A Theory of Kinematic Gravitation, and Some Fundamental Consequences

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We will be concerned with the study of relativistic density and hence demonstrate from first principles the possibility of kinematic black hole formation in inertial systems of coordinates in Minkowski spacetime. We will discuss the applicability of these principles to elementary particles on the basis of a set of geometrical assumptions, some general consequences, and also present alternative gravitational equations on the basis of some related elementary considerations. Finally, we will conclude with some general remarks on the meaning of these results.

1. On Relativistic Density:

Let an isolated spherical rigid solid S of rest mass m_0 and of radius r remain sufficiently removed from all other bodies in space. In the rest frame K there is $r_x = r_y = r_z = r$, thus its classical Euclidean volume V_0 , as observed from K can be defined by the following relation:

$$V_0 = \frac{4}{3}\pi r^3 \tag{1}$$

Its rest density ρ_0 is then given by:

$$\rho_0 = \frac{m_0}{V_0} \tag{2}$$

Consider a second frame of reference K’. In K’, the body is moving at velocity $\bar{v}$ along the x axis, therefore according to Special Relativity it shall experience length contraction only in the x-direction, such that its radius r'_x in the x will be given by:

$$r'_x = r_x \cdot \sqrt{1 - \frac{v^2}{c^2}} \tag{3}$$

Hence its the new volume V' is:

$$V'(v) = \frac{4}{3}\pi \cdot r_y \cdot r_z \cdot r'_x = \frac{4}{3}\pi \cdot r^2 \cdot r'_x \tag{4.1}$$

by substituting the r'_x value from eq. (3) we can rewrite:

$$V'(v) = \frac{4}{3}\pi \cdot r^2 \cdot r_x \cdot \sqrt{1 - \frac{v^2}{c^2}} \tag{4.2}$$

Which simplifies into:

$$V'(v) = \frac{4}{3}\pi r^3 \cdot \sqrt{1 - \frac{v^2}{c^2}} \tag{4.3}$$

Therefore there is:

$$V'(v) = V_0 \cdot \sqrt{1 - \frac{v^2}{c^2}} \tag{4.4}$$

Hence assuming mass is invariant, in the moving frame K' the density $\rho'(v)$ can be found by the following relation:

$$\rho'(v) = \frac{m_0}{V'(v)} \tag{5}$$

$$\rho'(v) = \frac{m_0}{V_0} \cdot \frac{1}{\sqrt{1-\frac{v^2}{c^2}}} \tag{5.1}$$

$$\rho'(v) = \rho_0 \cdot \frac{1}{\sqrt{1-\frac{v^2}{c^2}}} \tag{5.2}$$

Where ρ_0 is the rest mass density. A priori, we will consider the expressions aforementioned as correct representations of the law of the relativistic density as a function of velocity v, for all massive solids undergoing inertial motion in general. In any case, it is true for spherical bodies and therefore will suffice in our analysis.

2. Physical Description of Kinematic Black-hole Formation:

Consider a Schwarzfield black-hole which happens to be of rest mass m_0, and whose radius r_S is therefore given by the well known expression:

$$r_S = \frac{2Gm_0}{c^2} \tag{6}$$

Where $G = 6.6743 \times 10^{-11} m^3 kg^{-3}$ is the gravitational constant and $c = 299792458\, ms^{-1}$ is the speed of light in vacuum. The volume of a spherical body at rest is given by expression (1), therefore by substituting into it the above radius r_s in the stead of r, we may obtain the quantity V_s denoting the volume of a Schwarzfield black hole:

$$V_S = \frac{4}{3} \cdot \pi \cdot \left(\frac{2Gm_0}{c^2}\right)^3 \tag{7.1}$$

$$V_S = \frac{32G^3 m_0^3 \pi}{3c^6} \tag{7.2}$$

By substituting V_s in the place of volume V_0 in equation (2), we may describe the density ρ_s of such a black-hole. In so doing we obtain the following relation:

$$\rho_S = \frac{3c^6}{32G^3 m_0^2 \pi} \tag{8}$$

Let us now consider the following special case. According to equation (5.2), special relativity predicts that the density of a rigid body increases in proportion to its inertial velocity. If a body was to reach a linear velocity of a sufficient magnitude such that its relativistic density $\rho'(v)$ is equal to its Schwarzfield density ρ_S, in that particular frame of reference it shall collapse into a black hole. Let us solve for the velocity v_S which does satisfy this condition. We set $\rho_S = \rho'(v)$ by means of eq. (5.1) and eq. (8) and obtain the following relation:

$$\frac{3c^6}{32G^3 m_0^2 \pi} = \frac{m_0}{V_0} \cdot \frac{1}{\sqrt{1-\frac{v_s^2}{c^2}}} \tag{10}$$

We solve for v_s^2 and take the square root of both sides. In doing so we obtain the following expression for v_s:

$$v_S = \sqrt{c^2 - \frac{1024G^6\pi^2 m_0^6}{9c^{10}V_0^2}} \tag{11}$$

This quantity v_s we may refer to simply as the Schwarzfield *velocity*, such that in theory, any spherical body of rest mass m_0 and rest volume V_0 will collapse under its own mass into a blackhole upon reaching a velocity of this magnitude. This is purely a consequence of the effect of the Lorentz contraction on the density of moving rigid bodies of mass, in other words, this effect is a purely kinematic effect, as opposed to a conventionally understood gravitational effect, and therefore we may refer to such a black hole as a *kinematic* black hole.

On the right-hand side of the relation, we take special note of the quantity $\frac{1024G^6\pi^2}{9c^{10}}$, which is a constant value, and can be approximated to $1.69271758 \times 10^{-143}$, which is extraordinarily small, enough to render the last term close to zero in most cases, and for all purposes sets v_s close to equal to the speed of light. We designate this limiting quantity as the kinematic gravitationnal collapse constant L_s, which in normal cases acts to prevent moving matter from collapsing into a singularity from Lorentz pressure. The attached independent variable determining uniquely the Schwarzfield velocity, namely the quantity $\frac{m_0^6}{V_0^2}$, which we may rewrite as the product $\rho_0^2 m_0^4$ acts a kind of a kinematic 'gravitational collapse' potential and will be designated as K_S. If it is large enough for a given body, it may in these particular cases offset the smallness of the kinematic constant L_S, and enable estimations of appreciable Schwarzfield velocities. This is the case of the Sun, whose mass $1.9885 \times 10^{30} kg$ and density 1408.286119 $kg \cdot m^3$, thus its kinematic potential K_S is given by:

$$K_S = \rho_0^2 m_0^4$$

$$K_S = (1408.286119)^2 \cdot (1.9885 \times 10^{30})^4$$

$$K_S = 3.10087442 \times 10^{127}\ kg^6 m^6$$

The unit of K_s corresponds to units of linear mass density raised to the 6th power, a priori suggesting that the kinematic "potential", and by extension the Schwarzfield velocity itself is sensitive to mass density as it relates to *rectilinear* motion in particular. The corresponding

Schwarzfield velocity for the sun, with volume estimated at $1.412\ \times 10^{27}\ m^{3}$, according to equation (11) will be equal to:

$$v_{Si} = \sqrt{c^{2} - \frac{1024G^{6}\pi^{2}m_{0}^{6}}{9c^{10}V_{0}^{2}}}$$

$$v_{Si} = \sqrt{(299792458)^{2} - \frac{1024\cdot(6.6743\times10^{-11})^{6}\cdot\pi^{2}\cdot(1.9885\times10^{30})^{6}}{9\cdot(299792458)^{10}\cdot(1.412\times10^{27})^{2}}}$$

$$v_{Si} = 299792457.9999999999999999999999991255\ ms^{-1}$$

Which is a velocity slightly below the speed of light, and therefore constitutes an example of kinematic black-hole formation which is feasible in practice, albeit with a particularly large quantity of energy required. The more precise approximation of this number is 299792457.99999999999999999999999912559950975302721919236195459281469076718 8259411078559699256133703 ms^{-1}. Evidently of course, the Sun is not a black hole, but this is assuming the case where the solar system is at rest, however according to relativity, rest is only relative to an arbitrary choice of coordinates, that is to say, there must exist a frame of reference, perhaps co-moving with a very distant star system, where due to all manners of cosmological contributors of inertia, gravitation, and due to the expansion of the universe, the Sun may appear phenomenologically to these distant observers to be a black hole, if only its perceived linear velocity in their particular system of coordinates exceeds the velocity aforementioned. By extension, it is possible to take the general point of view that given some particularly chosen frames of reference, any arbitrary given massive body in the universe is a kinematic black hole, even if it happens not to be the case in our particular frame of reference. Consider now the following compact form of the Schwarzfield velocity equation:

$$v_{S} = \sqrt{c^{2} - L_{S} \cdot K_{S}} \tag{12}$$

In the case of a so-called *gravitational* black hole, we can make the reasonable hypothesis that $v_{s} = 0$, since it is already a black hole in the rest frame. That is, for the leftmost term, there is $c^{2} = \frac{1024G^{6}\pi^{2}m_{0}^{6}}{9c^{10}V_{0}^{2}}$, which we can notice is equal to the square of the ratio of the object's Schwarzfield density to its rest density multiplied by c^{2}. Therefore in general we can rewrite the product of the kinematic potential and constant in the form:

$$L_{S} \cdot K_{S} = \frac{\rho_{0}^{2}}{\rho_{S}^{2}} \cdot c^{2} \tag{13}$$

In the unique case of a Schwarzfield black hole, there must be $\frac{\rho_{0}^{2}}{\rho_{S}^{2}} = 1$. Assuming (13) to be true in general, even in frames of reference where the massive objects considered are not black holes, it follows that the following form of the Schwarzfield velocity v_{S} equation is valid:

$$v_{S} = \sqrt{c^{2} - c^{2} \cdot \frac{\rho_{0}^{2}}{\rho_{S}^{2}}} \tag{14}$$

Overall the units of expression (14) for v_S explicitly correspond to units of speed, therefore dimensionally the expression is self-consistent. We may compare the output for this relation in the case of the Sun as compared to that which was found earlier with eq. (11) to see if they are in perfect agreement. In doing so we take the rest density of the Sun as $\rho_0 = 1408.286119\, kg \cdot m^3$ according to eq. (2) and its Schwarzfield density as $\rho_S = 1.84279599 \times 10^{19} kg \cdot m^3$ in agreement with eq. (6). Substituting these values into eq. (14) we find a Schwarzfield velocity of:

$$v_{Sii} = \sqrt{(299792458)^2 - \frac{1}{(299792458)^2} \cdot \frac{(1408.286119)^2}{(1.84279599 \times 10^{19})^2}}$$

$$v_{Sii} = 299792457.99999999999700207542\, m \cdot s^{-1}$$

Which is a somewhat different value from v_{Si}. It must be noted however, equations (11) and (14) are the same equations from the point of view of the derivations of this section, and any numerical differences that are apparent here may be entirely attributed to differences in the precision, accuracy, and of the nature of the instruments and techniques used in obtaining the different experimental values involved. In this particular case, the Sun's density ρ_0 and its Schwarzfield density ρ_S only have 10 and 9 significant figures respectively, which contrasts with the number of significant figures used to compute v_{Si}, which is up to 90 significant figures, and this difference in precision alone should suffice in explaining the discrepancies. For many practical cases, it will be preferable to utilize eq. (14) if both rest density and Schwarzfield density are known with sufficient precision and accuracy. Despite this numerical equivalence between the equations, we may note the elegance and simplicity of eq. (14), which also makes explicit the role played by volumetric mass density in gravitational phenomena. Equation (11) has the advantage of only requiring the mass and volume of a material object. Equation (14) suggests that for all ordinary bodies possessing mass and extension in space, such that there is a meaning in evaluating their mass density in the rest frame, there exists an indefinite number of subliminal inertial frames of reference, such that these bodies, in other words most objects known in the observable universe, would be perceived as black holes by the observers co-moving with these particular frames of reference. An alternative form of eq. (14) is obtained by factoring out c^2 such that there is:

$$v_S = c \cdot \sqrt{1 - \frac{\rho_0^2}{\rho_S^2}} \tag{14.1}$$

Which is more simple and elegant from the point of view of redundancy of terms, and will be of equal use in all situations applicable to eq. (14).

3. Physical validity for quantum particles:

The physical validity of a Schwarzfield velocity equation can be discussed only to the extent that any and all bodies of mass collapse into black holes upon reaching their Schwarzfield density ρ_s in all inertial frames of reference, and also to the extent that there can be a meaning in defining “volumes” and “densities” for a particular class of massive objects. A priori, this is not the case for elementary particles according to quantum field theory, where particles are considered as geometrical points in a quantum field of infinite extent, neither is it the case even in conventional quantum mechanics, where they are either undefined in the sense of superposition, or they are exactly localized as geometrical points in situations where they have been measured. Although this rather mathematical point of view has been fruitful both theoretically and in relation to experimental predictions, it seems to prevent one from ever taking seriously the notion of kinematic gravitational collapse in the case of individual massive elementary particles, as a matter of principle. We will attempt to resolve this issue by artificially assuming that there can be a sense in which massive elementary particles occupy non-zero physical volumes in space, and as such undergo linear translations of finite velocity in space, firstly on account of the relativity of motion, and secondly on account of experiments attesting of such kinds of translations with respect to definite dimensions. For instance, double slit experiments betray the extendedness of electrons in space, since there exists a finite range of slit lengths which are compatible with the propagation of electrons in space, beyond which even interference effects no longer occur, indicating that there is a meaning in discussing the “size” of an electron, whereby certain slit lengths are capable of appreciably affecting their trajectories, and certain slit lengths are even too *small* to let electrons through. Recent nano-scale electron optics experiments confirm that for slits of length inferior to the electron’s wavelength, which is a function of its momentum, the probability of transmission becomes negligible (Zewail, A. H., 2010). This suggests that there exists a physical correlation between the volumetric extension of an electron in space and its wavelength in a particular frame of reference. We postulate this correlation as a valid physical characteristic of all elementary and quantum particles in general. Accordingly, we will turn our attention to the Compton wavelength, that is a fundamental wavelength corresponding to the Planck-Einstein relation. We will remind first the usual form, applicable for a quantum particle, including the electron as:

$$E = hf \tag{15.1}$$

Where E is the energy associated with an elementary particle of frequency f, and h is the Planck’s constant in SI units which we take as $h = 6.62607015 \times 10^{-34} J \cdot s$. In terms of wavelength, eq.(15.1) corresponds to:

$$E = h \cdot \frac{1}{\lambda} \tag{15.2}$$

Where λ is the wavelength for that particular energy value. It might also be re-rewritten in the following form for the particle at rest:

$$m_0 c^2 = h \cdot \frac{1}{\lambda_C} \tag{15.3}$$

Where λ_C is the particle’s so-called Compton wavelength.

Solving for λ_C we get:

$$\lambda_C = \frac{h}{m_0 c^2} \tag{16}$$

We would like now to define the “volume” V_C of an elementary particle at rest as the volume of a sphere of diameter equal to its Compton wavelength λ_C. Hence, its radius will be $\frac{\lambda_C}{2}$. We can thus write the volume of an elementary particle at rest as:

$$V_C = \frac{\pi\lambda_C^3}{6} \tag{17}$$

Therefore the particle’s density at rest ρ_C is defined:

$$\rho_C = \frac{6m_0}{\pi\lambda_C^3} \tag{18}$$

We now apply these relations to an electron. We solve eq. (16) for an electron of mass $m_e = 9.10938356 \times 10^{-31} kg$ so that we can find its Compton wavelength:

$$\lambda_C = \frac{h}{m_e c^2}$$

$$\lambda_C = \frac{6.62607015\times10^{-34}}{9.10938356\times10^{-31}\cdot(299792458)^2}$$

$$\lambda_C = 2.426 \times 10^{-12} m$$

Therefore, solving eq. (18) with the Compton wavelength, the electron’s rest density ρ_e is found by:

$$\rho_e = \frac{6\cdot9.10938356\times10^{-31}}{\pi\cdot(2.426\times10^{-12})^3}$$

$$\rho_e \approx 121,848.36222579\, kg \cdot m^{-3}$$

Which can be expressed more precisely as 121848.36222578919208132691278758694489031567683253076511503477795612627073301230604601391118245 $kg \cdot m^{-3}$. In the case of elementary particles in general, which are normally impossible to localise precisely in space due to their quantum nature, we tentatively defined, by lack of an alternative definition, and on the basis of the Compton wavelength λ_C, their corresponding Compton volume V_C and Compton density ρ_C, which can be used, a priori, as good practical values for any given elementary particle for the sake of some theoretical calculations, according to a particular interpretation of electron optical experiments. We may now find Schwarzfield density value for the electron using eq. (8):

$$\rho_{Se} = \frac{3\cdot(299792458)^6}{32\cdot(6.6743\times10^{-11})^3\cdot(9.10938356\times10^{-31})^2\,\pi}$$

$$\rho_{Se} = 8.78113133 \times 10^{139}\, kg \cdot m^3$$

Now using ρ_e, ρ_{Se} and eq. (14) we can compute the Schwarzfield velocity of an electron as:

$$v_{Se} = \sqrt{(299792458)^2 - (299792458)^2 \cdot \frac{(121848.36222579)^2}{(\ 8.78113133\times10^{139}\ )^2}}$$

$$v_{Se} = 299,792,457.9999999\, ms^{-1}$$

Which is approximated more precisely by the value 299792457.9997113781842802685473ms^{-1}, which corresponds to about 99.9903726125185% of the speed of light. This velocity is not in contradiction with the principle of locality, and is therefore achievable in practice, provided that an electron is given a sufficient quantity of kinetic energy. Let us find the magnitude of this energy. The total energy of a particle in a given state of inertial motion is defined in special relativity as:

$$E = \frac{m_0 c^2}{\sqrt{1 - \frac{v^2}{c^2}}} \tag{19}$$

Which reduces to the rest energy $m_0 c^2$ in the rest frame. Hence, kinetic energy can be defined as:

$$E_K = m_0 c^2 \left[\frac{1}{\sqrt{1 - \frac{v^2}{c^2}}} - 1 \right] \tag{20}$$

Let us find first in general, for a given body of mass m_0 and rest density ρ_0, the energy value required to reach its Schwarzfield velocity v_S by substituting the value from eq.(14) into equation (20), such that the body's relative velocity v will be defined as $v = v_S$. We define this energy as the body's Schwarzfield kinetic energy E_S. It can be expressed as:

$$E_{KS} = m_0 c^2 \left[\frac{1}{\sqrt{1 - \frac{\left(c \cdot \sqrt{1 - \frac{\rho_0^2}{\rho_S^2}} \right)^2}{c^2}}} - 1 \right] \tag{21.1}$$

Which reduces simply to:

$$E_{KS} = m_0 c^2 \left[\frac{\rho_S}{\rho_0} - 1 \right] \tag{21.2}$$

Thus, the particle's total Schwarzfield energy E_S is simply:

$$E_S = \frac{m_0 c^2 \rho_S}{\rho_0} \tag{22}$$

Of course, this total relativistic energy equation is general, and therefore should also apply to massive bodies at a macroscopic scale. Calculating E_{KS} and E_S for quantum particles will involve using their Compton volumes and densities. In any case, according to the above expression the energy required to accelerate an electron from rest to its Schwarzfield velocity is:

$$E_{KS} = (9.10938356 \times 10^{-31})\cdot (299792458)^2\left[\frac{(8.78113133\times10^{139})}{121848.362} - 1\right]$$

$$E_{KS} = 5.90012444 \times 10^{121} J$$

Which exceeds the total known available mass energy in the observable universe. Therefore, according to our assumptions about the size of elementary particles, and our initial reasoning, it is exceedingly difficult for a single electron to collapse into a “kinematic black hole”. We may understand this result if we consider the electron’s gravitational collapse potential in this case:

$$K_S = \rho_0^2 m_0^4$$

$$K_S = (121848.36222579)^2 \cdot (9.10938356 \times 10^{-31})^4$$

$$K_S = 6.8858246 \times 10^{-121} kg^6 m^6$$

Which is exceedingly small and therefore will have very little effect in offsetting the gravitational collapse constant L_S as seen in eq.(12). However despite the energy required, achieving the velocity v_{Se} is not physically impossible with respect to the principle of locality. Furthermore, in light of the Galilean relativity principle, and to the extent that elementary particles have finite volumetric extensions which are subject to kinematic Lorentz contraction, we may consider that all massive elementary particles and massive quantum particles by extension are *quantum* kinematic black holes according to observers in an indefinite number of inertial frames of reference in spacetime that exist in theory for possible observers. On the particular point of the practical plausibility of this energy, we further extend the case of cosmic inflation in Big-Bang like situations, where velocities and energies may well be in excess of E_{KS}.

We will now turn to the non-trivial question of describing what this should exactly mean in practice in the case of an elementary particle. According to the form of the Planck-Einstein relation in eq.(15.2), it is evident that the energy of a particle is inversely proportional to its wavelength λ, which we have taken for lack of a better definition, to define the extent of its diameter in spherical volumetric space in a particular inertial reference frame. Firstly, we must say that this assumption is not trivial, since it goes blatantly against the expected physical geometry of moving spheres in Minkowski space, which appear to be ‘flattened' ellipsoids in a Synge world-map (Penrose, 1959). However, on account of the aforementioned experiments in electron-optics, we are compelled to accept the view that relativistic contractions affect elementary particles in all 3 spatial dimensions, instead of 1, such that their volumes remain spherical even during motion, for if it were not the case, the de Broglie wavelength would not be a function of linear momentum, and to the extent that it must be, it would not be expected at all to be correlated to the probability of transmission for slits directly orthogonal to their direction of travel. Elementary particles must have a spherical extension in space in all frames of reference such that their *overall* effective dimensions are a direct function of their momentum in any arbitrary direction. Having formulated more clearly the basis of this geometrical postulation, we return to the question of the wavelength value for the fastly moving particle. Firstly, we equate the energy terms in the relativistic energy expression from eq. (19) with the wave energy term from eq. (15.3) in the context of a transformation from a rest frame to a moving frame, such that there is:

$$\frac{m_0 c^2}{\sqrt{1-\frac{v^2}{c^2}}} = h \cdot \frac{1}{\lambda} \tag{22}$$

Which reveals an evident relation of inverse proportion between energy and wavelength. This proportionality, if we consider that there is any meaning, even in principle, in our suppositions about the density and volume of elementary particles, is in accordance with the relativistic density equation expressed in eq. (5.2). In fact, given the Lorentz contraction, this is to be very much expected, nevertheless, this relation highlights the potential for a classical analogy between volumetric-mass-density and *wavelength-mass-density* in the context of relativistic kinematics applied to elementary particles, and hence potential applications for quantum gravity research. In any case, we may now describe a theoretical quantum kinematic black hole as: a quantum particle whose total relativistic energy corresponds to a wavelength which is sufficiently small in comparison to its mass so as to cause a local singularity in space-time.

We will now find the wavelength corresponding to such a 'quantum' kinematic blackhole in relation to the previous considerations in this section. Let there be a wavelength λ_S for an elementary particle corresponding to the particle's Schwarzfield velocity v_S. Let the Planck-Einstein energy of a moving quantum particle, which can be expressed according to the form of eq. (15.3), be exactly equal to its Schwarzfield kinetic energy E_S as described by eq. (22). Therefore there will be:

$$\frac{m_0 c^2 \rho_S}{\rho_C} = h \cdot \frac{1}{\lambda_S} \tag{22}$$

Solving for λ_S we get:

$$\lambda_S = \frac{h\rho_C}{m_0 c^2 \rho_S} \tag{23}$$

In general, we define a quantum black hole as an elementary particle whose de Broglie wavelength abides by the above relation. This wavelength can also be written in the following manner on account of the definition of Schwarzfield density ρ_S in eq. (8):

$$\lambda_S = \frac{32 G^3 h \pi m_0 \rho_C}{3c^8} \tag{23}$$

4. Consequences for Gravity:

Additionally, as laws of nature have a tendency to be linear, if gravitational collapse can occur as a result of an exceedingly high velocity, it can be considered that any arbitrary increase in velocity is necessarily correlated with an increase in the gravitational field strength of a body of mass, such that there exists a general equation of gravitational field strength which is both a function of its mass and its relative velocity for all inertial coordinate systems. From the above considerations it can be said that gravitation is necessarily relative. In agreement with the form of eq. (14) and previous considerations in this paper, we make the hypothesis that the gravitational field will be proportional in particular to relative density $\rho'(v)$, as opposed to $(\rho'(v))^2$ or even relative volume for instance. This hypothesis happens to also be in agreement with the conventional units of the classical gravitational field strength. Let us attempt to find this total gravitational field strength equation $g'(v)$, as well as evaluate the strictly kinematic contribution to the gravitational field strength $g_K(v)$. We make the hypothesis that both of these equations will be functions of density, which by the law of Lorentz contraction is dependent on velocity v of a body of rest mass m_0, rest volume V_0 and rest density ρ_0, as determined by eq. (5.2). Let us first consider the classical Newtonian gravitational field strength, which can be expressed in the following form:

$$g_0 = G \cdot \frac{V_0 \cdot \rho_0}{r^2} \tag{15}$$

We denote g_0 as the acceleration experienced by a point mass M_2 of mass m_2 separated by a distance r to to a volumetric body M_1 of rest of mass m_0 and density ρ_0 due to the gravitational attraction of the latter, under the aforementioned hypothesis that such a quantity varies with velocity. Hence for our purposes, we will refer to the quantity g_0 as the ‘rest’ gravitational field strength. We now rewrite eq. (15) by substituting $\rho'(v)$ as the value for density, according to eq. (5.3) in order to find $g'(v)$. In doing so we obtain:

$$g'(v) = G \cdot \frac{V_0 \cdot \rho_0}{r^2} \cdot \frac{1}{\sqrt{1-\frac{v^2}{c^2}}} \tag{16}$$

Hence we can simply write:

$$g'(v) = g_0 \cdot \frac{1}{\sqrt{1-\frac{v^2}{c^2}}} \tag{16.1}$$

The quantity $g'(v)$ corresponds to a general velocity dependent gravitational field strength, which in the special case of $v = 0$ reproduces the classical Newtonian gravitational field strength equation. Therefore, at least to the humble extent that Newton’s law of universal gravitation applies to rigid bodies of mass and extension, the associated gravitational field strength in a particular inertial frame of reference is approximated more accurately by $g'(v)$. Now, assuming that the kinematic contribution $g_K(v)$ to this general field strength is in addition to the purely ‘gravitational’ field strength g_0, we may define it as such:

$$g_K(v) = g'(v) - g_0 \tag{17}$$

Which, by substituting the corresponding values from eq. (15) and (16.2), we may rewrite it more explicitly in the following form:

$$g_K(v) = g_0 \cdot \left[\frac{1}{\sqrt{1 - \frac{v^2}{c^2}}} - 1 \right] \tag{17.1}$$

Therefore, according to our assumptions, and within the range of validity of eq. (15) the *kinematic* gravitational field strength $g_K(v)$, which is a gravitational intensity acquired by an object of mass m_0 and volume V_0 only by means of its increasing velocity can be approximated by expression (17.1). The total field strength of a moving mass will be given by the quantity $g'(v)$. For negligible masses, and especially in the regime of relativistic velocities, the field strength should be given almost exactly by $g_K(v)$, since in both of these cases the quantity g_0 is negligible in comparison to $g'(v)$.

Furthermore, according to this line of reasoning, the total magnitude of the gravitational force F'_g experienced by a hypothetical point mass M_2 of mass m_2 due to the inertia of M_1 is simply:

$$F'_g = g'(v) \cdot m_2 \tag{18}$$

Hence,

$$F'_g = g_0 \cdot \frac{m_2}{\sqrt{1 - \frac{v^2}{c^2}}} \tag{18.1}$$

Similarly, the kinematic gravitational force this moving mass exerts on the hypothetical point mass M_2 in its vicinity will be:

$$F'_K = g_K(v) \cdot m_2 \tag{19}$$

$$F'_K = g_0 \cdot \left[\frac{m_2}{\sqrt{1 - \frac{v^2}{c^2}}} - m_2 \right] \tag{19.1}$$

The form of expression (19.1) suggests that for inertially moving bodies of mass, as $v \rightarrow c$, the kinematic gravitational force F'_K approaches infinity, which is a further indication suggesting the possibility of purely kinematic black-hole formation.

Furthermore, in this new framework, if an observer is in the coordinate system where a moving mass M_1 moves rectilinearly at constant velocity v, such that $v = v_S$, which corresponds to the minimal inertia for a volumetric massive body to collapse into a kinematic black hole, the total gravitational force F'_{gK} of such a body can be by obtained by substituting the Schwarzfield velocity v_S from eq. (14.1) into eq. (18.1) :

$$F'_{gK} = g_0 \cdot m_2 \cdot \frac{1}{\sqrt{1 - \frac{c^2 \cdot \left(1 - \frac{\rho_0^2}{\rho_S^2}\right)}{c^2}}} \tag{20}$$

Therefore,

$$F'_{gK} = g_0 \cdot \frac{\rho_S}{\rho_0} \cdot m_2 \tag{21}$$

F'_{gK} approximates the total gravitational force exerted by a kinematic body on a point mass M_2 of mass equal to m_2. These gravitational force equations, to the extent that they correlate with reality, and any physically valid gravitational relation in general which depends upon volumetric mass density, may be applicable both to classical objects and to elementary particles, and particles within the scope of quantum mechanics, by way of our postulations of section 3.

5. Further Consequences and Final Remarks:

The connection between Relativity and It is known from formal considerations of the General Theory of Relativity that, from the perspective of an outside observer, a wormhole is indistinguishable from a black hole. Let us now consider two identical massive elementary particles α and β in empty space in a suitably chosen frame of reference K, such that their respective velocities have magnitudes equal to or greater to their corresponding Schwarzfield velocities, in relation to their mass and ordinary 'volume' at rest. We denote their respective immediate spatial vicinities as systems A and B. In such a frame of reference, an observer may equally conclude, depending on the circumstance, either that the system consists of 2 disconnected kinematic quantum black holes in space, or that the system constitutes the 2 opposite ends, in four-dimensional spacetime, of a single wormhole, let us suppose, having been formed by an ulterior interaction between two corresponding kinematic black holes in the sense described in our investigation, or by any other allowable physical means of interaction between the two particles enabling the formation of a wormhole. This special type of hypothetical structure, which is, in this particular case, phenomenologically frame-dependent, i.e. relative according to inertial observers, may be simply referred to as a *kinematic* quantum wormhole. If the observer in K happens to be in the latter situation, there is a possibility that a quantity of information may travel from one end of the kinematic wormhole to another, assuming the stability of the structure. If they are sufficiently separated in space, information will thus appear to travel at a rate 'exceeding' the speed of light according to the observer, who is located outside the wormhole and therefore calculates distances according to 3-dimensional extensions in a flat spacetime. We consider here this very case, where the information transfer from system A to system B appears to occur at a rate 'exceeding' the rate of the speed of light with respect to the flat spatial distance separating the particles according to the observer in K. Nevertheless, if they have been made aware of the wormhole's existence by empirical proof or via logical deduction, they will conclude that this phenomenon must be simply enabled by its unusual spacetime geometry, and is therefore neither in contradiction with locality nor with the conservation of information, since the total information in the system A+B is entirely conserved. Let there be a second observer in any other arbitrarily chosen inertial frame of reference K', which happens to be characterized only by a state of motion such that our two identical particles have observable velocities in the regime below their Schwarzfield velocity v_S, and therefore behave neither as black holes or wormholes by extension, and appear to behave as perfectly ordinary quantum particles. By the law of conservation of total energy in the universe, and by the law of causality, which implies the conservation of information, the sum of the total amount of information in the vicinity of system A added to that in the vicinity of system B must yet remain conserved, however far they may be separated, and therefore the information transfer from system A to system B as described previously must be a relativistic invariant. Let us suppose that the observer notices this transfer and attempts to explain it: they will note of information being transferred from system A, which contains a particle α of a specific mass and volume in space, and a corresponding quantity of information affecting system B, constituted of an identical particle β of equal physical attributes, such that their respective states always appear to be *correlated* supraliminally. In K', the particles are not behaving as blackholes, but as ordinary particles, and therefore the observer in K' must conclude that the particles are simply entangled. By Occam's razor, there can only be one explanation for a single phenomenon. Similarly, it had been the case for the magnetic force, which having been previously ineffable and mysterious to physicists, eventually came to be explained as the result of a net static force caused by differential charge densities, arising as an effect of the Lorentz contraction on electrical currents as viewed by observers in the frame of reference of the moving charges. Therefore, in light of our investigation, the possibility of kinematic black hole formation in the context of relativity opens the door to novel rational explanations for quantum entanglement, by concession of only very conservative hypotheses regarding the dimensions of elementary particles, hereby elegantly reconciling the 'spooky' phenomena of quantum mechanics with the principle of locality and the conservation of information.

We hesitate here to make additional conjectures about cosmology regarding dark matter and energy, but in any case, it appears evident that if kinematic black holes do exist in certain inertial frames of reference, then to the extent that phenomenology of gravitation includes invariant physical quantities and irreversible entropic events, it is likely impossible to fully comprehend all modern results of cosmology without fully considering the consequences of kinematic gravitation, which follows from the principle of relativity.

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