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Is QM Compatible with GR?

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Abstract

It is commonly believed that QM and GR are incompatible as shown via few plausible arguments. What is not common however, is that the first papers on QM by Heisenberg (1925) and that on GR by Einstein (1915) start from the same premise- That is; particles experience force/acceleration resulting from the local gradient of energy density. The two theories diverge considerably afterwards using different mathematical tools to achieve their specific goals. This well based common origin is the very reason why these two monumental theories appeared to reproduce accurate practical results when applied to various physical problems. That is despite looking incompatible and even counterintuitive at times. The large number of correct results must also point to a further area of similarity. This comes from Tylor's theorem of algebra which states that knowing the values of a function and its derivatives should point to the same functional form. In this work we first expose the common origin of QM and GR, then point at the different mathematical routes taken by each to make them look so different. We next examine the common reasons supporting the claims of incompatibility. But we also try to determine if these are unfounded or possibly misunderstood standpoints- supported by diagrams and algorithms. It is hoped that this work can divert mostly negative efforts to prove incompatibility, into positive efforts exploring the common grounds between the two theories and benefit from it.

Keywords: QM, GR, indeterminacy, nonlocality, nonlinearity, superposition, gradient of energy, Spring model of the atom, Rydberg formula, Ricci tensor, Einstein quanta, Bell's inequality

1 Introduction

After nearly a century of thinking and successful usage of QM and GR, many think the two theories are both correct as theories of physics but are also not compatible with each other. In our opinion, this can't be the correct understanding of the problem for two reasons. One is that their initial starting point is the same as will be discussed below. The other is algebraic. According to a conclusion from Taylor theorem; if two functions (of any number of variables) predicted the same physical results with high accuracy, they must in essence be the same. That is because any reasonably behaved function is determined by its values (the measurements) and all of its derivatives at that point- as can determined by the neighbouring points of agreement. This should encourage us to look for the similarities instead of incompatibilities. In **[3],** it was shown that the common laws of physics can be derived via the Einstein radiation quanta together with the well-known characteristics of radiation. A simple and most general law of motion was identified- namely that:- forces on matter are inevitably caused by the local (negative) gradient of the local energy density. We then find that both the first QM paper by Heisenberg and the first on GR by Einstein, principally used this simple law of motion as a basic starting point. We show this first, then describe the subsequent mathematical development that set the two theories apart and made them look incompatible and discuss the arguments in this regard.

2 QM and early development

2.1 Radiation, matter and QM

The first progress in QM came from studying the properties of light/EM radiation. Roger Bacon in the 13^{th} century said that the rainbow is a result of sunlight experiencing scattering like that in glass. Newton in turn in the 17^{th} century demonstrated that a glass prism can separate sunlight to its colour components. Kirchoff in 1860 studies the emission and absorption of light and spoke of a well-defined spectrum for a perfect blackbody radiation that is related to the temperature of that body. As is well known, heating an iron changed its colour from dull red to red and white. Wiens in 1893 **[15],** attempted to explain this and introduced his empirical displacement law for the wavelength at peak intensity as; $\boldsymbol{\lambda(peak)=b/T}$, where $\boldsymbol{b}$=2.9e-3 m.K and is still useful today. He introduced another empirical formula for the blackbody radiation few years before Plank. Plank in1900, introduced his analytical and more accurate formula for the detailed spectrum of radiation from a blackbody as given below. He achieved it based on Boltzmann/Gibs kinetic theory of gases. In his argument, he considered radiation in an adiabatic expanding/contracting cavity and concluded via the doppler principle that energy changes '*exactly the same way as the frequency*' **[10,15]**. Note that since $\boldsymbol{T}$ is proportional to $\boldsymbol{E}$, for a *narrowband spectrum*, this became a precursor to Plank's formula; $\boldsymbol{E=hf}$, since $\mathbf{c=\lambda f}$. This is probably the first known QM expression as found first by Wien. In fact, Wien is also credited to have first to suggest that *mass has an EM origin*. He missed the Einstein formula by a factor of 4/3. Impressively, he was also the first to identify a particle with a positive charge later named the proton!

Now, on the matter side, Bernoulli in 1738 was the first to suggest that the *pressure of a gas is caused by fast moving particles hitting the surface of a container* and reflecting back and change momentum in the process- as would be given much later in Maxwell's work. In 1859, Maxwell following Clausius work developed the Maxwell distribution for the spectrum of kinetic energy distribution in a gas, which was the first statistical law in physics. In 1877 Boltzmann generalized Maxwell statistics to the Maxwell-Boltzmann distribution. Here, particles interact with the retaining walls but not significantly with each other as in the case of low density gases. The result was in the form: $N_i/N=exp(-E_i/k\ T)/\sum_j exp(-E_j/k\ T)$, where N_i is the number of particles out of N particles at energy E, and k=1.38e-23 J.K is the Boltzmann constant, with i,j referring to the number of particles in one microstate and the total number of these respectively. The pressure from a change of momentum in this distribution is found as; $p = (2/3)\ .5\ \rho\ v^2$, where ρ is density. Comparing this with the ideal gas law; $pV=NkT$ gives; $(3/2)kT=.5mv^2$. This relates the temperature of the gas to the average kinetic energy of its molecules. This relation proved very useful in finding other theoretical expressions for the properties of matter- like viscosity, conductivity, diffusion etc.

Plank completed this and derived theoretically, the formula to fit the blackbody radiation spectrum for high as well as low frequencies- that is the blue as well as the red end frequencies in the form; $B=(2hf^3/c^2)/(exp(hf/kT)-1))$, where B is the equilibrium spectral radiance at temperature T, with h,k being the Plank and Boltzmann constants. In deriving the formula Plank needed to assume that: *the energy is exchanged in fixed quanta 'h'* between matter and radiation as in between mechanical springs. This he called 'the quantum of action h=6.626e-34 J.s, which implied the discrete energy relation; $E=hf$. The units of h are those of angular momentum. This indicated that angular momentum as well as the energy for one cycle(f=1) are quantized which Einstein noticed and built upon.

Einstein in turn in 1905, rederived Wiens empirical law using the statistical theory of gases and noticed that the Plank blackbody radiation formula of Plank is a product of two parts **[3]**; one from the statistical kinetic theory of gases and other from a wave theory. He subsequently made the bold postulate that *not only the exchange of radiation with matter is quantized as Plank suggested, but also radiation itself in empty space is composed of constant energy quanta* ***h***. This then proved very useful in connecting laws governing radiation with those governing matter molecules of thermodynamics **[3,10,11]**.

Earlier in 1888, Rydberg presented an empirical accurate formula to generalize the Palmer series for the emission and absorption radiation wavelengths from *any* atom. His formula was astonishingly simple, unexpected and general in the form; $1/\lambda =f/c=R(1/m^2 -1/n^2)$, where λ,f are the wavelength and frequency of radiation, R is named the Rydberg constant, c the speed of light, and m,n are *any two* integers. Explaining this simple and accurate formula became the main driver for research in the subject and for Heisenberg to make the first steps of QM in its early matrix mechanics form.

2.2 The Bohr hydrogen atom

The electron was discovered in 1897 and Thompson in 1904 coined his plum pudding model of the atom. This was made obsolete by the discovery of the nucleus by Rutherford in 1911, then was followed by the highly successful Bohr model in 1918, **[10,11]**. Following the work of Nicholson of1912, Bohr used his quantization idea and that of Plank, to construct a new model to explain the source of atomic radiation emission and absorption. Bohr's model managed to find the form of the celebrated Rydberg formula analytically and produced a formula for the value of the Rydberg constant- a major achievement at the time.

Bohr assumed the balance of the forces of electrostatic Coulomb and centrifugal acceleration Fe, Fc within the atom. That is; $Fe=k\, e^2/r^2$ equals $Fc=mv^2/r$, in any orbit, where; $k=1/4\pi\varepsilon_0$ is the Coulomb constant, e,m are the charge and mass of the electron and v is its velocity . Radiation is emitted or absorbed by electrons when they moved down or up orbits with radiation energy being quantized and given by Plank formula; $E=hf$. As h has the units of angular momentum as given above, Bohr- assumed the angular momentum of atomic orbits must be an integer n multiple of h, such that; $nh=2\pi\, mvr$. Combining this with the above results, gave the radius of an orbit as; $r=n^2\, h^2/4\pi^2\, kme^2$. With the energy of an orbit given by; $E_n=.5mv^2=2\,\pi^2\, k^2\, e^4\, m/n^2\, h^2$, *or* $E_n=R/n^2$, with R named the Rydberg constant. This would give the energy jump as; $E_{mn}=R(1/m^2-1/n{*}2)$, and with the help of $E=hf=hc/\lambda$, we get the Rydberg formula; $1/\lambda_{mn}=(R/hc)\ (1/m^2-1/n{*}2)$. This is the biggest achievement of the Bohr model.

One problem remained here which is that orbiting electrons experience radial acceleration and would emit radiation like any other charged body. QM subsequently made a postulate- that radiation is emitted only on moving between orbits m,n. To justify this, De Broglie suggested that matter as well as radiation can have an associated wavelength related to its momentum. From $E=hf$ we get; $p=h/\lambda$, and p now is momentum given by $p=mv$ for a particle with mass. Thus, the atomic orbit is quantized, is equivalent to a condition of standing wave at each orbit. In **[3]** this was explained without the need for this unneeded matter waves- using Einstein quanta for radiation- taken as single radiation cycles of constant angular momentum and energy as given above. Matter moves by absorbing radiation quanta. As the energy of a particle increases, the number of these absorbed quanta increase and this in effect is an increase in frequency(decrease of wavelength) of the radiation energy. Orbiting electrons can be thought as being in an equilibrium of loss and gain of radiation energy to stay in orbit. That is; electrons remain in orbit only with the help of a continuous radiation exchange with the surroundings. Any chemical solution in equilibrium is a good example in this regard with reactions going in both directions all the time. Also, if we take matter to outer space, its temperature would plummet to near zero Kelvin. On earth, the temperature is held at its higher level only because of equilibrium between lost and gained heat radiation.

2.3 Heavier Atoms- the QM solution

Despite the analytical success and the derivation of the Rydberg formula, predicting what ***m,n*** orbit values existing in each atom remained an unsolved problem. Also, the value of the constant ***R*** in the formula depended on atom specific values. Single and double Fourier series were used in early attempts with modest achievements- despite the use of complicated math models **[11]**. Heisenberg in 1925 **[7]** had a better success- (via hard trial and error). He abandoned attempts to model the electron position and *decided to determine the coefficients of his series expansion so as to just fit the Rydberg formula*. He found that a double Fourier series can be found and written as the product of two separate series/matrices/(vectors in Hilbert space). This was the first step of the new QM thinking. That is: Instead of speaking of a model for the electron motion in heavy atoms, we only concentrate on the energy levels as deduced from emission and absorption data.

The method can be imagined with the help of **Fig (1)**, Heisenberg reduced the 2D and 3D electron motion around the nucleus to one dimension which is the radius- represented by the motion of an anharmonic spring. The figure example shows the traces of two particles confined inside a circular space. The same trace can be plotted using a complex function whose amplitude is the radial distance and phase corresponding to the angular position(s). This can further be compressed to be a spring motion in one dimension ***x,t***, in which ***x*** can be a vector representing more than one spring. For the equation of motion of a spring, Heisenberg **[7]** used this formula; $a=-(1/m)dV/dx$, derived from an ideal mass-spring equation; $m\,a + f(x)=0$, where ***a*** is acceleration, ***m*** mass and ***V*** is a local potential well. Heisenberg then comments that: *This equation is a general equation for the electron if the potential in which it moves V is known*. We notice that this equation is a statement that: *The acceleration of the electron is solely determined by the negative gradient of the local energy density- which is the potential*. This as we know, is the same form used in the Newtonian gravity for a mass in a gravity potential.

In addition to replacing the frequency of the double Fourier harmonics by the transitional frequencies between atomic levels as given by the Rydberg formula, Heisenberg took the square of the amplitude of these harmonics to represent the *intensity of the spectral lines*. Hamiltonian rather Newton's mechanics was used as it deals with energies that directly translate to frequencies via Plank formula; $E=hf$.

The use of the Rydberg formula in the form; $f=R(1/m^2 -1/n^2)$, gives the emitted frequency between two levels as; $f_{mn}=f_{mk} -f_{kn}$, and in terms of orbital energies; $f_{mn}=(E_{mk} -E_{kn})/h$. The series solution choses the harmonics/coefficients to agree with the wavelengths in the radiation spectrum. This way*: the position and momentum became hidden in the intervals between transitions- but known at the emission nodes only.* A limit on the values within emission intervals can then be obtained from; $E=hf$, with ***f*** replaced by ***f/2*** for a *standing wave* in any orbit to give; $E*t \geq h/2$ since f has the units of inverse time. This is one form of what came to be known as the *uncertainty principle*. Note that we now have; mass, energy and angular momentum, all quantized- all because of the quantization of light itself and matter as a result. That is, the uncertainty formula is true due to a basic a property of radiation and its condensate at matter.

In 1926, Schrodinger at nearly the same time of Heisenberg first paper, came up with a single empirical wave equation of in the form; $i\partial\hbar\ \partial/\partial t\ (\Psi) = -\hbar^2/2m(\nabla^2 + V)\ \Psi$, where Ψ is a complex (weight) function of space and time and i is the imaginary root . The equation was not derived from first principles and can be described as a heat-like spread of Ψ (instead of temperature), and the presence of i at the start then changes it from diffusion to wavelike repeating. The square of the amplitude of complex Ψ is taken here to represent the probability of existence of a particle at any position as given by the so called Born rule. This equation had the extra advantage of getting the m,n values plus other useful numbers directly from the application of the boundary conditions

To sum up, the electron motion in heavy atoms proved difficult to solve. As a result, the motion was reduced to 1D with the spatial and temporal variable x,t corresponding to that of a springs. The multiplicity of electrons are handled via a single potential well but with a strength depending on the multiplicity of charges within the nucleus. The energy nodes of the solution are made to correspond to the Rydberg frequencies and the behaviour of particles in the intervals in between are assumed to fit a probability distribution. The Schrodinger method had the extra advantage with the harmonics appearing naturally from the boundary conditions.

Later, It was found that despite the uncertain and random distribution of position and momentum, it is still possible to write an equation of motion relating the mean/expectation of the variables instead. This is provided by the Ehrenfest theorem in the form; $\mathrm{mean}(p) = m\ (d/dx)\ \mathrm{mean}(x)$; and $(d/dt)\mathrm{mean}(p) = -\ (d/dx)\ \mathrm{mean}(V)$. Again this equation has the same energy density gradient form which was derived from the space spring equation by Heisenberg, but using averages instead of exact variable values.

Buthe use of averages leads to the loss of some information- like the directionality for example. This then gave people the false impression that the equation of motion are symmetric with respect to both space and time, when in reality they are not in the original gradient form. Without average/divergence operations, the arrow of time is clearly visible- since acceleration is always from high to low energy densities and never symmetric. Symmetry happens only at equilibrium when there is no apparent direction.

3 GR- the early derivation

From Poincare in 1905 to Einstein in 1915 there was many attempts to derive a relativistic gravity equation to replace that of Newton to take care of the effects of high speeds and large masses on gravity with relativistic approach like SR. The prominent problems that needed a solution at the time were the low accuracy of

Newton's predictions for complex gravitating systems, the bending of light by large bodies, and the gravitational doppler effect. Einstein in 1915 introduced an equation the form **[6,13,14]**; $\boldsymbol{R_{\mu\nu}= \kappa\ T_{\mu\nu}}$, where $\boldsymbol{R}$ is the Ricci curvature tensor, $\boldsymbol{\kappa}$ is a constant and $\boldsymbol{T}$ is the energy density tensor. This tensor included all energies from mass energy to stress energy and kinetic energy- hence the energy-momentum use in the name. *This* equation ***correctly predicted the perihelion of Mercury, the gravity phase shift and the deflection of light*** *by massive bodies* and so had Einstein very excited.

In deriving this equation, Einstein was attempting a covariant tensor generalization of Newton's gravity in the form of Poisson equation; $\Delta\boldsymbol{\varphi} = \mathbf{4}\ \boldsymbol{\pi}\ \boldsymbol{G}\ \boldsymbol{\rho}$, where Δ is the Laplacian, $\boldsymbol{\varphi}$ is the gravity potential, $\boldsymbol{G}$ *(or* $\boldsymbol{\kappa}$ *in the paper)* is the gravitational constant and $\boldsymbol{\rho}$ is the matter density. The Ricci curvature tensor itself is the generalization of the Laplacian, and the energy density tensor $\boldsymbol{T}$ is the generalization of the matter density in the Poisson equation above. This already showed Einstein's genius- as he *realized that the energy equivalence of matter* $\boldsymbol{\rho c^2}$ *- like all other energies; kinetic, electromagnetic etc are what causes the acceleration of gravity*- which he envisaged as equivalent to acceleration in his *equivalence principle* . This jump is in fact is a hallmark of Einstein's style of thinking- similar to his earlier suggestion; *radiation itself is made of quanta of fixed energies and angular momentum* when others said only the interactions with matter are quantized.

But Poisson's equation for Newtonian gravity has Green's function solution in the form; $\boldsymbol{\varphi(r)=-Gm/r}$, where $\boldsymbol{m,G}$ are the mass and gravitational constants, from which we can derive the equation; $\boldsymbol{F=ma=-\nabla\varphi}$, where $\boldsymbol{F = m\ a}$. This is the **same starting equation of Heisenberg for his oscillator model** given above as; $\boldsymbol{a=-(1/m)dV/dx}$, with the general form; *acceleration is caused by the negative gradient of energy density*. In **[2,3]**, it was shown that by taking the curvature of spacetime to be the curvature of the matter path (rather than that of empty space), the gradient of the path curvature translates to acceleration. If the gradient is also taken of the right-hand side of the Ricci form GR, the equation simply becomes an energy gradient driven matter acceleration in tensor form that takes all directions in one step.

Despite his success, Einstein was not happy with his Ricci tensor equation form and decided to update it in the same year using a new combined tensor called the Einstein tensor. See this mention **[14]**; " *it was soon realized that the equation was inconsistent with the conservation of energy-momentum unless the universe has constant density of mass-energy-momentum. In other words, air, rock and even a vacuum should all have the same density*". But here where we can talk of an unneeded step that; greatly complicated the mathematics of GR and made it nearly impossible to solve. This change amounted to transforming the Ricci GR from finding acceleration due to energy density to; establishing a region of energy conservation or energy balance. But the Newton-Poisson equations on which the first GR version was a generalization for example, doesn't require energy conservation on both sides. In fluid mechanics as another example, 'auxiliary equations; are added to enforce conservation via the continuity equation.

In [3] it was shown that the gradient of kinetic energy for example as one of the entries in the T tensor is; $\partial s(.5v^2)=v\partial v/\partial s= v\partial v /(\partial s/\partial t)= \partial v/\partial t=a$, which is acceleration. This says, the gradient of kinetic energy is acceleration which is what the Ricci tensor version of GR says, and includes all energies into account as its novel generalization. This says that the first Ricci form GR is correct, sufficient and needing no adjustment- since its right-hand side is energy density like kinetic and other energies, and its left-hand side is a curvature of path, the gradient of which is also acceleration. We could look at the Ricci GR form as like the integration of $a=-(1/m)\nabla\varphi$ to give the velocity(the flow) **v=f(φ)**. We simply we have; The curvature in a particle path (a velocity) is a function of all the energies at that point. That is: *GR curvature clearly refers to that of the energy density surfaces rather than the spacetime itself* as is usually claimed. We further note here that despite the gradient operation being local, the energy (radiation in particular), follows an integral not a point differential equation which requires an integration over all space. This makes GR both local and nonlocal in character and brings it nearer to QM thinking.

In **[13,14],** it is given that the forces in GR can be broken via the 'effective potential' theory, into three forces: $F = -F_g + F_c - F_r$, which is a sum of gravity, centrifugal and relativistic forces. The first is negative since it is attractive, the second is positive and repulsive, and the relativistic third comes from a change of mass with speed as given in SR- resulting from absorbing radiation energy with momentum. The first term can be looked at as a gradient of the mass energy of the *distant masses*- hence the negative sign showing its direction coming from there. The second is the gradient of kinetic energy from the position of the rotating/path curving mass to the outward direction- the centrifugal force- hence it is positive/repulsive. The third term is due to the mass itself being augmented by the energy absorbed to gain KE and move. This however, need not be a separate term if the relativistic mass is taken instead of the bare rest mass in the calculations.

4 Incompatibility arguments

In the light of the above, we here discuss some of the well-known incompatibility arguments and examine if they are justified or mainly a result of the modelling process.

4.1 Linearity

It is said that QM is linear whereas GR is not. This effectively amounts to whether the sum of two solutions is a solution or not! QM is linear in this regard, but GR is not. The nonlinearity of GR is said to come from the claim that; *the energy of the gravitational field is itself a source of further gravity, which in turn contributes to gravity*- thus forming a ***positive feedback loop***, or a ***run-away solution and a possible singularity***. What is unfortunately missed in this argument is that the term 'field' is a short for the term 'force field', and ***a force doesn't have energy***! Many seem to miss this point. I can for example, lean on my car for hours without getting tired, but the moment the car starts moving and I continue pushing, I become tired in no time. The reason is that work/ energy is; ***W=F*d,*** (force times displacement). If the displacement is zero, the energy generation is zero too. We also note that: ***Forces can be magnified and attenuated*** *as in scissors and hydraulic pistons for example, but energy stays constant all the time-* That is if no external source is provided. Instead of defining force as coming from acceleration, some use the definition of force coming from the gradient of potential and as the latter is energy density, they conclude that force must be related to energy too. It is related but not equal unless there is motion and a change of position as given above. The energy in the field can be harnessed only vial motion. The electrical potential across a wire is depleted if the electrons are allowed to move and gain energy and there was no new supply as in the case of a storage capacitor.

In the Ricci version of GR, the gradient of energy density creates an acceleration(force), not energy. AneEnergy change doesn't occur unless a particle moves along the gradient and gain kinetic energy (or loose it moving in the opposite direction). This way, energy is conserved and ***no runaway solution is ever possible***. *This should make gravity linear as we neglect this non-existing 'gravity force field energy'.* Note also that a similar false argument can be met within electromagnetism by claiming that a changing magnetic field induces an electric field and this in turn can induce a magnetic field in a non-ending process.

The existence of a singularity due to a huge mass as in blackholes was also ruled out in [1,2] as matter experiences a phase change to radiation- a boson, can exist in any intensity and balance any pressure to prevent any singularity. It should be mentioned that one of the reasons behind attempts to unify QM and GR is to look into what happened at extremely small length scales. With radiation composed of soft quanta particles of constant energy per cycle and constant angular momentum, and with matter as the condensate of this, we get gravity, EM and elementary particles all possessing unified characteristics.

4.2 Nonlocality

QM is said to be nonlocal- in the sense that there are cases of 'entangled' particles(entangled states) in which the measurement of one affects the outcome of another instantaneously and regardless of the distance between them **[4,12].** Few practical case are discussed in the literature showing this to be apparently true. The problem in question is; the laws of physics should be local and effects from one position to the other can't travel faster than light as given in GR. Einstein and others examined this in the famous EPR paper and concluded that for such an entanglement to happen there must exist some *hidden variables* that cause this observed and odd behaviour. The author is of the opinion that the universe can indeed 'appear' non-local, and the hidden variable in question is nothing other than 'conservation of linear and angular momentum'- aee **[5]** and quote. Einstein finding was dismissed at the time based on the results of experiments discussed below.

Conservation of momentum means that if a particle moving at a constant linear or rotational speed will continue to do so for ever- if not affected by other factors on the way. The reason for it is simple; To change momentum in magnitude or direction as a particle needs an (additional) external momentum input since momentum is conserved. By its nature, angular momentum however, is more likely to persist/stay conserved/not easily disturbed than linear momentum. The swirls of water in a river, wind tornadoes, smoke rings and even the rotation of planets and stars are examples of this. It is not surprising therefore to see two particles starting with a fixed, momentum values would show a 'strong correlation' after some time and over any distance. This what was Einstein referring to and ignored. But then the Bell's (complex) statistical tests advanced to test this hypothesis experimantally showed that QM entanglement violated the expectation from the hidden variable reasoning and gave different correlation figures.

We present **Fig(2)** (with the algorithm producing it) a way to show that the different entanglement correlation results can indeed by obtained if we allowed for some random interferences. With no interference, the algorithm gives the correct theoretical curve given in **[4],** then gives some other possible outcomes(the dots in the figure) after a certain noise is added. Many possible outcomes are possible depending on which 'loophole' is being missed in the set-up of the reported experiments. Few oter research articles found some convincing arguments too which dismiss the claimed entanglement violation results - see **[5,8,9]**.

4.2 Intrinsic Spin

Experiments shooting a beam of silver vapour atoms (which have one electron in the outer layer) between the poles of a very strong magnet showed that the beam splatted into two up and down traces rather than forming a random distribution as would be expected. This was taken as a proof that the lone electron has a magnetic dipole moment interacting with that of the magnet and produce the observed trace segregation. The spinning electrons (as magnets) must be interacting with the external field for this to happen. But it is claimed that this should not happen because the electron would just precess keeping is dipole direction and not flip- as what happens to a gyroscope pushed sideways. This should only produce a random not a segregated trace on the screen as the direction of such dipoles in the oven are random..

While static charges are not affected by a unform static magnetic field, moving charges experience a cross Lorenz force. The electron is also spinning/rotating around a fixed atom. The magnetic axis of both rotation can't both produce stable recession. As is well known in mechanics, there will always a direction flip to get into a minimum energy state. To show this is indeed the case, a numerical experiment is done using electrical dipoles which are theoretically equivalent to their magnetic counterpart **[1]**. The conclusion is that the splitting can indeed happen theoretically for the case of dipole and disappear if it is randomized by an additional input. The direction the electron is rotating around itself initially has a random direction in the oven, but it gets directed by the strong external magnetic field. If the rotation axis is normal to the field, it will remain so and the field has no effect. But this is an unstable condition in a narrow angle. If the little magnet axis is slightly up it will flip up and the reverse is true in order to align with the field.

This will produce the observed split in the Stern-Gerlach experiment- see **Fig (3)**. Later confirmation (public on the author's drive) was obtained by experimentally dropping either iron balls or magnetic balls of the same size between two very strong magnets. The iron balls produced a normal distribution curve as they collect in vertical bins, whereas the magnet balls produced two traces in the form of a double hump distribution. This again shows the flipping of the magnetic axis is possible and real both theoretically and in experiment.

4.3 Indeterminacy

This claim is in fact at odds with the whole of mechanics not just GR. The claim is that a particle position and state of motion can't be known *or even exist in real*, before the act of measurement. Even when measured, these can be known only probabilistically and not exactly. Some aspect of this claim are discussed below.

a-Regarding the claim that what a particle does can't be known before measurement, or even worse, because it could be everywhere, and only the act of measurement causes all the possibilities to 'collapse' then appear at a single point. The reason for within QM should obvious. The model/black-box that QM uses was derived and adjusted to fit the start and end of an energy jump(emission/absorption) process. We can't then come back and complain that the model doesn't predict the in-between states. A good example of this is a sliding mass down a frictionless hill path. If we know the drop and the initial energy, we can accurately predict the final energy/velocity. But it is impossible in this case to find the actual path whether straight or zigzag or whatever. The act of measurement has clearly nothing to do with the claim. It is a model specific issue and nothing to do with reality.

b-There exist sets of variables that can't be all known accurately ever, and the error in the product of two can't be smaller than the so-called Heisenberg uncertainty figure. That is; the more accurate we measure one such variable, the less accurate is the measurement result of the other compliment. Position/momentum or energy/time are examples. We find that this phenomenon has its origin in the discrete nature of radiation energy itself and not specific to QM. Radiation and condensed matter are formed of indivisible quanta of fixed momenta and energy in one cycle $\boldsymbol{h}$, as discussed in sec 2.3- which comes directly from Plank radiation-energy formula. That is the reason for the uncertainty is the very specific nature of radiation and its matter condensate as shown in the above section.

c-The third source indeterminacy comes from the probabilistic definition of the variables in QM. The definition of the weight function representing the motion variables is defined via a probability distribution. We saw earlier that by construction, in QM, the motion in 3D, 2D is reduced to that of a complex 1D (apace) spring motion. The laws of motion were then applied to the averages (means/expectations) of the problem variables. Then to ensure realistic results and not to follow a non-existent particle appearing out of nowhere, the probability of existence is forced to add up to exactly unity or 100%- via the so called 'unitarity' principle. Clearly there is nothing to stop one from applying the same techniques work within GR that involves masses and gravity potentials instead of EM potentials.

5 Conclusions

We showed that QM and GR used the same principles as their starting point- namely that: Energy density (of any kind) is the prime cause of acceleration in matter. Particles move from high to low energy densities and pocket the difference in terms of kinetic energy. This law automatically conserve energy (in a region or a point) and determines the arrow of time- a direction towards equilibrium and maximum entropy as energy continues to spread from large to smaller energy densities.

The near impossibility of following the motion within many electron atoms required their modelling as oscillating springs as in the case in QM, with one space and one time variables instead of the **x,y,z,t** coordinates. The effect of a large complex nucleus/multi-particle system in general, is handled via an effective local potential well(energy density) method. This model is exact in energy variable terms but not exact in the variables of mechanics of position and momentum. This was compensated for using a probability distribution within the modal intervals. The structure of the potential well controlling the general motion is chosen so that the eigenvalues corresponded to those of the Rydberg formula that is proven accurate by experiment. The direct consequence of this is that a QM model can't predict the actual motion of electrons at any time apart from those at the nodal frequencies. This led to indeterminacy and unpredictability claims. But this is a QM model specific problem and not a general classical mechanics one. Further, nothing in this stops the model from being applied to gravity as well using similarly well proven formulae. As shown by Dirac later, the change in mass due to speed discovered in SR, is a separate issue and can easily be incorporated in the model as an addition to the rest mass by absorbed radiation to create motion.

We also showed that GR started as a generalization of the Newton-Poisson equation for gravity. The early version equated the Ricci curvature tensor to the local energy density. The novelty here is the inclusions of all energies as generators of acceleration. This managed to predict correctly the gravity phase shift, the bending of light by large masses, and the perihelion precession of Mercury. The Ricci curvature was assigned to spacetime, but it can instead refer to matter trajectories in spacetime as shown in **[2].** The Newton-Poisson equation itself is a derivative of acceleration driven by a gravity potential/energy density gradient, which is a common basis used by Heisenberg in early QM. The form of GR however was later changed despite its success in solving the anomalies met in applying Newton's equation. The author thinks this was unnecessarily since it was done only to ensure energy conservation- when the original Newton-Poisson equation didn't require this step with no application problems. This unfortunately made GR nearly impossible to solve apart from very simple cases- since the solution in this case is trying to do two jobs at once- one determining particle motion and the other ensuring energy conservation at that point. Without this modification, GR is compatible with the whole of mechanics including QM with its novel addition of all sources of energy in the equation of motion.

Further we showed that a gravitational field has no energy of its own and this denies any runaway solution or the creation of a singularity. The other possibility of a singularity resulting from high gravity pressure was shown **[2]** to lead to a phase change of matter to radiation that can exist in any intensity and resist any gravity pressure with no singularity.

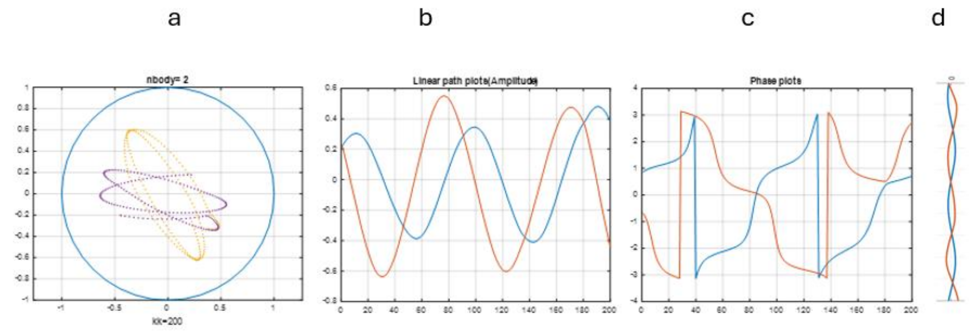
The arrow of time problem was also shown to be not real. The original energy density caused acceleration as the fundamental equation of motion, is one directional leading to eventual equilibrium and maximum entropy. The arrow of time is lost when we take the divergence (a second derivation) or the expectations of the equation of motion. Then we are speaking of a steady state or a standing wave solution with no time direction but rather a symmetry in time and space. Both QM and GR suffer from this by ending to use a wave equation derived from the original gradient equation. The numerical discrete version of the 2nd time derivative; $f_{tt}= f_1+ f_2 -f_0$, as an example, shows how the directions of the future 2, the past 1, and now 0, are all mixed to produce a single number with a built-in symmetry.

We found that both QM and GR so is physics as a whole to be naturally quantized because of the quantization of radiation itself(Einstein quanta) and in which matter is simply its condensate.

6 Figures and Algorithms

Fig (1): Reducing electron motion to a spring motion

(a):Plot of two particles in 2D motion. (b,c):Corresponding amplitude and phase, (d): Reducing the motion to that of a string vibration. ***See generating algorithm below.***



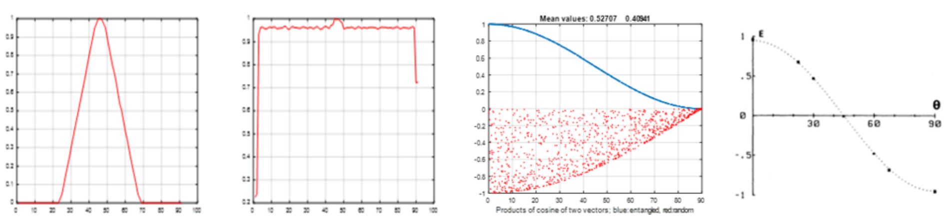

```
%program to calcul1ate the nbody problem in 2D.
clear all; close all;ee=1e-10;X=[];Y=[];
kb=1e-2;kw=6*kb; a=1;  dt=.05;                    nt=200;
figure(1);th=0:pi/20:2*pi; xw=a*cos(th); yw=a*sin(th);hold on;axis equal;
hold on;plot(xw,yw);
nb=2; nbv=1:nb;  x=1*(rand(nb,1)-.5); y=1*(rand(nb,1)-.5); vx=2*(rand(nb,1)-.5);
```

```
vy=2*(rand(nb,1)-.5);
for kk=1:nt; for jj=1:nb;  xj=x(jj); yj=y(jj); vxj=vx(jj);vyj=vy(jj);
xb=xj-x; yb=yj-y; rb=ee+sqrt(xb.^2+yb.^2); xbw=xj-xw; ybw=yj-yw;
rbw=ee+sqrt(xbw.^2+ybw.^2);
axb=kb.*xb./rb.^3; ayb=kb.*yb./rb.^3;
axbw=kw.*xbw./rbw.^3;aybw=kw.*ybw./rbw.^3;
'no walls
zw=0';zw=1;ax=sum(axb)+zw*sum(axbw);ay=sum(ayb)+zw*sum(aybw);
vxj=vxj+dt*ax; vyj=vyj+dt*ay;  xj=xj+dt*vxj; yj=yj+dt*vyj;  x(jj)=xj; y(jj)=yj;
vx(jj)=vxj;
vy(jj)=vyj; r2(jj)=xj^2+yj^2; v2(jj)=vxj^2+vyj^2;
end; 'jj'; pause(.01);if round(kk/10)*10==kk;hold off;
figure(1);plot(xw,yw);axis equal;hold on;xlabel(['kk=' num2str(kk)]);
end;plot(x,y,'.');
X=[ X x];Y=[Y y];end; 'kk';Th=tan(Y./X);Z=X+i*Y;
figure(1);plot(X',Y','.');title(['nbody= ' num2str(nb)]);grid on;
figure(2);plot(real(Z'),'');grid on;title('Linear path plots(Amplitude)');
figure(3);plot(angle(Z'),'');grid on;title('Phase plots');
```

Fig (2): The observer effect

(a,b) Simulating the normal distribution curve using a Galton board, then destroying it by injecting an interference signal. ***See generating algorithm below****.*
(c): Producing the correct predictions of hidden variables statistics then destroying it by injecting an interference noise. ***See generating algorithm below***
(d): Hidden variable prediction curve from Alain Aspect et al ***[4]****..*

a b c d

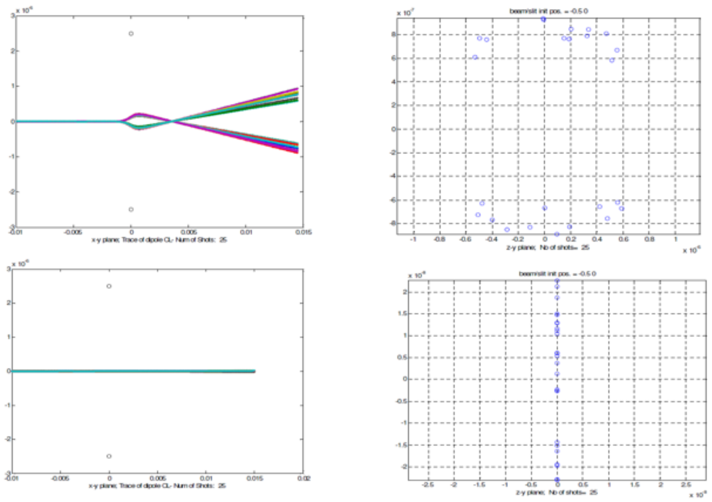



```
%Program to test the effect of sampling on normal distribution curve(Fig 2a,b).
%Create zero matrix, start from second top. at i,j guess 1/0 and add to the
%next row before and after j, then add and repeat.
clear all; close all;X=[];Y=[];    ni=21;nj=91;
M=zeros(ni,nj);nj1=1+(nj-1)/2; M(1,nj1-2:nj1+2)=1;
for kk=1:1000;for ii=2:ni;for jj=2:nj-1;m=0;if M(ii-1,jj)>0;m=1;end;'if';
```

```
pm1=0; pm2=0; pm1=round(rand);if
pm1==0;pm2=1;end;'if';m1=m*pm1;m2=m*pm2;%Change to + for disturbance.
M(ii,jj-1)=M(ii,jj-1)+m1;M(ii,jj+1)=M(ii,jj+1)+m2;
end;'jj';
end;'ii'; end;'kk';M1=sum(M,1);M1=M1/max(M1);
figure(1);plot(M1,'-r');grid on;
% ----------------------------------------------------------------------------------

%Program to simulate Bell's inequality test(Fig 2c).
clear all; close all;
n=1000;th1=rand(1,n)*pi/2; th2=pi+th1; th3=rand(1,n)*pi/2;thd=th1*180/pi;
x1=cos(th1);x2=cos(th2);x3=cos(th3);
x12=x1.*x2;x13=x1.*x3;x12m=mean(x12);x13m=mean(x13); [x12m x13m]
figure(1);plot(thd,-x12,'.');hold on;plot(thd,-x13,'.r');grid on;
xlabel('Products of cosine of two vectors; blue:entangled, red:random’)
```

Fig (3): Numerical simulation of the Stern-Gerlach experiment
T: Fixed dipoles fired across two strong poles- side and end views, B:Randomized dipoles scatter and produce a scatter trace on end screen. **Algorithm given in [1]**.



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https://dnb.info/1342321979/34#:~:text=The%20same%20cosine%20form%20is,violates%20Bell's%20inequality%20%5B13%5D
Quote:“ *Pearson correlation, between spins projected as up or down on the analyser axes also follows the cosine form hitherto uniquely ascribed to the quantum mechanical expectation value. The common cause for the classical correlation is the conservation of intrinsic angular momentum that aligns the two spins antiparallel at the breakup. Thus, as long as the spins retain their orientations relative to each other, the measurement of one spin in a chosen frame of reference also discloses the opposite orientation of the other in that frame.* “

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