Please return to

GUIDELINES TO ANTI-GRAVITY

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Abstract:

This essay emphasizes some little-known aspects of Einstein's General Theory of Relativity. These features, although of minor theoretical importance, can lead us to the generation and control of gravitational forces. Four distinctly different non-Newtonian gravitational forces are described. Those research areas which will lead to control of gravitation are pointed out and guidelines for initial investigation into these areas are given.

Introduction:

In Einstein's General Theory of Relativity[1] there are a number of different ways to generate non-Newtonian gravitational forces. All of these methods could theoretically be used to counteract the gravitational field of the earth and thus are a form of anti-gravity.

The three methods of obtaining non-Newtonian gravitational fields which are outlined below were probably known by Einstein before he published his paper on the principle of general relativity in 1916,[1]. They were first specifically derived by Thirring[2] in 1918 and they have been contained in every text on general relativity since then[3,4,5]. These forces are well known to the theorists in general relativity, but are little known to those outside of the field.

The forces arise from the application of the principle of general relativity to systems of moving masses. The moving masses give rise to forces on a test body which are similar to the usual centrifugal and coriolis forces, although much smaller. The accelerations given to the test body by these forces are independent of the mass of the test body, and are therefore true gravitational forces.

Effect of Rotating Masses on Stationary Bodies:

When a rotating system of masses is investigated using Einstein's General

Theory of Relativity, it can be shown that besides the usual Newtonian term, the gravitational scalar potential contains terms which arise from the rotation of the body. One of the shapes which has been investigated is the rotating massive ring[3].

For a massive ring rotating in the x-y plane, the acceleration on a stationary test body near the origin is approximately:

$$\ddot{x} = \frac{MG\omega^2}{2c^2R}x$$

$$\ddot{y} = \frac{MG\omega^2}{2c^2R}y$$

$$\ddot{z} = -\frac{MG\omega^2}{c^2R}z$$

Where M and R are the mass and radius of the ring, ω is the angular velocity, G = 6.67×10^{-8} cm^3/gm sec^2 is the Newtonian gravitational constant, c is the speed of light, and x,y,z are the coordinates of the test body with respect to the origin of the rotating mass.

From these equations we see that not only does the rotating mass force the test body away from the axis in an imitation of centrifugal force, but it also pulls it into the plane of rotation.

<u>Effect of Rotating Masses on Moving Masses</u>:

In the previous section it was pointed out that a rotating mass will exert forces on a stationary test body which act like the usual centrifugal force. In addition, if the test body is moving at some constant velocity $\bar{v}$, then it will experience an additional force which is proportional to the cross product of the angular velocity of the rotating mass and the linear velocity of the test body. This particular force has two analogies. From a mechanical point of view, it acts like a very weak coriolis force. From an electromagnetic point of view,[4,6] it acts like the gravitational equivalent of the Lorentz force on a charged particle moving through a magnetic field.

One of the shapes which has been investigated is the rotating massive spherical shell. The acceleration on a test body moving with a velocity $\bar{v}$ inside the shell is approximately:[4]

$$\ddot{x} = \frac{GM}{3c^2R}\left[\frac{4}{5}\omega^2 x - 8\omega v_y\right]$$

$$\ddot{y} = \frac{GM}{3c^2R}\left[\frac{4}{5}\omega^2 y + 8\omega v_x\right]$$

$$\ddot{z} = -\frac{8GM\omega^2 z}{15c^3R}$$

where v_x and v_y are the x and y components of the velocity of the test body, M and R are the mass and radius of the spherical shell, and the other quantities where defined in the previous section.

The first term in each expression is the centrifugal type force on a stationary test body that was described in the previous section. The second term in the x and y components of the acceleration are seen to depend upon the velocity of the test body.

Effect of Accelerated Masses on Stationary Test Bodies:

When we investigate the effect of a large accelerated mass on a small test body using Einstein's Theory, we find that the accelerated body drags the test body along with it. The exact equations are:

$$\ddot{\bar{r}} = \nabla\frac{GM}{R} + \frac{4GM}{c^2R}\bar{a} + \frac{4GM}{c^3}\left(\frac{\bar{a}\cdot\bar{R}}{R^2}\right)\bar{v}$$

Where M, $\bar{a}$ and $\bar{v}$ are the mass, acceleration and velocity of the large body and $\bar{R}$ is the distance from the small body to the larger body.

Notice that besides the usual Newtonian attraction, the test body experiences forces in the direction of the acceleration and of the velocity of the large body.

Devices Using Moving Masses:

All of the above equations contain two common factors. One is the Newtonian gravitational field and the other is the ratio of the system velocity to the velocity of light

$$\frac{GM}{r^2} \approx \frac{4\pi}{3} G\rho r$$

$$\frac{v^2}{c^2} \quad or \quad \frac{a_r}{c^2}$$

In order to obtain measurable amounts of gravitational force, these quantities must be as large as possible. For the gravitational field to be high we need either a large mass or a high density. The greater the density, the less total mass we need to get the same gravitational field.

It will not be possible to obtain systems with sufficiently high rotations or velocities using the mechanical strength of materials. It will be necessary to use fields to hold the system together under inertial stresses. One field we could use is the high gravitational field obtainable with dense matter, although practical devices will probably find ways to use electric or magnetic fields.

An example of a system of rotating masses held together by fields is a contact binary dwarf star systems The two dense stars are kept in their orbits by their mutual gravitational field.

The force equation describing their mutual rotation is:

$$-\frac{GMM}{(2r)^2} = -M\omega^2 r = -\frac{Mv^2}{r}$$

A particle coming near the system will not only experience a radial acceleration[4]

$$\ddot{x}_r = -GM\left[\frac{1}{(b r)^2} + \frac{1}{(b+r)^2}\right] - \frac{4GMa}{c^2}\left[\frac{1}{b-r} - \frac{1}{b+r}\right]$$

but also a tangential acceleration

$$\ddot{x}_r = -GM\left[\frac{1}{(b r)^2} + \frac{1}{(b+r)^2}\right] \approx \frac{1}{c^3 b}\left(\frac{GM}{r}\right)^{5/2}$$

where b is the distance of the particle from the center of the system.

If the test object (such as a space vehicle) passes by this star system the radial accelerations will not introduce any net change in velocity but the tangential acceleration will transfer energy and momentum to the vehicle. For a neutron binary star these accelerations can be greater than one million g's. Thus star systems can be used to accelerate space vehicles to the speed of light.

An important fact to remember is that these are gravitational forces. They act independently on each individual particle of the body and although you are being accelerated at 10^9 cm/sec^2, you will feel no forces on your body; you are still in free fall.

By using electromagnetic forces to contain the rotating systems it will be possible to attain relativistic velocities and in this manner a comparatively small amount of matter can give usable gravitational effects if it is dense enough.

<u>Devices Using Electromagnetic Analogies</u>:

There are other types of devices for obtaining non-Newtonian gravitational forces which use Einstein's General Theory of Relativity, but they have not been fully investigated in a rigorous manner. For instance, two rotating gyroscopes should repel each other if oriented properly, two pipes with massive liquid flowing through them should exhibit a pinch effect, etc.

An example of such a device, which is readily visualized by its analogy to electromagnetism, is a system of accelerated masses whose mass flow can be approximated by the current flow in a wire-would torus.[8]

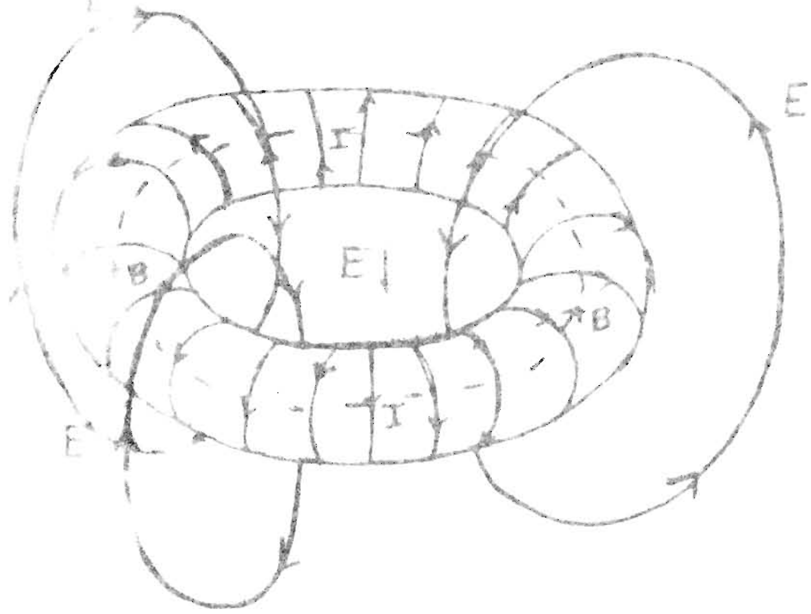
In the electromagnetic case, the current $\bar{I}$ through the wire causes a magnetic field in the torus. If the current is constantly increasing, then the magnetic field also increases with time. This time-varying magnetic field then creates a dipole electric field. The value of this field at the center of the torus is:

$$E = -\dot{B} = \frac{d}{dt}\left(\frac{\mu N I r^2}{4\pi R^2}\right)$$

Where R is the radius of the torus, r is the radius of one of the loops of wire wound around it, and N is the total number of turns.

$$E = -\dot{B}$$

$$= \frac{\mu_0}{4\pi}\,\frac{N\dot{I}\,r^2}{R^2}$$



4a

$$G = -\dot{K}$$

$$= -\frac{\eta_0}{4\pi}\,\frac{N\dot{T}\,r^2}{R^2}$$

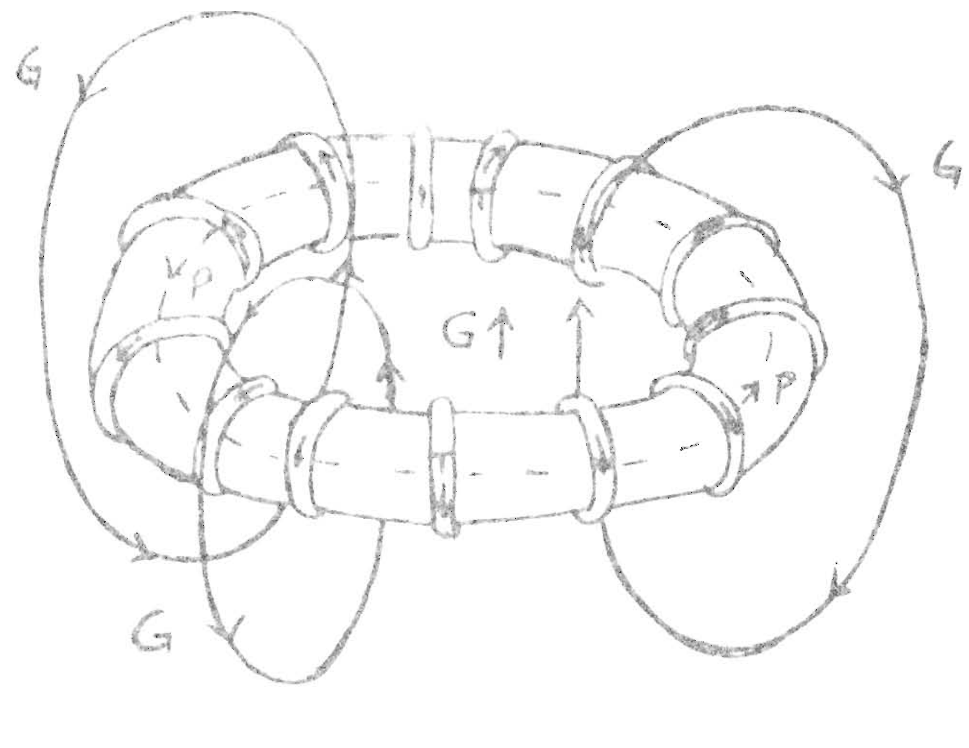


FIGURE 4b

We can now use the known analogies between the electromagnetic and gravitational fields.[6] We transform all the electromagnetic quantities to their equivalent gravitational quantities to get:

$$G = -\dot{K} = -\frac{d}{dt}\left(\frac{\eta N T r^2}{4\pi R^2}\right)$$

Where G is the gravitational field generated by the total mass current N T and η is the gravitational equivalent to the magnetic permeability.

When looking at the above equation, it is important to notice that the time derivative operates on the entire quantity in the brackets. Normally one would then say that all quantities are independent of time except the mass flow T. If the amount of mass flow increases with time then $T > 0$, and we will generate a gravitational field G. However, in electromagnetism the permeability of some materials such as iron is non-linear. This allows the construction of highly efficient electromagnetic field generators. A material with a highly non-linear would be useful in the construction of efficient gravitational field generators.

<u>Research Areas</u>:

Dense Materials - It was emphasized in the previous sections that in order to obtain measurable gravitational effects with moderate amounts of mass it is necessary to use dense matter. Thus, the most important research area that will lead to the generation and control of gravitation is the study of degenerate matter. We must learn how to manufacture, contain and control matter with densities from 10^8 to 10^{15} gm/cm^3. This is not an impossible task. This type of matter exists right now. From one to ten percent of all stars in the galaxy are made of degenerate matter. We can see this ultra dense matter through telescopes, and study it with spectrographs. All we have to do is duplicate what nature already has shown us can be done. It would seem that the best place to begin is the study of the neutron-neutron interaction. We know the internucleon forces are attractive, but why are there no particles consisting of only neutrons? Is it because the neutron decays into a proton and electron in 12 minutes? If we assembled a large enough drop of neutrons from a cold neutron gas in less than this decay time, would the binding forces prevent decay as they do in the stable atom? These and similar questions deserve intensive study.

Gravitational Properties of Matter - When we look at the gravitational analogies to electromagnetism, we notice that there is one analogous quantity which has not been investigated. This is the gravitational equivalent to the magnetic permeability. Our electrical power distribution systems depend upon the anomalously large and non-linear permeability of iron and other magnetic materials. Since all atoms have spin, all materials will have a gravitational permeability different than that of free space. Rough calculations show that this difference is very small but experimental investigation may find anomalously large or non-linear effects that can be used to enhance time-varying gravitational fields.

Since the magnetic moment and the inertial moment are combined in an atom, it may be possible to use this property to convert time-varying electromagnetic fields into time-varying gravitational fields.

The only way at present to look for such materials is to intersperse wedges of material between gravitational wave generators and detectors such as those described by J. Weber[9] and look for a change in amplitude or direction of propagation.

None of this work will be easy. We are not going to have anti-gravity in every home. But we don't have a Saturn rocket in every garage either. Future progress in the control of gravitation like all modern sciences will require special projects involving large sums of men, money, and energy.

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