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Zero-Point Energy (ZPE), $E_0 = \frac{1}{2} h\nu$, the *Quantum Magician* of Modern Physics

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Abstract: This is a peculiar paper wherein the Zero Point Energy (ZPE), $E_0 = \frac{1}{2} h\nu$ is impersonated as a Quantum Magician who is named as Greek lett**er,** λ also standing for Einstein's Cosmological constant, Λ. It is the Quantum Magician who gives the entire paper except the Conclusion. Addressing an audience, the Magician begins with a 'Foreword' and at various stages gives out his revelation by speaking out. In his Magic Wands are shown various items he finds out. Whenever a new idea is given out, he waves his Magic Wand and speaks. There is a vast coverage of topics and the entire paper is given a philosophical outlook. Mathematical treatment is given right from the second derivation of Planck's law of thermal radiation. Dirac's electrons, positrons and concept of 'Holes' are extensively discussed. The Planckian System of Units are systematically derived. Einstein's Cosmological Constant is critically discussed making use of Alexander Friedman's equation. The D'Sitter Space with Flat and Spherical geometry are included. There is a brief mention of Stochastic Electrodynamics, Zetterbewegung and Unruh-Davies-Fulling Effect.

As the reference to Review of Literature are chosen at random, references in the text in square brackets are not given. But, however ,there is a list of References. The paper ends with an independent Conclusion given by the Author wherein the "Trinity Triangle of Reality" of Roger Penrose is worth reading. The text of the paper is such that the meaning of the title of the paper with its theme is highly justified.

(All pictorial representations regarding the Quantum Magician are done by Author)

KeyWords: Casimir Effect, Cosmic Microwave Background Radiation, Cosmological Constant Λ, Dark Energy, Dirac's Holes, D'Sitter Space, Einstein's Field Equations, Friedman's Equations, Higg's Field, Mass of ZPE Particle, Models of Expanding Universe, Planckian System of Units, Pressure of Space, Quantum Vacuum, Scholastic Electrodynamics, Trinity Triangle of Reality, Unruh-Davies-Fulling Effect, Vacuum Energy, Zero Point Energy and Zetterbewegung.

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Note: Various Reference numbers in square brackets ([ ]) required as per Research Methodology are not shown in the text of the Paper as matter is referred at random at different contexts.

I. PHILOSOPHY

1.1 **"**The idea that Mathematics is the rightful interpreter of Nature originated with the Pythagoreans and doubtless with Pythagoras himself".

…….From Euclid to Eddington - A Study of Conceptions of the External World by Sir Edmund Whittaker, FRS, Dover Publications, New York, 1958, Sec.9, p.19.

1.2 **"**One thing I know for sure is that I know Nothing'

…….Socrates, the Greek Philosopher (470 BC-399 BC)

The philosophy followed by author in the preparation of this Paper

II. A FOREWORD BY THE QUANTUM

MAGICIAN, $E_0 = \frac{1}{2} h \nu$

The Quantum Magician,

THE QUANTUM MAGICIAN,

$E_0 = \frac{1}{2} h \nu$ Speaks

2 Singly I have only half the energy, but have multiple forms and all together have enough energy even to topple the Universe. To derive energy from me is a Herculian task for which you may have to take help of my ancestor, Mathematics with which I can appear in many forms. There are many things about me unknown to you. As on today only few things are known. Find out something new and get a Nobel Prize. You have first to be a mathematician. I would rather call him a *Mathemagician* as I am myself a Magician. I do not want to call you 'Folks'. You are being scientists, the correct,

appropriate and general word to address you should be "Readers!" You have to recall my great grandfather, Sir Isaac Newton (1642-1727 Pic-2) because Dark Energy, a by-product of the Zero Point Energy is found as far back as Newton's Principia.

As the author has chosen me as the title, I would like to prove myself as a real Magician. Leave aside Classical Physics as I have no place there. I reside in Quantum Physics and with my Magic Wand I shall show you many things that are unknown.

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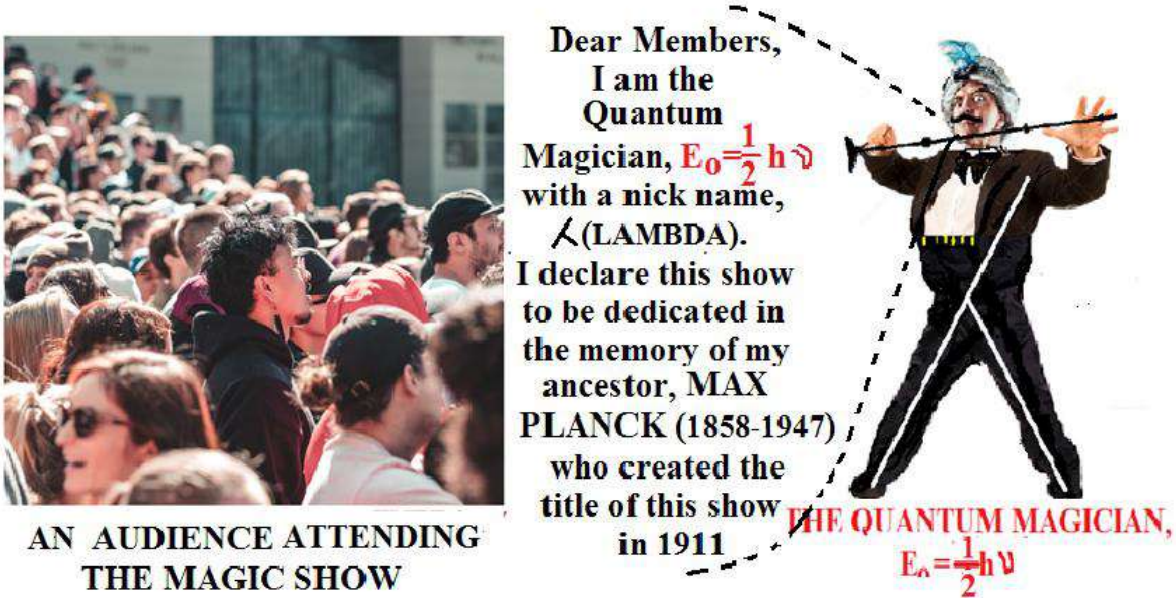
2.1 THE DEDICATION: The Dedication by the Quantum Magician



III. INTRODUCTION

3.1 A Peculiar Paper: This is a peculiar Research Paper differing from the usual Research Papers regarding its structure and Research Methodology.

This is my 30th Research Paper and I felt that I should give something altogether new and different to the readers.

The Zero Point Energy (ZPE) and its related philosophy is the main content of the Paper. The subject of the Paper is ZPE impersonated as a Magician who brings out many new and interesting concepts related to Quantum Mechanics, Astronomy, Cosmology and Gravitation. The Quantum Magician does not do anything on his own. But the tricky play is done by the Physicist dealing with it. From this point of view, the real magician is the Physicist and the ZPE is his main Magic Wand. Well!!! Readers! I am a Physicist (At least people call me so) and I am 81+ and at this age I have become more a Magician than a Physicist.

3.2 Note: The personal pronoun, 'I' refers either to the Quantum Magician or the author of this research paper in the text. The reader should judge appropriately from the context of the text.

3.3 The Birth of the Quantum Magician, $E_0 = \frac{1}{2}$ h ν: The Quantum Magician speaks: Well Readers! You should know my horoscope. I was born on 3 Feb. 2011 at the German Academy of Sciences at Berlin when my father Max Planck (1858-1947) (Pic-4) introduced his second theory of black body radiation in an address to the German Physical Society.

3.4 The Magic Wands: In the Paper, I will be presenting a large number of new concepts brought out from the magic wands of the Quantum Magician, ZPE. In the normal case a magician shows many tricks with one magic wand. This Quantum Magician in our case has a number of magic wands and shows a different one each time with a single magic wand as shown in Fig.2.

3.5 The Extent of Display by the Magician in Brief: Physics is a derivative subject and Mathematics is the language of Physics. The Magician has taken us from nothing (Vacuum) to a Sea of Energy, the Universe proving itself to be a wonder player and not a mere gambler. Readers can get a rough idea from Fig.1, the extent of coverage the ZPE has done. In the Figure 2 is shown the Quantum Magician with his Magic Wand in hand and few magic wands on either side. In fact,

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there are much more. Only few are shown.

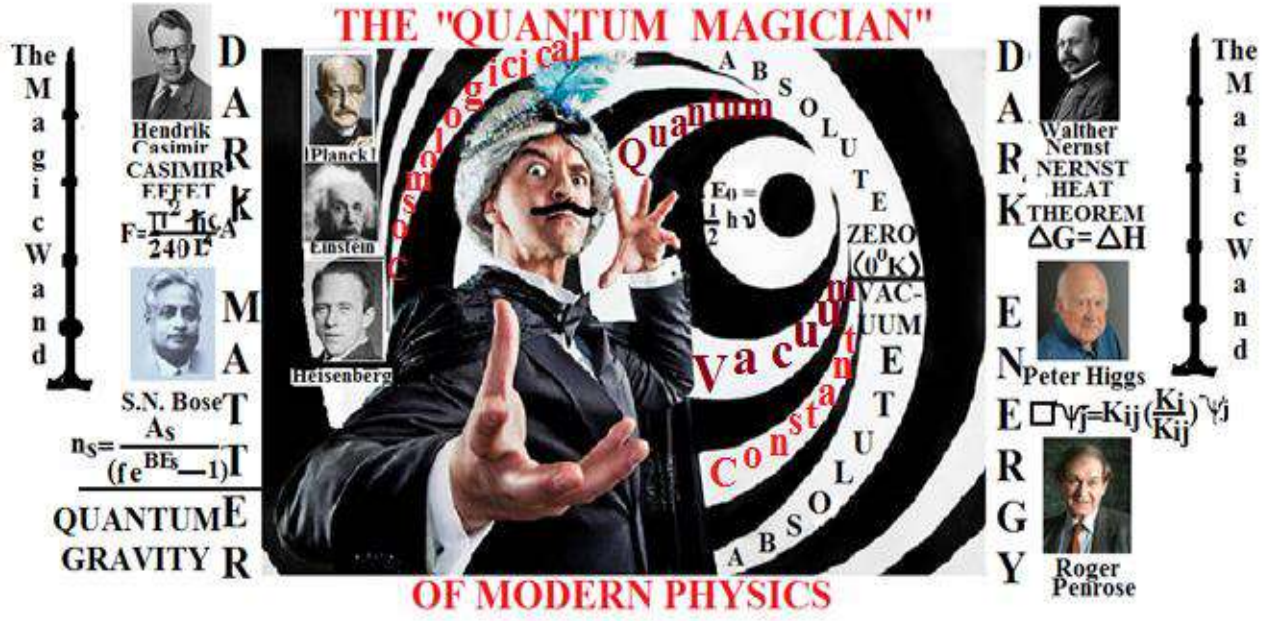

Fig.1 Figure illustrating the extent of coverage by the Quantum Magician

Fig.2 Illustrating the display of few of his Magic Wands and their related physical concepts

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REVIEW OF LITERATURE
IV. RESULT OF WAVING OF THE MAGIC WANDS

4.1 Generosity of the Magician: The Quantum Magician, Zero Point Energy, $E_0 = \frac{1}{2}$ h ν is highly generous and gives more than what is asked of him. Here, I quote the French mathematician, physicist and philosopher, D'Alembert, famous for the operator d'Alembertian, and whose interesting subject was Algebra. He quotes: "Algebra is a generous subject. She often gives more than what is asked of her" Let us see what the Magician speaks about Quantum Vacuum.

4.2 The Quantum Vacuum: The Magician says that there is no Absolute or true Vacuum as shown in the graph in Fig.3. Trying to obtain an absolute vacuum is an impossibility in Physics. Readers are advised to go through the research paper, titled, "The Four Impossibilities in Physics" mentioned in the Reference[10]. However hard you try you get only false vacuum with at least one particle. That particle must have its anti-particle. It is something like getting married. Each particle has its own field.

According to Einstein's mass-Energy relation, $E=mc^2$, energy is associated even with that false vacuum wherein principles of Quantum Mechanics can be applied and hence it is the Quantum Vacuum.

4.3 The Vacuum of Space: After the Big Bang, when the planets were formed the situation was almost like a highly magnified

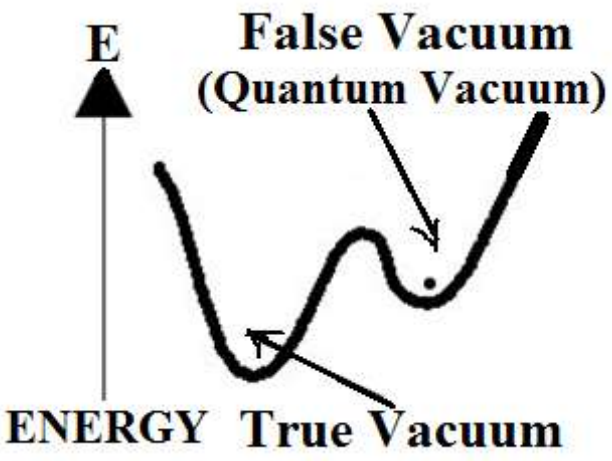

Fig.3 Illustration of Quantum Vacuum

Torricellian Vacuum filled with Zero Point Energy as illustrated in Fig.4 below:

4.4 My origin and Christening: Today (year 1911) I am only an infant born out of a thoughtful derivation by my father, Max Planck (1858-1947) in 1911. The spectral density per unit bandwidth for radiant energy is given by

$$\rho_E(\nu, T)\, d\nu = 8\pi\left(\frac{\nu^2}{c^3}\right)\left(\frac{h\nu}{e^{\frac{h\nu}{kT}}-1} + \frac{h\nu}{2}\right) d\nu \quad \ldots\ldots\ldots\ldots\ldots \quad (1)$$

From this equation it is clear that as T⟶0, the exponential term in the bracket tends to ∞ making that additive term to disappear but the energy does not vanish because of the second term, $\frac{1}{2}h\nu$

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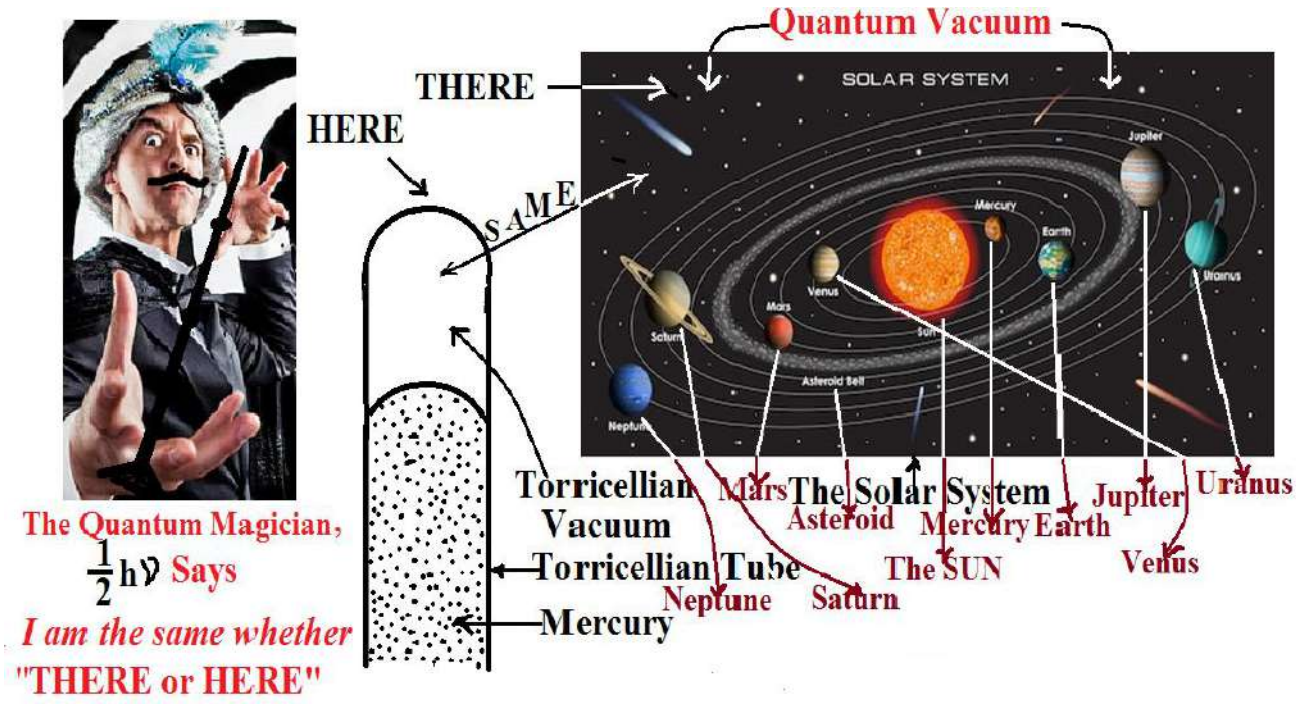

Fig.4 Illustration of Torrecellian Vacuum and the Vacuum of interstellar space as one and the same

in the bracket for each oscillator mode. The equation now takes the form

$$\rho_E \, d\nu = (8\,\pi \frac{\nu^2}{c^3} \frac{h\,\nu}{2})\, d\nu$$

$$= 4\pi\, h \frac{\nu^3}{c^3}\, d\nu \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (2)$$

The second multiple, $(\frac{1}{2}h\nu)$ joining with $8\,\pi \frac{\nu^2}{c^3}$ creates wonders. German-American Physicists, Albert Einstein (1879-1955) (Pic-8) and Otto Stern (1888-1969) (Pic-11) in the year 1913 coined this term, $(\frac{1}{2}h\nu)$ as ***Nullspunktenergie*** in German language meaning as Zero Point Energy (ZPE). This is my christening. I am the ground state energy even when the entire matter in the universe is eliminated.

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THE QUANTUM MAGICIAN, $E_0 = \frac{1}{2}h\nu$

The Quantum Magician further says that there is nothing as "NOTHINGNESS". But, there is always "SOMETHING" in that Nothingness. What is that something is the Confusion. I shall help you with my Magic Wand to find out that "Something".

Scientific American (18 August 1997) defined me as the shift:

E (ZPE) = E (Quantum Minimum) – E (Classical Minimum) > 0

'Empty' vacuum is actually a seething cauldron of energy. The energy is present even at Absolute Zero (−273 ℃), and of course, even when no matter is present.

Readers!! Is this not a wonder?

4.5 Dirac's Ocean of Electrons and Positrons (Holes): As early as 1928 a famous British Quantum Physicist, P.A.M. Dirac (1902-1984) (Pic-15) brought forward the idea of 'Positron' which was later, in the year 1932, discovered by an American Physicist, C.D. Anderson (1905-1991). Positron is a positive electron, a particle having the same mass of an electron but with a positive charge. . What Dirac said is that when the particles move, a vacancy created by an electron having a Negative charge will be occupied or rather filled by a similar particle with the same mass as that of the electron but acquires a positive charge and that is the positron. Dirac called this new particle 'Hole'. This is shown in Fig.5.

An interaction between an electron and positron in the sea of Holes and Electrons creates two Quanta of energy and the process is called "Annihilation of Matter" When a photon of energy greater than 2 m_0c^2 is utilized to raise an electron from a state of negative energy to a state of positive energy, a pair of particles (an electron and a positron together) is created and this process is called "Materialization of Energy" or "Pair Production". Here, an Electron is considered as 'Matter', Positron is considered as 'Anti-matter' and vice versa.

Readers!! As mentioned earlier in my Foreword, I have only half Quantum of energy but live with "Matter" (Electron) and "Anti matter" (Positron) trying to create an Avalanche full of Energy.

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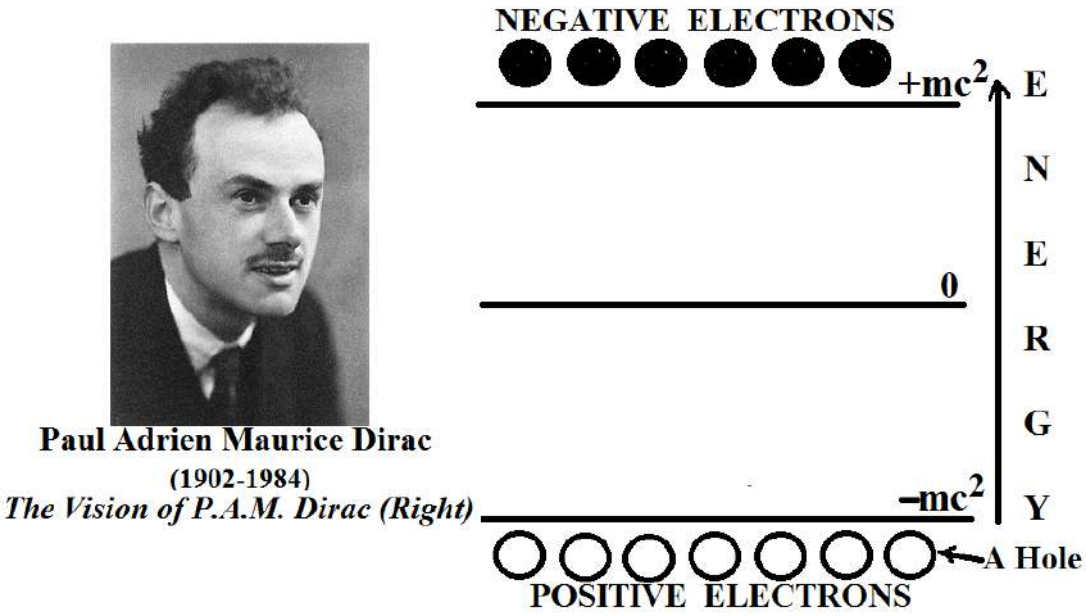

Fig.5 Illustration of Dirac's formations of Electrons and Positrons

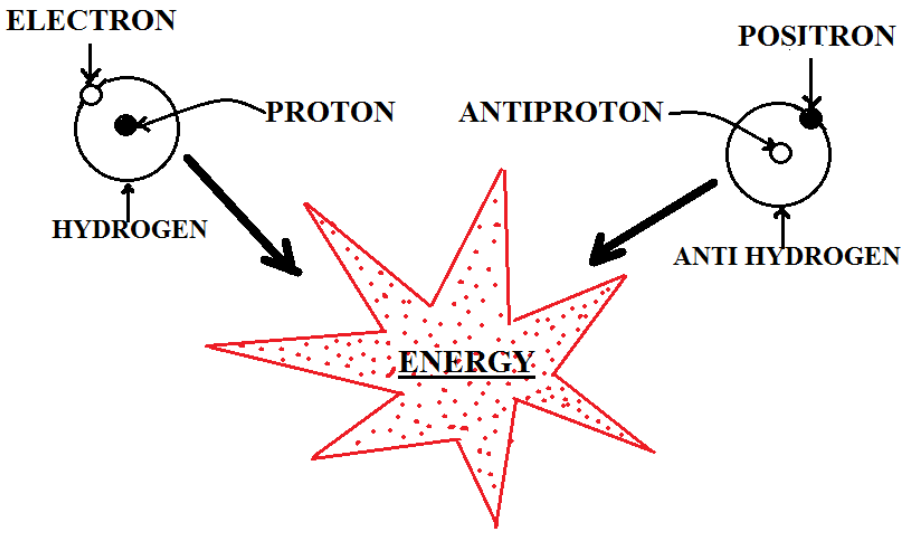

Fig.6 Pictorial illustration from 'Why is there something rather than nothing?'p.162-171, The Big Questions – Physics, Michael Brooks, Series Editor, Simon Blackburn, Metro Books, New York.

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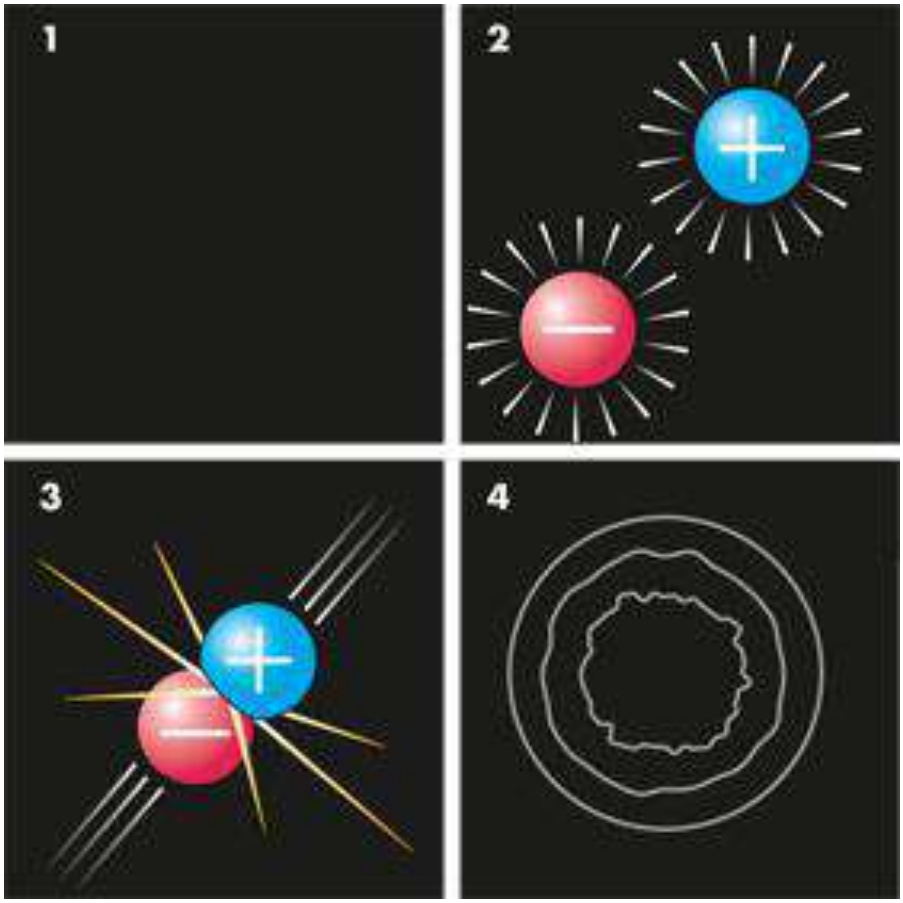

Fig. 7 1. Empty space. 2. Two particles suddenly appear. 3. Particles ram together and annihilate each other. 4. They leave ripples of energy through space. [Illustration by Tim Jones, Professor of Physics, University of Liverpool]

The Magician continues: Well! Readers, I am the Expectation Value of the Hamiltonian in the ground state. As you will come to know later that I am the greatest gift for all of you to enjoy for ever. I am surrounded by Quantum fluctuations. If I am surrounded by electrons and protons, I have a Fermion field having negative energy. And if surrounded by photons, I have a Boson field having positive energy. As these energies cancel only in a state of super symmetry, which is generally not observed, Einstein had to introduce a Cosmological Constant, Λ in his field equations of General Relativity

The wonder of the Quantum Magician is "How oscillations are sustained without matter?" Hence, it is conjectured that the ZPE must be of cosmological origin and the vacuum energy is predicted as a relic of the conditions present at the Big Bang. It is also conjectured that the vacuum energy density decreases in the vicinity of elementary particles the proofs for which are evident in the Casimir effect, the variability of speed and bending of light near a massive body and also the effect of gravity.

The Quantum Magician further says that for a proper and clear understanding of what is given above, Max Planck with the help of his second equation (Equation, 1) developed a system of units involving 3 basic constants, the velocity of light, c, Planck's constant, h and Newton's constant of gravitation, G and called them as the Planckian Metric. The quantities with suffix p standing for Planck are given below:

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$E_p \longrightarrow$ Maximum energy

$\omega_p \longrightarrow$ Maximum frequency

$l_p \longrightarrow$ Minimum length of Quantum space which is equal to wavelength, $\lambda_p = \frac{2\,\pi\,c}{\omega_p}$ . . . . . (3)

Based on Classical Mechanics and applying the same to Relativity and Quantum Mechanics we can write making $v \longrightarrow c$, the centripetal acceleration, $\frac{c^2}{r}$ can be equated to the force per unit mass, $\frac{G\,m}{r^2}$. That is,

$$\frac{c^2}{r} = , \frac{G\,m}{r^2}. \text{ from which}$$

$$r = r_s = \frac{G\,m}{r^2} \qquad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (4)$$

where we have made $r = r_s$ the Schwarzschild's (Pic-7) radius. Using the Heisenberg's (Pic-14) Uncertainty relation, $\Delta x\, \Delta p \geq \hbar$, expressing Δp as mc, we can write for the Compton radius

$$r_c = \frac{\hbar}{mc}. \qquad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (5)$$

as the minimum possible size of a Quantum object of mass, m.

Now, for scientist like Einstein, an electron or Earth is just a particle and the laws of Physics remain the same for both. Hence, equating the Schwarzschild's radius with the Compton radius we get

$$\frac{G\,m}{r^2} = \frac{\hbar}{mc}$$

That is, $m^2 = m_p^2 = \frac{\hbar\,\mathbf{c}}{G}$ or

$$m_p = \sqrt{\left(\frac{\hbar\,\mathbf{c}}{G}\right)} = 2.2 \times 10^{-8} \text{ kg} \qquad \ldots\ldots\ldots\ldots\ldots\ldots (6)$$

where m_p is the Planck mass limit. Substituting this m_p in the Compton radius we get

$$r_e = l_p = \frac{\hbar}{c}\sqrt{\left(\frac{\mathbf{G}}{\hbar\,\mathbf{c}}\right)} = \sqrt{\left(\frac{\hbar\mathbf{G}}{c^3}\right)} = 1.6 \times 10^{-35} \text{ m} \qquad \ldots\ldots\ldots\ldots (7)$$

where l_p is the Planck length referred to as the shortest length in space.

From the above we can get the maximum density of matter that can possibly exist as

$$\text{Density, } \rho_p = \frac{\text{Mass}}{\text{Volume}} = \frac{m_p}{{l_p}^3} = \frac{\sqrt{\left(\frac{\hbar\,\mathbf{c}}{G}\right)}}{\left[\sqrt{\left(\frac{\hbar\mathbf{G}}{c^3}\right)}\right]^3} = \frac{c^5}{\hbar\,\mathbf{G}^2} \text{ That is,}$$

$$\rho_p\,(m) = \frac{c^5}{\hbar\,\mathbf{G}^2} \qquad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (8)$$

Now, applying Einstein's mass-energy relation, $E = m\,c^2$, we get

$$E_p = m_p c^2 = \sqrt{\left(\frac{\hbar\,\mathbf{c}}{G}\right)} c^2 = \sqrt{\left(\frac{\hbar\,\mathbf{c^5}}{G}\right)} = 1.98 \times 10^9$$

$$\therefore E_p = 1.98 \times 10^9 \text{ J}$$

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From equation, (8) ρ_p (E) = $\frac{c^5}{\hbar \mathbf{G}^2}(c^2) = \frac{c^7}{\hbar \mathbf{G}^2}$ . . . . . .(9)

Now, dividing by the elementary charge q_e = 1.602 x 10^{-19} Ampere second which is about 1.23 x 10^{28} eV we get the Planck charge, q_p as

$$q_p = \sqrt{\hbar c 4\pi\varepsilon_0} \approx 1.876 \text{ x } 10^{-18} \text{ As} \quad \text{. . . . . .(10)}$$

From the above treatment we may write for the highest oscillations that can be sustained in space as

$$\omega_p = \frac{E_p}{\hbar} = \frac{\sqrt{(\frac{\hbar c^5}{G})}}{\hbar} = \sqrt{\frac{c^5}{\hbar \mathbf{G}}} = 1.9 \text{ x } 10^{43} \text{ rad/ s} \quad \text{. . . . . .(11)}$$

The Planckian units given above are the fundamental units of nature. The total average volumetric density of the Universe within its visible size is given by cosmologists as the square root of the squared density given by equation, (9). That is,

$$\rho_p = \sqrt{(\frac{c^{14}}{\hbar^2 \mathbf{G}^4})} \approx 4.6 \text{ x } 10^{113} \frac{J}{m^3} \quad \text{. . . . . .(12)}$$

An explanation for such a high value of energy density given by equation, (12) lies in the temperature more correctly the Planck temperature given by

$$T_p = \frac{m_p c^2}{k_B}. \quad \text{. . . . . .(13)}$$

where k_B is the Boltzmann constant. From the previous treatment we can write (13) as

$$T_p = \sqrt{(\frac{\hbar c^5}{G k_B^2})} = 1.41679 \text{ x } 10^{32} \text{Deg.K} \quad \text{. . . . . (14)}$$

This is the Planck temperature at the Big Bang and the Universe has cooled to the present epoch temperature of about 2.7^0K which is the effective temperature of the Cosmic Microwave Background Radiation by thermodynamic expansion and cooling.

Now, in order to work out the total volumetric density, ρ_{tot}, we need a higher frequency limit, ν_{high} and a lower frequency limit, ν_{low}. ν_{high} is taken as the frequency associated with a top quark pair which is the heaviest known elementary particle. The known frequency for this particle pair is:

$$\nu_{high} = 2.5 \text{ x } 10^{34} \text{ Hz}$$

For the lower limit, ν_{low} one may take ordinary light per unit wavelength (λ = 1m). That is, $\nu_{low} = \frac{c}{\lambda} = \frac{c}{1}$ = c. Thus, the Quantum Magician, $E_0 = \frac{1}{2}h\nu$ says that you have to take my integration. Well! Take it.

$$\rho_{tot} = \int_{\nu_{low}}^{\nu_{high}} (\frac{8\pi\nu^2}{c^3}) \frac{h\nu}{2} d\nu$$

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$$= \frac{4\pi h}{c^3}\int_{\nu_{low}}^{\nu_{high}} \nu^3 d\nu$$

$$= \frac{4\pi h}{c^3}\left[\frac{\nu^4}{4}\right]_{\nu_{low}}^{\nu_{high}}$$

$$= \frac{\pi h}{c^3}(\nu_{high}^4 - \nu_{low}^4)$$

$$= \frac{3.14\ x\ 6.62\ x\ 10^{-34}}{(3x10^8)^3}\left[\ (2.5\ x\ 10^{34})^4 - (3x10^8)^4\ \right]$$

$$= (2.567 \text{ x } 10^{-67})\ (3.8441 \text{ x } 10^{137})$$

$$\therefore\ \rho_{tot} = 9.87 \text{ x } 10^{70}\ \frac{J}{m^3} \ldots\ldots\ldots\ldots\ldots\ldots (15)$$

On the other hand, if one takes the higher frequency limit as the one from the Grand Unification Theory [The Grand Unification Theory (GUT) is a marriage between Quantum Physics and Cosmology. It is the most preferred development in Science since Isaac Newton realized that the Laws of Physics are strictly Universal Laws.

$$\rho_{GUT} = \int_{\nu_{low}}^{\nu_{GUT}} \left(\frac{8\pi\nu^2}{c^3}\right)\frac{h\nu}{2}\, d\nu = 2.56 \text{ x } 10^{99}\ \frac{J}{m^3} \ldots\ldots (16)$$

With all these we should remember that we are dealing with particles in the Dirac's ocean subject to Quantum fluctuations and Uncertainty principle.

The Planck density given by equation (12) and the density, ρ_{GUT} obtained by the Grand Unification Theory, both being very high, the former extraordinarily higher, cosmologists arrive at a compromise and take the square root of equation, (12) as the average vacuum energy density, ρ_{av}. That is,

$$\rho_{av} = \sqrt{\rho_p} \approx 10^{56}\ \frac{J}{m^3} \ldots\ldots\ldots\ldots\ldots\ldots\ldots (17)$$

V. EINSTEIN'S COSMOLOGICAL CONSTANT, Λ

5.1 Einstein's Concept of Space: Before discussing 'Matter' and 'Energy' of space, discuss about space itself. If you discuss space as what Newton did it, will bring everything to disaster. Newton said that "When matter and energy disappear from space, space still remains. This is totally wrong according to Einstein. Einstein says that with the disappearance of matter and energy, space also disappears. Space, actually is an undefined concept. Space is indestructible and exists everywhere including in an absolute vacuum supposed to be an impossibility. According to Einstein, matter and energy are equivalent because of the equation, $E = mc^2$ whereby energy exists even in vacuum and that is why I am in existence there.

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5.11 [A Preamble: On February 8, 1917, Einstein published a paper titled '*Kosmologische Betrachtungen zur allgemeinen Relativitätstheorie*' ('Cosmological Considerations in the General Theory of Relativity'). In it, he described a number called the cosmological constant. The constant had a value such that, when used in his newly created equations describing the behavior of the gravitational force, a non-changing universe was spit out – agreeing with knowledge at the time, as well as his belief, that the universe was static. Without the constant in the picture, on the other hand, Einstein's general theory of relativity suggested that the gravitational pull of masses contained in the universe would pull all the matter together, keeping the universe dynamic]

5.2 The Rejection and the Revival: It is found that the Universe is undergoing an accelerated rate of expansion without slowing down and the expansion is being attributed to a certain amount of vacuum energy density. This is done in the year 1917 by introducing an additive term, $\Lambda *$ called the Cosmological Constant. Denoting the vacuum energy density as ρ_0, the cosmological constant, Λ can be written as

*Usually the capital letter 'lambda', Λ is used. The small letter, λ (lambda) is also used in literature. Both are Greek symbols for wavelength of any radiation. Hence, in the text that follows both λ and Λ will be synonymously used – Author

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$$\Lambda = \left(\frac{8\pi G}{3}\right)\rho_0 \ldots\ldots\ldots\ldots\ldots\ldots\ldots \quad .(18)$$

This is just a definition for Λ as a multiple of ρ_0 with the Newton's constant of gravitation, G..

In modern cosmology it is mentioned that Λ is the leading candidate for Dark Energy and it is the simplest realization of Dark Energy. In Quantum Physics Λ enters in the form of Vacuum Energy. For a static universe, Einstein had to introduce the constant in his field equations and here is what he said:

"The term is necessary only for the purpose of making possible a quasi-static distribution of matter, as required by the fact of the small velocities of the stars" – Albert Einstein, 1917

Einstein's main argument is that the distribution of energy determines the geometry of space-time given by his field equations,

$$R_{\mu\nu} - \frac{1}{2} R g_{\mu\nu} = \frac{8\pi G}{c^4} T_{\mu\nu} \ldots\ldots\ldots\ldots\ldots\ldots (19)$$

where $g_{\mu\nu}$ is the metric tensor, $T_{\mu\nu}$, the energy momentum tensor.

To achieve a static universe, Einstein added the cosmological constant, Λ in the above equation as shown below:

$$R_{\mu\nu} - \frac{1}{2} R g_{\mu\nu} + \Lambda g_{\mu\nu} = \frac{8\pi G}{c^4} T_{\mu\nu} \ldots\ldots\ldots\ldots\ldots\ldots .(20)$$

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Cosmologists had lot of criticism over the introduction of Λ. Physicist, George Gamow (1904-1968), for reasons best known to him, criticized over the introduction of Λ and remarked in 1970 some 15 years after the death of Einstein in 1955 that the introduction of the constant in the field equations by Einstein was a greatest blunder in his life.

According to cosmologists, vacuum energy and cosmological constant have identical behavior as is evident from the equation (18) that Λ is proportional to ρ_0 with a multiple, $\frac{8\pi G}{3}$. The expansion of the Universe suggested by many physicists in the 1930's led Einstein to abandon the cosmological constant (The 'Rejection' as mentioned in the title of this section 5.2). But, in 1931 an eminent Dutch astronomer, Willem de Sitter (1872-1934, Pic-6) thought for a while that now the constant was more important than ever. (The 'Revival' as mentioned in the title of this section) It was he who believed in the expansion of space.

The Quantum Magician

The Quantum Magician
$E_0 = \frac{1}{2}h\nu$ Retorts:

The abandonment of the cosmological constant, Λ does not fit to the genius of Einstein. Let us wait for someone to revive

what Einstein abandoned. Readers! I speak this with lot of restraint and regrets. I am now rigorously waving my magic wands with anger. Later on, you may find one Alexander Friedman (1888-1925, Pic-10) who even corrected Einstein in support of the cosmological constant, Λ Soon I shall take you to that great mathematical cosmologist, Alexander Friedman

Within about a decade, though, astronomer Edwin Hubble (1889-1953, Pic-12) discovered that the universe is expanding. Einstein discarded the cosmological constant, calling it his greatest scientific blunder.

A pictorial illustration of the Quantum Magician, $E_0 = \frac{1}{2} h \nu$ shown as the Cosmological Constant, λ blowing and expanding the Universe is shown in Fig.8. The expansion depends on Lambda alone. Two years later, a Belgian Catholic priest-turned mathematical physicist and astronomer, Georges Lemaitre (1894-1966) and an ardent supporter of the expanding universe argued that the effect of the cosmological constant, Λ is equivalent to a negative cosmic pressure. In a talk given on 20 November 1933 to the National Academy of Sciences in Washington DC, Lemaitre made it clear that *"We must associate a pressure, $p = -\rho c^2$ to the density of energy ρc^2 of vacuum. This is essentially the meaning of the Cosmological Constant, λ* – Lemaitre, 1934. According to Lemaitre, the energy-mass density of vacuum was given by

$$\rho_v = \frac{\Lambda c^2}{4\pi G} \approx 10^{-27} \text{ gram per c.c.} \ldots\ldots\ldots\ldots\ldots\ldots (21)$$

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Fig.8 A pictorial illustration of the Quantum Magician, $E_0 = \frac{1}{2} h \nu$ shown as 'λ; blowing and expanding the Universe.

Lemaitre thus offered a physical interpretation of the cosmological constant as a vacuum energy density. As Quantum vacuum was at its infancy, Lemaitre did not correlate his result with Zero Point Energy (ZPE). An eminent author, Heige Krash in one of his papers says that "With the inevitable benefit of hindsight, one can perhaps say that Dark Energy has two grandfathers. Nernst (1864-1941, Pic-5) and Lemaitre. Nernst, a German Quantum Chemist famous for the Third Law of Thermodynamics which led to the Nernst Heat Theorem, argued through his paper

of 1916 that space is filled with Zero Point Energy as per Quantum Theory and Lemaitre in 1934 said that the Cosmological Constant, λ works as vacuum energy. The ideas of these two grand fathers were made to remain isolated til 1960's when in the year 1968, a Russian theoretical physicist, Zel dowich thought of integrating the vacuum energy of the cosmological constant with the Quantum Mechanical Zero Point Energy for which he assumed a cutoff corresponding to the mass of the proton. In this way he started independently a line of development that would lead to the famous cosmological constant problem and assign the vacuum energy a critical role in cosmological research.

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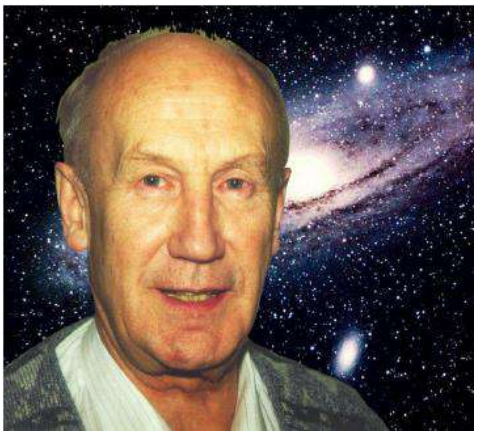

Fig.9 Wolfgang Priester (1924-2005)

Wolfgang Priester (Fig.9) was one of Germany's most versatile and quixotic astrophysicists, reinventing himself successively as a radio astronomer, space physicist and cosmologist, and making a lasting impact on each field. We focus in this personal account on his contributions to cosmology, where he will be most remembered for his association with quasars, his promotion of the idea of a nonsingular "big bounce" at the beginning of the current expansionary phase, and his ecognition of the importance of dark energy (Einstein's cosmological constant, Lambda) well before this became the standard paradigm in cosmology

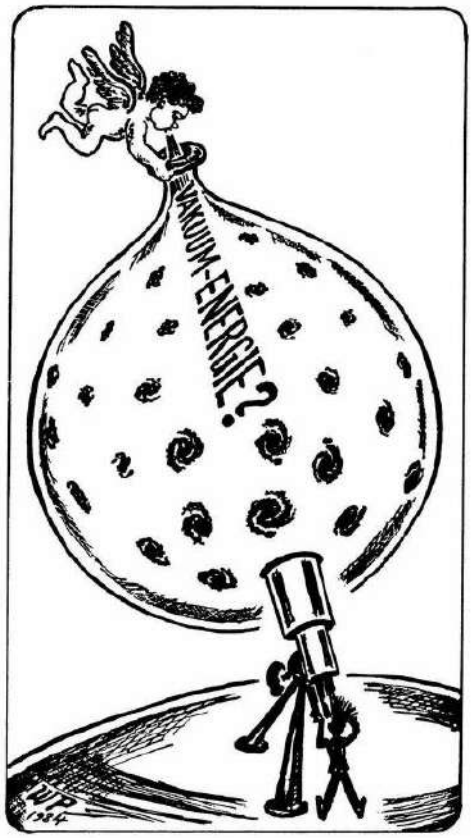

Fig.10 Wolfgang Priester's illustration of Vacuum Energy

In Fig.10 is shown Wolfgang Priester's illustration of vacuum energy

The Quantum Magician, $E_0 = \frac{1}{2} h\nu$

After having given this much, the Quantum Magician further Speaks and specifies that the reader should be made known regarding a young Russian mathematical scientist, Alexander Friedman (1888-1925) who in the year 1922 at his young age of about 35 brought out an equation known as Friedman equation given by

$$\left(\frac{\dot{a}}{a}\right)^2 = \frac{8\pi G}{3}\rho_0 - \frac{k}{a^2} \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (22)$$

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where a is a scale factor of the universe normalized to 1 as on today, $\dot{a}$ (dot over a) is the time derivative of the scale factor a, G and ρ_0 are as mentioned earlier and k is the curvature of universe given by k = +1, 0 or −1 for positive, flat or negative curvature respectively. After presenting the equation, no further development could be made as Friedman died in 1925 at a very young age of 37. In the year 1917 when Einstein added and later discarded the cosmological constant, Λ in his field equations, Willem de Sitter made use of the Friedman equation, (22) and came to the conclusion that in an homogeneous isotropic universe the geometry is defined by the Friedman-Lemaitre-Robertson-Walker Metric (FLRW Metric and the dynamics of the universe are governed by the Friedman equations in which the first term on the right of equation (22) is the cosmological constant Λ as defined in equation (18). Thus,

$$\left(\frac{\dot{a}}{a}\right)^2 = \Lambda - \frac{k}{a^2} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (23)$$

$\frac{\dot{a}}{a}$ is also known as the Hubble's constant, H. Thus,

$$H^2 = \Lambda - \frac{k}{a^2} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (24)$$

Λ is also called as the Dark Energy. Dark because it does not glow. Λ is responsible for the expansion of the universe. The Quantum Magician presents few diagrams (Figures 11, 12, 13 and 14) illustrating the expansion of the Universe

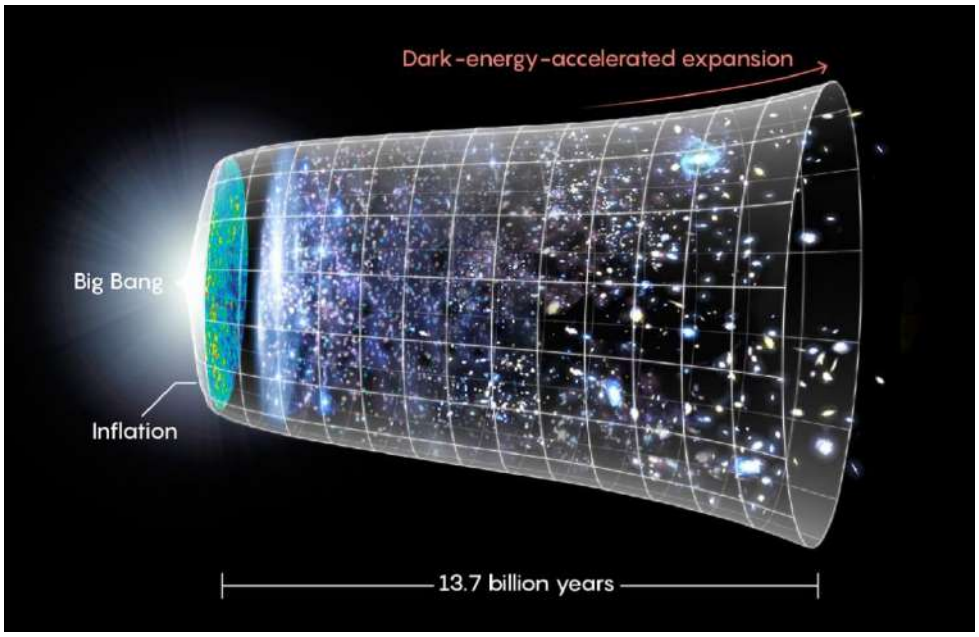

Fig.11 Illustration of the time-line of the Universe

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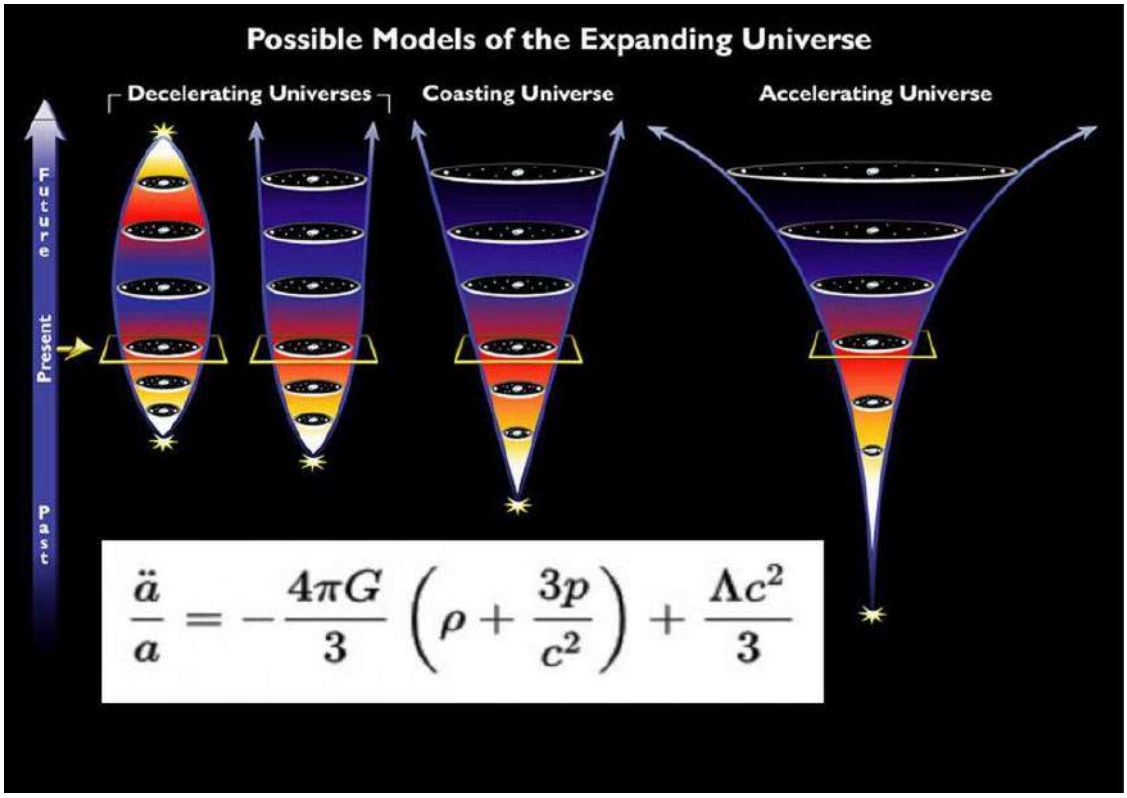

Fig.12. Illustration of Expanding Universe. Below: Friedman Equation

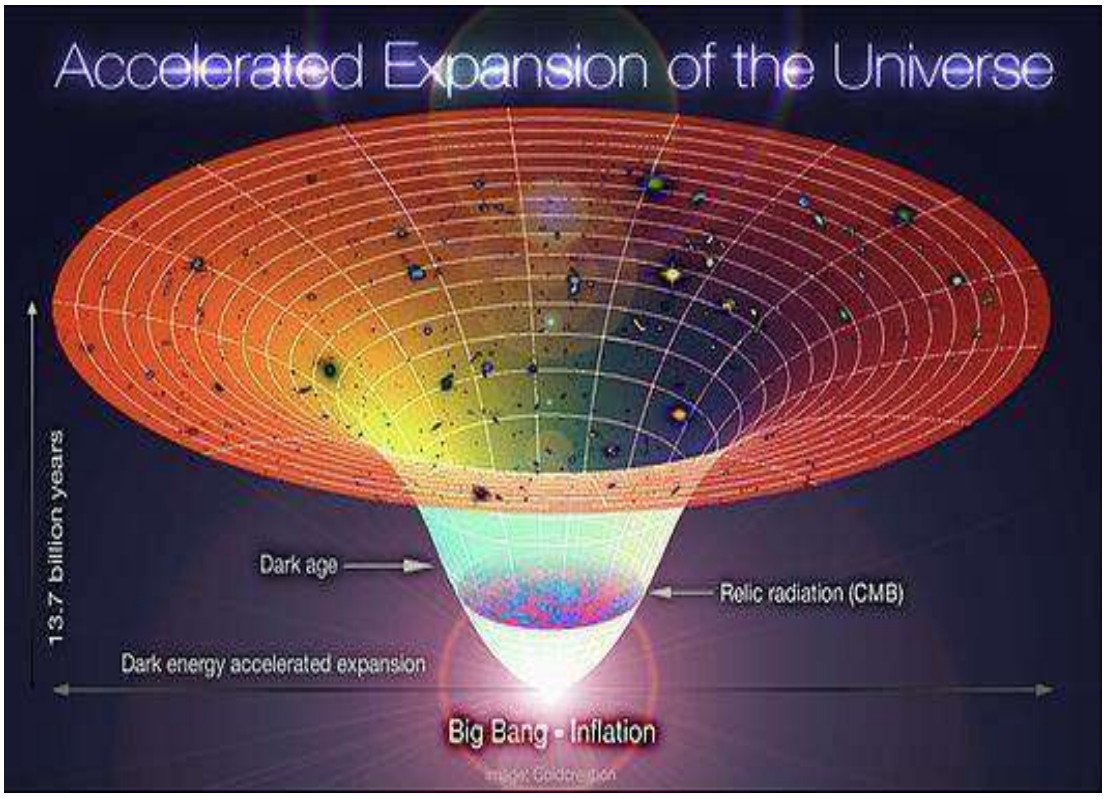

Fig. 13 Illustration of Accelerated Expansion of Universe

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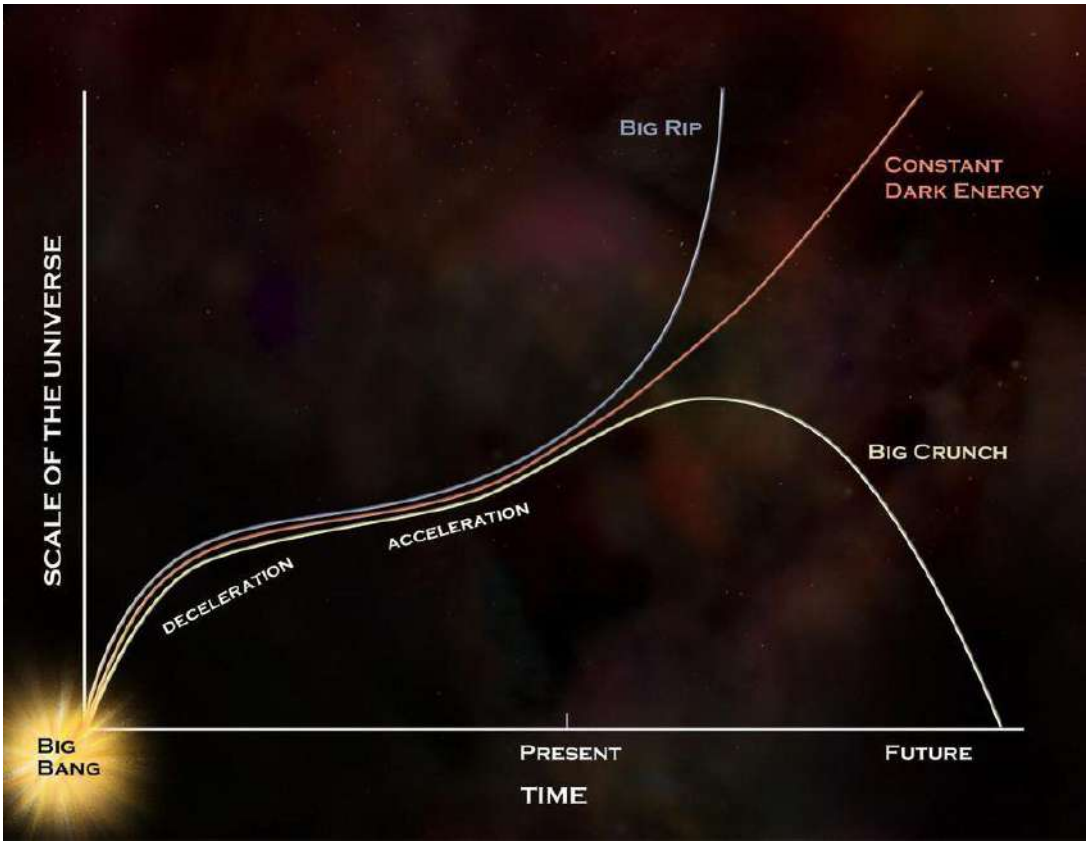

Fig.14 Graphical illustration of the Expansion of Universe since the Big Bang

5.3 De Sitter Space with Flat Geometry: This is important in a general sense a**s** Λ negative is meaningless. Λ has to be positive (non zero) and k = 0 so that the above equation (24) becomes

$$H^2 = \left(\frac{\dot{a}}{a}\right)^2 = \Lambda \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (25)$$

or $\dot{a} = a\sqrt{\Lambda}$ ..... (26)

That is, $\frac{da}{dt} = a\sqrt{\Lambda}$. so that

$$a(t) = c\, e^{\sqrt{\Lambda}\, t} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots (27)$$

where c is some constant, but not velocity of light. This equation shows that the universe exponentially expands which is a consequence of vacuum energy.

From equation (25) the Hubble constant is

$$H = \sqrt{\Lambda} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (28)$$

Thus, we can rewrite equation, (27) as $a(t) = c\, e^{H\, t}$ ..... (29)

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This equation is called de Sitter Space

5.4 De Sitter Space with Spherical Geometry: In this case k is not equal to zero, but +1. We have from equation (23),

$$\left(\frac{\dot{a}}{a}\right)^2 = \Lambda - \frac{1}{a^2} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (30)$$

Multiply both sides of this equation, (30) by a^2 so that

$$\dot{a}^2 = \Lambda\, a^2 - 1 \text{ That is,}$$

$$\dot{a}^2 - \Lambda\, a^2 = -1 \ldots\ldots\ldots\ldots\ldots\ldots\ldots (31)$$

A curve corresponding to the above equation, (31) is a parabola shown in Fig.11. – 1 corresponds to some arbitrary point A_0 on the parabola. The meaning of equation (31) is that the

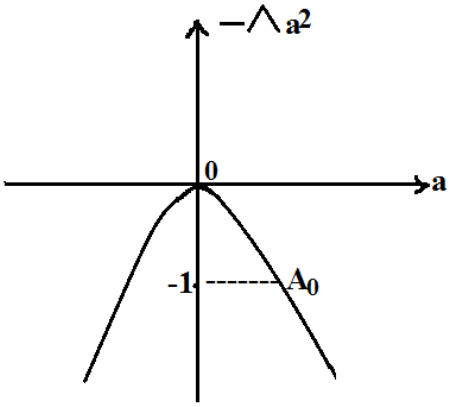

Fig. 15

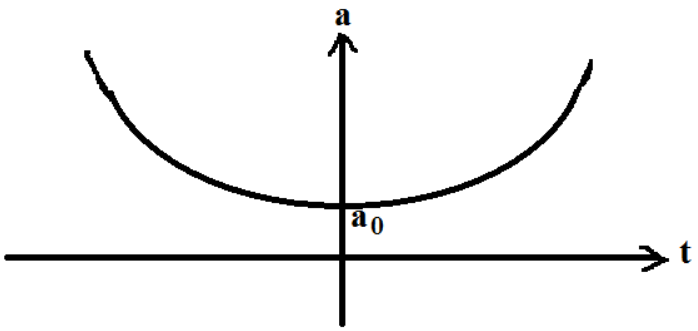

Fig. 16

Total energy, kinetic plus potential of the particle is equal to – 1. As exact solution for equation (31) will involve hyperbolic cosines, we may write

$$A = \frac{1}{\sqrt{\Lambda}} \text{Cosh}\,(\sqrt{\Lambda}\, t) \ldots\ldots\ldots\ldots\ldots\ldots (32)$$

where the hyperbolic Cosine is

$$\text{Cosh}\,(\sqrt{\Lambda}\, t) = \frac{1}{2}\left[e^{\sqrt{\Lambda}\, t} + e^{-\sqrt{\Lambda}\, t}\right].$$

For large values of t, $e^{-\sqrt{\Lambda}\, t}$ can be neglected whereas $e^{\sqrt{\Lambda}\, t}$ increases exponentially. This situation is shown in Fig.16. The scale parameter increases exponentially into the future and also into the past. A spherical universe expanding with time is shown in Fig. 17. At t=0, the spherical Universe is the smallest circle of radiusa_0. This is called the de Sitter Space.

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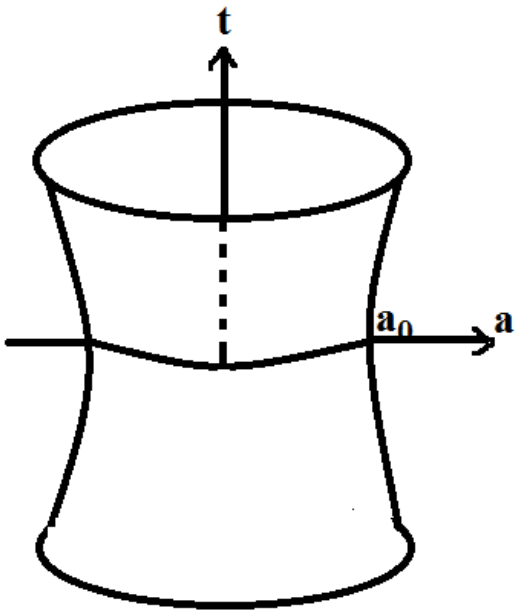

Fig.17

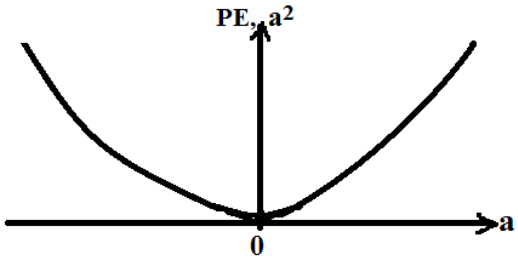

Fig. 18

5.5 Universe with negative Vacuum Energy: In this case, $\Lambda < 0$ and the Friedman equation becomes

$$\left(\frac{\dot{a}}{a}\right)^2 = -|\Lambda| - \frac{k}{a^2}$$

Let $|\Lambda| = -1$, then the equation becomes

$$\left(\frac{\dot{a}}{a}\right)^2 = -1 - \frac{k}{a^2} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (33)$$

A suitable solution for this equation can be obtained for values of k other than +1 and 0. Hence, take $k = -1$. The equation (33) becomes

$$\left(\frac{\dot{a}}{a}\right)^2 = -1 + \frac{1}{a^2} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (34)$$

Expanding (34) we get $\dot{a}^2 = -a^2 + 1$

That is, $\dot{a}^2 + a^2 = 1 \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (35)$

$\dot{a}^2$ is the kinetic energy and a^2 is the potential energy showing that the sum of the two is equal to 1. This equation is nothing but an equation of a harmonic oscillator with unit spring constant. A graph of PE (a^2 versus a) is shown in Fig.18. That is to say that the situation is like a hyperbolic universe with negative Λ behaves like a harmonic oscillator. The trajectory of its scale factor is positive half of the sinusoidal period. The right part of the graph is only meaningful. The position a

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= 0 is the time zero of the Big Bang. The universe then expands eventually reaching a maximum expansion, turns back and crashes again. This happens due to the negative cosmological constant. It should be noted that a too large negative and too large positive value for Λ will be deadly. Either there will be a tearing apart or a Crunch.

From equation (25), $H = \frac{1}{a}\frac{da}{dt}$. That is,

$$\frac{1}{H} = \frac{a}{\frac{da}{dt}} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (36)$$

$$= \frac{\text{Size of universe}}{\text{Speed of expansion}} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (37)$$

The mode of expansion of the universe is shown in Fig. 14. Starting from the Big Bang the deceleration curve climbs a plateau reaching curve of Acceleration up to the present time (To day) from where the curve splits and starts diverging one parallel to the scale of universe axis reaching the Big Rip. In physical cosmology the Big Rip is a hypothetical cosmological model concerning the ultimate fate of the universe with its entire matter from stars and galaxies to atoms and sub-atomic particles. The second one diverges towards the right and moves on. This corresponds to the constant Dark Energy. The third one moves down and meets the x-axis (Time-axis) depicting the Future.

The Quantum Magician, $E_0 = \frac{1}{2}h\nu$

The Quantum Magician further points out that the usefulness of the cosmological constant, Λ in the above treatment and waves his Magic Wand and says that Alexander Friedman whose famous equations helped to solve the cosmological constant issue of Albert Einstein.

In fact, Λ is the kernel of Einstein's Field Equations

The Quantum Magician continues waving of his Magic Wand and reveals many new things not mentioned so far.

VI. FURTHER REVELATIONS BY THE QUANTUM MAGICIAN

6.1 The Casimir Effect: A Dutch Physicist, Hendrik Casimir (1909-2000) (Pic-16) revealed a reality of the vacuum energy. He pointed out theoretically in 1948 that when two metal plates of distance d in vacuum, the virtual photons of the Quantum Vacuum in the gap between the plates will experience a force, F given by

$$F = \left(\frac{\pi^2 \hbar c}{240\, d^4}\right) A \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (38)$$

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where A is the area of the plates, $\hbar$, the reduced Planck's constant and c the velocity of light. The Casimir force was precisely measured by U Mohideen and Anushree Roy of the University of California at Riverside of the US. The measurement of Casimir force is a microscopic measurement when two plates (mirrors) with an area of 1 cm^2 separated by a distance of 1 μm the attractive Casimir force was found to be 10^{-7} newton.

6.11 Casimir effect is an interdisciplinary subject. In Quantum Field Theory (QFT) the Casimir effect has many applications involving long-range interactions and light elementary particles predicted by unified gauge theories, supersymmetry, supergravity and string theory. It has applications in Condensed Matter Physics, Gravitation, Astrophysics and Cosmology. In Atomic Physics the long-range Casimir interactions leads to corrections to energy levels of Rydberg states

6.2 The Pressure of Space: U.W. Massie in one of his papers titled, "Gravity and Zero Point Energy" published by Elsavier in 2012 reveals many interesting things. For example, he has shown the pressure of space as $6.9 \times 10^{12} \frac{N}{m^2}$ or 100,000,000 psi which is greater than the strength of any known material, and is strong enough to support the measured strength of all materials. In the Conclusion of the paper, Massie asserts that the space is filled with Zero Point Energy particles the density of which is measured by the gravitational constant G. The Earth does not drift through the sea of ZPE particles, but flows in the Sun's vortex stream with the same velocity as the vortex stream. The author has accounted for the speed of neutrinos being greater than the velocity of light – by saying that the speed of light – is the speed of wave front in the ZPE particles whereas the random motion of ZPE takes place in 3 directions

6.3 The Mass of the ZPE particle: The mass of the ZPE particle can be calculated from the energy of the Cosmic Microwave Background (CMB) Radiation which is given by

$$E = k_B T = M c^2 \quad \ldots\ldots\ldots\ldots\ldots\ldots \quad (39)$$

where k_B is the Boltzmann constant, T the absolute temperature of CMB radiation = 2.72^0 K. From equation (39) the value of M is

$$M = \frac{k_B T}{c^2}\ ; \text{Putting } k_B = 1.38 \times 10^{-23} \frac{J}{K}, \quad M = \frac{1.38\ x\ 10^{-23}}{9x10^{16}} = \frac{3.7536\ x\ 10^{-23}}{9x10^{16}} = 0.417 \times 10^{-39}$$

$$\text{That is, } M = 0.42 \times 10^{-39} \text{ kg} \quad \ldots\ldots\ldots\ldots\ldots \quad (40)$$

This mass is equivalent to 2.36×10^{-4} electron Volt predicted for the axion, the exponential order of which is the same as that of a neutrino whose mass is 1.2×10^{-39}kg

6.4 Highlights by J.S. Namwetako and G.S.W. Murunga of the Department of Physics, University of Eldoret in their Research Paper titled, "Zero Point Energy as Sea of Energy" published in the Annex Publication, Vol.7, Issue-3 dated 7 August 2019.

The authors mention Zero Point Energy (ZPE) as the greatest gift given to mankind by the Quantum World. They mention that John Wheeler and Richard Feynman calculated the ZPE of vacuum and showed that its magnitude is bigger than the Nuclear Energy so much so that a tea cup has en= ough energy so as to boil the world's oceans. A vacuum should n ot be viewed as an empty space, but a combination of Zero Point Fields. In QFT this combination of fields is called the

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vacuum state and the energy associated with ZPE is called vacuum energy and the average energy value is called Vacuum Expectation Value (VEV) also called its Condensate.

6.4.1 ZPE trapped in Crystalline state: In a crystalline state the atoms (or neutron on the side of neutron star are in a square well potential of depth V and width b. To get a bound state of (the neutron Pair – Pair neutrons), the minimum depth V_m turns out to be

$$V_m = \frac{\pi^2 \hbar^2}{4mb^2} = \frac{1.0\ 26\ x10^{-28}}{b^2}\ \text{MeV} \ldots\ldots\ldots\ldots (41)$$

where m is the mass of a neutron, $\hbar$ the reduced Planck's constant and allowing b to have a value 2 fm, where fm = 10^{-15} m is the Fermi length, the potential depth is found to be 25 MeV. The authors in the Conclusion answers to a query, "Why atoms don't collapse?" by saying that there is a dynamic equilibrium in which the ZPE stabilizes the electron in a set state ground orbit. Thus, there is a sea of energy called ZPE. The emissions such as X-rays occur due to transitions to lower levels due to conversion of Zero Point Electromagnetic Energy.

VII. ADDITIONAL TOPICS RELATED TO ZPE

7.1 Theory of Stochastic Electrodynamics (SED): This is an extension of the de Broglie-Bohm interpretation of Quantum Mechanics with the Electromagnetic Zero Point Field (EZPF) playing a central role as the guiding pilot wave. Stochastic Electrodynamics describes energy contained in electromagnetic vacuum at absolute zero as scholastic, fluctuating zero point field. This theory is a classical approach to Quantum Zero Point Field. There is no much application of this theory as the Quantum theory of Zero Point Energy is well set and established even though many authors such as the British physicist Trevor Marshall (Pic-3) and American physicist, Timothy Boyer (Born:1941, Pic-20) have done lot of research on it in the 60's.

7.2 Zetterbewegung: Zetterbewegung is a German word "Jither motion". Zero Point Energy is also associated with the phenomenon dubbed by this word by Schrodinger (1887-1961) (Pic-7). It is a rapid oscillatory motion of elementary particles that obey relativistic wave equations. As particles move with the speed of light such as photons they are said to be massless. Such massless particles when accelerated in an electric field Zetterbewegung suggests a helical motion with spin. Zetterbewegung has deep connection with ZPE and mass-energy relationships.

7.2.1 The Higg's Field: The connection in SED theory between zitterbewegung and the zero-point fluctuations have led to speculative investigations of a possible mass-generating role as an alternative to the Higgs field. The Higgs (Peter Higgs: Born:1929..Pic-18) field was first proposed in 1964 It is needed to confer the property of mass on the fundamental particles. In the theory, all particles are intrinsically massless until acted upon by the Higgs field. The quantum of the Higgs field is the Higgs boson. Attempts to detect the Higgs boson, and therefore to verify the Higgs field as the mass-generating mechanism of the Standard Model, tentatively succeeded in 2013.

7.3 Unruh-Davies-Fulling Effect: In the year 1973 an American Mathematical Physicist, Stephen A Fulling (Born:1945, Pic-22), a British Physicist, Paul Davies (Born:1946, Pic-23) in 1975 and in 1976 a Canadian physicist, William G. Unruh (Born:1945, Pic-21) observed a remarkably peculiar phenomenon known as the "Fulling-Unruh-Davies Effect". When an accelerating detector is sent through a medium of Zero Point Energy radiation. The detector is found to move as if immersed in

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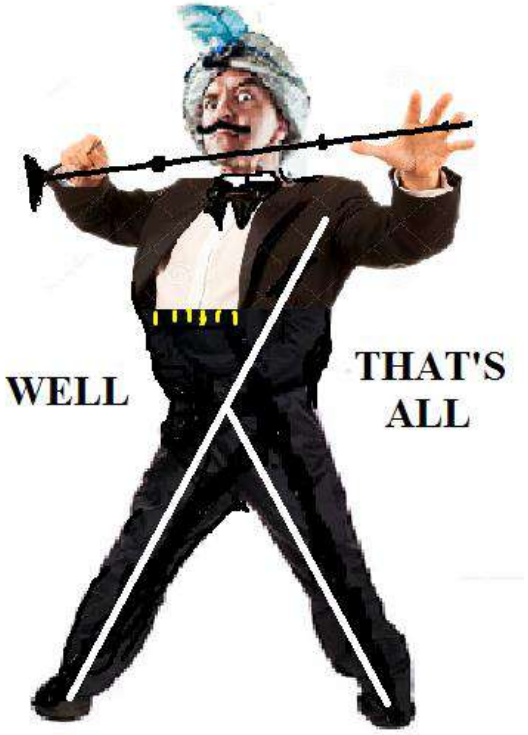
thermal spectrum even though no heat and temperature are involved. The authors measured the temperature T using the formula,

$$T = \frac{ah}{4\pi^2 ck} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (42)$$

where a is the acceleration, c the speed of light, h the Planck's constant and k the Boltzmann constant.

According to the mass-energy relation, large quantities of Zero Point Energy is equivalent to such great mass that it should gravitate and produce positive curvature in space-time ultimately leading the Universe to a minute size when the spectrum of Zero Point Energy extends to a Planck scale, the energy density would be the mass equivalent to about $10^{96}\ \frac{kg}{m^3}$ and this would reduce the Universe to a size smaller than the atomic nucleus.



VIII. A VOTE OF THANKS

Even though I am the author of this paper, I also take myself as a reader and listener to what presented by the Quantum Magician, $E_0 = \frac{1}{2} h\nu$. I have certainly the privilege to propose a Vote of Thanks due to many of my academic achievements. To mention few, I hold a Master's degree in Physics with Spectroscopy, the subject of the 1930 Nobel Laureate, C.V. Raman from the University of Mumbai, India, a Ph.D in Geophysics at age 73 from Shri J.J.T. University, Rajasthan-333001, India of which a Distinguished Alumnus and a Chancellor-designated Resource Person in the area of Physics, having published in International Journals nearly 30 Research Papers in Physics, Geophysics and Philosophy and a registered Research Guide in Physics of the University.

The wide exposition of the topics presented by the Quantum Magician regarding his origin and applications to Gravitation, Astrophysics, Astronomy and Cosmology are highly laudable. The

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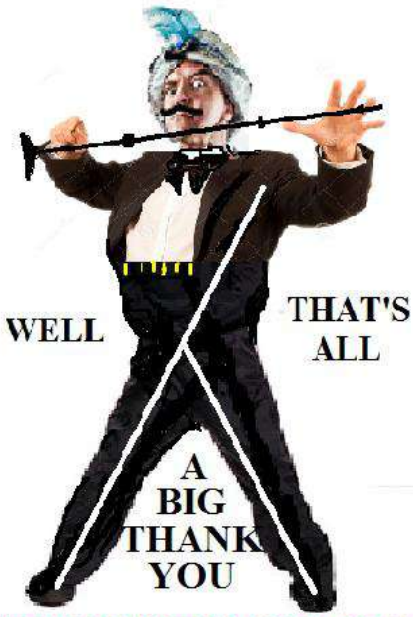
mathematical treatment given by him at many appropriate places added qualities to the Paper. He worked with his Magic Wands so well that each topic chose and presented by him was vivid and clear. A topic of this type is generally very vast but the Quantum Magician abridged everything and put the entire matter in a nutshell.

A Big Thank You!!, Quantum Magician



THE AUDIENCE OF LISTNERS THE QUANTUM MAGICIAN, $E_0 = \frac{1}{2}h\nu$

IX. CONCLUSION

9.1 A NOTE: *The following Conclusion is given by the author of the Paper and not by the Quantum Magician.*

9.2 The Ancient Concepts: The concept of Zero Point Energy in a most generalized form existed even at the time of Aristotle. Any agency having no energy is said to be of zero point energy. This, however has no relevance to the present ideas of Zero Point Energy. In Indian Philosophy, the concept of ZPE existed millions of years ago. In the famous Epic, 'Mahabharata', Lord Krishna* mentions to his disciple, Arjuna@ through the world-renown verse, 'Bhagavat Geeta'. Lord Krishna says: Oh! Arjuna, 'It is the Soul that is dynamic, more lively than the life possessed before death and absolutely unperishable. Lord Krishna shows to Arjuna a number of lifeless dead bodies and tells him regarding the mighty and powerful indestructible Souls spread and lingering around them. This revelation came after many years in the field of Physics where the concepts were applied even to Biological Systems.

Lord Krishna is the greatest Mathematician ever known and tells Arjuna to take an Integral which on solving accompanies by an arbitrary constant. In the present day this was done almost at the same time by two eminent Physicists, one German born in 1901 and another a British born a year later in 1902. The former is Werner Heisenberg who gave in the 1930's a lively picture to Zero Point Energy

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and the latter, P.A.M. Dirac who explained with his concept of sea of Holes. Immediately after the discovery of the ZPE in the second derivation of the Planck's in 1911 there was no much research related to ZPE.

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*One of the main characters in the Indian Epic, Mahabharata.
@An important disciple of Lord Krishna

9.3 The Work Unending: Just leave aside everything. Try to clean up an enclosure appearing to be very handy by removing everything from it (if you have enough time). You may have to continue for long without success. At this stage I request readers to go through one of my previous Research Papers titled, "The Four Impossibilities of Physics" mentioned in the ReferenceNo.10. I have rightly named the title of this Paper, "The Zero-Point Energy, $E_0 = \frac{1}{2}h\nu$, the Quantum Magician of Modern Physics" Is it not a wonder that you have taken out everything from the enclosure and the next moment say that it (at least a part of it) is still there? (See the False vacuum in Fig.3). As an extension of meaning of 'Space' given in sec. , I would like to mention how Einstein philosophically made a statement in 1917 when Zero Point Energy was at its infancy. Einstein said: *"The curvature of Space determines the future behavior of matter and energy in the Universe and the presence of matter and energy determines the curvature of space"* Some 11 years after, that is in 1928, P.A.M. Dirac's sea of Electrons and Holes brought a reality to the existence of ZPE.

9.4 Experimental Proof: As reality to any theory is an experiment and what goes on in the common platforms, is "Seeing is Believing". Well! Where have you seen the Quantum vibrations of ZPE?. We have already shown the proof in the Casimir Effect. It is a microscopic measurement on the Nano scale can be seen only by physicists. Common people have questions difficult to be answered. It is something like when people not knowing what an Atom is, a Nucleus inside the Atom is far from his imagination. Rutherford had a narrow escape from the Plum-Pudding model of the Atom and came to the Nuclear Model. Breaking that Nucleus was a greater wonder the proofs of which were the explosion of nuclear bombs on Hiroshima and Nagasaki of Japan in 1945 during the World War II. It was a proof shown by the Physicists to the entire world. ZPE has also shown wonders in Quantum Gravity and Cosmology.

In the recent developments on ZPE, researchers have shown computerized photographs of the Quantum vibrations of the ZPE. Two such pictures are shown in Fig.20 and Fig.21.

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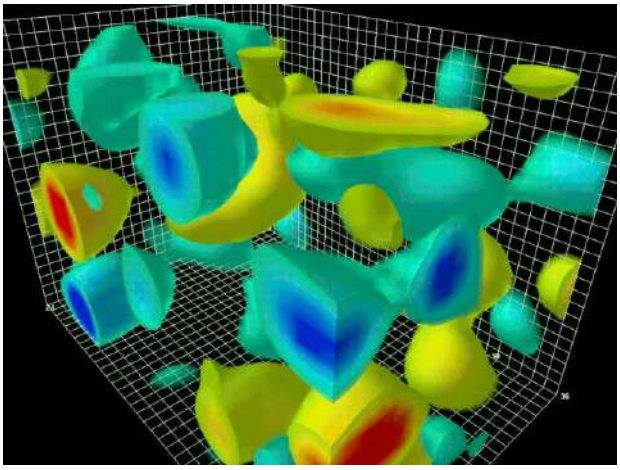

Fig.20 Computerized illustration of Quantum Vibrations

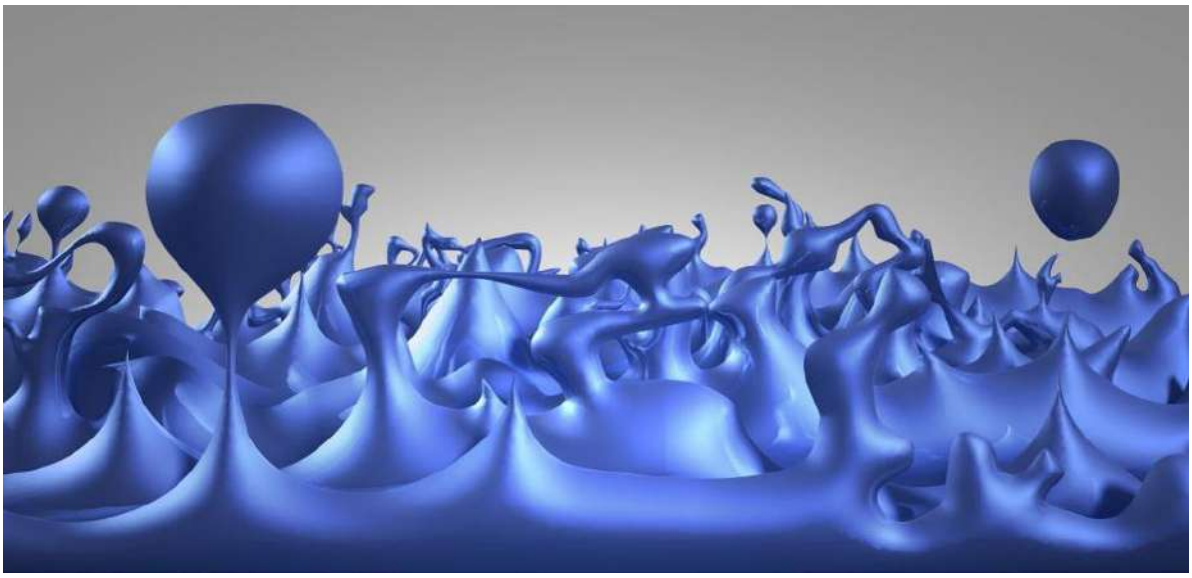

Fig.21 Another Computerized illustration of Quantum Vibrations

9.5 The Intensity far greater: Introduction to ZPE-Calphysics Institute www.calphysics.org – It is argued that the Zero Point Energy fluctuations must cease at a corresponding Planck frequency, 10^{43} Hz. In that case the ZPE density would be 110 orders of magnitude greater than the radiant energy at the center of the Sun

9.6 Utilization of ZPE: It is mentioned in literature regarding the design and invention of the so-called frequency devices similar to perpetual motion machines. These machines purport to "Tap" the Zero Point Field and "Somehow" extract energy from it thus providing an inexhaustible, cheap and non-polluting energy source.

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The ZPE can be very well applied to biological systems. In one of my earlier papers, I have cited the ignorance regarding the exact time of sleep of a man to Heisenberg's Uncertainty Principle. Taking into consideration the Thermodynamics of Life, the Zero Point Energy is associated with any life on Earth. ZPE is indestructible and reappears as fantastic energy after death. In normal life ZPE is always at work. Its existence is beyond our consciousness. As an illustration, experiencing a dream at sound sleep and not knowing when you are awake, is due to the part played by ZPE with the neurons of your Brain (See Fig.22).

9.7 The Trinity Triangle of Reality: The mathematician and the British Physicist, Sir Roger Penrose (Born:1931) (Fig:Pic-19) has suggested that if we want to understand what 'reality' is, we may need to address this fundamental issue. What is given by Penrose has been marginally modified by me in a 'Trinity Triangle of Reality shown in Fig.22 The Physical Reality is only discernible because of the 'Mental Reality' or Consciousness constructed by our Brains and can

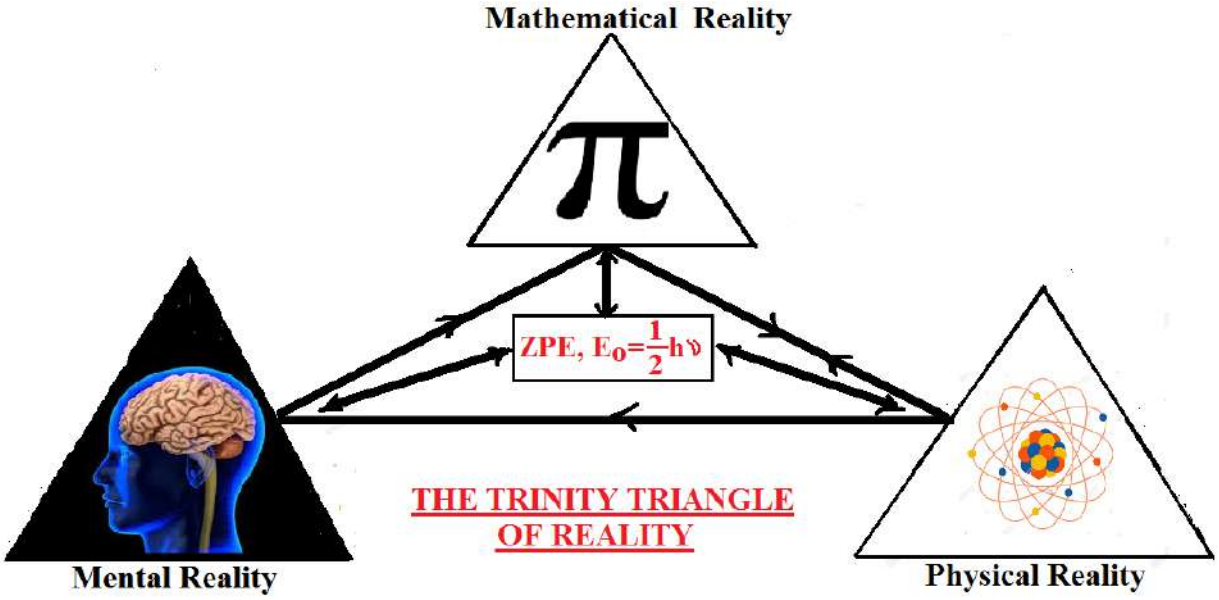

Fig.22 Pictorial illustration of the Trinity Triangle of Reality

only be described if we believe that our equations and laws of Physics come from some 'Mathematical Reality'. I have mentioned time and again in this Paper and also in the previous Papers that "Mathematics is the Language of Physics" and there is no wonder in the Philosophy given by Edmund Whittaker I have reproduced in 1.1 of this Paper. I have given it a rightful place in the Trinity Triangle of Reality by positioning it right at the Vertex of the Triangle. The Human Brain and the Physical Systems do have their rightful place positioned at the base of the Triangle.

Now, coming to the directions of arrows and their meaning: Mathematical Reality at the Verterx has a cyclic interaction with both Physical Reality and the Mental Reality. The ZPE, $E_0 = \frac{1}{2} h\nu$ lies at the centroid of the Triangle having mutual interactions with all the three vertices of the Triangle. The double arrow from the vertex to Physical Reality, obviously an indication of 'Mathematics as Language of Physics'

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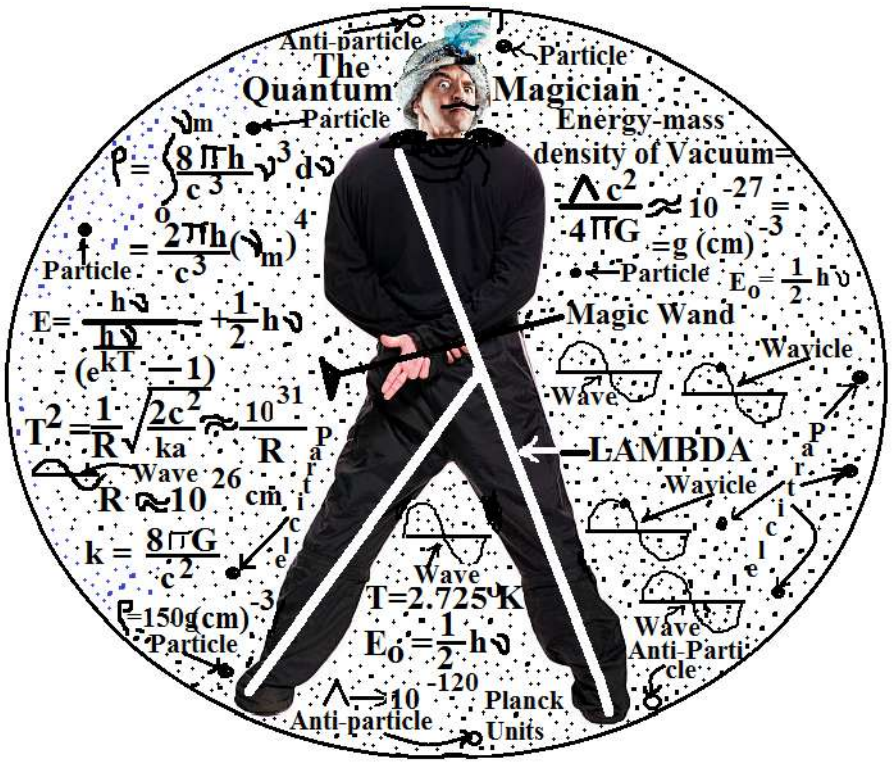

Fig.23. The Quantum Magician amidst the Mathematics collusion

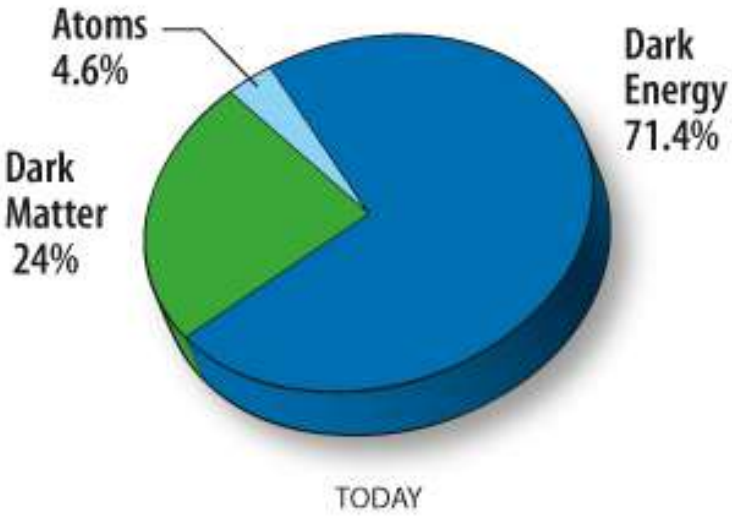

Fig.24 Present distribution of particles in the Universe

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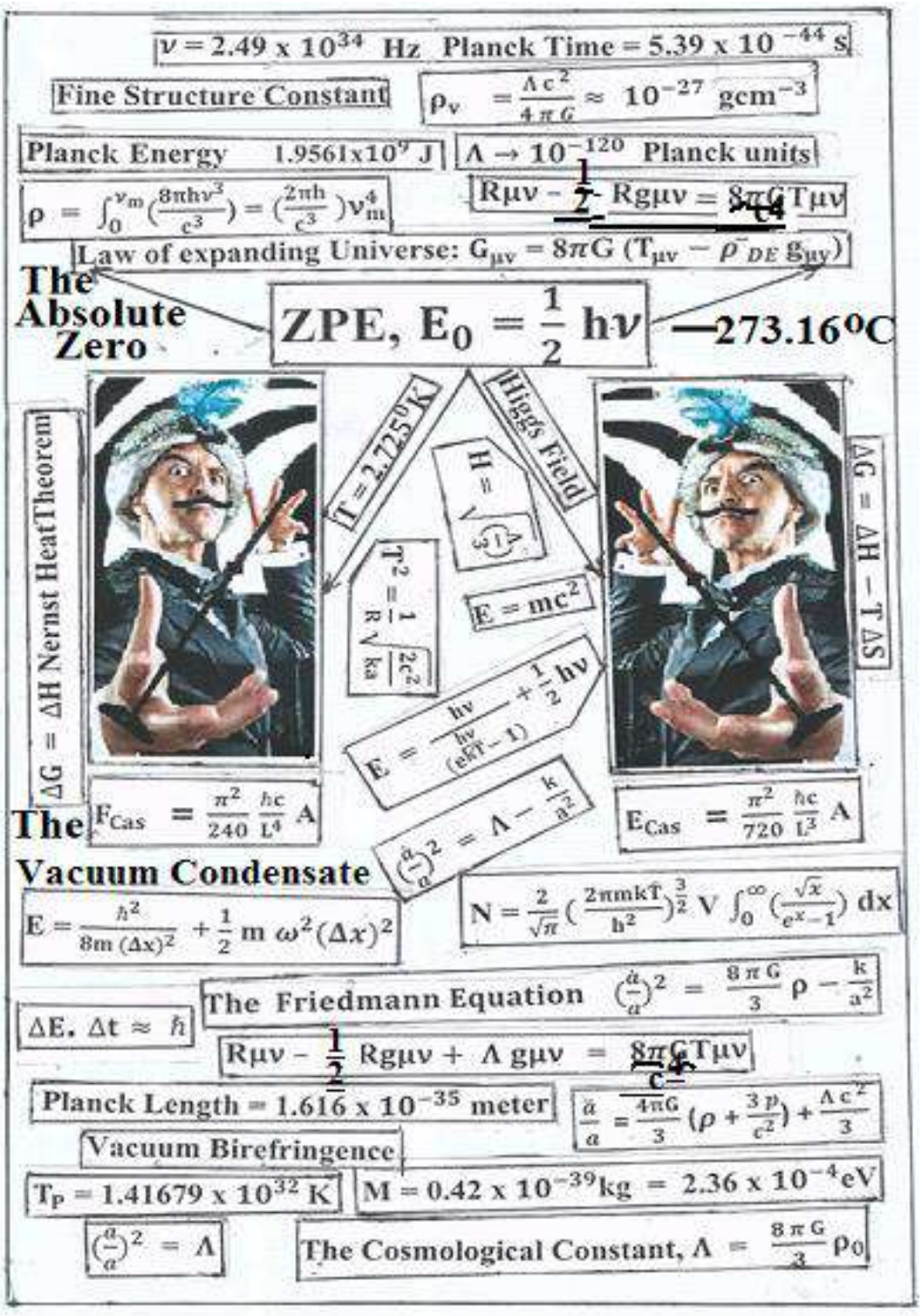

Fig.25 The jugglery of Mathematics and Terms which are the offspring of the Quantum Magician, $E=\frac{1}{2}h\nu$ and each brought out from a Magic Wand. (Some terms not included in the Text)

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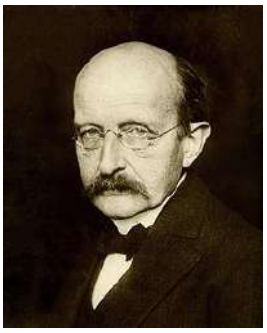
X. LIST OF SCIENTISTS INCLUDED IN THE TEXT IN A CHRONOLOGIAL ORDER

Pic-1 Evangellista Torricelli (1608-1647)

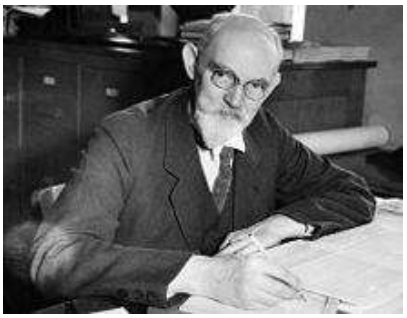
Pic-2 Sir Isaac Newton (1642-1727)

Pic-3 Trevor Marshall (Born: 1848)



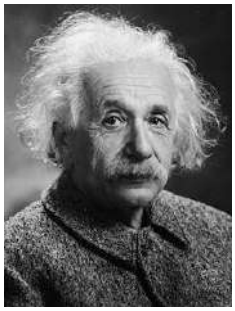
Pic-4 Max Planck (1858-1947)

Pic-5 Walther Nernst (1864-1941)



Pic-6 Willem De Sitter (1872-1934)

Pic-7 Karl Schwarzschild (1873-1916)



Pic-8 Albert Einstein (1879-1955)

Pic-9 Erwin Schrodinger (1887-1961)

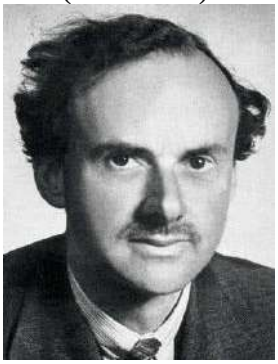
Pic-10 Alexander Friedmann (1888-1925)

Pic-11 Otto Stern (1888-1969)

Pic-12 Edwin Hubble (1889-1953)

Pic-13 Satyendranath (1894-1974)

Pic-14 Werner Heisenberg (1901-1976)



Pic-15 P.A. Dira c (1902-1984)

Pic-16 Hendrik Casimir (1909 -2000)

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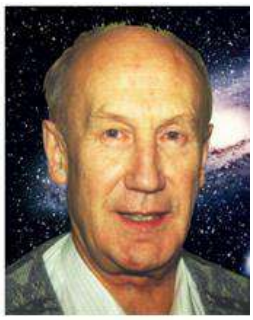
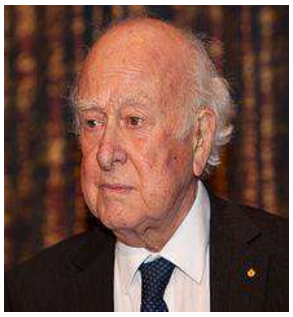
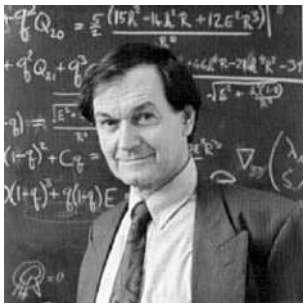


Pic-17 Wolf Priester (1924-2005)



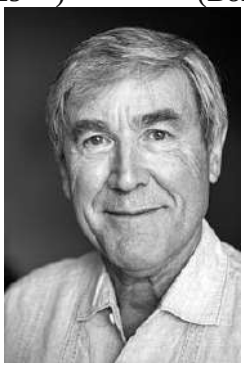
Pic-18 Peter Higgs (Born:1929-)



Pic-19 Sir Roger Penrose (Born: 1931-)

Pic-20 Timothy Boyer (Born: 1941..)

Pic-21 W.G. Umruh (Born: 1945)



Pic- 22 Stephen Fulling (Born: 1945)

Pic-23 Paul Davies (Born: 1946)

BIOGRAPHY

***Dr.(Prof.) V.C.A. Nair** (b.15th Aug. 1939) is an Educational Physicist, Counselor, Research Guide and Consultant. He did his Masters in Physics from Mumbai University, India and Ph.D. from JJT University, Rajasthan also in India He is a Research Guide and distinguished alumni of JJT University. He is also a Chancellor designated Resource Person in the area of Physics in the University. He has to his credit over 4 decades of teaching Applied Physics in eminent Polytechnics under the Department of Technical Education, Government of Maharashtra, Mumbai, India.. He has the credit of having taught Applied Physics to nearly 16,000 students since 1965. He has published nearly 30 research papers in Physics, Geophysics Philosophy of Physics in International and UGC recognized Journals some of which can be seen in the net 'Google Search' when the name of the author or his e-mail is typed in that style. He is a Life Member of Indian Society for Technical Education which is an all India body. He had been to USA a number of times and visited eminent Universities such as Stanford, Harvard, MIT, 3 Universities of California at Berkeley, Los Angeles and also at Davis ,University of Princeton at New Jersey, University of Chicago , Roosevelt University at Chicago and University of San Francisco. At present Dr. Nair is a Research Guide for Physics at Shri JJT University, Rajasthan-333001, India and having successfully guided 3 Research Scholars leading to their Ph.D Degrees He is member of the Editorial Board of this Journal. His Ph.D. Thesis is in Geophysics and he is working on topics such as Tides, Clouds, Global Warming and Climate Change. – *Editor.*

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