International Journal of Geophysics and Geochemistry
2015; 2(2): 8-17
Published online April 10, 2015 (http://www.aascit.org/journal/ijgg)

AASCIT American Association for Science and Technology

Keywords
Earth,
Formation,
Evolution,
the Solar System,
Expansion of the Universe,
Global Climate Change

Received: February 15, 2015
Revised: March 24, 2015
Accepted: March 25, 2015

The Formation and Evolution of the Earth as well as Global Climate Change

Cui-Xiang Zhong

Department of Science and Technology, Jiangxi Normal University, Nanchang, China

Email address
cuixiang_zhong@sohu.com

Citation
Cui-Xiang Zhong. The Formation and Evolution of the Earth as well as Global Climate Change. *International Journal of Geophysics and Geochemistry.* Vol. 2, No. 2, 2015, pp. 8-17.

Abstract
The research on the origin of the Earth can not only find the formation and evolution law of the Earth but also reveal the formation and evolution law of galaxies in the universe. Hence many people have studied the Earth, but the origin of the Earth remains a mystery. Thus, the author of this paper has studied the origin of the Earth and found some orbit-variation mechanisms of the Earth, therefore has revealed the formation and evolution law of the Earth. According to this law, we can further reveal the formation and evolution law of the Solar System and other galaxies in the Universe, and explain the expansion of the Universe as well as the cause of global climate change.

1. Introduction

The origin of Earth and the structure of matter as well as the origin of life are three major topics in natural science, to which human have attached great importance. Since the Earth is a member of the Solar system, the origin of Earth naturally becomes a sub-problem of the origin of the Solar system [1]. Although early in 1543 Poland astronomer Copernicus published “On the Revolutions of Heavenly Spheres”, in which he proposed heliocentrism, thus made great contributions to human correctly understanding the Solar System, yet in nearly 500 years, the origin and evolution of the Solar System remained a mystery. Although people have put forward various hypotheses, including more than 40 kinds of hypothesis which have more impacts, yet so far no one is perfect, they all have unsolvable problems [2]. Among these hypotheses, the most widely accepted hypothesis of planetary formation is Kant and Laplace nebular hypothesis, which maintains that 4.6 billion years ago, the Solar System formed from the gravitational collapse of a giant molecular cloud which was light years across. Most of the mass collected in the centre, form the Sun; the rest of the mass flattened into a proto-planetary disc, out of which the planets, moons, and other bodies in the Solar System formed. However, since the dawn of the space age in the 1950s and the discovery of extra-solar planets in the 1990s, the theory has been both challenged and refined to account for new observations [3]. But even if the refined hypotheses still cannot explain some basic facts. Why the planets can move around the Sun? Why Mercury and Venus, which originally had more matter near the disc centre to form their moons, haven’t had their own moons? Hence, the existing hypotheses are incredible.

Recently, the author of this paper, through a study on the origin of the Moon and the Earth, has discovered some orbit variation mechanisms of natural satellites and planets, therefore, could reveal the formation and evolution of the Solar System including the Earth, the structure of other galaxies, the expansion of the universe and global climate change [4].

2. A New Theory of the Formation and Evolution of the Earth

Since the Earth moves around the Sun, the formation and evolution of the Earth should be traced back to the origin and evolution of the Sun [5]. When the protosun grew up into a planet like the Earth, it was large enough to absorb much vapor from the cosmic space to form an extended atmosphere and even large bodies of water-ice on the planet. The rotation of the planet around its axis caused it to bulge around the Equator, making the planet become an oblate spheroid and polar water tend to flow to the equatorial region. Hence, the equatorial region suffered water erosion much earlier and more serious than other places, therefore this region had the earliest volcanic eruptions of the planet. During violent volcanic eruptions, some ejecta could obtain high enough speed to enter some orbits around the planet, forming layers of nebular around the planet. In addition, when the direction of a volcanic eruption coincide with the direction of the planet'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 planet'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 planet. Hence, the prograde planetsimals could merge more prograde particles and bump less into retrograde particles, therefore easily grew up into satellites. As the planet grew up into a fixed star, some of its satellites grew up into planets. That is why the eight planets around the Sun are prograde planets. In addition, since the gravity is weaker in the equator region than in the polar regions, the debris erupted by the volcanoes in the equator region could easily obtain high enough speed to enter some orbits around the planet, therefore easily grew up into satellites. That is why the orbits of the eight planets lie almost in the same plane, and the angle between this plane and the solar equatorial plane is very small [6].

The formation and evolution of the eight planets can largely be divided into three stages [7]: formation from nebula to satellite, evolution from satellite to planet and growth of planet, which can be illustrated using the Earth as an example.

2.1. Formation from Nebula to Satellite

The orbit of the young-earth was much closer to the protosun than it is today. There were a lot of protosun ejecta in the orbit around the protosun, such as volcanic ash, watervapor, and aerosol, which could stay in the stratosphere for a very long time. Hence, the young-earth, like a snow ball, has unceasingly merged these ejecta to become larger and larger, and farther and farther away from the protosun. This can be proved as follows [3]: When the young-earth moved around the protosun normally, the centrifugal force produced by the young-earth's rotation around the protosun and the protosun's gravitation pull on the young-earth had the same size but opposite directions, as is shown in Fig.1 Let M be the mass of the proto sun, m_1 be the mass of the young-earth, r_m be the radius of the young-earth, r be the centroid distance between the protosun and the young-earth, v be the tangential velocity of the young-earth around the protosun, then:

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

Near the orbit of the young-earth, there were also many smaller prograde planetsimals moving around the protosun's centre in circular orbits of radius r_x (r-r_e<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 Earth. When a smaller planetsimal approached the young-earth, the young-earth'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_x be its velocity when it impacted the young-earth, then the centrifugal force of the young-earth merged with the planetsimal was:

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

That is, the centrifugal force produced by the young-earth's rotation around the protosun was larger than the protosun's gravitation pull on the young-earth, therefore the young- earth's center of mass has a trend moving away from the protosun.

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

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

therefore, the young-earth's center of mass moved a reasonable distance from the protosun.

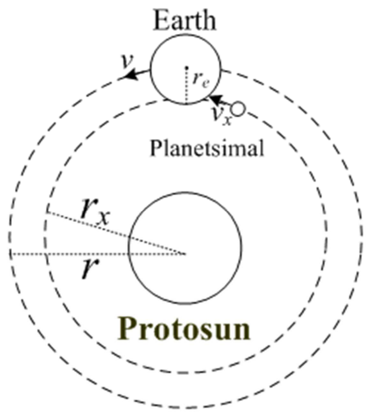

Fig. 1. *The orbits of the Earth and planetsimals*

In fact, another reason for the young-earth moving away from the protosun is the increase in the protosun's rotation speed. This is because the protosun originated from a satellite of the planet that formed a fixed star later. Originally, the mass of the protosun 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. Afterwards, it has unceasingly incorporated the nebula materials near the orbits to become larger and larger, and gradually moved away from its mother star. With the increase of protosun'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 protosun's hemisphere near its 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 protosun's revolution around its mother star, the protosun's hemisphere near its mother star encountered more air resistance than the other hemisphere, making the protosun rotate from west to east. And with the growth of protosun's atmosphere and hydrosphere, the speed of the protosun's rotation would become higher and higher. Due to protosun's inner fluid activities, volcanic activities, great earthquakes, or tidal activities, protosun's figure axis was often shifted and the speed of protosun's rotation was often increased, sometimes making protosun's center of mass draw a circular trace around the original axis in the space during protosun's rotation. Hence, under the drag of the protosun's gravitational force,the Earth's revolution around the protosun was also speeding up, thus increasing the centrifugal force of the Earth, finally making the Earth move away from the protosun. That is why the Earth is so far away from the Sun.

For the same reason, batch after batch of volcanic ejecta or planetsimals were moved away from the protosun or other planets and sent to the Earth, making the Earth become a giant satellite covered with interstellar matter in billions years.

2.2. Evolution from Satellite to Planet

In addition to the impact of planetesimals and the drag of the gravitational force of the protosun whose rotation was speeding up, volcanic eruption on the Earth was another factor driving the Earth away from the protosun.

At the beginning of the formation of the Earth, it's a cool homogeneous sphere. But with the continuous increase in the mass and volume of the Earth, the heat inside the Earth accumulated continuously, including the heat caused by the air flow friction generated by the high-speed rotation of the Earth around the protosun, the heat generated by the Earth's own gravitational contraction process, the heat generated by the chemical reactions inside the original Earth, 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 Earth: crust, mantle and nucleus. In addition, when the Earth was still a satellite without rotation around its own axis, in the process of the Earth revolving around the protosun, the eastern hemisphere of the Earth is always at the head of the moving satellite. The friction between the eastern hemisphere of the Earth and air is much more violent than that between the western hemisphere of the Earth and air, producing more heat and therefore making the temperature in the eastern hemisphere of the Earth higher than that in the western hemisphere, thus causing the degree of differentiation of the eastern hemisphere is higher than that of the western hemisphere.

The early orbit of the Earth was much closer to the protosun's atmosphere than it is now, especially the near side of the Earth has a large surface soaking in the protosun's atmosphere, so the Earth had absorbed much water vapor from the protosun's atmosphere to form many large ice-covered or water-covered regions.In the process of the Earth revolving around the protosun, when the Earth was still a satellite without rotation around its own axis, since the temperature in the eastern hemisphere of the Earth was higher than that in the western hemisphere, the air flow in the eastern hemisphere of the Earth was more active than that in the western hemisphere, therefore it's more difficult to form water or ice in the eastern hemisphere of the Earth than in the western hemisphere. Hence there was more water-ice in the western hemisphere of the Earth than in the eastern hemisphere.

Due to the constant erosion of water, many places of the earth's 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 Earth 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 were more volcanoes in the western hemisphere than in the eastern hemisphere of the Earth. The synthesis of the volcanic eruptions in both hemispheres accelerated the revolution of the Earth around the protosun, making the Earth move from an orbit near the protosun to another orbit farther away from the protosun. This can be proved as follows.

2.2.1. Speeding Up the Earth's Revolution Enlarged Its Orbit Around the Protosun

Assume that the protosun's mass is M and the Earth's mass is m, and the Earth moves around the protosun in a circular orbit of radius r_1 to do uniform circular motion, as is shown in Fig.2, then the Earth's rotation speed

$$V_1=\sqrt{\frac{GM}{r_1}}\ .$$

If the Earth at position A is accelerated by a pushing force, the protosun's gravitational pull on the Earth is less than the centripetal force required by the Earth's uniform circular motion around the protosun,thus doing centrifugal motion to enter an elliptic orbit. So we can assume that when the Earth's orbital speed at point A is increased from V_1 to V_{A2}, it can enter elliptical orbit 2 whose perihelion distance is r_1 and aphelion distance is r_2. Assume alsothat the Earth's orbital speed at point B is V_B. According to the law of conservation of mechanical energy, when the Earth moves from perihelion A to aphelion B, we have [8]:

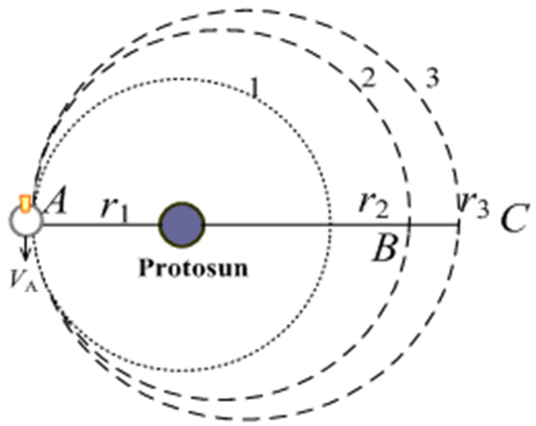

Fig. 2. *Speeding up the Earth's revolution enlarging the Earth's orbit.*

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

Where ΔE_p is defined as follows:

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

According to Kepler's second law, we also know

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

For any time interva lΔt.

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 Earth in a circular orbit of radius r_1 enter elliptical orbit 3 whose perihelion distance is r_1 and aphelion distance is r_3, the Earth'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:

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

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

i.e., if the Earth's orbital speed V_{A2} at perihelion 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 Earth can be transferred from elliptical orbit 2 to orbit 3.

For example, assuming the mass of the Earth is 7.349e20 kg, it moved in an elliptical orbit whose perihelion distance r_1 = 8,200,000 m and aphelion distance r_2 = 8,220,000 m, and the Earth's orbital speed at perihelion is V_{A2} = 6,975.75 m/s. In order to make the Earth be transferred from this orbit to an extended elliptical orbit of aphelion distance $r_3 = (r_2 + 0.035)$ m, the Earth's orbital speed at perihelion 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 perihelion A to aphelion B, assume the Earth'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:

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

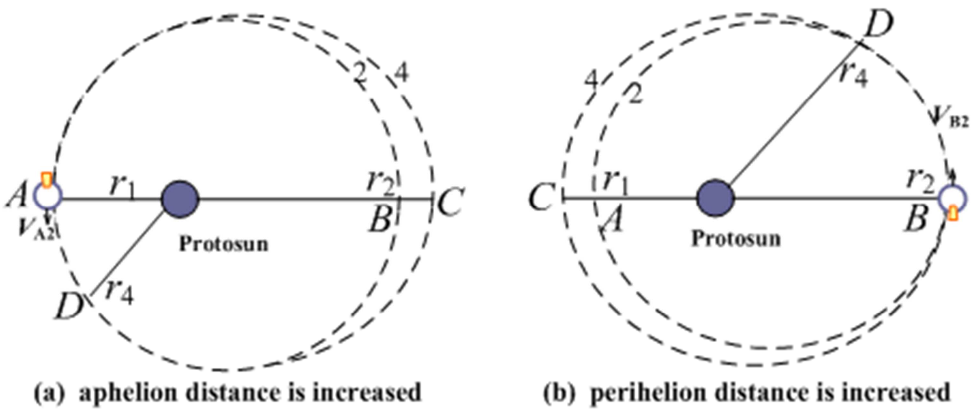

Fig. 3. *The Earth's orbit is extended due to the increase of speed*

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

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

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

i.e., if an increase as much as ΔV in the Earth's orbital speed at point A of orbit 2 can make the Earth 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 Earth's orbital speed at point D of orbit 2 is required to make the Earth be transferred to orbit 4. Hence, the probability of an increase in the Earth's orbital speed causing an extension of the Earth's orbit is large.

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

2.2.2. Thrusting-Forward Volcanic Eruptions Increase the Earth's Orbital Speed

As is shown in Figs. 3 and 4, during the Earth's revolution around the protosun, 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 Earth's revolution, it could produce a tremendous impetus on the Earth, increasing the Earth's orbital speed. Hence, we can also employ the principle of rocket flight [9] to calculate the increment of the orbital speed of the Earth.

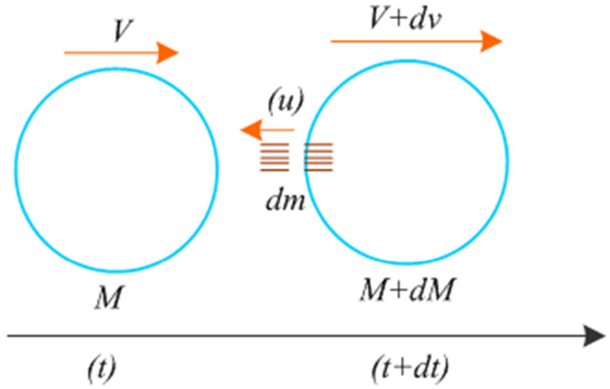

Fig. 4. *Thrusting-forward volcanic eruptions increase sthe Earth's orbital speed*

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

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

Notice that *dM*=-*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*:*

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

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

Let the ratio of the mass of the entire Earth 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 Earth in the *i*-th second of volcanic eruption, and v_i be the speed of the Earth 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 Earth than in the eastern hemisphere of the Earth, we can moderately assume when the Earth approached its perihelion, a volcano group in the western hemisphere of the Earth 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 hours of propulsive eruption, the Earth's orbital speed can be increased by 7.55955e-6 m/s (＞ 7.41648e-6 m/s), making the Earth be transferred to an extended elliptical orbit whose aphelion distance is 0.035 m longer than that of the previous orbit, which is 8,220,000 m .

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 perihelion A to aphelion B can produce almost the same effect on the increase in the Earth's orbital speed, therefore produce almost the same effect on the variation of the Earth's orbit. Hence, the probability that the Earth's orbit changes several times along this long semi-elliptic orbit is very high. So it's very natural that the aphelion distance is increased by 0.035 m in a year due to the variation of the Earth's orbit; meanwhile, it's also very natural that the perigee distance is increased by 0.035 m due to the variation of the Earth's orbit.

Similarly, Table 1 also shows some other data about the Earth's orbital variation corresponding to different scales of volcanic eruptions. According to such a calculation, the Earth could move a long distance away from the protosun in billions years.

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

Perihelion distance; aphelion distance(km)	Earth'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 Earth's aphelion 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

Since the Earth had unceasingly incorporated the nebula materials near the orbits to become larger and larger, and gradually moved away from its mother star. With the increase of Earth's mass, it was able to absorb more and more vapor from the cosmic space to form its own extended atmosphere and even large bodies of water-ice. As the protosun grew up into a fixed star, the Earth grew up into a planet. When the Earth moved counter-clockwise around its mother star, its hemisphere near the mother star was exposed to the "sunlight" from the mother star, 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 others, even forming clouds impacting high mountains or massive storms blocking the Earth's revolution. Hence, during the Earth's revolution around its mother star, the Earth's hemisphere near the mother star encountered more air resistance than the other hemisphere, causing the Earth to rotate from west to east. In addition, due to the constant erosion of water, volcanic eruptions frequently occurred on the Earth, and the Moon was formed from the ejecta of the Earth, becoming the first natural satellite around the Earth [10]. Hence, the Earth has evolved into a standard planet around the Sun.

2.3. Growth of Planet and Global Climate Change

With the Solar System revolving around the centre of the Milky Way Galaxy, the Earth has unceasingly incorporated the nebula materials near its orbits, making its mass and especially its atmosphere and hydrosphere increase continuously, finally making the Earth become a big planet with changeable climate. During Earth's rotation around its own axis, there are not only volcanic eruptions accelerating the revolution of the Earth but also volcanic eruptions decelerating the revolution of the Earth, therefore it is not only possible to extend Earth's orbit around the Sun but also possible to reduce Earth's orbit around the Sun, causing global cooling or warming, even leading to the alternation of glacial and interglacial periods. This can be proved as follows:

2.3.1. Decelerating the Earth's Revolution Reduces the Earth's Orbit

Contrary to that speeding up the Earth's revolution enlarges the Earth's orbit, as is shown in Fig.5, if the Earth's orbital speed at perihelion A of elliptical orbit 3 is decreased from V_{A3} to V_{A2}, then the Earth can be transferred from elliptical orbit 3 to elliptical orbit 2. From Eq.(9), we obtain

$$V_{A3}\text{-}V_{A2}=(1-\sqrt{\frac{r_2(r_1+r_3)}{r_3(r_1+r_2)}})V_{A3} \tag{21}$$

i.e. if the Earth's orbital speed V_{A3} at perihelion A of elliptical orbit 3 is decreased by $(1-\sqrt{\frac{r_2(r_1+r3)}{r_3(r_1+r2)}})V_{A3}$, then the Earth can be transferred from ellipticalorbit 3 to orbit 2.

For example, now the earth moves in an elliptical orbit whose perihelion distance r_1= 147098074000 m and aphelion distance r_2= 152097701000 m, and the Earth's orbital speed at perihelion is V_{A3}= 30287 m/s. In order to make the Earth be transferred from the current elliptical orbit to a contracted elliptical orbit of aphelion distance $r_3=r_2$-0.02m, the Earth's orbital speed at perihelion should be decreased by 9.78497e-10 m/s.

Generally, as is shown in Fig. 6(a), for any point D on semi-elliptic orbit 4 starting from perihelion A to aphelion C, assume the Earth's orbital speed at point A and point D are V_{A4} and V_D respectively, the distance between D and the Sun is r_4, then according to Kepler's second law, we have

$$V_{A4}\bullet r_1=V_D\bullet r_4 \tag{22}$$

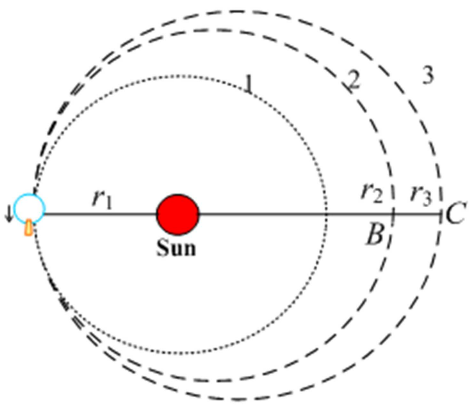

Fig. 5. *Decelerating Earth's revolution reduces Earth's orbit*

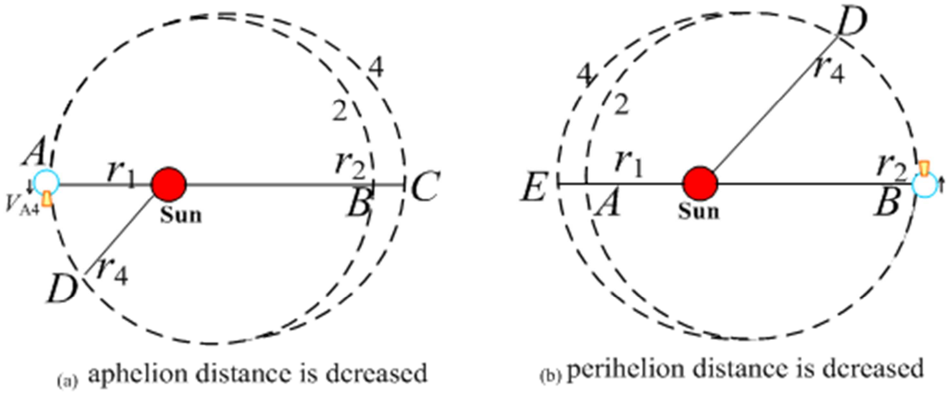

Fig. 6. *The general case of Earth's orbit reduction*

If the Earth's orbital speed at point D is decreased by a reverse-thrust force, making V_D become V_2, then the Earth is transferred to a smaller elliptic orbit marked as 2. Since the perihelion distance of the elliptic orbit is invariant, its aphelion distance must be decreased. Assume when the Earth's orbital speed at point A of orbit 4 is decreased from V_{A4} to V_{A2}, the Earth can also enter orbit 2, then

$$V_{A2}\bullet r_1=V_2\bullet r_4 \tag{23}$$

From Eq.(22) and Eq.(23), we can obtain

$$V_{A4}\text{-}V_{A2}=\frac{r_4}{r_1}(V_D\text{-}V_2) \tag{24}$$

$$V_D\text{-}V_2=\frac{r_1}{r_4}(V_{A4}\text{-}V_{A2}) \tag{25}$$

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

Similarly, as is shown in Fig. 6(b), for any point D on semi-elliptic orbit 4 starting from aphelion B to perihelion E, if the Earth's orbital speed at point D is decreased by a reverse-thrust force, then the Earth is transferred to an elliptic orbit (marked as 2) with shorter perihelion distance.

2.3.2. Reverse-Thrust Volcanic Eruptions Decrease the Earth's Orbital Speed

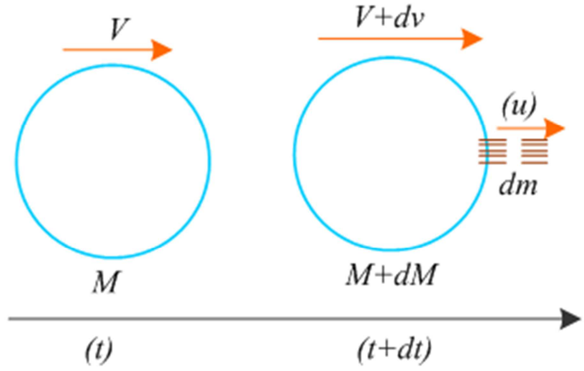

Fig. 7. *Reverse-thrust volcanic eruptions decrease the Earth's orbital speed*

As is shown in Fig.5 and Fig.7, during the Earth's revolution around the Sun, when a volcano continuously erupt and send a huge amount of material into the stratosphere with great speed towards the tangential direction of the Earth's revolution, which can produce a tremendous resistance to the Earth, decreasing the Earth's orbital speed. Hence, we can employ the principle of rocket flight to calculate the negative increment of the Earth's orbital speed.

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

$$Mv=[M+dM](v+dv)+dm(v+dv+u)]$$

Notice that dM=-dm, we have

$$dv=u*dM/M$$

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

$$\int_{v_i}^{v_j} dv = u\int_{M_i}^{M_j} dM/M \rightarrow \quad v_j-v_i=-u\ln(M_i/M_j)$$

Let the ratio of the mass of the entire Earth 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 Earth in the i-th second of volcanic eruption, and v_i be the speed of the Earth after the i-th second of volcanic eruption, then

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

Generally, we can think that $u_1=u_2=\cdots=u_k=u$ and $N_1=N_2=\cdots=N_k=N$ for some positive number u,N, so

$$v_k-v_0=-ku\ln(N)$$

In the calculation of volcano activity, we should refer to statistical data. There are 1500 more active volcanoes around the world, and out of these volcanoes, 50~80 volcanoes erupt every year. The famous Vesuvius volcano in history could spew volcanic substances at the rate of 1.54321 million tons per second. Stromboli volcano in Italy has been in almost continuous eruption for hundreds of years. The well-known Vulcanian eruption is a type of explosive eruption that can eject volcano substances with a speed greater than 350m/s. Just as the volcanoes discovered by Voyager 1 on Jupiter's satellite, Io, whose velocity of spewing volcano substances could reach 1000m/s, many volcanoes on the Earth are also very violent. Their eruptions could eject a cloud of stones, ash and fumes to a height of dozens of miles. The Moon is formed by this kind of "volcano cloud" moving around the Earth. This shows that the velocity of some erupted matter can reach the first cosmic velocity, which is 7.9 km/s.

Volcanic eruption has relation with time. For the same region, before dawn, the temperature is usually lower than other time of a day, it is easy to form raindrops, so the probability of rain in this period is larger than that in other periods. When the rainfall is large enough, the rainwater can permeate through crust cracks into volcano's magma chambers, causing violent volcanic eruptions or earthquakes. Hence, for the same region, the probability of volcanic eruption before dawn is larger than that in other periods. In addition, the direction of volcano ejection occurring between 3:00 am and 7:00 am almost coincides with the direction of the Earth's revolution, therefore decreasing the Earth's revolution.

Since some volcano groups have several volcanoes erupting simultaneously, we can moderately assume when the Earth approaches its perihelion, a volcano group ejects 1.54321e9 kg per second (which amounts the ejecta mass of a Vesuvius volcano per second), and the ejection velocity is 350 m/s, then after 4 hours of continuous eruption, the Earth's orbital speed can be decreased by 1.1191e-9 m/s (＞9.78497e-10 m/s), making the Earth be transferred to a contracted elliptical orbit whose aphelion distance is 0.02m shorter than that of the previous orbit.

Just as what Eq.(24) and Eq.(25) shows, a volcanic eruption of the same scale occurring at any point D on the semi-elliptic orbit from perihelion A to aphelion C can produce almost the same effect on the decrease of the Earth's orbital speed, therefore produce almost the same effect on the variation of the Earth's orbit. Hence, the probability that the Earth's orbit changes fifty times along this long semi-elliptic orbit is very high. So it is very natural that the aphelion distance is deceased by 1 m in a year due to the variation of the Earth's orbit. In the course of one hundred years, it's very natural that the aphelion distance is deceased by 100 m due to the variation of the Earth's orbit; meanwhile, it's also very natural that the perihelion distance is deceased by 100 m due to the variation of the Earth's orbit. So it is no wonder that the Earth's surface temperature has been increased by 0.8 ºC. Similarly, table 1 also shows some other data about the Earth's orbital variation corresponding to different scales of volcanic eruptions.

Table 2. *Earth's orbit reduction caused by different scales of volcanic eruptions*

Eruption velocity(m/s)	Erupted mass per second(kg/s)	Eruption duration at a time(h)×number of times	Yearly decrease of Earth's aphelion distance(m)	Centennial decrease of Earth's aphelion distance(m)
350	1.54321e9	4×50	≥0.020×50	≥100
500	1.54321e9	4×40	≥0.025×40	≥100
1000	1.54321e9	4×20	≥0.05×20	≥100
2000	1.54321e9	4×10	≥0.1×10	≥100
3200	1.54321e9	2×10	≥0.1×10	≥100
7900	1.54321e9	2×4	≥0.25×4	≥100
7900	1.54321e9	2×8	≥0.25×8	≥200

From above calculation, we see that volcanic eruptions at a certain scale can indeed cause the Earth's orbital variation, thus causing global warming or cooling [11]. In fact, after the protosun became a fixed star, its atmosphere has almost been burned, the Sun can only absorb gas and dust unceasingly from space to maintain its thermonuclear fusion. Hence, the unburned outer layer of Sun's atmosphere is slight and even on all sides, making the rotation speed of the Sun unchangeable, neither accelerating nor decelerating. In addition, planetesimals' impacts on the Earth are few and the planetesimals are usually very small. Hence, in this phase, the main factor effecting Earth's orbit variation is volcanic eruptions. Since slight variations in Earth's orbit lead to changes in the seasonal distribution of sunlight reaching the Earth's surface and how it is distributed across the globe. There is very little change to the area-averaged annually averaged sunshine; but there can be strong changes in the geographical and seasonal distribution. Hence, the orbital variations have a large impact on climate and are notable for their correlation to glacial and interglacial periods [12].

In addition, with the Earth unceasingly absorbing dust and gas from the cosmic space, including water vapor and carbon dioxide produced by the combustion of the Sun, Earth's hydrosphere and atmosphere is gradually thickened. Since the mass of the Sun is more than 98% of the mass of the entire Solar System, the greenhouse gases produced by the combustion of the Sun is much more than that produced by the Earth, thus the greenhouse gases absorbed by the Earth from cosmic space is much more than that produced by human activities. The concentration of greenhouse gases in Earth's atmosphere has increased significantly, thus causing global warming. Especially, the increase of Earth's water vapor can also increase the magnitude and frequency of Earth's rainfall, even causing the rising of sea level or flood disasters. Additionally, the increase of Earth's rotation speed can also exacerbate the friction between the gas molecules and the ground or iceberg, causing the rising of Earth's temperature or the melting of iceberg.

3. Conclusions

From the previous sections, we know that during some violent volcanic eruptions, the young-earth was sent to an orbit around the protosun, then it has unceasingly incorporated the nebula materials from the protosun or other planets to become larger and larger, and gradually moved away from the protosun under the impact of moving objects or the driving of volcanic eruptions or the drag of the gravitational force of the protosun whose rotation was speeding up. When the protosun became a fixed star, the Earth became a big planet with a hydrosphere and an atmosphere. Under the effect of sunlight and Earth's atmosphere, the Earth rotates from west to east. Frequent volcanic eruptions on the Earth produced the Moon. With the continuous increase of Earth's mass, atmosphere and hydrosphere, the Earth has become a big planet with changeable climate.

References

[1] Bowring, S.; Housh,T. (1995). "The Earth's early evolution". *Science* 269(5230):1535–40.

[2] M Woolfson (2000). "The origin and evolution of the solar system". *Astronomy & Geophysics* 41(1):1.12.

[3] Zellik, M. 2002. *Astronomy: The Evolving Universe,* 9th ed. UK: Cambridge University Press.

[4] Cuixiang Zhong. "Formation and Evolution of the Solar system as well as Expansion of the Universe and Global Climate Change". Journal of Earth science and Engineering 4(2014):544-557.

[5] Dalrymple, G. Brent (2001). "The age of the Earth in the twentieth century: a problem (mostly) solved". *Geological Society, London, Special Publications* 190(1):205–21.

[6] Jane S. Greaves. (2005). "Disks around Stars and the Growth of Planetary Systems." *Science* 307(5706):68-71.

[7] Yin, Qingzhu; Jacobsen, S.B.; Yamashita, K.; Blichert-Toft,J.; Télouk, P.; Albarède, F. (2002). "A short timescale for terrestrial planet formation from Hf-W chronometry of meteorites". *Nature* 418(6901):949–52.

[8] X.P. Mao. (2012). "Let students understand the problem of satellite orbit transfe r through instance calculation". Physics Teacher, 33(4):53 (inChinese).

[9] Zhang San-hui.(2008). *University Physics—Mechanics, Thermodynamics*. Beijing: Tsing hua University Press (in Chinese).

[10] Astrobio. (2012). "Titanium Paternity Test Says Earth is the Moon's Only Parent." University of Chicago. ttp://www.astrobio.net/pressrelease/4673/titanium-paternity-test-says-earth-is-the-moons-only-parent (*accessed* October14, 2012).

[11] Oppenheimer, Clive. (2003). "Climatic, environmental and human consequences of the largest known historic eruption: Tamboravolcano (Indonesia) 1815". Progressin Physical Geography, 27(2):230.

[12] Cuixiang Zhong. Cause of Global Climate Change and ts Computation [C]. Proceedings of the 5th Global Conference on Global Warming", Peking University, Beijing, China, 2014.