EIENSTEN SPACE HANDLE FOR GENERAL RELATIVITY

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ABSTRACT *We restrict attention for simplicity to "Cold catalyzed matter", i.e., matter, which has reached the end point of thermonuclear burning. We consider densities so great that the mass-energy of compression is appreciable in comparison to the rest mass of the individual baryons (special relativity effects in both pressure and density!). The ρ includes not "matter density" alone but density of mass-energy from all local sources, rest mass, kinetic energy, short range particle-particle interactions.*

Keywords: *Cold Catalyze Matter, Astrophysics, Space- time, Space Engineering*

Fact Tithering:

Mass-energy curves space and enough mass-energy curve space up into closure Space, curved up into a 3-sphere of uniform, curvature and radius a, has a scalar curvature in variant of magnitude

$$^{(3)}R = 6/a^2 = 16\ \pi\rho$$

From this formula, one finds how large a
system can be before it can not be, an object of solar mass will not curve space up into closure even when compacted to the density of nuclear matter. In such a system, general relativity effects have not yet reached the point where they are all-powerful, but they are nevertheless significant. These effects force one to give up the Newtonian equation of hydrostatic equilibrium for the variation of pressure with depth,

$$-dp(r)/dr = \rho(r)m(r)/r^2$$

and replace it by the corresponding Tolman-Oppenheimer-Voltkoff (T-O-V) equation,

$$-dp(r)/dr = \frac{(\rho+P)\ (M + 4\pi R^3 P)}{R\ (R-2M)}$$

To integrate the system of equations, we need to have a relation between pressure and density, $p = p(\rho)$. Once this additional equation is given, we choose a value for the central density p(0) = p0 with corresponding pressure $p(p_0) = p_0$. We assume the boundary condition m (0) = 0 and integrate outward from r = 0. For every value of r we find the value of the pressure p(r), of the density ρ(r) and the mass m(r) contained inside a sphere of radius r. The integration is continued to the surface of the star, defined as the place where the pressure drops to zero.

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Now questions arise

For a star model of a given central density, how sensitive is the mass to (1) the difference between Einstein's geometrostatic to Newton's gravitational theory, (2) the difference between Einstein's gravitation of Brains and Dicks **(1)**, and (3) uncertainties in the equation of state? To clarify issues (1) and (2) first, we pick one equation of state and compare the prediction of different equations of state. In the 1st part of our investigation we pick for the sake of definiteness the Harrison-wheeler equations of state, the deviation and details which are given in the literature(2).

Fact Findres:

The Newtonian equilibrium configuration for any selected value of the central density is immediately obtained by the integration of equations. In strict Newtonian theory the outcome of the integration out to the surface of the star

(place where p goes to zero) is threefold: (1) a value for the radius, R, of the star, (2) a value for the amount of "matter" in the star, and (3) enough supplementary information to according to special relativity, energy of the star. However, according to special relativity, energy has mass. This blurs the distinction between (3) and (2). The distinction is re-established already in special relativity when we give up the idea of measuring amount of "matter" by amount of mass and use instead for the measure of that quantity the number of baryons (Law of conservation of baryons). Here we have not taken the trouble to calculate the baryon number for Newtonian configuration. We do calculate the mass, with all its contribution, rest mass of the particles, mass-energy of compression (positive), and gravitational binding (negative). In actuality they are automatically combined in our definition of density ρ of mass-energy (rest mass plus kinetic
energy plus energy of local interactions) in the
equation of state. Therefore, the "mass" that comes out of our Newtonian analysis,

$$M = \int_0^R 4\pi\rho r^2 dr$$

is neither the strict Newtonian mass (including as it does mass-energy of compression) nor the strict-special relativity value for the mass. It fails to correct for mass-energy equivalent of gravitational binding,

$$M_{gr} = -\int^R [m(r)/r]\,dm(r)$$

it is simple to make the necessary correction, thus,

$$M_{rr} = M + E_{gr}$$

The general relativity equilibrium

Configuration for any ρ0 is obtained by integrating equations. General relativity has a much greater effect at the second maximum, moving it from
~- 1016g/cm3 to ~ 6x1015g/cm3. Moreover, the location of the maximum indicates the point of change of stability, according to the general relativity theory of equilibrium configuration. Thus, general relativity lowers the central density required to reach instability by a factor of the order two. In addition it reduces the critical mass for the largest stable neutrons star from 1.2 MΘ to 0.7 MΘ Thus, in the physics of a neutron star, general relativity does not introduce those small effects so well know in the three traditional tests of general relativity.
Instead it makes a difference of the order of a factor of two both in density and in Critical Mass.

The Jordan and Brains and Dicks Version of Equation

The Scalar-Tensor theory of Jordan and Brains and Dicks leads to a system of equation for hydrostatic equilibrium more complicated then either the Newtonian or the simple standard Einstein theory. These equations take the following simplified form in Schwarzschild co-ordinates,

$$dm(r)=4\pi r^2 \left[\frac{P}{\varphi} + \frac{\omega\varphi^2}{16\pi\theta^2} \cdot \frac{r-2m}{r} + \frac{1}{\varphi} \quad \frac{[3p\,(r) - p\,(r)\,]}{3+2\omega} \right] r^2$$

[The Jordan an Brans and Dicke, Version of
equation is given by]

$$\frac{-dp\,(r)}{dr} = \frac{p+\rho(p)}{r\,(r-2m)} \left[m + 4\pi r^3 — \left\{ \frac{p}{\phi} \left[- \frac{w}{4\varphi^2} \quad 1- \frac{2m\,(r)}{r} \right] \right\} \right] \phi'^2$$

(The Jordan and Brains and Dicks version of equation)and finally we have the scale wave equation with source term

$$\varphi'' + \left[\frac{3}{r} - \frac{r-2m}{r^2} + \frac{4\pi}{\varphi}(p-\rho) - \frac{\omega\varphi'^2}{2\varphi^2}(r-2m) - \frac{8\pi r\,(3p-\rho)}{\varphi\,(3+2\omega)} \right] \omega'$$

$$= \frac{8\pi}{(3+2\omega)} - (3p-\rho)\frac{r}{(r-2m)}$$

Here it indicates the scalar field with φ and with the prime its derivative with respect to r. The quantity ω is a dimension less constant for which Dicker favors a value in the range $4 \le \omega \le 6$. To recover the general relativistic equations it is sufficient to make $\omega \to \infty$.

The integration of this system of equations with $\omega = 4$ gives results which are qualitatively identical to the general relativistic ones. the only quantitative difference is an increase of approximately two percent ($M_{crit} = 0.730\ M\Theta$) in the value of the critical mass for a neutron star and an increase of a similar order of magnitude in the radius of the neutron star.

Facts and Findings:

In general, relativity makes a difference by a factor of two in the critical mass for a neutron star, compared to Newtonian Theory, what are the prospects for measuring this effect as a new test of Einstein's Theory? Poor today, perhaps better tomorrow. The Principal difficulty is an uncertainty by a factor of the order two in the critical mass arising from ignorance about the equation of state at super nuclear densities (from 10^{14} g/cm^3 (nuclear matter) to 5 x 1015 g/cm^3 (central density for initiation of instability)). No such uncertainty apply to the equation of state at uclear and sub-nuclear densities where inter-polations of existing experimental and theoretical evidence can be applied with some confidence. A look at this region of lower densities will illustrate the kind of information that one would also like to have for the high-density region. The entire discussion will refer to the idealized and well-defined case of matter at the end point of thermonuclear evolution. How close to this end point does matter end up after the violent and high temperature implosion. White dwarf neutron star. Remnants of past history may persist in the most fraction of a kilometer of a neutron star of near critical mass. However, below that depth the density exceeds 10^{12}gm/cm^3. The pressure is enormous. All traces of the past history of thermonuclear reactions in the material are wiped out. The idealisation reactions in the material are wiped out. The idealisation of "Cold Catalyzed matter" would therefore appear to be legitimate through out the interior.

For a first study of this situation, it is helpful to define a "Local Gamma Law" in this situation of state by the equation -

$$\gamma = \frac{p+\rho}{P}\ \frac{dp}{d\rho}$$

And this quantity is function of density. Values of $\gamma > 4/3$ are the region of stability. On the right hand side we show the region of stability and instability as obtained by integration of the equation of hydrostatic equilibrium correlated with the regions where γ is less than 4/3 and greater than 4/3

References

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