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# Quantitative Study of Lunisolar Precession Mechanism

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## Abstract

**According to Xiaodong Song *et al.*'s study about difference rotation in the Earth's inner core, a physical model of lunar motion changing the angular momentum of the Earth's circles is presented in this work. The Lunar motion makes there be a huge gap existing in the core angular momentum between far lunar hemisphere and near lunar hemisphere. The gap results in the difference rotation in the Earth's inner core, meanwhile, it increases the angular velocity of far lunar hemisphere and decreases the angular velocity of near lunar hemisphere. The Earth's liquid outer core generates an astro-geodynamical effect including the difference rotation among the Earth's circles. It is found that when the moon moves into the apogee or the perigee of the lunar orbit, and the moon phase is the upper and lower chords (*i.e.* semi-diameter place), the true anomaly of the moon will change from 270-degree back (or forward) to 90-degree; this results in the mantle shell of the Earth westward, and forms lunisolar precession, the vernal equinox westward and Chandler polar motion.**

## Keywords

**Lunar Motion, Lunisolar Precession, Intersection Westward, Chandler Polar Motion, Formation Mechanism**

## 1. Introduction

Formation mechanism of lunisolar precession and lunar orbit nodes regression is still a scientific conundrum. According to difference rotation research achievements presented by Song Xiaodong *et al*. for the earth's inner core, the author puts forward a physical model of "lunar orbit motion changing angular momentum of various circles of the earth". Due to the mass of earth-moon system which is located inside the earth as well as liquid state characteristics of the earth's outer core, it is deemed that angular momentum of all circles of the earth can be varied by lunar orbit motion so that a huge gap is generate between angular momentums of far and near lunar hemispheres of the core. In addition, difference rotation is also formed for the core (solid inner core and liquid outer core). Considering that conservation of angular momentum of the earth, mantle crust westward is caused together with lunisolar precession and spring equinox westward. It is found that inner core of the earth wavers inside the liquid core along with lunar orbit motion to change the location of the earth's center of mass. When

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elliptical orbit motion of the moon enters a place near the sun or the earth (that is, semi-diameter place), true anomaly of the moon changes from 270˚ back (or forward) to 90˚. This results in lunar orbit nodes westward and Chandler polar motion. Such a finding has a significant meaning to explain the formation mechanism of lunisolar precession and spring equinox westward. Profound implications in the "Greatness in Simplicity; Rare Voice of Big Sound" said by Lao Tzu in Tao Teh King and the "Heaven and earth have made great beauty, four seasons have clear without proposed, does not talk contribution has everything" given by Zhuangzi can be experienced.

## 2. Two Important Findings from Chinese Scholars

The case that the earth revolves around the sun for a round can be divided into a sidereal year and a tropical year. Similar to the earth, revolution of it around the earth forms a sidereal month or a synodic month. If the moon revolves for 360˚ around the earth, it is referred to as a sidereal month, which is the actual cycle of moon revolution equal to 27.3216 days. The sidereal month regards fixed stars in astrospace as its directional signs. In the case that it is calculated according to phase variation cycle of the moon, for example, a cycle from crescent to crescent or full moon to full moon, it is named as the synodic month with a length of 29.5306 days. "revolution orbit plane for the moon moving around the earth is also known as the plane of moon's path which does not coincide with the ecliptic plane; otherwise, an inclination of 5˚9' is formed by them and it is known as obliquity of the moon path. If these two planes intersect with each other to form a straight line, this line is named as nodal line. In addition two nodes exist between the nodal line and the celestial sphere. ... When it moves through a node from the south of ecliptic to its north, one is an ascending node while the other is descending node." "One critical feature of nodes is that they keep moving (westward) with a cycle of 18.6 years; moreover, they move for 19˚21 each year. The time required by the moon to move through the node for the second time is 27.21222 days, known as a nodal month." "The moon rotates around the earth in an elliptical orbit and the earth is situated at a focus. Time interval for the moon to pass perigee between two times is an anomalistic month which is equal to 27.55455 days. ... Perigee of the lunar orbit also keeps moving with a cycle of 8.85 years." [1].

Chen Guoxian from Natural Disaster Prediction Committee of the Chinese Geophysical Society thoroughly studies lunar orbital motions with an aim to predict geo-hazards. In his opinion, "the length of lunar orbit (motion) cycle is decided by the location of the earth's orbit corresponding to perigee of the moon; from the perspective of mathematical meaning, such a length is defined by elliptical eccentricity; that is, it is formed by elliptical focus changes specific to the center of the circle (Earth)". The range of movement lies between O and O' or Q and Q′, which are all focuses of the elliptical, in a bilateral symmetry manner, as shown in **Figure 1**. According to Chen, what is noteworthy is that when perigee of the lunar orbit appears near upper or lower chord, anomalistic month cycle with only more than 24 days is shortened; however, when it is next to the location of synodic month, cycle of an anomalistic month is extended to be 29 days. That is a difference of nearly 5 days at the maximum." In addition, he also found that, "projection curves of the moon on ecliptic are not coincident at the end and beginning of a year, as presented in **Figure 2**. In detail, it is 90˚ ahead each year and that is 360˚ after 4 years when phase retrieval of the moon takes place" [2]. During the study on Earth's polar motion, Song Guanyi, a research in Hebei Seismological Bureau, finds that, "among positions where the earth is located during its revolution at all seasons, reverse motion for pole of rotation (the north pole) occurs from November 1 of the year

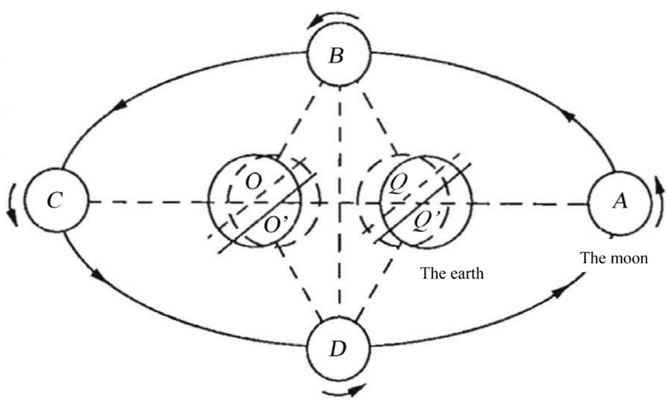


**Figure 1.** The length of the orbit of the Moon.

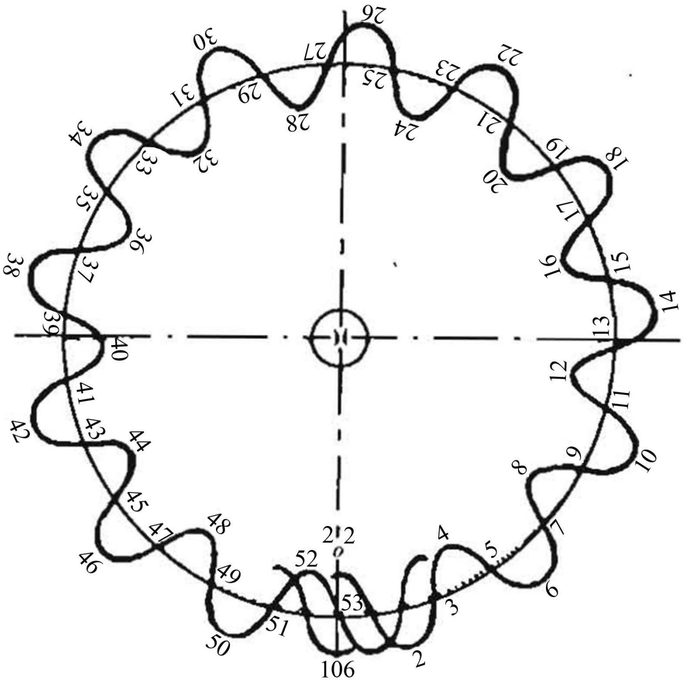


**Figure 2.** Projection of the Moon's orbit in the zodiac.

(the date when winter begins is November 7 or 8) to February 15 of the next year (the spring-beginning-day is February 4 or 5); other time (season) is the forward movement period (from west to east) of the rotational pole" [3]. Why time for forward and reverse motion (polar motion) of rotational pole is differentiate in terms of the earth's Chandler polar motion? As it's known to all, the reverse motion only takes place from November 1 of the year to February 15 of the next year.

Findings of Chen & Song are very significant without any doubt, because a research orientation is provided for researches on lunisolar precession, lunar orbit node westward and Chandler polar motion mechanism.

## 3. Physical Model of Lunar Motion Changing the Angular Momentum of the Earth's Circles

"According to research accomplishments of inner core difference rotation published in 1996 by Song Xiaodong *et al*., it is estimated that the inner core of the earth rotates 1.1 more degrees from west to east than the outer core each year. From 1990 to 1996, it rotates 1/4 more circle accumulatively, which attracted attentions from international academia and is evaluated as one of the global top ten scientific news of 1996." "People are aware that as no prominent changes occur to fast axis of centrosphere within a short term if compared with the inner core, ... causes for such variations are obvious differences that exist in rotation speed between centrosphere and the whole earth. Therefore, as long as variation rules with time of the fast axis of inner core can be mastered, the different rotation rate between inner core and other solid circles such as the crust mantle is determined" [4]. In line with inner core difference rotation research accomplishments achieved by Song Xiaodong *et al*., the author puts forward a physical model of "Lunar Motion Changing the Angular Momentum of the Earth's Circles". Dynamic mechanism of difference rotation of the earth's inner core is studied on one hand; while on the other hand, the result of an annual increase of 0.000286˚ in spin velocity of inner core is figured out [5]. It is substantially different from inner core difference rotation research accomplishments published by Song Xiaodong *et al*. in 1996, according to which, the inner core of the earth rotates 1.1 more degrees from west to east than the outer core every year. In August 2012, an article titled with "Rotation Speed of Centrosphere Increases by 1 Degree Every Millions of Years" was reported by CERNET. Depending on it, "as far as scientists are concerned, the rotation speed of centrosphere is higher than other regions of the earth and it is 1 degree faster every millions f years. ...In addition, it is pointed out that they have accurately worked out the rotation speed difference between entrosphere and other regions for the first time. In fact, the rotation speed of centrosphere is far lower than previous predictions about 1 degree increase every millions of years" [6]. We hold the opinion that, although the difference rotation mechanism of inner core and the specific degree of increase fail to be defined ultimately, such a peculiar finding has an important significance as it is able to provide extremely favorable opportunities and approaches to understand the earth's interior dynamic process.

Why the rotation speed of the earth's inner core exceeds other regions of it? In conformity with research findings of predecessors, a physical model of lunar motion changing the angular momentum of the Earth's circles is presented. **Figure 3** is a schematic plot for the moment of inertia of the earth's circles; among which, O, O' and O'' are centers of mass of centrosphere, earth-moon system and the moon. The center of mass and radii of the earth and the centrosphere (including liquid outer core and solid inner core) are as follows respectively.

$$M_{ear} = 5.976\times10^{24}\,kg,\quad R_d = 6.371\times10^{6}\,m;$$

$$M_{dh} = 1.882\times10^{24}\,kg,\quad R_{dh} = 3.48\times10^{6}\,m;$$

Moment inertia of the whole earth and the centrosphere (including inner core and liquid core) are shown below.

$$I_d = \frac{2M_{ear}\cdot R_d^2}{5} = 9.7\times10^{37}\,kg\cdot m^2;\quad I_{dh} = \frac{2M_{dh}\cdot R_{dh}^2}{5} = 9.12\times10^{36}\,kg\cdot m^2;$$

Then, angular momentum of the mantle crust is $I_{mq} = I_d - I_{dh} = 8.79\times10^{37}\ \text{kg}\cdot\text{m}^2$;

The average distance from earth-moon system to the earth's core can be expressed as $R_{ec} = \overline{OO'} = 4671\text{km}$. The moon rotates on celestial sphere elliptically along the moon's path; while the center of mass of the earth also remains at a narrow elliptical motion in liquid core. In the light of our survey, during the centrosphere rotating around earth-moon center of mass, the centrosphere is categorized into far and near lunar hemispheres respectively by treating rotation axis of the earth's core as boundary. Based on the equation for the center of mass, for a hemispheroid with a uniform distribution radius Rdh for its spherical symmetric mass, the location of its center of mass is: $R_{dhbc} = \dfrac{\int_0^{R_{dh}}\int_0^{\pi}\int_0^{\pi} r\cdot r^2\cdot Sin\theta d\varphi d\theta dr}{\int_0^{R_{dh}}\int_0^{\pi}\int_0^{\pi} r^2\cdot Sin\theta d\varphi d\theta dr} = \dfrac{3}{4}R_{dh} = 2.61\times10^{6}\,m$; is the distance from the center of mass of both far and near lunar hemispheres to the center of mass of the earth. Then, the linear velocity for center of mass of the far lunar hemisphere rotating around O, the common center of mass for the earth-moon system from west to east can be expressed as $V_{dhby} = (R_{ec}+R_{dhbc})\cdot\omega_{yq} = 19.38(m/s)$. Where, $\omega_{yq} = 2.66\times10^{-6}\,\text{rad/s}$ refers to the angular velocity of the earth and the moon revolving around O' that serves as the center of mass of the earth-moon system. In comparison, the velocity for the center of mass of the near lunar hemisphere from west to east is $V_{dhbj} = (R_{ec}-R_{dhbc})\cdot\omega_{yq} = 5.486(m/s)$ (velocity of the center of mass for both far and near lunar hemispheres is in an identical direction). If geocenter is used as a reference point, difference of angular momentum between far and near lunar hemispheres can be figured out as follows.

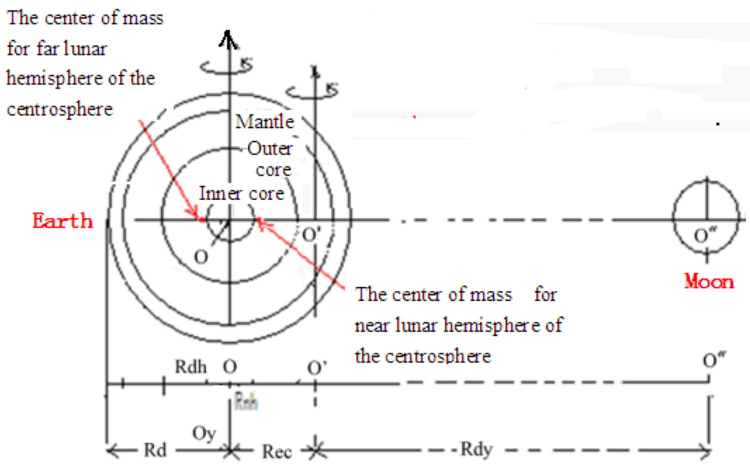


**Figure 3.** The moment of inertia of the Earth, the Earth's core and the Earth's inner core.

$$dL_{dh} = 1/2\, M_{dh}(V_{dhby} - V_{dhbj}) \cdot R_{dhbc} = 3.41312 \times 10^{31}(kg \cdot m^2 \cdot s^{-1})$$

Kinetic equation for earth rotation is presented below. $\frac{\mathrm{d}\boldsymbol{L}}{\mathrm{d}t} + \boldsymbol{\omega} \times \boldsymbol{L} = \boldsymbol{M}_{wlj}$

Where, $\boldsymbol{L}$ refers to the angular momentum and $\boldsymbol{M}_{wlj}$ to the external torque suffered from. If $dL_{dh}$ the difference of angular momentum between far and near lunar hemispheres of centrosphere, does not vary with changes in time, no mechanical effect can be induced. For example, in the case that the earth is solid, the difference $dL_{dh}$ of angular momentum between far and near lunar hemispheres of centrosphere does not vary with changes in time, which thus fails to give rise to any mechanical effect. In practice, when orbital motion of the earth-moon system around the sun, due to effects of tide generating forces from both the sun and planetary, "the shape of lunar orbit also changes, which is reflected in the variation of orbital ellipse eccentricity within a range of 1/15-1/23; moreover, the average value of them is 0.0549" [2]. If the eccentricity reaches its mean value, the earth-moon distance approximately changes from $R_{dyj} = 3.5641 \times 10^8 (m)$ to $R_{dyy} = 4.067 \times 10^8 (m)$. Such a phenomenon indicates that the position of the center of mass of the earth-moon system is variable. Computational formula for such a position is $R_{ecj} = (M_{yq} / (M_{yq} + M_{dq})) \cdot R_{dyj}$.

Then, in the case of the moon being located at perigee or apogee, distances from the center of mass of the earth-moon system to the geocenter are respectively worked out below. $R_{ecj} = 4.3297 \times 10^6 (m)$; $R_{ecy} = 4.94 \times 10^6 (m)$

On this basis, when centrosphere is at the perigee of the moon, linear velocity for the center of mass of the near lunar hemisphere rotating around the center of mass of the earth-moon system can be written into the following formula.

$$V_{dhbcj} = (R_{ecj} - R_{dhbc}) \cdot \varpi_{yq} = 4.57737 (m/s)$$

By contrast, when centrosphere is at the apogee, such a linear velocity can be expressed as follows.

$$V_{dhbcy} = (R_{ecy} + R_{dhbc}) \cdot \varpi_{yq} = 20.0975 (m/s)$$

The velocity direction of far lunar hemisphere from west to east is identical to that of earth rotation, while it is against the direction of earth rotation as far as the near lunar hemisphere is concerned. Linear velocity caused by earth rotation at $R_{yhbc} = 2.61 \times 10^6 m$; $V_{dhbc} = R_{dhbc} \cdot \omega_{dq} = 189.81 .m/s$; in this equation, $\omega_{dq} = 7.292 \times 10^{-5}$ $\mathrm{rad/s}$; denotes angular rate of earth rotation; plus linear velocities for the center of mass position of far and near lunar hemispheres, incurred by orbital motion of the moon, the rotation linear velocities for the center of mass of the far/near lunar hemisphere are shown below.

$$V_{dhbcy} = 209.902 (m/s);\ V_{dhbcj} = 185.227 (m/s)$$

Consequently, the difference of angular momentum between far and near lunar hemispheres of the centrosphere can be calculated in line with the below formula.

$$dL_{dhbyjc} = 1/2\, M_{dh}(V_{dhbcy} - V_{dhbcj}) \cdot R_{dhbc} = 6.06147 \times 10^{31}(kg \cdot m^2 \cdot s^{-1})$$

With regard to the comparison between $dL_{dh}$, the difference of angular momentum for far and near hemispheres calculated based on the average distance from the center of mass of the earth-moon system to the geocenter, and $dL_{dhbyjc}$ which is the difference calculated according to the distance from perigee to apogee for angular momentum for movements along with the earth and the moon orbits, there exists a giant gap. Through computing, the following equation can be acquired.

$$dL_{dhc} = dL_{dhbyjc} - dL_{dh} = 2.64835 \times 10^{31}(kg \cdot m^2 \cdot s^{-1})$$

It indicates that during orbital motions from perigee to apogee, angular momentum of the earth's centrosphere circle is increased thanks to the orbital motion of the moon. Such a momentum makes the rotation of centrosphere (both the inner core and the liquid core) accelerated, giving rise to shaking of the earth's axis so as to form polar motion and nutation. The increase in rotation of the centrosphere (both the inner core and the liquid core) is $d\omega_{dh} = (dL_{dhc} / I_{dh}) \times 180/\pi = 0.000166405°$; for each round. Therefore, the physical model of "lunar motion changing the angular momentum of the Earth's circles" presented by us has the capability to not only explain difference rotation among circles of the earth, but interpret lunisolar precession and spring equinox westward together with ascending node westward for lunar orbit as well as the excitation mechanism of Chandler polar motion.

## 4. Quantitative Calculations for Lunisolar Precession and Equinox Westward

As the angular momentum of the earth's circles changes during the orbital motion of the moon, it is dynamic, transient and accumulative. For example, on January 1 of 2013, through astronomical year book consulting and computing, the earth-moon distance of the day is $R_{dyi} = 4.3054\times10^{8}(m)$; in accordance with the computational formula for the center of mass, $R_{eci} = (M_{yq}/(M_{yq}+M_{dq}))\cdot R_{dyi}$. Therefore, the distance from the center of mass of the earth-moon system at this position to the geocenter is $R_{eci} = 5.2314\times10^{6}(m)$ on one hand; on the other hand, at this position, linear velocity for the near lunar hemisphere center of mass of the centrosphere that moves around the center of mass of the earth-moon system is written as $V_{dhbcji} = (R_{eci}-R_{dhbc})\cdot\varpi_{yq} = 6.9773(m/s)$. However, linear velocity for the far lunar hemisphere center of mass moving around the center of mass of the earth-moon system is $V_{dhbcyi} = (R_{ecy}+R_{dhbc})\cdot\varpi_{yq} = 20.8714(m/s)$. Furthermore, the velocity of far lunar hemisphere rotating from west to east has a direction identical to the earth rotation, while as far as the near lunar hemisphere is concerned, its velocity like this is against earth rotation. Linear velocity caused by earth rotation is $V_{dhbc} = R_{dhbc}\cdot\omega_{dq} = 189.81.m/s$ within a distance of $R_{yhbc} = 2.61\times10^{6}m$; plus the linear velocity at the center of mass for far and near lunar hemispheres of centrosphere incurred by orbital motion of the moon, rotation learn velocities of the center of mass of far/near lunar hemisphere can be gained and they are

$$V_{dhbcyi} = 210.676(m/s);\quad V_{dhbcji} = 182.8272(m/s);$$

espectively. As a result, on January 1 of 2013, the difference of angular momentum between far and near lunar hemispheres of centrosphere is also the angular momentum increment of the centrosphere on this day, which is expressed below.

$$dL_{dhi} = 1/2\,M_{dh}(V_{dhbcyi}-V_{dhbcji})\cdot R_{dhbc} = 6.8411\times10^{31}(kg\cdot m^{2}\cdot s^{-1})$$

According to the law of conservation of angular momentum, it is assumed that friction coefficient between liquid core of the earth and mantle crust is zero, centrosphere angular momentum of the earth system rises, so that angular momentum of both mantle and crust of the earth is negative. In other words, mantle crust moves westward which is against the direction of earth rotation. Hence, an equation of $\mathrm{I}_{dh} * \mathrm{W}_{dq} + dL_{dhi} + \mathrm{I}_{mq} * \mathrm{W}_{mqi} = 0$ is obtained and dynamic angular velocity of the earth's mantle crust is given below.

$$\mathrm{W}_{mqi} = -\left(\mathrm{I}_{dh} * \mathrm{W}_{dq} + dL_{dhi}\right)/\mathrm{I}_{mq} = -8.3217\times10^{-6}(s^{-1})$$

Considering that the angular momentum of centrosphere is both dynamic and accumulative, angular momentum increment of it at the beginning of a year is set to be the initial value (on January 1 $dL_{dhiz} = 0$) which is zero. By annual angular momentum increment accumulation, we can obtain.

$$dL_{dhiz} = dL_{dhiz} + \mathrm{dL}_{dhi}$$

Matlab is adopted to establish a program to simulate orbital motions of the sun, the earth and the moon; in addition, accumulations of mantle crust's dynamic angular moment during their orbiting within a year are computed (please see **Figure 4** pictured above). In this figure, the red ball in the middle represents the sun, pozidriv cross recessed Pozi stands for the earth (pozidriv cross recessed Pozi can be employed to observe seasonable variations of the earth; the bold line in black is the earth motion trajectory on the north of ecliptic plane; the green asterisk with a solid ball in the center (e.g., *10/1) is the approximate time and date when the moon if at perigee). Moreover, the law of conservation of angular momentum of the whole earth is applied to calculate the dynamic angular velocity accumulations for the earth's mantle crust which is described as
$\mathrm{W}_{mqiz} = -\left(\mathrm{I}_{dh} * \mathrm{W}_{dq} + dL_{dhiz}\right)/\mathrm{I}_{mq} = -2.6\times10^{-4}(s^{-1})$

Then, angular displacement within one year of the mantle crust westward is also figured out as follows. $\mathrm{J}_{mqiz} = \mathrm{W}_{mqiz}\cdot(180/\mathrm{pi}) = -53.69''$ ("/Year). (See **Figure 4** Pictured Below)

"Equinox westward has an average velocity of 50.24''/year and such a velocity is referred to be the precession of equinox" [7]. For **Figure 4** (pictured below), the physical model of lunar motion changing the angular momentum of the Earth's circles is adopted to calculate the annual phase difference of angles westward and such a difference can be denoted as $\mathrm{J}_{mqwc} = -50.24'' - 53.69'' = 3.64''$/year. Reasons for the occurrence of the above situation are the liquid state of earth's outer core. According to findings of Song Guanyi, "among positions

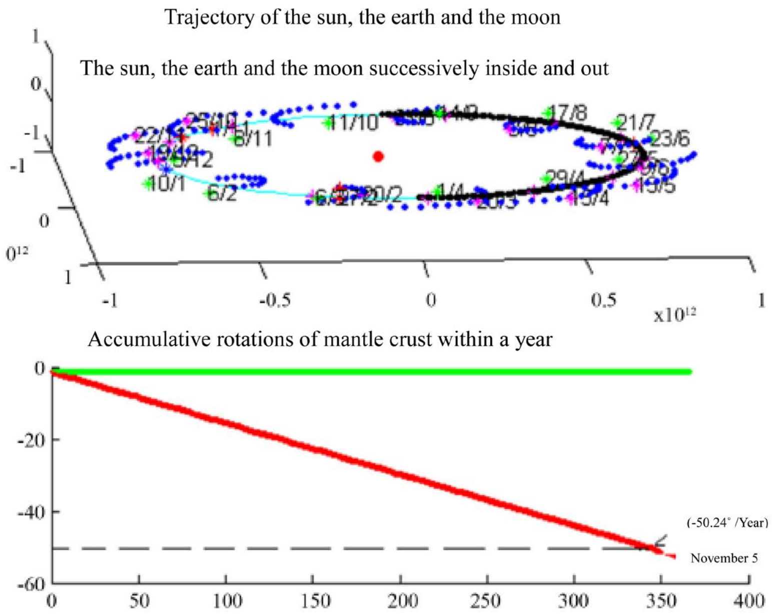


**Figure 4.** The Earth takes the Moon around the Sun (pictured above) and calculation chart of the accumulative rotation angle of the mantle crust for a year (pictured below).

where the earth is located during its revolution at all seasons, reverse motion for pole of rotation (the north pole) occurs from November 1 of the year to February 15 of the next year". Then, combining calculation chart for the annual accumulative intersection angle (second of arc) of the earth's mantle crust given in **Figure 4** (pictured below), the author deems that viscosity property of the earth's liquid outer core makes all circles of the earth rotate forwardly from the beginning of a year to November (the earth's mantle crust) of this year. When elliptical motion of the moon approaches perihelion or perigee, it is very likely that there exists a physical mechanism (under the action of a certain factor) that makes the earth rotation pole (the North Pole) rotates inversely; consequently, the increased angular momentum of centrosphere is released through mantle crust westward (just as the angular momentum conservation principle makes figure skating athletes open their arms to stop spinning). Hence, lunisolar precession and equinox westward take place. Meanwhile, moon orbit node westward and Chandler polar motion also occur. In addition, the corresponding excitation mechanism requires being further studied.

## 5. Formation Mechanism Study on Lunisolar Precession and Chandler Polar Motion

According to findings of Chen, "the (motion) length of the orbit of the moon is determined by the location for earth's orbit specific to the perigee of the moon"; "projection curves of the moon on the beginning and the end of the year on ecliptic does not coincide with each other, as presented in **Figure 2**; it is 90˚ ahead each year and that is 360˚ after 4 years when phase retrieval of the moon takes place".

Song Guanyi finds that, "among positions where the earth is located during its revolution at all seasons, reverse motion for pole of rotation (the north pole) occurs from November 1 of the year to February 15 of the next year; other time (season) is the forward movement period (from west to east) of the rotational pole." On this basis, it is found that, when inner core moves along with orbit motions of the earth and the moon, under the joint actions of solar wind and the moon orbit motion which change the angular momentum of centrosphere, it also wavers in the liquid core so as to alter the position of the earth's center of mass. (Please refer to **Figure 1**, The length of the orbit of the moon). On about November 5 of the year when elliptical motion of the moon approaches perihelion and perigee, its elliptical motion arrives at semi-latus rectum phase of about the $12^{th}$ round (upper/lower chord), because this phase is the radius vector in the case of true anomaly $f = 90˚$ or $270˚$ and the radius vector of $P = a\cdot(1-e^2)$ [1] is equal. Plus liquid state of the earth's outer core and the angular momentum conservation, the pole of rotation (the North Pole) moves inversely (that is, a motion westward against mantle crust) so that angular momentum of centrosphere decreases sharply and automatically returns to zero on a day around the winter solstice. In the next year, the moon orbit motion starts to increase angular momentum for the centrosphere.

Synergic orbit motions of the sun, the earth and the moon within one year can be described as follows. Under the joint action of solar wind and the moon orbit motion changing the angular momentum of centrosphere, solid inner core wavers in the liquid core so that the location of the center of mass is altered. At the same time, the orbit motion of the moon makes angular momentum of centrosphere go up continuously so as to accelrate the rotation of liquid core. As angular speeds of revolution formed between the liquid core and the moon, and the center of mass of the earth-moon sytem, are equal, a phenomenon of "projection curves of the moon on the ecliptic with 90˚ forward each year" appears in terms of the moon orbit motion. When the earth-moon system approaches the winter solstice location near the perihelion or the perigee, true anomaly for orbit motion of the moon revolution changes from f = 270˚ back (or forward) to f = 90˚. As a result, the phenomenon discovered by Song Guanyi occurs (Please refer to **Figure 5**, True near point of lunar elliptical orbit by f = 270˚ back to f = 90˚). In fact, in this time interval, true anomaly of the moon's elliptical motion can be deemed to move forward 180˚ from f = 270˚ to f = 90˚; during this period, angular momentum of the centrosphere goes down abruptly and reaches zero in the end. In the next year, angular momentum of will be risen due to the orbit motion of the moon. Furthermore, when the moon's orbit motion completely enters a semi-latus rectum phase of f = 90˚, it passes into the start site for increase in angular momentum to make the "reverse rotation of the pole of rotation changed into forward kinemation". The semi-latus rectum phase of f = 90˚ is a critical phase giving rise to Chandler polar motion. Cycle length for orbit motion of the moon passing through such a phase twice successively is the cycle of Chandler polar motion. Reverse motion of the pole of rotation (the North Pole) reflects that mantle crust westward (relative to centrosphere) occurs as the earth abides by the law of conservation of angular momentum to form lunisolar precession and spring equinox westward as well as other phenomena such as anniversary and Chandler polar motion, etc.. In consistency with findings of Chen Guoxian, the author deems that, due to synergic motions of the sun, the earth and the moon in the solar system, orbit motion of the moon makes the angular momentum of centrosphere go up continuously so as to accelerate the rotation of liquid core; on every November when the earth and the moon moves to perihelion or perigee, true anomaly for elliptical motion of the moon goes back to f = 90˚ from f=270˚ back and automatic zero resetting adjustment takes place once for the angular momentum of the earth on perihelion. As it moves forward 90˚ each year and that is 180˚ for two years, "bi-aanual quasi-periodic variation" occurs to the earth rotation rate [8].

## 6. Conclusions

(1) When the earth takes the moon rotating around the sun, orbit motion of the moon changes angular momentum of the earth's circles so that a giant gap exists between angular momentum of far and near lunar hemispheres. As a result, not only is difference rotation formed, but give rise to shaking of the earth's axis as well as polar motion.

(2) Orbit motion of the moon causes angular momentum difference for far/near lunar hemisphere and increases the angular momentum of centrosphere. Due to angular momentum conservation of the earth, mantle crust westward takes place to form lunisolar regression and equinox westward.

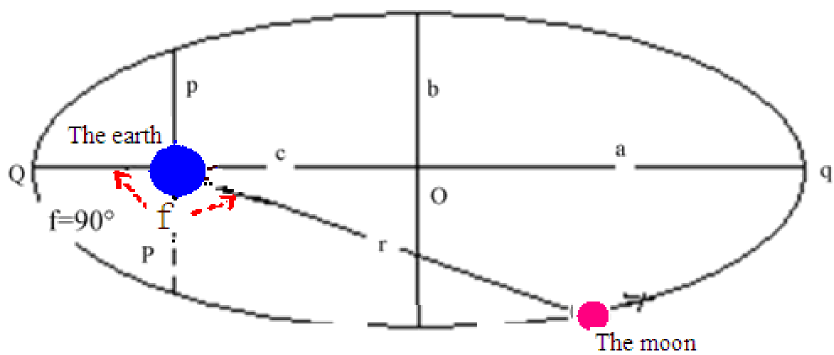


**Figure 5.** True anomaly of lunar elliptical orbit by f = 270˚ back to f = 90˚.

(3) It is found that when elliptical motion of the moon approaches perihelion or perigee (that is the semi-latus rectum phase), true anomaly for elliptical orbit varies (moves forward) to f = 90˚ from f = 270˚ back and automatic zero resetting adjustment takes place once for the angular momentum of the earth in perihelion. As it moves forward 90˚ each year and that is 180˚ for two years, "bi-aanual quasi-periodic variation" occurs to the earth rotation rate. Power producer for the earth's 1.2 years of Chandler polar motion is deemed to come from the moon, while from the sun as far as its annual polar motion is concerned.

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