# Gravitational and Magnetic Fields

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The Higgs boson and graviton supposedly exchanged between pieces of neutral matter inside atomic nuclei give matter the property of mass and the gravitational attraction between masses that cause matter to clump together in stars, planets, moons etc. The exchange interaction is analogous to the sharing of electrons in Helium molecules. We are proposing another rationale based on the spinning orbiting nature of stars planets and their moons. Electric dipoles are produced by spinning orbiting astronomical bodies which give rise to their magnetic and gravitational fields.

## 1. Introduction

We have shown in "The Speed of Light: Cumulative Instantaneous Dipole Field Forces at a Distance" [1,6,7,8] how electric dipoles are produced inside current carrying wires to account for the magnetic force between parallel currents. Atomic nuclei and electrons are composed of oppositely charged particles with a net positive charge for a nucleus and a net negative charge for an electron. The core of these electrons and of these nuclei contains most of their mass. The orbital part in each case was shown to have a mass of $\sim 10^{-55}$ kg. An electric force applied to an electron or a nucleus or an atom or a group of atoms can produce an excitation of the $\sim 10^{-55}$ kg part so as to produce an electric dipole. The magnetic and gravitational forces of spinning, orbiting, stars, planets and their moons can be shown to be due radial and longitudinal electric dipoles in their atomic nuclei and ions. This is the unknown mechanism that Gold said was needed for the Blackett and Wilson theory relating magnetism and gravity to the angular momentum of planets and stars [4]. Zollner speculated on a similar mechanism in 1882.

## 2. Electric Dipoles inside Dielectrics

Why does charge polarization with its magnetic effects not occur in dielectric strips subject to an electric field? It's because the loosely bound electrons around atomic nuclei in these dielectrics redistribute themselves to cancel the effects of the outside electric field on the central nuclei. The dielectric as a whole becomes polarized opposite to the applied field.

But if the applied field is constantly changing, then the nuclei of dielectrics have a chance to respond to the applied field before the surrounding electrons can completely cancel the changing applied field. The result of each change in force will be a small amount of charge polarization transverse to the force or force change.

In fact, this happens all the time. At the equator, the Earth spins about its axis one circumference per day at average velocity

$$v_E = 2\pi R_E / T_E = 2\pi\left(6.37\times10^3\right) \Big/ \left(24\cdot3600\right) = .463 \text{ m/s}, \qquad (1)$$

where $R_E \approx 6370$ km is the radius of the Earth and period $T_E$ is just one day. It also orbits the Sun at average velocity

$$v_{Eo} = 2\pi R_{Eo} / T_{Eo} = 2\pi\left(1.49\times10^8\right) \Big/ \left(365\cdot24\cdot3600\right) = 29.7 \text{ km/s}, \quad (2)$$

where $R_{Eo} = 1.49\times10^8$ km is the average distance from the Earth to the Sun and period $T_{Eo}$ is one year. Finally, the Sun orbits the Galactic center at average distance $R_{SG} \sim 26{,}000$ light-year in period $T_{SG} \sim 225{,}000{,}000$ years, at an average velocity [9]

$$v_{SG} = 2\pi R_{SG} / T_{SG} = 2\pi\left(3.0\times10^5\right)\left(26\times10^3\right) \Big/ \left(225\times10^6\right) \approx 220 \text{ km/s}, \quad (3)$$

where $c = 3.0\times10^5$ km/s is the speed of light. Thus, the internal motion of Earth's atoms implies constantly changing forces.

These mechanical forces are ultimately electrical. They act on the Earth's major dielectric atoms, e.g., silica and oxygen, and so produce a small amount of charge polarization in these atomic nuclei each time the tangential velocity changes direction. (That mechanical, contact forces are ultimately electrical, is seen from the example of two colliding billiard balls and the electrical nature of the constituent atoms.)

As the Earth turns, the centripetal force due to the initially created radial collinear dipoles that attract each other is at any point, perpendicular to a tangent line which itself is at a slight angle to a subsequent tangent line and thus has a non zero component projection on this subsequent tangent line. And this tangential dipole force produces radial oriented dipoles along a subsequent radial line from the Earth's center to this subsequent tangent line. And in this way the radial and longitudinal dipoles are sustained.

Another possible mechanism to account for the radially and longitudinally oriented dipoles: The initial force that caused the rotation and after, sustained by inertia, was tangential along a west to east line of latitude and thus perpendicular to a radial line to the Earth's center and to a north-south or longitudinal line.

The initially produced radial and longitudinal dipoles cause collinear attraction along radial and longitudinal lines, etc. But in addition to causing attractions between already existing dipoles they can, in combination, produce dipoles in protons, initially without dipoles. That is a chain of longitudinal dipoles would produce a radial dipole in a proton without a dipole and a chain of radial dipoles would produce a longitudinal dipole in a proton without a dipole. In this way, new radial, longitudinal, and latitudinal or tangential dipoles would be continually produced.

Thus it is possible that an un-cancelled electric field, $E_{\text{rot}}$ exists inside the average dielectric atom for an average duration, $\tau$, and due to this time limitation and not just to surrounding electrical forces produces an elliptical extension of orbital charge inside the protons of eccentricity $\varepsilon$.

This is similar to what we showed for conducting wires in [1]. In the lattice nuclei of a copper wire, the increase in orbital velocity of a particle of mass $m_0 \approx 10^{-55}$ kg from $v_0 \approx 10^{21}$ m/s to $v$ $\Delta v = v - v_0 \approx \frac{\varepsilon}{2} v_0 = .238 v_0$, produces a dipole with a the distance between centers of charge of $R\varepsilon/(1-\varepsilon)$ = .9R where $R$ is the distance from the point on ellipse nearest the focus on the ellipse, the periapsis. In the example in [1], the proton radius $R \approx 10^{-15}$ m, $\varepsilon = 0.477$, $E \approx 7\times10^{-3}$ V/m is the field producing dipoles in a lattice nuclei and free electrons of a conducting wire, and $t = 2\times10^{-14}$ s the average time between thermal collisions.

In the case of a dielectric atom in the spinning orbiting Earth, the forces causing these motions also produces charge polarization inside the nuclei of dielectrics. If the produced dipole length is $s = 10^{-18}$ m, then $\mathrm{R}\,\varepsilon/(1-\varepsilon) = 10^{-18}$, so with $R = 10^{-15}$ m, the proton radius, $\varepsilon \approx 10^{-3}$ is the eccentricity.

The electrical force impulse, $p = eE_{\mathrm{rot}}\tau$, producing dipoles responsible for the gravitational field of the Earth, is proportional to the force or torque that produced the spin angular momentum of the Earth:

$$F_{\mathrm{rot}} = eE_{\mathrm{rot}} = k\frac{m_E v_E^{\,2}}{R_E} = k\frac{\left(5.98\times10^{24}\right)(.463)^2}{6.37\times10^6} = 2.0\times10^{17}\,k\ \mathrm{N}\,, \quad (4)$$

where $m_E = 5.98\times10^{24}$ kg and $k$ is the constant of proportionality. So $\mathrm{E}_{\mathrm{rot}}\tau = 10^4\,k\,[\mathrm{V/m}]\bullet\tau$. The duration may be inversely proportional to the 24-hour period as a measure of how rapidly the tangent lines change direction.

The net result is the existence of 1) co-linear, similarly (and so, attractively) oriented electrostatic dipoles along the Earth's radii and 2) parallel repelling longitudinal dipoles along lines of longitude.

Thus a magnetized steel compass needle is pulled downward and made to line up with lines of longitude—pointing north and south. The Earth's magnetic field and that of other planets is thus accounted for. The Earth's magnetic field is just the Earth's gravitational field measured by magnetic measuring instruments.

The slight difference in the pattern of relative strengths of gravitational and magnetic fields over the Earth's surface is attributable to the susceptibility of such instruments to the non-uniform distribution of iron, cobalt, and nickel beneath the Earth's surface and their net direction of magnetization at specific locations.

(The molten iron core is too hot to produce the constant magnetic fields of magnetized solid iron. But the iron nuclei here have net electric dipoles, just like the other elements, in directions transverse to the spin of the Earth on its axis and to the orbital motion of the Earth around the sun and with the sun around the galactic center).

The magnetism of steel compass needles and in general of iron, cobalt, and nickel is due to peculiar least energy alignments of the spins or electric dipoles of their atomic electrons that produce a net electric dipole in each iron atom. This was discussed in the previous section. In domains of many such adjacent atoms, a common orientation is produced.

The alignment of these randomly oriented domains by a current carrying coil produces the observed net magnetic effect of bar magnets or the compass needle. But this is in addition to the electric dipoles inside the iron nuclei due to the rotational and orbital motion of the Earth and whose effect is much weaker.

Thus, the gravitational force of the Earth on terrestrial objects is attributable to charge polarization inside their atomic nuclei transverse to the direction of the Earth's spin, i.e., along an Earth's radius and along a line of longitude. Similarly for the Sun on planets and the Galactic center on the Sun, etc.

The inverse-square gravitational force is equivalent to an inverse-fourth-power electrostatic dipole-dipole force if the dipoles in any pair-wise interaction are proportional also to the distance between the dipoles. Thus, adjacent objects along a radius toward the Earth's center attract because of the attractively oriented collinear dipoles in adjacent nuclei along a radial line. Objects on adjacent longitudes repel because of the repelling parallel dipoles, while objects on the same longitude or north-south line tend to attract because of the attractive collinear dipoles in adjacent nuclei along these lines.

But the total force on any object is the sum total of all such pair-wise forces. The influence of more distant dipoles on any given dipole is obviously less than the nearer dipoles, and the expansion of the dipole lengths, $rs$, where $r$ is the dipole length at one meter, $s$ is unitless, and $rs$ is the dipole length at $r$ meters. At increasing distances, $r$ is subject to the restriction that $rs$ is less than the distance between atoms or, in a plasma, between ions and electrons.

Thus

$$F = \frac{k_e \cdot ers \cdot N_E ers}{r^4} = \frac{k_e N_E (es)^2}{r^2}\,, \quad (5)$$

is the force between a radially oriented dipole moment on the surface of the Earth and all of the $N_E$ dipoles of the earth, some of which attract and some of which repel the surface proton dipole. This can be represented by a net average dipole that produces the same force as the Newtonian force directed toward the Earth's center. Of course, the nearer dipoles along the same radial line have a greater influence than the more distant dipoles at greater angles to the surface dipole under consideration etc.

That is, we can represent all of the pair-wise forces as the force between a concentration of dipoles near the center of the Earth and the test object where the concentration of dipoles are radially oriented toward the test object and sufficient to give a force equal to the Newtonian force on the test object. Every pair-wise dipole force has a component along such a radial line. Adding these forces gives a net radial dipole force, while dipole forces from parallel dipoles on opposite sides of the test object cancel and add to zero.

If we consider two pairs of objects such as the two small (2 gram) gold beads at the ends of a 73" long torsion balance, suspended from a fixed point by a 40-inch wire and .3 meters horizontally from two stationary 8 kg lead balls in the Cavendish version of Michel's torsion experiment, the attraction between the small beads and the large balls is in part the projection of the radially oriented force toward the Earth's center on the small balls and the radially oriented dipoles inside them.

If the horizontal arm holding the moveable gold beads was placed along an east-west line, the collinear dipoles along an altitude line would be attracted downward while the north-south oriented electrostatic dipoles inside the atomic nuclei of the balls would be in an attractive collinear, north-south alignment, and the slight twist of the suspension wire shows the observed, roughly $10^{-7}$ Newton, force.

If the arm was placed along a north-south line, the orientation of the electrostatic dipoles in adjacent balls of each pair would be in a parallel repelling alignment and there would be no collinear attractive dipoles. An intermediate placement of the arm would show the effect of collinear attractive force components and parallel repelling forces.

The sum of these effects is generally attractive because repelling, parallel dipole forces are half as strong as collinear dipoles forces for the same size dipoles. (However the effect of all of the other dipoles inside the Earth will reduce these local effects. One way of considering the total force is that there is a horizontal component of the downward radial force on each of these smaller moveable balls that produces an apparent attraction to the larger balls.)

This phenomenon, not a fifth force, explains the gravitational repulsion observed by Eötvös in the 1890s [10] and analyzed later by Fishbach in 1986 [11]. Eötvös measured the pull of a weight when the weight and the spring holding it were moving eastward in a boat on the Black Sea and were both heavier than when his boat was moving westward. But most of the effect was due to the spin of the Earth and the tangential velocity, centrifugal force offsetting the radial gravitational force as the boat followed the curvature of the Earth.

That is, the downward movement of the weight toward the Earth's center appeared less for this reason. In a plane, after takeoff, usually westward into the wind (blowing from west to east) opposite to the Earth's spin, the subsequent difference in eastward and westward speeds of 400 mph produces a noticeable difference in radially oriented electrostatic dipoles, making eastward moving objects heavier. But the greater tailwind on eastward moving planes hides this effect.

The unexpectedly small gravitational effect of the largest mass on the Earth, the Himalaya, which was carefully investigated by Pratt and Airy with a plumb line on the Indian side in 1855 [12] is attributable to the electrostatic dipole representation of gravity. They reported that the plumb line is not deflected as much as expected assuming the same average density of the mountain as of the Earth. And we see that this could be due to the plumb line being placed north or south of the mountain.

That is, the east-west line from the plumb to the mountain contains no collinear dipoles in the plumb or the mountain, only parallel repelling dipoles oriented in the up-down direction. (Of course, there is small horizontal component of the downward force along an Earth radial that might attract the plumb line to the mountain.)

From these considerations, we can write the radially oriented centrally directed Newtonian force on an atom or group of atoms on the Earth's surface as the force on the radially oriented total dipole of the atom or group of atoms produced by part of a ring of radially oriented dipoles around the Earth's center representing the net effect of the total number of dipoles in the Earth.

There are $N_A = 6.02\times10^{26}$ atoms in a volume of element whose mass in kg is the total of the protons and neutrons in the atom; e.g., 28 kg of silicon contains $6.02\times10^{26}$ atoms. The Earth has $m_E = 5.98\times10^{24}$ kg, which, were it all silicon, would have $5.98\times10^{24}/28$ times $6.02\times10^{26}$ such atoms, each of which with 28 dipoles, allowing one dipole per proton or neutron $\approx 36\times10^{26+24}$ and so $N_E = 3.6\times10^{51}$ dipoles.

Hence, whatever the average atom, the force $F$ between these dipoles concentrated at a point $R = 6.37\times10^6$ meters from the surface and a single dipole at the Earth's surface is

$$F = \frac{k_e N_E (Rqes)^2}{R^4} = \frac{k_e N_E (qes)^2}{R^2} = \frac{\left(9\times10^9\right)\left(3.6\times10^{51}\right)\left(.918\times10^3\cdot1.6\times10^{-19}s\right)^2}{\left(6.37\times10^6\right)^2} \tag{6}$$

where we let $q$, the number of electron–positron charges on the poles of the dipole $qes$ inside the proton, be equal to $1836/2 = .918\times10^3$. That is, we assume the 1836.15 proton-to-electron mass ratio allows the possibility that the positrons and electrons involve positively charged core masses orbited by smaller negatively charged masses such that the net charge is that of the electron or positron.

The form such charged masses would take inside the proton could be orbital charged masses around other orbital charged masses, as in our hypothesis above of a single $10^{-55}$ kg mass with the charge of an electron orbiting a collection of positrons and electrons with 2 more positrons than electrons and giving this total charge of the proton equal to that of a positron. Support for the hypothesis is that it explains the charge polarization produced in current carrying wires consistent with the observed force between the wires.

With hydrogen mass $m_H = 1.67\times10^{-27}$ kg/atom, setting the above dipole-dipole force in Eq. (6) equal to the Newtonian force and solving for $s$, we have

$$F = \frac{Gm_E m_H}{R^2} = \frac{\left(6.67\times10^{-11}\right)\left(5.98\times10^{24}\right)\left(1.67\times10^{-27}\right)}{\left(6.37\times10^6\right)^2} = 1.64\times10^{-27}\ \mathrm{N} = \frac{69.9}{40.6}\times10^{16}s^2\,, \tag{7}$$

$$s^2 = \frac{1.64\times10^{-27}}{1.72\times10^{16}} = .953\times10^{-43}\,,\quad s = 3.09\times10^{-22}\,, \tag{8}$$

$$R_E s = \left(6.37\times10^6\right)\left(3.09\times10^{-22}\right) = 1.97\times10^{-15}\,. \tag{9}$$

The length $R_E s$ is well within the upper limit imposed by the surrounding orbital electron shells of the atoms and estimates of proton and nuclear radii. We have thus explained a possible mechanism of the gravitational fields of the inner four planets in our solar system. For the outer four gaseous planets, the nuclear dipole length can be longer and so long enough.

The fact that this mechanism explains gravity as an electrical dipole force suggests that the precessions of elliptical planetary orbits around the Sun not accounted for by the additional oppositely directed forces due to other planets besides the Sun on each planet could be explained in terms of electric dipole-dipole forces and torques.

Specifically, the small angles between the planetary orbital planes and the Sun's equatorial plane mean that the orbital radial dipole on a line from the planet's center to the Sun's center is at an angle to the Sun's spin radial dipole.

The Sun's radial dipole can be projected onto the planet's orbital radius to give the attractive force between the Sun and the planet along the planet's orbital radius. The projection then of the Sun's radial dipole on a line perpendicular to the Mercury-Sun line and to Mercury's tangential velocity acts at right angles to the planet's radial dipole to give a force perpendicular to the attractive force component toward the sun.

We also show that the further excitation of the naturally occurring oscillating charge inside atomic nuclei in a radio or light receiver by sources of radiation that after a delay produce radiation in the receiving atomic nuclei and atoms, that such further oscillation is inhibited by the gravitational field at the receiver.

Einstein's General Relativity explanation of such phenomena starts with the fact that the advances of planetary perihelia, and the time delay of light from stars observed in the day, were due to proximity to the Sun. Newton's gravitational formula for the elliptical planetary orbits was also based on this fact, but there were other effects of proximity to the Sun and large masses in general not captured by Newton's formula.

The proposed nuclear electric dipole theory is another way of getting at these influences based on the classical premises of Newton and Coulomb and not requiring the premise of curved space-time.

The theory proposed here also explains the otherwise unexplained reason that the Earth pulls negative ions produced by sunlight or cosmic rays and positive ions from the solar wind or beyond the solar system to the Earth's surface (e.g., a net negative charge and a potential difference of 100 volts per meter with an increase of altitude above the Earth's surface but less so as we go up to about 400,000 volts at the top of the stratosphere, 50 km up).

The negative charges at the Earth's surface pull positive charges down and lose negative charges with a current of 10 micro-micro-amps in regions of fair weather due to this average potential difference. (This current is similar to the solar wind of positive particles moving from the Sun past the planets to a roughly spherical solar system boundary of $100\text{AU} = 1.5 \times 10^{13}$ meters from the Sun. There it appears to stop and interact with the interstellar medium so as to produce a very bright narrow ribbon of light, according to the spacecraft Cassini's ion and neutral camera.

On the Earth, this process is interrupted by thunderstorms and lightning, bringing, nine times out of ten, negative charges to the Earth and making the region near the Earth again more negative. A similar process of current reversal of the solar wind is suggested in the Thornhill-Talbot book [2], where the vast volume of a large total flow of negative charge toward the Sun is not manifest until it nears the Sun.

There, such plasma, non-atmospheric, lightning effects and flares become evident. The analogy between the Earth and Sun is clear, but the analogy between Earth's ionosphere and the edge of the solar system is less so.

That the potential difference between the Earth's surface and the top of the stratosphere is due to electrical charge on the Earth's surface is shown by the following experiments: A copper plate with a wire attached to the Earth is suspended a few inches above and parallel to the Earth. Its charge is measured by an electrometer to be negative.

Then another plate, parallel to the first but larger and above the first, is also connected to the ground. It also shows negative charge, but the smaller plate beneath it shows none and the current measured from the lower smaller plate shows the previous amount of negative charge on it.

Now let's confirm that the gravitational attraction of the planets to the Sun may be represented in terms of electrostatic dipoles.

(Note the planet masses from Mercury to Pluto are multiples of $10^{24}$ kg, namely, .22, 4.87, 5.97, .64, 1899.7, 568.8, 86.9, 103.0, and .013 times $10^{24}$ kg vs. the Sun's $2 \times 10^{30}$ kg. The distance between the Sun and Mercury through Pluto is .58, 1.0728, 1.49, 2.235, 7.748, 14.155, 28.608, 44.849, and 58.855 times $10^{11}$ meters). The distance between the Sun and the Galactic center is $10^4$ parsecs $= 3{\times}10^{20}$ meters.

The Sun is .92H+.08He. A kg of H contains $6.02 \times 10^{26}$ molecules, each of which contains one proton, and 4 kg of He contains $6.02 \times 10^{26}$ molecules. So 1 kg of He contains $(6.02/4) \times 10^{26}$) molecules, each of which contains 2 neutrons and 2 protons.

Thus, an average Sun kg contains $(.92)\left(6.02 \times 10^{26}\right)$ protons-neutrons plus $(.08)(4\ \text{'protons-neutrons'})\left(6.02 \times 10^{26}/4\right)$. We multiply this sum times the mass of the Sun $m_S$ in kilograms to obtain the total number of 'protons-neutrons' in the Sun:

$$N_A m_S = \left(6.02 \times 10^{26}\right)(.92 + .08)\left(2 \times 10^{30}\right) = 1.2 \times 10^{57}$$

We could also divide by the mass of the proton (roughly the same as the neutron), $1.67 \times 10^{-27}$, to get the approximate number of protons plus neutrons.

Hence, whatever the atoms, the Sun contains $6.02 \times 10^{26}$ times $m_S$ or $1.2 \times 10^{57}$ protons-neutrons, and each of these contains a dipole, $qes_S$, oriented along a line from the Sun to the Earth perpendicular to the tangents of the orbital motion of the Earth and to the tangents of the spin direction of the Sun.

The magnitude of this dipole associated with a proton could be a composite of dipoles associated with 1896 electron or positron core masses that make up a proton given the electron to proton mass ratio of 1 to 1896.15. Orbital $10^{-55}$ kg charged masses, implied by the electric-dipole representation of the magnetic force, moving between the large core masses of the proton and neutron, could account for the binding together of the proton and neutron. They could also account for charge polarization inside the proton and neutron. As a first estimate of the dipoles inside the proton, we will assume 919 positive poles +e, 917 negative poles –*e*, and a negative charged particle orbiting the rim of the proton, leaving a net charge of +*e*.

Thus, since the atomic mass per dipole, $A_D \approx 1\ \text{kg/kmole}$, for all substances, there are

$$N = \frac{N_A m_E}{A_D} \approx \frac{\left(6.02\times10^{26}\ \text{dipoles/kmole}\right)\left(5.98\times10^{24}\ \text{kg}\right)}{1\ \text{kg/kmole}} = 3.6\times10^{51} \quad (10)$$

protons-neutrons each containing a unit dipole, $qes_{\text{E}}$, in the Earth. The attraction $F$ between the net dipoles in the Sun and Earth, $R$ meters apart, with $q = .918\times10^3$ is

$$\begin{aligned} F &= \frac{k_e\left(NRqes\right)_{\text{E}}\left(NRqes\right)_{\text{S}}}{R^4} = \frac{k_e\left(N_A qe\right)^2 m_{\text{E}} m_{\text{S}} s_{\text{E}} s_{\text{S}}}{A_D{}^2 R^2} \\ &= \frac{\left(9\times10^9\right)\left(6.02\times10^{26}\cdot.918\times10^3\cdot1.6\times10^{-19}\right)^2 m_{\text{E}} m_{\text{S}} s_{\text{E}} s_{\text{S}}}{1^2 R^2} \\ &= 7.8\times10^{40}\frac{m_{\text{E}} m_{\text{S}}}{R^2} s_{\text{E}} s_{\text{S}} = G\frac{m_{\text{E}} m_{\text{S}}}{R^2} \end{aligned} \quad (11)$$

Cancelling $m_{\text{E}} m_{\text{S}}/R^2$ on both sides leaves

$$G = 6.67\times10^{-11} = 7.8\times10^{40} s_{\text{E}} s_{\text{S}} \quad (12)$$

$$s_{\text{E}} s_{\text{S}} = .86\times10^{-51} \quad (13)$$

Thus, if $Rs_{\text{E}} = 10^{-15}$ meters is the maximal allowable dipole length pointing to the Sun, then, with distance from the Earth to the Sun $R = 10^{11}$ m, $s_{\text{E}} = 10^{-15-11} = 10^{-26}$, $s_{\text{S}} = 10^{-51+26} = 10^{-25}$ and $Rs_{\text{S}} = 10^{11-25} = 10^{-14}$ meters as the length of dipoles in the Sun.

Similarly for the attraction of the Sun to the Galactic center. The unit dipole and that of the Sun, assumed to be as small as required to give the observed "gravitational" force, would shed light on the nature of these nuclear particles.

## 3. Conclusion

The gravitational force as a dipole force explains the heretofore-unexplained combination of electrical and thermal forces in and around the planets and the stars. Also variations in the gravitational force on Earth; the precession of the planetary orbits; the Newtonian gravitational forces between planets and the Sun and between the Sun and the Galactic center can be represented as due to dipoles transverse to the spin and orbital movements of the planets and the Sun.

The heretofore-unexplained mechanism of gravity, that Newton regarded as desirable but unnecessary to provide the predictive validity of his force equation, is now explained in terms at least of a more basic and commonly observed force: The Coulomb force between point charges and the magnetic or electric dipole force.

Precession and light bending, i.e., light reception delay effects associated with proximity to the Sun, are explained without resorting to the added premise of the average curvature of space-time near a large mass and ad hoc rules for its variations needed to give the observed data.

## References


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