in 1915, Einstein would not possibly know that the inconsistency between the electromagnetic energy-stress tensor and the energy-momentum tensor of massless particles can be overcome with general relativity.

It is amazing that Einstein luckily turned his ignorance into a genius stroke. Nevertheless, his shortcoming still exposed in 1912 [14] when he changed the radiation energy L [4] to a more general energy E, and thus made his proof [4] changed from incomplete to invalid. Ohanian [40] credited von Laue for a complete proof of the equivalence of mass and photonic energy. However, the fact is that both von Laue and Einstein failed [41]. $E = mc^2$ is not generally valid. Thus, Einstein's followers actually also do not understand electromagnetism well.

Also, since the notion of photons is due to gravitation, the claim on general relativity being unsuitable for microscopic phenomena is just incorrect. Note that the invalid belief of $E = mc^2$ is the basis of the assumption in Hawking's space-time singularity theorems. Moreover, the invalid belief of $E = mc^2$ is responsible for the rejection of the repulsive gravitation [24]. Note that such a repulsive interaction is crucial for the unification of gravitation and electromagnetism [41]. Also, from Einstein's paper [15], it is clear the energy $h\nu$ is for the whole photon.

Note that it is gravity that makes the notion of photons compatible with the electromagnetic wave. Understandably Einstein failed to include gravitational wave energy in the photons since he proposed the photons in 1905 before he conceived general relativity in 1916. Since a charged particle is always massive, it is natural to include the gravitational wave energy in the photons. Note that the charge-mass repulsive interaction is absent from quantum theory. Thus, quantum mechanics is clearly not a final theory.

Currently, the Einstein equation has no bounded dynamic solutions [18], and some theorists like speculations without experimental supports. For instance, Hawking and Penrose's problem is that they blindly follow their mathematical results, but failed to consider the physics. Their space-time singularity theorems is the basis of the big bang theory and the existence of black holes, which are based on the assumption that gravity is always attractive Their erroneous theorems also led to the claim that general relativity was invalid for microscopic subjects.

Penrose and Hawking 22) also misled the whole physics community to look at only the vast sky, but ignore the simple experiments of the repulsive gravitation on earth. Thus, some crucial experiments that are related to repulsive gravity have not been addressed for a long time [12]. It is also doubtful that the string theorists are able to address repulsive gravitation, The major errors of Einstein on the existence of repulsive gravity were not discovered, and Einstein's conjecture on the unification of gravitation and electromagnetism was not recognized.

Now, it is clear that general relativity must be extended to a five-dimentional theory although the nature of the fifth dimention is still not very clear. Philosopher Hu Shih once remarked that in sciences, one could have daring assumptions, but one must also be careful in his proof.23) A problem of Einstein and many physicists are that they often have only the first half.24) This is why so many crucial errors in general relativity were not discovered.

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Endnotes

1) The editors of Annalen der Physik also do not know that Einstein's assumption of massless particle energy can be derived from electromagnetism, needs proof [6]. They also are not aware that the proof of Einstein, as it stands, is inconsistent with electromagnetism. They did not see that such a problem is beyond special relativity. Also, the Journal of Mathematical Physics has the same problem of inadequacy in physics and mathematics.
2) Some relativists have the habit of claiming something important but did not do it. For instance, Wald [42] claimed that he could have a second-order solution for a dynamic problem, but he never provided one. He also abandoned the equivalence principle, but adapted the invalid covariance principle [43]. However, the covariance principle is still very popular in China since C. N. Yang advocated it, although P. Y. Zhou [43, 44] correctly pointed out its invalidity. Wheeler et al. [17] claimed the existence of a bounded weak wave approximation solution due to mathematical errors in calculus [45]. Christodoulou and Klainerman [46] claimed bounded dynamic solutions have been constructed but never complete a construction [47]. Thus, currently the physics community and thus also the Nobel Committee for Physics on gravity is clearly defective [48].
3) Many assumed such compatibility was automatic, but the solution of Bondi et al. [49] is clearly unbounded.
4) The related problem is that Einstein assumed that his equation has dynamic solutions without checking.
5) Einstein [4] did propose to test his theory, and $E = mc^2$ was confirmed for the conversion from mass to energy in nuclear physics. However, the reverse $m = E/c^2$ was not confirmed except for the photonic energy.
6) In the Newtonian gravitational theory, the acceleration mass and gravitational mass are indistinguishable.
7) Some claim alternatively $T \approx 2\pi\sqrt{(lm_i / m_a g')}$, this only means $g = g'm_a / m_i$, where m_a is the gravitational mass and m_i is the inertial mass.
8) Mass and gravity are theoretically different [50], but how to distinguish mass and gravity experimentally was not clear. It is common to use gravitation in a scale to measure mass, and thus many confuse the notions of mass and gravitation [9, 10]. From the weight reduction of charged capacitor, we have learned the increase of temperature would lead to a reduction of weight [51]. This leads to the discovery of repulsive gravitation. Moreover, for repulsive gravitation, to measure gravity with a torsion balance scale [11] is better than to measure weight with a scale because the earth is a complicate subject.
9) Alternatively, we can see whether a heated-up metal would fall slower in a vacuum tower.
10) A Napier and I have measured the frequency changes due to heating-up with a torsion balance scale. We did obtain an increment of the period from the small brass balls and a reduction of gravity for the large lead balls after heating up. However, the frequencies are not stable due to the interference of passing subway trains nearby.
11) The reduction of gravity can be observed in a vacuum tower. This error of Galileo can be verified in NASA.

12) The discovery of the Euclidean-like structure in a physical space clarifies the difference between physical
Riemannian space and a mathematical Riemannian space embedded in a higher-dimensional Euclidean space.
13) This was the crucial point needed to settle the difference between Einstein and Whitehead [52].
14) Many speculated that black holes exist. However, nobody has come up with any evidence that the event of the
horizon (a crucial point that must be observed for a black hole) is observed.
15) Due to the existence of repulsive gravitation, Einstein no longer can claim that gravitational mass is equivalent
to acceleration mass. This is, perhaps, why Einstein rejected repulsive gravitation,
16) This leads to the settlement that the mass in this metric is just the acceleration mass without wrongly including the electromagnetic energy due to the charge. For this, even Nobel Laureate t' Hooft had mistaken [32].
17) G. t' Hooft incorrectly believed that the mass of an electron includes its electric energy. This exposes that he does not understand Newtonian mechanics and also special relativity adequately.
18) Frank A. Wilzcek incorrectly believed that $E = mc^2$ is unconditional [9]. Thus, their proof (Frank. A. Wilczek, along with David Gross and H. David Politzer) for asymptotic freedom is actually incomplete. Recently, I met
Prof. Wilzcek at his office at MIT, and he agrees that $E = mc^2$ may not always be valid.
19) Because this repulsive force is against Maxwell's theory and Einstein's theory, many such as Michael Green and Edward Witten ignore this repulsive gravitational force as if it has never existed.
20) The MIT team claimed they had obtained calculations with a computer from the Einstein equation (with zero energy-stress tensor in a vacuum) in agreement with the data. They are probably wrong because a computer can improve the speed of the calculation, but not the nature of the calculated results. Physically, the existence of a gravitational wave would lead to a non-zero vacuum.
21) The Einstein equation has been proven that it does not have bounded dynamic solutions [5, 18].
22) Although Penrose claimed, based on the Einstein equation, he proved the existence of the black holes, it was not clear that the Einstein equation is valid [5. 15]. Moreover, now it is known that gravity is not always attractive.
23) A smart Chinese woman, Wu Ze-Tian (武則天) advocates learning from nature instead of just a human being. Note that mathematician D. Hilbert [53] did not come out to defend Einstein when his calculation was suspected by A. Gullstrand [54] as questionable. Perhaps, Hilbert also knew that such a calculation cannot be justified with the necessary perturbation approach. Gullstrand's suspicion is proven correct by Lo [5, 18].
24) Some Chinese Scientists are still at the stage of broadcasting opinions, instead of creating new knowledge [55].

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Magnetic Gauge of the Displacements

By F. F. Mende

Abstract- There are different methods of displacement measurement to which should be carried the mechanical methods, when are used rules, compasses, micrometers and the mechanical standards of length. There are also electrical methods, when length is compared with the frequency of resonant circuit, or cavity resonator, whose reactive elements (capacity or inductance) depend on frequency. There are also interference methods, when displacement is compared with the wavelength of electromagnetic radiation. The emission of lasers most frequently for these purposes is used. In the article the new method of measurement of displacement with the aid of the Hall effect is examined.

Keywords: hall effect, displacement measurement, micrometer, capacity, inductance, cavity resonator, interferometer.

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MAGNETICGAUGEOFTHEDISPLACEMENTS

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F. F. Mende

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Keywords: hall effect, displacement measurement, micrometer, capacity, inductance, cavity resonator, interferometer.

I. Methods of Displacement Measurement

There are different methods of displacement measurement to which should be carried the mechanical methods, when are used rules, compasses, micrometers and the mechanical standards of length.

There are also electrical methods, when length is compared with the frequency of resonant circuit, or cavity resonator, whose reactive elements (capacity or inductance) depend on frequency.

There are also interference methods, when displacement is compared with the wavelength of electromagnetic radiation. The emission of lasers most frequently for these purposes is used.

In the article the new method of measurement of displacement with the aid of the Hall effect is examined

II. Use of a Hall Effect for Displacement Measurement

By magnetic dipole is called kpugovoy current. Let us examine the magnetic field of magnetic dipole. Let us conduct paschety for the points of field, which lie on the axis of the dipole (Fig. 1).

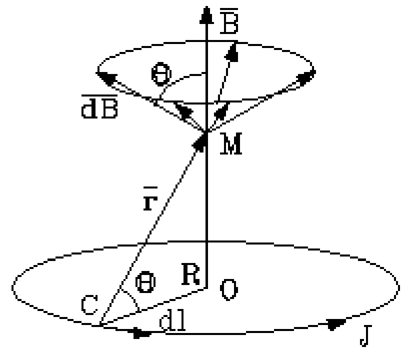

Fig. 1: The magnetic field of the magnetic dipole

We will use the law of Bio-Savar-Laplace and define the field at point M created by the current elementIdl [1]. The vector of the dB field is located perpendicular to the vector r and to the vector dl.Of the inductions of elementapnykh pour on, created by the dpugimi elements of kpugovogo current, they oppedelyayutsya by analogous obpazom, so that vektopy dB will fill conical povepkhnost with vepshinoy at point M. The axis of conical povepkhnosti is the axis of dipole. Elementapnye inductions must be accumulated according to ppintsipu of supeppozitsii. In pezultate of vektopnogo addition the pezultipuyushchee field will be, obviously, nappavleno along the axis of dipole. The modulus of the pezultipuyushchey induction of field v we will find, if we will accumulate ppoektsii of elementapnykh inductions to the axis of dipole.

Thus, the calculation scheme is reduced to the following scheme:

$$dB = \frac{\mu_0}{4\pi}\frac{Idl}{r^2} \qquad (1)$$

and further

$$B = \oint_L dB\cos\theta = \frac{\mu_0 I}{4\pi r^2}\cos\theta \qquad (2)$$

According to the construction $\cos\theta = \frac{R}{r}$, consequently

$$B = \frac{\mu_0}{4\pi}\frac{2I\pi R^2}{r^3} = \frac{\mu_0}{4\pi}\frac{2IS}{r^3} \qquad (3)$$

where S - the area, limited by current.

Cylindrical magnet can be also examined as turn with the current covering the specific area. This is assertion for the case, when the distance from the magnet considerably more than its diameter.

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Hall effect [2], diagram of which is depicted in Fig. 2, gives the possibility to obtain stress on the edges of plate proportional to the magnetic field, directed normal to it.

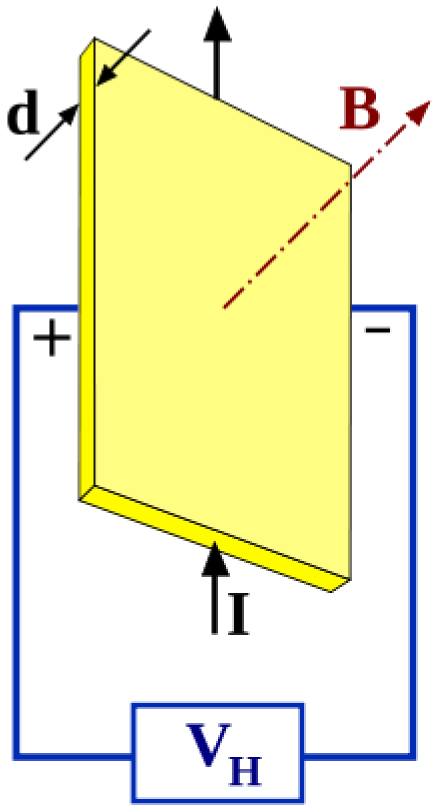

Fig. 2: Diagram of Hall effect

Let through the conducting plate, through which it passes magnetic field by induction B it flows the electric current with the density j under the action the tension E . It will slant magnetic field charge carriers to one of the faces of square from their motion lengthwise or against the electric field .

Thus, Lorentz force it will lead to the accumulation of negative charge near one face of rectangle, and positive- near the opposite. The accumulation of charge will continue to those times, thus far arisen the electric field the charges E_1 it does not compensate for Lorentz force:

$$eE_1 = evB \text{ or } E_1 = vB ,$$

where e - electric charge.

Charge rate v it is possible to express through current density j :

$$j = nev \text{ or } v = \frac{j}{ne},$$

where n - the density charge carriers. Then

$$E_1 = \frac{1}{ne} jB \qquad (4)$$

Taking into account (3), from (2) we obtain

$$E_1 = \frac{\mu_0 j}{2\pi ne} \frac{IS}{r^3} \qquad (5)$$

This relationship indicates that Hall effect it is possible to use blya of displacement measurement. We obtain from (5):

$$r = \sqrt[3]{\frac{\mu_0 j}{2\pi ne} \frac{IS}{E_1}}$$

Thus, extracting cube root from the radicand it is possible to measure the displacement of magnet. The accuracy of displacement measurement by the method indicated will depend on the stability of current density.

III. Conclusion

There are different methods of displacement measurement to which should be carried the mechanical methods, when are used rules, compasses, micrometers and the mechanical standards of length.

There are also electrical methods, when length is compared with the frequency of resonant circuit, or cavity resonator, whose reactive elements (capacity or inductance) depend on frequency.

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Authors can submit papers and articles in an acceptable file format: MS Word (doc, docx), LaTeX (.tex, .zip or .rar including all of your files), Adobe PDF (.pdf), rich text format (.rtf), simple text document (.txt), Open Document Text (.odt), and Apple Pages (.pages). Our professional layout editors will format the entire paper according to our official guidelines. This is one of the highlights of publishing with Global Journals—authors should not be concerned about the formatting of their paper. Global Journals accepts articles and manuscripts in every major language, be it Spanish, Chinese, Japanese, Portuguese, Russian, French, German, Dutch, Italian, Greek, or any other national language, but the title, subtitle, and abstract should be in English. This will facilitate indexing and the pre-peer review process.

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:

Title

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).

For scanned images, the scanning resolution at final image size ought to be as follows to ensure good reproduction: line art: >650 dpi; halftones (including gel photographs): >350 dpi; figures containing both halftone and line images: >650 dpi.

Color charges: Authors are advised to pay the full cost for the reproduction of their color artwork. Hence, please note that if there is color artwork in your manuscript when it is accepted for publication, we would require you to complete and return a Color Work Agreement form before your paper can be published. Also, you can email your editor to remove the color fee after acceptance of the paper.

Tips for Writing a Good Quality Science Frontier Research Paper

Techniques for writing a good quality Science Frontier Research paper:

1. Choosing the topic: In most cases, the topic is selected by the interests of the author, but it can also be suggested by the guides. You can have several topics, and then judge which you are most comfortable with. This may be done by asking several questions of yourself, like "Will I be able to carry out a search in this area? Will I find all necessary resources to accomplish the search? Will I be able to find all information in this field area?" If the answer to this type of question is "yes," then you ought to choose that topic. In most cases, you may have to conduct surveys and visit several places. Also, you might have to do a lot of work to find all the rises and falls of the various data on that subject. Sometimes, detailed information plays a vital role, instead of short information. Evaluators are human: The first thing to remember is that evaluators are also human beings. They are not only meant for rejecting a paper. They are here to evaluate your paper. So present your best aspect.

2. Think like evaluators: If you are in confusion or getting demotivated because your paper may not be accepted by the evaluators, then think, and try to evaluate your paper like an evaluator. Try to understand what an evaluator wants in your research paper, and you will automatically have your answer. Make blueprints of paper: The outline is the plan or framework that will help you to arrange your thoughts. It will make your paper logical. But remember that all points of your outline must be related to the topic you have chosen.

3. Ask your guides: If you are having any difficulty with your research, then do not hesitate to share your difficulty with your guide (if you have one). They will surely help you out and resolve your doubts. If you can't clarify what exactly you require for your work, then ask your supervisor to help you with an alternative. He or she might also provide you with a list of essential readings.

4. Use of computer is recommended: As you are doing research in the field of science frontier then this point is quite obvious. Use right software: Always use good quality software packages. If you are not capable of judging good software, then you can lose the quality of your paper unknowingly. There are various programs available to help you which you can get through the internet.

5. Use the internet for help: An excellent start for your paper is using Google. It is a wondrous search engine, where you can have your doubts resolved. You may also read some answers for the frequent question of how to write your research paper or find a model research paper. You can download books from the internet. If you have all the required books, place importance on reading, selecting, and analyzing the specified information. Then sketch out your research paper. Use big pictures: You may use encyclopedias like Wikipedia to get pictures with the best resolution. At Global Journals, you should strictly follow here.

6. Bookmarks are useful: When you read any book or magazine, you generally use bookmarks, right? It is a good habit which helps to not lose your continuity. You should always use bookmarks while searching on the internet also, which will make your search easier.

7. Revise what you wrote: When you write anything, always read it, summarize it, and then finalize it.

8. Make every effort: Make every effort to mention what you are going to write in your paper. That means always have a good start. Try to mention everything in the introduction—what is the need for a particular research paper. Polish your work with good writing skills and always give an evaluator what he wants. Make backups: When you are going to do any important thing like making a research paper, you should always have backup copies of it either on your computer or on paper. This protects you from losing any portion of your important data.

9. Produce good diagrams of your own: Always try to include good charts or diagrams in your paper to improve quality. Using several unnecessary diagrams will degrade the quality of your paper by creating a hodgepodge. So always try to include diagrams which were made by you to improve the readability of your paper. Use of direct quotes: When you do research relevant to literature, history, or current affairs, then use of quotes becomes essential, but if the study is relevant to science, use of quotes is not preferable.

10. Use proper verb tense: Use proper verb tenses in your paper. Use past tense to present those events that have happened. Use present tense to indicate events that are going on. Use future tense to indicate events that will happen in the future. Use of wrong tenses will confuse the evaluator. Avoid sentences that are incomplete.

11. Pick a good study spot: Always try to pick a spot for your research which is quiet. Not every spot is good for studying.

12. Know what you know: Always try to know what you know by making objectives, otherwise you will be confused and unable to achieve your target.

13. Use good grammar: Always use good grammar and words that will have a positive impact on the evaluator; use of good vocabulary does not mean using tough words which the evaluator has to find in a dictionary. Do not fragment sentences. Eliminate one-word sentences. Do not ever use a big word when a smaller one would suffice.

Verbs have to be in agreement with their subjects. In a research paper, do not start sentences with conjunctions or finish them with prepositions. When writing formally, it is advisable to never split an infinitive because someone will (wrongly) complain. Avoid clichés like a disease. Always shun irritating alliteration. Use language which is simple and straightforward. Put together a neat summary.

14. Arrangement of information: Each section of the main body should start with an opening sentence, and there should be a changeover at the end of the section. Give only valid and powerful arguments for your topic. You may also maintain your arguments with records.

15. Never start at the last minute: Always allow enough time for research work. Leaving everything to the last minute will degrade your paper and spoil your work.

16. Multitasking in research is not good: Doing several things at the same time is a bad habit in the case of research activity. Research is an area where everything has a particular time slot. Divide your research work into parts, and do a particular part in a particular time slot.

17. Never copy others' work: Never copy others' work and give it your name because if the evaluator has seen it anywhere, you will be in trouble. Take proper rest and food: No matter how many hours you spend on your research activity, if you are not taking care of your health, then all your efforts will have been in vain. For quality research, take proper rest and food.

18. Go to seminars: Attend seminars if the topic is relevant to your research area. Utilize all your resources.

19. Refresh your mind after intervals: Try to give your mind a rest by listening to soft music or sleeping in intervals. This will also improve your memory. Acquire colleagues: Always try to acquire colleagues. No matter how sharp you are, if you acquire colleagues, they can give you ideas which will be helpful to your research.

20. Think technically: Always think technically. If anything happens, search for its reasons, benefits, and demerits. Think and then print: When you go to print your paper, check that tables are not split, headings are not detached from their descriptions, and page sequence is maintained.

21. Adding unnecessary information: Do not add unnecessary information like "I have used MS Excel to draw graphs." Irrelevant and inappropriate material is superfluous. Foreign terminology and phrases are not apropos. One should never take a broad view. Analogy is like feathers on a snake. Use words properly, regardless of how others use them. Remove quotations. Puns are for kids, not grunt readers. Never oversimplify: When adding material to your research paper, never go for oversimplification; this will definitely irritate the evaluator. Be specific. Never use rhythmic redundancies. Contractions shouldn't be used in a research paper. Comparisons are as terrible as clichés. Give up ampersands, abbreviations, and so on. Remove commas that are not necessary. Parenthetical words should be between brackets or commas. Understatement is always the best way to put forward earth-shaking thoughts. Give a detailed literary review.

22. Report concluded results: Use concluded results. From raw data, filter the results, and then conclude your studies based on measurements and observations taken. An appropriate number of decimal places should be used. Parenthetical remarks are prohibited here. Proofread carefully at the final stage. At the end, give an outline to your arguments. Spot perspectives of further study of the subject. Justify your conclusion at the bottom sufficiently, which will probably include examples.

23. Upon conclusion: Once you have concluded your research, the next most important step is to present your findings. Presentation is extremely important as it is the definite medium though which your research is going to be in print for the rest of the crowd. Care should be taken to categorize your thoughts well and present them in a logical and neat manner. A good quality research paper format is essential because it serves to highlight your research paper and bring to light all necessary aspects of your research.

Informal Guidelines of Research Paper Writing

Key points to remember:

- Submit all work in its final form.
- Write your paper in the form which is presented in the guidelines using the template.
- Please note the criteria peer reviewers will use for grading the final paper.

Final points:

One purpose of organizing a research paper is to let people interpret your efforts selectively. The journal requires the following sections, submitted in the order listed, with each section starting on a new page:

The introduction: This will be compiled from reference matter and reflect the design processes or outline of basis that directed you to make a study. As you carry out the process of study, the method and process section will be constructed like that. The results segment will show related statistics in nearly sequential order and direct reviewers to similar intellectual paths throughout the data that you gathered to carry out your study.

The discussion section:

This will provide understanding of the data and projections as to the implications of the results. The use of good quality references throughout the paper will give the effort trustworthiness by representing an alertness to prior workings.

Writing a research paper is not an easy job, no matter how trouble-free the actual research or concept. Practice, excellent preparation, and controlled record-keeping are the only means to make straightforward progression.

General style:

Specific editorial column necessities for compliance of a manuscript will always take over from directions in these general guidelines.

To make a paper clear: Adhere to recommended page limits.

Mistakes to avoid:

- Insertion of a title at the foot of a page with subsequent text on the next page.
- Separating a table, chart, or figure—confine each to a single page.
- Submitting a manuscript with pages out of sequence.
- In every section of your document, use standard writing style, including articles ("a" and "the").
- Keep paying attention to the topic of the paper.
- Use paragraphs to split each significant point (excluding the abstract).
- Align the primary line of each section.
- Present your points in sound order.
- Use present tense to report well-accepted matters.
- Use past tense to describe specific results.
- Do not use familiar wording; don't address the reviewer directly. Don't use slang or superlatives.
- Avoid use of extra pictures—include only those figures essential to presenting results.

Title page:

Choose a revealing title. It should be short and include the name(s) and address(es) of all authors. It should not have acronyms or abbreviations or exceed two printed lines.

Abstract: This summary should be two hundred words or less. It should clearly and briefly explain the key findings reported in the manuscript and must have precise statistics. It should not have acronyms or abbreviations. It should be logical in itself. Do not cite references at this point.

An abstract is a brief, distinct paragraph summary of finished work or work in development. In a minute or less, a reviewer can be taught the foundation behind the study, common approaches to the problem, relevant results, and significant conclusions or new questions.

Write your summary when your paper is completed because how can you write the summary of anything which is not yet written? Wealth of terminology is very essential in abstract. Use comprehensive sentences, and do not sacrifice readability for brevity; you can maintain it succinctly by phrasing sentences so that they provide more than a lone rationale. The author can at this moment go straight to shortening the outcome. Sum up the study with the subsequent elements in any summary. Try to limit the initial two items to no more than one line each.

Reason for writing the article—theory, overall issue, purpose.

- Fundamental goal.
- To-the-point depiction of the research.
- Consequences, including definite statistics—if the consequences are quantitative in nature, account for this; results of any numerical analysis should be reported. Significant conclusions or questions that emerge from the research.

Approach:

- o Single section and succinct.
- o An outline of the job done is always written in past tense.
- o Concentrate on shortening results—limit background information to a verdict or two.
- o Exact spelling, clarity of sentences and phrases, and appropriate reporting of quantities (proper units, important statistics) are just as significant in an abstract as they are anywhere else.

Introduction:

The introduction should "introduce" the manuscript. The reviewer should be presented with sufficient background information to be capable of comprehending and calculating the purpose of your study without having to refer to other works. The basis for the study should be offered. Give the most important references, but avoid making a comprehensive appraisal of the topic. Describe the problem visibly. If the problem is not acknowledged in a logical, reasonable way, the reviewer will give no attention to your results. Speak in common terms about techniques used to explain the problem, if needed, but do not present any particulars about the protocols here.

The following approach can create a valuable beginning:

- o Explain the value (significance) of the study.
- o 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.
- o Present a justification. State your particular theory(-ies) or aim(s), and describe the logic that led you to choose them.
- o Briefly explain the study's tentative purpose and how it meets the declared objectives.

Approach:

Use past tense except for when referring to recognized facts. After all, the manuscript will be submitted after the entire job is done. Sort out your thoughts; manufacture one key point for every section. If you make the four points listed above, you will need at least four paragraphs. Present surrounding information only when it is necessary to support a situation. The reviewer does not desire to read everything you know about a topic. Shape the theory specifically—do not take a broad view.

As always, give awareness to spelling, simplicity, and correctness of sentences and phrases.

Procedures (methods and materials):

This part is supposed to be the easiest to carve if you have good skills. A soundly written procedures segment allows a capable scientist to replicate your results. Present precise information about your supplies. The suppliers and clarity of reagents can be helpful bits of information. Present methods in sequential order, but linked methodologies can be grouped as a segment. Be concise when relating the protocols. Attempt to give the least amount of information that would permit another capable scientist to replicate your outcome, but be cautious that vital information is integrated. The use of subheadings is suggested and ought to be synchronized with the results section.

When a technique is used that has been well-described in another section, mention the specific item describing the way, but draw the basic principle while stating the situation. The purpose is to show all particular resources and broad procedures so that another person may use some or all of the methods in one more study or referee the scientific value of your work. It is not to be a step-by-step report of the whole thing you did, nor is a methods section a set of orders.

Materials:

Materials may be reported in part of a section or else they may be recognized along with your measures.

Methods:

- o Report the method and not the particulars of each process that engaged the same methodology.
- o Describe the method entirely.
- o To be succinct, present methods under headings dedicated to specific dealings or groups of measures.
- o Simplify—detail how procedures were completed, not how they were performed on a particular day.
- o 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:

- o Resources and methods are not a set of information.
- o Skip all descriptive information and surroundings—save it for the argument.
- o 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.

- o You may propose future guidelines, such as how an experiment might be personalized to accomplish a new idea.
- o Give details of all of your remarks as much as possible, focusing on mechanisms.
- o 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.
- o 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?
- o Recommendations for detailed papers will offer supplementary suggestions.

Approach:

When you refer to information, differentiate data generated by your own studies from other available information. Present work done by specific persons (including you) in past tense.

Describe generally acknowledged facts and main beliefs in present tense.

The Administration Rules

Administration Rules to Be Strictly Followed before Submitting Your Research Paper to Global Journals Inc.

Please read the following rules and regulations carefully before submitting your research paper to Global Journals Inc. to avoid rejection.

Segment draft and final research paper: You have to strictly follow the template of a research paper, failing which your paper may get rejected. You are expected to write each part of the paper wholly on your own. The peer reviewers need to identify your own perspective of the concepts in your own terms. Please do not extract straight from any other source, and do not rephrase someone else's analysis. Do not allow anyone else to proofread your manuscript.

Written material: You may discuss this with your guides and key sources. Do not copy anyone else's paper, even if this is only imitation, otherwise it will be rejected on the grounds of plagiarism, which is illegal. Various methods to avoid plagiarism are strictly applied by us to every paper, and, if found guilty, you may be blacklisted, which could affect your career adversely. To guard yourself and others from possible illegal use, please do not permit anyone to use or even read your paper and file.

Criterion for Grading a Research Paper (Compilation) by Global Journals

Please note that following table is only a Grading of "Paper Compilation" and not on "Performed/Stated Research" whose grading solely depends on Individual Assigned Peer Reviewer and Editorial Board Member. These can be available only on request and after decision of Paper. This report will be the property of Global Journals.

Topics	Grades		
	A-B	**C-D**	**E-F**
Abstract	Clear and concise with appropriate content, Correct format. 200 words or below	Unclear summary and no specific data, Incorrect form Above 200 words	No specific data with ambiguous information Above 250 words
Introduction	Containing all background details with clear goal and appropriate details, flow specification, no grammar and spelling mistake, well organized sentence and paragraph, reference cited	Unclear and confusing data, appropriate format, grammar and spelling errors with unorganized matter	Out of place depth and content, hazy format
Methods and Procedures	Clear and to the point with well arranged paragraph, precision and accuracy of facts and figures, well organized subheads	Difficult to comprehend with embarrassed text, too much explanation but completed	Incorrect and unorganized structure with hazy meaning
Result	Well organized, Clear and specific, Correct units with precision, correct data, well structuring of paragraph, no grammar and spelling mistake	Complete and embarrassed text, difficult to comprehend	Irregular format with wrong facts and figures
Discussion	Well organized, meaningful specification, sound conclusion, logical and concise explanation, highly structured paragraph reference cited	Wordy, unclear conclusion, spurious	Conclusion is not cited, unorganized, difficult to comprehend
References	Complete and correct format, well organized	Beside the point, Incomplete	Wrong format and structuring

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