Principle of Natural Inertial Motion Evolution of Spatial Objects

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Abstract

Addressing the long-controversial problem of universal gravitation, this work discusses how the development of spatial objects from small entities to celestial bodies constitutes a natural evolutionary process characterized by the object' s moment of inertia (I). This characteristic of I is elucidated through three factors: time, path, and mass. Time accounts for the duration that the I-object has persisted from its small beginnings to the present. Path demonstrates that I is a naturally uniformly moving inertial object; however, during its motion, its inertial action in space generates an inertial-medium torque mediated by the spatial medium, and this torque, through the spatial medium, establishes a connection with another object and gradually forms an elliptical orbit. Mass accounts for changes in mass, as after I becomes associated with other objects, it gradually merges them, causing its mass to increase, and consequently I is correspondingly enhanced. The inertial balance equation for two spatially related celestial bodies is presented. The spatial equilibrium point of the two objects is solved from this equation. Through real data from the Earth-Moon system and equilibrium point data, the corresponding motion trajectories of both bodies are obtained, along with the ratio of rigid inertial force to inertial-medium force used to measure the degree of closeness between the two, as well as the acceleration principles of the two celestial bodies and their respective calculated acceleration values. Comparison proves the correctness of the inertial motion balance equation. This achievement will greatly promote further understanding of the inertial characteristics of the solar system.

Full Text

Preamble

This paper analyzes and verifies the long-controversial problem of gravitation, presenting corresponding conclusions. The law of universal gravitation posits that all objects possess mutual gravitational attraction, whose strength varies with mass and distance [?][?]. General relativity, in contrast, describes inter-object forces as resulting from spacetime curvature–a geometric effect [?]. Based on these divergent conclusions and starting from the primordial state of matter, we propose a natural evolution principle for spatial objects characterized by moment of inertia. The validity of this conclusion is demonstrated through analysis of the typical Earth-Moon system.

Spatial objects, from microscopic particles to planets and galaxies, all move in regular patterns. This regularity constitutes an inertial system that forms naturally, characterized by the object' s moment of inertia. This evolutionary process can be described by a conceptual integral formulation, where I represents the moment of inertia, denoting an object' s capacity for inertial motion; t represents the duration from microscopic beginnings to the present for celestial bodies; and o represents the inertial trajectory of I. Objects instinctively move at constant velocity through space, forming an inherited circular rotation only where spatial medium density achieves complete equilibrium–at which point the object is balanced and the medium is isotropic in all directions. During this trajectory, inertial momentum continuously generates medium vortices in the surrounding space, which interact with neighboring objects of similar properties. If both rotate in the same direction, the rotational flow induces mutual angular acceleration, gradually forming new trajectories. In other words, mutual inertial vortices produce corresponding accelerations, causing objects in uniform motion to acquire angular acceleration passively. According to the definition of rigid body torque [?]:

$$M(\text{torque}) = I(\text{moment of inertia}) \times \alpha(\text{angular acceleration})$$

This generates a spatial medium torque around rotating objects, termed **inertial medium torque**. Its magnitude is determined by medium density, the value of I, and the object' s velocity, while the strength of association depends on inter-object distance and the relative angle between rotation axes. For associated objects, inheriting previous trajectories is a natural attribute due to prior inertia and associated inertial medium torque. I exhibits strength hierarchies, and because connections are non-rigid, its additional function is for stronger objects to gradually incorporate weaker ones through inertial medium torque. The parameter m represents mass variation over time, which corresponds to changes in I. The inertial medium torque generated by I' s motion can incorporate associated objects, increasing their mass and inertia. Simultaneously, under combined action of external inertial medium torque and inherent inertial forces, objects gradually assume spherical shapes. After incorporating multiple objects, compression accumulates until high heat generation, luminosity, and thermal emission occur.

Thus, objects with I capability naturally move at constant velocity without energy consumption. The resulting inertial medium force, a product of constant-velocity motion interacting with other objects' inertial medium forces, becomes the means to incorporate other objects and strengthen itself. Evidence for inertial medium torque can be drawn from general relativity' s demonstration that distant starlight bends when passing the Sun—an abstract description of spacetime distortion caused by solar mass—proving that spatial medium generates directional vortices (inertial medium force) while balancing inertial objects.

Clearly, establishing balance equations using moment of inertia can determine equilibrium points between two objects, thereby deriving their degree of association, corresponding trajectories, and intrinsic characteristics. For two celestial bodies with masses M and m (idealized as solid spherical rigid bodies), we now formulate the balance equation, solve for equilibrium points, and present related applications.

3 Balance Equation

Consider two spatial celestial bodies with masses M and m, separated by distance p. Let H and h be the distances from the centers of mass of M and m to the equilibrium point, respectively, where $p = H + h$. Based on the solid spherical rigid body moment of inertia formula [**?**] and the parallel axis theorem [**?**], we have:

$$(IC + IH)T \times J = (ic + ih)t \times j$$

where IC and ic are the spherical moments of inertia of M and m about their own centers of mass; IH and ih are the parallel axis moments of inertia of M and m from their centers of mass to the equilibrium point; T and t are the rotation angles of M and m within a given period; and J and j are angular functions formed by the rotation axes of M and m with the normal to the line-of-sight plane.

Substituting variables yields:

$$2MR^2/5 + MH^2 = (2mr^2/5 + mh^2)t \times j/(T \times J)$$

Performing equivalent substitution of known data values to simplify this equation, if $M = x \times m$, $R = y \times r$, $z = t \times j/(T \times J)$, and substituting $h = p - H$:

$$2(x \times m)(y \times r)2 + 5(xm)H^2 = 2mr^2 z + 5mz(p^2 - 2pH + H^2)$$

Dividing by m and expanding parentheses after combining terms yields:

$$5(x - z)H^2 + 10zpH + 2(xy^2 - z)r^2 - 5zp^2$$

For this quadratic equation, applying the root formula where $b = 10zp$, $a = 5(x - z)$, and from the discriminant $\Delta = b^2 - 4ac$, we obtain the following conclusions with $c = 2(xy^2 - z)r^2 - 5zp^2$:

- $\Delta < 0$: No real roots; m lies within M and cannot appear
- $\Delta = 0$: Two overlapping roots, indicating M rotates only at its center of mass with a point equilibrium range
- $\Delta > 0$: Positive and negative roots define the equilibrium range between M and m at positive and negative points, where M rotates within a balanced range

From this, equilibrium points H_1 and H_2 can be solved, yielding various applications for the two-body system, as demonstrated below.

4 Earth-Moon Inertial System Example

Applying the theory to the typical Earth-Moon system, we formulate balance equations, solve for equilibrium points, and thereby determine Earth' s orbital trajectory around the Moon, the ratio coefficient between rigid and medium inertia, and the respective gravitational acceleration values for the Moon and Earth.

4.1 Determining Earth-Moon Trajectory

The equilibrium point domain of the Earth-Moon system lies along the Earth-Moon line (the lunar orbit) [**?**] as a dynamic point domain (to be determined). This point represents the dynamic balance of inertial medium torques between the two bodies and serves as the common point for the Earth-Moon system to balance within the solar system.

Let M and m be the masses of Earth and Moon, H and h the distances from Earth and Moon centers of mass to the equilibrium point, and p (average Earth-Moon distance) $= H + h$. During one 27.32-day period in the Earth-Moon system, Earth and Moon rotate through angles of $27.32\times 2\pi$ and 2π, respectively, giving $T = 27.32 \times 2\pi$ and $t = 2\pi$. The intersection angles between Earth' s and Moon' s rotation axes and the normal to the Earth-Moon distance plane range from $18.5° \sim 28.5°$ and $3.69° \sim 6.69°$, respectively. Using values of 27° and 6°, with Earth' s and Moon' s rotation axes as the hypotenuse of cosine, we have $J = 1/\cos(27°)$ and $j = 1/\cos(6°)$. Thus:

$$z = t\times j/(T\times J) = 2\pi\times\cos(27°)/(27.32\times 2\pi\times\cos(6°)) = \cos(27°)/(27.32\times\cos(6°)) = 0.032797$$

Given the known Earth-Moon mass and radius ratios: $M = 81.3m$, $R = 3.66r$, with lunar radius $r = 1737$ and average Earth-Moon distance $p = 384748$ (data from the National Earth System Science Data Center; distance in km, mass in kg, 下同). Substituting these ratios $x = 81.3$, $y = 3.66$ into equation (1):

$$a = 5(x - z) = 5 \times (81.3 - 0.032797) = 406.33$$

$$b = 10 \times 0.032797 \times 384748 = 126185.8$$

$$c = 2(81.3\times(3.66)^2-0.032797)(1737)^2-5\times0.032797\times(384748)^2 = 6571571992.4-24274867390 = -177032953$$

$$\Delta = b^2 - 4ac = 28789867809726, \sqrt{\Delta} = 5365619$$

Earth-to-equilibrium-point distances:

$$H_1 = (-b + 5365619)/(2 \times a) = 6447.69$$

$$H_2 = (-b - 5365619)/(2 \times a) = -6757.71$$

Corresponding Moon-to-equilibrium-point distances:

$$h_1 = 384748 - 6447.69 = 378301.31$$

$$h_2 = 384748 - (-6757.71) = 391505.71$$

Moon-to-Earth balance ratio values:

$$k_1 = h_1/H_1 = 378301.31/6447.96 = 58.68$$

$$k_2 = h_2/H_2 = 391505.71/(-1)6757.71 = -57.93$$

From these ratios, calculate the average positive and negative semi-major axes of Earth' s orbit around the Moon (using the Moon as reference frame):

$$g_+ = p(\text{average lunar semi-major axis})/k_1 = 384748/58.68 = 6556.54$$

$$g_- = p/k_2 = -6641.6$$

This yields the schematic diagram of Earth' s revolution trajectory around the Moon, shown in Figure 1 [Figure 1: see original paper].

4.2 Determining the Ratio of Rigid Inertia to Medium Inertia

Comparing measured versus theoretical (ideal) apogee and perigee distances for the Moon's orbit around Earth yields the ratio of rigid inertia to medium inertia. Using apogee as an example:

Measured apogee - measured mean value $= 406731 - 384748 = 21983$

From Figure 1, the total rigid eccentricity length is:

$$|g_+| + |g_-| = 6556.5 + 6641.6 = 13198.1$$

The ratio coefficient is:

$$j = 13198.1/21983 = 0.600377$$

Here, j quantifies the gap between inertial medium torque and theoretical rigid torque. Larger values (approaching 1) indicate better association. In Figure 1, the outer circle represents the measured trajectory while the inner dashed line shows the rigid trajectory.

4.3 Gravitational Acceleration in the Earth-Moon System

When testing gravitational acceleration on an object m, all inertial forces from the inertial system act upon it. However, when released, m loses only the accelerations α_y and α_d from the Moon and Earth, causing it to collide with the Moon and Earth at these accelerations. This constitutes the theoretical origin of Earth and Moon gravitational accelerations, whose values are jointly determined by two elliptical orbits: the Moon-Earth system and the Moon-Earth-Sun system.

4.3.1 Calculating the Moon's Gravitational Acceleration in the Earth-Moon System As shown in Figure 1, for the Moon' s orbit, the circle with semi-minor axis b as radius represents the length of uniform motion, while the elliptical circumference minus the circular circumference represents the acceleration length. The calculation method for the Moon' s average acceleration is:

Given lunar orbital eccentricity $e = 0.0549$, we have $b = \sqrt{a^2(1-e^2)}$ and $a - b = a(1-\sqrt{1-e^2}) = 0.0015081$. The semi-major axis of the lunar orbit is $a = 384748$. As marked in Figure 1, α_y represents an acceleration above uniform velocity v_r over the same time interval. Letting L_t be the elliptical circumference, L_r the circular circumference, and period $T = 27.32(\text{days}) \times 86164(\text{seconds per day})$, we obtain:

$$\alpha_y = (L_t - L_r)/T = (2\pi b + 4(a-b)) - 2\pi b = 4(a-b)/T = 4a(1-\sqrt{1-e^2})/T = (4\times384748\times0.00150814)/(27.32\times8$$

This value represents only the Moon' s gravitational acceleration within the Earth-Moon system.

4.3.2 Calculating Earth' s Gravitational Acceleration in the Earth-Moon System First, Earth' s rotation trajectory must be determined. Since the Moon' s revolution and rotation are synchronized in one complete cycle, the balance relationship definitively requires Earth to have a corresponding motion. Using the Moon as a reference frame, Earth' s revolution around the Moon shares the same trajectory as its rotation. Dividing one month' s revolution trajectory into 27.32 positions, each position implements one rotation identical in shape to the revolution trajectory. From equations (2) and (3), the average semi-major axis a_d of the rotation ellipse is:

$$a_d = (|g_+| + |g_-|)/2 = (6556.7 + 6641.60)/2 = 6599.15$$

Second, considering Earth's orbit around the Moon (using the Moon as reference frame), each revolution period contains 27.32 occurrences of a_d on the orbital path, with 27.32/2 occurrences in half a revolution period (equivalent to one large semi-major axis a). This yields the acceleration, as shown in Figure 2 [Figure 2: see original paper] (only half the major axis is shown; the other half is identical). Based on the equivalent relationship after extending the semi-major axis of rotation on the revolution orbit (essentially dynamically expanding step-by-step with a_d length, totaling 13.66 steps, into one large elliptical trajectory), the large ellipse' s semi-major axis is:

$$a(\text{large ellipse semi-major axis}) = a_d \times 27.32/2 = a_d \times 13.66$$

The large ellipse shares the Moon' s eccentricity $e = 0.0549$, giving $(1-\sqrt{1-e^2}) = 0.001508$. Referring to Figure 2:

$$\alpha_d = (L_t - L_r)/T(\text{Earth rotation period duration}) = (2b\pi + 4\times a(1-\sqrt{1-e^2})) - 2b\pi)/T = 4(6599.16\times 13.66\times 0.0$$

This value represents only Earth' s gravitational acceleration within the Earth-Moon system.

5 Earth-Moon System' s Orbit Around the Sun

From solar system data for the Earth-Moon system, we directly obtain Earth' s perihelion, aphelion, and mean distances from the Sun. The average Earth-Sun distance is 149597870 km with orbital eccentricity $e = 0.0167$, yielding $1-\sqrt{1-e^2} = 0.00013945$ and period $T = 365.256(\text{days per year}) \times 86164(\text{seconds per day}) = 31471917.984$ s. Following the Moon-Earth acceleration method, the solar system' s acceleration on Earth is:

$$\alpha_t = (4 \times 149597870 \times 0.00013945)/31471917.984 = 2.6515 \text{ m/s}^2$$

This acceleration α_t has a superposition relationship with Earth' s gravitational acceleration α_d in the Earth-Moon system (equation (5)). The combined Earth gravitational acceleration α_{dt} is:

$$\alpha_{dt} = \alpha_d + \alpha_t = 6.3 \text{ m/s}^2 + 2.6515 \text{ m/s}^2 = 8.9515 \text{ m/s}^2$$

Due to the corresponding relationship between interactive orbits in the Earth-Moon system, their interactive accelerations also correspond. Using the ratio $k_t = \alpha_y/\alpha_d$ as the interactive acceleration ratio (see equations (4) and (5)), we can calculate the increased acceleration Δ_{yt} on the Moon from the Sun-Earth-Moon orbit:

$$\Delta_{yt} = \alpha_t \times k_t = \alpha_t \times (\alpha_y/\alpha_d) = 2.6515 \text{ m/s}^2 \times (0.98598/6.3) = 0.41497 \text{ m/s}^2$$

The combined lunar gravitational acceleration is therefore:

$$\alpha_{yt} = \alpha_y + \Delta_{yt} = 0.98598 + 0.41497 = 1.40095 \text{ m/s}^2$$

The difference between measured values and α_{dt}, α_{yt} is:

$$1.63 \text{ m/s}^2 - \alpha_{yt} = 1.63 - 1.40095 = 0.2290 \text{ m/s}^2$$

This difference should originate from higher-level systems. According to inertial system balance conditions, the orbital eccentricity of higher-level galaxies must be smaller than that of the current system. Relatively larger mass and greater moment of inertia yield greater stability and smaller orbital eccentricity. From the proportional relationships among Moon, Earth, and Sun, we conclude that gravitational acceleration from higher levels diminishes significantly with more hierarchical layers. Therefore, gravitational acceleration from higher levels (Sun-Galaxy system) should be far smaller than that from the current level (Sun-Earth-Moon system) (2.6515 m/s^2), which basically matches measured values.

6 Conclusion

In summary, this paper discusses the characteristics of celestial rotational inertia using three elements—time, trajectory, and mass. It demonstrates that regular celestial rotation results from long-term inertial effects, while orbital revolution arises from mutual inertial medium torque between two bodies. The moment of inertia balance equation is thus established. Using real Earth-Moon data, we calculate Earth' s revolution and rotation trajectories around the Moon and derive corresponding gravitational accelerations for Earth and Moon. Similarly, through the Sun-Earth-Moon orbit, we derive corresponding solar gravitational accelerations on Earth and Moon. This proves the correctness of the conclusion that action-at-a-distance forces do not exist. This method can be extended to analyze other planets in the solar system.

References:

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Note: Figure translations are in progress. See original paper for figures.