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The Formation and Evolution of the Moon

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Abstract
Since the formation of the Moon remains a mystery， the author of this paper has studied the origin of the Moon again and found some orbit variation mechanisms of the Moon, therefore has revealed the formation mechanism of the Moon for the first time. Then according to this formation mechanism, the author could also reveal the formation and evolution of the Solar System and other galaxies in the Universe, and explain the expansion of the universe.

1. Introduction

The Moon is the closest natural satellite to us. Since the Moon is the brightest object in the sky after the Sun and has regular cycle of phases, it has had an important cultural influence on language, calendars, art and mythology since ancient times. Although the Moon is the only celestial body other than Earth on which humans have set foot, human's knowledge and concepts of Moon is far from enough, even being confused and perplexed by the origin of the Moon [1].

Several mechanisms [2] have been proposed for the Moon's formation 4.5 billion years ago. One is fission theory, i.e., some people suggest that the Moon was originally part of the Earth during the birth of the Solar System, when the young Earth was almost completely molten, but then the Moon detached from the Earth's crust through centrifugal force, which would require too great an initial spin of the Earth. Another is capture theory, i.e., some people postulate that the Moon was formed somewhere in space, then moved through space until it came into contact with the Earth's gravitational force and began its orbit around the Earth, but that would require an unfeasibly extended atmosphere of the Earth to dissipate the energy of the passing Moon. In addition, if this theory were true, the Moon would have crashed into the Earth or drifted far out of the Earth's orbit. Still, another one is co-formation or condensation theory [3], which posits that the Moon and the Earth were condensed from a solar nebula at the same moment in the same place, and then the Moon began to orbit around the Earth. This theory answers the question of why the Moon is in its fixed location near the Earth, but falls short when it comes to explaining the depletion of metallic iron in the Moon.

The prevailing hypothesis today is that the Earth-Moon system formed as a result of a giant impact: a Mars-sized body hitting the newly formed proto-Earth, blasting material into orbit around it, which accreted to form the Moon [4]. However, meteorites show that other inner Solar System bodies such as Mars and Vesta have very different oxygen and tungsten isotopic compositions to the Earth, while the Earth and Moon have near-identical isotopic compositions. Published in 2012, an analysis of titanium isotopes in Apollo lunar samples showed that the Moon has the same composition as the Earth, which conflicts with the impact event hypothesis for its formation. In addition, the large amount of energy released in the giant impact event and the subsequent reaccretion of material in Earth orbit

would have melted the outer shell of the Earth, forming a magma ocean. The newly formed Moon would also have had its own lunar magma ocean; estimates for its depth range from about 500 km to the entire radius of the Moon. But such is not the case. So the impact event hypothesis is still debated [5].

Now that the Moon is neither a pre-formed celestial body nor a result of a giant impact, it must have been produced by the Earth. But normally, the Earth's rotation is not fast enough to throw the Moon joined tightly with the Earth into the lunar orbit. Hence, the material composing the Moon must have been launched by a special force into some orbits around the Earth to form the Moon.

2. A New Theory for the Formation and Evolution of the Moon

Many scientific studies have shown that, about 4.5 billion years ago, at the beginning of the formation of the Earth, frequent volcanic eruptions began to occur on the Earth, because then the Earth was much closer to the Sun and moved much more quickly around the Sun than now, making immense heat be accumulated inside the Earth, thus causing frequent and violent volcanic eruptions on the Earth. During some violent volcanic eruptions or celestial body's impacts on the Earth, obviously the probability of volcanic eruptions is much larger than that of celestial body's impacts, some volcanic ash or rock debris could have achieved a velocity no less than the first cosmic velocity to enter some orbits around the Earth, forming layers of nebular around the Earth. Especially, when the direction of a volcanic eruption coincide with the direction of the Earth's rotation, the erupted debris could easily achieve a velocity no less than the first cosmic velocity; when the direction of a volcanic eruption contradicts with the direction of the Earth's rotation, the erupted debris have more difficulty achieving such a velocity. So there were more prograde debris than retrograde debris in the same orbit around the Earth. Hence, the prograde planetsimals could merge more prograde particles and bump less into retrograde particles, therefore easily grow up to be a moon. That is why the Moon is a prograde satellite.

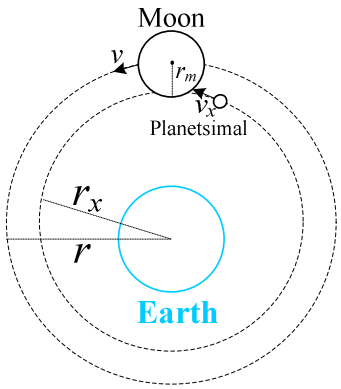


Fig. 1. *The orbits of the Moon and planetsimals.*

The orbit of the young Moon was much closer to the Earth than it is today. There were a lot of Earth ejecta in the orbit around the Earth, such as volcanic ash, water vapor, and aerosol, which could stay in the stratosphere for a very long time. Hence, the Moon, like a snowball, has unceasingly merged these ejecta to become larger and larger, and farther and farther away from the Earth. This can be proved as follows [6]: When the Moon moved around the Earth normally, the centrifugal force produced by the Moon's rotation around the Earth and the Earth's gravitation pull on the Moon had the same size but opposite directions, as is shown in Fig.1.

Let M be the mass of the Earth, m_1 be the mass of the Moon, r_m be the radius of the Moon, r be the centroid distance between the Earth and the Moon, v be the tangential velocity of the Moon around the Earth, then:

$$\frac{Gm_1M}{r^2}=\frac{m_1v^2}{r} \quad \rightarrow \quad v=\sqrt{\frac{GM}{r}} \tag{1}$$

Near the orbit of the Moon, there were also many smaller prograde planetsimals moving around the Earth's centre in circular orbits of radius r_x $(r-r_m<r_x<r)$ with velocity v_x. Since

$$v_x=\sqrt{\frac{GM}{r_x}}>\sqrt{\frac{GM}{r}},$$

which implies $v_x > v$, these smaller planetsimals would finally catch the Moon. When a smaller planetsimal approached the Moon, the Moon's gravitation force would accelerate the motion of the planetsimal, making the planetsimal's velocity become much larger than v_x. Let m_2 be the mass of the planetsimal, v_y be its velocity when it impacted the Moon, then the centrifugal force of the Moon merged with the planetsimal was:

$$m_1\cdot\frac{v^2}{r}+m_2\cdot\frac{v_y^2}{r}>(m_1+m_2)\cdot\frac{v^2}{r}=G(m_1+m_2).\frac{M}{r^2} \tag{2}$$

That is, the centrifugal force produced by the Moon's rotation around the Earth was larger than the Earth's gravitation pull on the Moon, therefore the Moon's center of gravity has a trend moving away from the Earth.

Especially, if a planetsimal or asteroid was large enough, it would impact the Moon fiercely, making the Moon's velocity increase to a larger value v_2, then:

$$(m_1+m_2)\cdot\frac{v_2^2}{r}>(m_1+m_2)\cdot\frac{v^2}{r}=G(m_1+m_2).\frac{M}{r^2} \tag{3}$$

therefore the Moon's center of gravity moved a reasonable distance from the Earth.

Another reason for the Moon moving away from the Earth is the increase in the Earth's rotation speed. This is because the Earth originated from a satellite of the planet that formed the Sun later. Originally, the mass of the Earth was small, there was no atmosphere on it, and it was near its mother star, so it

was almost synchronously tidally locked with the mother star, unable to rotate on its own axis, like Mercury and Venus. Afterwards, it has unceasingly incorporated the nebula materials near the orbits to become larger and larger, and gradually moved away from its mother star, just like the Moon moving away from the Earth. With the increase of Earth's mass, it could absorb more and more water vapor to form its own atmosphere, even forming a massive hydrosphere. When its mother star became a star constantly giving off light and heat, the Earth's hemisphere near the mother star was exposed to the sunlight, so the temperature of this hemisphere was generally higher than that of the other hemisphere, making more vapor evaporated from this hemisphere than from the other hemisphere, even forming massive clouds impacting high mountains or massive storms blocking the planet's revolution in this hemisphere. Hence, during the planet's revolution around its mother star, the planet's hemisphere near the mother star encountered more air resistance than the other hemisphere, causing the earth to rotate from west to east. And with the growth of Earth's atmosphere and hydrosphere, the speed of the Earth's rotation will become higher and higher. The observation result of American National Institute of Standard Technology in 1999 also shows that the Earth's rotation is speeding up. Due to Earth's tidal activity , inner fluid activity , volcanic activity, or great earthquake, Earth's figure axis is often shifted away from the north-south axis [7], which it spins around once every day at a speed of about 1,000 mph (1,604 kph), making Earth's center of mass draw a circular trace around the north-south axis in the space during Earth's rotation. For example, 2011 Tohoku earthquake has shifted Earth's figure axis by about 25 centimeters and accelerated Earth's spin [8]. Hence, under the drag of the gravitational force of the Earth whose rotation is speeding up gradually, the Moon's revolution around the Earth is also speeding up, thus increasing the centrifugal force of the Moon, finally making the Moon move away from the earth. That is why people have observed that the Moon is moving away from the earth gradually.

For the same reason, batch after batch of volcanic ejecta or planetsimals were moved away from the Earth or other planets and sent to the Moon, making the Moon become a giant satellite in four billion years.

Some people may believe that the Moon is moving away from the Earth is caused by the Earth's tides raised by the Moon: Because the tidal bulges on the Earth exert a gravitational pull on the Moon. The Earth rotates faster (once every 24 hours) than the Moon orbits (once every 27.3 days), thus the bulge tries to "speed up" the Moon, making the Moon move away from the Earth. In fact, they have distorted Newton's theory of tides. Although Newton had proved that the Moon's gravitational pull can raise the tides on the Earth, he didn't mention that the tidal bulges on the Earth can speed up Moon's revolution. Since the mass of a tidal bulge is much less than the mass of the Moon, it has almost no gravitational pull on the Moon. Even if a raised wave ahead has a little gravitational pull on the Moon, a raised wave behind has also a little gravitational pull on the Moon, which can offset the gravitational pull of the wave ahead. Especially, when the mass of the Moon was still small, its gravitational pull on the ocean water wasn't strong enough to raise Earth's tides, not to mention Earth's tidal bulges exerting a gravitational pull on the Moon or speeding up Moon's revolution. Hence, their viewpoint is wrong.

In addition, volcanic eruptions on the Moon was another force driving the Moon away from the Earth. At the beginning of the formation of the Moon, it's a cool homogeneous sphere. But with the continuous increase in the mass and volume of the Moon, the heat inside the moon accumulated continuously, including the heat caused by the air flow friction generated by the high-speed rotation of the moon around the Earth (this rotation speed could reach 7.9 km/s when the Moon was near to the earth) and the high-speed rotation of the Earth-Moon system around the Sun when the Earth was near to the Sun, the heat generated the moon's own gravitational contraction process, the heat generated by the chemical reactions inside the original moon, etc. It is just the original energy accumulated to a certain extent that made the original lunar material melted and differentiated, forming the different layers of the moon: crust, mantle and nucleus.

The early orbit of the Moon was much closer to the Earth's atmosphere than it is now, especially the near side of the moon has a large surface soaking in the earth's atmosphere, so the Moon had absorbed much water vapor from the Earth's atmosphere to form many large ice-covered or water-covered regions, such as lunar maria. Especially, in the process of the Moon revolving around the Earth from west to east in high speed, strong air flows or storms from eastern edge to western edge could be produced on the near side of the Moon, finally resulting in Oceanus Procellarum on the western edge of this side. Now NASA (National Aeronautics and Space Administration) has found that lots of water-ice still exists at lunar poles. On the other hand, in the process of the Moon revolving around the Earth, the eastern hemisphere of the Moon is always at the head of the moving satellite. The friction between the eastern hemisphere of the Moon and air is much more violent than that between the western hemisphere of the Moon and air, producing more heat and therefore making the temperature in the eastern hemisphere of the Moon higher than that in the western hemisphere. Hence, the air flow in the eastern hemisphere of the Moon is more active than that in the western hemisphere, therefore it's more difficult to form water or ice in the eastern hemisphere of the Moon than in the western hemisphere. That is why there was more water-ice such as lunar maria in the western hemisphere of the Moon than in the eastern hemisphere.

Due to the constant erosion of water, many places of the lunar crust were broken. When the water permeated through the crack in the crust to contact magma, the water gasified immediately, causing violent volcanic eruption. Since the western hemisphere of the Moon had more water-ice than the eastern hemisphere, the probability and strength of volcanic eruption in the western hemisphere is higher than that in the eastern hemisphere. That is why there are more volcanoes in the western hemisphere than in the eastern hemisphere of the

Moon. The synthesis of the volcanic eruptions in both hemispheres accelerated the revolution of the Moon around the Earth, making the Moon move from an orbit near the Earth to another orbit farther away from the earth. This can be proved as follows:

(1) Speeding up the Moon's revolution enlarges its orbit around the Earth

Assume that the Earth's mass is M and the Moon's mass is m, and the Moon moves around the Earth in a circular orbit of radius r_1 to do uniform circular motion, as is shown in Fig.2, then the Moon's rotation speed $V_1=\sqrt{\frac{GM}{r_1}}$. If the Moon at position A is accelerated by a pushing force, the Earth's gravitational pull on the Moon is less than the centripetal force required by the Moon's uniform circular motion around the Earth, thus doing centrifugal motion to enter an elliptic orbit. So we can assume that when the Moon's orbital speed at point A is increased from V_1 to V_{A2}, it can enter elliptical orbit 2 whose perigee distance is r_1 and apogee distance is r_2. Assume also that the Moon's orbital speed at point B is V_B. According to the law of conservation of mechanical energy, when the Moon moves from perigee A to apogee B, we have:

$$\tfrac{1}{2}MV_{A2}^{\ 2}=\tfrac{1}{2}MV_{B}^{\ 2}+\Delta E_p \tag{4}$$

where ΔE_p is defined as follows:

$$\Delta E_p=\int_{r_1}^{r_2}\frac{GMm}{r^2}dr=GMm(\tfrac{1}{r_1}-\tfrac{1}{r_2}) \tag{5}$$

According to Kepler's second law, we also know

$$\tfrac{1}{2}V_{A2}\cdot\Delta t\cdot r_1=\tfrac{1}{2}V_B\cdot\Delta t\cdot r_2 \tag{6}$$

for any time interval Δt. From Eqs. (4)-(6), we can deduce the following formula:

$$V_{A2}=\sqrt{\frac{2r_2}{r_1+r_2}}\sqrt{\frac{GM}{r_1}}=\sqrt{\frac{2r_2}{r_1+r_2}}V_1 \tag{7}$$

Similarly, in order to make the Moon in a circular orbit of radius r_1 enter elliptical orbit 3 whose perigee distance is r_1 and apogee distance is r_3, the Moon's orbital speed at point A should be increased from V_1 to V_{A3} :

$$V_{A3}=\sqrt{\frac{2r_3}{r_1+r_3}}\sqrt{\frac{GM}{r_1}}=\sqrt{\frac{2r_3}{r_1+r_3}}V_1 \tag{8}$$

From Eqs. (7) and (8), we can deduce the following formula:

$$V_{A3}=\sqrt{\frac{r_1+r_2}{2r_2}}\sqrt{\frac{2r_3}{r_1+r_3}}V_{A2}=\sqrt{\frac{r_3(r_1+r_2)}{r_2(r_1+r_3)}}V_{A2} \tag{9}$$

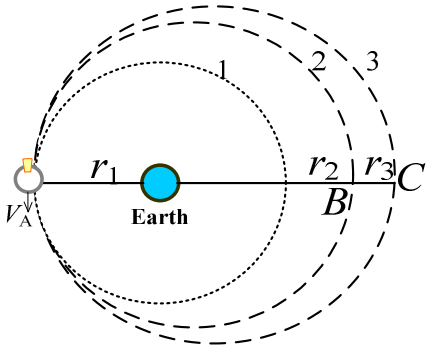


Fig. 2. *Speeding up the Moon's revolution enlarges the Moon's orbit.*

$$V_{A3}-V_{A2}=(\sqrt{\frac{r_3(r_1+r_2)}{r_2(r_1+r_3)}}-1)V_{A2} \tag{10}$$

i.e., if the Moon's orbital speed V_{A2} at perigee A of elliptical orbit 2 is increased by $(\sqrt{\frac{r_3(r_1+r_2)}{r_2(r_1+r_3)}}-1)V_{A2}$, then the Moon can be transferred from elliptical orbit 2 to orbit 3.

For example, assuming the mass of the original Moon is 7.349e20 kg, it moved in an elliptical orbit whose perigee distance r_1 = 8,200,000 m and apogee distance r_2 = 8,220,000 m, and the Moon's orbital speed at perigee is V_{A2} = 6,975.75 m/s. In order to make the Moon be transferred from this orbit to an extended elliptical orbit of apogee distance r_3 = (r_2 + 0.035) m, the Moon's orbital speed at perigee should be increased by 7.41648e-6 m/s.

Generally, as shown in Fig.3a, for any point D on semi-elliptic orbit 2 starting from perigee A to apogee B, assume the Moon's orbital speed at point A and point D are V_{A2} and V_D respectively, the distance between D and the Earth is r_4, then according to Kepler's second law, we have:

$$V_{A2}\cdot r_1=V_D\cdot r_4 \tag{11}$$

If the Moon's orbital speed at point D is increased by a propulsive force, making V_D become V_4, then the Moon is transferred to a larger elliptic orbit marked as 4. Since the perigee distance of the elliptic orbit is invariant, its apogee distance must be increased. Assume when the Moon's orbital speed at point A of orbit 2 is increased from V_{A2} to V_{A4}, the Moon can also enter orbit 4, then:

$$V_{A4}\cdot r_1=V_4\cdot r_4 \tag{12}$$

From Eqs. (11) and (12), we can obtain:

$$V_{A4}-V_{A2}=\tfrac{r_4}{r_1}(V_4-V_D) \tag{13}$$

$$V_4-V_D=\tfrac{r_1}{r_4}(V_{A4}-V_{A2}) \tag{14}$$

i.e., if an increase as much as ΔV in the Moon's orbital speed at point A of orbit 2 can make the Moon be transferred to orbit 4, then only an increase as much as $\frac{r_1}{r_4}\Delta V$ ($\frac{r_1}{r_4}<1$) in the Moon's orbital speed at point D of orbit 2 is required to make the Moon be transferred to orbit 4. Hence, the probability of an

increase in the Moon's orbital speed causing an extension of the Moon's orbit is large.

Similarly, as shown in Fig.3b, for any point D on semi-elliptic orbit 2 starting from apogee B to perigee A, if the Moon's orbital speed at point D is increased by a propulsive force, then the Moon is transferred to an elliptic orbit (marked as 4) with longer perigee distance.

(2) Thrusting-forward volcanic eruptions increase the Moon's orbital speed

As is shown in Figs. 3 and 4, during the Moon's revolution around the Earth, when a volcano continuously erupted and sent a huge amount of material into the stratosphere with great speed contrary to the tangential direction of the Moon's revolution, it could produce a tremendous impetus on the Moon, increasing the Moon's orbital speed. Hence, we can also employ the principle of rocket flight to calculate the increment of the Moon's orbital speed.

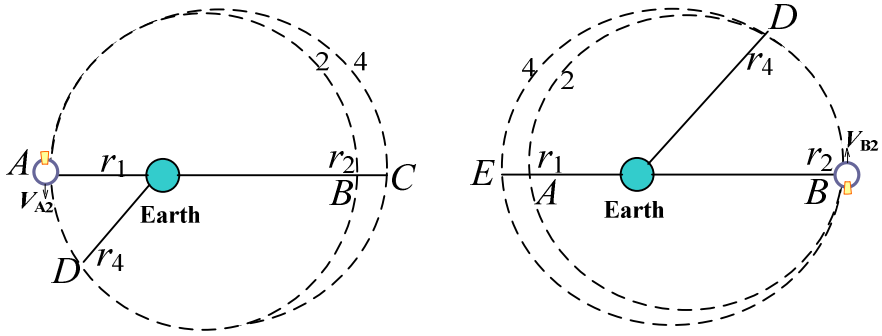
At a given instant t, let the mass of the Moon be M and its speed be v, then during the period from time t to time $t+\mathrm{d}t$, the volcanoes erupted substance of mass $\mathrm{d}m$, the velocity of these substances erupted from the Moon be u, making the Moon's speed increase $\mathrm{d}v$. Therefore, at the time $t+\mathrm{d}t$, the mass of the Moon is $M+\mathrm{d}M$, its speed is $v+\mathrm{d}v$, the mass of the erupted substances is $\mathrm{d}m$ (if $\mathrm{d}t$ is very small, such as $\mathrm{d}t \leq 1$, these substances can be regarded separated substances flying in the air) and the speed of these substances is $(v+\mathrm{d}v-u)$. Since the Earth's gravitation pull on the moon and the centrifugal force produced by the Moon's revolution around the Earth had the same size but opposite directions, the resultant external force exerted on the Moon is zero, therefore according to theorem of momentum, we have:

$$Mv=[M+dM](v+dv)+dm(v+dv-u)] \tag{15}$$

Notice that $\mathrm{d}M=-\mathrm{d}m$, we have

$$\mathrm{d}v=-u\cdot \mathrm{d}M/M \tag{16}$$

Let $v=v_i$ and $M=M_i$ when $t=t_i$, during the period from time t_i to time t_j, the volcanoes erupted some substances, then at instant t_j, $v=v_j$ and $M=M_j$, therefore we obtain:



(a) apogee distance is increased (b) perigee distance is increased

Fig. 3. *The Moon's orbit is extended due to the increase of speed.*

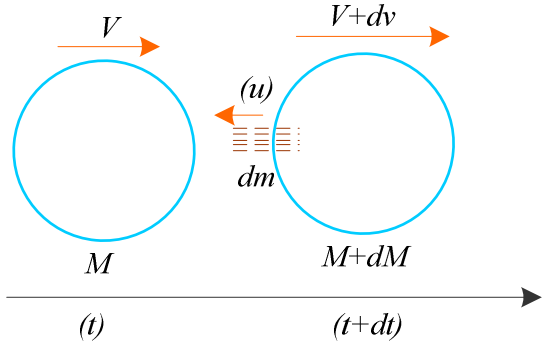


Fig. 4. *Thrusting-forward volcanic eruptions increasing the Moon's orbital speed.*

$$\int_{v_i}^{v_j} dv=-u\int_{M_i}^{M_j} dM/M \tag{17}$$

$$v_j-v_i=u\ln(M_i/M_j) \tag{18}$$

Let the ratio of the mass of the entire Moon to the remaining mass after the first second of volcanic eruption be N_1, the ratio of the mass before the 2nd second of volcanic eruption to the remaining mass after the 2nd second of volcanic eruption be N_2, and so on. Let u_i be the speed of the substances erupted from the Moon in the i-th second of volcanic eruption, and v_i be the speed of the Moon after the i-th second of volcanic eruption, then:

$$\begin{aligned} v_1-v_0&=u_1\ln(N_1),\\ v_2-v_1&=u_2\ln(N_2),\\ v_3-v_2&=u_3\ln(N_3),\\ &\cdots\cdots,\\ v_k-v_{k-1}&=u_k\ln(N_k) \end{aligned} \tag{19}$$

Generally, we can assume that

$$u_1=u_2=\cdots=u_k=u$$

and

$$N_1=N_2=\cdots=N_k=N$$

for some positive number u and N, so:

$$v_k - v_0 = ku\ln(N) \tag{20}$$

Since there are more volcanoes in the western hemisphere of the Moon than in the eastern hemisphere of the Moon, we can moderately assume when the moon approached its perigee, a volcano group in the western hemisphere of the Moon eject together 1.54321e9 kg per second (which amounts the ejecta mass of a Vesuvius volcano per second), and the ejection velocity is 1,000 m/s (which amounts the eruption velocity of some volcanoes discovered by Voyager 1 on Jupiter's satellite, Io, whose velocity of spewing volcano substances could reach 1,000 m/s), then after one hour of propulsive eruption, the Moon's orbital speed can be increased by 7.55955e-6 m/s (> 7.41648e-6 m/s), making the Moon be transferred to an extended elliptical orbit whose apogee distance is 0.035 m longer than that of the previous orbit.

Just as what Eqs. (13) and (14) shows, a volcanic eruption of the same scale occurring at any point D on the semi-elliptic orbit from perigee A to apogee B can produce almost the same effect on the increase in the Moon's orbital speed, therefore produce almost the same effect on the variation of the Moon's orbit. Hence, the probability that the Moon's orbit changes several times along this long semi-elliptic orbit is very high. So it's very natural that the apogee distance is increased by 0.035 m in a year due to the variation of the Moon's orbit; meanwhile, it's also very natural that the perigee distance is increased by 0.035 m due to the variation of the Moon's orbit.

Similarly, Table 1 also shows some other data about the Moon's orbital variation corresponding to different scales of volcanic eruptions. According to such a calculation, the Moon could move a long distance away from the Earth in one billion years. But when the Moon was driven to an orbit much nearer to the Sun, the immense heat from the Sun could make the water vapor on the Moon be evaporated away, leaving a dry Moon. So it could no longer produce volcanic eruptions to drive itself away from the Earth. Now the drag of the Earth's gravitational force is the main force driving the Moon away from the earth.

Table 1. *Moon's orbit variation caused by volcanic eruptions in different orbits.*

Perigee distance; Apogee distance (m)	Moon's mass (kg)	Eruption velocity (m/s)	Erupted mass per second (kg/s)	Eruption duration at a time (h) × number of times	Yearly increase of Moon's apogee distance (m)
8,200,000; 8,220,000	7.349e20	1,000	1.54321e9	1 × 10	≥ 10 × 0.033
10,000,000; 11,000,000	2.940e21	1,000	1.54321e9	1 × 10	≥ 10 × 0.013
20,000,000; 22,000,000	7.349e21	1,000	1.54321e9	1 × 10	≥ 10 × 0.015
30,000,000; 33,000,000	1.470e22	1,000	1.54321e9	1 × 10	≥ 10 × 0.014
40000,000; 44,000,000	2.940e22	1,000	1.54321e9	1 × 10	≥ 10 × 0.011
50,000,000; 55,000,000	4.421e22	1,000	1.54321e9	1 × 10	≥ 10 × 0.010
60,000,000; 66,000,000	5.879e22	1,000	1.54321e9	1 × 10	≥ 10 × 0.0080
80,000,000; 88,000,000	6.614e22	1,000	1.54321e9	1 × 10	≥ 10 × 0.013
90,000,000; 99,000,000	7.349e22	1,000	1.54321e9	1 × 10	≥ 10 × 0.014
100,000,000; 110,000,000	7.349e22	1,000	1.54321e9	1 × 10	≥ 10 × 0.017
200,000,000; 210,000,000	7.349e22	1,000	1.54321e9	1 × 5	≥ 5 × 0.046
300,000,000; 310,000,000	7.349e22	1,000	1.54321e9	1 × 2	≥ 2 × 0.083
350,000,000; 360,000,000	7.349e22	1,000	1.54321e9	1 × 2	≥ 2 × 0.100
363,000,000; 380,000,000	7.349e22	1,000	1.54321e9	1 × 2	≥ 2 × 0.110

3. The Advantages of the New Theory

The above theory established by reasoning can be well verified by modern artificial satellite launch experiments. It has many advantages over the existing explanations. It can answer many questions that the existing hypothesis couldn't explain.

For the question "why the Earth and the Moon have nearly identical isotopic composition?", the answer is because most of the Moon came from the ejecta of the Earth, they have nearly identical isotopic composition, which conflicts with the impact event hypothesis.

For the question "why the Moon lacks iron?", the answer is during the formation of the Earth, the original Earth material had melted and differentiated, forming the different layers of the Earth: crust, mantle and core. Iron as heavier element had sunk into Earth's core, and the lighter elements had floated into the upper layers. Most of Moon's material were erupted from the crust or mantle of the Earth, hence the Moon lacks iron.

For the question "the previous hypotheses couldn't account for the high angular momentum of the Earth-Moon system", the answer is that with the growth of Earth's atmosphere, the speed of the Earth's rotation will become higher and higher; under the drag of the Earth's gravitational force, the Moon's revolution around the Earth is also speeding up, thus making the Moon gradually move away from the Earth. So there should be no special restriction on the angular momentum of the Earth-Moon system.

For the question "why some planets have satellites while some planets don't have satellites?", the answer is since the surface temperature of Mercury and Venus is very high, their water vapor had been evaporated away by sunshine, therefore they couldn't produce enough volcanic eruptions to form their moons. But the other planets have had abundant water or ice, and have produced many volcanic eruptions to form their moons.

Since the above theory shows that the Moon is actually generated by the Earth, it can be called "generation theory".

4. Conclusion

Many people have studied the Moon, and several mechanisms have been proposed for the Moon's formation, but they all have unsolvable problems. Hence the author of this paper studied the origin of the Moon again, and found some orbit variation mechanisms of the Moon, therefore could reveal the formation and evolution of the Moon. Then according to the formation law, we can also reveal the formation and evolution of the Solar System and the structure of other galaxies in the Universe, and explain the expansion of the Universe as well as global climate change.

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