Gamma-Ray Bursters and Lorentzian Relativity

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In the dynamic interpretation of relatively by Lorentz and Poincaré, Lorentz invariance results from real physical contractions of measuring rods and slower going clocks in absolute motion against an ether. As it was shown by Thirring, this different interpretation of special relativity can be extended to general relativity, replacing the non-Euclidean with a Euclidean geometry, but where rods are contracted and clocks slowed down. In this dynamic interpretation of the special, (and by implication of the general) theory of relativity, there is a balance of forces which might be destroyed near the Planck energy, reached in approaching the event horizon. In gravitational collapse, the event horizon appears first at the center of the collapsing body, thereafter moving radially outward. If the balance of forces holding together elementary particles is destroyed near the event horizon, all matter would be converted into zero rest mass particles which could explain the large energy release of gamma ray bursters.

Cosmic gamma-ray bursters pose a serious challenge to our known laws of physics, because if their energy is released isotropically into all directions, this amounts to the complete conversion into gamma ray energy of a solar mass within a fraction of a second. Less energy is needed if the gamma-ray bursts are beamed, but the high frequency of such bursts (several bursts per day) make´s this hypothesis implausible. The same is true if gamma ray bursters are caused by the collision of two neutron stars, something which must be quite rare. A model predicting the direct conversion of an entire stellar rest mass into gamma ray energy remains the most plausible.

In the Lorentz-Poincaré theory of relatively [2], there is an ether and bodies in absolute motion against the ether suffer a true contraction, with clocks going slower as a result of this contraction. This alternative theory can account for all the relativistic effects observed. It was shown by Thirring [1] that general relativity can likewise be interpreted by replacing the non-Euclidean geometry with a Euclidean geometry of contracted rods and slower going clocks. Because of the difficulties to quantize Einstein's gravitational field equations, this interpretation was preferred by Heisenberg [3]. Figure 1 shows the replacement of the non-Euclidean Schwarzschild metric with a Euclidean metric of shrunken measuring rods.

Lorentz considered only attractive electromagnetic forces in his derivation of Lorentz invariance as a dynamic symmetry, ignoring a repulsive force needed for an equilibrium. This repulsive force is the quantum force, having its origin in the zero point vacuum energy. Because it is also Lorentz invariant, the dynamic interpretation of special relativity requiring the establishment of an equilibrium between attractive and repulsive forces can be formulated in a fully conistent way [4] (see appendix).

There though is an important difference between the Lorentz-Poincaré and the Einstein theory of relativity: As can be seen from (A.5), the elliptic differential equa-

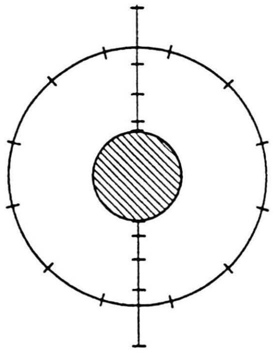

Fig. 1. Replacement of the Non-Euclidean Schwarzschild metric with a Euclidean metric having contracted measuring rods. Note that with the contracted measuring rods, the circumference of a circle U divided by its diameter D is different from π. (From R. U. Sexl and H. K. Urbantke, Gravitation und Kosmologie, Spektrum Verlag, Heidelberg 1995, p. 302.)

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tion for $v < c$ becomes a hyperbolic differential equation for $v > c$. The latter cannot be reduced by a uniform length contraction to (A.2). This means that for $v > c$ there can be no static equilibrium. Therefore, whereas in Einstein's theory particle masses diverge in the limit $v = c$, in the Lorentz-Poincaré theory particles become unstable in approaching that limit and can then break up only into zero rest mass particles.

If an ether is responsible for the transmission of the forces holding material bodies in a state of equilibrium, and if this ether has a discrete structure at the Planck length, the balance of the forces, and with it the Lorentz invariance, would be destroyed if the kinetic energy of elementary particles relative to the ether approaches the Planck energy.

According to Einstein the experimental facts can be described by a flat four dimensional Minkowski space-time, with undeformed rods and clocks in a system at rest with the rods and clocks. According to Lorentz they are the result of true contractions and slower going clocks for bodies in absolute motion against an ether, with the Minkowski space-time an illusion caused by the contractions and slower going clocks. The two different interpretations go over into the general theory of relativity, with an equivalence between a Riemannian curved Minkowski space-time with undeformed rods and clocks, and a flat space and absolute time with deformed rods and slower going clocks in absolute motion against an ether. As before, the curved space-time is an illusion caused by true contractions and slower going clocks.

In Einstein's gravitational field theory the metric surrounding a spherical mass M is given by Schwarzschild's line element in spherical polar coordinates r, θ, φ (G Newton's constant, c velocity of light):

$$\mathrm{d}s^2 = \frac{\mathrm{d}r^2}{1 - 2GM/c^2 r} + r^2(\mathrm{d}\theta^2 + \sin^2\theta \mathrm{d}\varphi^2) - c^2(1 - 2GM/c^2 r)\,\mathrm{d}t^2. \tag{1}$$

According to Newtonian mechanics the velocity v of a body falling from infinity into the gravitational field of a mass M is

$$v = \sqrt{2GM/r}. \tag{2}$$

In the Lorentzian ether theory this leads to a contraction of the body in its radial direction given by

$$\mathrm{d}r = \mathrm{d}r'\sqrt{1 - v^2/c^2} = \mathrm{d}r'\sqrt{1 - 2GM/c^2 r} \tag{3}$$

and a likewise clock retardation

$$\mathrm{d}t = \mathrm{d}t'/\sqrt{1 - v^2/c^2} = \mathrm{d}t'/\sqrt{1 - 2GM/c^2 r}\,. \tag{4}$$

Inserting (3) and (4) into $\mathrm{d}s^2 = \mathrm{d}r'^2 - c^2\mathrm{d}t'^2$ one obtains (1) [5].

In approaching the Schwarzschild radius $R_s = 2GM/c^2$, an infalling particle reaches relativistic velocities. Seen from an observer infinetely far away this velocity is

$$v = \frac{\mathrm{d}r}{\mathrm{d}t} = -c\left(1 - \frac{R_s}{r}\right), \tag{5}$$

approaching $v \to$ o for $r \to R_s$, but if measured in a local inertial reference system, at rest relative to the collapsing body, the infalling particle approaches $v = c$. From (5) one has

$$-ct = \int \frac{\mathrm{d}r}{1 - R_s/r} \approx R_s \int \frac{\mathrm{d}r}{r - R_s} \tag{6}$$

and hence

$$r - R_s = \text{const}\; e^{-ct/R_s}. \tag{7}$$

If at $t = 0$, $r = (a+1)\,R_s$, $a \gg 1$, it follows that

$$\frac{r - R_s}{R_s} = a e^{-ct/R_s}. \tag{8}$$

To reach the Planck energy $m_p c^2 \simeq 10^{19}$ GeV, where $m_p \sim 10^{-5}$ g is the Planck mass, one must have for an elementary particle mass m:

$$m/m_p = \sqrt{1 - v^2/c^2} = \sqrt{1 - R_s/r} \tag{9}$$

hence

$$\frac{r - R_s}{R_s} \simeq \left(\frac{m}{m_p}\right)^2. \tag{10}$$

Inserting (10) into (8) and solving for $t = t_0$, the time needed to reach the distance r where the kinetic energy of the infalling particle becomes equal the Planck energy, one finds [6]

$$t_0 = \frac{R_s}{c} \log\left[a\left(\frac{m_p}{m}\right)^2\right]. \tag{11}$$

In the limit $m_p \to \infty$, $t_0 \to \infty$, as in general relativity where v can come arbitrarily clos to c. For a finite value of m_p this is not the case. For an electron of mass m one has $m_p/m \sim 10^{22}$ and log $(m_p/m) \sim 10^2$, making the collapse time about 100 times longer than the Newtonian collapse time $t_N \sim R_s/c$. For baryons the collapse time t_0 is not significantly different. If $R_s \sim 1$ km (typical for a solar mass) one has $t_N \sim 3\times10^{-6}$ sec, and $t_0 \sim 3\times10^{-4}$ sec.

According to Schwarzschild's interior solution [7] the event horizon where $v = c$ moves from the center of the collapsing body radially outwards, with the time needed to convert an entire solar mass into energy of the same order of magnitude as t_0.

If a mass of 50 solar masses $\sim 10^{35}$ g is converted into radiation, an energy of $\sim 10^{56}$ erg would be set free. In the process of the conversion into energy, baryons (together with the charge- neutralizing electrons) would be converted into GeV gamma ray photons.

We should add that, contrary to a widespread misconception, Einstein's gravitational field equation can also be formulated as a non-linear field theory in flat Minkowski space [8, 9], but the equations become inapplicable inside an event horizon, where physics can be different. The predictions obtained by extrapolating Einstein's theory into this region have never been confirmed by observation.

Finally we would like to mention that a similar idea (though depending on GUT theories) was proposed by Dehnen et al. [10].

Appendix

In the Lorentz-Poincaré ether theory of relativity Maxwell's equations are only valid in the ether rest frame. There the electrostatic potential Φ obeys the inhomogeneous wave equation:

$$-\frac{1}{c^2}\frac{\partial^2 \Phi}{\partial t^2} + \nabla^2 \Phi = -4\pi\varrho(\boldsymbol{r}, t), \tag{A.1}$$

where $\varrho(\boldsymbol{r}, t)$ is the electric charge density. For a solid body at rest in the ether and in static equilibrium, one has

$$\nabla^2 \Phi = -4\pi\varrho(\boldsymbol{r}), \tag{A.2}$$

where $\varrho(r)$ is the microscopic distribution of the positive and negative electrical charges within the body, holding the body together.

If set into absolute motion along the x-axis with the velocity v, the coordinates at rest with the moving body are obtained by the Galilei-transformation

$$x' = x - vt,\ y' = y,\ z' = z,\ t' = t \tag{A.3}$$

whereby (A.1) is transformed into

$$-\frac{1}{c^2}\frac{\partial^2 \Phi'}{\partial t'^2} + \frac{2v}{c^2}\frac{\partial^2 \Phi'}{\partial x' \partial t'} + \left(1 - \frac{v^2}{c^2}\right)\frac{\partial^2 \Phi'}{\partial x'^2} + \frac{\partial^2 \Phi'}{\partial y'^2} + \frac{\partial^2 \Phi'}{\partial z'^2} = -4\pi\varrho'(\boldsymbol{r}', t'). \tag{A.4}$$

After the body has settled into a new equilibrium one has $\partial/\partial t' = 0$, and hence

$$\left(1 - \frac{v^2}{c^2}\right)\frac{\partial^2 \Phi'}{\partial x'^2} + \frac{\partial^2 \Phi'}{\partial y^2} + \frac{\partial^2 \Phi'}{\partial z^2} = -4\pi\varrho'(x', y, z). \tag{A.5}$$

Comparing (A.5) with (A.2) one sees that the l.h.s. of (A.5) is the same as (A.2) if one sets $\Phi' = \Phi$, and $\mathrm{d}x' = \mathrm{d}x\sqrt{1 - v^2/c^2}$. Clocks made up of solid matter must then go slower by the same factor. It thus follows that Lorentz invariance is here seen as a dynamic effect caused by true contractions of objects in absolute motion, with the four-dimensional Minkowski space-time an illusion caused by these contractions.

To keep the body in static equilibrium the attractive electrostatic forces between the positive and negative electric charges of the body must be balanced by repulsive forces, the latter provided by quantum mechanics. These quantum forces prevent electrons from falling into atomic nuclei, for example, and they have their origin in the zero point vacuum energy. For the electromagnetic field the zero point energy is for each mode of frequency ω equal to

$$E_0 = (1/2)\hbar\omega. \tag{A.6}$$

This leads in frequency space to the spectrum

$$f(\omega)\,\mathrm{d}\omega = \mathrm{const}\ (1/2)\hbar\omega \times 4\pi\omega^2 \mathrm{d}\omega = \mathrm{const}\ \omega^3 \mathrm{d}\omega. \tag{A.7}$$

The remarkable thing about this spectrum is that it is not the only one which is Lorentz invariant, but it is also the only one which is frictionless.

Therefore, both the attractive electrostatic and repulsive quantum force, holding together a body in static equilibrium, are Lorentz invariant, establishing the equivalence of the dynamic Lorentz-Poincaré theory of relativity with Einstein's special theory of relativity, at least for electromagnetic forces. Very much as Einstein had conjectured that the equivalence of energy and mass is universally valid, not just for the electromagnetic energy (which was already known before Einstein), it is reasonable to conjecture that the alternative Lorentz Poincaré theory of relativity is universally valid as well, and not restricted to electromagnetic interactions.

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