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A CURSORY EXAMINATION OF "ELECTRIC UNIVERSE" CLAIMS REGARDING PLANETARY ORBITS

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ABSTRACT

In this paper I examine the claim that the orbits of planets can be explained by nothing more than the electricity and magnetism. For the "overdensity claim," I find that the surface charge densities required to account for observations of the orbits of planets in our own Solar System are not physical. For the "dipole claim," I find that the electric field from the Sun is negligibly small, causing a central force that is 75 orders of magnitude too small to account for the motion of the Earth. These models cannot explain planetary orbits.

1. INTRODUCTION

The "electric universe" idea (EU) claims that gravity is not a satisfactory explanation when it comes to planetary orbits, and that electromagnetic effects actually account for these orbits. Here I examine two popular EU claims:

1. The Overdensity Claim: Each body has an overdensity of charge on its surface. The Sun has a certain charge and the planets have an opposite charge, which causes them to attract each other, accounting for the central forces observed in orbits[1].
2. The Dipole Claim: The electric dipoles that make up neutral atoms all add up to create "electric gravity," accounting for the central forces observed in orbits[2].

The first of these two claims has to do purely with surface charges of the Sun and planets. The idea is that the opposite net charges of these bodies attract each other, which keeps them bound for billions of years. I will ignore the fact that charged objects radiate away their energy when they are accelerated (which would cause these orbits to decay over time). Because the electrostatic force is being invoked as the explanation for these orbits, these charge overdensities must be bound within the surfaces of these bodies, so that the electromagnetic forces between the bodies will pull the bodies along with those charges. I will be treating each body as a conductor, as without this, orbits would not even be possible in this model.

The second claim deals with electric dipole fields. Proponents of this model claim that all celestial bodies are electrically polarized upon formation. The model is much like an electrically-neutral dielectric material within a capacitor: All of the atomic dipoles line up to create an electric field through the body, leaving the electrons and protons within the neutral atoms lined up perpendicular to surface.

In both cases, I examine the motion of the Earth about the Sun. Because the Sun is so much more massive than the Earth, its motion will be far less pronounced from any of these effects, as $\vec{F} = m\vec{a}$.

[1] http://www.electricuniverse.info/Electric_Sun_theory
[2] http://www.holoscience.com/wp/electric-gravity-in-an-electric-universe/

2. BACKGROUND

Both of these ideas make claims about central forces. In order for objects to stay in orbit, they need to be acted on by a central force. The standard view in the scientific community is that this central force is provided by gravity:

$$F_g = \frac{GMm}{r^2}. \quad (1)$$

Here, G is the gravitational constant, M is the mass of one of the bodies (the Sun in this example), m is the mass of the other body (the Earth in this example), and r is the separation between the centers of mass of the bodies.

In rotational motion, the centripetal force is given by the following equation:

$$F_c = \frac{mv^2}{r}. \quad (2)$$

Both conventional scientists and proponents of EU accept this equation as accurate when describing circular motion. In conventional science, the gravitational force is the only force considered to account for the centripetal force (the rationale for this is outlined in the Overdensity Claim section). Setting $F_c = F_g$, we arrive at the following:

$$\frac{mv^2}{r} = \frac{GMm}{r^2}.$$

Solving for v, we have

$$v = \sqrt{\frac{GM}{r}}.$$

The values for the Earth-Sun system are (in MKS units) $G = 6.67 \times 10^{-11}$, $M = 1.99 \times 10^{30}$, and $r = 1.5 \times 10^{11}$. Plugging in these values, we have

$$v = 30 \text{ km s}^{-1}.$$

We know that this is the correct value for the orbital speed of the Earth, as dividing its orbital path by this speed gives the length of the year to be ∼365 days. In the following sections I will examine whether electricity alone can account for this orbital speed.

3. THE OVERDENSITY CLAIM

The electrostatic force is given by the following equation:

$$F_e = \frac{kQq}{r^2}. \tag{3}$$

Here, k is Coulomb's constant, Q is the charge of one of the bodies (the Sun in this example), q is the charge of the other body (the Earth in this example), and r is the separation between the centers of the bodies. This has the same functional form as Equation 1. If the electrostatic force is the only force responsible for the orbit of the Earth, we can set this equal to Equation 2:

$$\frac{mv^2}{r} = \frac{kQq}{r^2}.$$

Solving for v, we have

$$v = \sqrt{\frac{kQq}{mr}}.$$

We know that this orbital speed must match our observations, so $v = 30$ km s^{-1}. By rearranging this equation, we can solve for the product of the charge overdensities:

$$Qq = \frac{mv^2r}{k}.$$

The values for the Earth-Sun system are (in MKS units) $m = 5.97 \times 10^{24}$, $v = 3 \times 10^4$, $r = 1.5 \times 10^{11}$, and $k = 8.99 \times 10^9$. Plugging in these values, we have

$$Qq = 9 \times 10^{34} \text{ C}^2.$$

We know from Maxwell's equations that any charged rotating sphere will generate a magnetic field. We can use this along with the known magnetic field strength at the surface of the Earth to calculate an upper limit for the amount of charge that would exist on the surface of the Earth. This is only an upper limit, of course, as there could still exist a magnetic dynamo beneath the Earth's crust contributing to this magnetic field. The upper limit is the case where the magnetic dynamo beneath the surface contributes nothing to the magnetic field. The formula for the magnetic field just outside the surface of a charged rotating sphere is as follows (Griffiths 2007):

$$\vec{B} = \frac{\mu_0 R^4 \omega \sigma}{3r^3}\left(2\cos\theta \hat{r} + \sin\theta\hat{\theta}\right). \tag{4}$$

The direction of the vector $\hat{r}$ is defined to point radially outward from the body in question, while $\theta = 0$ points toward the north pole, $\theta = \pi/2$ points toward the equator, $\theta = \pi$ points toward the south pole. This field is strongest at the surface where $r = R$ and $\theta = 0$ or $\theta = \pi$. The magnitude of the field at either location is

$$B = \frac{2\mu_0 R^4 \omega \sigma}{3r^3}.$$

Solving for the total charge on the surface (where σ is the surface charge, so $\sigma = q/4\pi R^2$),

$$q = \frac{6\pi BR}{\mu_0 \omega}.$$

These values for the Earth are (in MKS units) $B = 6.5 \times 10^{-5}$, $R = 6.37 \times 10^6$, $\mu_0 = 1.26 \times 10^{-6}$, and $\omega = 7.29 \times 10^{-5}$. Plugging in these values, we have

$$q = 8.5 \times 10^{13} \text{ C},$$

which implies

$$Q = \frac{Qq}{q} = \frac{9 \times 10^{34}}{8.5 \times 10^{13}}$$

$$Q = 1.1 \times 10^{21} \text{ C}.$$

This result already suggests one glaring problem: The surface of the Earth would have a charge overdensity of over 150,000 Coulombs per square kilometer. The amount of charge contained within a typical lightning bolt is on the order of tens of Coulombs, so this result suggests that there should be an excess of on the order of 10,000 lightning bolts of charge per square kilometer of surface area. However, as stated previously, this is an upper limit, so this model could allow for less charge overdensity to exist on the surface of the Earth, as long as even more charge overdensity were to exist on the surface of the Sun. That, however presents an even greater problem, as this lower limit on the Sun's charge overdensity is already at a surface density of over $2,000$ C m^{-2}, or over 100 million lightning bolts of charge per square kilometer!

If this is the case, then the amount calculated for the surface of the Sun is a lower limit. With this lower limit, we can calculate the effects of the Sun's magnetic field on the Earth to see if they make a difference in the field strength at Earth's surface. Equation 4 shows us the magnetic field outside of a charged spinning sphere. We can use this to determine a lower limit on the magnetic field strength from the Sun at the orbit of the Earth. The values for the Sun (and the distance to the Earth's orbit for the value of r) are (in MKS units) $\mu_0 = 1.26 \times 10^{-6}$, $R = 6.96 \times 10^8$, $\omega = 2.02 \times 10^{-6}$, $\sigma = Q/4\pi R^2 = 181$, $r = 1.5 \times 10^{11}$, and $\theta = \pi/2$. Note that the Sun rotates differentially, but that the slowest rotation rate has been used to find the lower limit. Plugging in these values, we have

$$B = 1.1 \times 10^{-8} \text{ T}.$$

This is much smaller than the value of the Earth's magnetic field assumed during the calculation, so it doesn't need to be accounted for in the upper limit on the Earth's surface charge. However, this magnetic field may impose a Lorentz force on the Earth:

$$\vec{F} = \vec{F_e} + q\vec{v} \times \vec{B}.$$

The first term in this equation is just Equation 3. The second term involves the orbital speed of the Earth and the magnetic field from the Sun. Because the orbital velocity and magnetic field vectors are perpendicular, their cross product is just the product of their magnitudes:

$$\vec{F} = -\frac{kQq}{r^2}\hat{r} + qvB\hat{r}.$$

The Sun and Earth are claimed to be oppositely charged (so one of the charge terms is negative, making the first term of this equation negative, implying an attraction). The direction of the second term is away from the Sun, as dictated by the right-hand rule. Because a new magnetic term is now added to the centripetal force, we must calculate the combined effect to determine whether is it negligible. Plugging in for B,

$$\vec{F} = -\hat{r}\left(\frac{kQq}{r^2} - qv\frac{\mu_0 R^4\omega(Q/4\pi R^2)}{3r^3}\right),$$

$$\vec{F} = -\frac{kQq}{r^2}\hat{r}\left(1 - \frac{\epsilon_0\mu_0 R^2\omega}{3r}v\right).$$

This new term is negligibly small, with a value of $\epsilon_0\mu_0 R^2\omega/3r = 2.4\times10^{-17}$ s m^{-1}, so orbital velocities of tens of kilometers per second will not change the results of any of the calculations done in this section. Calculations were also performed for the other planets in the Solar System, and all yielded similar unphysical results.

4. THE DIPOLE CLAIM

In this section, I will consider both bodies are polarized in such a way that their dipole fields align, creating a central force between them. The electric field produced by a dipole is given by the following equation:

$$\vec{E} = \frac{kq\vec{d}}{r^3}.$$

Here, k is Coulomb's constant, q is the charge of the proton, $\vec{d}$ is the distance between the proton and electron in the atom creating the dipole, and r is the distance between the dipole and the point of interest. If the dipole fields between the Sun and Earth are aligned (giving the maximum possible field strength), then $\hat{d} = \hat{r}$, and so

$$\vec{E} = \frac{kqd}{r^3}\hat{r}.$$

I use the maximum possible field strength to obtain an upper limit. I do the same for the value of d, using the size of the largest known naturally-occurring atom ($\sim 3\times10^{-10}$ m). Using these values and the distance between the Sun and the Earth, the dipole electric field due to one dipole (consisting of one proton and one electron) is

$$E_{Dipole} = 1.29\times10^{-52}\ \mathrm{N\ C^{-1}}.$$

In order to obtain an upper limit for the total dipole field of the Sun, I use the smallest area within which a polarizable atom can reside, and then divide the total surface area of the Sun by that value. It is the surface area that is important here, as only the surface dipoles will contribute a net field, since all of the dipoles beneath the surface dipoles have their field contributions effectively cancel each other out (this is trivial to show).

The smallest atomic size to consider is that of a hydrogen atom ($r_H \approx 5.3\times10^{-11}$ m). The surface area occupied by a hydrogen atom is its cross section: $A_H = \pi r_H^2 = 8.8\times10^{-21}$ m^2. The surface area of the Sun is $A_S = \pi r_S^2 = 1.52\times10^{18}$ m^2, and so the largest number of these dipole atoms that could exist on the Sun's surface is $N = A_S/A_H = 1.7\times10^{38}$ atoms. Because each of these atoms contributes the same field strength to the overall field, the electric field from the Sun at the orbit of the Earth is

$$E_{Total} = NE_{Dipole} = 2.2\times10^{-14}\ \mathrm{N\ C^{-1}}.$$

The total force necessary to account for the orbit of the Earth is the centripetal force $F_c = 3.5\times10^{22}$ N (Equation 2). For this model to work, this must equal the electric force on the Earth from the Sun. The dipoles across the surface of the Earth will each have one particle attracted to the Sun ($F_1 = q\vec{E_1}$) and one repelled from the Sun ($F_2 = q\vec{E_2}$). These particles are separated by the same value d that was used to calculate the Sun's dipole field. So, the centripetal force will be the net force on these particles across the Earth's surface by the Sun's electric field:

$$\vec{F_c} = \vec{F_1} + \vec{F_2} = q\left(\vec{E_1} + \vec{E_2}\right) = qN\left(\frac{kqd}{r^3} - \frac{kqd}{(r+d)^3}\right)\hat{r}.$$

$$F_c = kq^2dN\left(\frac{1}{r^3} - \frac{1}{(r+d)^3}\right).$$

Plugging in values, this is

$$F_c = 2.1\times10^{-53}\ \mathrm{N}.$$

This is 75 orders of magnitude (10^{75} times) too small to account for the orbit of the Earth.

5. CONCLUSIONS

In this paper, I have shown the following:

1. Surface charge densities needed in the "overdensity" model are too high and unphysical: trillions of Coulombs. These surface charge densities are not measured on Earth or any other celestial bodies.

2. Dipole forces needed in the "dipole" model are 75 orders of magnitude too weak to account for observed orbits. In addition, the $1/r^3$ form of such a central force makes the problem even worse for bodies farther from the Sun.

After this examination, it is clear that electricity alone cannot account for planetary orbits. Gravity is a much simpler and much more solid explanation for planetary orbits; it gives the correct answers, and it doesn't predict impossibilities like EU does.

REFERENCES

Griffiths, D. J., 2007, *Introduction to Electrodynamics, 3rd Edition.*