

## A NEUTRAL CHARGE PAIR GRAVITATIONAL MODEL

Emory Menefee

Before general relativity, physicists commonly believed that gravity was a property of matter, though no generally acceptable hypothesis ever emerged. Einstein introduced the notion of a "flat" four dimensional space that is warped by mass objects, with reciprocally the warping giving rise to a restoring gravitational force (1). Space curvature due to the presence of mass objects has been amply verified by experiment, so the duality that mass generates a curvature of space and that space curvature conversely "produces" mass (that is, makes it apparent via a gravitational force) would seem secure. Nevertheless, the classical view that gravity is a characteristic of massive objects is not necessarily ruled out. The magnitude of space curvature, or its very presence, depends on the magnitude of the gravitational constant  $\kappa$ . It is of interest to consider how this constant could originate as a material effect.

P.W. Bridgman speculated about a material origin of gravity: "Lorentz has pointed out that gravitational action between bodies can be accounted for if we assume a slight difference in the electric force between equal positive and negative charges, so that there is a resultant force between two electrically neutral bodies. It is possible by a proper adjustment of the constant determining the difference between the action of the two sorts of charge to reproduce the gravitational constant, and it was shown by Lorentz that the change in the law of force between elementary charges necessary to do this is so slight that it is forever beyond reach of any possible experiment on electrical forces, and that it could be detected only by the ordinary gravitational

experiments." (2)

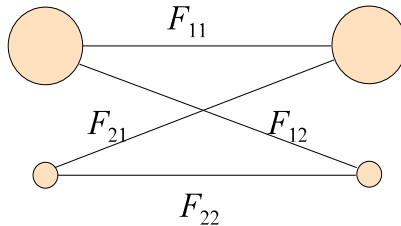
The Lorentz article (3) revealed that he did not claim this idea as original, but referred to earlier work by Mossotti: "I shall start from an idea that has been suggested long ago by Mossotti and has been afterwards accepted by Wilhelm Weber and Zollner. According to these physicists, every particle of ponderable matter consists of two oppositely electrified particles. Thus, between two particles of matter, there will be four electric forces, two attractions between the charges of different, and two repulsions between those of equal signs. Mossotti supposes the attractions to be somewhat greater than the repulsions, the difference between the two being precisely what we call gravitation." Lorentz gave no reference, either to Mossotti or others (4). As will be shown later, this explanation is incomplete.

The suggestion that different charged particles may have different force constants is a logical outgrowth of observations of interactions between different ions or different atoms. According to this hypothesis, it would be implausible to expect the force constant between two electrons to be exactly the same as that between two protons. Bridgman was correct in his supposition that the difference would be too small to be directly measured, but we can examine how large it might be. The assumption of equality of force constants among charged particles is a cornerstone of electromagnetic theory, which asserts that the force between any two charged particles at some distance apart in a vacuum is given by

$$F = \frac{1}{4\pi\epsilon_0} \frac{Q_1 Q_2}{d^2} = K_0 \frac{Q_1 Q_2}{d^2}$$

where  $\epsilon_0$  is the permittivity of free space,  $Q$  is the charge, and  $d$  is the distance between the particles. Like charges give a positive force, representing repulsion. The crucial assumption here is that permittivity is assumed to be the same whether the particles are protons or electrons.

When Lorentz examined this problem, the notion of an "ether" was current. He assumed that a positively charged particle will interact with the ether through a different force constant than that of a negatively charged particle, and that the particles are in motion. We instead begin with a general model that is conceptually simpler, namely the existence of three slightly differing permittivities: proton-proton, electron-electron, and electron-proton. The model we consider is the following:



In this case, two separated neutral particles, each containing a proton and an electron, will interact with a net force

$$\Delta F = (K_1 + K_2 - 2K_{12}) \frac{Q^2}{d^2} = k \frac{Q^2}{d^2}$$

Here,  $K_1$  represents  $1/4\pi \epsilon_{11}$  for, say, the proton-proton pair,  $K_2$  for the electron-electron pair, and  $K_{12}$  for the two oppositely signed pairs. It is apparent that if  $2K_{12} > K_1 + K_2$  then the two neutral particles will show a net attraction, represented by the very small net force constant  $k$ .

Although many averages to produce this inequality are possible, one of the simplest is

$$K_{12} = \left( \frac{K_1^N + K_2^N}{2} \right)^{1/N}, \quad \text{with } N > 1$$

For two distant bodies with  $n_1$  and  $n_2$  neutral pairs, respectively, the force difference analogous to Eq. 2 is

$$\Delta F = k n_1 n_2 Q^2 \left( \sum_{i=1}^{n_1} \sum_{j=1}^{n_2} \frac{1}{d_{ij}} \right)$$

The force given in Eq. 4 will be considered to be equivalent to the gravitational force.

The connection is straightforward. Between two distant bodies containing  $n_1$  and  $n_2$  neutral pairs of oppositely-charged particle pairs, the number of interactions will be proportional to  $n_1 n_2$ .

The gravitational force between two such bodies is given by

$$F = \kappa m_1 m_2 \left( \sum_{i=1}^{n_1} \sum_{j=1}^{n_2} \frac{1}{d_{ij}} \right)$$

Comparing Eq. 5 with Eq.4 and equating the two forces we find

$$k n_1 n_2 Q^2 = \kappa m_1 n_2$$

If we define  $\mu$  as the mass of a single neutral pair (essentially the mass of a proton), then we can write

$$k = \frac{\kappa \mu^2}{Q^2} \quad (7)$$

This has the approximate value  $7.2 \times 10^{-27}$  newton-meter<sup>2</sup> / coulomb<sup>2</sup>. It is not known if Bridgman calculated this quantity, but he realized it was beyond the limits of contemporary experimental measure.

Several predictions can be made from the neutral charge model. For example, one would expect two antimatter masses to produce the same attractive gravitational force as normal matter. However, an antimatter mass will repel ordinary matter; that is, have negative gravity. This is evident when the signs for  $K_1$ ,  $K_2$ , and  $K_{12}$  in Eq. 2 are reversed.

The model suggests that not all matter has exactly the same attraction. Instead of only neutral pairs of protons and electrons, matter is considered to be made up of 12 fundamental particles: six leptons (electrons, muons and tau particles), and six quarks (4). Each kind of lepton can have a neutrino form (charge 0), and a charged form (charge -1). Principally, ordinary matter

contains electrons (charge -1), up-quarks (charge  $+2/3$ ), and down-quarks (charge  $-1/3$ ). A proton contains two up-quarks and one down, to give a net charge of +1. A neutron has two down-quarks and an up-quark for a net charge of 0. Hence, it seems apparent that  $k$  between two neutral proton-electron pairs should be slightly different from that between two neutrons. This could be of considerable importance in defining the gravitational field of, say, a neutron star, or in dealing with a system collapsed to quark dimensions. A "truly" neutral particle (e.g., a neutrino) should show no gravitational attraction. However, aside from photons and possibly neutrinos, there seem to be no neutral particles that are not made up of combinations of quarks and leptons.

A theory that was current for a time, but now discredited, is that of the so-called "fifth force." While experiments have failed to yield any conclusive support, the possibility of a weak interaction of this kind could be supported by the neutral charge pair gravitational model. Although matter is largely empty space, one might expect slight shielding effects to be observed within the neutral charge pair model, the effect probably being a lessening of the gravitational interaction in more dense material. The "fifth force" is supposed to arise from such a difference. For example, a feather would, for the same mass, show a slightly larger gravitational attraction than a more dense metal ball, since its zero-charge elements would be less shielded from earth's gravity. The extent of shielding is difficult to calculate, since it would depend on the apparent cross section of quarks, not experimentally determined at this time. One can safely say, however, that the cross section is so small as to make ordinary matter essentially invisible to particles such as neutrinos.

The attribution of gravitational force to differences in force constants between pairs of neutral particles would suggest that “dark matter” consisting of weakly interacting massive particles (WIMPs) may be made of neutral clusters of quarks. As pointed out in the preceding paragraph, the small quark cross section would render it as a quasi-gas essentially invisible, though still retaining a collectively large gravitational field.

.

- 
1. Frankel, T., Gravitational Curvature, W.H. Freeman, San Francisco, 1979.
  2. Bridgman, P.W., The Nature of Physical Theory, Dover Publications, New York [from Princeton Univ. Press, 1936], p. 93.
  3. Lorentz, H.A., Proc. Kon. Akad. Amst. 2 559-574 (1900).
  4. See for example Close, Frank, The New Cosmic Onion, Taylor & Francis, New York, 2007/