CODATA CONSTANTS PROCESSING EXPOSES NEW PROPERTIES OF BLACK HOLES AND LINKS GRAVITY TO QUANTUM PHYSICS

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Introduction

The Standard Model describes the three fundamental forces important at the subatomic scale: electromagnetism, strong nuclear force, and weak nuclear force. These forces are mediated by particles called bosons, which are force carriers that can be exchanged between matter particles called fermions. The Standard Model also includes the Higgs boson, which is responsible for giving mass to some of the particles; but it does not include gravity, because of incompatibilities that arise when trying to combine it with general relativity and the modern theory of gravity.

Gravity, however, is not considered a force in the same sense as the other three. According to general relativity, gravity is the result of the curvature of spacetime caused by the presence of mass-energy. Gravity affects all forms of energy and matter, not just fermions. Gravity is also seen to be much weaker than the other forces at the subatomic scale. The gravitational attraction between two protons is weaker than their electromagnetic repulsion by a factor of 10^{36}. Therefore, gravity has been neglected in most situations involving elementary particles. However, gravity cannot be ignored in situations where spacetime curvature becomes very large, such as near black holes or in the early universe. In these cases, one would need a quantum theory of gravity that can describe how gravity behaves at very small scales and high energies. Such a theory would also need to explain how gravity interacts with the other forces and particles in a consistent way. One possible way to do this is to introduce a hypothetical particle called the graviton, which would be the quantum of the gravitational field and act as a force carrier for gravity.

The problem is that there is no known way to make a quantum theory of gravity compatible with both general relativity and quantum mechanics. The two theories have different mathematical frameworks and physical assumptions that are hard to reconcile. For example, general relativity assumes that spacetime is smooth and continuous, while quantum mechanics assumes that physical quantities are discrete and probabilistic. General relativity also predicts singularities, where spacetime becomes infinitely curved and physical laws break down, while quantum mechanics forbids such infinities.

There have been many attempts to create a quantum theory of gravity, such as string theory, loop quantum gravity, causal dynamical triangulation, asymptotic safety, and others. However, none of these theories have been experimentally verified or widely accepted by the physics community. They also face many conceptual and technical challenges, such as finding a unique solution, explaining the origin of spacetime, avoiding paradoxes and inconsistencies, and making testable predictions.

Therefore, gravity is not included in the Standard Model because it is not well understood at the quantum level, and it does not fit into the existing framework of particle physics. The Standard Model is an effective theory that works very well for describing most phenomena at low energies and small curvatures of spacetime, but it is incomplete with general relativity and needs to be extended or replaced by a more fundamental theory that can account for gravity and other open questions.

The disagreements that arise when trying to combine general relativity, the modern theory of gravity, and quantum mechanics are mainly due to the different assumptions and frameworks that these theories use to describe physical reality. General relativity is a classical theory that assumes that spacetime is smooth and continuous, and that gravity is the result of the curvature of spacetime caused by the presence of mass-energy. Quantum mechanics is a quantum theory that assumes that physical quantities are discrete and probabilistic, and that the other three forces are mediated by particles called bosons. Some of the main contradictions between these two theories include:

- **The problem of time**: Quantum mechanics regards the flow of time as universal and absolute, meaning that there is a single clock that measures time for all observers and events. General relativity regards the flow of time as malleable and relative, meaning that different observers and events may experience different rates of time depending on their motion and position in a gravitational field. This leads to difficulties in defining a consistent notion of time in a quantum theory of gravity.

- **The problem of nonrenormalizability**: Quantum mechanics uses a technique called renormalization to deal with infinities that arise in calculations involving interactions between particles. Renormalization involves introducing some arbitrary parameters, called cutoffs, that limit the range of energies or distances involved in the calculations. These parameters are then adjusted to match experimental observations. General relativity, however, predicts singularities, where spacetime becomes infinitely curved and physical laws break down. These singularities cannot be removed by renormalization, because they involve infinite energies or distances. This means that a naive quantum theory of gravity would produce nonsensical results that depend on arbitrary choices of cutoffs.

- **The problem of locality**: Quantum mechanics allows for nonlocal phenomena, such as entanglement and tunneling, where particles can influence each other instantly or appear in places where they have zero probability of being. These phenomena violate the principle of locality, which states that physical effects can only propagate through spacetime at a finite speed (the speed of light). General relativity, on the other hand, respects the principle of locality, because it is based on the idea that spacetime is a smooth manifold that can be described by local coordinates and tensors. This leads to conflicts between the two theories when trying to describe how gravity interacts with quantum systems.

These are some of the main conflicts between general relativity and quantum mechanics, but there are others as well. For example, there is the problem of measurement, which involves the role of observers and decoherence in quantum systems; the problem of causality, which involves the possibility of closed timelike curves and paradoxes in general relativity; and the problem of information loss, which involves the fate of quantum information that falls into a black hole.

To overcome the problems of quantum gravity, physicists need to find a new theory that can consistently describe how gravity behaves at very small scales and high energies, and how it interacts with the other forces and particles in a quantum way. Such a theory would also need to explain the origin of spacetime, avoid paradoxes and inconsistencies, and make testable predictions that can be verified by experiments or observations. There are many possible ways to approach this challenge, but none of them have been proven or widely accepted yet. Here are some of the main approaches that physicists have pursued:

- **String theory**: This theory proposes that the fundamental entities of nature are not point-like particles, but rather tiny vibrating strings that can have different modes and shapes. These strings can also form higher-dimensional objects called branes. String theory aims to unify all the forces and particles by describing them as different vibrations of strings in a 10- or 11-dimensional spacetime. String theory also incorporates general relativity by showing that gravity emerges from the geometry of the extra dimensions. However, string theory faces many difficulties, such as finding a unique and realistic solution among the vast landscape of possible string vacua, explaining why we observe only four dimensions of spacetime, and testing its predictions experimentally.

- **Loop quantum gravity:** This theory attempts to quantize general relativity directly, without introducing any new entities or dimensions. Loop quantum gravity uses a mathematical framework called spin networks, which are graphs that represent the quantum states of spacetime geometry. These spin networks evolve in discrete steps, implying that spacetime is granular and has a minimum length scale. Loop quantum gravity also predicts that black holes have discrete spectra of area and entropy, and that they eventually evaporate into Planck stars. However, loop quantum gravity faces many challenges, such as incorporating matter fields and interactions, deriving the classical limit of general relativity, and testing its predictions observationally.

- **Causal dynamical triangulation**: This approach tries to construct a quantum theory of gravity using a technique called lattice gauge theory, which is widely used in quantum field theory. Causal dynamical triangulation approximates spacetime as a collection of *simplices* (triangles in two dimensions, tetrahedra in three dimensions, etc.) that are glued together in a way that preserves causality and dynamical evolution. By summing over all possible configurations of simplices, one can obtain an effective action for quantum gravity. Causal dynamical triangulation has shown some promising results, such as reproducing the dimensionality and shape of spacetime at large scales and predicting a phase transition between quantum and classical regimes. However, causal dynamical triangulation also faces some problems, such as incorporating matter fields and interactions, explaining the origin of time asymmetry, and testing its predictions experimentally.

These are some of the main approaches proposed to overcome the problems of quantum gravity, but there are others as well. For example, there is asymptotic safety, which is an idea that quantum gravity becomes well-defined at high energies by reaching a fixed point; there is causal sets, which is an idea that spacetime is composed of discrete elements that form a causal order; there is emergent gravity, which is an idea that gravity is not a fundamental force but a consequence of thermodynamics or entanglement; and there are many more.

Known properties of the event horizon of black holes

The black hole boundary past which light cannot escape, is the event horizon. It is not a physical boundary, but rather a region in spacetime that marks the limit between an area where matter and energy can escape and one where they cannot. The escape velocity at the event horizon is equal to the speed of light, and nothing inside the event horizon can ever cross the boundary and escape outside, including light. The event horizon is what makes a black hole black, and it is considered the black hole's surface. Some of the known properties of the event horizon in black holes include:

- The size of the event horizon depends on the mass of the black hole. The radius of the event horizon is proportional to the mass of the black hole, according to the formula: $\mathbf{rs = 2GMc^2}$, where *rs* is the radius of the event horizon, G is Newton's gravitational constant, M is the mass of the black hole, and c is the speed of light. This radius is also known as the Schwarzschild radius, after Karl Schwarzschild, who first derived this formula in 1916.

- The shape of the event horizon depends on the rotation and charge of the black hole. A non-rotating and uncharged black hole has a spherical event horizon, as described by the Schwarzschild solution. A rotating black hole has a distorted, oblate spheroidal event horizon, as described by the Kerr solution. A charged black hole has a deformed, prolate spheroidal event horizon, as described by the Reissner-Nordström solution. A rotating and charged black hole has a more complicated event horizon, as described by the Kerr-Newman solution.

- The temperature of the event horizon depends on the surface gravity of the black hole. The surface gravity of a black hole is a measure of how strong its gravitational pull is at its event horizon, the higher the surface gravity, the lower the temperature of the event horizon. The temperature of the event horizon is inversely proportional to its surface gravity, according to the formula: $\mathbf{T = \hbar c^3/(8pi\ G\ k_B\ M)}$, where T is the temperature of the event horizon, ħ is the reduced Planck constant, c is the speed of light, G is the gravitational constant, k_B is the Boltzmann constant, and M is the mass of the black hole. This temperature is also known as the Hawking temperature, after Stephen Hawking, who first predicted that black holes emit thermal radiation due to quantum effects near their event horizons in 1974.

There has been no complete theory that can describe both black holes and subatomic particles consistently. Black holes are objects of general relativity, the theory of gravity and spacetime, while subatomic particles are objects of quantum mechanics, the theory of matter and energy at the smallest scales. These two theories are incompatible with each other, and we need a theory of quantum gravity to unify them.

However, some physicists have proposed some possible connections or analogies between black holes and subatomic particles, based on certain properties that they may share. For example:

- **Hawking radiation** is a process by which black holes can emit subatomic particles and lose mass over time. This is a quantum effect that arises from the interaction of the black hole's event horizon with quantum fluctuations in the surrounding vacuum.

- **Quantum entanglement** is a phenomenon by which two or more subatomic particles can share a quantum state and influence each other, even when they are far apart. Some physicists have suggested that quantum entanglement may also play a role in the structure of spacetime and the formation of wormholes, which are hypothetical shortcuts in spacetime that could connect distant black holes.

- **Spin** is a property that measures the intrinsic angular momentum of subatomic particles and black holes. Spin affects how these objects interact with magnetic fields and other particles or fields. However, the spin of a black hole is not the same as the spin of a subatomic particle, because a black hole is not a point particle, but a region of spacetime with a singularity at its center.

These are some examples of properties that may relate to black holes and subatomic particles, but they are not definitive or conclusive. There may be other properties that we do not know yet or that we cannot measure or observe. We need more theoretical and experimental progress to understand the nature of these objects better.

Objective

The objective of this paper is to analyze and process the constants and conversion factors of physics and chemistry published by the 2014 Committee on Data for Science and Technology (CODATA) and other reputable sources, to explore possible connections and associations between the data in relation to black holes and quantum physics. The results will present evidence of new properties of the event horizon of black holes; and how they share the same properties with the subatomic particles from the quantum world.

Insight

The concepts and theoretical formulas about the speed of light, rest mass, gravity at a surface of a massive body, escape and orbital velocities, Newton's second law of motion, kinetic, and potential energies, and the Schwarzschild radius have been extensively studied and associated with the Newton's gravitational constant G in classical physics, culminating with Einstein's theory of general relativity and its many verifications that proof its validity. While quantum physics have been very successful in explaining the subatomic world in terms of the speed of light, Planck's constant, Compton's and Debroglie's wavelengths, frequency and internal energy, which have paved the way and shaped the basis of today's technologies. Both theories have been studied well, but trying to merge them into a single theory has proven to be a major challenge. All the efforts to solve the puzzle have a common condition, they have been approached from the point of view of masses in motion and in relation to other masses, as commonly observed in the universe.

There is little, if any, information about addressing the problem from an isolated mass and at rest, probably because it has been deemed a superfluous and obvious condition. However, it is known that masses and energy curve the surrounding spacetime to generate gravity by themselves, without the need of them being in motion or in association with other masses. Therefore, my purpose with this paper is to explore gravity from a motionless and isolated condition, from the point of view of potential energies and from the framework of the mass itself.

Assumptions

The one thing that both theories have in common is the speed of light and, in one way or another, a relationship with time. However, that time is not related to our every day understanding of yesterday, today or tomorrow. Their time is specific and directly related to the conditions at the moment and location of the observation. Therefore, the speed of light will be the starting point.

Since the focus will address the motionless condition, it is irrelevant to talk about linear or angular momentum. Once angular momentum is discarded, there is no need to include pi (π) as a factor in the calculations, (except when area, and therefore pressure is concern). In consequence, the Planck's constant will not be in its reduced form, and angular frequency (ω_o) will not be used, it will simply be frequency.

The time of orbital period will be replaced by a time that corresponds to the time taken by a falling object from a given distance under the influence of the local gravity, which correlates to with the time of oscillatory systems. But to be consistent with the motionless notion, and using a distance equal to the radius of an isolated and motionless spherical body, I named it the *virtual collapse time* (from the eventual collapse if a mass were to fall into the singularity due to its own gravity, as if there were no internal forces acting on it to prevent the collapse). Therefore, the time in a motionless gravitational system is simply: $\mathbf{t = (2r/}\boldsymbol{g}\mathbf{)^2}$, Where *t* is the virtual collapse time, *r* is a radial distance, and *g* is the value of gravity at distance *r* from the center of the gravitational mass. This virtual collapse time in a motionless system, forces the observer to be in same framework of the particle, eliminating the *problem of time* posed by general relativity.

Having defined time in this way, it is possible to express escape velocity as $\mathbf{V_{esc} = 2r/t}$ and gravity as $\mathbf{g = 2r/t^2}$, without the need of external masses. Although orbital velocity in a motionless system is irrelevant, in case it is needed, it could be calculated from the escape velocity: $\mathbf{V_{orb} = V_{esc} /2^{1/2}}$. The notion of escape velocity is still valid in a motionless system, since it is an intrinsic property of the gravitational mass, independent if it is moving, or not, and not related to the mass escaping from the gravitational influence.

In a system in motion, energy is defined by $\mathbf{E_k = ½ MV^2}$, where E_k is the kinetic energy and V is the speed of the moving mass (M). The corresponding energy in a motionless gravitational system is $\mathbf{E_p = Mgr}$, where E_p is the potential energy, M is the mass source of the spacetime distortion, and g and r are the same as those described above. The same potential energy can be defined in terms of the escape velocity: $\mathbf{E_p = MV_{esc}^2}$, having a recognizable resemblance to Einstein's formula for the mass-energy equivalence $\mathbf{E = Mc^2}$, where c is the speed of light and coincides with the escape velocity from the event horizon of black holes, becoming the cornerstone of this work.

It is evident that for every physical variable in a dynamics system there is an equivalent variable in motionless gravitational systems. All this is leading to an overwhelming conclusion*: there is an area of physics that has been completely overlooked, with the potential to allow us to view the universe with new eyes. This area is the area of motionless systems with potential energies (as it is the case of any isolated mass, being it an electron or a black hole). It offers the possibility to explore and understand the universe from a simpler and all-encompassing point of view, with equal applicability to the worlds of quantum and classical physics, without the inherent complications from those of kinematic and dynamic systems in motion.* By taking the approach of motionless isolated particles, and being the observer in the same framework as the particle, the problem of *locality* becomes irrelevant.

From black holes to regular masses

It is acceptable to say (at least theoretically) that in order to convert an isolated spherical mass into a black hole, all that is needed is to compress it to the point where its radius (r) becomes a Schwarzschild radius (rs). The opposite is also true, a black hole might turn into a regular mass if its Schwarzschild radius is expanded without acquiring additional mass; a condition that might have occurred at the early universe when it was extremely hot and dense, then expanding while cooling with time.

Considering this compression/expansion process and applying it to the solution that Schwarzschild gave to Einstein's field equation, the escape velocity (the speed of light) at the event horizon corresponds directly to the lower escape velocity (V_{esc}) at radius r for any given mass.

$$\mathbf{MG = \tfrac{1}{2} c^2 rs = \tfrac{1}{2} V_{esc}^2 r}$$

Where M = mass source of the spacetime distortion, G = Newton's gravitational constant and c, rs and r are as described before. This expression tells us that there is a direct correspondence between rs and r with V_{esc} and c for any given mass.

$$\mathbf{V_{esc}^2/c^2 = rs/r}$$

Moreover, it is valid for any radius outside the event horizon. Additionally, the term MG (known as the standard gravitational parameter) can be derived from the radius (or any distance equal or greater that the Schwarzschild radius) and the value of gravity at such distance from any spherical mass, as follows:

$$\mathbf{MG = r^2 \mathit{g}}$$

By implementing the virtual collapse time at the event horizon of a black hole, the escape velocity becomes $\mathbf{c = 2rs/t'}$, and the corresponding gravity (g) becomes $\mathbf{\mathit{g}' = 2rs/t'^2}$, where the primed notation denotes the conditions at the event horizon. In consequence, the coupled relationship between rs and the virtual collapse time provide another way to obtain the speed of light, allowing us to derive one if the other is known, analogous to the case with frequency and wavelength in the quantum world. This process of implementing an expansion/contraction factor corresponds to an **event horizon renormalization**, setting the distance limit to the Schwarzschild radius, consistent with the speed of light. By doing so, gravity becomes renormalized.

Combination of universal constants

Processing some of the self-consistent set of values of the basic constants and conversion factors of physics and chemistry recommended by the 2014 Committee on Data for Science and Technology (CODATA)[i], (based on a multi-variant least-squares adjustments), one can combine them to derive several properties of the event horizon of black holes. The process consists in taking advantage of the interrelationship that exists between some of these constants and the speed of light, which we already know is the escape velocity from any black hole's event horizon.

One possibility is to combine the parameters used in quantum and classical physics in a way that they are consistent with the speed of light as shown below:

$$\mathbf{c = \lambda' f' = 2rs/t' = g' t' = h/(M \lambda') = 1/2\, e^2/(\epsilon_o h \alpha)}$$

Where: λ' = Compton's wavelength, f' = frequency, rs = Schwarzschild radius, g' = gravity, t' = virtual collapse time, h = Planck's constant, M = mass source of the spacetime distortion, e = Electrical charge, ϵ_o = permittivity of free space, and α = fine structure constant, and as stated earlier, all primed variables correspond to those at the event horizon.

From this expression, one can derive how the Schwarzschild radius relates to frequency, Planck's constant, the electrical charge, Compton's wavelengths (not just that from the electron but from any mass), and even to the fine structure constant, as follows:

$$\mathbf{rs = \tfrac{1}{2} \lambda' f' t' = \tfrac{1}{2} g' t'^2 = \tfrac{1}{2} h t'/(M \lambda') = \tfrac{1}{4} e^2 t'/(\epsilon_o h \alpha)}$$

Implementing these equivalent values of the *rs* into the Schwarzschild solution to the Einstein's field equation, the value of Newton's gravitational constant (G) can be redefined in terms of these constants:

$$\mathbf{G = \tfrac{1}{2} c^2 rs/M}$$
$$\mathbf{G = \tfrac{1}{4} c^2 \lambda' f' t'/M}$$
$$\mathbf{G = \tfrac{1}{4} c^3 t'/M}$$
$$\mathbf{G = \tfrac{1}{4} c^2 g' t'^2/M}$$
$$\mathbf{G = \tfrac{1}{4} c^2 h t'/(M^2 \lambda')}$$
$$\mathbf{G = 1/8\, c^2 e^2 t'/(M \epsilon_o h \alpha)}$$

By describing G in terms of variables normally applied in the quantum world, the veil that separated the quantum physics from the classical physics disappear, integrating gravity into the world of subatomic particles and the later to the world of black holes and gravitational masses.

Other scenarios consist in combining some of the CODATA constants in such a way that it is possible to find the relationships between the frequency with the virtual collapse time, and the Schwarzschild radius with the Compton's wavelength at the event horizon of any black hole, as following:

$$\mathbf{f'/t' = 2hG/c^4} \quad \text{and} \quad \mathbf{\lambda' rs = 2hG/c^3}$$

The above expressions are completely defined in terms of physical constants, allowing us to find the value of one parameter if the other one is known.

Once the parameters from the event horizon are known, it is a straightforward process to convert them into the corresponding parameters of spherical masses of any size larger than the Schwarzschild radius, or vice versa, applying the expansion/compression process described earlier, by simply implementing any one of the factors **rs/r** or $\mathbf{Vesc^2/c^2}$, as needed.

A test for dissimilar masses

Let us consider two different masses as dissimilar as the earth and the electron and see if consistent results for the value of G are obtained after the corresponding parameters are applied into the formulas for G described above.

In order to obtain the parameters for earth, the starting values were the values of mass, average surface radius and gravity found in the literature. From there, the parameters for MG, virtual collapse time (t), escape velocity (V_{esc}), orbital velocity (V_{orb}), wavelength (λ), frequency (f), force (F), pressure, energy (E) and power (P) were derived by applying the corresponding formulas (presented with the matching units in the *parameter* column of Table 1 below), and applied to the surface conditions. The Schwarzschild radius (rs) was calculated from $\mathbf{rs = 2MG/c^2}$, gravity at the event horizon (g') becomes $\mathbf{g' = MG/rs^2}$, and the other parameters in the same way as it was done for the surface condition, but applying the newly found rs and g'.

Table 1 summarizes the values of the parameters listed above, including the formula for expansion factor applied to each parameter to have it transformed from the event horizon condition to the surface condition. Column *Verif.Earth* presents the value for each parameter at the surface when the expansion factor was applied to the event horizon condition, instead of the formulas provided in the *Parameter* column; this column confirms the validity of the expansion factor.

Table 1: Expansion Factors from rs to Surface r for Earth				
Parameter	**rs**	**Surface r**	**Verif.Earth**	**Factor**
r (m)	8.865E-03	6,373,603	6.374E+06	$(rs/r)^{-1}$
g ($m\ s^{-2}$)	5.069E+18	9.81	9.81	$(rs/r)^{2}$
$MG = r^2 g$ ($m^3\ s^{-2}$)	3.9839E+14			
M (kg)	5.9690E+24			
$t = (2r/g)^{1/2}$ (s)	5.914E-11	1,140.09	1,140.09	$(rs/r)^{-3/2}$
$V_{esc} = (2rg)^{1/2}$ ($m\ s^{-1}$)	299,792,458	11,180.87	11,180.87	$(rs/r)^{1/2}$
$V_{orb} = 2^{-1/2} V_{esc}$ ($m\ s^{-1}$)	211,985,280	7,906.07	7,906.07	$(rs/r)^{1/2}$
$\lambda = h/MV_{esc}$ (m)	3.703E-67	9.928E-63	9.928E-63	$(rs/r)^{-1/2}$
frequency = c/λ (Hz)	8.096E+74	1.126E+66	1.126E+66	(rs/r)
Force = Mg = E/2r (N)	3.026E+43	5.854E+25	5.854E+25	$(rs/r)^{2}$
Area (m^2)	9.876E-04	5.105E+14	5.105E+14	$(rs/r)^{-2}$
Pressure = F/A ($N\ m^{-2}$)	3.063E+46	1.147E+11	1.147E+11	$(rs/r)^{4}$
$E = MV_{esc}^{2}$ (J)	5.365E+41	7.462E+32	7.462E+32	(rs/r)
Power = E/t (W)	9.071E+51	6.545E+29	6.545E+29	$(rs/r)^{5/2}$

Note: The product of the wavelength and the frequency at the surface or at any distance other than the Schwarzschild radius yields the escape velocity from that distance, not the speed of light.

Table 2 is equivalent to Table 1 but for an electron, using the same conditions, except that the starting value was rest mass of the electron, from which the MG value was determined and served to derive the remaining parameters at the event horizon. The Bohr radius was used as the radius outside the event horizon to prove if the values of the parameters at this radius were equally satisfactory for the test.

The test consists of:

1. Confirm that the expansion factors applied to each parameter in one particle is the same as the expansion factor applied to the other particle.

2. Verify that the value obtained for each parameter, when applying the expansion factor at the event horizon, is consistent with the surface value obtained from the formula.

3. Asses if the parameters used for one particle will produce the same results for the calculation of G when the other particle is used, both, at the event horizon and at the given radius.

Table 2: Expansion Factors from rs to Surface r for Electron

Parameter	e- rs	Bohr radius	Verif. e-	Factor
r (m)	1.353E-57	5.292E-11	5.292E-11	$(rs/r)^{-1}$
g $(m\ s^{-2})$	3.321E+73	2.171E-20	2.171E-20	$(rs/r)^2$
$MG = r^2 g\ (m^3\ s^{-2})$		6.080E-41		
M (kg)		9.109E-31		
$t = (2r/g)^{1/2}$ (s)	9.026E-66	6.982E+04	6.982E+04	$(rs/r)^{-3/2}$
$V_{esc} = (2rg)^{1/2}\ (m\ s^{-1})$	299,792,458	1.516E-15	1.516E-15	$(rs/r)^{1/2}$
$V_{orb} = 2^{-1/2}\ V_{esc}\ (m\ s^{-1})$	2.120E+08	1.072E-15	1.072E-15	$(rs/r)^{1/2}$
$\lambda = h/MV_{esc}$ (m)	2.426E-12	4.798E+11	4.798E+11	$(rs/r)^{-1/2}$
frequency = c/λ (Hz)	1.236E+20	3.159E-27	3.159E-27	(rs/r)
Force = Mg = E/2r (N)	3.026E+43	1.978E-50	1.978E-50	$(rs/r)^2$
Area (m^2)	2.300E-113	3.519E-20	3.519E-20	$(rs/r)^{-2}$
Pressure = F/A $(N\ m^{-2})$	1.315E+156	5.620E-31	5.620E-31	$(rs/r)^4$
$E = MV_{esc}^{\ 2}$ (J)	8.187E-14	2.093E-60	2.093E-60	(rs/r)
Power = E/t (W)	9.071E+51	2.998E-65	2.998E-65	$(rs/r)^{5/2}$

Table 3 presents the values for Newton's gravitational constant (G) as they result from applying the above formulas. It is important to note that in this table *c* represents the speed of light only when the condition is at the event horizon, and becomes the escape velocity when applied at the given radius.

Table 3: Values of G from Different Parameters $(m^3\ kg^{-1}\ s^{-2})$

Test Condition	At Event Horizon		At given radius	
	Earth	**Electron**	**Earth**	**Electron**
$G = ½\ c^2\ rs/M$	6.67430E-11	6.67430E-11	6.67430E-11	6.67430E-11
$G = ¼\ c^2\ \lambda\ f\ t\ /M$	6.67430E-11	6.67430E-11	6.67430E-11	6.67430E-11
$G = ¼\ c^3\ t\ /M$	6.67430E-11	6.67430E-11	6.67430E-11	6.67430E-11
$G = ¼\ c^2\ g\ t^2/M$	6.67430E-11	6.67430E-11	6.67430E-11	6.67430E-11
$G = ¼\ c^2\ h\ t/(M^2\ \lambda)$	6.67430E-11	6.67430E-11	6.67430E-11	6.67430E-11
$G = ¼\ c^4/F'$	6.67430E-11	6.67430E-11	N/A	N/A
$G = 1/8\ c^2\ e^2 t'/(M\ \epsilon_o\ h\ \alpha)$	6.67430E-11	6.67430E-11	N/A	N/A

The resulting G values obtained by the formulas that include the force (F') and the fine structure constant (α), are valid only when the conditions are those of the event horizon.

It is important to remember that the product of the frequency times the wavelength represent the escape velocity, which is the speed of light only at the event horizon, at any other distance this product is simply the escape velocity at that distance (not c).

The values in the columns *Verif.Earth* and *Verif.e-* confirm that the expansion/compression factor is equivalent to the physical formula that calculates each parameter in both cases (for Earth and the electron) and should be valid to any other mass. The column factor is identical to both particles; and the calculated values for G are identical under all conditions, except when the force and the fine structure constant are used. In that case, to obtain the proper value of G, only the parameters at the conditions of the event horizon should be used.

Table 4 shows how a combination of some CODATA's constants result in additional properties of the event horizon, commonly shared by all black holes, in addition to the already known escape velocity, the speed of light.

Table 4. Event Horizon Properties that Remain Constant in All Black Holes

Property	Value of Constant	Units
F'= Mg'= Mc/t' = h/λt' = hf'/2rs	$1/4\ c^4/G$	N
rs λ'	$2hG/c^3$	m m(λ)
rs/f'	$2\ h.G/c^4$	m Hz^{-1}
f'/t'	$1/4\ c^5/hG$	Hz s^{-1}
M/rs	$1/2\ c^2/G$	Kg m^{-1}
M/t'	$1/4\ c^3/G$	Kg s^{-1}
M.λ'	h/c	Kg m(λ)
M/f'	h/c^2	kg/Hz
$c\ f'/M = \lambda'\ f'^2\ M^{-1}$	c^3/h	m(λ) $Hz^2\ kg^{-1}$

Probably one of the most important and unexpected properties that is shared by every black hole is that they have the same force at their event horizons. Having a constant value for the force means, that it is up to the diameter of the event horizon to determine the potential energy of the black hole. The potential energy in turn defines the escape velocity that any particle needs to escape from the black hole at any given distance, and consequently the gravity at that distance. The larger the Schwarzschild radius is in a black hole, the bigger the field range at which gravity is strong.

Quantization

It is known that if the product of one quantized variable times another variable results in a constant value, the second variable must be inversely quantized (meaning that while one variable increases, the other decreases) in order to maintain valid the quantized character of the first one and proportionality with the constant.

As presented before, the products of the frequency (assumed a quantized variable, as seen in the quantized energies of electron jumps in the atom) times the reciprocal of virtual collapse time, results in a constant; as it is the case for the product of the frequency times the Compton's wavelength that equals the speed of light, then in virtue of the previous axiom, both the virtual collapse time and the Compton's wavelength should be quantized variables.

Similarly, as the product of the Compton's wavelength (assumed a quantized variable) times the Schwarzschild radius results in a constant, by the same reasoning, the Schwarzschild radius should be a quantized variable, as well.

An interesting result is obtained if the same axiom is applied to the Schwarzschild solution to the Einstein's field equation. If the Schwarzschild radius is a quantized variable, and G and c are constants, the remaining variable, mass, should be quantized.

Nuclear reactions provide the perfect scenario where quantization of mass is evident. When a nucleus captures an electron, a neutron or a proton, the nucleus can increase its mass only by discrete amounts, in steps proportional to the mass of the particle being captured. Similarly, when a nucleus decays, it does it in discrete amounts, which is characteristic of quantized systems. Additionally, in most cases, the daughter nucleus is formed after the excess energy is released in the form of radiation (alpha, beta or gamma) with specific energy levels.

Conclusion

In this paper, became evident the existence of a physics parallel to the physics of masses in motion (dynamics and kinematics), where a mass is described in function of its motion in relation with other masses or in relation to observers with different frameworks of reference. This alternate physics is the physics of isolated masses at rest, with the mass itself being the observer framework. The application of this physics is particularly useful for masses source of gravitational systems, which by themselves modify the spacetime around them without needing to be in motion or in relationship with other masses.

By means of the escape velocity, which is a property intrinsically related to the mass source of the gravitational field, not the escaping mass, it was possible to treat all masses in the same way, independently if they were astronomical or subatomic.

Implementing and understanding the physics of motionless masses, some of the main problems found in the attempts to unify gravity with quantum physics are overcome. The problem of locality is eliminated by the motionless approach with the observer being in the framework of the isolated static mass, and the problem of time is resolved by the implementation of the virtual collapse time. By introducing the Schwarzschild radius as a limit for mass, the infinities normally encountered in general relativity are avoided. By implementing an event horizon expansion/contraction factor gravity can be renormalized.

This paper demonstrates how mass can be quantized, bringing the worlds of classical physics and quantum physics together in an elegant and extremely simple way.

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