An explanation of the entropic nature of the mass using classical physics

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Introduction

After a century of relativity theory it is now indisputable that energy can be stored in matter. The combined mass of the decay products of a uranium atom is less than the mass of the latter and the energy is indeed proportional to the mass-energy relationship $E = mc^2$.

The mass-energy equivalence should logically apply at any scale. At the chemical level, that energy is stored as mass after an endothermic reaction is perfectly anecdotal; even though Lavoisier was finally wrong, in practice, it's always right. At the mechanical scale, this phenomenon seems so insignificant that it is difficult to conceptualize. At the level of galactic mechanics this phenomenon seem also so insignificant that astrophysicists tend to ignore it completely to rely solely on Newtonian physics. The goal of this paper is to demonstrate that this is not the case, and that after reaching a minimum value in systems of familiar sizes, the importance of the mass-energy balance become increasingly significant with size.

This mass-energy balance is present within the potential energy field, and the fact that it has remained so long invisible and intangible is a mystery, it is possible to quote here Leon Brillouin[1,2]

"There is no energy without mass, but it seems that most authors simply ignored the case of potential energy. The founders of Relativity keep silent about it. As a matter of fact, the corresponding energy is spread all around in space, and so is the mass. Symmetry properties of this distribution suggests splitting the mass fifty-fifty between interacting particles. It is necessary to re-evaluate the values of masses, even in the classical theory of relativity, where this consideration was simply ignored. *Renormalization* is absolutely essential, before quantum theory, and must start at the beginning of Einstein's relativity."

Assumptions

1. The relationship of mass-energy equivalence $E = mc^2$ must imperatively be interpreted as follows: *no physical system can gain or lose mass without gain or loss of energy and vice versa*. Here, the energy is composed of exchange particles with energy but without the associated mass like the photon, the gluon or the hypothetical graviton.
2. Nothing suggests that the potential energy of the gravitational field does not have mass. The Higgs boson, likely mediator in the heart of the mechanism of gravitation, is very heavy.

Let us explore the example of a body being absorbed by a black hole within the framework of these two assumptions. It is known that a massive black hole of mass M will attract a mass m_0 initially at rest at a distance d from the outer limit of the black hole, as defined by the Schwarzschild radius. The kinetic energy achieved by this mass before disappearing behind the horizon is $E = ½\, m_0 c^2$, this implies a 50% increase in mass. The speed of the body is calculated by the relativistic equation of the mass $3m_0/2 = m_0/[1 - (v/c)^2]^{1/2}$ or $v/c = (5/9)^{1/2} = 0.745$. Curiously, in considering the potential as having no mass, an external observer of the system would see a gradual increase of the whole mass of the system $M + m_0$ to $M + 3m_0/2$ then stabilize after issuing 10% of kinetic energy in the form of radiation. Thus, a fundamental physical system could increase its mass without any external energy input; this situation is in complete disagreement with the relationship of mass-energy equivalence. The most straightforward solution to this would be that the mass is simply stored in the field of gravitational potential energy and was gradually transferred to the system.

The storage of potential energy in gravitational systems of familiar sizes

Consider now the example of several balls, perfectly isolated and floating in space, possessing no relative speed and arranged a few meters from each other. It is known that after some time, gravity will bring these balls into a larger compact ball, whose state is the lowest possible energy state [i,3]. It is also known that energy is released as heat by the system during the inelastic collision of the balls. Furthermore, the system of the larger compact ball is necessarily lighter than the original system due to emission of heat radiation.

The gravitational potential energy of a system of *n* balls of mass m_i at the distance r_{ij} from each other is given by this equation (this is the sum of the $(n^2 - n)$ /2 potential energy relationship between the balls) :

$$E = -\sum_{i=1,\, j=i+1}^{n-1,\, n} G m_i m_j / r_{ij}$$

To determine the energy loss by the system as radiation when it reaches the state of a pseudo-compact body, that state must be known. The only exact solution is given by a simulation of the system evolution. Even if all balls are perfectly spherical, with the same mass and the same radius, a final compact spherical state composed of balls is not so simple to calculate.

Let us now assume that the radius R and the mass M_0 of the final state sphere is known, that n is very large and $m_i << M_0$ for all balls. Furthermore, the mass center of the final state ball is the same as the original system. Now imagine the almost final compact state of mass $M_0 - m_i$ composed of the meeting of all the small balls except for a single m_i which is kept in its place. The mass center of the almost final compact state is very near to the final compact state but slightly separated from it, and located on the line joining the two bodies. The distance of m_i to the mass center of the system is defined by d_i and the mass $M_0 - m_i$ and M_0 are practically the same. So the calculation of the part of m_i in the energy difference between the final state and the initial state is given by $\Delta E_i = GM_0 m_i / R - GM_0 m_i / d_i = GM_0 m_i (d_i - R) / d_i R$. Thus the total energy difference (entropy) is given by the following equation:

$$\Delta E = \sum_{i=1}^{n} GM_0 m_i (d_i - R) / d_i R$$

This is the total amount of energy lost as radiation, to permit passing from the initial state to the final spherical state. The details of the reasoning are provided in Annex A. In summary, it is necessary to consider that the system is conservative because the gravitational field is conservative. Let us consider the mechanical work w_i of moving a ball m_i from the surface of the final compact state to its initial position. By the law of the conservation of energy, if the same work is performed to another step of the process (intermediate state) and that if the work w'_i is different from w_i then the difference $\Delta w_i = w_i - w'_i$ has been spent or conserved during the transition from the initial state to the intermediate state. The following rule still applies: *if doing work A prior to work B facilitates doing work B, is that the work A was harder, conversely, if doing work A prior to work B makes work B more difficult is that the work A was easier.* It is also necessary to use the permutation symmetry of identical particles (the balls) to accept the fact that moving m_i to the surface of the final state is strictly equivalent to its natural position in the pseudo-sphere letting the system evolve naturally. The thought experiment is much simpler with balls of liquid, the final state is a homogeneous sphere of mass M_0.

The link with the theory of black holes seems obvious; the entropy is necessarily proportional to their surfaces because it's simply the application of the Carnot principle to the phenomenon of gravitation.

This illustrates why physical systems of familiar sizes (Human scale) do not have much mass-energy induced by the gravitational potential energy; the induced mass $M = \Delta E / c^2$ is small because of the c^2 denominator. However, the mass is inversely proportional to the radius of the final minimal energy compact state.

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i See here Carnot principle and also the black hole thermodynamics and the holographic principle. The decisive step was made by Erik Peter Verlinde who has deduced Newton's laws of the holographic principle; in a formal system, the theorems can always be reused as axioms.

The storage of potential energy in the gravitational systems at a galactic scale

The big difference between galactic systems and mechanical systems of familiar sizes is that the minimum energy compact state is a black hole; and the radius R is defined by the equation of Schwarzschild: $R_s = 2GM_0/c^2$. Black holes illustrate that it is the existence of the other forces at the level of mechanical systems of familiar sizes which, against gravity, prevents the potential energy of the gravitational field from being significant. In this case, it is convenient to write the ratio of the mass-energy induced by the inert mass as follows $\Delta E_i/m_ic^2 = GM_0/R_sc^2 - GM_0/d_ic^2$ it follows that $m_i'/m_i = 1/2 - GM_0/d_ic^2$. Here, the second term is negligible and corresponds to values of low energy. By summing all the masses ($\sum m_i' = \sum m_i/2$), the result is $M'/M_0 = 1/2$. Therefore, it is necessary to consider that at least one third of the total mass of the galactic systems is in the form of mass-induced energy.

The self-induction of the mass

The major problem with the phenomenon of gravitational potential energy that can generate mass, is that this new mass must also generate induced gravitational potential energy and therefore additional mass, and so on. This phenomenon does not occur for the other fields such as the electric field, which, by the principle of mass-energy equivalence, also generates induced mass by potential energy. It is also important to note that unlike the magnetic field that is induced by variations of the electric field, the induced mass is constrained to not grow too quickly because otherwise it would tend to infinity. The equation of the mass induced, without the low-energy term, allows to obtain $m_i' = m_i/2$. Thus, curiously, the mass-induced part of the system is independent from the total inert mass of this system, and therefore it is easy to calculate the total mass of a part m_0 which is defined by $m = \sum m_0\ (1/2)^i = 2m_0$. Therefore, the sum of all the parts is $M = 2M_0$. Consequently it seems necessary to consider that at least half, by the principle of self-induction, of the total mass of the galactic systems is in the form of induced mass-energy.

It would be useful to know how the potential energy can diverge; to that end, a self-induction factor Φ can be introduced, therefore $m = \sum m_0\Phi^i$ and this geometric series converges to $m = m_0/(1–\Phi)$ and $M = M_0/(1–\Phi)$. However, it diverges when $\Phi = 1$ and tends to produce a negative mass for values greater than 1 and a mass less than the inert mass for values less than 0; therefore $\Phi \in [0,1[$. However, contraction of the relativistic mass only signifies a loss of energy, then let us stay open-minded to $\Phi \in]-1,1[$ which is the convergence limits of this geometric series.

Relationship between self-induction and kinetic momentum

The introduction of the self-induction factor Φ in the original formula gives $m_i'/m_i = 1/2 = \Phi = (GM_0/c^2)(2\Phi/R_s)$. In this equation, the only variable factor is R_s which is the one affected by self-induction. Therefore, the absolute limit of the radius with $\Phi \in [0,1[$ is $R_h = R_s/2\Phi$ so $R_h \in]½R_s,\infty[$. This limit is exactly that predicted[4] by Kerr using the theory of general relativity. In the case of a Kerr black hole, the radius of the event horizon R_h is written:

$$R_h = \frac{R_s}{2\Phi} = \frac{R_s}{2}[1+\sqrt{1-a^2}];\ a = \frac{Jc}{GM^2} \quad \text{thus} \quad \Phi = \frac{1}{1+\sqrt{1-a^2}} \quad \text{and} \quad a = \sqrt{\frac{2}{\Phi} - \frac{1}{\Phi^2}}$$

Where $a \in [0,1[$ represents the spin of the black hole, J is the black hole momentum and M the black hole mass.

These equations make the link between the mass induced to the angular velocity of the black hole and, by the law of the conservation of the kinetic momentum, to the equivalent system of higher potential energy. For a given spin, its possible to calculate the self-induction as well as the ratio of the total mass to their inert mass. Thus, for Sagitarius A * the spin is $a = 0.44$[5] producing a self-induction factor $\Phi = 0.53$ and a ratio of mass-energy $M/M_0 = 2.11$. The equation (see calculation in Annex B) producing the coefficient x of dark matter for a galaxy such as $M = xM_0$ is $x^4 - x^3 = (RVc/8GM)^2$. For the Milky Way with $M = 2.50 \pm 0.50 \times 10^{42}$ kg[6], $R = 5.50 \pm 1.00 \times 10^{20}$ m, $V = 2.25 \pm 0.25 \times 10^5$ m/s, there is only one real positive root $x = 5.5 \pm 1.5$ which is fully consistent with current estimates. The error margins used are much higher than suggested in the literature, the aim being to show the approximate sensitivity of the function. For the Milky Way with $M = 2.0 \times 10^{42}$ kg, $R = 5.3 \times 10^{20}$ m, $v = 2.2 \times 10^5$ m/s, the dark matter factor is $x = 6.0$.

Induction of dark energy

Dark energy could also be the product of the gravitational potential field. The negative term of the fundamental equation of the entropic mass-energy ($\Phi = m'/m = \Delta E/mc^2 = GM_0/R_hc^2 - GM_0/dc^2$) which was negligible at the galactic level becomes important to the superior scales. The following table shows the value of this term at different scales:

Object	**Mass (kg)**	**Radius (m)**	**-GM/dc²**
Sun	2×10^{30}	7×10^{8}	-2×10^{-6}
Galaxy	2×10^{42}	2×10^{21}	-7×10^{-7}

The value used is the radius of the body, however, in spherical shells extremely close to the mass center of the system (inside the Schwarzschild radius), the Φ value could be negative. This feature significantly alter the study of the universe as a whole. Considering the critical density ρ_c, radius $r = c/H$ and the mass of the stationary universe (see the discussion in Annex C) of Fred Hoyle[7] $M_0 = 4/3\pi\rho_c r^3$ and our GM_0/rc^2 term then:

$$\rho_c = \frac{3H^2}{8\pi G} \quad , \quad M_0 = \frac{4\pi\rho_c c^3}{3\mathrm{H}^3} \quad \text{and so} \quad M_0 = \frac{c^3}{2\mathrm{GH}} \quad \text{and consequently} \quad GM_0/rc^2 = \frac{1}{2}$$

It is remarkable that the black hole equivalent to the universe does not have spin, which is consistent with Mach's principle. It is possible to calculate the negative side of the equation by assuming that the universe is homogeneous and by setting the average position of the mass at $r/2$ which gives $2GM_0/rc^2$ therefore 1 so $\Phi = -1/2$. Since the familiar ratio of a geometric series may be negative, the symmetry break which occurs when $\Phi < 0$ is more easily treatable by not introducing an absolute value in this equation, in this case $M = M_0/(1-\Phi) = 2M_0/3$ but the physical meaning of an alternating series is strange. Consider that if the positive mass-energy has induced a negative mass-energy then, this in turn, the negative mass-energy induces a positive mass-energy and so on.

By considering that the $2M_0/3$ result shall be read as a contraction of the inert mass and like with a positive Φ value it comes to the total mass then: $M = M_0 + \overline{M}_0/3 = 2M_0/3$. However, by considering that the inert mass M_0 is only the baryonic mass then this mass should be multiplied by a dark matter factor k and therefore $M/kM_0 = 1/(1-k\Phi)$. With k=4, this results in $M = kM_0 + 2k\overline{M}_0/3 = kM_0/3$ or 66.7% of dark energy, 25% of dark matter and 8.3% of baryonic matter. With k=5, this results in $M = kM_0 + 5k\overline{M}_0/7 = 2kM_0/7$ or 71.4% of dark energy, 22.8% of dark matter and 5.7% of baryonic matter. These results are very similar to the dark energy inferred from the Plank satellite data[8] estimated at 68.3% and the ratio of dark matter to baryonic matter evaluated between 4 and 6 according to the different measures. These equations seem to make it possible to establish a functional relationship between the amount of dark energy and the ratio of dark matter to baryonic matter. All this suggests that potentially $\Phi \in]-\infty,1[$ and by symmetry $\Phi \in]-\infty,\infty[$ with a singularity at $\Phi = 1$.

Comparison with general relativity

The self-induction factor is logically necessary: if a body of mass m_0 exposed to a physical factor directly induces a mass m' then this new induced mass exposed to the same physical factor, should also induce a proportional mass. This seems comparable to the expansion of the mass produced by relativistic speed. It is possible to write $\Phi(d) = GM_0/R_hc^2 - GM_0/dc^2 = R_s/2R_h - R_s/2d$ where the first term is a renormalization term dependent on the size and kinetic momentum of the system and is independent of d, therefore, it is practical to define $\omega = 1 - R_s/2R_h$, $\phi = \phi(d) = R_s/2d$ and $\Phi(d) = (1-\omega) - \phi(d)$, which gives $m_0/m_d = 1 - \Phi = \omega + \phi$. The conjecture of the equivalence between gravitational mass and inertial mass forces us to set the following equivalence:

$$\frac{m_0}{m_d} = \frac{t_0}{t_d} = \frac{l_d}{l_0} = \sqrt{1-\left(\frac{v}{c}\right)^2} = \sqrt{(\omega+\phi)^2} = \sqrt{\omega^2 + 2\omega\phi + \phi^2}\,;\, 1-\left(\frac{v}{c}\right)^2 = (\omega+\phi)^2 = \omega^2 + 2\omega\phi + \phi^2$$

By posing $R_h >> R_s$ then $\omega \rightarrow 1$, which simplifies the equation at the scale of celestial mechanics, this allows comparison of the mass-energy equation to the Schwarzschild metric:

$$\frac{m_0}{m_d}=\frac{t_0}{t_d}=\frac{l_d}{l_0}=1+\phi=1+\frac{R_s}{2d}=\sqrt{1+2\phi+\phi^2}=\sqrt{1+\frac{R_s}{d}+\left(\frac{R_s}{2d}\right)^2}\ versus\ \frac{t_d}{t_0}=\frac{l_0}{l_d}=\sqrt{1-\frac{R_s}{d}}$$

Although different, these equations have numerically the same behavior. Indeed, $1+R_s/2d$ is the second order development of a Maclaurin series of $(1-R_s/d)^{-1/2}$:

$\frac{R_s}{d}$	$1+\frac{R_s}{2d}$	$\frac{1}{\sqrt{1-\frac{R_s}{d}}}$	**Relative Differences**
1 / 2	1.2500	1.4142	1.2×10^{-1}
1 / 10	1.0500	1.0541	3.4×10^{-3}
1 / 100	1.0050000	1.0050378	3.8×10^{-5}
1 / 1000	1.0005000000	1.0005003753	3.8×10^{-7}
1 / 987456	1.0000005063517	1.0000005063521	3.8×10^{-13}

Here, the more space is flat, the more the equations converge to the same value, which is expected since the Schwarzschild metric uses the "weak field approximation" and that our simplification $R_h >> R_s$ achieves the same effect. The deduction of a fundamental theorem of general relativity without using the Schwarzschild metric is a strong argument in favor of the theory of self-induction of the mass. Since the curvature of space-time predicted by self-induction and that predicted by general relativity are perfectly in agreement at our experimental scale, it is not possible to distinguish both at this scale. Furthermore, the variation of the mass produced by a massive body is completely insignificant at our experimental scale and does not appear to be measurable.

By posing $R_h = R_s$ then $\omega = 1/2$, which normalizes the equation at the static black hole scale, which gives: $1/2+R_s/2d$. There is no singularity here before $d = 0$ and so there is no wormhole as predicted by the Kruskal-Szekeres geometry. Moreover, the time dilation and lengths contraction are infinitely less in proximity to the horizon such that the horizon of a black hole is a place without distortion of space-time.

The case where self-induction is high, consequence of the entropic factor when the body rotates rapidly and has enough mass to collapse into a Kerr black hole, makes comparison much more difficult. Indeed, it is difficult to address the problem of contraction of bodies with self-induction and the complexity of general relativity. This represents the most significant handicap of this theory. The simplicity of the theory of the entropic self-induction permits the use of conventional methods for treating the gravitational field ϕ using the Laplace equation or Legendre[i] polynomials, the geodesics are simply calculated using the relativistic Lagrangian :

$$L=-m_0 c^2\sqrt{1-\left(\frac{v}{c}\right)^2}=-m_0 c^2(\omega+\phi)\,;\,E=\frac{m_0 c^2}{\omega+\phi}$$

Here, the relativistic Lagrangian L is perfectly consistent with our theory and the total mass produced by the free body m_0, calculated relativistically, is indeed $m = E/c^2 = (\mathbf{p}\cdot\mathbf{v} - L)/c^2 = m_0/(\omega+\phi)$. Annex D contains a more philosophical discussion on the differences with general relativity.

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i $(\partial_1^2+\partial_2^2+\partial_3^2)V=G\int_M(\partial_1^2+\partial_2^2+\partial_3^2)r^{-1}dM=0 \qquad V(\vec{x})=-\frac{G}{|\vec{x}|}\int_{n=0}^{\infty}\left(\frac{|\vec{r}|}{|\vec{x}|}\right)^n P_n(\cos\theta)\,dm(\vec{r})$

Black hole and relativistic sphere

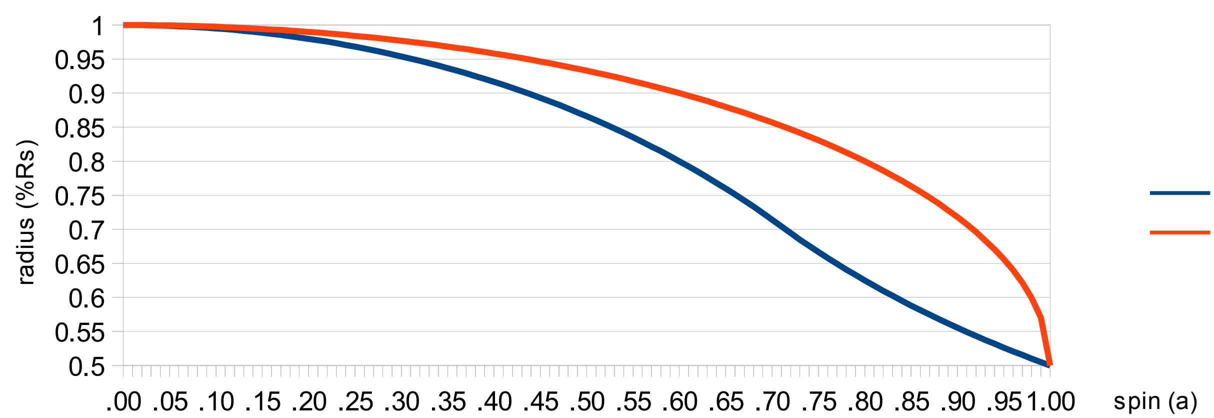
The theory described here is derived from Newtonian physics, the fundamental theorem of mass-energy equivalence of special relativity and from the limit theorem of the Schwarzschild radius which can also be derived from Newtonian physics; if we set the escape velocity $V = (2GM/R)^{1/2}$ equals to c which correctly gives: $R = 2GM/c^2$. The deflection of light produced by a massive body is given by the two equations of Newton $F = ma$ and $F = GMm/R^2$ so $a = GM/R^2$. Thus, it is perfectly clear that light is attracted by a massive body and notwithstanding the fact that the mass of the photon is zero, the only thing that Newton's equations say is that two photons do not attract each other. Thus, the phenomena of black holes and gravitational lenses are necessary consequences of the Newtonian theory. It is important to remember this fact because many authors neglect it; a theory of relativistic gravitation requires only an appropriate modification of the Lagrangian.

Currently, the theory of self-inductive entropic gravity (GEST, Gravitational Entropic Self-inductive Theory) uses the characteristics of Kerr black holes deducted from the general theory of relativity. This situation is disagreeable and should be corrected using classical mechanics and special relativity. The only necessary assumption is that the rotating black hole is equivalent to a rigid sphere of radius Rs and therefore it is completely described by a mass M and angular velocity ω or spin $a = \omega/\omega_{max}$. Since the sphere is a stack of disks, the equatorial disk, turning more rapidly, itself determines the minimum radius.

In a circle of radius R and circumference $C = 2\pi R$ in rotation over its center with an angular velocity ω any differential length ∂C of the circumference C can be viewed as moving linearly with velocity $v = \omega R$ and R is therefore contracted to an external inertial observer by a relativistic factor $\partial C'/\partial C = (1\text{-}v^2/c^2)^{½}$. Thus, for the inertial observer, the entire circumference is reduced by this same factor $C'/C = (1\text{-}v^2/c^2)^{½}$ and is the same for the measurement of the radius $R'/R = (1\text{-}v^2/c^2)^{½}$. It should be understood here that this is a thin ring rotating around its mass center and thus there is no physical reality to the radius; the radius measurement is simply deducted from circumference.

A disk of radius Rs can be viewed as a collection of nested circle of radius $R < Rs$ and the maximum angular velocity is determined by the maximum speed of the outer circle $\omega_{max} = c/Rs$. The maximum contraction of all circles occurs when the angular velocity of the disk is ω_{max}. Thus, the relativistic radius R_{rel} of the radius at rest R when the disk has a spin $a = \omega/\omega_{max}$ is $R_{rel}(R,a) = R(1\text{-}\omega^2R^2/c^2)^{½} = R(1\text{-}\omega^2R^2/\omega_{max}{}^2Rs^2\ )^{½} = R(1\text{-}a^2R^2/Rs^2)^{½}$. The calculation of the derivative gives $\partial R_{rel}(R,a)/\partial R = (1\text{-}a^2R^2/Rs^2)^{½}\text{-}a^2R^2/[Rs^2(1\text{-}a^2R^2/Rs^2)^{½}]$ and by posing $\partial R_{rel}(R,a)/\partial R = 0$ then $R = |Rs/a\sqrt{2}|$ and $R_{rel}(Rs/a\sqrt{2},a) = Rs/2a$.

The maximum contraction of the disk when $a = 1$ is $Rs/2$ but, what is surprising is that the circles of radii $R \in [Rs, Rs/\sqrt{2}[$ are found contracted inside the disk and the border is actually made by the circle of radius $Rs/\sqrt{2}$ of the disk at rest. These equations show that for $a \in [0, 1/\sqrt{2}]$ it is the outer circle of radius Rs at rest who determines the radius of the disk by a contraction $R \in [Rs, Rs/\sqrt{2}]$ given by $R = Rs(1\text{-}a^2)^{½}$ while when $a \in [1/\sqrt{2}, 1]$ the radius R of the disk is determined by $R \in [Rs/\sqrt{2}, Rs/2]$ given by $R = Rs/2a$. This relationship should be compared with the Kerr relationship $R = ½Rs[1+(1\text{-}a^2)^{½}]$:



Conclusion

This paper develops a theory that is the logical extension of two assumptions perfectly consistent with modern physics. This theory is derived from Newtonian physics, from the fundamental theorem of mass-energy equivalence of special relativity and from the limit theorem of the Schwarzschild radius which can also be derived from Newtonian physics. To remain consistent, this theory must introduce the concept of self-induction of the gravitational field energy. This phenomenon of self-induction is used to calculate an absolute limit of contraction of bodies perfectly consistent with our knowledge of the dynamics of black holes, which is also derived from the general relativity.

This theory generates naturally, without the introduction of any constant, dark matter and dark energy at the galactic scale and universal scale respectively. In addition, the order of magnitude predicted by this theory for the amount of dark matter and dark energy appears consistent with current measurements. The strange coupling relationship between ordinary matter and dark matter[9] supports the concept that self-induction of mass, as presented, is an integral part of the phenomenon. This theory, unlike an ad hoc modification of the dynamics[10], helps to explain the origin of this renormalization and can be consistently integrated into physics. The study of the dynamics of galaxies, considering the self-induction of dark matter, remains entirely to produce. Currently, it can be postulated that bursting galaxies, driven by the centrifugal force, are held back by a negative feedback mechanism; the more rapidly a galaxy rotates, the more it generates mass, slowing it by inertia and counteracting by gravity the centrifugal force. To achieve this end, the development of the theory of the relativistic sphere, as the calculation of its moment of inertia, would likely create a totally independent mathematical formulation of general relativity.

By using the conjecture of equality between the heavy and the inertial mass, it is possible to set the equality between the expansion of the mass produced by the self-induction to that produced by special relativity, then we obtain a relativistic field producing the same distortions of time and space that does general relativity at our experimental scale. However, the real difference is that the gravitational field produces mass or in a generalized way is itself the mass. If it is not very difficult to accept the idea that electricity is the electric field or magnetism is the magnetic field, the same thinking with regards to mass seems more difficult. However, the theory of general relativity is the answer to the following constraint: *a measure of the mean curvature of spacetime = a measure of the energy density.* By including the assumption of heavy potential energy in theory of general relativity, it is obtained: *the mass is strictly equivalent to the mean curvature of spacetime and vice versa*. It is important to note that without the self-induction phenomenon, general relativity necessarily underestimates the energy density.

This theory having a much simpler mathematical structure than general relativity is probably much easier to integrate into the standard model and in a grand unified theory. In addition, as for classical Newtonian physics, the singularity occurs only at a null distance from the center of the system, like for all other fields. It is also important to note that the induced laws, used to build this theory, are only the Newton law of the universal gravitation and the invariance of the speed of light used to deduce special relativity. It is simply the strengthening of the principle of universality of the mass-energy equivalence which forces the logical deduction of this theory.

Annex A : The storage of potential energy in gravitational systems of familiar sizes

The calculation of the energy of systems

The gravitational potential energy of a system of n balls of mass m_i at the distance r_{ij} from each other is given by this equation (this is the sum of the $(n^2 - n)/2$ potential energy relationship between the balls) :

$$E = -\sum_{i=1, j=i+1}^{n-1, n} G m_i m_j / r_{ij} \qquad [1]$$

Let I the initial potential energy of the system and F the final potential energy of the system (compact ball state) and either, respectively, the initial potential energy $\overline{I}_k$ and $\overline{F}_k$ the final potential energy of the system without the ball m_k then:

$$I = -\sum_{i=1, j=i+1}^{n-1, n} G m_i m_j / r_{ij} \qquad \overline{I_k} = (-\sum_{i=1, j=i+1}^{n-1, n} G m_i m_j / r_{ij}) - (-\sum_{i=1}^{n/\{k\}} G m_i m_k / r_{ik}) = I - I_k \qquad [2]$$

$$F = -\sum_{i=1, j=i+1}^{n-1, n} G m_i m_j / b_{ij} \qquad \overline{F_k} = (-\sum_{i=1, j=i+1}^{n-1, n} G m_i m_j / b_{ij}) - (-\sum_{i=1}^{n/\{k\}} G m_i m_k / b_{ik}) = F - F_k \qquad [3]$$

This highlight a fundamental property of the potential energy of the systems: that the total energy of a system is the sum of individual contributions (here I_k and F_k) divided by two. Indeed, the sum of individual contributions has twice added each potential energy relationship between two specific balls ($Gm_im_j/r_{ij} + Gm_jm_i/r_{ji}$), therefore:

$$I = \frac{\sum_{k=1}^{n} I_k}{2} \qquad F = \frac{\sum_{k=1}^{n} F_k}{2} \qquad [4]$$

Let $\Delta E = I - F$ then $\Delta E = (\Sigma I_k - \Sigma F_k)/2$ and therefore $\Delta E = \Sigma(I_k - F_k)/2 = \Sigma \Delta E_k/2$ [5]

The problem with this concept of the potential energy is that the sum of the parts does not equal the whole. As Leon Brillouin[1,2] suggests, the potential energy must be divided equally between the different interacting particles, thus:

$\boldsymbol{I_k} = I_k/2$, $\overline{\boldsymbol{I}}_{\boldsymbol{k}} = I - \boldsymbol{I_k}$, $\boldsymbol{F_k} = F_k/2$, $\overline{\boldsymbol{F}}_{\boldsymbol{k}} = I - \boldsymbol{F_k}$, $\Delta E = \Sigma \boldsymbol{I_k} - \Sigma \boldsymbol{F_k}$ and therefore $\Delta E = \Sigma(\boldsymbol{I_k} - \boldsymbol{F_k}) = \Sigma \boldsymbol{\Delta E_k}$ [6]

These two distinct views of the potential energy highlight a major problem when it comes to this concept. Indeed, is it the proper potential energy $\boldsymbol{\Delta E_k}$ or the improper ΔE_k. The proper potential energy $\boldsymbol{\Delta E_k}$ of a ball m_k is characterized by the fact that the system would possess the energy $\boldsymbol{\Delta \overline{E}_k} = \Delta E - \boldsymbol{\Delta E_k}$ if the ball m_k would not exist (would not be a component of the system). [7]

The calculation of the energy of a ball

This being said, evaluation of ΔE_k is used to evaluate ΔE. Starting from the initial energy state I, it is possible to move each ball, one by one, from its initial position to its position within the final compact sphere F. Because the field is conservative, the path taken is irrelevant. In addition, the order in which the movements are performed is also irrelevant, the simplest order is $m_1, m_2, \ldots, m_n, m_k$, the ball m_k will be by cons the last.

Thus, by this operation, the system gradually changes from the I energy level to the lower energy level F. Each amount of work (moving) transitions the system of the energy levels I to $I(m_1), I(m_2), \ldots, I(m_n), I(m_k) = F$. Since each energy level is strictly determined by the relative positions of balls, removing the ball m_k in step $I(m_i)$ we simply obtain $\overline{I}_k(m_i)$. Thus, the sequences $SI = \{I, I(m_1), I(m_2), \ldots, I(m_n), F\}$ and $\overline{SI}_k = \{\overline{I}_k, \overline{I}_k(m_1), \overline{I}_k(m_2), \ldots, \overline{I}_k(m_{n-1}), \overline{F}_k\}$ differs only by the presence or not of the m_k ball. Let $TI = \{T(m_1), T(m_2), \ldots, T(m_n), T(m_k)\}$ and $\overline{TI}_k =$

$\{\bar{T}_k(m_1), \bar{T}_k(m_2), \ldots, \bar{T}_k(m_n)\}$ the work done to move each ball such as $T(m_i) = I(m_i)\text{-}I(m_{i-1})$ and $\bar{T}_k(m_i) = \bar{I}_k(m_i)\text{-}\bar{I}_k(m_{i-1})$. Now, let us study the transitions of energy states starting from the first:

$I \xrightarrow{[T(m_1)]} I(m_1)$

$\bar{I}_k + I_k \xrightarrow{[T(m_1)]} I(m_1)$ (by [2])

$\bar{I}_k + I_k \xrightarrow{[\bar{T}_k(m_1)]} \bar{I}_k(m_1) + I_k$ (by definition of $S\bar{I}_k$ and $T\bar{I}_k$ and by conservation of energy)

$\bar{I}_k(m_1) + I_k \xrightarrow{[\bar{T}_k(m_2)]} \bar{I}_k(m_2) + I_k$ (by definition of $S\bar{I}_k$ and $T\bar{I}_k$ and by conservation of energy)

…

$\bar{I}_k(m_{n-1}) + I_k \xrightarrow{[\bar{T}_k(m_n)]} \bar{F}_k + I_k$ (by iteration)

Consequently, $SI = \{\bar{I}_k+I_k, \bar{I}_k(m_1)+I_k, \bar{I}_k(m_2)+I_k, \ldots, \bar{F}_k+I_k, \bar{F}_k+F_k\}$ and hence SI is distinguished from $S\bar{I}_k$ only by the additional energy I_k of the m_k ball. All this leads to the conclusion that $\Delta E_k = I(m_n) - F = (\bar{F}_k+I_k) - (\bar{F}_k+F_k) = I_k - F_k$. It is therefore possible to calculate ΔE_k for each ball m_k and then summing the whole $\Delta E = \Sigma\Delta E_k/2$ for all the balls.

By [6], it is possible to revisit the entire previous reasoning with the proper energy and conclude that $\boldsymbol{SI} = \{\bar{\boldsymbol{I}}_k+\boldsymbol{I}_k, \bar{\boldsymbol{I}}_k(m_1)+\boldsymbol{I}_k, \bar{\boldsymbol{I}}_k(m_2)+\boldsymbol{I}_k, \ldots, \bar{\boldsymbol{F}}_k+\boldsymbol{I}_k, \bar{\boldsymbol{F}}_k+\boldsymbol{F}_k\}$ and hence $\boldsymbol{SI}$ is distinguished from $\boldsymbol{S\bar{I}}_k$ only by the additional energy $\boldsymbol{I}_k$ of the m_k ball. All this leads to the conclusion that $\boldsymbol{\Delta E}_k = I(m_n) - F = (\bar{\boldsymbol{F}}_k+\boldsymbol{I}_k) - (\bar{\boldsymbol{F}}_k+\boldsymbol{F}_k) = \boldsymbol{I}_k - \boldsymbol{F}_k$. It is therefore possible to calculate $\boldsymbol{\Delta E}_k$ for each ball m_k and then summing the whole $\Delta E = \Sigma\boldsymbol{\Delta E}_k$ for all the balls.

In the present case, it is indeed the proper energy. Indeed, it must be considered that the energy $\boldsymbol{\Delta\bar{E}}_k = \bar{\boldsymbol{I}}_k - \bar{\boldsymbol{F}}_k$ is the total energy emitted in radiation by colliding the n-1 balls (without m_k) and thus, $\boldsymbol{\Delta\bar{E}}_k = \Delta E\text{-}\boldsymbol{\Delta E}_k$ which is indeed the proper energy by [7].

The calculation of the energy of the collision of a ball with the final compact sphere

Thus, it is possible to calculate $\boldsymbol{\Delta E}_k$ which is simply the work required to returning the ball m_k to the compact massive state $\bar{\boldsymbol{F}}_k$.

Let us now assume that the radius R and the mass M of the final state F is known, that n is very large and $m_k \ll M$ for all balls. Furthermore, the mass center of the final state ball is the same as the original system. Now imagine the almost final compact state $\bar{\boldsymbol{F}}_k$ of mass $M - m_k$ composed of the meeting of all the small balls except for m_k which is kept in its place. The mass center of the state $\bar{\boldsymbol{F}}_k$ is very near to F but slightly separated from it, and located on the line joining m_k. Likewise, the masses $M–m_k$ and M are practically the same. The distance of m_k to the mass center of the system is defined by d_k. So the contribution of m_k in the energy difference between the final state and the initial state is given by $\Delta E_k = GMm_k/R - GMm_k/d_k = GMm_k(d_k - R) / d_kR$. [8]

Thus the total energy difference (entropy) is given by the following equation:

$$\Delta E = \sum_{i=1}^{n} \Delta E_i \qquad \Delta E = \sum_{i=1}^{n} GMm_i(d_i - R)/d_i R \qquad \text{(by [6] and [8])}$$

Annex B: Self-induction of the mass and induction of the dark matter

This concept is so new and strange that it could easily be misinterpreted, in particular it implies that energy could be generated, but of course it is not the case. Here, there is no more energy generation than in the phenomenon of magnetic self-induction of a coil of wire. Instead this concept implies that the bigger a body is, the more geometrically massive it is, and therefore it requires energy to exist. This phenomenon is practically identical to relativistic velocity, the more a body moves rapidly, the more it requires energy to exist at this speed.

The relationship between the size of a system and the speed is even more important when one considers that the "relationship between the self-induction and the kinetic momentum" more a body rotates quickly more it generates mass. Thus, a body having a self-induction factor of $\Phi = ½$ can be regarded as a body moving at a velocity $v = 87\%\ c$ (par $\Phi = ½ = \sqrt{1-(v/c)^2}$), although it is immobile. This represents the minimum factor for any galaxy.

Calculation of dark matter in a galaxy

This calculation raises profound issues about the nature of mass-energy. In fact, normally a body contracting itself rotates faster by the conservation of angular momentum and therefore, if this speed becomes relativistic as like in the contraction into a black hole, it gains in mass-energy. Yet this is exactly the opposite of what is happening here, the body mass $M = xM_0$ [1] loses mass-energy when it contract itself to reach the mass-energy M_0. Thus, the speed seems to play a reverse role and contracts mass-energy. It follows that $m/m_0 = (1 - (v_h/c)^2)^{½}$ [2] without further consideration in order to maintain energy balance. By cons, this trick reverse the real order of the physical process and therefore probably equally reverses the initial state and the final state [3]. This has the consequence is that we must consider that what is actually being calculated is a body mass M_0 expanded into a black hole with a mass-energy of xM_0 and with radius $R_s = 2GxM_0/c^2$ [4]. In the worksheet from A1 to C2, it is possible to select the desired interpretation by replacing all m/m_0 by m_0/m

Let us posit, without further consideration, that it is the mass of the outer shell of the galaxy that will collapse last in the black hole and so that the angular momentum of this shell is identical to the angular momentum of the outer shell of the black hole. It will also be laid, without further consideration, that any part of the galaxy has the same angular momentum and thus the spherical shell or a part thereof is representative of the whole. The angular momentum of the outer shell of the galaxy is unknown, but the angular velocity ω of rotation of the edge of the galaxy of radius R is experimentally determined. Let a thin ring of mass $m = xm_0$ [5] and with a radius R then $q = I\omega$ avec $I = mR^2$ [6] (moment of inertia of a thin ring rotating around its center). The angular momentum of the ring contracted in the black hole is given by $q_h = I_h\omega_h$ with $I_h = m_0R_s^2$ [7]. By the principle of conservation of angular momentum, it be possible to state $q = q_h$ [8].

	A	B	C
1	$(m/m_0)R^2\omega = R_s^2\omega_h$ by [6],[7],[8]	$v = R\omega$ by definition of ω	$v_h = R_s\omega_h$ by definition of ω_h
2	$(m/m_0)Rv = R_sv_h$ by A1,B1,C1	$(m/m_0)(Rv/R_s) = v_h$ by A2	$m/m_0 = (1-(v_h/c)^2)^{½}$ by [2]
3	$(1-(v_h/c)^2)^{½}(Rv/R_s) = v_h$ by B2,C2	$v_h^2 = (1-(v_h/c)^2)(Rv/R_s)^2$ by A3	$v_h^2 = (1-(v_h/c)^2)k,\ k = (Rv/R_s)^2$ by B3
4	$v_h^2 + kv_h^2/c^2 - k = 0$ by C3	$c^2v_h^2/c^2 + kv_h^2/c^2 - k = 0$ by A4	$((c^2 + k)/c^2)v_h^2 - k = 0$ by B4
5	$v_h = \pm(k(c^2 + k)/c^2)^{½}/((c^2 + k)/c^2)$ by C4 and quadratic equation	$v_h = \pm ck^{½}(c^2 + k)^{½}/(c^2 + k)$ by A5 and simplification	$v_h = \pm c\beta/(c^2 + \beta^2)^{½},\ \beta = Rv/R_s$ by B5, C3 and simplification

Calculating of v_h uses a radius of the black hole R_s constant but the calculation of self-induction factor requires the Kerr radius. To maintain this at a constant radius, the thin ring merely needs to rotates around a central axis. In this situation, the ring could not be subject to relativistic contraction of its length. It is possible to match the angular momentum of a horizontal ring rotating about its center to a vertical ring that rotates about its axis by setting $q = mR^2\omega = m'R^2\omega/2$, and thus $m' = 2m$. Thus, it will be stated for the rest of calculation, without further consideration, $m = 2xm_0$, $M = 2xM_0$ et $R_s = 4GxM_0/c^2$ [9].

	A	B	C
6	$a = \omega_h/\omega_{hmax} = R_s\omega_h/R_s\omega_{hmax}$ by definition of spin a	$a = v_h/c$ by A6, B1 and speed limit c	$\Phi = 1/(1+(1-a^2)^{1/2})$ by GEST and RG
7	$\Phi = 1/(1+(1-v_h^2/c^2)^{1/2})$ by B6, C6	$m/m_0 = 1/(1-\Phi)$ by GEST	$2xm_0/m_0 = 1/(1-\Phi)$ by B7 et [9]
8	$\Phi = 1-1/2x = (2x-1)/2x$ by C7	$2x/(2x-1) = 1+(1-v_h^2/c^2)^{1/2}$ by A8, A7	$1/(2x-1)^2 = 1-v_h^2/c^2$ by B8
9	$v_h^2/c^2 = (4x^2-4x)/(4x^2-4x+1)$ by C8	$v_h^2/c^2 = \beta^2/(c^2+\beta^2)$, $\beta = Rv/R_s$ by C5	$\beta = Rvc^2/4GxM_0, \alpha = 2x\beta$ by C5, [9]
10	$v_h^2/c^2 = 4x^2\beta^2/4x^2(c^2+\beta^2)$ by B9	$v_h^2/c^2 = 4x^2\beta^2/(4x^2c^2 + 4x^2\beta^2)$ by A10	$v_h^2/c^2 = \alpha^2/(4c^2x^2 + \alpha^2)$ by C9, B10
11	$(4x^2-4x)/(4x^2-4x+1)=\alpha^2/(4c^2x^2+\alpha^2)$ by A9, C10	$x^4 - x^3 - \alpha^2/16c^2 = 0$ by A11 and simplification	$\alpha^2/16c^2 = (Rvc)^2/(8GM_0)^2$ by C9

Thus by B11, C11 it is obtained the relation $x^4 - x^3 = (Rvc)^2/(8GM_0)^2$, but this equation is false. However, by reversing the final state M_0 and the initial state M (by [3]) then $x^4 - x^3 = (Rvc)^2/(8GM)^2$ and since $M = xM_0$ then $x^6 - x^5 = (Rvc)^2/(8GM_0)^2$.

This is the term $\Omega_0(M_0, R, v) = (Rvc)^2 / (8GM_0)^2$ which causes the functional dependence between the baryonic mass, the radius, the angular velocity of the galaxy and the proportion of dark matter. It is sufficient afterwards to find the roots of the polynomial $x^6 - x^5 - \Omega_0 = 0$ which unfortunately, by the theorem of Galois, has no algebraic root, so it must be solved numerically. However, with $\Omega(M, R, v) = (Rvc)^2 / (8GM)^2$, it suffices to find the roots of the polynomial $x^4 - x^3 - \Omega = 0$ which has an algebraic solution, which gives:

$a = \Omega(256\Omega+27)^{1/2}/(2\cdot 3^{3/2}) - \Omega/2$, $b = a^{1/3}$, $c = a^{2/3}$, $d = ((12c+3b-16\Omega)/b)^{1/2}$, $e = \sqrt{3}/2d$, $f = 4\Omega/3b$, $g = d/4\sqrt{3}$.

$$x_1 = -(-e-b+f+½)^{1/2}/2 - g + ¼$$

$$x_2 = (-e-b+f+½)^{1/2}/2 - g + ¼$$

$$x_3 = -(e-b+f+½)^{1/2}/2 + g + ¼$$

$$x_4 = (e-b+f+½)^{1/2}/2 + g + ¼$$

For the Milky Way with $M = 2.50 \pm 0.50 \times 10^{42}$ kg, $R = 5.50 \pm 1.00 \times 10^{20}$ m, $v = 2.25 \pm 0.25 \times 10^5$ m/s, x_1 and x_2 are complex roots, x_3 is negative and $x_4 = 5.5 \pm 1.5$ which is perfectly in agreement with the accepted values. The error margins used are much higher than suggested in the literature, the aim being to show the approximate sensitivity of the function. It is important to note that in C6 it is the equivalence of Kerr who was used and therefore this demonstration valid indirectly thereof. It follows that our model of the relativistic sphere must be improved so as to be identical to that of Kerr. For the Milky Way with $M = 2.0 \times 10^{42}$ kg, $R = 5.3 \times 10^{20}$ m, $v = 2.2 \times 10^5$ m/s the dark matter factor is $x = 6.0$.

Annex C: The induction of dark energy

Discussion on the mention of the steady state universe

The mention of the model of the stationary universe of Fred Hoyle, although the calculations use only the characteristics of a flat universe, demonstrated experimentally, suggests a position that is not anecdotal. In fact, the standard model is based on the assumption that there is an amount of energy E in expansion and that universe follows the law of conservation of energy. Unfortunately, it is experimentally demonstrated that the universe has 2/3 of negative energy and that energy balance thereof is -1/3. In this situation, only thermodynamics, by the second principle, can explain what should happen: the universe should seek thermodynamic equilibrium by extracting energy from the vacuum, that is to say, in creating mass. The fundamental equation of the entropic induced mass-energy ($M = M_0/(1–\Phi)$, $\Phi = GM_0/R_hc^2 – GM_0/dc^2$) can explain what must happen: the more rapidly the universe expands, the faster the radius increases, further increasing the vacuum energy, increasing the speed of expansion and decreasing the mass density. Under these conditions, how can we explain that our mass density is exactly what it should be if the universe was stationary and that mass was continuously generated to neutralize the balance sheet. The simplest explanation is that the universe is stationary and constantly generates mass in order to maintain a constant energy imbalance. In addition, the same equation can explain the production, by the galaxies, of non-baryonic mass that is in fact simply the gravitational field. Nothing prevents by $E = mc^2$ to transform the field energy into baryonic mass and the universe could thus use the galaxies like a vacuum energy pump. All of this is obviously speculative as is generally the case in cosmology.

On the calculation of the average position of the mass at r/2

To perform this calculation, it takes two axioms and corollaries:

[1] The universe is a hypersphere U of radius r

> Let two points $c, p \in U$ then p is in the sphere S_c of radius r and of center c.

[2] The universe is flat and its geometry is therefore Euclidean.

> Let two points $a, b \in U$ then exist two line segments linking a and b together, one with the length d and the other with the length $2r – d$ (in going to the opposite direction).

[3] The average distance d of two points $\{a, b\}$ randomly selected in a hypersphere of radius r is r.

> The average distances of two points {a, b} randomly selected in a sphere of radius r is $35r/36$ (by known theorem on the sphere), but obviously r for the hypersphere because the distance should be the same in both directions by [2].

[4] The average position of the mass in a hypersphere of radius r is $r/2$.

> The average position is here naturally defined with respect to an arbitrary center c. By [3], it is possible to take two random points a, b and arbitrarily consider either a or b as the center c. By randomly taking points on the segment a-b, these points should be distributed according to the density and the average will be located at the average position of the mass. But since the space is considered with a homogeneous density and there is no privileged center, the mean position of the mass is indeed necessarily $r/2$.

Annex D: Comparison with general relativity

Ontological difference with the nature of the mass-energy

The first ontological doubt should occur when comparing the fundamental equation of special relativity with a fundamental theorem of general relativity, the Schwarzschild theorem.

$$\frac{m_0}{m_d}=\frac{t_0}{t_d}=\frac{l_d}{l_0}=\sqrt{1-\left(\frac{v}{c}\right)^2}\ versus\ \frac{t_d}{t_0}=\frac{l_0}{l_d}=\sqrt{1-\frac{R_s}{d}}$$

The absence of the mass-energy in the equation of general relativity stands out and should have been immediately alert the founding fathers of this theory. Indeed, for a theory which is intended to be generalized, it does seem to miss a third of the equalities. The strangest thing is that the maintenance of this difference is fundamentally ontological; in the first case it is the properties of a body, in the second case it is the properties of the space. The ontological paradox is obvious, if in one case the length and time are the properties of space, they should therefore also be in the second. If in both cases the length and time are the properties of space then how to explain the functional dependence of the mass-energy and space-time; the simplest solution would be to consider that these are three distinct facets of the same phenomenon. This latter position is that of the GEST (Gravitational Entropic Self-inductive Theory).

If the distortion of space-time in the SR is the cause of the increase in mass-energy the same phenomenon should occur in the GR; equal causes, equal effects. If, instead, it is the increase of the mass-energy that is the cause of the distortion of space-time then it would be a common cause because it is the presence of mass-energy that deforms space-time in GR. By cons, it would then also assuming that the mass-energy in the GR also varies in the same proportion to that of the SR. Whichever way you to examine the question, there is really an ontological issue about the causes and effects.

Difference on the notion of relative space and time

The hypothesis of a nonexistent space and time, without the presence of matter, is not only unnecessary but is improvable; it can only be taken as a metaphysical position. It is much easier to ask that a completely flat space, empty of any matter, has a spatial curvature and its own time absolutes, those of space-time at rest. In fact, this is almost the same time and the same spatial curvature that of small body at rest because it does not have enough mass-energy for distort space-time. According to this conception, each position of the space has its own curvature and its own time based on the gravitational field produced by the presence of the mass-energy, of a moving body, or both.

Thus, space-time at rest can be considered to be a classical Newtonian space with the same universal time clock rate. In contrast, a better concept would be to consider the space as having in each point a clock with a frequency proportional to the curvature of the space at this point. All clocks in a space at rest has the same rhythm. This latter position is that of the GEST.

Difference in the interpretation of the principles of strong and weak equivalence

Einstein, adopting the principle of inertia of Galileo, formulated here by Newton : "*Every body perseveres in its state of rest, or of uniform motion in a right line, unless it is compelled to change that state by forces impressed thereon."* and noting that the passenger in a falling elevator is paradoxically "weightless" in a Galilean reference frame, has imposed the only logical conclusion to keep the two consistent facts: ask that the elevator follow the straight line which is defined as the shortest path between two points, which turns out to be defined by a curve in a gravitational field.

This concept, although correct, neglects an important aspect: an inertial body at rest or with a constant velocity follows the law of SR and it (or the space it occupies) undergoes a deformation of the space-time and a dilation of its mass-energy. Let us posit that the falling elevator is equivalent to a Galilean reference frame is equivalent to ask that it follows SR and therefore it is undergoes a deformation of space-time and a constant expansion of its mass-energy. But here's the real problem, it is not a Galilean reference frame since it is accelerated and it is impossible to resolve this paradox without redefining the Galilean reference frame:

“A Galilean reference frame or inertial, is a reference frame where a body on which no force is exerted or on which the resultant force is zero, is moving in a uniform rectilinear translation or **accelerated uniformly.**”

Gravity is simply the only known way to accelerate a body without applying force, which allows the inclusion of the acceleration in the definition of inertia. In the phenomenon of gravity, all particles constituting a body are accelerated evenly (or almost) simultaneously. It is this simultaneous acceleration of each of the parts of the body that explains the lack of any deformation caused by the transmission, of the acceleration between its constituent neighbor particles.

Since the gravitational field is inertial, it is possible to define it as a field of relativistic acceleration or a field of relativistic speed. In the first case each point in space (or position) p infinitesimal should undergo the equivalent to a relativistic acceleration (∂m, ∂t, ∂l) in the second case it would undergo the equivalent of a relativistic speed, thus (m, t, l). In the first case, it is a rate of change of the mass-energy, time and length, and in the second case it's a fixed change in mass-energy, time and length. Since this rate of change is the same for all three variables, it is possible to combine these in a single scalar factor ϕ.

Einstein believed that since a ray of light entering an elevator immobilized in a gravitational field, follows the same path that it would follow if the elevator was in a uniformly accelerated motion then this implies that the gravitational field is a field of acceleration. That concept is wrong and this was demonstrated experimentally by verifying the GR. Indeed, a fixed clock in a gravitational field undergoes constant deformation of time according to its position and not a constant variation of this variation. Thus, the immobilized clock in a gravitational field, behaves like a clock at constant speed and not as an accelerating clock. Therefore, the acceleration of the gravitational field is indeed caused by the gradient of the field, not by the field itself. This latter position is that of the GEST.

The idea that a Galilean reference frame is an accelerated reference frame goes against the physical sense, but gravity is a striking demonstration of this. Continuing the thought experiment of Galileo with two balls of different natures and masses and placing these two balls in a constant electric or magnetic field, it is possible to notice, unless extraordinary coincidence, that these two balls do not have the same acceleration. It follows that, by linking the two balls together by a rope, to form a single system, one of these two balls pulls on the other. This thought experiment shows that for all other fields this is the phenomenon of the differential of the acceleration, inside the body, which has the effect of force usually associated with the acceleration and not the acceleration itself. It is important to note that this occurs even for gravitation, in fact, every body is broken by the gravitational gradient if it finds itself in free fall in a very strong field, like that of black hole.

Difference with the mathematical interpretation

Quantum theory has the advantage of having two separate formalisms: Heisenberg’s matrix mechanics, and Schrödinger’s wave mechanics. Wave mechanics, not using at that time the, the new theory of matrix algebra but the good old differential equations, was much more popular than the matrix mechanics, at least initially. In GR, there is only one formalism, extremely complex, which unfortunately rebuilt completely the gravitation, disregarding all the old concepts. In particular, the geodesics are interpreted as the path along the greater length contraction whereas if $m/m_0 = l_0/l$ the same path can be interpreted as that of least action allowing the body to acquire the most energy in the immediate; that is to say, as much as possible to increase its mass in the immediate. Since the relativistic speed can be interpreted as a gravitational field ϕ_v produced by a moving body, for a moving body in a gravitational field ϕ_g, the Lagrangian is equivalent to minimizing ϕ_v-ϕ_g in the immediate.

One must consider that the formalism of GR, the theory of tensors, is an accident of history. Indeed, if this mathematical theory, originally developed for the modeling of elastic bodies, did not exist then the GR would probably have been developed with other tools. We must clearly distinguish the principles of formalism. This is why it is so important to focus on the basics such as inertia, acceleration and field. Unlike the GR, the GEST is not attached to a particular formalism and seeks simplicity.

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Marie-Andrée Cormier (2011), “*Paysage Humain*”, Montreal Museum of Contemporary Art

In this installation, two orthogonal screens show a 3D world perfectly representative of the holographic model of the universe of Verlinde. Characters evolve moving boxes, producing inelastic collisions, the only possible source of photons and therefore of the information on the screen of the universe.