Frontiers of Astronomy, Astrophysics and Cosmology, 2016, Vol. 2, No. 1, 10-12
Available online at http://pubs.sciepub.com/faac/2/1/2

DOI:10.12691/faac-2-1-2

Rethinking the Binding Mechanism between the Earth and the Moon

Ding Jian[1,*], HU Xiuqin[2]

[1]Power Divisions, Integrated Electronic Systems Lab Co. Ltd., Jinan, China
[2]Department of Computer Sciences, Qilu Normal University, Jinan, China
*Corresponding author: jiandus@163.com

Abstract The Moon is always with the same face toward the Earth. However, the prevailing theory to explain this phenomenon, there is a dead angle. That is why the Moon does not rotate around the axis which is a straight line between the Earth and Moon to connect to their mass centers. Because many of meteorite impact craters on the lunar surface indicate that the Moon is entirely possible to obtain momentums to rotate around the axis. In this paper, we propose a plain explanation which is the universal gravitation between the Earth and Moon as well as the Earth's magnetic field to have formed a trinity binding mechanism about the Moon to be locked. According to this explanation, the Moon can be locked, the mechanism of lunar libration has been revealed out, which can confirm mutually with the natural phenomenon that the Moon has sought a balance in the swing. In addition, with all kinds of detection data from the Apollo moon landings and other circumlunar spacecraft to detect, as well as the studies of lunar soil samples, the conclusion is that as a whole for the Moon, which belongs to the paramagnetic substance, its relative permeability is between 1.008 and 1.03. Although due to the impact of the solar wind, the Earth's magnetic flux density in the lunar orbit has been dropped below 0.000065 nT, but can not become a reason to assert that present-day Moon has no global dipole magnetic field. Unless it can be confirmed that a constant magnetic field does not exist in the lunar orbit.

Keywords: *moon, earth, tidal locking, dipole magnetic field, solar wind, moonfall*

Cite This Article: Ding Jian, and HU Xiuqin, "Rethinking the Binding Mechanism between the Earth and the Moon." *Frontiers of Astronomy, Astrophysics and Cosmology*, vol. 2, no. 1 (2016): 10-12. doi: 10.12691/faac-2-1-2.

1. Introduction

The Moon is a celestial body closest to the Earth, also the Earth's only natural satellite. Its diameter is 3476 kilometers, the volume is equivalent to 1/49 of the Earth, but the mass is only about 1/81 of the Earth. Therefore, the average density is smaller, only about 3/5 of the Earth. The cycle of the Moon's elliptical orbit around the Earth is about 27.3 days, the perigee is 363300 kilometers, the apogee is 405500 kilometers, and the average orbital radius is about 384,400 kilometers.

On the Earth, we can only see the same face of the Moon, while the other half of the Moon is always facing away from the Earth. Accordingly, the lunar side toward the Earth is called the front, and the other side is the back. Conversely, if you standing in the lunar front to see the Earth, in addition to the rotation, its position in the sky is always constant, just like we are standing in a room to watch a globe on the desk. Of course, you will not see the Earth if standing in the lunar back.

2. There is a Dead Angle in the Theory of Tidal Locking

The Moon's rotation and orbital cycle are the same, so it is always with the same face toward the Earth. This phenomenon is known as "synchronous rotation", and supplemented by the theory of "tidal locking" to explain [1]. Its meanings are briefly summarized below:

The early Moon orbit around the Earth at the faster speed, it was not always with the same face toward the Earth. Due to the effect of tidal friction between the Earth and the Moon, part of the angular momentum of the Earth's rotation was transferred to the Moon, leading to the lunar orbital radius around the Earth increased slightly. Of course, the speed of Earth's rotation has been decelerated slightly. After long years, it has finally reached that the Moon is always with the same face toward the Earth.

So-called the effect of tidal friction, can only be passed through the universal gravitation between the Earth and Moon. Because of this, in the theory of tidal locking, there is a dead angle. That is, it can not explain why the Moon does not rotate around the axis which is a straight line between the Earth and Moon to connect their mass centers. Why do we choose this straight line as an axis? Because the delivered tidal friction force, the resulting torque which relative to the axis is equal to zero.

We all know that there are many of meteorite impact craters on the lunar surface, which indicate that the Moon is entirely possible to obtain momentums to rotate around the axis. That is to say, when the moon to get a random external momentum, it can be divided into three mutually perpendicular momentum components:

The first is parallel to the axis, the second is perpendicular to the axis and acting on the lunar mass center, they do not produce the torque relative to the axis, so the lunar mass center can only be moved slightly; while the third is perpendicular to the axis, and does not act directly on the lunar mass center, thereby producing the torque relative to the axis. If the rotation does exist, and then supplemented by the theory of tidal locking to explain, the mechanism that we do not see the back of the moon may be available to attain perfection. But in fact, the Moon does not rotate around the axis. That is to say, we need to rethink the binding mechanism between the Earth and Moon.

3. A Plain Explanation and the Authoritative Assertion

We need to explain the question is why does the Moon not rotate around the axis which is a straight line between the Earth and Moon to connect their mass centers? In this regard, we propose a plain explanation which is the universal gravitation between the Earth and Moon as well as the Earth's magnetic field to have formed a trinity binding mechanism about the Moon to be locked. Due to the characteristics of the Moon itself, the location of the lunar mass center relative to its centroid has shifted about 2 kilometers toward the direction of the Earth [2], so the lunar mass center is not on the straight line connecting its two magnetic poles. It is the binding mechanism of the triangle to cause that we can only see the same side of the Moon.

In such a trinity binding mechanism, once the Moon obtaining a random external momentum to cause its mass centers to be moved, and obtaining the torque to rotate around the axis, it is bound to cause a contrary force generated by this mechanism, trying to stop the lunar mass center to be moved, also an opposite torque simultaneously, to stop the Moon rotating around the axis. Therefore, the Moon has sought a balance in the swing, as a natural phenomenon presenting to us. This is called the lunar libration, it has been observed by astronomers as early as 17th century. Because of the libration, people on Earth can see the lunar surface which can reach 59%, only the remaining 41% is unseen.

For this kind of the trinity binding mechanism, there is a premise that the Moon should have a global dipole magnetic field like the Earth. But unfortunately, most of scientists having a consensus that present-day Moon has no global dipole magnetic field [3], which was based on the last century's Apollo moon landings and other circumlunar spacecraft to detect the resulting data.

Apollo 15 and 16 subsatellites, Luna 10 and Explorer 35, and Lunar Prospector spacecraft, as well as other probes orbiting the Moon obtained the data to show that the average magnetic flux density of the entire lunar surface is about 4 nT; and there are larger differences in different regions. Such as it is generally 0.75 - 6 nT in the lunar front, and even more than 100 nT in individual regions. The Apollo moon program, a total of six times manned lunar landing, there were 12 American astronauts to the Moon. That is to say, if each astronaut to hold a compass which could be applied to 0.75 - 100 nT magnetic flux density, when they were in different regions of the Moon, the directions indicated by the compass were not the same.

4. Estimating the Strength of Earth's Magnetic Field in Lunar Orbit

The Earth has a global dipole magnetic field. Generally speaking, the magnetic flux density of the magnetic dipole at a point in space, is inversely proportional to the third power of the distance between this point and the center of the magnetic dipole [4]. The magnetic flux density on the Earth's surface, is about 30000 - 40000 nT near the equator, 61000 nT geomagnetic North Pole, 68000 nT geomagnetic South Pole. We have known that the Earth's average radius is 6371 kilometers, the average distance between the Earth and Moon is about 384,400 kilometers. If the magnetic flux density of the Earth's surface to use an average of 50000 nT, the Earth as a magnetic dipole, whose magnetic flux density in the lunar orbit can be roughly estimated, as follows:

$$B_1 \approx 50000 \times (\frac{6371}{384400})^3 = 0.227637 \qquad (\text{nT}).$$

First of all, it is necessary to review the precision of the magnetometer carried by each lunar spacecraft. For example, it appears difficult to competent because the precision of the magnetometer carried by the Lunar Prospector was only 0.2nT [5]. Moreover, due to the solar wind interacts with the Earth's magnetic field, the result is that in the lunar orbit, the Earth's magnetic flux density is far less than 0.2 nT.

The solar wind is a kind of plasma, it also has a magnetic field. In the action against the Earth's magnetic field, the solar wind bypasses the Earth's magnetic field and continues to move forward. Thereupon, the Earth's magnetic field is surrounded by the solar wind to form a comet shaped region, which is the Earth's magnetosphere at 600 - 1000 kilometers altitude above sea level. It is generally believed that in 50000 - 70000 kilometers altitude above sea level, the outer boundary of the magnetosphere has been formed, which is called the magnetopause. In there, the Earth's magnetic field has been minimal, or may be considered to stop there.

If there are still very weak the earth's magnetic fields in the lunar orbit, how much the magnetic flux density are there in? We have known that the magnetic flux density of the Earth's surface is about an average of 50000 nT. Based on Apollo 15 subsatellite magnetic field observations, an upper limit of 1.3×10^{18} gauss-cubic centimeters has been determined for the permanent dipole moment in the lunar orbital [6]. Then according to the seventh generation of International Geomagnetic Reference Field model, in 1965 the geocentric magnetic dipole moment was 8×10^{22} ampere-square metres [7], which was 1×10^{27} gauss-cubic centimeters. With the help of the ratio between them, for the Earth's magnetic field in the lunar orbit, whose upper limit of magnetic flux density can be roughly estimated, as follows:

$$B_2 \approx 50000 \times \frac{1.3\times10^{18}}{1\times10^{27}} = 6.5\times10^{-5} \qquad (\text{nT}).$$

5. The Main Reason of the Existence of Things can not be Ignored

Although this value is very small, but can not be ignored, because it constitutes the basis to deny that present-day Moon has no global dipole magnetic field. For the issues raised earlier in this article, why does the Moon not rotate around the axis which is a straight line between the Earth and Moon to connect their mass centers? If you can not find another main reason to cause the fact, for the Earth's magnetic field in the lunar orbit, even if the magnetic flux density very small, also should not be excluded. Accordingly, present-day Moon has no global dipole magnetic field, this authoritative assertion also needs to re-examine.

We have known that according to the magnetic phenomena of substances exhibited under the action of outer magnetic field, generally can be divided into three categories of paramagnetic and diamagnetic and ferromagnetic. So, under the action of outer magnetic field, how should the Moon behave?

In the Apollo moon landing project, a total of 12 NASA astronauts landed on the lunar surface. In addition to all kinds of detection, they also brought back 381.7 kilograms of lunar soil samples. The analysis of samples of lunar rocks showed that 3.1 billion years ago the Moon had a stronger magnetic field [8], its strength might be roughly the same as the Earth's magnetic field. If the Moon once had a global dipole magnetic field, then there should have been an iron core [9]. But Present-day Moon has no global dipole magnetic field, the various reliable evidences which led to this authoritative assertion have shown that the Moon could not have such an iron core. The two seemingly opposing conclusions, their essence is to express a consistent implication that the Moon must contain a number of substances related to iron [10].

In fact, it is Indeed so. Studies on the characteristics of remanence of lunar soil samples have shown that the Iron in lunar soil possesses the superparamagnetic characteristic [11]. The implication is that there is a considerable number of pure iron without magnetic hysteresis, whose remanence and coercivity are almost zero. In addition, the lunar soil also contains a number of extremely rare metal elements on the Earth, such as titanium, chromium, yttrium and so on. These metals only at very high temperatures, about 4500 degrees Fahrenheit or so, can be melted with the surrounding rock. Perhaps, now we should go to think broadly about the iron core, 3.1 billion years ago, how it was broken up the whole into parts, and turned Into the superparamagnetic pure iron, and melted in the lunar soil.

More convincing measurement data, from ALSEP automatic instrument station placed on the lunar surface and Explorer 35 spacecraft, it showed that the moon as a whole was paramagnetic substances, its relative permeability ($u_r=u/u_0$) between 1.008 and 1.03 [6].

6. Conclusion

Rethinking the binding mechanism between the Earth and Moon, we propose a plain explanation which is the universal gravitation between the Earth and Moon as well as the Earth's magnetic field to have formed a trinity binding mechanism. This explanation does not exclude the theory of tidal locking, and can make up for the deficiency of the theory, as well as the Moon can be locked and not rotate around the axis which is a straight line between the Earth and Moon to connect their mass centers. Furthermore, it can also explain libration of the Moon, and confirm mutually with the natural phenomenon that the Moon has sought a balance in the swing. But there is a premise that the Moon should have a global dipole magnetic field like the Earth.

Apollo moon landings and other circumlunar spacecraft to detect as well as the studies of lunar soil samples have shown that there is a considerable number of pure iron with superparamagnetic characteristics in the Moon, as well as the moon as a whole is paramagnetic substances, its relative permeability between 1.008 and 1.03. In view of this, if want to assert that present-day Moon has no global dipole magnetic field, there must be a prerequisite that the effect of external constant magnetic field does not exist. That is to say, if there is a constant magnetic field in the lunar orbit, then the Moon should have a global dipole magnetic field.

Of course, the constant magnetic field should be the Earth's magnetic field. Although due to the impact of the solar wind, the magnetic flux density has been dropped below 6.5×10^{-5} nT, but it can be a reason to lock the moon and not to rotate around the axis which is a straight line between the Earth and Moon to connect their mass centers. If you can not find another main reason to cause the fact, for the Earth's magnetic field in the lunar orbit, even if the magnetic flux density very small, also can not be easily ignored.

References

[1] C.D. Murray, S.F. Solar System Dynamics[M]. England: Cambridge University Press, 2001.

[2] Kong X Y, Li J C, Guo J M, et al. Determination of gravitational constants for Earth and Moon and geocentric center and mass center of Moon[J]. Journal of Geodesy and Geodynamics, (in Chinese), 2006, 20(3): 109-114.

[3] Li Y Q, Liu J Z, Ouyang Z Y, et al. Lunar magnetism and lunar evolution[J]. Progress in Geophysics, (in Chinese), 2005, 20(4): 1003-1008.

[4] Ren L P, Zhao J S, Hou S X. The Distribution Model of Magnetic Dipole in Magnetic Field[J]. Hydrographic Surveying and Charting, (in Chinese), 2002, 22(2): 18-21.

[5] Xiao Z Y, Zeng Z X. New Progress of research on the Lunar magnetic field[J]. Progress in Geophysics, (in Chinese), 2010, 25(3): 804-808.

[6] Russell C T, Coleman P J, Schubert G Jr. Lunar magnetic field : permanent and induced dipole moments[J]. Science, 1974, 186: 825-826.

[7] Wang Y H. Feature of the global change of geomagnetic field[J]. Progress in Geophysics, (in Chinese), 1999, 14(3): 115-121.

[8] Fuller M. Lunar magnetism--a retrospective view of the apollo sample magnetic studies[J]. Physics and Chemistry of the Earth, 1998, 23(7, 8): 725-735.

[9] Runcorn S K. The formation of the lunar core[J]. Geochimica et Cosmochimica Acta, 1996, 60: 1205-1208.

[10] Nagata T, Fisher R M, Schwerer F C. Lunar rock magnetism[J]. The Moon, 1972, 4: 170-196.

[11] Nagata T, Carleton B J. Natural remanent magnetization and viscous magnetization of apollo 11 lunar materials[J]. Journal of geomagnetism and geoelectricity, 1970, 22(4): 491-506.