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A Tidal Theory Based on the Inertial Motion of the Matter in the Universe

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Abstract

Newton's theory of gravity has difficulties in attributing the explanation of the Earth's tidal phenomena. The reason is that Newton's gravitational law is statistically a mathematical form but not an essential description for the phenomena of matter motion in the universe. The current movement of matter in the universe is the inertia left over due to early collision history. The elliptical motion of planets relative to the Sun, the elliptical motion of the Moon relative to the Earth, the elliptical energy distribution of the Earth's oceanic and atmospheric fluids relative to the Earth's axis and their variations are all manifestations of inertial motion, which are legacy products of previous material interactions, particularly from an early orthogonal collision. This inertia tidal theory shows that the most obvious semidiurnal tide and the half-monthly (spring-neap cycle) tide in oceans are oval distributions of fluid inertial motion energy relative to the Earth's axis, and the annual tide component is the inertial expression of the Earth's elliptical motion associated with the Sun's revolution. The tidal phenomena in Earth's fluids have nothing to do with gravity, but rather are an energetic manifestation of the inertial motion of fluids on a planetary scale.

Keywords

Tidal Theory, Gravity, Inertial Motion, Orthogonal Collision, Legacy Product

1. Introduction

Tides are a natural phenomenon varied a temporal rhythm that can be directly observed on Earth, such as the regular change in the height of seawater near the coast with time. Tidal phenomena are not only the content of marine scientific research [1] [2], but also the content of solid Earth scientific research [3] [4] and

the content of atmospheric scientific research [5] [6]. The oceanic tidal origin has been a subject of continuous investigation for over 2000 years. Patricius is understood as a direct predecessor of Kepler in the theory of tides, a hundred years before Newton [7]. The work of Newton is considered as the beginning of the true understanding of the phenomenon, in which ocean tides are the result of gravitational force. After his universal theory of gravitation published in 1687, he described in his "*Principia Mathematica*" how the tides arose from the gravitational attraction of the Moon and the Sun on the Earth.

At the beginning of the 20th century, Einstein explained tides as the effect of mass-energy distribution and space-time curvature [7]. In dynamical theory, all works have not left the framework of Newtonian gravity [8]. Common oceanography textbooks adopt a non-inertial reference frame fixed to the Earth in which the fictitious centrifugal force appears [9] while a misconception is considered an age-old problem [10]. Historically, Johannes Kepler in 1609 suggested that the gravitation of the Moon causes the tides. However, Galileo Galilei in 1616 wrote *Discourse on the Tides.* He strongly and mockingly rejects the lunar gravitational theory of the tides, and tries to explain the tides as the result of the Earth's rotation and revolution around the Sun [11], which ignored the Moon's influence [12]. Therefore, tides are a natural phenomenon that objectively exists and has a long history of research, but it is a phenomenon that has not yet been explained in essence in terms of formation mechanism.

Indeed, the whole issue of tidal effects is non-trivial, and many earlier books either oversimplified or wrongly presented the issue. In 1972, Godin published his book *The Analysis of Tides* [13], summarized the celestial origin of tidal forces, the development of the tidal potential, and the main features of ocean tides with some statistical methods based on classical mechanism. Currently, the US NOAA website summarized the following facts about ocean tides based on the textbooks of three authors [14] [15] [16]. Six facts are indicated by italics and then following is an interpretation from each item.

1) *One cycle of tides actually takes* 24 *hours and* 50 *minutes*. One cycle of tides is the largest energy fluctuation (geopotential energy change with time) in the phenomenon of planetary-scale regular motion of Earth's oceanic fluids. This time interval roughly expresses the daily cycle that is prevalent in tides. Strictly speaking, it is not caused by the thermal and dynamic forcing of the Sun but is close to the rate of the Earth's rotation of 24 hours per day. This tidal component may be an inertial motion related to the rotation of the Earth. The surface tidal lag relative to the Earth's rotation and the Moon's moving lag relative to the Earth's rotation show that the farther away from the Earth's axis, the relatively longer the period of inertial motion.

2) *The highest tides occur when the Moon is new or full.* The time interval when the highest tide level occurs has a cycle of nearly lunar half a month (14 days) or so. On the lunar calendar, the highest tide occurs at the beginning and in the middle of a lunar month, which is related to the position between the Moon and the Earth, but it is not completely consistent. In most places, the

highest tides usually occur a day or two days after the new or full Moon. The lunar monthly changes in tide levels that do not exactly coincide with the positions of the Moon and the Sun can raise doubts about the theory of gravitational tides. The mechanism of tidal vibration at the lunar half-monthly scale (the spring-neap cycle) needs to be studied.

3) *High tides sometimes occur either before or after the Moon is straight overhead*. Because of the Earth's rotation, tidal bulge precedes the Moon by about 3 degrees. This fact is tantamount to telling people that the high tide and the Moon's arrival at the zenith are misaligned, implicitly suspecting the direct gravitational force relationship between the ocean tide and the Moon. Perhaps, the Earth's tides have their own laws of operation.

4) *Twice a month, the difference between high tide and low tide is at its smallest. These tides are called neap tides.* For twice a month neap tides, the difference is minimal. The amplitude of semidiurnal tide is changed from a spring-tide period (or a neap-tide period) to next one observed at a place. The dynamic reasons for this difference are not well explained by the gravitational pull of the Sun and Moon.

5) *Some places have only one high tide and one low tide in a cycle* (24 hours and 50 minutes). The coast of a diurnal tide is limited to the western Pacific Ocean, while the coastal extent of semidiurnal tide and mixed semidiurnal tide is larger over the world ocean. The greatest causes of tide variation are the topography of the local shoreline and the bathymetry (the profile of the depth) of the ocean floor. Therefore, the dynamic interpretation of the semidiurnal tide is a key component.

6) *The maximum tidal bulge will usually be either above or below the equator*. This is a fact observed from standing above the Earth's North Pole, expressing two phenomena. One is that two maximum bulges form an ellipse on the Earth's tropics. Another is that the largest semidiurnal tide elevation is near the Earth's equator, not in the plane of the Moon's revolution. This fact once again suggests that the Moon's gravity is not the essential origin of tides. The Earth's tides have their inherent laws.

The above gives many tidal facts which can enough doubt about the causes of gravitational tides. In addition to the annual cycle of tides, the two key components of Earth's tides are the semidiurnal cycle and the lunar half-monthly cycle. Standing above the north and south poles of the Earth, the shapes of the semidiurnal tide and the lunar half-monthly tide are periodic variations in the oval geopotential height (potential energy) of the Earth's fluids relative to the Earth's axis. The purpose of this paper is to first negate the dynamical theory of the Earth's fluid tides which is based on the Newtonian gravity and then dynamically reconstructs a new theory of the Earth's fluid tides as a manifestation of its own inertial motion. Section 2 reviews traditional Newtonian tidal force. Section 3 astronomically describes the evolution history of the formation of the Earth-Moon system in terms of the inertial motion of matter in the universe. Section 4 gives the dynamics of the formation of the Earth-Moon system. Section 5 uses

this dynamical result to explain the formation of tides in Earth's fluids, including the ocean tides and atmosphere tides. Finally, conclusions and discussion of this article are given in Section 6.

2. Gravitational Tide Theory

Tidal dynamics is to explain the tidal bulge of planet's peripheral fluid shape varied with time and space by a combined method from mathematics and physics. Tidal variations of the oceans are on the order of few meters. The connection between the Moon's repeated appearance in the sky and tidal phenomena on the ocean has received widespread attention in human history. Since the discovery of Newtonian mechanics, the theory of the lunar gravity for the origin of tides has emerged. We start to examine the theory of gravitational tides, which is presented in many physical oceanography textbooks and technology websites.

In Figure 1, there are four objects in a universal system. The largest object is the Earth with its mass N. The second largest object is the Moon with its mass M. In addition, there are two small solid objects or oceanic fluid parcels A and B with their mass m located on the surface of the Earth. The distance from the center of the Earth to the center of the Moon is R. The distance from the parcel A or the parcel B to the center of the Earth is the radius r of the Earth. Since they are all in a straight line, we only consider the plus and minus signs of gravity, with positive to the right (pointing to the Moon) and negative to the left.

If seawater or oceanic fluid parcels A and B have their unit mass of 1, they on the Earth's surface are subjected to the gravitational pull of the Moon, so they have gravitational acceleration,

$$a_g = G\frac{M}{(R \mp r)^2} = G\frac{M}{R^2(1 \mp r/R)^2}. \tag{1}$$

Expanding the series $\frac{1}{(1 \mp r/R)^2} = 1 \pm 2(r/R) + 3(r/R)^2 \pm \cdots$, Equation (1) becomes,

$$a_g = G\frac{M}{R^2} \pm G\frac{2M}{R^2}\frac{r}{R} + \cdots. \tag{2}$$

Among them, the first term is the gravitational pull of the Moon on the unit mass of the Earth's centroid parcel (or object) and the second term is considered as the gravitational difference of the parcel A (or B) related to the Earth's

Figure 1. There are four objects in a universal system. The distance between the Earth's centroid and the lunar centroid is R, and the distance between the oceanic fluid parcel A (parcel B) and the Earth's centroid is (Earth's radius) r.

centroid parcel caused by the Moon,

$$\Delta a_g = \pm 2rG\frac{M}{R^3} = \pm GD\frac{M}{R^3}. \quad (3)$$

where $D = 2r$ is the diameter of the Earth and G is the gravitational constant. This gravitational difference is proportional to the diameter of the Earth and inversely proportional to the third power of the distance between the Earth and the Moon. This result is the same as showed by an analog of freely falling laboratory model [10]. If it is used as a gravitational tide force, then at the point A, the gravitational tide force is directed towards the Moon, which can explain the increase in the water level at the point A facing the Moon. At the point B, the gravitational tide force is turned away from the Moon, which can explain the rising water level at the point B away from the Moon. This seems to explain the natural phenomenon of the semidiurnal tide. The gravitational tide force on surrounding surface sides of the two points A and B gradually decreases but has a horizontal component.

Theoretically, the two points A and B are equilibrium points forced by the Moon's gravitational force. There are two types of tidal theories namely equilibrium theory and dynamic theory. The former predicts that each day there will be two high and two low tides as shown in **Figure 1**, which does not consider the effects of topography and many other factors. The latter considers other factors, so the tides are much more complicated and variable from place to place. Surrounding surface sides of the two points A and B, oceanic fluid parcels have vertical and horizontal periodic (half day) displacement components, but the magnitude of the displacement is locally small. The effect of the Coriolis force on tidal patterns should be ignorable. In fact, equilibrium theory is depended on dynamic theory.

For the above dynamic theory, the derivation from gravitational Equation (1) to consequential Equation (3) is mathematically misleading in the explanation of tidal phenomena. In Equation (3), because R is large, $r \ll R$, and because the gravitational constant G is small, the term Δa_g is small compared with the Earth's gravitational acceleration on the Earth's surface, so it is difficult to explain the tidal phenomenon through Δa_g.

The above gravitational tide force can also be considered as the difference between the Moon's gravity acted on the point A (or B) and the Moon's average gravitational pull on the solid Earth. Another idea is that the solid Earth has an overall centripetal (or centrifugal) force in motion. The centripetal (or centrifugal) force is inward (or outward) to the Moon in direction. Thus, the tide forces at the points A and B are the difference (resultant force) between the centripetal (or centrifugal) force and the Moon's gravity. Two opposite resultant forces at the points A and B can also explain the phenomenon of seawater bulges on both sides. However, the resultant force is too small to cause the observed tidal phenomenon.

In fact, the gravitational difference in Equation (3) is not a tidal force. Using it

as a tidal force is a physical misdirection derived by the mathematical series expansion. In Figure 1, following the above mathematical derivation, the acceleration of parcels A and B caused by the gravitational pull of the Moon is,

$$a_{gA} = G\frac{M}{R^2} + 2rG\frac{M}{R^3}, \tag{4}$$

$$a_{gB} = G\frac{M}{R^2} - 2rG\frac{M}{R^3}. \tag{5}$$

In Equation (3), the term Δa_g is not the gravitational tide force rather that is the gravitational force difference of parcels A and B relative to the Moon on the Earth's central parcel or object. The central point of the Earth as an isolated object without considering other solid and magmatic layers is impossible for Newton's gravity.

The Earth's gravitational pulls on the oceanic fluid parcels A and B are,

$$g_A = -G\frac{N}{r^2}, \tag{6}$$

and

$$g_B = G\frac{N}{r^2}. \tag{7}$$

Thus, combined results of the parcel A and parcel B being affected by the gravitational forces of the Earth and the Moon are, respectively.

$$\Delta g_A = -G\frac{N}{r^2} + \left(G\frac{M}{R^2} + 2rG\frac{M}{R^3}\right) < 0, \tag{8}$$

and

$$\Delta g_B = G\frac{N}{r^2} + \left(G\frac{M}{R^2} - 2rG\frac{M}{R^3}\right) > 0. \tag{9}$$

Since $R \gg r$, $N \gg M$, the gravitational force in parentheses is much smaller than the Earth's gravitational pulls on the parcels A and B. At the same time, this differential force cannot explain the phenomenon of time and space advance or leading and lag of high tide.

Similarly, as shown in Figure 1 for the two seawater parcels, Figure 2 is used to examine the two air parcels A and B.

The Moon's gravitational pull on the unit mass of air parcel A is,

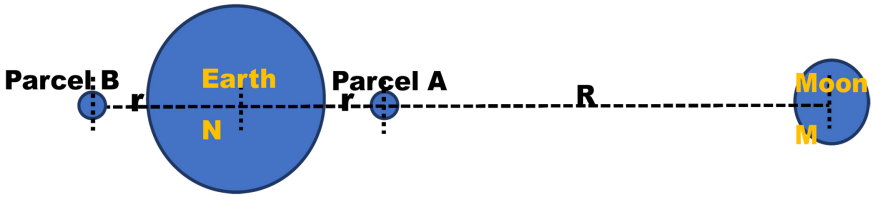

Figure 2. Similar as in Figure 1, only except that the two air parcels A and B. The distance R is from the air parcel A to the center of the Moon, and the distance r is from the air parcel A or the air parcel B to the center of the Earth. The mass of air parcels A and B is set to 1.

$$F_{AM} = G\frac{M}{R^2}. \tag{10}$$

The Earth's gravitational pull on the unit mass of air parcel A is,

$$F_{AN} = -G\frac{N}{r^2}. \tag{11}$$

The Earth's gravitational pull on the unit mass of air parcel B is,

$$F_{BN} = G\frac{N}{r^2}. \tag{12}$$

The unit mass of air parcel A is subjected to the sum of the gravitational forces of the Earth and the Moon,

$$F_A = -G\frac{N}{r^2} + G\frac{M}{R^2} < 0. \tag{13}$$

Since $r \ll R$, $N \gg M$ and the above equation is less than zero, the air parcel A is mainly affected by the gravity of the Earth, and it is difficult to form a bulge higher than the sea level but tends to sink.

The unit mass of air parcel B is subjected to the sum of the gravitational forces of the Earth and the Moon,

$$F_B = G\frac{N}{r^2} + G\frac{M}{(R+2r)^2} > 0. \tag{14}$$

Because the gravitational pulls of the Earth and the Moon in the same direction, the superposition of the Moon's gravity makes air parcel B more inclined to sink downwards the sea level. The air parcel B has a greater tendency to sink downwards to the Earth's center than the air parcel A. The combined effect of the Moon's gravity and Earth's gravity on the air parcel A or the air parcel B makes it difficult to explain the raised tidal phenomenon. Under Newton's gravitational framework, Equations (13) and (14) make sense. However, Equations (8) and (9) are misled by the mathematical derivation of series expansion so that the result is meaningless. The above results are valid on the premise that gravity must be a real force.

Dynamically, if the gravitational action of the Moon is not considered, the matter (or parcel) on the Earth's surface is subjected to the following inertial forces,

$$\boldsymbol{F}' = -m\boldsymbol{g} - 2m(\boldsymbol{\Omega}\times\boldsymbol{v}) - m\boldsymbol{\Omega}\times(\boldsymbol{\Omega}\times\boldsymbol{r}) - m\mathrm{d}\boldsymbol{\Omega}/\mathrm{d}t\times\boldsymbol{r}. \tag{15}$$

Here, m is the mass of an object (parcel). $g = GN/r^2$, N is the mass of Earth, G is the gravitational constant, $\boldsymbol{\Omega}$ is the rotating angular velocity of the Earth, $\boldsymbol{v}$ is the velocity of the object (parcel) relative to the rotating Earth, $\boldsymbol{r}$ is the position vector of the object (parcel) relative to the Earth' center. In Equation (15), the term $-m\boldsymbol{g}$ is the force on an object (parcel) acted upon by Earth's gravitational force, the $-2m(\boldsymbol{\Omega}\times\boldsymbol{v})$ is the Coriolis force, the term $-m\boldsymbol{\Omega}\times(\boldsymbol{\Omega}\times\boldsymbol{r}')$ is the centrifugal force, and the term $-m\mathrm{d}\boldsymbol{\Omega}/\mathrm{d}t\times\boldsymbol{r}'$ is the Euler force indicating the variation of $\boldsymbol{\Omega}$ with time.

The last three terms at the right-hand side of Equation (15) are all related to the Earth's rotation $\boldsymbol{\Omega}$. The Earth's rotation $\boldsymbol{\Omega}$ is originated from the formation of the Earth so the last three terms are inertial forces. The first term is also an inertial force. The magnitude of the last two terms is small, and only the second term is something we can feel. When considering a fluid parcel per unit mass, the Coriolis force is,

$$\boldsymbol{F}_C' = -2\left(\boldsymbol{\Omega}\times\boldsymbol{v}\right). \tag{16}$$

For the periodic semidiurnal tide, the seawater parcel speed $\boldsymbol{v}$ is locally too small in open ocean. The Coriolis force is passive force in the Earth's fluid motion.

3. The Formation of the Earth-Moon System

The origin of tides on Earth involves the formation of the Earth and the Moon. We must first know, how did the Earth and the Moon form? What is the relationship between them? Are changes in tides related to gravity? Is the Moon's rotation around Earth also related to gravity? Therefore, we need to know, what is the nature of gravity?

Newton was worried about why an object can act on another distant object through a vacuum without any medium to transmit action and force from one to the other. He panicked at the explanation of the nature of gravity because it can be very well used in practice, but it is absurdly explained in theory. Without knowing the nature of gravity, Newton was the first to quantitatively describe the relationship or the law between two objects with a statistical constant G [17]. People benefit from this statistical equation in their daily lives and in scientific research. This statistical equation also drove the Industrial Revolution. Einstein also did not recognize gravity, and his great contribution was to eschew a direct description of an unjustified gravity instead of using the idea of general relativity and the method of geometric mathematics. Newton's gravitational formula (or law) has only a mass variable and a distance between two objects. Einstein's equations include distributions of spacetime for not only the mass of many objects, but also the energy (rotation) of all objects. Newton described a world of two objects, while Einstein described a world of many objects. But they still belong to the same gravitational worldview, except that they describe the world with different methods of mathematics.

In the gravitational worldview, the relationship between things in the world is that large objects attract small objects, which can be described by Newton's statistical mathematics and Einstein's geometric mathematics. Numerous small objects are passively attracted by large objects. Einstein used mass-energy distribution and space-time curvature to attract cosmic matter. In fact, the relationship of attraction only occurs within a system. We propose a new worldview called the inertial worldview. This worldview is an alteration from the passive attraction of many small objects in the system by large objects into the active convergence of many objects to the center of their system. The convergence route and

destination come from inertial motion, which is the traces left by the transformation of two worlds (or universes) happened after a collision.

Under the inertial cosmology, the current Earth-Moon system, the current solar system, and the current Milky Way are still in the process of inertial motion, which is the traces left by the transformation of two different universes. Along these traces, one can trace the past state and look to the future state from the present state. How do we trace to the past state from the present state? The current Moon can be seen as the result or event of the convergence of past inertial movements of matter. To see the event and process, two cases of "universal system" evolution are given in the following paragraph.

The two cases showed that there are four spiral rain bands around a strong tropical cyclone (super typhoon or super hurricane) and there are also four spiral nebular belts around the center of the Milky Way. Their similarity in structures was investigated [18]. The four spiral rain bands converge to the center of the typhoon, and the adjacent two spiral rain bands are orthogonally converged (collided). Orthogonal collisions between air parcels form shear stresses, *i.e.*, huge energy density and new moving directions of new matter are formed. This energy density is infinitely higher than the sum of the energies of the original air parcels. Two moving directions of new matter are perpendicular to the horizontal movement of the original air parcels. Almost all extreme weather events are the result of vertical convective motion transforming from the horizontal convergence of abnormal atmospheric motion. However, no one in dynamics has given how the horizontal force vector is converted into a vertical force vector in the motion of the Earth's fluids. The vertical shear stress is exactly what is needed for the development of severe weather in the center of tornadoes and abnormal weather in the center of typhoons. The transformation of energy and direction during orthogonal collisions is the transition between the old and new worlds, as well as the formation of new state of matter [19]. The inner and outer structure of a black hole and the transition between the old and new worlds are the same as those described above by typhoons [18].

The eye of typhoons and the event horizon of black holes are orthogonally interactive result of material motion in two different cases [18]. Similarly, the Moon can also be seen as the result of solar system evolution. We can find traces left on the Moon during the convergence of matter in the last stage of solar system. Since the formation of solar system, the Earth has undergone tectonic movements such as horizontal continental drift and vertical orogeny. The Moon is much smaller in size and mass than the Earth. The lunar surface does not have the Earth-like structure. There is no atmospheric fluid or oceanic fluid on the surface of the Moon but obvious traces of planetary-scale material convergence at the lunar polar area, as well as traces of local-scale volcanic activity and small celestial impacts left since its early formation. **Figure 3** is a topographic image of the Moon's south polar surface, with red dotted arrows roughly indicating traces left by the convergence of planetary-scale material. To understand these traces

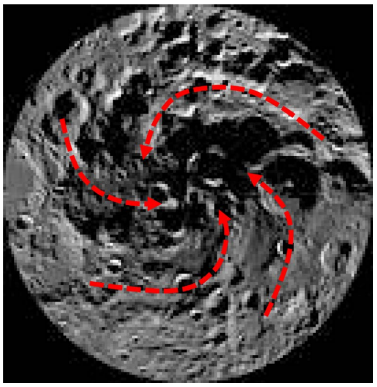

Figure 3. Image of the lunar south pole topography. The red dotted arrows roughly indicate the traces left behind when the substance converges in motion.

left one needs to see many backward steps. One backward step is if the Moon are shattered and radiated in the opposite direction, the spatial range of this material (debris) would expand to an accretion disk, like the four spiral nebula belts around the Milky Way galaxy and four spiral rain bands around a super typhoon. This accretion disk coincides with the current equatorial plane of the Moon's rotation.

Similarly, one can crush the Earth and distribute its debris on the accretion disk of the Earth's rotation equator. The Earth is formed by the convergence of multiple spiral nebulae material (debris) bands on the accretion disk. The angle between the accretion disk of the Earth and the accretion disk of the Moon is the same as that of the current equatorial plane of the Earth and the current equatorial plane of the Moon. This basic feature of evolution can be speculated from the forming process of black holes [20].

We go on the trace backwards: why are the Moon and Earth one system? We know that 99% of the mass in the solar system is concentrated on the Sun, and 99% of the angular momentum occurs on the planets of the solar system. One assumption is that all planets, moons, and small celestial bodies of the solar system are smashed and sprinkled on the current plane of the planet's orbit [17] [21]. The inertial motion of these crushed nebulae material relative to the Sun is like the motion of Saturn's rings relative to Saturn. However, on this plane of nebular material motion rotating around the Sun, their velocity around the Sun gradually decreases from the Sun, which is consistent with the current decrease in the velocity of planets relative to the Sun. This reduced velocity distribution causes fluctuations of matter.

Figure 4 is a schematic diagram of the fluctuation of velocities on the material bands of nebulas around the Sun. Among terrestrial planets, Mercury's velocity shear band A is located innermost, forming many eddies or vortices of material motion that turn left. On the outer side of Mercury's material shear band, there is the Venus material shear band B, which forms many right-turning vortices of

material motion. In the C space interval band, many left-turning vortices of material motion are formed there, where are also vortex belts of material motion formed for the Earth family (Earth and Moon) and the Martian family (Mars and its two Moons). These material motion vortices form lots of rotating planetary embryos. On an interval nebula material motion shear band, only one or several planetary embryos can be maximally developed to become the last planets. In the interval band A, the shear of these nebula vortices is the angular momentum of their rotation. When this part of the angular momentum is concentrated on a large developing embryo, Mercury is formed on the shear band A. The direction of Mercury's rotation consists of the angular momentum of all nebular embryos in this interval band. In the interval band B, one embryo finally developed into Venus which rotates in the opposite direction to Mercury.

In the interval band C, this wider shear band is divided into two parts. The area close to the Sun is reserved for the Earth-Moon family, and the area far from the Sun is given to the Martian family. Angular momentum and planetary embryos on the Earth-Moon family region are assigned to the Earth embryo and the lunar embryo. They form an Earth-local vortex and a lunar-local vortex, respectively. All the embryos on the lunar-local vortex eventually converged on the Moon in Figure 3, determining the size and direction of rotation of the Moon. All the embryos on the Earth-local vortex converged on the Earth, determining the size and direction of rotation of the Earth. The Earth and Moon are in a common shear zone of nebular material motion, which determines that they have approximately the same rotation direction and a common center rotated. Since the formation of the Earth and the Moon is intrinsically linked, so that the Moon presents only one face toward the Earth. The rotation of the Earth and the Moon, rotating each other (the Moon looks likely around the Earth) and the common orbit around the Sun, form a three-level velocity distribution. The Martian family also has a similar distribution of rotation, rotating each other,

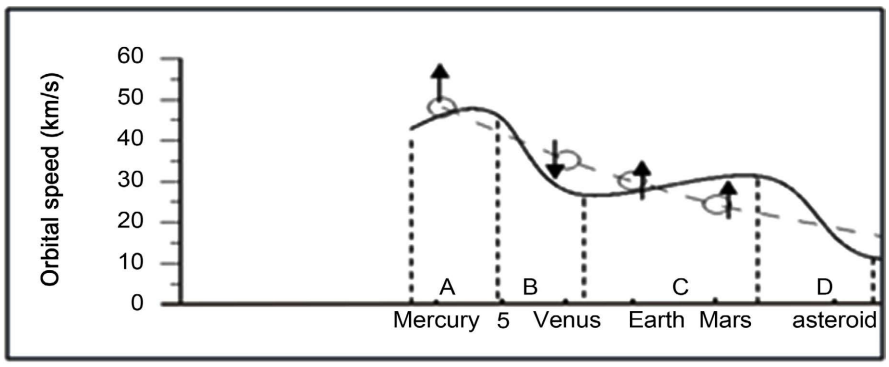

Figure 4. The orbital speed (vertical y-axis, km/s) and distance (horizontal x-axis, $x = 3\ln(10R)$) of each planet (hollow circle) relative to the Sun ($x = 0$). The letter $R = 1$ astronomical unit (15,000,000 km) is the distance between the Sun and the Earth. The long dashed line connects the locations and orbital speeds of planets relative to the Sun while the black-solid curve line indicates the wave-like velocity distribution of nebula motion. Black-dashed vertical lines separate different shear bands (A, B, C, and D) of nebula ellipse rings. Arrows denote different directions of planet rotation [17] [21].

and orbital velocity as the Earth family. Therefore, the Earth family and the Martian family have the same rotation direction, but approximately the opposite direction of rotation to neighboring Venus. On the asteroid band D, the larger asteroids that form there should rotate in the opposite direction to the Earth and Mars.

The above description is a reversal from the motion of present terrestrial planets to the early state, and then from the past state to the present state. This is a trace of inertia material motions from the initial state to the modern state or vice versa under the inertial worldview. The conditions before the formation of the solar system and before the shear band of material velocity distribution for the nebula in Figure 4 are unknown. At that time, it experienced the interaction (collision) of abnormal matter velocities and experienced a transition from the old universe to the new universe. According to the traces and inertia left behind after the collision, in the same universe, we can trace the early cosmic distribution, but we cannot know everything before the collision.

4. Dynamics of the Earth-Moon System Formation

Newton was good at using statistical mathematics to describe the dynamical relationship but not physical causality between two objects in the universe. Einstein's geometric mathematics could hardly describe the dynamical relationships between materials in the universe, but he was good for describing the linkage of phenomenology. In the left part of the interval band C in Figure 4, a large vortex is formed. This large vortex splits into two small vortices (*a* and *b*). The rotational centripetal forces of two vortexes (*a* and *b*) are, respectively,

$$\boldsymbol{F}_a = \frac{m_a}{r_a} v_a^2 \boldsymbol{n}_a , \tag{17}$$

$$\boldsymbol{F}_b = \frac{m_b}{r_b} v_b^2 \boldsymbol{n}_b . \tag{18}$$

where the term $\frac{m}{r} v^2 \boldsymbol{n}$ is a mass centripetal force with mass m and velocity v at the $\boldsymbol{n}$ direction.

Considering that two vortices collide with each other under the action of centripetal forces,

$$\boldsymbol{\tau}^{a,b} = \left(\frac{m_a}{r_a} v_a^2 \right) \cdot \left(\frac{m_b}{r_b} v_b^2 \right) \cdot \left(\boldsymbol{n}_a \times \boldsymbol{n}_b \right) . \tag{19}$$

where r_a and r_b are the moving radius of two vortexes, the direction of shear stress $\boldsymbol{\tau}^{a,b}$ is perpendicular to the plane formed by two-unit vectors $\boldsymbol{n}_a \times \boldsymbol{n}_b$. After a collision, the shear stress modulus is,

$$\tau = \left(m_a v_a^2 \right) \cdot \left(m_b v_b^2 \right) \sin\theta / r^2 . \tag{20}$$

where θ is the angle between two directions $\boldsymbol{n}_A$ and $\boldsymbol{n}_B$. The shear stress modulus can be seen as the density of mass-energy product (or mass-energy density for simply) formed by the collision of two vortexes, which is distributed in a new

area r^2. We study a new cosmic system left behind by the collision consisting only of two objects (the Earth and the Moon). The state or information of matter of the old universe was lost when the formation of this new universe. By this collision the shear stress modulus or the new mass-energy density τ is determined and associated with the mass-energy term $m_E v_E^2$ of the Earth and the mass-energy term $m_M v_M^2$ of the Moon. The Earth has a speed v_E in the sky. It orbits around the center of Earth-Moon system, around the center of solar system, and around the center of the Milky Way galaxy. Thus, the mass-energy term $m_E v_E^2$ of the Earth varies over time following its orbital path.

From Equation (20), we have only considered the orthogonal (angle 90 degrees) collisions, *i.e.*, to see how the mass-energy density is when $\sin\theta = \sin\left(\frac{\pi}{2}\right) = 1$. Then, we move the Earth's mass-energy term $m_E v_E^2$ to the left-hand side,

$$\tau \Big/ \left(m_E v_E^2\right) = \left(m_M v_M^2\right) \Big/ r^2 . \tag{21}$$

We take the ratio of the shear stress modulus τ (or the total mass-energy density) of the system to the mass-energy term $m_E v_E^2$ of the Earth as $K = \tau \Big/ \left(m_E v_E^2\right)$. We can consider that this ratio does not change with time, or changes over time. Thus, we have,

$$Kr^2 = mv^2 . \tag{22}$$

where r is the distance of Moon relative to the Earth, m and v are the mass and velocity of Moon, respectively. We now have a relative coordinate system for the movement of the Moon on the Earth. Considering that the mass of Moon does not change, in the above formula, K and r and v are change over time. To find the derivative of time, it has,

$$r^2 \frac{\mathrm{d}K}{\mathrm{d}t} + 2Kr\frac{\mathrm{d}r}{\mathrm{d}t} = 2mv\frac{\mathrm{d}v}{\mathrm{d}t} . \tag{23}$$

If the ratio K does not change with time ($\frac{\mathrm{d}K}{\mathrm{d}t} = 0$), then the above equation is,

$$Kr\frac{\mathrm{d}r}{\mathrm{d}t} = mv\frac{\mathrm{d}v}{\mathrm{d}t} . \tag{24}$$

The trajectory formed by the change of two variables v and r with time t is an ellipse. Equation (24) shows that the Moon has the shortest elliptic radius and the slowest velocity when it is closest to the Earth (at perigee). When the Moon is farthest from the Earth (at apogee), it has the longest ellipse radius and the fastest velocity. When the Moon is at perigee or at apogee, changes in radius length and velocity with time are zero, so that the Moon are at two special locations on the ellipse. As the Moon moves from perigee to apogee, the radius r increases with time t, namely $\mathrm{d}r/\mathrm{d}t > 0$. The closer to apogee, the result shows the larger $r\mathrm{d}r/\mathrm{d}t$ and the faster speed v and the larger $v\mathrm{d}v/\mathrm{d}t$. The Moon returns from apogee to perigee in the opposite tendency. The Moon's path is an elliptical orbit under Newtonian gravity. Under this limit, the Moon orbits to meet the

Kepler's second law, sweeping out the equal area within the ellipse in the equal time interval. This relationship or the Kepler's second law is correctly described in Equation (24). The above description shows that simplifying the inertial theory in this paper can lead to the traditional Newtonian theory of gravity and the Kepler's second law.

If the radius of Moon's orbit around the Earth is constant, namely $\frac{\mathrm{d}r}{\mathrm{d}t}=0$, we have $\frac{\mathrm{d}v}{\mathrm{d}t}=0$, the Moon traveling around the Earth is an exact circle. If the ratio K changes over time but is a constant, namely $\mathrm{d}K/\mathrm{d}t=C$, then Equation (23) becomes,

$$K\frac{\mathrm{d}r^2}{\mathrm{d}t}-m\frac{\mathrm{d}v^2}{\mathrm{d}t}=-r^2C. \tag{25}$$

This constant C at the right-hand side of Equation (25) acts with the Moon's distance r squared relative to the Earth, which causes the position of the ellipse at the left-hand terms to drift over time. The long axis of the ellipse changes with r (the distance between a planet and the Sun and/or between the Moon and the Earth). Also, the coverage or the long/short radius of the lunar ellipse is changed over time with C. Therefore, $-r^2C$ is a core term for the drift of Moon's closest point (perigee) and farthest point (apogee) relative to the Earth. Obviously, when this core term is zero or $C=\mathrm{d}K/\mathrm{d}t=0$, The Moon's perigee (apogee) does not drift. In Equation (25), the ellipse shape of Moon's path is theoretically changed with r so that its path is an eccentric ellipse. It is known that the Moon's orbit (or the Earth's orbit) is an eccentric ellipse (or pear-shaped orbit) with a varying apogee and perigee (or perihelion and aphelion). The above description shows that the relative motion relationship between the Earth and the Moon is very complex, but the dynamics are clear.

It is well known that there is the precession of the perihelion of Mercury when it orbits to the Sun [22]. Also, there are the precession rate of the Earth-Moon system relative to the Sun and a precession of the lunar orbit relative to the Earth [23] [24]. Since the Earth's orbital velocity around the Sun varies, so does the Moon's orbit. In addition to the rotation of the Moon, there are other three-level motions: 1) an elliptical motion relative to the center of the Earth-Moon system (rotation around the Earth) and the precession caused by them, 2) an elliptic orbit around the Sun with the Earth and the precession caused by them, and 3) the movement of the Sun around the center of the Milky Way and the precession caused by them. The elliptical motion of the Moon relative to the Earth is characterized by the same as that of Mercury relative to the Sun [25]. In the multi-level environment of the Earth, the Sun and the Milky Way, the Moon's orbit also changes at different scales. Therefore, Equation (25) describes the elliptical path of the Moon changing, while Newton's gravity can only describe an average elliptical path of the Moon.

Equation (25) indicates that the Moon's orbit is an eccentric ellipse and not circular. From their formation process of planets and moons, the Moon does not

orbit at the Earth's equatorial plane. The Moon's declination effect means that its orbit is offset from the Earth's equator, orbiting at 5 degrees above and below the plane of the ecliptic from the observation. It is known that the Moon's orbit around the Earth has two different periods. The Moon's sidereal period of about 27.3 days is its orbit around the Earth measured by comparison of the Moon's motion to the fixed stars. The Moon's synodic period about 29.5 days, viewed from Earth as the phases of the Moon, is the Moon's orbit around the Earth with respect to the Sun. If there are several small natural satellites or small objects located between the Earth and the Moon, they all should have the two similar periods.

5. Tides in Earth's Fluids

The formation of the Earth began with a planetary embryo on the left side of nebulashear band C in **Figure 4**. In the vortex of the Earth embryo, all the other small embryos and interstellar material converge on the Earth embryo under their inertia. At first, the temperature of the Earth's embryos is low, and as the number of embryos is increased, the kinetic energy of embryos that are later gathered is converted into heat. At one time point, the central part of the Earth's embryo becomes a solid core, and the periphery becomes a molten magmatic fluid. When all the embryos and interstellar matter in this vortex have converged, the Earth is formed. At that time, the Earth was a planet with a molten surface, showing that it has only two circler layers: inner solid and outer magmatic layer (sphere). The deep layer is the Earth's magmatic fluid sphere. Through inertia and density separation, heavy matter and elements are lowered to the bottom layer of the magmatic fluids, and light matter and elements are floated to the surface of the magmatic fluids. The rotation of magmatic fluids around the Earth's axis creates elliptical motion. This elliptical motion comes from the overall result of the inertial motion of all embryos and matter that converge. This is the basic tide of the surface magmatic fluids. A series of other elliptical motions and precessions on the superposition give the magmatic fluid several components of different amplitudes of tides.

After the formation of the Earth, there was no other source of convergent material. The Earth began to cool, forming an outer crust. Oceanic fluids outside the Earth's crust and outermost atmospheric fluids also form. There is a magmatic fluid sphere between the solid core and the crust, and other two are an oceanic (or seawater) sphere and an atmosphere outside the crust. According to Equation (25), the farther away a seawater (or air) parcel from the Earth's axis should have the larger the elliptic range. Therefore, the elliptical major axis of atmospheric air motion is the longest, and the elliptical major axis of oceanic seawater motion is the second longest. Under inertial motion, air parcel and seawater parcel have all the elliptical motion characteristics and various motion periods as similarly occupied by the Moon.

The Earth fluids (magma, seawater, and air) differ from the Moon because the

latter can be seen as an isolated object that makes an eccentric elliptical motion relative to the Earth. The Moon's elliptical path is clearly with a perigee and an apogee. If magmatic fluids, oceanic fluids, and atmospheric fluids are also some isolated parcels, then their motions are also independent elliptical paths. But now they are continuous fluids, made up of infinite parcels. As a result, the Earth's fluid parcels together form a spherical shell of elliptical motion, reflecting the energy of fluid elliptical motion. This energy is reflected in the change in the kinetic energy of the horizontal motion of fluids and the change in geopotential energy in the vertical direction relative to the sea level (or geo-centricity). These fluid parcels have not moved along elliptical paths as moved by the Moon rather locally moved in a limited space. Thus, the elliptical (ellipsoidal) shape changes that occur in the movement of Earth's fluids are the tides.

The elliptical shape changes or tidal phenomena that occur in the Earth's fluids require space for movement. By Equation (25), the Earth's magmatic fluids are closest to the solid core of the Earth (the shorter r so the smaller elliptical shape domain), so that the amplitude of the magmatic tides is smaller than that of the tidal amplitudes in the oceans and atmosphere (the longer r so the larger elliptical shape domain). The tidal movement of the Earth's magmatic fluids is confined below the Earth's crust, affecting the propagation of tidal energy in the magmatic layer. However, there are still studies found that the tides in the Earth's interior trigger Earthquakes and volcanic activity [26] [27]. This local-scale vertical movement energy comes from large-scale horizontal energy transport through tidal waves and interaction with the above crust. By Equation (25), the atmospheric fluids are far from the Earth's axis so that the tidal amplitude is maximum. However, the atmosphere is heated differently from the Sun and the underlying surface, forming that atmospheric storm surge in amplitude is usually stronger than that of astronomical atmospheric tides. The movement of ocean fluids is limited only by the ocean basin, and the sea surface is a free surface. Therefore, astronomical tides in the ocean are the most regular and observable.

We now consider the trajectories of air and seawater parcels on the Earth's surface. As shown in **Figure 2**, the position r and velocity v of an isolated oceanic fluid parcel or an atmospheric air parcel on/over the Earth's surface relative to the center of the Earth also follow Equation (25). The distance from the oceanic/atmospheric fluid parcel on the Earth's equator to the Earth's axis is the largest, and the long axis of the elliptical motion of an oceanic/atmospheric parcel is the longest. At the point farthest from the elliptical axis, the air/seawater parcel has a maximum amplitude (high tide level). On the opposite side of the ellipse, the air/seawater parcel has a sub-large amplitude (sub-high tide level). This is the fundamental dynamic explanation of the semidiurnal tide of the Earth's oceanic fluids. The similar semidiurnal tide should appear in the atmosphere.

In addition to the semidiurnal tide described above, in $C = \mathrm{d}K/\mathrm{d}t$ and

$K = \tau / \left(m_E v_E^2 \right)$, there is an elliptical motion with the velocity v_E relative to the center of the Earth-Moon system, reflected in atmospheric and oceanic tides as the variable component of the lunar half-monthly cycle or the spring-neap cycle. There is an annual cyclical variation in the Earth's velocity v_E relative to the Sun's revolution, so there is a component of the annual cycle change in the atmospheric and oceanic tides. In addition, some elliptical movements produce precessions, so there are other low-frequency vibrations in the atmospheric and oceanic tides [28]. Thus, several major tidal components can be explained by dynamics in Equation (25).

6. Conclusions and Discussion

The gravitational force derived from Newton's statistical equations of gravity can roughly describe the space-time phases of the tides of Earth's oceans. Some phase locks of oceanic tide are synchronized with the position of the Moon relative to the Earth, such as two tides a day, relative and equilibrium tidal heights, and tidal dissipation and lengthening of day. These are superficial phenomena, not the essence of tidal formation. In the traditional tide equation derived from gravity, the magnitude of the gravitational tide force is not enough, and there are unexplained differences of tidal phases between theory and observation. A planet without moons can also have tides in its atmosphere. It is impossible to form four tidal peaks in the Martian atmosphere which are caused by two moons at the same time. It is also impossible for 2N (N is the number of moons) tidal peaks in the atmospheres of Saturn and Jupiter to occur at the same time. The difficulty in describing the observed tidal phenomenon suggests that the nature of gravity is an inertia remained in the motion of matter, which has not been understood for a long time. Newton's law of gravity is a statistically mathematical description of the inertial motion of the universe.

The most obvious two tidal components of the semidiurnal cycle and the lunar half-monthly cycle or the spring-neap cycle in the Earth's fluids (magmatic, oceanic, and atmospheric fluids) have nothing to do with the Moon. The tides that appear in Earth's fluids are derived from the inertial motion of matter at the beginning of the formation of planets. Each type of inertial motions determines a tidal component such as different-scale precessions. Other inertial forces such as the Coriolis force and the centrifugal force are too small for forming tide. The semidiurnal tide and the lunar half-monthly tide in the Earth's fluids are the space-time distribution of the inertial motion energy of the fluids relative to the elliptical ring of the Earth's axis of rotation. The annual tidal component is the result of the elliptical motion of the Earth relative to the Sun. Thus, attributing Earth's fluid tides to the Moon was a wishful thinking.

Since the energy (inertia) of the movement of the Moon and the energy (inertia) of the movement of the Earth's fluids come from the same origin, they have basically the same laws of motion. The only difference between them is a continuous fluid and an isolated object. Continuum mechanics is more convenient

for applying to Earth's fluids (magmatic fluids, oceanic fluids, and atmospheric fluids), such as that the Navier-Stokes equation can be used in the Earth's fluids. The inertial motion of convergence and divergence for the Earth' fluids can be described by continuum mechanics. Obviously, the predecessors have made good use of the movement law of the Moon relative to the Earth to understand and predict the tidal movement of the Earth's fluids. This article only explains the fundamental physics of the formation of the Moon and Earth's fluid tides. Equation (25) can be specifically applied to the calculation of the precession of the Moon relative to the Earth or to the calculation of the precession of the planets relative to the Sun. This precession is called the tide and needs to be introduced into the traditional geo-hydrodynamic equation. Tides are an energy source that came from the beginning of the Earth's formation and are a non-renewable resource. There is no direct contact or no momentum (energy) exchange between the Moon and Earth except for radiation. The direct relative motion between the Earth's fluids and the solid Earth is caused by the tidal friction, so the rotation speed of the solid Earth will slow down for a long time.

Orthogonal collisions generate new states of matter. The formation of the solar system is the product or traces of a material interaction (collision). Before and after the collision there are two different states of matter without any information exchange between them. The product after the collision is the inertia left since that time. Under inertia, objects can have new collisions and produce new states of matter, forming new inertia of matter. The Earth and Moon are the consequence of the aggregation of two adjacent vortex-material interactions (orthographic collisions) during the formation of the solar system. They belong to brotherhood. The Earth-Moon system and the adjacent Mars-satellite system are brothers on another level. These families of planets and moons have formation hierarchies and inertial motions, but they have no gravitational relationship. The observed phase relationship between the Earth's fluid tidal phenomena associated with the positions of Moon and Sun belongs to phenomenology, and the physical nature behind them needs to be studied.

For the mater relationship in the universe, the inertial motion and gravitational action come from two different worldviews. The inertial motion of matter is natural and active. The gravitational action of matter is passive and requires a medium to transfer force, such as graviton or ether as a medium. However, no graviton was found, and ether was rejected. Gravity is a human feeling. Newton and Einstein stood on the gravitational worldview and used statistical mathematics and geometric mathematics to describe the motion of matter. Einstein's theory of spacetime relativity did not fundamentally change Newton's gravitational worldview. The mathematical approach and physical idea to the inertial worldview are that orthogonal collisions between objects in the universe can revolutionize the world and leave behind the inertial motion of new matter. There are no statistical constants in the dynamical equations of matter motion under the inertial worldview, which can objectively and accurately describe and predict

natural phenomena.

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Conflicts of Interest

The author declares no conflicts of interest regarding the publication of this paper.

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