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THE POSSIBILITY OF DISCOVERING AN ABSORBER INSULATOR OR REFLECTOR FOR GRAVITY WAVES

Serious scientists are not supposed to concern themselves with freedom from gravity. Such ideas make exciting material for pulp magazines, but anyone who seriously considers screens for gravity is immeadiatly set off as a potential crackpot. The method of science has always been one of careful observation, generalization and mathematical expression, and then deduction and prediction. A theory to be valid must explain positive and negative evidence equally well, and its predictions must be found true in subsequent experimentation and observation. But the theory must be careful not to indicate anything which is known to be absent.

Unfortunately the tendency has been in developing theories on gravity to ignore the one effect which cannot be adequately explained, namely that of gravitational screening. But gravitational screening is the one effect crucial in all theories of gravitation. The absence of any gravitational screening would make gravitation almost unique among physical phemenon, while the existence of it would be contrary to the myriad daily observations made consciously or unconsciously by everyone.

For a discussion of gravitation, and of gravitational screening in particular, Newton's law is a convenient starting point, since it was the first mathematical

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expression of it, and was capable of surviving two centuries in which physical concepts of all kinds were rapidly changing. We will be concerned with what the implications of Newton's law are, and whether they can still be held valid in the light of new observations. Newton's law of Gravitation, $F = G\frac{m m'}{r^2}$, implies that gravitation is independent of (1) the physical condition of the mass, i. e. solid, liquid, or gaseous, amorphous or crystalline, (2) The chemical composition of the mases, (3) the temperature of the masses or of the intervening medium, (4) directional effects, (5) the nature of the intervening medium, and that it acts as if it were concentrated at the centroid of the masses.

The work of A. S. Mackenzie[1] and others has indicated that the inverse square law holds to distances of several cemtimeters. The precision of these experiments in some cases is as high as one part in 3000.[3] The behavior of most astronomical bodies, the moon in particular since it is most readily observed, indicates that the inverse square law must be equally true for large distances.

The acceleration due to gravity, which according to Newton must be the same for all objects regardless of their mass or composition, has been found constant to one part in a billion by the work of Eötvös[2] and his associates. The materials tested were of many types both in chemical composition and in physical state. He also tested radioactive substances, but in all cases the results were substantially the same.

The question of the effect of temperature on gravitation was investigated by P.E.Shaw, who found at first a small positive result, but later observations showed it due to an experimental error. Shaw concluded that there was no effect on gravitation due to temperature to an accuracy of two parts in a million per degree Centigrade.[5]

Likewise, the isotropic property of gravitation seems quite well established. Professor A. S. Mackenzie,[1] Dr. Stratton of the U. S. Bureau of Standards and other workers of the Bureau,[3] and Dr. Louis A. Bauer,[3] of the Department of Terrestrial Magnetism of the Carnegie institution of Washington are the principal figures in this research. In all, crystals of the five non-isotropic systems, as well as magnetized and unmagnetized steel, were tested. Accuracy ranged up to one part in a billion without any positive indication of an anisotropic property of gravity.

Of course, we are most interested in the effect of intervening matter in this discussion. It would seem that astronomical evidence would be the best because of the high precision necessary and the large scale plus the great lengths of time involved can give this precision. If gravitational screening took place on an astronomical scale, the following effects would be observed; (1) the moon, being screened from the sun's attraction each time there was a lunar eclipse would recede slightly from the earth so that in time the moon's orbit would be shifted, (2) a perceptable irregularity in the tides would be noted, and (3) a difference in the rate of clocks at noon and at mid-night might be noticeable. We must not conclude, however, that a failure to detect these indicates conclusively that gravitational screening is impossible, as something may be preventing the effect from showing up in these examples (see par. 2 , p 4).

On a smaller scale, the experiments of L. W. Austin and C. B. Thwing[4] at the University of Wisconsin in 1897 show that there is no effective screening by mercury, lead, water, alcohol, and glycerine. The accuracy of their experiments was such that the experimental error was less than .2%. Austin and Thwing point out that an arguement against gravitational screening isthe fact that no counterpart of the tangential law of refraction of lines of force has been found in gravitation.

Now let us site certain observations where Newton's law does not hold, and where there might be basis for new concepts. One of the most significant deviations is the irregularity of the orbit of Mercury. This would seem to indicate a function involving distance to the -2.000,000,1612 power instead of the -2 power. Since the inverse square law is apparently followed elsewhere, it would be wrong to assume that Newton's law is wrong because it does not fit. The phenomenon must be due to some other effect entering in, and any theory of gravitation must be able to account for it. Einstein's theory has been the first one since Newton to adequately explain it.

An American, Charles F. Brush, conducted experiments which, if valid, would indicate that certain complex silicates have a falling rate of less than other substances such as lead.[6] Brush also conducted work on the mass-weight ratio of metals under strain. He found a loss of weight of one part in 40,000 . Two years later, F. I. Wold,[7] using Brush's alloy samples attempted to duplicate Brush's results. He found a loss of one part in 150,000 which was said to be greater than accountable by experimental error, and secured curves of weight versus pressure which showed the same characteristics as curves obtained by Dr. Brush. The lack of more experimentation, particularly on the loss of weight in stressed metals makes it impossible to acertain the validity of Brushes researches. It does not seem possible that his determinations of the falling rate of silicates could be valid in view of Eötvös' findings.

It is significant that the Lick Observatory claimed at one time to have noticed a small difference in the rates of their clocks at various times of the day. The records of the U. S. Naval Observatory find no effect one-tenth as great as the Lick Observatory,[3] but this does not seem valid proof that the effect is entirely non-existent.

An Italian researcher, Majorana, at first found a slight screening effect. His later researches indicate a somewhat less effect, but one about 100 times greater than could be present without being evident in the Lick Observatory records. The difficulties of the work are many, and it is conceded that Majorana's high values may be due in part, possibly entirely, to experimental error.

Let us for the moment assume that there is a screening effect due to slight gravitational permeability. This would necessarily have to be of the order of less than $2 \cdot 10^{3}$ (according to Thwing and Austin, early workers on gravitational permeability; or $7.7 \cdot 10^{10}$ according to Majorana.[8] Even this small amount should have been detectable in observations between test masses and the earth, due to the large mass of the earth. However, Poynting showed that failure to find such effects does not necessarily indicate that it does not exist. The earth's spherical form might render such observations inconclusive for the same reason that concentric electrified shells have the same external field regardless of the specific inductive capacity of the dielectric.[4]

If such a slight gravitational permeability existed, as pointed out before, refraction of the field would occur in passing through substances. While no such effect is now known, it might be small enough not to be obvious. no real attempt seems to have been made to determine if it exists at all.

The significance of finding even a very slight gravitational permeability is tremendous in determing the ultimate nature of the mechanism involved in gravitation. All of the theories advanced in the two centuries from Newton to Einstein have failed because they indicated gravitational permeability, and because no such effect is definitely known to exist.

The particle theories, such as that of LeSage,[9] and the wave or ray theories, such as that of A. J. Shneiderov[9] and C. F. Brush[10] make gravitation a push due to greater pressure on the far sides of two bodies than between them. Unless the matter possessed some ability to stop the particles, waves, or rays, there could be no gravitation between them. Thus these theories are invalid if there is no gravitational permeability.

Any theory which explains gravity in terms of electromagnetic fields, such as the "field theory" of C. Lanczos[11] must imply the existence of screening effect also, since it is impossible to imagine any combination in which one or both elements is not subject to screening.

In like manner, it can be shown that virtually any theory proposed so far which is not based on some property of space-time co-ordinates must be rejected if there is no gravitational permeability. Einstein's theory is the first positive advance in the field of gravitation since the time of Newton. It would seem that a satisfactory explaination of gravitation must go beyond the limitations of Euclidian geometry, unless some effective gravitational permeability is discovered. It becomes a matter of great importance to investigate the screening effect in gravitation and to determine definitely whether or not it exi sts. It took two hundred years from the time of Newton to the time of Einstein for a major advance to be made in learning the ultimate nature of gravitation. We must face the question directly and impartially if we are to avoid a similar setback.

Einstein's theory certainly is not the last word in gravitation. We have seen that the question of gravitational permeability is an open one. Einstein himself is said to have made the statement: "No amount of experimentaion can ever prove me right. A single experiment may at any time prove me wrong."[3]

> "It may not be an unattainable hope that some day a clearer knowledge of the processes of gravitation may be reached; and the extreme generality and detachment of the relativity theory may be illuminated by the particular study of a precise mechanism."