COMPLETED EINSTEIN GENERAL THEORY OF RELATIVITY (CGTR)

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Abstract: Einstein general theory of relativity (GTR) has been criticized for their philosophic problems (both which came from STR and its own problems), despite of their **predictability and accuracy.** Indeed all the problems could be eliminated by using "Vacuum Mechanics" i.e. the mechanism of vacuum medium!

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1) Introduction.

This article is another expanding part of the author's original article **"Vacuum mechanics a New Approach to the Theory of Everything"** (VMTE) [1]. Einstein special theory of relativity (STR) is one theory that has been expanded with the title **"Completed Einstein special theory of relativity"** (CSTR). Here in this paper, GTR will be expanded to "Completed Einstein general theory of relativity" (CGTR) in a more scientific detail. And because CGTR is related to some part of VMTE and CSTR, so they are summarized as below.

In VMTE we have started with the fundamental hypothesis that "**Vacuum medium is the fabric structure of vacuum space".** And it was proved that vacuum space is not the conventional empty vacuum space; instead it is **vacuum medium space!** In more detail it is the **privileged absolute reference frame** of a continuous isotopic homogenous medium and having a peculiar mechanical property; it is very thin in mass density which is permeable by all matters, and almost without any observed resistance!

"Electrons and protons are (something like) **tiny black holes"** is the consequence hypothesis, and they were proved to be the **condensed** of vacuum medium. Both of them are the two elementary particles which form to be **all kinds of the material matters existed in the universe!** So our universe is composed of material matters immerge in a huge volume of vacuum medium space.

Vacuum mechanics – a new conceptual mechanics. It is the **mechanism** of vacuum medium, i.e. the action of condensed vacuum medium with vacuum medium, and the interaction between condensed vacuum medium or vacuum medium themselves. All the mentioned interaction is **responsible for all natural phenomena in our universe!** Latter we will see how this vacuum mechanics is the key for solving the philosophic problems in GTR.

For CSTR, we have derived the **Lorentz transformation** by using vacuum medium as the privileged reference frame, and so we could understand its physical meaning! Then we have showed that **"the increasing mass"** of the moving object **was due to the inertial resistance** of vacuum medium (not the increasing of the material mass of the object itself).

And we showed that **"time dilation"** of the moving frame **was the slowing of the measuring clock's mechanism** (due to the inertial resistance of vacuum medium) and we have called it as "relativistic clock". Also there is **no real "length contraction"**, it is an appearance of **relative length** which occurred in STR for trying to keep the constancy of light velocity referenced to the moving observer! Finally we have shown how to solve the unsolved problem in classical mechanics (as STR does), but with a more rational and understandable way.

Now to **improve GTR to be CGTR,** we will first point out detail of the **philosophic** idea of the main parts that involved; the concept of gravity, mass, space, and time. Next, using the new proposed concept of **vacuum mechanics** to solve the problems**.** Finally what we got after modification is a more rational and understandable GTR; it is CGTR!

2) Mechanism of gravity. Sir Isaac Newton had first provided us with his Universal law of Gravitation via the formula (1) below, which state that two mass attract each other with the force *F* that directly proportional with their masses m_1 and m_2, and inverse proportional to square of the distance r between them.

$$F = G\frac{m_1 m_2}{r^2} \ldots. (1), \qquad \varphi = GM / r \ldots. (2), \qquad G_{\mu\nu} = kT_{\mu\nu} \ldots (3).$$

But Newton said nothing about "**why and how masses attract each other**". To solve the problem, modern physicists try to explain it via gravitational field concept. And according to the formula (2) that the gravitational potential φ at any point around a source mass M is direct proportion to the mass over the separate distance *r*. This seems to be okay, but why and how? We could not visualize the working process; **it is just an ad hoc solution**!

Lastly, while Einstein said that **gravity is the manifest of curved space-time** according to his famous field equation (3) (where $G_{\mu\nu}$ is Einstein tensor $T_{\mu\nu}$ is energy-momentum tensor and *k* is a coupling constant), but why and how mass and energy cause space-time to curve is unexplained! Armed with the concept of the mechanism of vacuum medium, i.e. **vacuum mechanics,** we are now going to see "why and how masses attract each other" together.

2.1) Why masses attract each other? First of all, we will have to summarize (from the original of matters in VMTE), what material mass is! In the first section that vacuum medium is the fabric structure of vacuum space, or we could say that "**space was created by using vacuum medium as raw material**". And the most special important intrinsic property of vacuum medium is that **every infinisimal part of them attracts each other with their own intrinsic gravitational force** (contraction force)!

Also in VMTE we have verified that **"electrons and protons are** (something like) **tiny black holes of condensed vacuum medium"**. (We could visualize them as two sizes of small solid spheres of the very concentrated vacuum energy; electron: a lighter one, proton: a heavier one). So electron and proton can attract each other (also with the surrounding vacuum medium space) via their **black hole forces**, which is much stronger attractive force than normal gravity (which created by masses attraction). Actually, these black hole forces are the familiar forces known as **electrostatic** or **Coulomb forces!**

(Please note that **all size of tiny black holes always attracts each other.** There is only one special case in which the same size (same type of charge) will repel, when both of them closing to each other at a certain distance. This is because of the repulsive stress in the vacuum medium between them is dominated (please see detail in VMTE). And from now on when talking about the interaction between charged particles **we will refer only to attractive force**, which is the force **between electron and proton!**)

Now to see the action of **black hole force** (or Coulomb force) **within masses,** first we have to start with the most simple atom i.e. **hydrogen** atom. We know that it was formed by electron and proton attract close together by black hole force. But notice that both particles are still **not attach together** because the existing of vacuum medium between them. To displace the medium between, some **external additional forces** was used. This extra force must be strong enough to tear off the medium which was called **weak force**! Next is **the nucleus of helium atom** which composes of two protons and two neutrons. From the former paragraph we could see that two protons will repel each other when they are closing together enough, but not yet attach together. So some **external additional force** must be used to overcome the repelling force, and this extra was called as **strong force!**

Next talking about **the attraction force between atoms within a molecule, and between molecules**, are they also black hole force? Indeed they are; all categories of bonding i.e. Val der Waals or molecular bonding, ionic bonding, covalence bonding, metallic bonding and hydrogen bonding **all are electrostatic forces** [2] i.e. **black hole force!**

Finally, we have to point out one of the most crucial concept about the action of force; that is **"any interaction of forces between two masses** which is not a direct contact action**,** there must be some kind of mediums acting as the **transmitting mechanism for the force"!** For example when we want to pull an object we must use some material such as rope as the transmission of force. And even within (or between) atoms of rope's material we would found that there are filled with vacuum medium which acting as force transmitter.

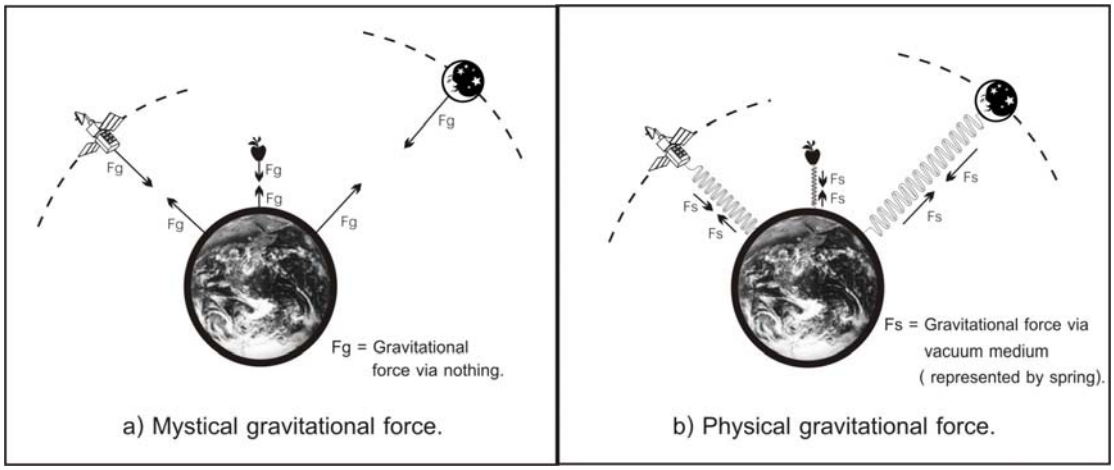

Figure 1 Attraction mechanism between masses

By the way, unfortunately in our daily life, we could not see vacuum medium, so we seem familiar that **no medium is required for gravity force** as in diagram fig.1 (a). And when we look at diagram1 (b) for the first time, **it would look crazy!** But after considering for a minute we would found that **it would be crazier** if there is nothing pulling between them (here, spring was used for representing contraction force of vacuum medium)**.** Why? Because **gravity is physics** (science of nature) **not a magic** (unscientific)!

In conclusion, **masses attract each other** because all the matters in the universe compose of two elementary charge particles i.e. electron and proton**.** And because both of them are something like tiny black holes of condensed vacuum medium (which have their own intrinsic gravity property), so it is inevitable that **gravity is also the property of material masses.** Anyway, we have to make clear that the gravity between masses is different from the gravity inside masses. All attraction forces at molecular level within material mass are **black hole forces,** while the attraction force between pieces of material masses are **normal gravitational forces!**

2.2) How masses attract each other? When physicists use gravitational field concept to explain the attraction force between masses, they are wondered why it is so similar to electrostatic field concept. And they seem to believe that they are **different thing**s. Armed with the concept of vacuum mechanics, we could understand without difficulty that **both fields are the same thing; it is the contraction force field (internal stress) in vacuum medium!**

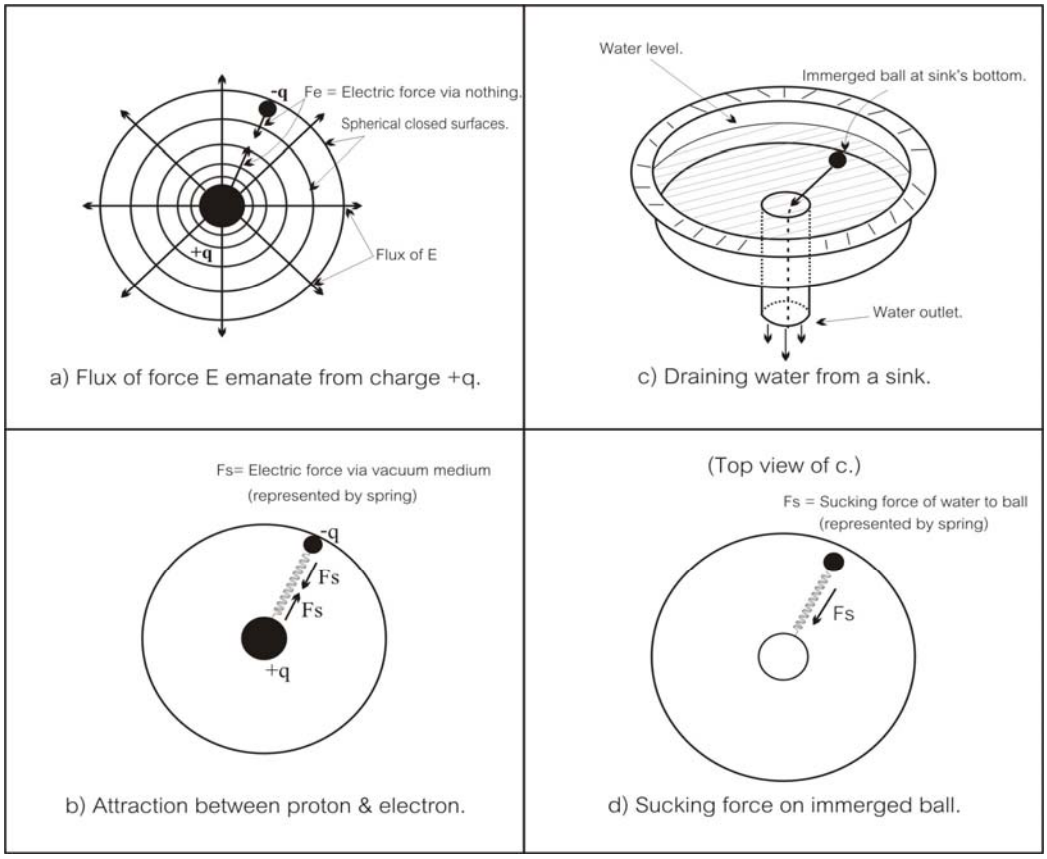

Figure 2 Attraction mechanism between two charges

Before seeing "how masses attract each other", it is easy to start with **"how charges attract each other"** by using the idea of "the flux of E (electric field)" explained by Richard P. Feynman [3].

According to diagram 2(a), flux of E emanate from charge +q (proton) in a spherical shape (shown in circle) around the charge, and at any distant r from center of charge,

$$E = \frac{1}{4\pi\varepsilon_0}\frac{q}{r^2} \quad \text{..... (4).} \qquad \text{(where } \varepsilon_0 \text{ is the permittivity constant).}$$

Actually **E is the force** that will act on a unit charge placed anywhere in the electric field E. So the total flux of force from charge +q is as follow.

Total flux of force through closed surface = $\oint E_n da = \left(\frac{1}{4\pi\varepsilon_0}\frac{q}{r^2}\right)\left(4\pi r^2\right) = \frac{q}{\varepsilon_0}$ .... (5).

Note, even "flux" means "flow" but "flux of force" does not mean "flow of force", instead **it means "emanating of attractive force" via the internal stress of vacuum medium"** around the charge sphere +q. Or we could say that at a distance *r* from charge +*q*, there is an attractive force (a contraction stress in vacuum medium) per unit area equal to $\left(1/4\pi\varepsilon_0\right).q/r^2$. And if -q charge is placed at r, then **the attractive force per unit area is equal to** $\left(1/4\pi\varepsilon_0\right).(+q)(-q)/r^2$ as showing as the **contraction spring** in fig.2 (b).

And to make it easy to understand "how charges attract each other", look at diagram 2(c) and 2(d) for analogous concept. **While water is draining from sink, the tiny ball immersed in water was sucked via water and moving forwards the drain!**

Now in the similar way of charge, we can calculate **the total flux of force from the normal mass M** in fig.1 (a) (Readers could found the detail in "Gauss's law for the gravitational field" [4].) as follow.

Total flux of force through closed surface = $\oint g_n da = G\left(M/r^2\right)\left(4\pi r^2\right) = 4\pi MG$ .. (6).

[Where $g_n = G\left(M/r^2\right)$ … (7) is the force of the gravitation field which acts at a unit mass placed at the surface of the sphere with a radius r and *G* is the gravitational constant. (g is the same thing as the acceleration of a unit mass.)]

To interpret the meaning of formula (6) we have to look at its unit, which is force * area / mass (newton·meter^2/Kg.). So the formula say that M Kg. of mass **creates gravitational force multiply by the enclosed area is equal to** $4\pi MG$ (newton·meter^2) **around the mass sphere** via the internal stress of the surrounding vacuum medium**.** Or we could say that, at any point r from the mass M there is a gravitational force act at a unit mass placed there **per unit area =** $G.M/r^2$. And if mass m was placed at r then **the gravitational force** between M and m **per unit area =** $G.Mm/r^2$, which shown as the contraction springs in fig.1 (b).

Now let us come back to explain more detail about diagram fig.1 above. For diag.1 (a), when considering it **scientifically** we would found that **it is a magic.** The reason is because there is no mechanism for gravity (for explaining how it works) so it is **a supernatural phenomenon!** Instead if we accept that there are infinite numbers of **unseen** spherical concentric shells of internal stress in vacuum medium around the earth. Then **each shell represents different value of gravitational force** which is **the manifest of internal stress in vacuum medium.**

While the closer shells to the earth mean the stronger of the gravitational force**,** and the far away shells mean the weaker of the gravitational force according to formula (7). So if we understand the mechanism which just explained, then the **mystic view of the unseen gravitational force is not mystery anymore!** Anyway, for someone who is not familiar with the unseen "internal stress in some material medium" it is still difficult to visualize. So the **contraction spring** in diag.1 (b) would give a better view, even though it may look strange and unfamiliar to us!

In conclusion; in this section we have explained the mechanism of gravity which is the action of the internal stress in vacuum medium between masses. While in the former section we have shown that mass which was formed from billions of tiny black holes (condensed vacuum medium), so it also has gravity as its own property. Then by using the concept of vacuum mechanics, we could say that **"masses create gravity and manifest it via the internal stress in vacuum medium"**, couldn't we?

3) Philosophy behind space-time. All of us live in the universe that involved with "space" and "time". So everything, all natural phenomena and human activities can not be separated from space and time. Nowadays we have two types of space-time; the first one is classical **Newtonian space-time** and another one is relativistic **Minkowskian space-time.** Anyway, it is interesting to note that both concepts of space-time still have **their own problem until now!** So we have to clarify them first before we could improve and got a complete GTR.

3.1) Newtonian space-time vs. Minkowskian space-time. Let us consider detail of Newtonian space-time with absolute three dimensions spatial space and one universal time. It is the same thing as Euclidean space in which the square of Euclidean "distance" between two adjacent Cartesian coordinates is

$$\sigma^2 = (x_1 - x_2)^2 + (y_1 - y_2)^2 + (z_1 - z_2)^2, \qquad t_1 = t_2 \ \ldots\ldots (8).$$

Note that each spatial distance term and time interval of (8) is **invariant** (constant).

But according to STR, where the constancy of speed of light (referenced to any moving initial observers) was used to link these three dimensions of space and one dimension of time, then what we got is a four dimensions space-time called **Minkowskian space-time**. And the square of space-time "interval" between two events is

$$s^2 = c^2 (t_1 - t_2)^2 - (x_1 - x_2)^2 + (y_1 - y_2)^2 + (z_1 - z_2)^2 \quad \ldots\ldots (9).$$

Note that each term of spatial distance and time interval in the right hand side of (9) **is not invariant** (not constant)!

Now by comparing Newtonian space-time with Minkowskian space-time we would found that in the former, **space is absolute** (constant) and **independent from time,** while in the latter **space and time are dependent.** And notice that both of them are the concept of **empty vacuum space** not physical space**.** There is also a weak point about universal time in Newtonian space-time; that is the concept of instantaneous action at a distance. Then it means that **any action of force or traveling of light signal occur with infinite speed**. But this is what it should be because it is correspond to Newton's concept that **space is empty**! The reason is that light speed is infinite in any medium with zero density (Wave speed in any medium is proportion to square root of elasticity over density).

Minkowskian space-time also has a weak point about **the distortion of both space and time;** that is there is both **the time dilation and length contraction!** The reason is because Einstein mixed them by keeping "constancy of speed of light referenced to any inertial moving observers" for his derivation of Lorentz transformation (Please see detail in CSTR). Up to now we have seen the problems which involved with both Newtonian and Minkowskian space-time. So what we want now is **a better view of space-time which has no side effect** mentioned above; that is **"Vacuum medium space-time".**

3.2) Vacuum medium space-time. Based on "vacuum medium is the fabric structure of vacuum space", vacuum medium space **is a physical space,** not an empty one. It is the same concept as Newtonian absolute space with universal time; the only **difference** is that vacuum medium space is a physical space not an empty as Newtonian space do. This means that **the distance between any two points in space is constant,** while the universal time means **at any instant, time is the same and it flows evenly everywhere.** So what was defined as the continuum of four dimensions space-time, actually **it is the continuum of three spatial spaces at any instant time!**

Another point that vacuum medium space-time **different** from Newtonian space-time is that **speed of any action or speed of light signal is c, not infinity** (according to vacuum mechanics, any disturbance in vacuum medium propagate with light speed c). And when measurement was made by a moving observer referenced to vacuum medium, **space and time could be mixed by using the constancy of light speed in vacuum medium space-time without any distortion!** So every term in equation (9) is **invariant**.

Below is **how the dynamics of a moving inertial frame work in vacuum medium space-time**, in which it is working according to **Lorentz transformation!** In the diagram of fig.3, a light source was placed at the origin O of the stationary absolute privileged vacuum medium referenced frame S, at time $t = x = y = z = 0$. Then light signal propagates radial outward as a sphere. And at any instant time t_p, what we got for the event at $\mathrm{P}\left(x_p, y_p, z_p, t_p\right)$ is the sphere formula;

$$s_p{}^2 = c^2 t_p{}^2 - x_p{}^2 + y_p{}^2 + z_p{}^2 = 0 \quad \text{…….. (10).}$$

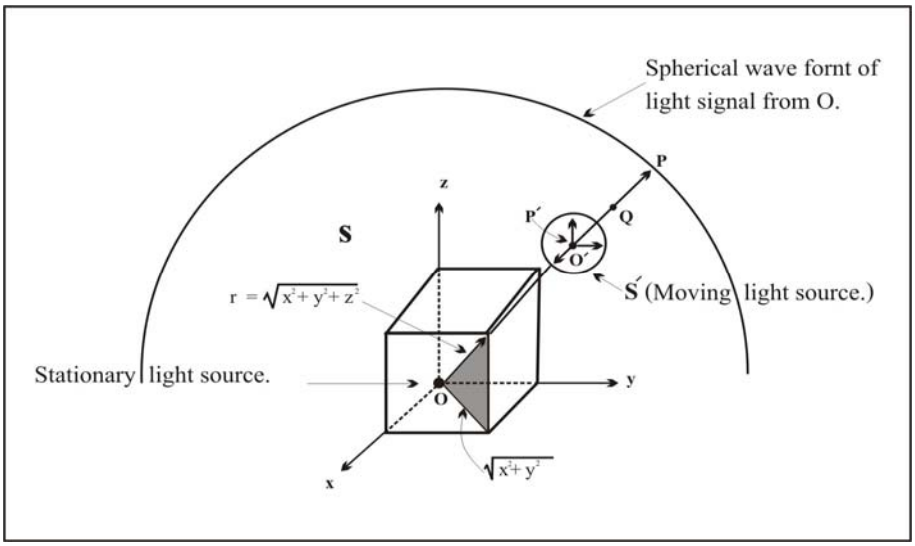

Figure 3 Vacuum medium space-time

Now, let us place the light source at the origin O' of a moving frame S' (referenced to vacuum medium rest frame). Again when O' is at O and at $t = t' = 0$, while light source is start emitting, S' is also moving with speed V (less than c). When S' is passing P' toward Q, the emitting signal from P' will reach P at the same instant that S' is at Q. And if we consider only for the co-ordinate x, then the time t' at P' and the distance x' (distance between P' and P) **are the time and the distance according to Lorentz transformation!**

To see the **physical meaning** of the invariance s^2 in S defined in (9), by comparing to $s_p{}^2$ of (10) in S', we would found that

$$s_p{}^2 = c^2 t_p{}^2 - x_p{}^2 + y_p{}^2 + z_p{}^2 = s'^2 = c^2 t'^2 - x'^2 + y'^2 + z'^2 = 0 .$$

Someone may say that it is just the concept of STR that "the constancy of speed of light referenced to any moving initial observers". But when consider the above diagram carefully we will found that, it is the emitting light signal from P' that reaches P not from Q (the actual position of S' at time t). **So it means that the constancy of light speed is reference to absolute vacuum medium space, not to the observer in a moving inertial reference frame!** That is, the propagation time of light signal from P' to P is t', not the time from the present position Q (of S') to P. Then **there is no real time dilation and no true length contraction!**

Finally if there is **no real** time dilation and **no real** length contraction, **are proper time and proper length still necessary?** The answer is yes; because both of them are **relative values** and still useful for some propose such as Doppler Effect. Besides that, we still have the **relativistic clock** instead of the conventional time dilation. And for length contraction, because it is only a **relative length**, so we must be careful **not to use the length contraction for guiding to the increasing density of mass!**

By the way, **proper quantity** was defined as **the intrinsic quantity** when measuring was done by an observer on his own reference frame. But according to STR & GTR, all reference frames are moving relative to each other. So **we could not find any "true" intrinsic quantities in our universe.** Instead according to vacuum medium space-time, we could preserve the meaning of "intrinsic quantity" because **it is only the same one true invariance measured quantity in any reference frame!**

4) Physical meaning of space-time curvature. According to GTR, our universe was built with four-dimension space-time (three spaces plus one time), but it is impossible to visualize how a curved space-time is. Let's refer to a famous professor in physics nowadays, Stephen W. Hawking word [5] **"It is impossible to imagine a four dimensional space."** Or (again) referenced to Richard P. Feynman word [6] "We live in three-dimension space and we are going to consider the idea that three-dimension space is curved ……, we can't imagine space being bent in any direction because our imagination isn't good enough. (Perhaps it's just as well that we can't imagine too much, so that we don't get too free of the real world.)" Is this word still being true forever? **Could we understand three-dimension space being curved while we still live in the real world?** For my opinion, **the answer is yes we could!** And let's us find out together by starting with a two-dimension space below.

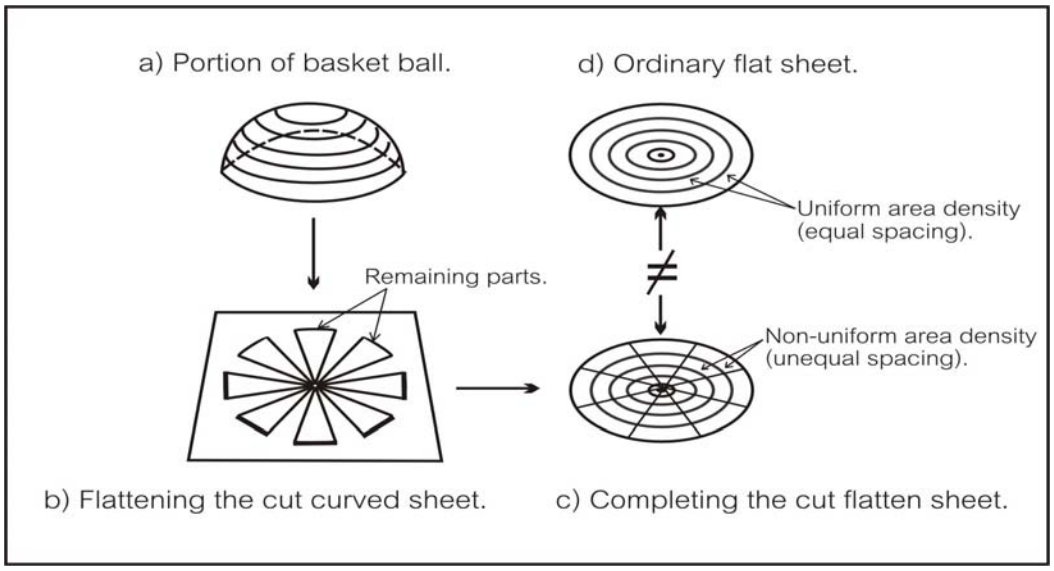

Figure 4 Comparing a curve surface with a flat surface

4.1) A new view of curved surface. All of us are familiar with a two-dimension curve surface such as a portion of elastic spherical surface sheet of a basket ball shown in the diagram fig.4 (a). After we flatten it out by making an appropriate cut where necessary, then what we got is **an incomplete flat sheet** as shown in (b). Next, we complete the cut-off parts by pulling the neighboring parts together (while keeping the sheet's thickness to be the same everywhere). Then what we got is **a completed flatten surface sheet** as in (c). Actually, we could get the flattened sheet (c) just by pressing the curved surface sheet (a).

Note that the **flattened surface sheet** (c) **is not the same thing as a true (ordinary) flat surface** (d) which made from the same elastic material**!** But, what is the difference?

The difference is that the area density of elastic material is **uniform in a true flat surface sheet** (d), while **it is not uniform in the flattened surface sheet** (c), i.e. the area density vary from high density around the center to the lower density at the rim of the sheet. So **the uniformity of material density of a physical space area of sheet is the crucial point** for considering whether it is a flat sheet or a curve sheet. Thus from this point of view**,** we may say that **a curve surface sheet is a non-uniform of material density of a flat surface sheet!**

4.2) A better view of curved space-time. Now we will extend the concept **"non-uniformity of the material density of a sheet"** (two-dimension curve sheet) to a three-dimension curve space (curve of **volume space**). First we start with a simple analogy of the atmosphere which covers the surface of our earth. We know that air density is higher near the earth's surface and decreasing to a lower density when the altitude is increasing. This non-uniform density of air was caused by the earth's gravity which is higher near the earth's surface and decreasing at a higher altitude. So we could say that **the atmosphere space (physical space of air) is curved.** But suppose that, if the gravitational attraction of the earth to the atmosphere is the same at any altitude, then the air's density will be uniform. **In this case we could say that the (three- dimension) atmosphere space is flat!** (Note, both the words "curve" and "flat" used for volume space may come from curve and flat sheet which we are familiar.)

Up to now we have found that it is easy to visualize and understand "flat and curve space" by using concept "uniformity of density of the material that constitute the physical space". So for **vacuum medium space, it is the uniformity density of vacuum medium energy that was used for considering the curvature.** But we have to be careful because there are two part of vacuum medium energy. The main part is the energy that constitutes and maintains the isotopic fabric structure of space (flat space). While the additional part is the internal stress energy in vacuum medium that occurred due to the existing of the near by mass (gravitational potential energy). To visualize the internal stress energy occurred in vacuum medium, it is easy to look at **"internal stress created in incompressible fluid such as water**, when it (the water) was subjected to external force. In this condition we would found that volume of the water is not change (mass density is the same as in the water without external force), but there is an additional stress energy occurred in the water!

To show formally how the concept of **"non-uniformity of energy density of vacuum medium space"** could explain **"curve space"**, we will go back to the three last paragraphs in section 2.2. There, we have said that gravitational force is the manifest of internal stress in vacuum medium space near the center of earths mass. While the stress in vacuum medium that closed to the mass is higher due to the stronger force of gravity, the far away part will be lesser due to the weaker gravity according to equation (7), that is $g = G\left(M / r^2\right)$.

Actually we could view the surrounding vacuum medium as **infinite numbers of unseen spherical concentric shells with different constant value of stress in vacuum medium** around the center mass. In this way, each shell would represent different value of some constant **"Gaussian surface curvature".** Also each shell represents different layer of **"Geodesic closed surface".** The closer layer of the shells to the mass means the larger curvature of the Geodesic path, while the far away shells mean the smaller curvature of the Geodesic path.

Below are the diagrams which show the deviation of light ray path through curve space-time. In a) the bending of light ray path follow **the imaginary curve space of rubber sheet**, while in b) the bending of light ray path follow the Geodesic path of the Gaussian surface curvature. So we could see that **it is more rational for curved space-time with non-uniformity of the internal stress created in vacuum medium space, rather than the conventional curved space-time of empty space!**

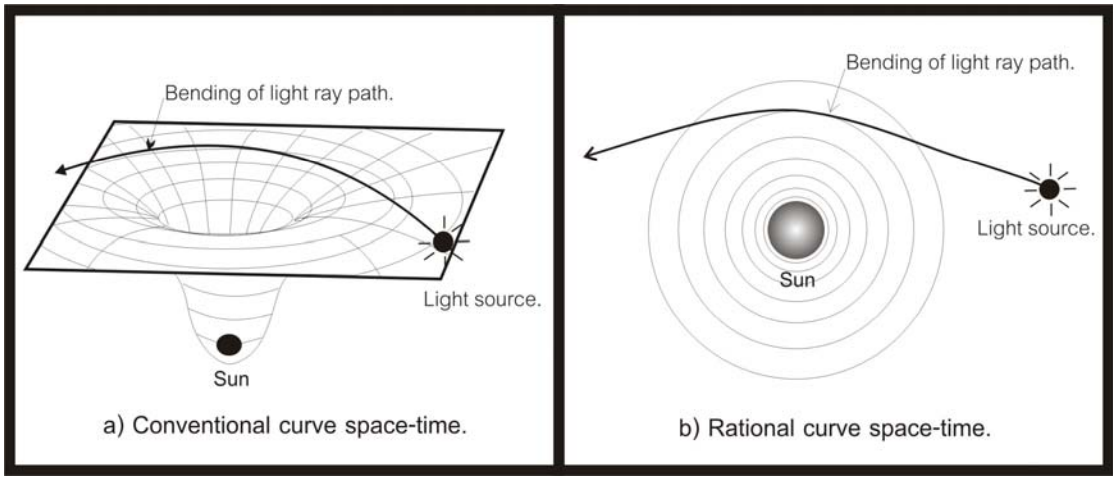

Figure 5 Light ray path through curve space-time

For an example, we will show how the concept of "uniformity of the internal stress in vacuum medium space" **could explain "curved space" in GTR by using Schwarzschild exterior solution** below.

$$ds^2 = (1-2m/r)\,dt^2 - (1-2m/r)^{-1}\,dr^2 - r^2(d\theta^2 + \sin^2\theta d\varphi^2) \quad \ldots. (11).$$

It is the metric equation of line element (square of interval) of curve space-time surrounding a spherical body mass M. And we can approximately express it in rectangular coordinate (and may be called isotopic) [7] as below

$$ds^2 = (1-2m/r)dt^2 - (1+2m/r)(dx^2 + dy^2 + dz^2) \quad \ldots.. (12).$$

When there is no gravitating body (M = 0) equation (11) and (12) reduce to a flat space-time as below

$$ds^2 = dt^2 - dr^2 - r^2(d\theta^2 + \sin^2\theta d\varphi^2) \ldots.. (13), \qquad ds^2 = dx^2 + dy^2 + dz^2 \ldots. (14).$$

(11)

Now consider the coefficient of time component g_{00} of (11) which is equal to $\left(1-2GM/rc^2\right)$. And we could see from (2) that the gravitational potential $\varphi = GM/r$, so $g_{00} = -1/g_{11} = 1+2\varphi/c^2$ [8]. When we compare g_{00} in (11) with g_{00} in (12) which is a flat space-time then we would see that **the additional term $2\varphi/c^2$ is the additional energy arisen from the gravitational potential due to M.** Also this additional energy is greater near mass M, and it will be reduce to zero when r is infinite.

Based on Vacuum medium space-time we could equally say that internal stress energy in vacuum medium is greater near mass M, while it will be reduce to zero when r is infinite. Or we could say that the **non-uniform of internal stress energy in vacuum medium create the curvature in space around mass M!**

In conclusion we could say that **a three-dimension flat space-time** is the space-time **with uniform internal stress of vacuum medium,** while **a three-dimension curved space-time** is the space-time **with non-uniform internal stress of vacuum medium!** This is more rational and understandable space-time, isn't it?

5) Modification of GTR. Up to now we have seen how the concept of vacuum mechanics (mechanism of vacuum medium) gives a better view of gravity, relativity and space-time. It let us to visualize and understand the mechanism of gravity, it gave us a more natural concept of space-time and it let us understand clearly what the curved space-time is. So if we want a complete GTR, we have to improve it by using this new better concept.

5.1) Reinterpret principle of equivalence. Since GTR was extended from STR in which the principle of relativity is valid only in the realm of inertial system, so the principle of equivalence was created by Einstein to cover system with **noninertial** reference frame in GTR.

Conventionally according to the principle of relativity of STR, two inertial observers will experience the universe in exactly the same way (laws of nature is the same for them), even though their observations are made relative two entirely different inertial systems. In GTR, the principle of relativity was generalized to include the observer in noninetial system forming to be **the principle of equivalence, i.e. laws of nature is the same for observer in any system!**

Under the concept of vacuum medium space which is absolute privileged reference frame, we have reinterpreted the principle of relativity of STR from "physics is the same in any inertial frame" to "physics is the same in any inertial frame referenced to vacuum medium space". In the same way for GTR, we have to reinterpret the principle of equivalence from "physics is the same in any system" to **"physics is the same in any system referenced to vacuum medium space"!**

5.2) Einstein tensor is vacuum tensor. Let's look again at Einstein field equation (3) below

$$G_{\mu\nu} = kT_{\mu\nu} \quad \ldots (3).$$

The formula said that Einstein tensor $G_{\mu\nu}$ is curvature tensor $R_{\mu\nu} - (1/2)g_{\mu\nu}R$, which provides a complete description of space-time curvature. And it **is equal to** energy-momentum tensor $T_{\mu\nu}$ of all matters and energy involved (except the gravitational energy created by the matters itself) in the system. But there is **no way to deduce the connection (between the two parts) from more fundamental principle** [9]**!**

When considering it in detail, the above **space-time geometry** $G_{\mu\nu}$ **is a geometry of "nothing"**; **it is the geometry of an empty vacuum space.** So it is difficult to visualize how to deal with the tensor of "nothing" which is unphysical. In the real world we normally use tensor for solving the problem with something which is physical such as electromagnetic field, fluid or solid materials. **It is Einstein's genius that he could imagine** (guided by Mach's principle and the principle of equivalence) **how to link an energy-momentum tensor** (physical tensor) **to describe the abstract geometry of space-time!**

But if we consider the energy-momentum tensor $T_{\mu\nu}$ in the view of the whole universe, we would found that it consists of all the matter and energy that irregularly distributed across the universe; **it is not a continuous physical medium which contains all the necessary information for Einstein tensor.** So he had designated a new kind of material field with mass, energy and momentum densities at each point in the system; that is the energy-momentum tensor required.

Now we have learned above that actually **space-time geometry is the physical geometry of vacuum medium.** And this vacuum medium is the main part of mass (energy) that pervaded across the huge universe. So all the observable matters of galaxies, stars, dust clouds etc. are the minor part that are immerged in the sea (of uniform distribution) of vacuum medium through out the whole universe. Then Einstein tensor which originally was an imaginary **becomes a real tensor of physical geometry of space-time.** So we could say that **Einstein tensor is vacuum medium tensor** (tensor of vacuum medium space)**!**

5.3) Return of cosmological constant. Someone who familiar with GTR would found that the total matter and energy existed in the form of energy-momentum tensor $T_{\mu\nu}$, which is the source that create the curvature of space-time **does not include gravitational energy** (which created form the total matter and energy) **itself.** So it means that **the total energy in the system is not conserved!** This is the crucial weak point of GTR**.**

And to solve the problem, it was proposed a quantity which play the same role as a gravitational potential; a 4x4 pseudotensor $t^{\mu\nu}$ (the gravitational potential energy of the field) by adding it to $T_{\mu\nu}$, to assure the energy and momentum to be conserved. How ever $t^{\mu\nu}$ is merely a pseudo-tensor, it does not have **a convincing physical presence** (or absence) [10]. Armed with vacuum medium space, it is easy to solve the problem**.** We start with **general form** of the full field equation with **cosmological constant** Λ as (15) follow.

$$R_{\mu\nu} - (1/2)g_{\mu\nu}R - \Lambda g_{\mu\nu} = kT_{\mu\nu} \text{ .... (15)}, \quad R_{00} + (1/2)R = kc^2\left(\rho_0 + \Lambda / kc^2\right) \text{ .... (16).}$$

Then after rearranging (15) and write out the 00-component as show in (16), where T_{00} was replaced by $\rho_0 c^2$ (ρ_0 = mass density). So reference to (16), Λ **functions as a constant mass density of vacuum medium energy,** and acting as the "**ambient mass**" which **spread through out space** [10']**!**

Einstein first introduced Λ to act **as a repulsive force** in the field equation to counter the gravity for a static universe. But after knowing that actually the universe is undergoing an expanding, he discarded it while said that "… the biggest mistake I ever made". Nowadays it is assumed to be 'very small' so it will be still including in most treatment of relativistic cosmology [11]. Anyway even the universe was found to continue expanding, but **what is the cause which made it to expand against the gravity? Here the author proposes to use** Λ **as the ambient mass of vacuum medium energy** which is the energy source for repulsive force mentioned.

In VMTE, we have said that the **ambient mass** of vacuum medium energy is so dilute. So it is insignificant on a planetary or local galactic scale, but **it will be dominant on the cosmic scale** (because the huge volume of the universe). As for an example, we could see it from Schwarzschild exterior solution derived including Λ [7'] as below

$$ds^2 = \left(1-2m/r-\Lambda r^2/3\right)dt^2 - \left(1-2m/r-\Lambda r^2/3\right)^{-1} dr^2 - r^2(d\theta^2+\sin^2\theta d\varphi^2) \text{ .... (17).}$$

Comparing (11) and (17) we could see that the effect of Λ term on the field surrounding the central mass M would increase with the size of the region considered. Hence, since the motion of the planets are actually given with great accuracy by (11), we can conclude that Λ **is in any case small enough not to produce appreciable effects within a region of the order of size of the solar system.** And we can calculate its value by setting Λ/kc^2 term in (16) equal to mass density of vacuum medium $\rho = 23.3\times10^{-28} Kg./m^3$ (from the last paragraph of section 6.1). Then **what we got is** $\Lambda = 4.34\times10^{-53} m^{-2}$ which is very small indeed!

Finally **we have solved the problem and fulfill the field equation** (3) by just add vacuum medium to energy-momentum tensor in term of Λ. **Actually the final result is just the returning back** to equation (15). What we have done is to give the appropriate meaning of Λ. Or we equally say that equation (15) is not just a more general field equation, but it is more rational than (3). And this is what we say that **it is the returning of the cosmological term Λ!**

6) Vacuum medium universe – a better view of our universe. The most interesting application of Einstein field equation (3) is that it was used to describe our universe; the story of cosmology. Anyway**, there are several weak points about the assumption for developing model of the universe** and also the problem about the model itself.

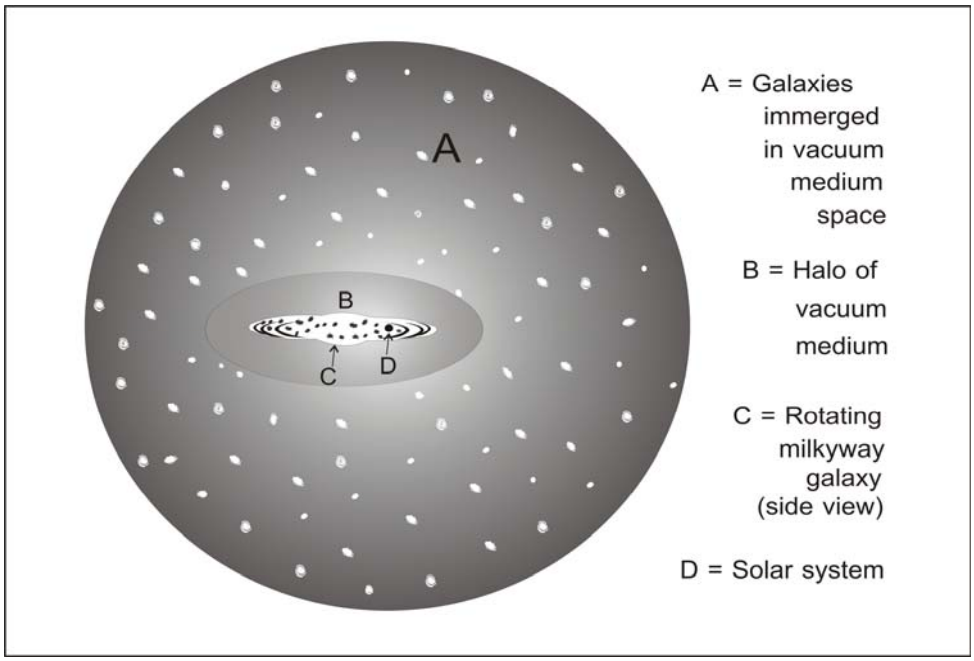

Figure 6 Vacuum medium universe

In section 5.1 we have shown that Vacuum tensor is a better view for Einstein tensor. Here we will show that Vacuum medium universe (the universe which was built from vacuum medium) is a better view of our universe. All the observable matters of galaxies, stars, dust clouds etc. are the minor part that are **immerged in the sea (of uniform distribution) of vacuum medium throughout the whole universe** as shown in the diagram which we will talk in detail later.

6.1) Fulfilling the cosmological principle. While the relativity principle was the foundation of STR, the equivalence principle provides the physical basic for GTR. In cosmology **cosmological principle was introduced to let the field equation manageable.** Note that the first two principles were modified to get a more rational meaning under the concept of vacuum medium; now this new concept will also **give the cosmological principle to be a more meaningful!** Let's start with the amended and presently accepted form of the cosmological principle [10''] which state that:

"The general overall features of the universe are the same relative to any local observer at corresponding epochs in the evolution of the universe".

What does it means for the principle is to take **all the existing matters (galaxies and stars) uniformly distributed across the universe.** But we know that actually the matters are irregularly distributed, so how could we improve this weak point? Armed with the existing of vacuum medium, the principle could be strengthening. The reason is because the **total mass of vacuum medium energy** (which uniformly distributed) is much more than that of the visible existing matters! And when we compare them in term of mass density, it is the ratio >20:1 (see section 6.4). So it doesn't matter how the tiny part of visible matters was distributed; **the total masses distribution in the universe is still uniform!**

6.2) The origin of universe. Nowadays, main part of cosmologists believes in the hot big bang with inflation universe. **"But the universe is the ultimate free lunch"**, this is Stephen W. Hawking's word [5']. The mentioned universe was suggested to start out from the hot infinite dense singularity; then it had expanded with acceleration (inflation) up to the present universe. **The big problem is that where did the huge quantity of the increasing matter come from, it contradicts to Law of conservation of energy (mass)!** To solve the problem, team of experts in astronomy & astrophysics has proposed a new cosmological model called "quasi-steady-state model" [12].

According to **the new theory "quasi-steady-state model", the major development is that matter creation occurs with energy conservation.** Their thesis that matter is created and ejected in the form of quasi-stellar objects and matter in other forms from the nuclei of galaxies are the observational evidences. In summary the general equation of the theory was derived from the friedmann-Robertson-Walker model **by introducing a scalar field C**. The role of C - field is to act as **a negative energy and negative pressure for the effect of matter creation**, and the matter creation is to accelerate the expansion of the universe. **So there is no need a hot big bang with inflation scenario!**

By the way in this new model, it was explained that the existence of **near – black hole** in the center of galaxies **is an indication of the creation events have taken place**. And to visualize such events in physical terms, the suggestion conceptual explanation is from the basic fabric of space-time. They are well-used to thinking that particles creation occur in association with a transition that involves space-time in a physical way, not just as a passive medium in which particles are supposed to exist. **In graphic language, particle creation would be associated with an opening-up of space-time!**

Now according to Vacuum medium space-time, in which we have mentioned early that it is the fabric structure of space-time created out of vacuum medium energy. Or we could say that **vacuum medium is the raw material for constructing the fabric structure of space-time!** This means that at the starting moment, the universe is zero size (no space-time) there is no vacuum medium either**.** When the universe is expanding its size, vacuum medium must be increased for expanding the fabric structure of space-time. And when the universe is reducing its size, it means that vacuum medium is decreasing. Then we could see that **vacuum medium universe is possible without hot big bang and inflation universe!**

Note that actually vacuum medium is just the contraction (gravity) energy that try to encounter its expanding (please see detail in VMTE). So if we view **the existing of vacuum medium as positive energy, and its intrinsic property (gravity) acts as negative energy, then the total energy of the universe is conserved!**

Finally we could see that vacuum medium universe and quasi-steady-state model **may be classified in the same group.** Both of them were created **without hot big bang and inflation!** In technical detail, vacuum medium energy in vacuum medium universe could be though as C-field in quasi-steady-state model. And in vacuum medium universe vacuum medium energy create space-time, while in quasi-steady-state model, particle creation would be associated with an opening-up of space-time. So in the future**, when we combine both models together, we may get a more complete theory of our universe!**

6.3) What is a hypersphere? Under the cosmological principle, a simple model of the universe was developed. A positive (spatial) **three-dimensional curve surface** called **"hypersurface"** which is embedded in a (spatial) **four-dimensional "hypersphere"** was introduced to be **a model of the universe.** To grasp it intuitively it was suggested looking at an analogy of the two-dimensional curve surface of our ordinary three-dimensional sphere balloon as the model of the universe.

Anyway it is very difficult for anyone to visualize such an extra spatial dimension surface of the balloon as our universe, and then a question arises immediately: is it any other **simple view of the universe which we could understand it?** Indeed the answer is yes, because the concept of vacuum mechanics helps us as below.

After the big bang in which the universe was born, and while all the observable matter i.e. **gas cloud stars, dust and galaxies etc** were created from vacuum medium, they are flying apart from each other after originated from a single common point. From this point of view, **the universe will look like a simple ordinary expanding sphere ball of vacuum medium.** It is not just only the ball's surface of a spherical shell enclosed with empty vacuum space!

Actually, we can use Newton gravitation law to develop the **simple sphere ball universe** [12'], and indeed, the **Friemann model of the universe** (standard model of the universe) was derived by using Newton gravitation law in Newtonian cosmology [11'].

By the way, we will explain **why a simple expanding sphere ball turn to be a four-dimensional** (not include time) **hypersphere** (when it was involved GTR, which is just a relativistic gravitational)? To answer this question, we refer to Roberson–Walker metric equation which was derived from the concept of "four- dimensional hypersphere" below

$$ds^2 = dt^2 - R^2(t)[dr^2/\left(1-kr^2/R^2\right) - r^2 d\theta^2 + r^2 \sin^2\theta d\varphi^2)] \text{ ..... (20).}$$

(Where R is the radius of the hypersphere, k = 1, 0 or -1 according to three models; closed, flat and open respectively.) Then we will compare it to the metric equation of "Einstein static universe" model, **which was derived from the spherically symmetrical static form of conventional space-time geometry** as below

$$ds^2 = dt^2 - dr^2/\left(1 - r^2/R^2\right) - r^2 d\theta^2 + r^2 \sin^2\theta d\varphi^2) \ldots\ldots (21).$$

Here we can see that when the term $R^2(t)$ in equation (20) was ignored, then (20) **is the same pattern** as (21)! Indeed in the reverse, equation (21) can be changed to the form of three-dimensional spherical surface which embedded in the four-dimensional Euclidean space (as shown in the reference); that is the starting point of Roberson – Walker metric equation.

6.4) Curvature of the universe. According to the hypersurface model of the universe, it was divided to three types of space-time's curvature depend on the value of k in Roberson – Walker metric equation (20). First where k = 1, it represents **closed universe** or the universe with positive curvature (something look like the earth surface), second where k = 0, this will represent **flat universe** or the universe with zero curvature (something look like ordinary flat surface) and third where k = -1, it represents **open universe** or the universe with negative curvature (something look like saddle shape surface). Indeed, all these three types of the universe are very difficult to visualize **how they are look like**!

Based on the concept of sphere ball of vacuum medium universe, it is easy to understand all three types of space-time curvature. As mentioned early that vacuum medium is uniform everywhere across the whole universe. **This doesn't mean that it make the universe flat.** The reason is because vacuum medium is just act as the background fabric structure of space-time (i.e. the ambient mass mentioned in section 6.1) which will **handle the internal stress energy** (gravitational potential energy) within! So when we talking about the mass density of the universe**,** what we mean is the **total energy** which **equal to the ambient mass plus the observable mass** (i.e. all the existing masses we are familiar)!

According to the new concept, when the universe is close (where k = 1). It means that **the average mass density is higher near the center of the universe and lower in the area far away**. Next when the universe is flat (where k = 0), its means that **average mass density is uniform through out the whole universe**. Lastly when the universe is open (where k = -1), this means that **the average mass density is higher near the rim and lower when approaching the center.** So now we could see that it is easy to visualize whether the universe is curved or not by using the new concept; that is **the uniformity of mass density is the indicator of space curvature!**

Now we come to the most **popular question**; whether our universe is close or open? Does it will expand forever, or at a certain time it will collapse back to the beginning again? Up to now, cosmologists found that **the universe seems to expand to the cold dead end rather than contract back to the hot big crunch singularity!** This is because the observed existing mass density was found to be around $\rho_0 = 10^{-28} Kg./m^3$. This is far from the critical density of mass $\rho_c = 60 \times 10^{-28} Kg./m^3$ [10'''] which was needed to close the universe. (Note $\rho > \rho_c$ means closed universe, $\rho = \rho_c$ means flat universe and $\rho < \rho_c$ means open universe.)

Anyway, the calculated critical mass density above was made on the assumption of zero value of cosmological constant. **Here we will recalculate by including the cosmological constant** that was found in section 5.2 above by using formula (22) [8''] below

$$\rho_c = (3H^2 - c^2\Lambda)/8\pi G \ldots. (22).$$ (Where *H* is Hubble constant.)

After calculation what we got is the **new calculated** value of critical mass density (A) $\rho_c = 36.7\times10^{-28} Kg./m^3$. And from the end part of section 6.1 **we found that the mass density of vacuum medium** $\rho = 23.3\times10^{-28} Kg./m^3$, which is the unseen ambient mass of space-time. When it was included with the observable existing mass density $\rho_0 = 10^{-28} Kg./m^3$ plus its equal amount of gravitational potential energy within itself, then we will get a **new existing mass density** (B) $\rho_0 = 25.3\times10^{-28} Kg./m^3$.

Now we could see that, based on concept of vacuum medium, **the new total mass density (B) is close to the new critical density (A)**. So these would give us a new possibility that **our universe is no need to be only the open universe. It may be a flat universe or a closed universe** depending on the accuracy of the parameters involved.

And if the observable mass density is about 30% of the critical density ($\rho_c = 60\times10^{-28} Kg./m^3$) which was reported lately [10""], that is about $18\times10^{-28} Kg./m^3$. Then we will get a new bigger value of (B), that is $\rho_0 = 43.3\times10^{-28} Kg./m^3$. So finally we will get $\Omega = \rho_0/\rho_c = 43.3\times10^{-28}/36.7\times10^{-28} = 1.2$, which means that **our universe is closed!**

Anyway, according to the concept of vacuum medium that space-time was created from vacuum medium energy. And **if the universe is flat or open,** this would mean that it will expand forever. Then what will follow is **the created amount of mass (energy) would be infinite** which seem crazy**!** So in this sense, the only possible choice is that the closed universe**,** isn't it?

7) Solution to the crucial problems in GTR. Let's start with a famous physicist S. Chandrasekhar (1980) word (when he had talk about problems in GTR) as "The element of controversy and doubt, that have continued to shroud the general theory of relativity to this day, derived precisely from this fact, namely that in the formulation of his theory Einstein incorporates aesthetic criteria; and **every critic feels that he is entitled to his own differing aesthetic and philosophic criteria**. Let me simply say that I do not share these doubt; and I shall leave it at that" [13]. In this paper **the author doesn't dare to do something like that**, the only aim is to complete GTR. Then this will make GTR to consistence with QMT and **paving the way to the theory of everything** as mentioned in the original paper!

7.1) Problem with speed of gravity wave. Einstein had showed that the existence of gravitational wave radiation is a natural consequence of the GTR. By considering the case of weak field equation (space-time curvature is small), he got a linear wave equation (of gravity) which is transverse wave traveling with velocity of light resemble to electromagnetic wave.

But, why gravity wave traveling with speed of light, **it is just his guessed that it would be the same speed** [14]. For electromagnetic wave it is obvious that we could prove that it traveling with velocity of light by using Maxwell equations, while we could not do the same thing with gravity wave! This may be the reason that most of the text books about GTR tried to avoid talking about it.

According to GTR, we known that **space-time is just an empty space without any physical entity,** so it is very difficult and even impossible to explain how gravity wave could propagate **without something act as the medium.** (Indeed there is no exception for every kind of waves, and in CEMT we have shown that it is unreasonable for electromagnetic wave traveling without vacuum medium.) Some author such as I.R. KENYON [8'] who has an insight; he tried to explain gravity waves via stress-strain relation of space-time. He said that **"gravitational waves are quite simply the vibration of space-time itself"**. Unfortunately we could not easily to visualize how space-time (which is just an empty space) could act as the mechanism of wave!

Instead, if we accept the vacuum medium concept, then it is easy to understand that **gravity wave is just the vibration (mechanism) of vacuum medium** which is the same thing as electromagnetic wave. Of course we must not expect to get everything for gravity the same thing we do with electromagnetism. This is obvious because the source of gravity is different from one of electromagnetism; **that is normal masses could not create all phenomena as electrons do!**

Now let us explore some more detail for gravity wave by using the same concept as of electromagnetic wave;

$$F = G\frac{m_1 m_2}{r^2} \quad \text{..... (1)}, \qquad F = \frac{1}{4\pi\varepsilon_0}.\frac{q_1 q_2}{r^2} \quad \text{..... (13).}$$

By considering equation (1) for gravity and (13) for electrostatic, we would found that **both are the result of the same attraction force arisen in vacuum medium** between two pieces of mass. The only difference between them is that while the first one is a weaker force (normal gravity) due to the neutral masses, the second is stronger force (black hole force) due to charged masses. So **both of the two constants** *G* **and** $1/4\pi\varepsilon_0$ **are the same property, i.e. it is the modulus (of elasticity) of vacuum medium!**

Next, how could we find magnetic field for gravity which was called **gravitomagnetic field** [15] or **cogravitational field** [16]? We know that the flowing of electric current create magnetic field around the carrier wire, but how **could we find mass current to create gravitomagnetic field?** Actually we know that a single moving electron also create magnetic field. (Note that when an electron is moving, it will rotate and drag surrounding vacuum medium creating magnetic field as explained in VMTE.) Then **a rotating (moving or not) sphere of mass should also create gravitomagnetic field**!

And show below is the formula for cogravitational field K (mentioned above) which was generated from a rotating sphere of mass moving with constant speed [15'],

$$K = \frac{v \times g}{c^2} \quad \text{..... (14)}, \quad \text{where} \quad g = G\frac{m\left(1 - v^2/c^2\right)}{r_0^3\left[1 - \left(v^2/c^2\right)\sin^2\theta\right]^{3/2}}.\vec{r}_0 \quad \text{..... (15).}$$

While *K* in (14) corresponds to in *B* (16) and *g* in (15) corresponds to *E* in (17) for a point charge moving with constant speed as below

$$B = \frac{v \times E}{c^2} \quad \text{..... (16)}, \quad \text{where} \quad E = \frac{q\left(1 - v^2/c^2\right)}{4\pi\varepsilon_0 r_0^3\left[1 - \left(v^2/c^2\right)\sin^2\theta\right]^{3/2}}.\vec{r}_0 \quad \text{.....}$$

(17).

By comparing (15) and (17), **what we got is** that G correspond to $1/4\pi\varepsilon_0$ or $\mu_0 c^2/4\pi$.

(19)

Finally we will try to find mass density of vacuum medium energy as mentioned in section 5.2. Referenced to the formula (m) in the derivation of Maxwell equation of CEMT, this will rewrite as equation (18) below,

$$c = \sqrt{M/\rho} = 1/\sqrt{\mu_0\varepsilon_0} \text{ ..... (18).} \quad c^2 = k/4\rho = 4\pi G/\left(4\pi G/c^2\right) \text{ ..... (19).}$$

(Where c is the velocity of light, M (elasticity) = ¼k (twist modulus), ρ = mass density, μ_0 = permeability and ε_0 = permittivity of vacuum medium.)

Replacing M with $k/4$ and ε_0, μ_0 in term of G in (18) what we got is (19). Then comparing the second and third terms of (19) **we will get** $\rho = \pi G/c^2 = 23.3\times10^{-28} Kg./m^3$ which is **mass density of vacuum medium energy!** Also we could found from (19) that **the twist (shear) modulus of vacuum medium is** $k = 4\rho c^2 = 6.3\times10^{-10} N/m^2$ which is very low!

7.2) Dark energy and dark matter problem. Dark energy & matter seem to be today's most hot issue in cosmology**.** And nowadays, cosmologists still **do not know what it is**! Why it is so mysterious and what prevent them from finding it? Armed with vacuum mechanics (the mechanism of vacuum medium), we could solve these problem without difficulty here!

7.2.1) Dark energy problem. Let us start with modern cosmologists which found that nowadays our universe is expanding! But when they make some calculation by using the conventional (non-ether based) general relativity (without the cosmological constant), they found that **dark energy** is needed to give enough **mass density** to do the acceleration of the expanding of our universe.

To explain and solve the problems about the dark energy, first let's start with the Friedman-Lemaitre-Robertson-Walker Universe as explained by the equations;

$$\frac{\dot{s}^2 + kc^2}{s^2} - \frac{\lambda}{3} = \frac{8\pi}{3} G\rho \text{ ..... (4)} \qquad \frac{2\dot{s}^2}{s} + \frac{\dot{s}^2 + kc^2}{s^2} - \lambda = -\frac{8\pi}{c^2} Gp \text{ ..... (5)}$$

Where the **size of the expanding universe** measured by a relative cosmic scalar factor *s(t)*, λ is the cosmological constant which correspond to the **repulsive force** that counteracting the conventional attractive gravity as required by Einstein for **static universe**.

For static flat universe in which $k = 0, \ddot{s} = 0, \dot{s} = 0$, then equation (x) and (y) give $\lambda = 8\pi G\rho = -(8\pi/c^2)Gp$, and then $\rho = -p/c^2$ which mean that the **cosmological constant** has **a positive energy density with negative pressure**! And at present time, the term $\lambda/8\pi G$ is what was so-called as "**vacuum energy density**" [17] (while $\lambda \approx 4\times10^{-52} c^2.m^{-2}$), and its main part is the **dark energy** density. But, unfortunately we **do not know** what it is, and why it has such a strange property (negative pressure)!

Reference to the new concept of **vacuum medium universe** (section 6) in which all the **visible matters** (condensed vacuum medium) are immerged in the **sea of vacuum medium space** as show in the diagram fig 6. (Please be careful that what which was shown in the diagram is not true scale, it just showing how the overall view of the universe looks like for us who located at the center!)

Now we could see that actually **the dark energy is vacuum medium energy** which is the fabric structure of our universe and it is the main part of the total energy of our universe. And the vacuum medium energy has a **constant** mass density $\rho = 23.3\times10^{-28} Kg./m^3$ (calculated from the mechanical property of vacuum medium in section 7.1), which we have called it as "**ambient mass** (energy) **density**". Indeed, the value of this ambient mass density is the same order as the **critical density** of the **vacuum energy** mentioned above (i.e. $\rho_c \approx 60\times10^{-28} Kg./m^3$)!

To see the reason of the "**negative pressure**" of the dark energy is easy, it is because vacuum medium energy has the **internal gravity** (contraction force) as its intrinsic property (see detail in VMTE)! If we interpret that the existing of vacuum medium (space) as positive energy and its internal gravitational force as negative energy, then the total energy is zero, i.e. **the principle of conservation of energy of the universe is preserved!**

Now we can show mathematically how the **negative pressure** works via its **internal gravity** in **vacuum medium universe** while preserving the **principle of conservation of energy** as follow.

For the **adiabatic expansion process** in the early state of the universe, its volume ***V*** and the energy ***E*** change according to the thermodynamics law as in $dE = -pdV$ ……(6), [where ***p*** = pressure]. And by the definition of vacuum medium density is **constant**, so we can write as

$$p = -dE/dV = -d\rho V/dV ...(7), or\ \rho dV = -pdV ....(8), or\ \rho = -p ...(9).$$

From (9), we can see that **vacuum medium density has internal gravity (negative pressure) = -*p***. Also from (8), we can see that when the universe's size is zero, both and ***p*** is zero. But when the universe's size is increasing, its energy is increasing while at the same time it always equals its negative pressure (energy). Then the **total energy of the universe is zero** and the **principle of conservation of energy is preserved**!

Finally, someone who familiar with the "**inflation**" concept in the **early universe** would found that **scalar field** concept was just an ad hoc solution; it is a hypothetical matter without any of its own property! Also it is facing with the severe problem of "**infinite hot dense amount of energy"** (at the beginning of the **big bang**) which **contradicts** to the **conservation of energy**!

But again, **armed** with **vacuum medium energy** which acts as the **scalar field energy**, it gives us a more physical meaningful and also the **new inflation** process in the beginning of the universe is **not violate** the principle of conservation of energy i.e. there is no need the **infinite hot dense amount of energy** for creating inflation of the big bang! Indeed, **vacuum medium** with its **internal gravity** will act as the inflation in **de Sitter universe**. But unlike the conventional de Sitter universe which is empty universe, vacuum medium universe is a physical one with **positive** vacuum medium energy together with its **negative** pressure within!

7.2.2) Dark matter problem. Up to now we have found that actually the dark energy is the same thing as vacuum medium, but what about dark matter, is it also the same thing as the vacuum medium?

First let us look more detail about **dark matter** in which cosmologists found that all galaxies have an abnormal rotation, i.e. their orbital rotational velocities do not obey **Newton law of gravity** (the velocity should **decease** while the distance from the center increases). Instead, the galaxies orbital rotational velocity is **uniform** for any distance from their center. So it seems as if there is something like **a halo of dark matter** of the galaxy!

Also there is missing mass for forming of galaxies into cluster of galaxies. And it was calculated that **the missing mass is 10 – 100 times the total amount of visible matter in the galaxies** [18]**.** This missing mass was thought to be the invisible dark matter, but no one knows what it is.

By the way, some cosmologists have try to explain the galaxies rotation problem by invent "**modified Newtonian dynamics** (MOND)" theory, but it is not so successful! Here, we will see how the aether based Einstein general theory of relativity could **lead to solve** the dark energy problem.

Armed with the concept of vacuum medium, we will see that actually **the missing mass** is also the same thing as **vacuum medium energy!** But the problem is that we just said that for the scale of galaxy's size, the vacuum medium (as dark energy) has a **negligible** effect on it, then how could the medium could has a **significant** effect on galaxy as the dark matter? The answer is because **galaxy's rotation** causes a drag of the surrounding vacuum medium!

As we have mentioned early that vacuum medium have a **peculiar mechanical property**; while it is uniform, transparent and continuous medium, with very thin in mass density. But in other side, it has **very large elastic coefficient** and sensitive to shear force (rotational force) while not to compressive or longitudinal force!

According to the stress action in any very large elastic coefficient medium, it means that large **stress energy** was created in the medium. Then **galaxy's rotation** creates a huge **stress energy** which is then makes the galaxy's **abnormal orbital rotational velocity** as if there is a large halo of matter around the Milky Way galaxy as shown in the diagram fig.6. So we can conclude that the large **stress energy** vacuum medium is acting as what which we called it as the **dark matter**, can't we?

7.3) Mysterious magnetic field in galaxies. Magnetic field with strengths of $1-10\mu G$ is widespread in the cosmos – in galaxies extended radio sources and in cluster of galaxies [12"]. And according to **the reference;** "most of the cosmological models have been **devoted to explain the amplification of an initial seed field by dynamo action in spiral galaxies.** Also our understanding of magnetic field in spiral galaxies is very limited".

"An observation which we believed is highly significant is that for many nearby spiral galaxies the measured interstellar magnetic fields falls off much more slowly with radius than the matter density, i.e. in the outer parts of such galaxies the magnetic stress become comparable to gravity. Not only is this hard to understand in theoretical modeling, but it is taking place at distances where the rotation curve is flat and the flatness is usually interpreted as **evidence for the presence of a halo of dark matter**".

The above paragraph has explained **the magnetic field pattern** that occurred in **the rotation spiral galaxies,** but we still could not understand **why it is something like that**. Armed with the concept of vacuum mechanics, it is easy to see that this is the appearance of the rotational stress of vacuum medium around the rotation of spiral galaxies! The reason is as mentioned in the above section that a big rotating mass will drags the surrounding vacuum medium with it. And what followed is **the rotational stress occurred in vacuum medium around is the manifest of the created magnetic field!**

7.4) Gravitation time delay. We know that in STR there is no explanation why a moving observer has a time dilation. And in the first section we have explained that **actually the conventional time dilation is just the slowing of the measuring clock** (due to the slowing of the moving clock mechanism). For GTR there is also no explanation why an observer in a stronger gravitational field has a time dilation (compare to observer in a weaker gravitational field or no gravitational field). **Based on the concept of internal stress in vacuum medium** (as explained in section 4.2), it is easy to explain why time dilation occur!

A measuring clock will run slower in stronger gravitational field (internal stress energy in vacuum medium) than the weaker one. This is because the stronger resistance of gravitational field energy, the more slows down the mechanism of the clock (compare to one in weaker gravitational field or no gravitational field). **This is a rational and understandable explanation of what was called "time dilation"!**

8) Conclusion & discussion. Up to now we have seen how GTR was improved by adding it with rational philosophical idea (which tell how the theory work); **the mechanism for relativistic mechanics** i.e. **the mechanism of vacuum medium** (or vacuum mechanics)! Indeed it is the same mechanism used in improving STR and extends to cover GTR. Here are their additional important points;

a) The crucial idea which **vacuum mechanics** give to GTR, are the mechanism of gravity, physical space-time, physical meaning of curve space curvature and how gravity wave propagates etc. All these things **could not be understood in the conventional GTR**, armed with the new concept, it is easy to visualize and explainable!

b) Comparing with STR, we would see that the topic in GTR is much wider and more complicate, and we could not go into more detail in this paper. For example, the topic such as conventional black hole topic was not mentioned here. Indeed the author fell that it is **unconvincing for the huge massive star to collapse into a singularity of mystic black hole** in which we could not imagine **how it is something like that!** (Note that even Einstein himself did not believe in the black hole [20].)

c) It is interesting to note that recently, it was reported by Stanford and NASA researchers that the "Gravity Probe B" experiment test has confirmed the prediction of "**frame-dragging**" of space-time (which is the effect that a spinning object pulls space and time with it as it rotates) according to GTR.

Anyway, this positive result of "frame-dragging" got from GTR is **contradicted** to the negative result of **Michelson-Morley** experiment which was used to verify the "aether dragging" in STR. Now, what is wrong and how could we solve the paradox? Armed with our aether based relativity, it is not difficult to see that the conventional interpretation of M-M is wrong, isn't it?

d) By the way, we know that there is one big problem for combining GTR with quantum mechanics in order to get successful **quantum gravity.** So our modified theory - Completed Einstein general theory of relativity (CGTR) would provide a new way to the desired theory!

e) Lastly, we could see that what was written in this paper is not fully mathematical rigor. Anyway, it is not a toy theory; what we have done **is just enough** to give **the new idea** to the readers with some **confidences.** So what was left here should be the work of professionals who are involved in the matter to complete it for **the virtue of academic merit and the progress of our world's knowledge!**

9) References.

(**Precaution;** Several GTR text books with different authors were used as the reference and each author used different pattern and different notation for the same formula. Here in this paper, the author has made some change of the original pattern and notation for the readers convenient, so please be careful!)

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