THE DIMENSIONLESS QUANTUM FIELD

BY

David J. M. Short

MAY 2017

A quotation frequently attributed to Albert Einstein was in regard to his supposed definition of insanity. His view was that “A person could be deemed insane if that person kept on doing the same thing a expected to obtain a different result each time”.

It could be said that a similar situation pertains to those who seek to understand the quantum world. That is to say that if one continually searches for and fails to find an explanation to a problem then one is either looking in the wrong place or alternatively a solution does not in fact exist. Virtually every scientist and philosopher of any note has attempted to define the quantum world in terms which are comprehensible to those of us who live in the classical world – that is to say everyone except possibly those who live in the world of mysticism and/or pseudo-science. Some of the theories proposed and results interpreted do themselves seem at best to border on the unprovable and at worst, totally fanciful These categories seem to stretch from say string theory through to many worlds theory and anything in between and more. The principle reason behind the failure to interpret quantum theory in terms of classical theory is simply that the classical world does not exist at the quantum level. Similarly the quantum world does not exist at the classical level. This may seem at first glance to be a rather obvious statement and to contain nothing new. But the statement merits a much closer examination. Take for example, the many attempts to quantise gravitation all of which have so far resulted in failure and which, I predict, will always continue to fail, The reason for this is simply that gravitation does not lend itself to quantization. That is to say that gravitation does not consist of physical quantities which are themselves quantised because gravitational forces have no effect at the quantum level.

In some of my previous work for example “The Meta-physics of Human Consciousness” etc., I have proposed that there may exist a meta-physical dimension to the universe which consists of an all-pervading field of consciousness which I describe as a “Universal Secular Consciousness” or USC. In that work I indicated that this dimension, because of its very nature, lay beyond mathematical description. On reflection this view may have been premature and the following is an attempt to describe the USC in a more precise manner.

One of the axioms of the USC field is as previously stated, a two state description of the USC field. That is to say it is a field which manifests itself simultaneously as both a point in space and an all pervading field. This is not the same as the usual description of a wave/particle quantum state, that is to say a state which can manifest itself as either a particle or a wave. The difference between the USC field and the quantum state is that the USC dimension is both point space or particle and a wave simultaneously and it is this unusual simultaneous dual/singular state which made it seem difficult to express in mathematical terms.

Further consideration of this matter shows that in fact, this state of simultaneity can be expressed at both the quantum level and the classical level.

Consider the state of consciousness or awareness. Awareness manifests itself in the classical world at the point of the interface between the quantum world and the classical world in the sense that sentient beings and by definition their senses, only come into being in normal biological and chemical processes following the so called “collapse of the wave function”. In many ways the quantum world and the USC world are very similar in their mathematical description.

The structure of the quantum world is usually described as existing within a very small volume of space (this is not to be confused with quantum events, the effect of which can be manifest in the classical world.

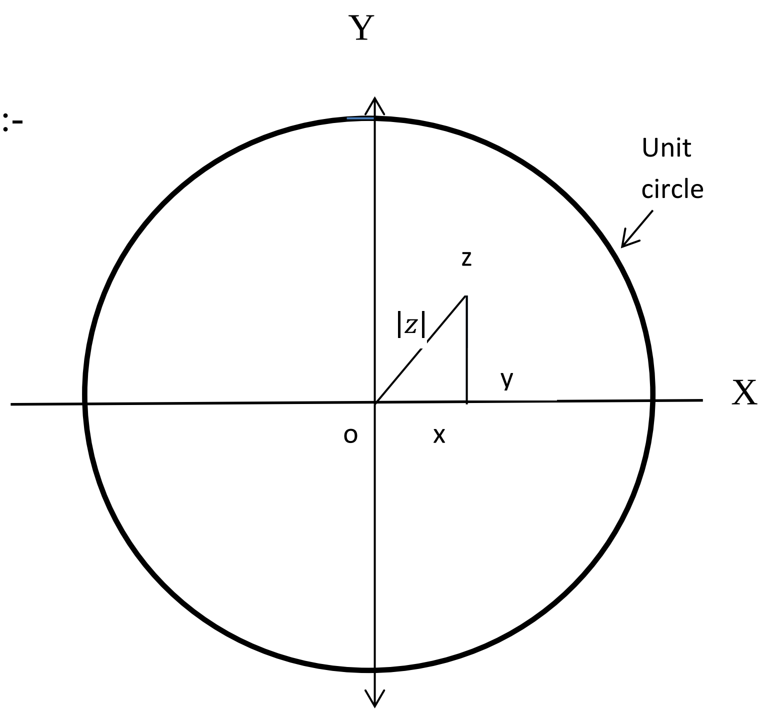
The quantum world exists within a range of $\approx 10^{-35}\ m.$ i.e. the Planck length and we note that the gravitational force between the electron and proton in a hydrogen atom is some $\frac{1}{2.85x10^{40}}$ smaller than the electrical force between those two particles i.e. it is negligible or non-existent. Thus these are some of the boundary conditions within which to describe the quantum world.

Both particle and field exist together in a superposition of states. This superposition exists within these boundary conditions. The boundary condition is therefore a distance or a length best described by the outcome of the familiar "two slit" experiment . This experiment demonstrates that in order to make the transformation from the quantum to the classical level one must take the squared modulus of the quantum complex amplitude of the quantum wave to get the classical probability of the classical world.

If a quantum wave passes from a source '*s*' through both slits of the two slit experiment to arrive at a point z the total amplitude of the wave function is :-

$$A(s,z) = A(s,t)\ x\ A(t,z) + A(s,b)\ x\ A(b,z)$$

Consider the diagram Fig. 1:-



(See Penrose 1989)

Here O represents the origin of the particle and Z represents the point of observation of the wave function. The particle having been detected at point Z has passed from the quantum state to the classical state of observation because the wave function has passed from an amplitude at the quantum level to a probability at the classical level. In order to express this change of state we take the squared modulus of the complex amplitude to obtain the classical probability.

The hypotenuse of O X Z is expressed as :-

$z = x + iy$

where x and y are real and the modulus of the complex amplitude is expressed as:-

$|z|^2 = x^2 + y^2$

If the total amplitude to include both slits of the apparatus is normalised to 1 i.e:-

$Tot = |w|^2 + |z|^2 = 1$

then for a particle to become manifest in the classical world the squared moduli must be greater than 1. If the amplitudes are not normalised i.e. they are less than 1 then the respective amplitudes for A and B are :-

$w/\sqrt{(|w|^2 + |z|^2)}$ and $z/\sqrt{(|w|^2 + |z|^2)}$

For a quantum event to become manifest in the classical world a correction term is added and we get:-

$|w + z|^2 = w^2 + z^2 + 2|w||z|cos\theta.$ Equ.1

The forgoing is a somewhat circuitous route to establishing that the normalised amplitudes in fact represent the radius of a circle. Thus we can say that any events which may occur within a quantum sphere are not manifest in the classical world. Moreover since the radius of the sphere sums to unity, any radius less than unity cannot be expressed as a distance. Thus both distance and space and therefore time do not exist at the quantum level. If this is indeed the case we can imagine that the quantum space or point resembles Hilbert space in which a single point in space can represent the quantum space of an entire system and can thus hold all the potential probability outcomes in that space.

The squared modulus procedure provides the boundary condition or radius of a sphere in which quantum events dominate classical events and it now remains for us to examine the physical system prevailing within the Hilbert space.

The quantum potential V within the Hilbert sphere at a distance from the centre of the sphere can be expressed as the potential due to a point particle using Gauss's law i.e:-

$$V = \frac{\emptyset}{\varepsilon_0}$$

Here $\emptyset$ is the flux density of the quantum field and ε_0 is the permittivity of free space.

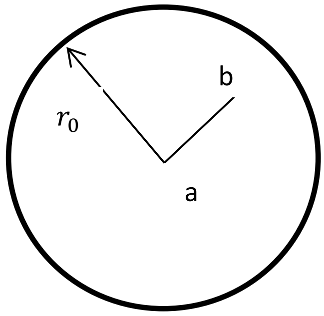
$$v_b - v_a = -\frac{\emptyset}{\varepsilon_0}\int_{r_a}^{r_b} r \;\; dr$$

$$= \frac{\theta}{\epsilon_0} \qquad \text{Equ. 2}$$

To find the quantum potential $V(r)$ at all points outside the Hilbert sphere let point a correspond to a distant point $(r_a = \infty, V_a = V\infty = 0)$ and point b correspond to the point where the potential is evaluated $\left(r_b = r, V_b = V(r)\right)$ Thus:-

$$V(r) = \frac{\emptyset}{4\pi\varepsilon_0 r}$$

Consider Fig. 2 below:-



The potential difference between two points a and b within the sphere can be expressed as follows:-

$$v_a - v_b = -\frac{\emptyset}{4\pi\varepsilon_0 r_0^3}\int_{r_a}^{r_b} r \; dr$$

$$= -\frac{\emptyset}{4\pi e_0 r_0^3}\left[\frac{1}{2}r^2\right]_{r_a}^{r_b}$$

$$= \frac{\emptyset}{8\pi\varepsilon_0 r_0^3}\;(r_a^2 - r_b^2)$$

The potential outside the Hilbert space is the same as that for a point particle at the centre of the sphere because outside the Hilbert space distance, space and time are now all manifest. Again using Gauss's law the quantum field outside the Hilbert sphere can be calculated . Let the expression for the flux for the surface of the Hilbert sphere be:-

$\Xi = B(4\pi r^2)$ where *B*= the quantum field and Ξ = the surface flux.

Let ρ = the volume flux density so:-

$$\rho = \frac{\emptyset}{4\pi r_0^3/3}$$

where $\emptyset$ is the total flux density on the sphere of volume $4\pi r_0^3/3$.

The amount of the quantum field inside a sphere of radius *r* is the product of the flux density and the volume of the sphere i.e;-

$$\Sigma\emptyset = \rho\frac{4\pi r^3}{3}$$

$$= \frac{\emptyset}{4\pi r_0^3 3}\,\frac{4\pi r^3}{3}$$

$$= \emptyset\frac{r^3}{r_0^3}$$

Gauss's law $\Xi = \Sigma\emptyset/\varepsilon_0$ for this case is:-

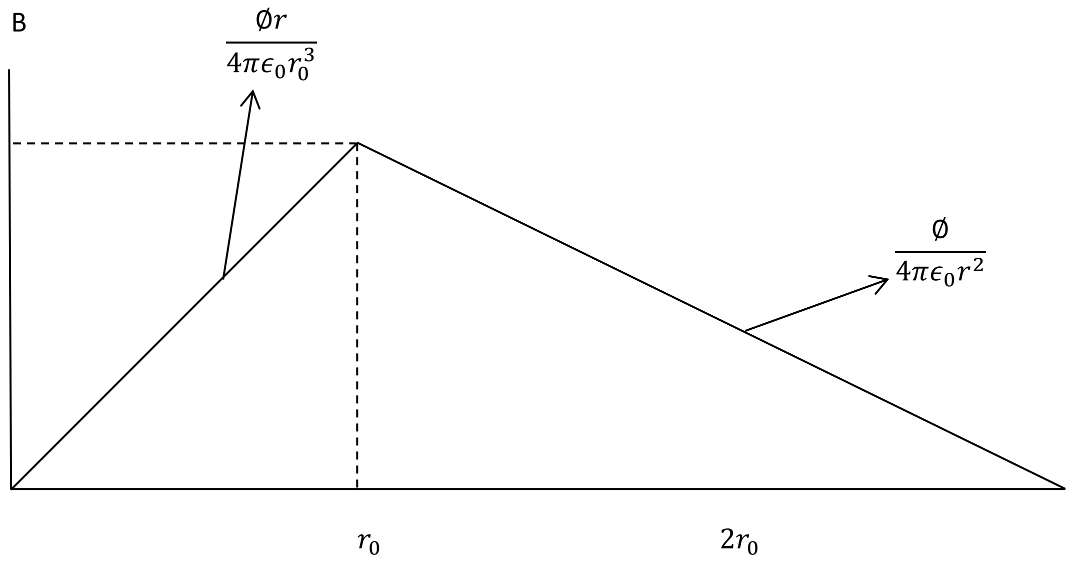
$$B(4\pi r^2) = \frac{\emptyset(r^3\ /\ r_0^3)}{\varepsilon_0}$$

and solving for *B* gives :-

$$B = \frac{\emptyset r}{4\pi\varepsilon_0 r_0^3} \qquad (r < r_0)$$

For the quantum field outside the Hilbert sphere the expression for the flux is again $B(4\pi r^2)$ and the flux density enclosed by the Hilbert sphere is the total flux density $\emptyset$ of the sphere i.e:- $B(4\pi r^2) = \frac{\emptyset}{\varepsilon_0}$ thus:-

$$B = \frac{\emptyset}{4\pi\varepsilon_0 r^2} \qquad (r > r_0)$$



That is to say that quantum conditions fall away at r_0 to be replaced by classical conditions and probabilities.

That the universe is expanding is now common knowledge but more importantly we know that the expansion is accelerating up to enormous velocities. Moreover it is accepted that this expansion takes the form of an inflationary models so that any point in the cosmos can be taken as the origin of an inflationary sphere.

Returning to Fig.1 we again note that the boundary conditions of the quantum world as discussed so far is a unit circle and that the squared modulus has been summed to unity i.e;-

$|w|^2 + |z|^2 = 1.$

How does this translate to the classical world on the scale of the universe at large?

Consider now two particles 9or galaxies) receding from each other and the angle between the two paths of recession is 180^0 i.e. the recessionary paths are diametrically opposed to each other and that both particles (or galaxies) have attained velocity *c*. Therefore the sum of the two velocities is :-

$V_{AB} = \frac{V_A+V_B}{1+\frac{V_A V_B}{c^2}}$

To provide an actual probability amplitude then both squared moduli should sum to 1 i.e. $|w|^2 + |z|^2 = 1$ therefore $|w|^2$ and $|z|^2$ each equal $\frac{1}{2}$ such that if both $|w|^2$ and $|z|^2$ represent the trajectories of two particles travelling at velocity c then $c = 1$ and $c^2 = 1$

Let c=1 then $\frac{1+1}{1+\frac{1}{1}} = \frac{2}{2} = 1$ and cos1 =1.

If θ = 180^0 then cosθ = -1 then the total probability is less than 1 and if less than 1 then the universe is deterministic not probabilistic on the classical scale.

If for the universe at large, the radius is normalised and normalisation unifies large and small $x^2 + y^2 = 1$ must hold for any radius in any quantum or classical event.

To summarise so far:-

1/ The quantum world exists in a superposition of states . This world is a complex number weighted state of probability amplitudes and evolves in a deterministic way governed by the Schrodinger wave equation. It is only when the squared moduli formed at the point of " collapse of the wave function that probabilities dominate and only one alternative survives into the classical world.

2/ The radius of the maximum quantum state is normalised to 1 at the point where the squared modulus $|z|^2$.

3/ Suppose 2 happens in the classical world where the radius equals $+\frac{1}{2}c$ and the diameter equals 1. Because the velocity c can never be achieved by any moving particle or galaxy the squared modulus =1 can never be formed in the classical world and therefore the classical world is in fact deterministic and the transfer from quantum to classical allows knowledge to become understood by human consciousness.

If it is the quantum world that is in fact the world of reality and our classical world is in fact the mysterious and irrational world of probabilities compared with the quantum world of certainties as described by the Schroedinger equation, then only now can we begin to describe the classical world in terms of time and space because only dimensions greater than $|w|^2 + |z|^2 = 1$ have any relevance and a gravitational field becomes relevant.

Thus we can now examine the effects of that gravitational field on the geometry of space-time contained within the coherent wave function and it will be shown that there is an inter-changeable equivalence between the negative gravitational field and the frequency and wavelength of any given wave function.

It is well known that a gravitational field can have the effect of changing the frequency and wavelength of an electromagnetic wave and I now propose to examine how it is that an electromagnetic wave produces a negative gravitational field.

If electromagnetic radiation of frequency f_1 is emitted at a point where gravitational potential is low an which is symbolised by ϕ_1 then frequency f_2 when measured at a place where gravitational potential is high and is symbolised by ϕ_2 is given by $f_2 = f_1\left(1 + \frac{\Delta\phi}{c^2}\right)$ where $\Delta\phi = \phi_2 - \phi_1$ and $f_1 = \frac{f_2}{1+\frac{\Delta\phi}{c^2}}$ and solving for $\Delta\phi$ we can write $\Delta\phi = -c^2\left(1 - \frac{f_2}{f_1}\right)$.

Since $\Delta\phi = \phi_2 - \phi_1$ represents a change in the potential energy caused by the change in frequency of an electromagnetic wave, so we can describe this change as the work being done by the change in frequency on the gravitational potential of the system as $W = \int_{\phi_1}^{\phi_2} F_x(x)dx$ thus $\phi_2 - \phi_2 = -\int_{\phi_1}^{\phi_2} F_x(x)dx$. That is to say that the change in potential is the manifestation of a force $F_x(x)$ which is caused by the change in frequency of the electromagnetic wave and we can note that $\Delta\phi$ represents the change in frequency due to the distance between the areas of high and low potential within the spherical wave. The force F_x can be expressed as $F = G\frac{f_2}{f_1}r^2$ that is to say the gravitational force is proportional to the square of the distance from the origin of the spherical wave. The properties of an electromagnetic wave can be described in terms of gravitation because the gravitational force within the wave is a product of the gravitational potential difference within the wave and can be described in terms of the gravitational red shift i.e. the changing frequency of the emitted wave with distance from the source.

Since the photon is a massless particle we can define the dimensionless red shift parameter z of a photon as being $z = \frac{gr}{c^2}$ where r is the distance between two points a and b spatially separated within the sphere radially and solving for g we note that $g = \frac{c^2 z}{r}$ and that z is equivalent to the potential difference $\Delta\phi$. Since the gravitational force within the sphere is distributed uniformly over the surface of the sphere, the point of origin of the wave is lying in a symmetrical force field and consequently there is no tidal (i.e. directional) effect. Since the acceleration due to gravity is due entirely to the area $4\pi r^2\rho$ thus $g = \Lambda = 4\pi G\rho$. The Λ term is an expression for repulsive gravitational field similar to that found in the laws of General Relativity and which modifies those laws at large distances into a repulsion proportional to distance.

As the area of the expanding wave front increases so does the volume of the space enclosed within the wave front and therefore the dimensions of any particular volume of space-time change proportionally with distance from the origin, for example the dimensions of a light cone within a repulsive gravitational field manifest themselves in a manner similar to Figure 1 below.

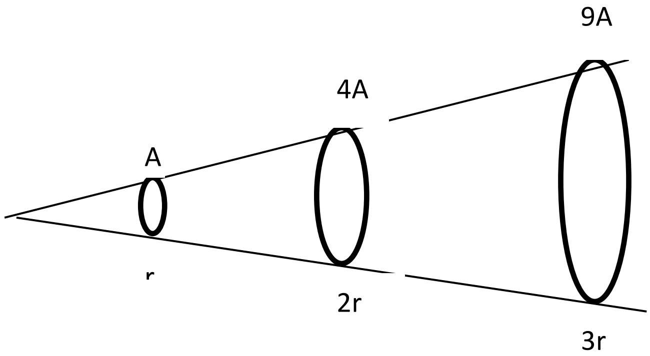


Fig.1

That is to say the area A at any point in the cone increases as the square of the distance from the origin and the relative curvature of space-time at any particular point can be calculated.

The quantum potential U within the cone is accompanied by an energy density $U_{(E)}$ so that we can again use Gauss's Law to calculate g due to a plane area of

$U_{(E)}$ at a point in the cone by treating the plane area as a disc or a very thin slice of a long cylinder. Around the curved surface of the disc the gravitational acceleration is perpendicular to the outward normal vector ***n*** so that the curved sides of the disc contribute nothing to the integral. At each side of the disc g is anti-parallel to ***n*** so $g \cdot \boldsymbol{n} = -g$ at each side and therefore we can write $\oint g \cdot \boldsymbol{n} dA = -4\pi G U_{(E)} \quad \therefore \quad -g \oint dA = -4\pi G U_{(E)}$. The integral in this case is the area of the two sides of the disc *2A* and therefore $-g(2A) = -4\pi G U_{(E)}$. Since the disc is very thin it can be treated as a circle of area A and energy density $U_{(E)}A$ and cancelling $-2A$ on both sides we get $g = 2\pi G U_{(E)}$ thus at any point on the area *A*, $U_{(E)}A$ is proportional to the square of the distance *r* from the source and therefore the reduction intensity is proportional to the change in gravitational potential energy within the sphere and we can write ${U_{(E)}}_f - {U_{(E)}}_i = -\rho g r_f - \rho g r_i$ (where ρ is the mass energy density) and this is the negative of the work done by the gravitational force manifested in the potential *U*. This then establishes the general form of the negative gravitational field within the spherical wave and its effects on the structure and geometry of space-time at the macroscopic level, but it is at the quantum level that the effects and magnitude of the potential *U* can be quantified.

The expression already referred to relating to the change in frequency of an electromagnetic wave which is under the influence of a gravitational wave is $z = \frac{gr}{c^2}$. Now while *z* itself is generally presented as a dimensionless figure both

r and g can be calculated and as the change in frequency is proportional to the change in gravitational potential of the field then a numerical value can be placed on the potential difference z and to achieve this we can resort to the familiar Planck units.

It will be recalled that Planck units (also known as natural units) represent the point at which relativistic space-time dimensions and quantum conditions share an interface and therefore can react with one another. The Planck units to be used are as follows :-

Planck time $t_p = \sqrt{\frac{G\hbar}{c^5}} = 5.4 \times 10^{-44}\ secs.$

Planck length $l_p = \sqrt{\frac{G\hbar}{c^3}} = 1.6 \times 10^{-35} mtrs.$

Planck mass $m_p = \sqrt{\frac{\hbar c}{G}} = 2.1 \times 10^{-5} gram.$

Planck energy $E_p = \sqrt{\frac{\hbar c^5}{G}} = 2.0 \times 10^{9} joul.$

And here we note that the constants $\hbar$, c and G are all normalised to 1.

With regard to the gravitational conditions which obtain inside a spherical electromagnetic wave and noting that the said gravitational field is repulsive, that is to say that the photons contained therein are moving apart from one another we can examine the expression for z as applied to the wave function and quantum state within the sphere. Taking the expression for *z* we can calculate the value for g (the acceleration due to gravity) within the sphere by writing $g = \frac{c-0}{t_p}$ i.e. the particles (photons) have been accelerated from rest to c and since the value for *c* is constant therefore $g = \frac{3\times10^8}{5.4\times10^{-44}} = 5.6 \times 10^{51}\ m.s^{-2}$.

Subsequent to this a value can be placed on *z* and this is especially pertinent because *z* is an expression for the change in frequency of an electromagnetic wave under the influence of a magnetic field and similarly it is an expression for the change in potential in a gravitational field. In expressing a value for *z* at the quantum level we can again write $z = \frac{gr}{c^2}$ and knowing the value of g an substituting l_p for *r* we can write:-

$$z = \frac{(5.6\times10^{51}) \times (1.6\times10^{-35})}{9\times10^{16}}$$

$$= \frac{9\times10^{16}}{9\times10^{16}}$$

$$= 1$$

We have previously noted that the values of Λ and g are related on the macroscopic scale via $g = \Lambda = 4\pi G\rho$ so if both *G* an *z* are normalized to 1 we can write $\Lambda = \frac{c^2}{r} = \frac{c^2}{l_p} = \frac{9\times10^{16}}{1.6\times10^{-35}} = 5.6 \times 10^{51}$ ∴ $\Lambda = g$.

The force required to initiate the expansion of the spherical wave at the quantum level can be calculated in the conventional way i.e:-

$F = m_p g = (2.1 \times 10^{-8}) \times (5.6 \times 10^{51}) = 1.18 \times 10^{44}\, N.$ and the energy required is given by:-

$W = E = Fl_p = (1.2 \times 10^{44}) \times (1.6 \times 10^{-35}) \approx 2.0 \times 10^{9}\, joul.$ Which is equivalent to the Planck energy already described.

In summary my proposition is that it is the quantum world which creates space-time and thus it is gravitation which is a product of space and time which defines the curvature of space-time.

END