(1)

On a general theory of gravity based on Quantum Interactions.

Mustafa A. Khan, M.D.

I) Introduction:

Sir Isaac Newton was the first scientist to propose a formal theory for gravitation. It is given by the famous formula, written in spherical coordinate system, for a mass 'M' at a distance 'r', from the center of the mass 'M', as $F(M,r) = G\ M/r^2$. However, he was was always plagued by the idea of " action at a distance" as he had no explanation as to how the mass 'M' causes an effect at distance 'r' instantaneously.

After him came others who developed the idea of a gravitational field that surrounds a body of mass 'M'. This helped in removing the " action at a distance" conundrum, but introduced several others. The first one being how does the mass produces this field in the first place? The second one being why does the mass produces this field? The third one being, if we were to suddenly make 'M' = 0, then how does the gravitational field, that supposedly extends to infinite distance, vanish in an instant? What process is there that transfers the information from the center to infinity instantaneously, making the field also disappear at the same instant when 'M' = 0. There are other such philosophical reasons that bothered the scientists with regards to the real existence of a gravitational field.

The latest attempt for a theory of gravitation was proposed by Einstein in 1915. He threw away the old idea of a gravitational field and introduced a new idea which consisted of a warping of the space-time continuum (STC) about a mass 'M' and due to the mass 'M'. He went on to develop a new set of field equations that were based on the curvature (called the metric) of the STC and used Tensors instead of Vectors which were used to describe the older field idea. This theory, The General Theory of Relativity (GTR), proved quite successful in describing the large scale structure of the universe and predicted several events which came out to be true. One such was the curving of a beam of light while passing a large object. The other was on the precession of planet Mercury's orbit which was exactly as predicted. The third one was the prediction about existence of black holes which has also been confirmed. Also, the GTR was similar to the Newtonian theory of gravity for weak gravitational fields as required by Bohr's Correspondence Principle (CP). But, unfortunately, even the GTR is not free from problems. One of the biggest problem is that it is totally silent about how the mass 'M' interacts with the STC to cause the warping of the STC about it. The warping of the STC occurs right from the edge of the mass and theoretically extends to infinity. The problem as to how this distortion takes place from the point where the mass exists to infinity is very similar to a similar problem we encountered with the old gravitational field idea. Again, as with the old field idea, there are other philosophical issues that also plague GTR, such as matter "acting" on nothingness and causing a distortion of this nothingness.

There is one unique problem that faces GTR, unlike the older field idea, and this deals with it's relation with Quantum Physics (QP). QP has been extremely successful in describing events and also in it's predictions about events at the microscopic scale. It is likely to be the physics that will one day supplant all other theories, including GTR, and be the paradigm for the " Theory of Everything". The problem is this – GTR is very successful on macroscopic/cosmic scale, while QP is very successful at microscopic/atomic/sub-atomic scale. The GTR idea of a STC, determinism and distortion of the STC has no correlate in QP. This is very problematic. These deep philosophical rifts between GTR and QP has been unbridgeable so far, that I am aware of, and also seem to be unbridgeable in the near future. The scientists are of the opinion that the GTR will either need to be re-formulated or abandoned altogether for a different theory of gravity that is compatible with QP. This is so, because, the QP seems to be a more correct theory that describes reality than the GTR. Therefore a theory of gravity that makes QP it's bedrock and still is able to describe the macroscopic/cosmic events/phenomenon (as well as the GTR) will be a welcome theory/idea. In this article I like to propose such a theory of gravity.

II) A new definition for object which is compatible with QP:

For the purposes of discussion we will take an object that is spherical with mass 'M'. Also, unless otherwise noted, we will use the spherical coordinate system centered at 'M'.

In QP, the concept of an object is very vague. It can be taken as a particle or a wave of infinite length depending upon the type of experiment or observation one is making. This concept was proposed by De Broglie and has been proven experimentally. However, for macroscopic objects the mass is considered to be compact and has a definite position and speed. This is due to the extremely short wavelength for macroscopic objects as given by the De Broglie equation $\lambda(m,v) \cong h/mv$

Here I like to introduce a concept for a mass 'M' of any size (microscopic/macroscopic) which is different than that of De Broglie's but not incompatible with QP. Any mass 'M' is never localized to a particular point/region of space but is smeared throughout the universe. However, this smearing of the mass follows a strict rule for the amount of mass per unit volume, $\rho_m(r)$, i.e density, depending upon the distance from the center of the mass 'M'. Superficially it appears to be similar to De Broglie's concept of an object, but fundamentally it is quite different from it. The exact equation for $\rho_m(r)$ is given by $\rho_M(r) = \lambda K M (1 - e^{-\alpha K/r^2})$, where,

1) M = Total mass of the object.
2) $K = (1 - e^{-\beta M})$ and $0 \leq K < 1$
3) α, β, λ are universal constants with appropriate units.

This equation can be graphed as follow:

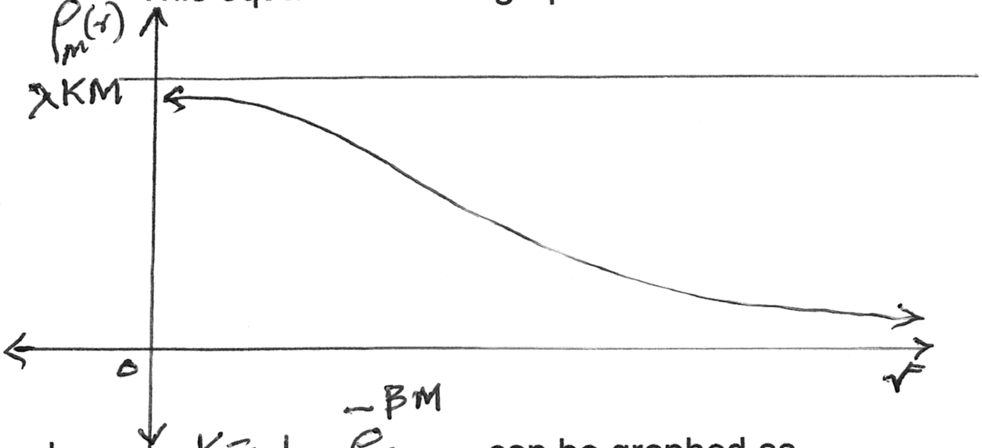


Figure # 1

and $K = 1 - e^{-\beta M}$ can be graphed as,

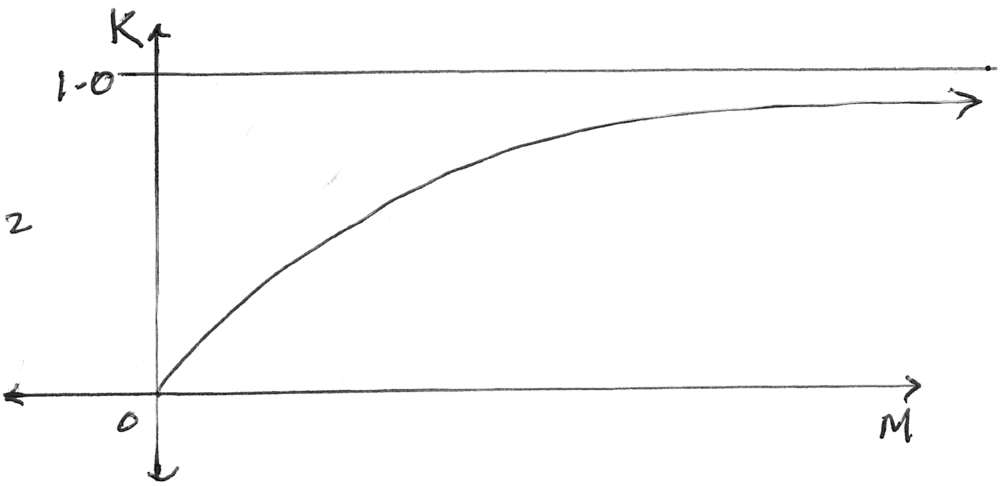


Figure # 2

The question of why the $\rho_m(r)$ has to have this particular distribution will be explained later. Suffice it to say for now that it is due to the quantum interactions between $\rho_m(r_1)$ and $\rho_m(r_2)$.

III) Characteristics of $\rho_m(r)$:

Considering the equation for $\rho_m(r)$ and the figure # 1, we can conclude the following properties for $\rho_m(r)$.

1) $\lim_{r \to 0} \rho_m(r) \to \lambda M(1 - e^{-M\beta}) = \lambda K M$

2) $\lim_{r \to \infty} \rho_m(r) \to 0$

3) For uniform spherical objects, $\rho_m(r) \neq \rho_m(r, \theta)$, i.e the density of matter is the same in all directions for any given 'r'.

4) For 'M', where $K \simeq 1$ we have $\rho_m(r) \simeq \lambda M(1 - e^{-\alpha/r^2})$.

From this we have $\lim_{r \to 0} \rho_m(r) = \lim_{r \to 0} \lambda M(1 - e^{-\alpha/r^2}) = M\lambda$. This means that for large objects where $K \simeq 1$ it can be assumed that the density of matter infinitesimally close to the center is proportional to the total mass of the object. This is similar to the Newtonian concept of the "center of mass". Newton took this to be intuitively true, but here we can prove that his intuition was not wrong. However, it should be borne in mind that this approximation applies only for specifically defined large objects and certainly not for the objects dealt with in QP. Also, just as it is true for the Newtonian center of mass that the entire mass is not actually concentrated at it, so also, here we find that only 'λM' of the total 'M' is actually concentrated infinitesimally close to 'r' = 0.

5) The "gravitational force" at distance 'r' is proportional to $\rho_m(r)$ and for well defined large objects, it is proportional to 'M' and inversely proportional to 'r^2'. This is simply the Newton's law of gravity, and what CP demands for new theory to be considered an improvement over an older theory. Let us consider a large 'M', such that we have $K \simeq 1$, then $\rho_m(r) \simeq \lambda M(1 - e^{-\alpha/r^2})$. Taking $(1 - e^{-\alpha/r^2})$ and assuming 'r' $\geq$ 'R', where 'R' is the "radius" of the large 'M' and $|R^2| \gg |\alpha|$, we have as a 1st approximation, $(1 - e^{-\alpha/r^2}) \simeq \alpha/r^2$. This

means for large 'M' with "radius" 'R' and $|R^2| >> |\alpha|$ we have $\rho_m(r) \simeq \alpha\lambda M/r^2$. Since we assumed $F(M,r) \propto \rho_m(r)$, this implies $F(M,r) \propto \alpha\lambda M/r^2$ or $F(M,r) \propto M/r^2$. This is Newton's law for gravitation and is in agreement with CP. But it should be kept in mind, once again, that we have assumed 'M' to have specific characteristics and therefore we cannot say that the Newton's law for gravitation is applicable for all masses, especially those that are dealt with in QP. From above, we can also conclude that '$G = \epsilon\alpha\lambda$', where '$\epsilon$' is the proportionality constant whose value is given by $|\epsilon| = |G/\alpha\lambda|$ and where 'G' is the universal gravitational constant.

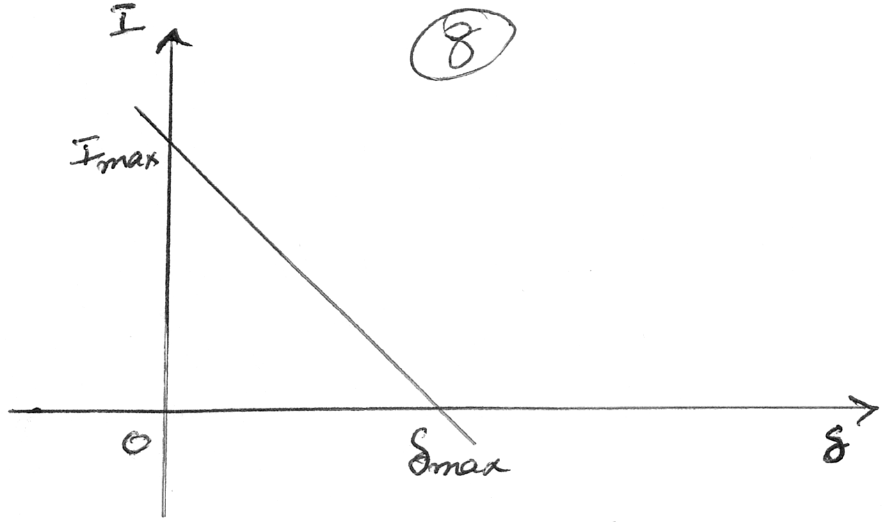
IV) On the quantum interaction that underpins the equation :

This entire theory with the mass being smeared throughout the universe has a specific quantum interaction between $\rho_m(r_1)$ and $\rho_m(r_2)$ that gives rise to the density of matter distribution equation $\rho_m(r) = \lambda K M(1 - e^{-\alpha K/r^2})$.

This quantum interaction I like to symbolize by 'I_t'. It has the following form and graph.

$$I_t(\delta) = I_{max}\left(1 - \frac{\delta}{\delta_{max}}\right), \text{ where}$$

δ = distance between $\rho_m(r_1)$ and $\rho_m(r_2)$



Like distances in QP, the δ_{max} is also a very short distance when compared to distances at macroscopic level and essentially zero when compared to distances at cosmic level. I also like to point out at this time that the equation $I_t(\delta) = I_{max}\left(1 - \frac{\delta}{\delta_{max}}\right)$ is a 1° approximation of a more general QI equation. But for our purposes here we will use the 1° approximation equation only.

When matter, i.e $\rho_m(r)$, is coming together for the first time, then around 'r' = 0 there will be a lot of $\rho_m(r)$ at distances $\delta < \delta_{max}$. As the matter accretes around 'r' = 0 and the spherical mass takes shape, there will be less and less $\rho_m(r)$ after a distance 'R', which can be taken to be the "radius" of the object. After this point the distance δ between $\rho_m(r_1)$ and $\rho_m(r_2)$ approaches δ_{max} and when $\delta = \delta_{max}$, the $I_t(\delta_{max}) = 0$. The final shape of the object will consist of a central, large (at non-quantum level) collection of matter followed by a gradual, smooth drop in the matter density, $\rho_m(r)$. Though theoretically the smearing can go on for infinity, in reality, it cannot because there is only a finite amount of matter to form an object. This is the reason that the "gravitational force", though can theoretically extend to infinity, in reality becomes negligible/non-existent after a certain r_{max}. To obtain the density distribution equation, $\rho_m(r) = \lambda K M (1 - e^{-\alpha K/r^2})$

, we will need to know the exact function represented by I_{max} . One interesting question that arises here is what exactly is present at 'r' = 0 that starts the process of the accretion of matter as described above, since the density of matter distribution equation never actually can have 'r' = 0? I propose that it is most likely "dark matter". If so, then this leads to two obvious conclusions. The first is that at the very center of any material object is "dark matter" without which there cannot exist any material objects irrespective of the size of the object. The second is that the matter density distribution equation automatically predicts the necessary existence of "dark matter".

V) Conclusions:

At this point we can come to certain conclusions based upon the theory here proposed:

1) We see that, at least regarding gravity, QP provides the final explanation at all levels, from the sub-atomic to the cosmic.

2) There is no " action at a distance " which plagued Newton and his theory of gravity.

3) There is no need for any warping of the STC due to matter as required by Einstein's General Theory of Relativity.

4) As a corollary to # 3, the mysterious reason by which matter causes distortion of STC is eliminated.

5) There is no such entity as a " gravitational field ".

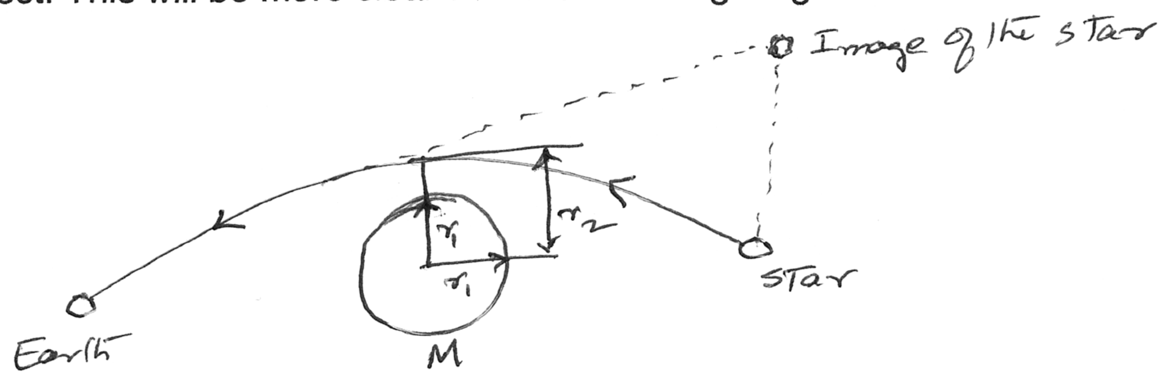
6) Gravitational " force " is reduced to quantum mechanical

interactions, 'I_t', at all levels, from the sub-atomic to the cosmic.

7) This is no such thing as a " gravitational interaction ", in reality, between two masses, m_1 and m_2. What we have is QI between $\rho_{m_1}(r_1)$ and $\rho_{m_2}(r_2)$.

8) The gravitational acceleration '$\vec{g}$' is most likely a representation of and a convenient concept to make calculations easy at macroscopic level between bodies.

9) The bending of light by a mass 'M' is not due to the bending of the surrounding STC by 'M', but due to the, (1) the quantum scattering effect on the light beam and (2) the gradient of $\rho_m(r)$ that is present around an object. This will be more clear with the following diagram:



The bending of the light beam from the star is due to the combination of (1) the quantum scattering effect on the light beam in the region $(r_2 - r_1)$ and (2) the gradient of $\rho_m(r)$ in the region $(r_2 - r_1)$ with $\rho_m(r_1) > \rho_m(r_2)$

10) For a singularity to exist, the Limit of $\rho_m(r)$ as 'r' approaches zero must be equal to infinity. However, from the matter density distribution equation we have the Limit of $\rho_m(r)$ as 'r' approaches zero being equal

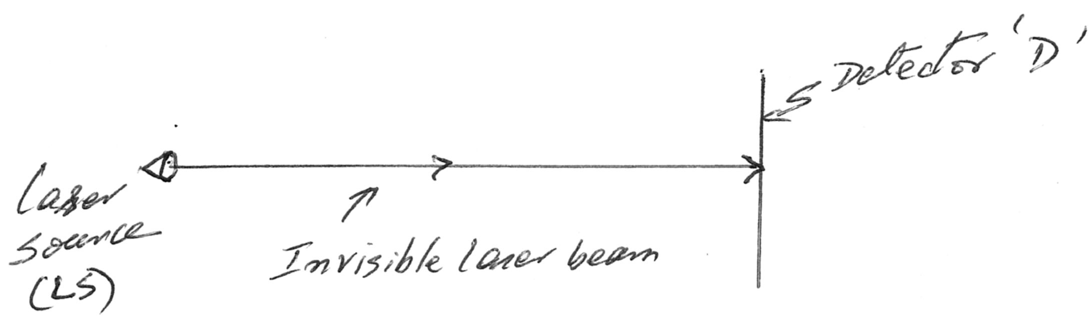
to $\lambda m (1 - e^{-m\beta})$, which is not equal to infinity unless 'M' is equal to infinity. Of course, there is no object in the universe with 'M' equal to infinity, and hence singularities cannot exist.

11) Theoretically, there cannot be any absolute empty space(s) within the universe. This is prevented by our equation $\rho_m(r) = \lambda K m (1 - e^{-\alpha K/r^2})$.

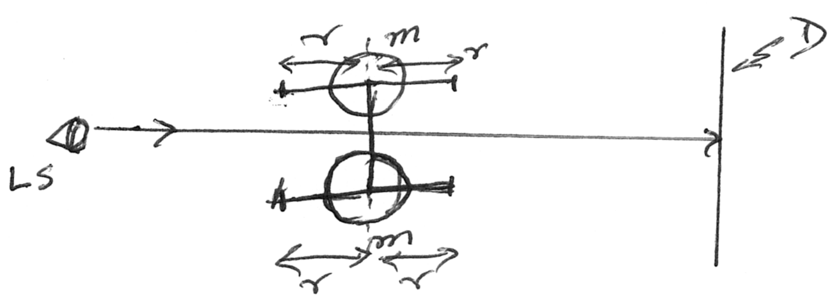
VI) Experiment to prove/disprove the theory:

In order for a theory to be taken seriously, one should be able to disprove it. Here I describe a simple experiment which can be done using modern technology.

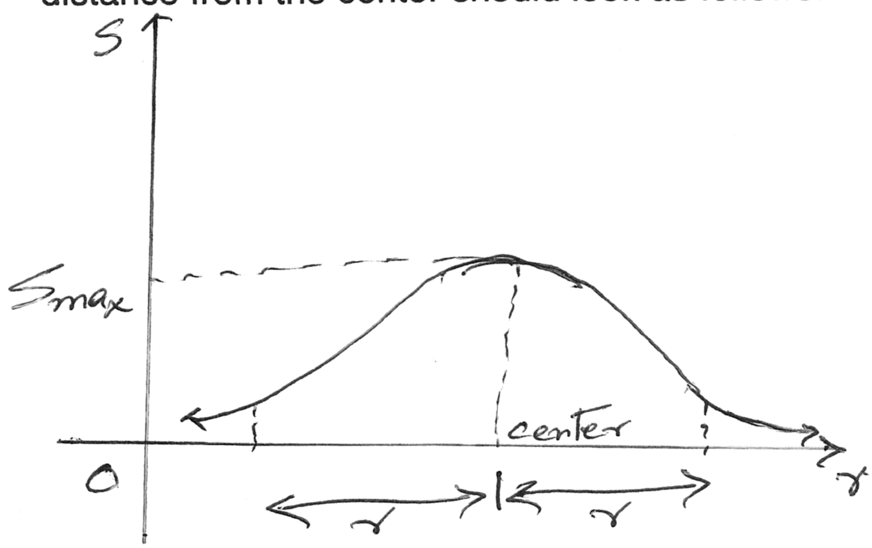
Let us take an invisible laser beam and set it up as follow:



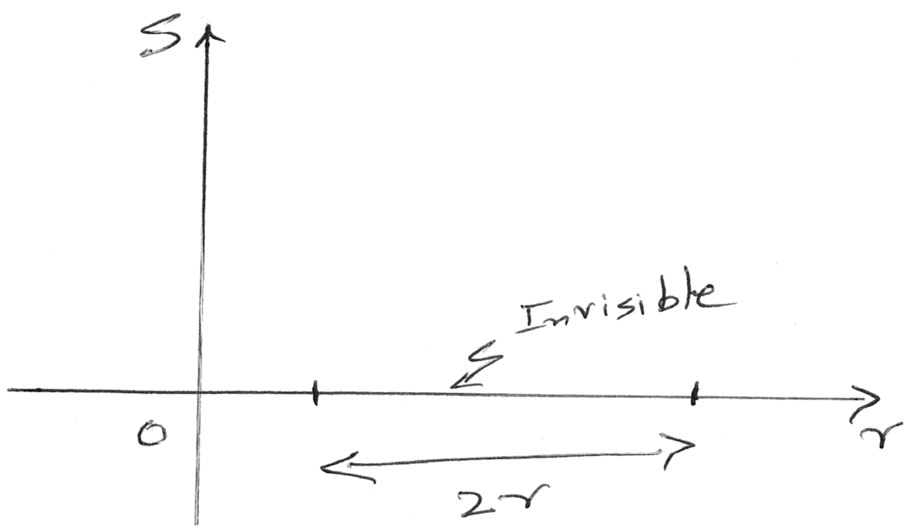
Now we bring two small masses, each of mass 'm', close to the laser beam but perpendicular to it and from the opposite directions as follows:



If our theory is correct, then we should see scattering 'S' of the laser beam within the region '2r'. Also, the intensity of the scattering will be greatest in the middle and falls off in either directions due to the gradient of the of each mass. If our theory is correct, then, the intensity of scattering v/s distance from the center should look as follows:



If on the other hand we get the following graph,



then the theory proposed here is likely to be incorrect. Of course, the laser beam will remain invisible as there will be no scattering effect on it.

Addendum:

1) $I_t(\delta) = I_A(\delta) + I_R(\delta)$

, where $I_A(\delta)$ and $I_R(\delta)$ are the attracting and repelling QI at distance 'δ', respectively.

2) If we assume $I_t(\delta)$ is given by $I_t(\delta) = I_{max} e^{-\delta/\delta_{max}}$, then as 1° approximation for $\delta < \delta_{max}$ we get $I_t(\delta) \simeq I_{max}(1 - \delta/\delta_{max})$

3) The total QI, $I_T(r)$, on $\rho_m(r)$ is given by $I_T(r) = \oint_v I_t(\delta)\, d\delta^3$, where 'v' = a solid sphere of radius δ_{max}.