Gravitation as a Thermodynamic Process of the Primary Gas That Represents a Particle – IX

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Abstract

The author after clarifying the concepts of imaginary time, reversible time showed that the progressive time which is experienced by the macroscopic systems are a direct result of the vean (vacuum energy absorption) process which also leads to the collapse of wave function apart from introducing limits to entanglements [1]. He now shows that the vean process could lead to a gradient in the energy of the vacuum fluctuations background near a massive body which in turn could produce the gravitational field. According to the author, the accumulation of the rest mass by a particle by the vean process would be so small that an electron would have increased its rest mass by only 40% over a period of 10 billion years. It is shown that part of the red shift observed in distant galaxies could be attributed to the reduced mass of electrons in the distant past. He suggests that the observed expansion of universe could be a direct result of the vean process.

PACs numbers: 03.65-w, 03.75 –b, 4.20,4.70, 05.70 Ce, 12.10-g

Key Words : Diffusive gravitation, Gravitational mass loss, Vean gravitation, Higg's field and space-time

1 Introduction

It was earlier shown that a particle having mass charge and half spin could be represented by a standing half wave called "staphon" which is formed by the confinement of a single circularly polarized luminal wave called "photino" [2],[3][4],[5]. It was further shown that the states occupied by the staphon successively in time by its interactions with the vacuum fluctuations in the Higgs field could be taken to form a gas called the primary gas. The only difference between the primary gas and the real gas is that while in the real gas the microstates are occupied simultaneously, in the case of the primary gas the micro-states are occupied successively in time. In spite of this difference, we could derive the thermodynamic relations of the primary gas based on the statistical mechanics [6]. It was observed that while the primary gas approach treats time as real, the wave representation of a particle treats time as imaginary. However, both approaches represents the same reality but with different perspectives. It has been brought out that the equivalence of these two approaches turns out to be a direct result of a new symmetry called the Wick symmetry. In fact, it was shown that quantum mechanics could be understood in terms of the statistical mechanics of the primary gas where time has not lost its directional symmetry [7][8]. The basic postulates of quantum mechanics are found to be compatible with the primary gas representation of a particle.

We know that time which shows directional symmetry at the microscopic world loses it by some unknown process in the macroscopic world. To account for this asymmetry at the macroscopic world it was proposed that each particle absorbs infinitesimal quantum of energy from vacuum during its interactions with the vacuum fluctuations. Remember that these interactions with the vacuum fluctuations which confines the photino generates the particle's mass, charge and spin. This process by which the particle absorbs infinitesimal quantum of the energy of vacuum is called the vean process. It was shown that while the microscopic particles could exist in the imaginary or reversible time, the macroscopic bodies can exist only in the progressive time. This process was found to cause the collapse of wave function apart from setting a space-time limit to the entanglements. In this paper we shall examine if the same process could lead to the gravitational field also.

2 Newtonian Gravitation

Newton's law of gravitation is a very simple theory which had such a profound influence in the making of the modern world. By his theory of gravitation he pioneered the scientific approach which presumed that there is nothing magical in the working of the physical world, rather all physical phenomena follow certain basic laws which are intelligible to the rational mind. According to Newton's law of gravitation, the attractive force acting between two bodies of mass m_1 and m_2 separated by distance r is given by

$$F = Gm_1 m_2 / r^2 \tag{1}$$

where G is a constant called the gravitational constant. In MKS system, the value of G works out to 6.6 10^{-11}. This simple law could explain phenomena like bodies falling on the Earth to the planets revolving around the Sun, to such precision that this law is used even today to compute the paths for rockets in their interplanetary voyages.

Newton's law of gravitation remained undisputed for more than 2 centuries. The only phenomenon which found Newton's theory wanting was the precession of the perihelion of the Mercury's orbit. The observed value was found to be slightly different from what was predicted by Newton's law of gravitation. The explanation for this anomaly had to wait till the beginning of the 20th century when Einstein came out with general theory of relativity. Newton's law of gravitation, in spite of its phenomenal success had left many important aspects of it unexplained. The most important one was the concept of mass.

The inverse square law of gravitation allows us to express the laws of gravitation in a more sophisticated formalism using the concept of field. The best way to express the same is using the gravitational potential denoted by ϕ. If we imagine a sphere having radius r with the gravitating mass at the centre, then the force acting on the surface of the sphere in the inward direction will be given by

$$\int f.d\mathbf{S} = -4\pi r^2 GM / r^2 = -4\pi GM \tag{2}$$

Here **f** denotes the field at a point which is the force acting per unit area. The negative sign indicates that **f** and **S** are in the opposite directions. Expressing the left hand side and right hand side as volume integrals, we obtain

$$\nabla.\mathbf{f} = -4\pi G\rho \tag{3}$$

where ρ is the mass density within the imaginary sphere. If we denote the gravitational potential by ϕ, then we know that $\mathbf{f} = -\nabla\phi$. Therefore, we have

$$\nabla^2 \phi = 4\pi G \rho \tag{4}$$

In classical physics, mass of a body is identified with inertia. The more massive a body is, more force has to be applied to make it move. The basic relation representing this aspect is given by

$$F = ma \tag{5}$$

where a is the acceleration of the body. In Newton's theory, the same mass plays the role of the charge of the gravitational field. Recall that the force between two electric charges e_1 and e_2 is given by

$$F = K\, e_1 e_2 / r^2 \tag{6}$$

Here K is the constant of proportionality and is called the dielectric constant. In Newton's theory there is no distinction between the inertial mass and the gravitational mass. This is taken for granted. Of course, such an assumption has not been disproved in spite of a number of experiments conducted with great accuracy [9]. In fact, the famous experiment reported to have been conducted by Galileo involves this equivalence of two masses. He showed that when two bodies of different masses are dropped from a given height, both of them fall at the same rate. This property can be explained by combining (5) with (1). We may take

$$F = m_1 a = G m_1 m_2 / r^2$$

where $$a = G\, m_2 / r^2 \tag{7}$$

Here we have taken m_1 as the test mass and m_2 as the gravitating mass. This means that the acceleration depends only on the mass of the gravitating body like Earth and is independent of the mass of the body falling. Although Newton's theory explained the result of the Galileo's experiment, the reason why gravitational mass and the inertial mass are the same is not given in the theory. It had to be taken as a happy coincidence.

Another area where Newton's theory was seen wanting was in its inability to unravel the mechanism involved in the attraction. The attraction between two masses involves action at a distance. According to Newtonian theory, if one of the two masses represented in (1) is moved away, the force on the other mass will get reduced instantaneously. This idea of action at a distance is not compatible with the theory of relativity which prescribes a ceiling velocity which is the velocity of light for transmitting any disturbance in the vacuum. This idea is also incompatible with the quantum mechanical idea that a force is mediated by exchange of particles that carry energy and momentum.

3 Einstein's General Theory of Relativity

Einstein generalized the theory of relativity to explain gravitation. He showed that a massive body warps the four dimensional space-time around it which is perceived as gravitation. Higher the mass, higher the curvature and therefore larger the gravitational field! He showed that the Newtonian gravitation is a special case applicable to only weak gravitational fields. He derived the famous field equations of the general relativity which are given below by equating the four dimensional curvature of space time at a point to the stress energy tensor at the same point

$$G_{ik} = 8\pi c^4 GT_{\mu\nu} \qquad (8)$$

Here G_{ik} is called the Einstein's tensor and represents the curvature of the four dimensional space-time while $T_{\mu\nu}$ denotes the stress energy tensor. We shall discuss about GR in detail in the next paper where we shall show that it has got its foundations on the vean process.

GR has been put to test in most dramatic way when the curving of light rays from a distant star by the Sun's gravitation was confirmed in the experiments conducted by Eddington [10] during the total solar eclipse of 1919. GR has been put to test by measuring the slowing down of clock in the gravitational field, and also in the red shift of light emitted by stars from their surface. The most accurate test has been in explaining the change in the frequency in the case of the pulsar PSR 1913 + 16, one of the binary pair located in the constellation of Aquila [11].

4 Feynman's Gravitation

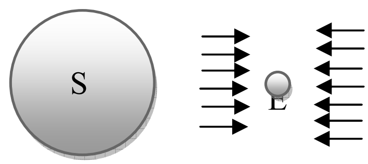
Although Feynman did not propose any theory of gravitation, he did in passing propose that there could be alternate theories of gravitation other than those proposed by Einstein and Newton and then showed why such alternate theories do not give correct results. The reason behind referring to the theory of gravitation proposed half jokingly by him was that it had certain simplicity and beauty and later we shall show that the gravitation that emerges from the vean process appears is very similar to it. It was unfortunate that he didn't pursue this venture to its logical conclusion. He was ready to give it up when faced with the first logical stumbling block. Possibly, his mind was too pre-occupied with the other great ventures he had undertaken (and completed with such panache) he hardly had time to open another front. In any case, the loss has been ours.

I quote his words about alternative approach to gravitation [12]. "On the other hand, take Newton's law for gravitation, which has the aspects I discussed last time. I gave you the equation

$$F = Gm\,m'/r^2 \qquad (9)$$

Just to impress you with the speed with which mathematical symbols can convey information. I said that the force was proportional to the product of the masses of two objects, and inversely proportional as the square of the distances between them, and also that the bodies react to forces by changing their speeds, or changing their motions, in the direction of force by amounts proportional to the force and inversely proportional to their masses. Those are the words alright, and I did not necessarily have to write the equation. Nevertheless it is kind of mathematical, and we wonder how this can be a fundamental law. What does the planet do? Does it look at the Sun, see how far away it is and decide and decide to calculate on its internal adding machine the inverse of the square of the distance, which tells it how much to move? This is certainly no explanation of the machinery of gravitation! You might want to look further. Newton was originally asked about his theory – 'But it doesn't mean anything –'it doesn't tell us anything'. He said, 'It tells you how it moves, not why. 'But people often are unsatisfied without a mechanism, and would like to describe one theory which has been invented, among others of the type you might want. This theory suggests that this effect is the result of large numbers of actions, which would explain why it is mathematical.

Suppose that in the world everywhere there are a lot of particles flying through us at very high speed. They come equally in all directions – just shooting by – and once in a while they hit us in a bombardment. We, and the Sun, are practically transparent for them, practically but not completely, and some of them hit. Look, then, at what would happen (see figure 1) if S is the Sun, and E the earth. If the Sun were not there, particles would be bombarding the earth from all sides, giving little impulses by the rattle bang- bang of the few that hit. This will not shake the earth in any particular direction, because there are as many coming from one side as from the other, from top as from bottom. However, when the Sun is there the particles which are coming from that direction are partly absorbed by the Sun, because some of them hit the Sun and do not go through. Therefore, the number coming from the Sun's direction towards the earth is less than the number coming from the other sides, because they meet an obstacle, the Sun. It is easy to see that the further the Sun is away, of all the possible directions in which particles can come, a smaller proportion



Here S represents Sun and E the Earth. Since S absorbs a small portion of the Particles moving to the right side, it results in E being hit more from the outer side than from the inner side resulting in the gravitational force on E towards S .

Figure.1

of the particles are being taken out. The Sun will appear smaller – in fact inversely as the square o the distance. Therefore, there will be an impulse on the earth towards the Sun that varies inversely as the square of the distance. And this will be a result of large numbers of very simple operations, just hits, one after the other, from all directions. Therefore, the strangeness of the mathematical relations will be very much reduced, because the fundamental operation is much simpler than calculating the inverse of the square of the distance. This design, with the particles bouncing, does the calculation.

The only trouble with the scheme is that it doesn't work for other reasons. Every theory that you make up has to be analyzed against all possible consequences, to see if it predicts anything else. And this does predict something else. If the earth is moving, more particles will hit it from in front than behind. (if you are running in the rain, more rain hits you in the front of the face than the in the back of the head because you are running into the rain). So, if the earth is moving, it is running into the particles coming towards it and away from the ones that are chasing it from behind. So more particles will hit it from the front than from the back, and there will be a force opposing any motion. This force which would slow the earth up in its orbit and it certainly would not have lasted the three or four billion years (at least) that it has been going around the Sun. So that is the end of that theory. "Well," you say, "it was a good one, and I got rid of the mathematics for a while. May be I could invent a better one. "May be you can, because no body knows the ultimate. But up to today, from the time of Newton, no one has invented another theoretical description of the mathematical machinery behind this law which does not either say the same thing over again, or make the mathematics harder, or predict some wrong phenomena. So there is no model of the theory of gravitation today, other than the mathematical form."

We may call this model of gravitation proposed jokingly by Feynman as “the diffusive gravitation”. Feynman thought that the idea of the particles hitting a gravitating mass from all sides equally in a random fashion is not a workable proposition because a uniformly moving mass would gradually slow down to a standstill as more forceful hits will be registered on the front side than the back. We shall shortly show that the vean process actually plays the role of the interaction with the particles proposed by Feynman and it would result in gravitation. Better still, the vean process does not in any way retard moving bodies.

5 The Vean Process and Gravitation

i) Higg’s Field and the Space-time

We saw from the earlier paper that the quantum of time and space intrinsic to the particle are given by

$$T_e = h/K\theta \quad and \quad X_e = h\mathbf{v}/K\theta \tag{10}$$

It is observed that if we take two particles with different rest masses, then

$$n_e NT_e = n'_e NT'_e \tag{11}$$

Here N which is taken as a constant denotes the number of microstate constituting a primary gas state while n_e denotes the number of primary gas states that is contained in a certain time interval. This means that in a given duration just as the intrinsic quantum of time of a particle decreases (remember that T_e = h/E), the number of microstates which can be occupied during the time interval increases proportionately. This allows us to introduce the relation

$$n_e NT_e = n'NT'_e = nNT \tag{12}$$

Here T is the intrinsic time of a particle which is taken as a norm. Note that T could be taken as small as required so that we can define the extensive time t = nNT which could be taken as a continuous function for all practical purpose. In fact t can function like the time coordinate of the laboratory frame of reference. We could define x also in a similar manner. This means that the time and spatial coordinates of the laboratory frame of reference has to be treated like the extensive time of a primary gas.

Now we should keep in mind that in terms of (10) we have T = h/Kθ. But we know that θ denotes the temperature which is proportional to the average energy of the interactions of the particle with the Higg’s field. Therefore, it becomes obvious that the space-time is the natural outcome of the interactions with the Higg’s field. We shall shortly show that in the vean process the energy absorbed by the particle is given up by the Higg’s field and this process ultimately generates the gravitational field. Clearly, this brings out the deep connection between the space-time and gravitation. Therefore it is no wonder that Einstein could represent gravitational field in terms of the curvature of the space-time.

ii) The Basis of Identifying the Gravitational Mass with the Inertial Mass

We know that vacuum could be assumed to be filled with waves of all possible energies moving in all possible directions with all possible phases [5]. These waves cannot be observed as they interfere with each other destructively on account of their random phases. In other words, vacuum is full of energy which does not get manifested. This complete destructive interference of waves occurs only if we take a reasonably long duration of time. But for very short duration, the fluctuations make their appearance. The energy of the fluctuations is such that shorter the duration higher is their energy. We know that this gives us the uncertainty principle [6]. We know that according to quantum field theory, these vacuum fluctuations could be taken as the generator of various types of interactions like strong, electromagnetic and weak.

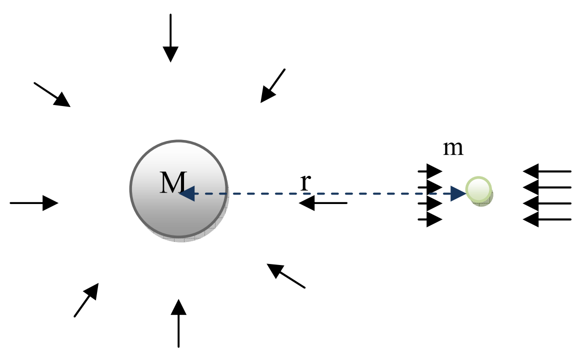
In the discussions till now it was assumed that all particles have an internal structure similar to the confined photino structure attributed to electron. Let us examine this issue further. We know that in the case of the electromagnetic wave, the electromagnetic field is directed perpendicular to the direction of the wave propagation. Therefore, the electromagnetic interaction also should be assumed to be along these directions. This means that when a photino is confined along the direction of progression, the field confining it should be of different nature. We ha identified it with the Higg's field [5]. Note that the confinement by the Higg's field generates mass at the most basic level. While electron can be easily identified with a confined photino, it is not possible to propose a similar structure to particles like quarks. This is because electron is acted upon by the Higgs field and the electromagnetic field while quarks are subject to the Higgs field and the strong field. Here we may recall the Kaluza-Klein theory where electromagnetic field is explained using a fifth dimension which is curved into itself like a cylinder [13]. Note that a cylindrical warping allows the field to be long ranged which is the case with the electromagnetic field. Therefore, according to this theory the electromagnetic wave could be taken as an entity defined by a five dimensional world. Based on a similar reasoning and borrowing from the string theory it is presumed that it is possible to account for the internal structure of quarks by invoking higher dimensions [14]. In that case we may imagine the existence of a composite wave having its amplitudes in many dimensions whose confinement by vacuum fluctuations in the Higg's field may create quarks. The only difference is that these higher dimensions may be warped like a sphere and not like a cylinder as the field described has a very short range. At present we do not want to speculate on the exact internal structure of the quarks based on the standing wave approach. However, we shall take it as a postulate that just as electrons have a standing electromagnetic wave structure, quarks also may be attributed a similar standing wave structure formed by a composite wave.

As discussed in the earlier paper [1] vean process involves absorption of energy from the vacuum fluctuations. Here it is interesting to note that the principle of the conservation of the energy could be traced to the isotropy of time. If this isotropy is broken, then the conservation principle for energy also should not hold good. We saw that time remains isotropic only when it is in the imaginary or reversible state. The progressive time by its very nature destroys this symmetry and therefore, the energy conservation principle should break down here. In the case of the micro-systems like electrons, atoms and molecules, the energy absorbed from the vacuum could be taken as zero for periods which are not astronomically long and therefore the energy conservation principle should hold good for such systems. But when we take the case of a macro-system, even for a short duration, the conservation principle would not hold. It could at best be an idealization. In that sense, the concept of the vean process is self consistent and does not go against the basic principles of symmetry at the micro-level for finite time intervals. It introduces asymmetry at the macro-level for even infinitesimal time duration.

In the vean process proposed in the earlier paper it was assumed that an infinitesimal part of the energy of the vacuum fluctuations is absorbed by the particle which is converted into random translational motion [1]. It is obvious that this energy should belong to the Higgs field which confines the photino. It could not have been from the electromagnetic field because there is no confinement to the photino on account of the electromagnetic field which acts in the transverse direction of the photino. Therefore we are able to relate the interactions with the Higg's field which creates the rest mass with the vean process. This leads us to conclude that there is a direct connection between the energy absorbed by a particle by the vean process and its mass. If we now show that this absorption of the infinitesimal quantum of energy results in gravitation, then, in way we can justify identifying the inertial mass with the gravitational mass.

iii) Vacuum Energy Gradient and the Gravitational Field

Let us now take a massive body constituted by a very large number of particles. In this case, total energy absorbed by the massive body by the vean process will cumulatively be quite substantial. Here we should recall that vacuum is assumed to be filled with waves of all energies moving in all directions with all possible phases with the result that they interfere with each other destructively making them virtual. Therefore, it is possible to imagine that the energy lost by vacuum to the particle will be compensated immediately by the diffusion of the virtual vacuum waves at the velocity of light. This would result in a drift in the energy and momentum of vacuum



M denotes the gravitating mass while m stands for the test mass which is negligibly small. The vean process undergone by M reduces the momentum from the vacuum fluctuations hitting the test mass from the left resulting in a net momentum transfer from the right side.

Figure.2

towards the massive body (see figure.2). Note that this energy-momentum drift will be real. Then a test mass in the vicinity of such a massive body will be impacted by this drift in the energy and the momentum of vacuum on the side facing away from the gravitating mass. This produces a force on the test mass and moves it towards the gravitating mass. Needless to say, from the very geometry of the space, it is obvious that the force felt by the test particle will be inversely proportional to the square of the distance from the gravitating mass.

The concept of the inverse square law brings to our attention the case of the electric field. But, we should keep in mind that in the case of the electric charge, the field around it is created by the exchange of virtual photons in a continuous manner. But in the vean picture, the gravitational field is created by the drift of real energy from the vacuum towards the gravitating mass. Gravitational field is not created by virtual particles as the flow of energy towards a gravitating mass is irreversible and continuous. This differentiates gravitational field from other fields.

6 The Basic Postullates

<u>Postullate I</u>

A particle is formed by the confinement of a composite wave by its interactions with vacuum fluctuations in the Higgs field..

This postulate is based on the primary gas representation of electron which is based on the confined photino structure. We saw that electron can be attributed a standing wave structure formed by a photino interacting with the vacuum fluctuations in the Higg's field. Since electron interacts only with the electromagnetic field (apart from the gravitational field), it is obvious that the confined photino structure would not be adequate to represent particles like quarks which interact with strong field. But if we assume the existence of a composite wave which has amplitudes in many dimensions which could be associated with different fields, then, we may extend the standing wave structure to particles like quarks also. We do not propose to investigate this aspect at present. However, it is reasonable to extend such a structure for all elementary particles also. Therefore, we propose to take it as a postulate.

<u>Postullate II</u>

While undergoing interactions with vacuum fluctuations in the Higg's field infinitesimally small portion of the energy gets absorbed by the particle which is proportional to the energy of the confined wave.

The process by which the particle absorbs this small portion of energy may be analogous to the generation of heat in an inelastic collision. For the present we shall take it as a postulate. We may assume that a very small portion of this energy is converted into heat which is retained by the particle in its random jiggling motion. On this basis, we may assume that the rest energy of the particle keeps on increasing by this absorption of energy. In other words, the particles act like an energy-sink for the energy of the vacuum fluctuation interactions and the energy absorbed is proportional to the rest mass of the particle.

The assumption that the energy absorbed is proportional to the rest mass of the particle is warranted only if the experimental proof confirms that the gravitational constant is the same whether mass involved is made up of baryons or leptons. Right now we do not have any experimental data to believe otherwise and therefore the energy absorbed in a vean process is assumed to be proportional to the rest mass of the particle.

7 The Vean Process and the Inverse Square Law

When the vacuum energy is absorbed by the vean process by a large body of mass, it creates a gradient to vacuum energy field. This is understandable. In fact, we have some what similar situation in the case of Casimir effect [15]. There two metallic plates with perfect reflecting surfaces are kept very close to each other with a separation of a few microns. Casimir had predicted that while the region outside the plate can have all types of electromagnetic waves, the region between the plates can have only such ones which can form standing waves in the space between the plates. In other words, only such electromagnetic waves can exist between the plates whose wave length is integral multiple of 2d where d is the separation between the plates. This would mean that the density of the vacuum waves between the plates is less than what is available outside the plates. This sets up a gradient in the energy and the momentum of the vacuum fluctuations which generates force on the two plates pressing them closer. The force will be more if the plates are closer. This effect has been found to exist on the basis of experimental observation.

We may attribute gravitation also to a similar effect, though much weaker. We may assume that a body having a certain mass absorbs a small quantum of the vacuum energy continuously, creating a gradient for vacuum energy around it (figure.2). So any test particle in the vicinity of the particular body will experience a force just as in the case of Casimir effect. The only difference could be that in the case of the Casiimir effect, the gradient is created in the electromagnetic field while in the case of the gravitational field, the gradient is created in the Higg's field by the vacuum fluctuations. This gradient would result in a weak attractive force that could be identified with gravitation. We should keep in mind that the test particle will be interacting with the vacuum fluctuations continuously. But since, there is a negative gradient in the direction of the gravitating mass, the test mass will experience a force towards it. It can be easily seen by the very geometry of the space that this force acting on the test mass will be inversely proportional to the square of the distance from the gravitating mass.

On the basis of the second postulate we may treat a mass as a sink for the vacuum energy. Let us now draw an imaginary sphere with the gravitating mass at the centre. If P is the total flux of the momentum of the vean process that crosses the surface area of the imaginary sphere over certain duration, then we may relate it to the gravitating mass by the relation

$$dP/dt \quad = \quad \alpha M \tag{13}$$

where α is a constant. Let us now suppose that the test mass is spread uniformly with its mass density per unit area, μ. Now if **þ** is the flux of momentum crossing over unit area of the sphere in a given duration, then we have

$$P \quad = \quad -\int \mu\, \mathbf{v}.d\mathbf{S} \quad = \quad -\int \text{þ}.d\mathbf{S} \tag{13A}$$

Here v is the velocity of the freefall of the test mass. The negative sign is introduced to show that the surface vector **S** and the momentum vector are in the opposite directions. Substituting (13A) into (13), we obtain

$$d\big/dt[\int \text{þ}.d\mathbf{S} \quad = \quad \int \mu\,(d\mathbf{v}/dt)\,.\,d\mathbf{S} \quad = \quad -\,\alpha M \tag{13B}$$

Denoting the acceleration by **g,** the above equation may be expressed as

$$\int \mu\, \mathbf{g}.d\mathbf{S} \quad = \quad -\,\alpha\, M \tag{14}$$

But we know that the force μ**g** can be expressed as a gradient of a potential field given by

$$\mu\, \mathbf{g} \quad = \quad -\,\nabla\, \phi \tag{14A}$$

and

$$\mu\, \nabla.\mathbf{g} \quad = \quad -\,\nabla^{2}\phi \tag{14B}$$

Substituting (14A) into (14) we obtain

$$\int \nabla \phi . d\mathbf{S} \quad = \quad \alpha \, M$$

Expressing the left hand side and the right hand side of the above equation as volume integrals, we obtain

$$\int \nabla^2 \phi \, dV \quad = \quad \alpha \int \rho \, dV$$

ie;
$$\nabla^2 \phi \quad = \quad \alpha\rho \tag{15}$$

We observe that if we take α = 4πG, the above equation will be identical to the Poison's equation given in (4) which defines Newton's gravitation. On the basis of the above discussion, we may treat the potential energy ϕ appearing in the Poisson equation as the energy density determined by the vean process.

8 The Vean Process and the Mass Gain

It should be kept in mind that in the case of an electric charge, the asymmetry is introduced by the absorption or emission of the virtual field quanta by it. But in the case of gravitation, this is done by actual absorption of the field quanta. For the same reason, when we say that the electrical potential energy of the vacuum gets a negative gradient towards the charge, we do not have to assume that there is actual absorption of energy by the charge. But in the case of the gravitational field, based on the vean process there is actual movement of energy towards the gravitating mass. This is the most important difference between the gravitational potential and the electric potential.

In the previous section we had taken P to be the total momentum of the vacuum that crosses an imaginary sphere with the gravitating mass at the centre. It is reasonable to assume that magnitude of the momentum crossing per unit area of the surface of the given imaginary sphere is a constant and as a result on absorption by the gravitating mass there will not be any increase in its translational momentum. The momentum from the opposite directions will cancel each other out. But this absorption will result in the increase in the rest energy of the gravitating body. Let us now go back to (13), and taking the constant of proportionality as 4πG, we have

$$dP/dt \quad = \quad 4\pi \, G \, M \tag{16}$$

Since P is the net momentum crossing the imaginary sphere, we may express it in terms of energy by the expression P = ξ_v/c. If ξ_v is the energy absorbed by the gravitating body in one second, then we have

$$d\xi_v/dt \quad = \quad 4\pi Gc \, M \tag{16A}$$

If we denote by ε, the energy absorbed by unit rest energy of the gravitating body (in Joules), then we have

$$d\varepsilon/dt \quad = \quad 4\pi Gc/c^2 \quad = \quad 4\pi G/c \tag{16B}$$

$$= \quad 4 \times 3.14 \times 6.67\; 10^{-11} / 3\; 10^8 \; J/\text{sec}$$

$$= \quad 2.7\; 10^{-18} \; J/\text{sec}$$

Let us now estimate how much the rest energy of a particle would change in one billion years. Note that one billion years works out 3.15 10^{16} seconds. We know that the mass will increase in an exponential rate. So we may write the equation for the mass increase as

$$m \quad = \quad m_o e^{\lambda t} \tag{17}$$

where m_o is the mass at the initial instant and m the mass after t seconds. λ is the growth constant and is equal to 2.7 10^{-18} J/s. In (17), substituting for λ and putting $t = 3.15\ 10^{16}$, we obtain

$$m \quad = \quad 1.094\, m_o \qquad or \qquad m_o/m \quad = \quad 0.91 \tag{17A}$$

This means that in 1 billion years the rest mass of a body would have been hardly 0.9 times its present mass. This variation is not appreciable. But if we take the period of 10 billion years, then

$$m_{10\ bill\ \ yrs} = \quad m_o\ e^{0.9} \quad = \quad 2.5\ m_o \tag{17B}$$

This would mean that the rest mass of a gravitating body 10 billion years back would have been only 0.4 times its present rest mass. This aspect should be observable from measurements of the spectra originating from galaxies which are more than 1 billion light years away. We know that the frequency of the electromagnetic waves emitted by a hydrogen atom is given by the Balmer-Rydberg series formula:

$$\nu \quad = \quad \frac{m_o e^4}{8\varepsilon_o^2 h^3}[\frac{1}{n^2} - \frac{1}{m^2}] \tag{17C}$$

where m_e is the rest mass of electron, e its charge, ε_o the permittivity of free space while n and m are integers. Since the rest mass appears on the numerator, it is obvious that in the epoch when the electron mass was only 40% of its present value, the frequency would have been only 40% of its present value. In other words, the red shift could be partially accounted by this smaller mass in the earlier epoch. This would mean that the universe may not be actually expanding at the rate which is presumed at present. We may have to investigate to what extend this picture would affect the Bg Bang Theory. That will be done in separate papers.

9 Mass Loss of a Test Mass in a Gravitational Field

If we go by the mechanism of the vean process, then it is obvious that the Higg's field loses its spatial symmetry in a gravitational field. The vacuum fluctuations interacting with the test particle from the outer side is slightly more than those from the side facing the gravitating mass M. If we take the test particle far away from M, then the interactions taking place on both sides could be taken to be equal. Since the staphon (standing electromagnetic wave) representing the test particle is in equilibrium with the vacuum fluctuations field, this would mean that the energy of the reversed half wave would be less than that of the forward one. This asymmetry while generating a force on the test particle towards the gravitating mass will also result in the reduction of the rest mass of the particle. We shall work out the reduction in the rest mass exactly later in this paper.

On a cursory glance, the reduction in the rest mass of a particle in a gravitational field may appear to go against the accepted tenets of the general theory of relativity (GR). In GR the rest mass is always taken as a constant. However, if we examine the theory in detail, we observe that such an assumption is quite unwarranted. The most obvious justification for reduction in the rest mass in GR is offered by the representation of a particle as a de Broglie wave. We know that a particle with rest mass, m can be treated as a standing vibration with frequency ω_o where $\omega_o = mc^2/\hbar$ [2]. But according to GR, time slows down in a gravitational field. This would mean that the frequency of the vibration, ω_o representing the rest mass of a particle should also decrease in a gravitational field.

Another justification for the variation in the rest mass of a particle comes out of the special theory of relativity (SR). We know from the Noether's theorem that each symmetry could be identified with a corresponding invariant quantity of the system. For example, the isotropy of space in any displacement leads to the conservation of the linear momentum while similar isotropy in time leads to the conservation of energy. Likewise, the directional isotropy of space leads to the angular momentum. SR shows that an observer in a system will not be able to make out whether it is moving with a velocity or is at rest by any experiments within the system. This invariance of the physical laws to the velocity transformation is a symmetry which should lead us to a corresponding conservation law. What is the corresponding conservation law?

It is interesting to note that this aspect is hardly discussed in any of the text books on SR. Since the four dimensional space-time intervals are conserved in a relativistic transformation, one may be tempted to associate this conservation of the four dimensional interval with the symmetry. Although, this may appear quite logical, this conservation is not related to any intrinsic property of the particle. Note that the other conservation laws apply to the linear momentum and energy which are intrinsic properties of the particle. Therefore, is it possible to identify any intrinsic property of a particle as the invariant quantity corresponding to the symmetry of relativity? The most obvious candidate for this emerges from the most basic equation of relativity, the relativistic energy momentum equation given by

$$E^2 - \text{þ}_x^2 c^2 - \text{þ}_y^2 c^2 - \text{þ}_z^2 c^2 \qquad = \qquad m^2 c^4 \tag{18}$$

One may say that this equation is the reciprocal relation of the four dimensional space-time relation given by

$$c^2 t^2 - x^2 - y^2 - z^2 \qquad = \qquad c^2 t^2 \tag{18A}$$

Just as the square of the four dimensional interval $c^2 t_o^2$ is invariant in a relativistic transformation, the square of the mass of the particle is also invariant in the transformation. This forces us to conclude that the conserved quantity corresponding to the symmetry of relativity is the rest mass.

The reason why such an obvious truth was not noticed earlier could be traced to the famous equation $E = mc^2$. This relation equates mass with energy and since energy is already conserved by the isotropy of time, the question of introducing a separate conservation principle for mass would have appeared pointless. But we know that mass is not just energy. In fact mass has to be taken as the internal heat of the primary gas that represents the particle [6]. Therefore, the relativistic energy momentum equation actually conveys the conservation of the internal heat of the primary gas. Any increase in the energy is entirely accounted by the mechanical work done.

This line of argument leads us to a very interesting insight. We know that in a gravitational field SR holds good to an infinitesimally small region. This means that if we take any finite region SR may not hold good. Therefore, the conservation of mass of a body may hold good only for an infinitesimally small region in a gravitational field. If we take any finite region, the rest mass may undergo variation. In the next section we shall show that the approach based on the vean process leads us to exactly same conclusion. This line of argument gives an added confirmation about the veracity the approach.

10 Adiabatic Expansion of the primary gas in a gravitational field

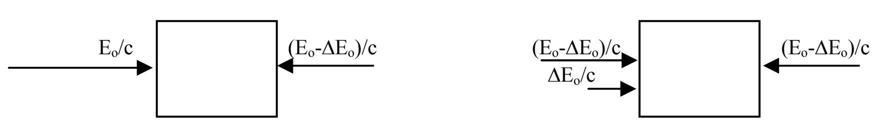
As already discussed in section 3 of this chapter, GR is based on the principle of equivalence. According to this principle, in a small region in space, the effect of gravitation in a frame of reference can be removed by giving it a suitable linear acceleration. To put it differently, it is possible to scaffold a Minkowskian four dimensional space-time on a body which is falling freely in a gravitational field in a small region. But the metric of such a coordinate system at one point would be slightly different from that at an adjacent point. Einstein showed this variation in the metric can be attributed to the curvature of the four dimensional space-time. He then proposed that the curvature at any point is proportional to the energy density at that point. We shall see what this principle implies in the approach based on the vean process.

Let us first of all take the case of the primary gas located in a field free region. Here the vacuum fluctuations field will be isotropic in all direction. In such a situation, we know that the total energy of the primary gas representing a particle can be expressed as [6]

$$E = E_o\sqrt{(1-\beta^2)} + \text{þv} = q + \text{F} \tag{19}$$

where E_o could be taken as the heat content of the gas in the rest frame, þv its free energy denoted by F and $\beta = v/c$. We also know that in the proper frame (the frame in which the particle is at rest) the energy of a particle is determined by the energy of the vacuum fluctuations field surrounding it. In other words, the primary gas is in equilibrium with the vacuum fluctuations field surrounding it. We know that this equilibrium is maintained in all inertial frames of reference and this forms the basis of the relativity principle [4].

The situation is different in a gravitational field. In a gravitational field, the vacuum fluctuations in the Higg's field acquire a gradient. We saw in the previous section that this gradient results in a force towards the gravitating mass. If we take a test particle in such field, then we observe that the energy and the momentum of the vacuum fluctuations background is less on one side of the particle compared to the other. This decrease in the energy of the vacuum fluctuations background (Higgs field) on one side could result in the decrease in the rest mass of the particle. Let us



(a) (b)

(a) shows the situation where the momentum of the vacuum fluctuations hitting a particle from one side is E_o/c while those from the side of the gravitating mass is $(E_o-\Delta E_o)/c$. (b) We may view the same situation by assuming that the particle is compressed by momentum of $(E_o-\Delta E_o)/c$ acting from both sides while momentum of $\Delta E_o/c$ acting from the left side results in its acceleration

Figure.3

assume that the energy and the momentum of the vacuum fluctuation waves hitting the particle from the side further from the gravitating mass is E_o and E_o/c respectively while those from the opposite side be (E_o-ΔE_o) and (E_o-ΔE_o)/c respectively (see figure.3). We need to study the variation in the vacuum fluctuation field only in one direction as it is assumed to remain constant in the other two. To make the picture simple, this situation could be viewed in the following manner. We may assume that the particle is imparted momentum of (E_o-ΔE_o)/c from both sides confining it. The remaining part of the momentum $\Delta E_o/c$ from the outer side will encounter no resistance from the other side. Therefore, this momentum will impart translational momentum to the particle as a whole. This will result in the increase in the kinetic energy. If the particle were initially having a uniform velocity v and momentum þ then the vacuum fluctuation momentum $\Delta E_o/c$ imparted on the particle from one side would result in an infinitesimal increase in the velocity and momentum of the particle. This explains the acceleration of bodies in the gravitational field.

We shall now study two identical particles, one kept in a gravitation free region where the average energy of the vacuum fluctuations is E_{vo} in all directions and another one kept in a gravitational field where the energy of the vacuum fluctuations on one side is E_{vo} while those on the other side is (E_{vo}-ΔE_{vo}). Let us assume that at a particular instant both of them are having velocity v. Let us apply a small force on the particle so that both of them get accelerated to velocity v' where v' = v + Δv which involves an infinitesimal increase in the energy of the particle. In the case of the first particle, since the rest energy remains invariant, we know from [6] that

$$E = E_o\sqrt{(1-\beta^2)} + \text{þ}\mathrm{v} \tag{20}$$

And

$$(dE)_{E_o} = \gamma E_o(-\mathbf{v}\, d\mathbf{v}/c^2) + \text{þ}\, \mathrm{dv} + \mathrm{v}\, d\text{þ}$$

$$= -\text{þ}\,\mathrm{dv} + \text{þ}\,\mathrm{dv} + \mathrm{v}\, d\text{þ} = \mathrm{v}\, d\text{þ} \tag{20A}$$

where $\gamma = 1/\sqrt{(1-v^2/c^2)}$. Note that here $(dE)_{E_o}$ represents the mechanical energy imparted on the particle while E_o remains a constant. In the case of the second particle, we have to keep in mind that E_o is no more a constant. Therefore, differentiating the right hand side of (20) taking E_o also as a variable along with v, we have

$$dE = -\gamma E_o(\mathbf{v}/c^2)\, d\mathbf{v} + dE_o\sqrt{(1-\beta^2)} + \text{þ}\,\mathrm{dv} + \mathrm{v}\,\mathrm{d}\text{þ}$$

$$= \mathrm{d}E_o\sqrt{(1-\beta^2)} + \mathrm{v}\, d\text{þ} \tag{20B}$$

Here v, þ and E_o are taken as variables. An interesting aspect of (20B) is that even when there is no external mechanical force acting on the particle, it could increase its momentum and energy by shedding its mass. In (20) let us take the case where no mechanical energy is imparted to the particle. Therefore equating dE to zero in (20B), we obtain

$$dE_o\sqrt{(1-\beta^2)} + \mathbf{v}\, d\text{þ} = 0 \tag{21}$$

Note that the first term on the left hand side represents the reduction in the heat content while the second term denotes the work done. Therefore, (21) can be understood in terms of the internal heat being used to get the work done. This allows us to treat mass as some sort of a potential determining the gravitational field. Note that the anisotropy of the vacuum fluctuations background which creates the gravitational field also reduces the rest mass of the particle. This means it is possible to assume that when a test particle undergoes free fall in a gravitational field, its total energy remains constant. When a test particle is allowed a free fall in a gravitational field, the particle does not absorb any energy from the vacuum as the kinetic energy gained by it is exactly equal to its mass loss. ***In other words, gravitation is defined by the adiabatic expansion of the primary gas near a massive body which in turn is determined by the gradient in the vacuum fluctuations in the Higg's field.*** Of course, here we ignore the infinitesimal energy absorbed in the vean process by the test particle itself.

Let us now take the case where the test particle is at rest at infinite distance from the gravitating mass. Therefore, we have

$$E = E_o \tag{22}$$

As the particle undergoes free fall, it gains kinetic energy. But we should keep in mind that the total energy of the particle should remain a constant because vacuum has not lent any energy to it. We should try to understand the Newtonian gravitational potential in terms of the gradient in the vacuum fluctuation background. Since the total energy of the particle remains the same while it gains kinetic energy, this could be explained only if the rest energy of the particle gets reduced commensurately. That is

$$\begin{aligned} E = E_o &= E_{ro}\sqrt{(1-\beta^2)} + þ_r\mathbf{v} \\ &= E_{ro} \Big/ \sqrt{(1-\beta^2)} \end{aligned} \tag{23}$$

Here E_{ro} denotes the rest energy of the particle at a distance r from the centre of the gravitating mass while v is the velocity at that point on account of the free fall from infinity. In other words, the free fall in a gravitational field is equivalent to an adiabatic expansion. The work is done by the particle at the cost of its internal energy which is the rest mass here. The only difference is that in the case of a real gas under adiabatic expansion, the thermodynamic variables are pressure and volume with the volume undergoing an expansion. But here pressure and volume are replaced respectively by velocity and momentum. P dV is replaced by v dþ.

11 Mass Loss and Time Dilation in the gravitational field

We know from (23) that

$$E_{ro} = E_o\sqrt{(1-\mathbf{v}^2/c^2)} \tag{24}$$

We should remember that v appearing in the above equation is the velocity of free fall from infinity. Let us now express this velocity v in terms of the gravitational potential. For this purpose we shall use the gravitational potential of the Newtonian gravitation. If we represent by E_k the kinetic energy of the particle, then we may equate it with the potential energy which is inversely proportional to distance as

$$E_k = mc^2 \Big/ \sqrt{(1-\mathbf{v}^2/c^2)} - mc^2 = GMm/r \tag{25}$$

This on simplification gives

$$\sqrt{(1-\mathbf{v}^2/c^2)} \quad = \quad 1/(1+GM\ /rc^2) \tag{25A}$$

Substituting for√(1-v^2/c^2) in (24) gives

$$E_{ro} \quad = \quad E_o/(1+GM\ /rc^2) \tag{26}$$

For weak gravitational fields, we have

$$E_{ro} \quad \approx \quad E_o(1-GM/rc^2) \tag{26A}$$

This is a very interesting result. This shows that the rest mass of a particle decreases in a gravitational field. In fact, such a result is quite logical if we combine the general theory of relativity with the concept of the de Broglie wave representation of a particle.

To show that we are on the right track we shall derive the dime dilation relation from (26).Since the rest energy of the particle could be related to the period of the corresponding de Broglie wave by the equation

$$E_{ro} \quad = \quad h/T_{ro} \quad \text{and} \quad E_o \quad = \quad (h/T_o)$$

we may express (26) as

$$T_{ro} \quad = \quad T_o(1+GM\ /rc^2) \tag{27}$$

This can be expressed in durative time as

$$t_{ro} \quad = \quad t_o(1+GM\ /rc^2) \tag{27A}$$

This is the time dilation equation according to GR. Thus we observe that the decrease in the rest mass of a particle in a gravitational field and the time dilation are two parts of the same coin.

12 Entropy of the Primary gas in the Gravitational field

We saw that in a gravitational field, the mass of a particle decreases and this lost mass is converted into its kinetic energy. Since the rest mass represents the heat content of the primary gas that represents the particle, it may seem that the entropy of the particle which is the ratio of heat content to its temperature also would gets reduced. But we have to keep in mind that the average energy of the vacuum fluctuations also would decrease in the gravitational field with the result that the intrinsic entropy of the particle

$$\hat{S} \quad = \quad E_o/\theta_o \quad = \quad E_{ro}/\theta_{ro} \quad = \quad K \tag{28}$$

This is because the primary gas is always in equilibrium with the vacuum fluctuations background which means $E_o = K\theta_o$ and $E_{ro} = K\theta_{ro}$. Remember that in a gravitational field the particle undergoes acceleration in order to maintain its equilibrium with the vacuum fluctuations background. But when it comes to the extensive entropy, the picture is different. We shall show in a separate paper that the extensive entropy of a particle gets reduced in a gravitational field. In other words, gravitational field acts as a sink for entropy.

13 Conclusion

We observe that the gravitation emerging from the vean process satisfies the inverse square law and is attractive by nature. The vean process provides us with a mechanism by which the gravitational field interacts with masses. The Newtonian gravitation just gave the law which masses would follow. It never explained how this force is transmitted from one body to another. The same is the case with GR. Here Einstein explained gravitation geometrically using the curvature of space-time to represent the field. But the process by which the force is transmitted at the quantum level was never explored. The vean process gives a cogent picture of the processes involved at the quantum level. In fact, it turns out that the same process that creates progressive time and gravity. Therefore, the intimate connection between space-time and gravity becomes obvious in this approach.

Since the loss of rest mass is one of the most direct results of the vean process, it should be possible to measure this by a simple experiment. Here since the electric charge does not undergo any change in the gravitational field, it would be easy to measure the ratio of charge to mass (e/m) of a particle like electron with sufficient accuracy to verify this. The ratio e/m could be measured on the surface of the earth and in the outer space. Decrease in the ratio in the outer space should confirm the veracity of the approach.

The vean gravitation differs fundamentally from the Newtonian and Einstein's gravitation when it comes to the mass loss of the test bodies in a gravitational field. Here we can take comfort on the fact that GR accounts for this by way of time dilation. In fact, it will be shown in the next paper that the field equations of GR are consistent with this mass loss. But the most striking difference of the vean gravitation with regard to others will be in cosmology. Here we observe that part of the red shift could be accounted by the fact that electrons had lesser mass in the earlier epoch. In that case, the galaxies may not be moving from each other at the rate which is generally accepted now. Attractive gravitational force should have slowed down the galaxies moving away from each other after the big bang. But experiments show that the expansion of the universe, instead slowing down is getting accelerated. The vean process could explain this phenomenon as the gain in the rest mass of a particle increases exponentially and as a result the red shift also would show the exponential dependence.

The vean process when applied to the case of black holes may give a consistent explanation of the thermodynamic behavior of the black holes. It will be in tune with the thermodynamic approach followed here in understanding gravitation. In the next paper we shall show that the vean process is basically compatible with general relativity. However it does not allow a black hole to collapse into a singularity.

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