Applications of Mathematical Induction in Astrophysics

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Abstract

Mathematical induction is a method that transforms infinite problems into two-step finite reasoning. According to its inductive principle, one can progressively generalize from the states of individual celestial bodies in space to the state of the entire cosmos. The main content of special relativity is summarized as several relativistic effects arising from velocity changes of spatial celestial bodies (material references) under the constraint of the Lorentz factor. Based on the principle of energy conservation, kinetic energy is defined from "relativistic mass," and corresponding rest energy is defined according to the conditions generating the Lorentz factor, along with a conversion equation between the two. By extremizing this equation, an extremal velocity (denoted as c) is obtained. It is concluded that when a celestial body operates below c, kinetic and rest energy interconvert while total energy remains constant; however, when exceeding c, total energy decreases correspondingly, with the lost energy being emitted as light energy. This thus explains that stellar luminosity results from the process where a star' s mass is gradually converted into light energy when the rotational linear velocity at its edges exceeds the speed of light, i.e., continuously emitting microscopic spin particles (denoted as S) possessing only kinetic mass and rotating at light speed. Microscopically, this forms an S-spin field wherever the star' s light reaches, facilitating the generation and transformation of matter (including biological organisms). Macroscopically, the life cycle of celestial bodies is deduced to be an evolutionary progression from ice-condensed state, vapor-condensed state, and rock-condensed state to luminous state under the action of rotational velocity. That is, the centripetal inertial spin force generated by a celestial body's natural inertial motion along its orbit and the S-spin field constitute the driving force for altering the state of celestial bodies and even the entire cosmos. And according to the principle of the mass-energy equation, the energy for a celestial body' s natural inertial motion originates from the body' s own mass. General relativity, based on the postulate that light speed is the ultimate velocity, denies the existence of gravitation possessing superluminal properties

(action-at-a-distance). Based on its principle of equivalence between gravitational and acceleration effects, the Moon' s acceleration within the Earth-Moon system is first obtained through lunar orbital data; then, through the moment of inertia equilibrium equation for the two bodies, Earth' s orbit relative to the Moon and the acceleration produced by Earth along this orbit are derived. The ratio of the obtained Earth-Moon accelerations is identical to that from actual measurements, thereby proving that a celestial body's gravitational acceleration is generated by its orbital motion rather than by gravitational attraction from its mass. According to the recursive nature of induction, the accelerations of the solar system and the Milky Way galaxy relative to the Earth-Moon system are derived hierarchically.

Differentiating the moment of inertia equilibrium equation for two celestial bodies yields the extremal distances for planetary engulfment of satellites and stellar engulfment of planets, and demonstrates that engulfment is a process where the primary body gradually acquires mass from the secondary body through high-speed abrasion. During the rotation of planets and stars toward the system center, planetary engulfment of satellites further strengthens the planet' s own inertial spin force, while stellar engulfment of planets transforms them into raw material for the star' s luminous energy. In the process of planetary engulfment of satellites, the gradually abraded satellite also splits into several remnants (asteroids), and in the process of stellar engulfment of planets, the gradually abraded planet likewise splits into several remnants (comets or asteroids).

Microscopically, according to the principle that extremal velocity of celestial bodies produces luminosity, stars continuously emit S (spinon) vortices that carry light energy outward. From relativistic arguments, S is deduced to be the smallest particle in celestial bodies, with each S possessing only kinetic mass and rotating at light speed—this corresponds to what is currently defined as electricity (kinetic mass) and magnetism (a gas vortex rotating at light speed)—generating an S-spin field centered on the star and extending to wherever S reaches. Under the action of this light-speed spin force from stars, S is driven to gradually and regularly aggregate into light atoms and subsequently into heavy atoms. In this process, the force generated by the increase or decrease of S is termed the weak nuclear force; while the process of strongly aggregating light atoms into heavy atoms is nuclear fusion, and the process of strongly splitting heavy atoms into light atoms is nuclear fission. Thus, S unifies the effects of current physical particles (photons, electrons, atoms), and the inertial spin force arising from the natural inertial motion and rotational nature of celestial bodies unifies the four fundamental forces of physics. Based on measured ratios of the "Local Standard of Rest LSR" (the region including the solar system) orbital velocity around the galactic center to the Milky Way' s revolution velocity, and the hierarchically decreasing acceleration ratios, the maximum spatial extent of celestial bodies is deduced. Within a stellar system, stars and planets exhibit dual macroscopic and microscopic relationships. Macroscopically, they gradually spiral into planets through collective inertial spin force; microscopically, stars emit S outward at light-speed rotation, with S entering space and within planets to gradually alter their material structure (all objects are ultimately composed of S ring superpositions, currently known as atoms).

Full Text

Preamble

Application of Mathematical Induction in Astrophysics

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Abstract

Mathematical induction is a method that transforms infinite problems into two-step finite reasoning. Following its inductive principle, one may progressively generalize from the state of individual celestial bodies in space to the state of the entire celestial sphere. The principal tenets of special relativity are summarized as several relativistic effects arising from the velocity changes of spatial celestial bodies (the physical reference points) under the constraints of the Lorentz factor. Based on the principle of energy conservation, the kinetic energy of 'relativistic mass' is defined. Corresponding rest energy and the conversion equation between kinetic and rest energies are established according to the conditions governing the Lorentz factor. By seeking the extremum of this equation, the critical velocity (denoted as c) is obtained. It is established that when celestial bodies travel below c, kinetic and static energies convert between each other while total energy remains constant. However, when traveling above c, total energy correspondingly decreases, with the diminished energy emitted as light energy. This elucidates stellar luminosity as the process whereby a star' s mass is progressively converted into light energy when its rotational linear velocity at the edge exceeds the speed of light. Specifically, it involves the continuous emission of particles (denoted as S) possessing only kinetic mass and rotating at the speed of light. At the microscopic level, this forms an S-rotor field wherever the star' s light reaches, facilitating the generation and transformation of matter (including living organisms).

Macroscopically, this deduces that a stellar body's life cycle evolves from a frozen state, through a gaseous state and a rocky state, to a luminous state under the influence of its rotational velocity. That is, the centripetal inertial rotational force naturally generated by the body' s orbital motion, together with the S-rotor field, constitutes the driving force altering the state of the stellar body and ultimately the celestial body. According to the mass-energy equivalence principle, the energy sustaining the body' s natural inertial motion derives from its own mass.

General relativity, grounded in the postulate that the speed of light constitutes the ultimate velocity limit, refutes the notion of a universal gravitational force possessing superluminal properties (action at a distance). Applying its principle of the indistinguishability of gravity and acceleration effects, we first derive the Moon' s acceleration within the Earth-Moon system using lunar orbital data. Subsequently, employing the equilibrium equation of rotational inertia for two celestial bodies, we determine both the Earth' s orbital path relative to the Moon and the acceleration generated by the Earth within this orbit. The ratio of Earth-Moon acceleration thus obtained matches precisely the experimentally measured value, thereby demonstrating that a celestial body' s gravitational acceleration arises from its orbital motion rather than from the gravitational pull of its mass. Employing the recursive nature of inductive reasoning, the accelerations of the Solar System and Milky Way relative to the Earth-Moon system are derived through hierarchical recursion.

Differentiating the inertia balance equation for two rotating bodies yields the critical distances for planetary capture of satellites and stellar capture of planets, elucidating that capture is a process whereby the primary body gradually acquires mass from the secondary through high-speed collisions. During rotation towards the system' s centre, planetary capture of satellites further enhances the planet' s own rotational inertia, while stellar capture of planets provides raw material for the star' s luminous energy. Satellites gradually eroded during planetary capture may fragment into several remnants (asteroids), while planets gradually eroded during stellar capture may fragment into several remnants (comets or asteroids).

At the microscopic level, based on the principle that luminous phenomena arise from the extreme velocities of celestial bodies, stars continuously emit S (spiral) vortices. These carry light energy outward. Through relative reasoning, S is deduced to be the smallest particle in the cosmos, each possessing only kinetic mass and rotating at the speed of light. This constitutes what is presently defined as electric (kinetic mass) and magnetic (rotating cyclonic currents at light speed), generating an S-rotational field centred on the star and extending to wherever S reaches. Under the influence of this light-speed rotational force within the star, S is driven to gradually and regularly aggregate into light atoms, which then aggregate further into heavy atoms. During this process, the force generated by fluctuations in S' s increase or decrease is termed the weak nuclear force. The process of forcibly fusing light atoms into heavy atoms is nuclear fusion, while the process of forcibly splitting heavy atoms into light atoms is nuclear fission. Thus, S unifies the effects of the various entities in contemporary physics (photons, electrons, atoms), and the inertial rotational force inherent in the natural inertia and rotation of stellar bodies unifies the four fundamental forces of physics. Based on measured data, the ratio of the local stationary reference frame (LSR) velocity (encompassing the solar system) around the galactic centre to the galactic orbital velocity, coupled with the progressively diminishing acceleration ratio, determines the maximum spatial extent of celestial bodies. Within a stellar system, stars and planets maintain

dual macro- and micro-level relationships. Macroscopically, the aggregate inertial rotational force gradually draws planets inward; microscopically, the star' s light-speed rotational motion outward emits S particles. These S particles, entering space and planetary bodies, progressively alter their material structure (all objects ultimately consist of S ring structures, currently termed atoms).

Keywords: Mathematical Induction; Four Fundamental Forces; Mass-Energy Equation; Moment of Inertia; Solar System; Inertial Rotational Force; Light Particles

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Mathematical induction, through its unique mechanism of "deriving infinite conclusions through finite steps," enables rigorous verification of hierarchical structures involving infinite properties, representing a combination of logical rigor and mathematical creativity. Special relativity explains the relativity of measurements in spacetime through two main arguments: "the effects of time and space" and "the nature of matter and energy." To this end, the temporal and spatial effects (time dilation, length contraction, mass increase) are summarized as being caused by relative changes in velocity constrained by the Lorentz factor (γ). These two arguments are combined under the principle of total energy conservation to derive the extremal velocity c of spatial celestial bodies. This demonstrates that when a celestial body travels at v < c, only conversion between static and kinetic energy occurs, with total energy remaining constant; when v > c and travels at speed C (speed of light), the body' s mass is gradually converted into light energy and total energy decreases accordingly, making the star luminous. This proves that a celestial body' s life cycle progresses from ice state, gas state, rock state to luminous state, with all these state changes induced by velocity (celestial inertial motion). This further generalizes that celestial bodies possess similar hierarchical structures of morphological transformation, with the driving force for generating such structures being the centripetal inertial rotational force of the bodies.

The unification of the four fundamental forces in nature (Bi Qiao 2023)—strong force, weak force, electromagnetic force, and gravity—has consistently failed to incorporate gravity (Manue 2023). General relativity considers space to be continuous, with celestial rotation being a geometric effect of spacetime distortion, while quantum mechanics considers spacetime to be discrete, creating a logical conflict in explaining the nature of gravity. Instances of light deflection (Fred Hurkx 2021; Mangut 2021) and the discovery of Einstein arcs and rings (Slava G et al. 2023) all demonstrate that powerful momentum vortices exist around stars due to their rotation, indicating that spatial air and celestial bodies are intimately connected as a whole. Rotating celestial bodies stir the air to balance themselves in space and continuously emit centripetal spiral airflow. This is a typical problem of motion mechanics. First, mechanical principles are used to demonstrate the source of gravitational acceleration—that is, to prove that the gravitational acceleration measured on Earth or the Moon results from the gradually strengthening inertial rotational force inherent to Earth or the Moon, not from gravity. According to the mass-energy equation principle (Alejandro et al. 2022), the kinetic energy source for celestial rotation is the body’ s own mass; the moment of inertia (Effrosyni et al. 2023) characterizes the gradually increasing rotational capacity (inertial rotational force); and the rotational inertia balance equation characterizes the equilibrium relationship of inertial rotational forces between two celestial bodies. Solutions to this equation yield the orbital paths that maintain equilibrium between the two bodies, from which their respective gravitational accelerations can be obtained. The calculated accelerations for Earth and Moon basically match the values measured on their surfaces. Using the recursive nature of mathematical induction (Wang y&Chen Z. 2024), the accelerations of the Solar System and Milky Way are derived through hierarchical recursion and proportionally superimposed on the Earth-Moon system, thereby proving that a celestial body’ s inertial motion is the source of gravitational acceleration.

In terms of applications, the rotational capture mechanism between two celestial bodies is explained, whereby a body with large inertial rotational force gradually acquires mass from another with smaller inertial rotational force. First, the method for planetary (Earth) capture of satellites (Moon) is described. The specific approach involves finding the extremal distance for Earth’ s capture of the Moon by taking the extremum of the Earth-Moon balance equation. Analysis shows this extremal distance matches the Moon’ s current state. Second, this method is extended to the Solar System to explain stellar capture of planets. In the Solar System, Jupiter (Burkhard et al. 2023) has the greatest mass and fastest rotation, indicating its large rotational inertia kinetic energy. Crucially, the Sun and Jupiter have identical rotation periods around the Solar System’ s balance point, indicating that the Sun primarily maintains inertial balance with Jupiter, forming a binary-like relationship, while other planets adapt their momentum within this balance to conserve angular momentum. Therefore, following the method of finding extremal values from the Earth-Moon balance equation, the balance equation for Jupiter (planet) and the Sun (star) is first established. The extremal distance for solar capture of Jupiter obtained from this equation serves as a standard reference value. The current distances of the eight planets from the Sun are then compared proportionally to this value to obtain their respective extremal distances for solar capture. Mercury is found to be within the extremal distance for solar (system) capture, while Pluto is at the edge of complete balance with the Sun (system). A method using eccentricity extremum is provided to determine the status of celestial bodies within the Solar System. It is inferred that asteroids and comets are generated through these processes. Comprehensive analysis reveals that the centripetal inertial rotational forces of the planets generate a vortex-like flow of celestial bodies and air. The Sun, rotating at high speed under this vortex flow (including air) at its core, emits light outward and radiates thermal energy. Objects outside the Solar System receive this thermal energy, gradually transforming the extremely cold gas beyond the system into frozen condensed objects. These are then drawn into the Solar System by its extended vortex flow, where under the system’ s internal inertial rotation, they evolve from frozen condensed bodies to gas-condensed bodies to rocky bodies, eventually being captured by the Sun to serve as raw material for its luminous energy, thus forming a complete evolutionary cycle of celestial bodies.

Microscopically, based on the principle that extremal velocities of celestial bodies produce light, it is proven that stellar luminosity results from the combined action of the star' s inertial rotational force with external planets, causing continuous emission of S-particles at light speed, which carry light energy outward. This demonstrates that stellar luminosity occurs when a star captures planets into its body and rotates at light speed to emit light, with the emitted energy conforming to the mass-energy equation. This dynamic process refutes the notion that solar luminosity is a slow, sustained process of internal elemental nuclear fusion constrained by gravity. It is proven that S-particles are the smallest particles in celestial bodies, continuously emitted by stars and permeating wherever their light reaches. Logically, as stars continuously emit S-particles that aggregate within objects to form atoms, the force generated by this process is abstracted as the weak nuclear force, while the force produced by externally splitting heavy atoms is called the strong nuclear force. This unifies the four fundamental forces of physics into the inertial rotational force of celestial bodies. Macroscopically, based on measured ratios of orbital velocities at different stellar levels and the progressively decreasing acceleration ratios, the maximum spatial extent of celestial bodies is derived. Within a stellar system, stars and planets maintain dual macro- and micro-level relationships. Macroscopically, the aggregate inertial rotational force gradually draws planets inward; microscopically, the star' s light-speed rotation outward emits S-particles that enter space and planetary bodies, progressively altering their material structure (all objects ultimately consist of S-ring structures, currently termed atoms).

1 Relativity and Inertial Rotational Force

Since the Lorentz factor γ in special relativity establishes spatiotemporal coordinate relationships between two inertial frames S (stationary frame) and S' (moving at velocity v along the x-axis), the "temporal and spatial effects" (time dilation, length contraction, mass increase) in special relativity are summarized as relative changes caused by an object's velocity (directly related to the Lorentz factor γ). This yields the general logical expression for dynamic and static effects:

$$P = (p_0 \times \gamma, p_0/\gamma)$$

where P is the total quantity, $p_0 \times \gamma$ is the dynamic quantity corresponding to inertial frame S' , and p_0/γ is the static quantity corresponding to inertial frame S. The change in total quantity $P = p_0$ is conditional: when velocity changes accelerate, if p_0 increases by a factor of γ in dynamic quantity $(p_0 \times \gamma)$, then p_0 simultaneously decreases by a factor of γ in static quantity (p_0/γ), with the two converting between each other. Generally, the total quantity $P = p_0$ remains unchanged, and vice versa. Clearly, temporal and spatial effects are all related to velocity changes of a specific object, and it is incomplete to mention only certain dynamic quantities (such as $p_0 \times \gamma$ or p_0/γ) as producing certain effects, such as the commonly discussed time dilation, length contraction, and mass increase effects. Now consider an object (celestial body) of mass M rotating in space. This celestial body is a specific object. Extending the mass-energy equation from special relativity, using the energy relationship of M ($E = MC^2$), the three effects of "temporal and spatial effects" (time dilation, length contraction, mass increase) are substituted. That is, when M rotates in space, combining the two main arguments of special relativity and integrating "temporal and spatial effects" with "mass-energy conversion" (mass M has mass-change effects, time T has clock-change effects, and distance L has length-change effects, with mass-energy conversion occurring during this process), the system comprehensively and thoroughly proves how celestial bodies produce relativistic effects under velocity constraints.

First, definitions of dynamic and static quantities are given based on relativistic mass, and then mass-energy conversion in celestial bodies is analyzed from their equilibrium relationship. The commonly discussed relativistic dynamic mass M_d is defined as:

$$M_d = m_0 \times \gamma = \frac{m_0}{\sqrt{1-(v^2/C^2)}} = m_0 \times \frac{C}{\sqrt{C^2 - v^2}}$$

where γ is the Lorentz factor, C is the speed of light in vacuum, m_0 is static mass, and v is the celestial body' s velocity.

Since the Lorentz factor γ establishes spatiotemporal coordinate relationships between two inertial frames S (stationary frame) and S' (moving at velocity v along the x-axis), and the transformation between x and x' is symmetric, introducing the constant speed of light condition yields γ. Therefore, there is also a corresponding relativistic static mass M_s, defined as:

$$M_s = \frac{m_0}{\gamma} = m_0 \times \sqrt{1 - \frac{v^2}{C^2}}$$

The relativistic static kinetic energy is given by:

$$E_s(v) = M_s \times C^2 = \left(m_0 \times \sqrt{1 - \frac{v^2}{C^2}}\right) \times C^2$$

while the relativistic dynamic kinetic energy is:

$$E_d(v) = PV = (M_d \times v) \times v = M_d \times v^2 = \left(m_0 \times \frac{C}{\sqrt{C^2 - v^2}}\right) \times v^2$$

where P is momentum. Since v and C share the same dimension, E_s and E_d are proportional homogeneous equations.

Let the total kinetic energy be $E = m_0 \times C^2$. According to the principle of kinetic energy conservation, the total kinetic energy conservation equation is $E(\text{total kinetic energy}) = (E_d(\text{dynamic kinetic energy}), E_s(\text{static kinetic energy}))$. Substituting the defined variables:

$$m_0 \times C^2 = \left(\left(m_0 \times \frac{C}{\sqrt{C^2 - v^2}}\right) \times v^2, \left(m_0 \times \frac{\sqrt{C^2 - v^2}}{C}\right) \times C^2\right)$$

Static analysis yields: when $v = 0$, $E_d(0) = \left(m_0 \times \frac{C}{\sqrt{C^2-v^2}}\right) \times v^2 = 0$, and $E_s(0) = \left(m_0 \times \frac{\sqrt{C^2-v^2}}{C}\right) \times C^2 = m_0 \times C^2 = E$, meaning the total kinetic energy equals static kinetic energy $E_s(0)$. When $v = C$, $E_d(C) = \left(m_0 \times \frac{C}{\sqrt{C^2-v^2}}\right) \times v^2 = \infty$, and $E_s(C) = \left(m_0 \times \frac{\sqrt{C^2-v^2}}{C}\right) \times C^2 = 0$, with dynamic kinetic energy being ∞ and static kinetic energy being 0, resulting in the relativistic-defined mass increase effect, which will be detailed below.

For the total kinetic energy conservation equation in dynamic conditions, the static C in $E_s(v) = M_s \times C^2$ must be replaced with dynamic v. Thus, an object of mass m_0 has a dynamic equation where dynamic and static kinetic energies convert between each other:

$$E = m_0 \times C^2 = \left(\left(m_0 \times \frac{C}{\sqrt{C^2 - v^2}}\right) \times v^2, \left(m_0 \times \frac{\sqrt{C^2 - v^2}}{C}\right) \times v^2\right)$$

From the kinetic energy conservation relationship, three inflection points are obtained: $v_0 = 0$; $v_1 = C$; and $v > (\sqrt{2}/2)C$, where v_0 indicates dynamic kinetic energy $E_d(0)$ is 0 and static kinetic energy $E_s(0)$ equals total kinetic energy E, as previously given in static analysis. v_1 represents the maximum velocity value (capable of producing speed C), meaning when m_0' s velocity reaches v_1, m_0 is completely converted into light energy m_{0C}^2. v represents the equilibrium point where dynamic and static kinetic energies are equal, denoted as c (lowercase) $= (\sqrt{2}/2)C$.

When $0 < v < c$, gradual acceleration or deceleration only involves conversion between static and dynamic energies: during acceleration, dynamic energy increases while static energy decreases, and vice versa. Three corresponding states can be identified for the "temporal and spatial effects." Consider an object of mass M: first, when the object' s velocity accelerates within $0 < v < c$, its dynamic mass M_d increases while static mass M_s decreases, commonly described as the object rotating faster but becoming lighter; second, the object' s dynamic time T_d flows increasingly while static time T_s flows decreasingly; third, the object' s dynamic distance L_d in the velocity direction shortens while static distance L_s lengthens. When $0 < v < c$ and gradually decelerating, the three effects are opposite to those during acceleration.

When the rotating velocity of object m_0 is in the range $c < v < C$, exceeding the equilibrium speed for static-dynamic energy conversion, another energy conversion form emerges. When v exceeds the limit value c and approaches superluminal C, the edge mass Δm of rotating mass m_0 will exceed C, causing $m_0 - \Delta m$ to decrease gradually. The reduced mass increment Δm is converted into a luminous energy state of $\Delta m \times C^2$, emitting S-particles outward. S-particles are particles possessing only kinetic mass and rotating at light speed. Thus, under super-C high-speed rotation, an increment Δm of mass m_0 produces a luminous state. The "temporal and spatial effects" can still be described relatively: first, when the object' s velocity gradually accelerates within $c < v < C$, dynamic mass reaches its maximum (mass increase effect), then decreases as Δm converts to light energy ($\Delta E = \Delta m \times C^2$), while static mass M_s approaches 0; second, because M_d decreases by Δm to emit light, v can only approach C, so for object m_0, dynamic time T_d (already near maximum) almost stops increasing (time flow nearly stops) while static time T_s approaches 0; third, because M_d decreases by Δm, v cannot exceed C, so dynamic distance L_d (at maximum) almost has no distance (length contraction effect) while static distance L_s approaches 0, with L_d effectively contracting.

Comparing the experiment of heating water with the thought experiment of accelerating an object helps understand this process. Consider water in a basin and an accelerating rotating object, both with mass M:

- Heating water ($0 < T < (\sqrt{2}/2) \times 100°$) corresponds to accelerating M ($0 < v < c$): total mass M remains unchanged, hot water increases while cold water decreases, temperature rises gradually; dynamic mass increases while static mass decreases, rotation speed increases gradually.
- Heating water ($(\sqrt{2}/2) \times 100° < T \leq 100°$) corresponds to accelerating M ($c < v \leq C$): boiling water Δm evaporates while cold water decreases to near 0; dynamic mass increases to $\Delta m C^2$ light energy while static mass decreases to near 0; total mass becomes $M - \Delta m$ (decreasing), emitting $\Delta m \times C^2$ light energy, a more refined and advanced energy form. Steam dissipates into space, condenses in air, forming thunder, rain, etc.

The conclusion is that all naturally luminous spatial objects (stars) have their outer edges (with fastest linear velocity) continuously operating in the range $c < v \leq C$, constantly converting mass to light energy. This conversion' s kinetic energy comes from the combined centripetal vortex force formed by the star' s own inertial rotational force and external celestial bodies' inertial rotational forces. Using the Sun as an example, all planets in the Solar System and the Sun itself apply inertial rotational force toward the system' s balance point, enabling the Sun at the centre to rotate at extreme speed (light speed) and convert mass to light energy. The vortex flow and captured planets provide the Sun' s energy source. This demonstrates that massive objects' velocities are not incapable of reaching light speed, but rather that reaching light speed converts the object into light. It follows that the faster a celestial body moves in space, the lighter its mass becomes (static mass converts to kinetic mass), and objects at light speed have no static mass, only kinetic mass. Clearly, the inertial rotational force generated by a spatial object' s natural inertial velocity is the sole force that changes celestial states. This motion generates momentum forming inertial rotational force that stirs air and expands outward, meaning the inertial rotational force triggered by a spatial object' s (celestial body' s) own inertial velocity is also the driving force for mutual rotation among spatial objects (celestial bodies). Microscopically, using quantum mechanics concepts, the generated S-particle is the smallest particle among celestial bodies, denoted as S (Spin particle). S is characterized very vividly as an entity possessing only kinetic mass and rotating at light speed in a counterclockwise direction (same as the generating star' s rotation direction). Microscopic explanations of S are provided in Section 9.

Based on this conclusion, inertial rotational force is completely different from the currently defined "(universal) gravitational force." Gravity is static (objects with mass have gravity), unbounded (requires no medium, infinite distance), inward-acting (attracts inward), and exerts force in all directions (all-dimensional attraction toward the centre of mass). Mutual gravitational attraction between celestial bodies cannot make a central star rotate at light speed. In contrast, inertial rotational force is dynamic (rotational power from object mass), bounded (transmitted through air vortex expansion), outward-acting (centripetal spiral expansion), and exerts force directionally (strength decreases from the equatorial plane toward the poles). Inertial rotational forces between celestial bodies acting in the same direction can accelerate a central star to light speed, continuously generating S-particles.

General relativity extends special relativity' s temporal and spatial effects to all reference frames, considering small-mass object rotation as a geometric effect caused by massive objects distorting spacetime (Yoshio et al. 2022). It points out that strong momentum vortices exist around stars, which not only enable their own rotation for balance but also distort surrounding spacetime to make other planets rotate associatively. Distorting spacetime is an abstract explanation of the momentum effect of celestial motion; its essence is the centripetal air vortex (inertial rotational force) generated when objects rotate in space, which for Earth (a planet) is its rotating atmospheric layer, with the strongest region called the blackout layer (zone) (Vincent F et al. 2023). For the Sun (a star), the inertial rotational force is the extremely dense cyclonic flow of S-particles emitted from its periphery, with the strongest region being where light deflection is strongest, known as Einstein arcs (rings) (Slava G et al. 2023).

Analyzing a celestial body' s natural inertial evolution process reveals the source and development of its inertial rotational force: micro-objects (anything with mass) → internal imbalance (non-uniform internal mass distribution) → natural inclination toward the heavier side generating centripetal rotation (formation of moment of inertia, inertial rotational force, and self-rotation orbit) → non-uniform spatial air vortices causing objects to naturally rotate in the direction of airflow (generation of orbital motion, expansion of inertial rotational force through spatial airflow) → generation of rotating inertial rotational force in space (association with other objects through this force) → two (or more) objects forming elliptical orbits through mutual inertial rotational forces (producing corresponding acceleration, with celestial acceleration originating from orbital motion) → gradually capturing other objects through acceleration intensity (increasing own mass and moment of inertia) → increasing inertia causing the body' s central inertial velocity to gradually approach light speed, making the star luminous (star formation) → ···

All spatial objects, including Earth, grow gradually through natural centripetal inertial advancement. During this process, moment of inertia marks the primary attribute of a celestial body, possessing both mass-accumulating characteristics and momentum-accumulating capacity. Internal and external imbalances cause rotation and inertial advancement. Using space as a reference frame, internal imbalance in a spatial object naturally generates centripetal self-rotation; environmental imbalance in space naturally generates revolution following the flow. This conforms to the mass-energy equivalence relationship $E = MC^2$, where mass (M) in inertial motion (V^2) is the source of energy (E). This process occurs without external forces, naturally formed by the object' s own inertia generating velocity. Let E, M, V, S, F, a, t, and Δ represent energy, celestial mass, velocity, distance, force, acceleration, time, and increment respectively. According to the definition of kinetic energy:

$$\Delta E = \frac{1}{2}M\times V_t^2 - \frac{1}{2}M\times V_0^2 = F\times\Delta S = M\times a\times\Delta S = M\times\left(\frac{\Delta V}{\Delta t}\right)(\Delta V\times\Delta t) = M\times(\Delta V)^2$$

The derived $E = MV^2$ is dimensionally consistent with the mass-energy equation $E = MC^2$. Relativity has proven that $E = MC^2$ is the highest form of kinetic energy from mass (energy produced by mass), while $E = MV^2$ is its general form (the mutual conversion between static and dynamic kinetic energies described above). $E = MV^2$ is the dynamic energy for the natural inertial motion of spatial celestial bodies, a process that occurs without external forces, naturally generated, with the celestial body' s moment of inertia gradually strengthening to promote accelerated rotational advancement. Thus, the mass of a spatial object and its natural inertial velocity constitute the energy source for its rotation.

2 Inertial Rotational Force and the Moon' s Gravitational Acceleration in the Earth-Moon System

[Figure 1: see original paper] is a schematic diagram showing the averaged equivalent of the Moon's orbit, where the orbital focus is shifted to the midpoint, and the perigee and apogee are averaged to serve as the semi-major axis of the equivalent orbit. Section 5.2 provides a detailed explanation of this orbital averaging transformation. As shown in Figure 1, the Moon's equivalent elliptical orbit (Bo-Sheng et al. 2023) can be logically divided into two path segments: first, a circular path length L_r given by the ellipse' s minor semi-axis b radius, representing the Moon' s uniform motion path at speed V_r; second, the total elliptical circumference L_t. Clearly, $L_t - L_r$ represents the average acceleration path, and $(L_t - L_r)/T$ (where T is one lunar period duration) gives the Moon' s equivalent average acceleration J_m on its orbit. As shown in Figure 1, J_m is the acceleration based on V_r.

According to data from the National Astronomical Data Center (nadc.china-vo.org) (distance in km, mass in kg, same below unless noted):

The average Earth-Moon distance is $a = 384,404$ km, serving as the Moon' s elliptical orbit' s average semi-major axis, with b as the minor semi-axis. The average orbital eccentricity is $e = 0.0549$. Based on the relationship between elliptical semi-axes:

$$a - b = a(1 - \sqrt{1 - e^2}) = 0.00150814a$$

Let T be one period' s duration (in seconds). The Moon' s orbital period is 27.32 days, with 86,164 seconds per day. Thus:

$$T = 27.32 \times 86,164 = 2,354,000.48 \text{ seconds}$$

The average equivalent gravitational acceleration is:

$$J_m = \frac{\text{elliptical circumference} - \text{circular circumference}}{\text{one period duration}} = \frac{L_t - L_r}{T} = \frac{(2\pi b + 4(a-b)) - 2\pi b}{T} = \frac{4(a-b)}{T} = \frac{4 \times}{}$$

This value represents only the Moon' s gravitational acceleration component in the Earth-Moon system; other components come from higher layers (Solar System, etc.), given in Section 4. The relationship between average equivalent gravitational acceleration and actual measured acceleration is discussed in Section 5.

J_m demonstrates that the Moon' s gravitational acceleration results from the Moon' s inertial motion, not from internal gravitational attraction.

3 Moment of Inertia Balance Equation and Earth' s Orbit

Within a system, the rotational inertia balance equation for two (or multiple) celestial bodies through space can obtain the correlation strength of inertial rotational forces between them. The equation' s solution yields the orbits of the two bodies relative to their balance point, thereby obtaining the celestial body' s gravitational acceleration.

[Figure 2: see original paper] shows a schematic diagram of Earth-Moon system parameters. Let the masses of the two bodies be M and m, the distance between their centers be p, and the distances from their centers to the balance point be H and h respectively, with $p = H + h$. Based on the solid sphere moment of inertia formula (Effrosyni et al. 2023) and the parallel axis theorem (Roberto Rojas 2019), the balance equation for the two bodies is:

$$(I_C + I_H) \times T \times J = (i_c + i_h) \times t \times j$$

where I_C, i_c are the solid sphere moments of inertia of M and m about their own centers; I_H, i_h are the parallel axis moments of inertia from M and m' s centers to the balance point; T, t are the rotation angles of M and m within a given period, possessing velocity properties; and J, j are angular functions aligning the equatorial planes of M and m in space.

Substituting variables yields:

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

Substituting known proportional values to simplify, with $M = x \times m$, $R = y \times r$, and setting $z = (t \times j)/(T \times J)$ and $h = p - H$:

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

Eliminating m, expanding brackets, and combining terms:

$$5(x - z)H^2 + 10z \times p \times H + 2(x \times y^2 - z)r^2 - 5 \times z \times p^2 = 0$$

This yields a quadratic equation in H with parameters: - $b = 10 \times z \times p$ - $a = 5(x - z)$ - $c = 2(x \times y^2 - z)r^2 - 5 \times z \times p^2$

3.2 Earth' s Gravitational Acceleration in the Earth-Moon System

The Earth-Moon balance equation can calculate the gravitational (acceleration) values of the Moon and Earth in the Earth-Moon system. As shown in Figure 2, let M and m be Earth's and Moon's masses, H and h be the distances from Earth and Moon centers to the balance point, with p (average Earth-Moon distance) $= H + h$.

Since the Earth-Moon system' s period is 27.32 days, Earth and Moon rotate $27.32 \times 2\pi$ and $1 \times 2\pi$ respectively, giving $T = 27.32 \times 2\pi$ and $t = 1 \times 2\pi$. As shown in Figure 2, setting Earth' s equatorial plane at 0°, the Moon' s equatorial plane intersection angle is 35.26° (23.44° + 5.14° + 6.68°), so $J = \cos(0°)$ and $j = \cos(35.26°)$. Thus:

$$z = \frac{t \times j}{T \times J} = \frac{2\pi \times \cos(35.26°)}{27.32 \times 2\pi \times \cos(0°)} = \frac{\cos(35.26°)}{27.32 \times \cos(0°)} = 0.029888$$

Known Earth-Moon mass and radius ratios are $M = 81.3 \times m$ and $R = 3.66 \times r$, with lunar radius $r = 1,737$ km and average distance $p = 384,404$ km. Substituting $x = 81.3$, $y = 3.66$ into equation (4):

- $a = 5(x - z) = 5 \times (81.3 - 0.029888) = 406.35$
- $b = 10 \times z \times p = 10 \times 0.029888 \times 384,404 = 114,890.76$
- $c = 2(x \times y^2 - z)r^2 - 5 \times z \times p^2 = 2(81.3 \times (3.66)^2 - 0.029888)(1,737)^2 - 5 \times 0.029888 \times (384,404)^2 = 6,571,589,546.27 - 22,082,216,078.679 = -15,510,626,532.409$

Solving this quadratic equation, the discriminant is:

$$\Delta = b^2 - 4ac = 25,224,172,252,511$$

with $\sqrt{\Delta} = 5,022,367.1961$. The Earth-Moon equilibrium distance solutions are:

$$H_{1,2} = \frac{-b \pm \sqrt{\Delta}}{2a}$$

- $H_1 = \frac{-b+\sqrt{\Delta}}{2a} = 6,038.48$ km
- $H_2 = \frac{-b-\sqrt{\Delta}}{2a} = -6,321.223$ km

As shown in Figure 1, H_1 and H_2 give the positive and negative balance ranges of Earth's orbit around the Earth-Moon balance point, forming Earth's elliptical orbit around this point. H_1 is the pericenter and H_2 the apocenter. Similar to the lunar orbit calculation, the average semi-major axis of Earth' s orbit around the Moon is the average of H_1 and H_2:

$$H = \frac{|H_1| + |H_2|}{2} = \frac{6,038.48 + |-6,321.223|}{2} = 6,179.85 \text{ km}$$

As shown in Figure 1, the ellipse with H as the average semi-major axis is a scaled-down version of the lunar orbit. Since the Moon' s orbital revolution is synchronized with its rotation (orbital size equals rotational dimensions), according to the inertia balance principle, Earth' s orbit around the Earth-Moon balance point must also be synchronized with the lunar orbit. Therefore, Earth' s orbital size around the balance point equals its rotational orbit size. Let A_e be the average semi-major axis of Earth' s revolution and rotation orbits, so

$A_e = H$, with average semi-minor axis B_e. Figure 3 is an enlarged schematic of Earth' s orbit around the Earth-Moon balance point from Figure 1. Earth rotates in a centripetal rolling manner on this orbit. As shown in Figure 3, if Earth starts self-rotation from position i and moves counterclockwise along the orbital dimensions to position $i+13.66+0.5$, it completes half a rotation period. Continuing similarly to position $i+1$ completes one rotation period, and the cycle repeats, with each period taking one day (Earth' s rotation). Each of Earth' s rotation orbit dimensions matches the revolution orbit shown in Figure 3. Earth' s orbital acceleration results from superposition of the synchronous revolution acceleration around the balance point and the asynchronous rotation acceleration at each position.

First, calculate the synchronous revolution acceleration around the balance point: Similar to Section 2' s method for the Moon' s synchronous orbital acceleration, Earth' s synchronous rotation acceleration around the Earth-Moon balance point is calculated. As shown in Figure 3, Earth' s revolution period around the balance point is 27.32 days, with 86,164 seconds per day, giving $T = 27.32 \times 86,164 = 2,354,000.48$ seconds. Unlike the lunar orbit, because Earth rotates in a centripetal rolling manner on its revolution orbit, the orbit is not fully expanded. Earth' s trajectory must travel back and forth within the revolution orbit, creating a 2-fold overlap relationship, making each period equivalent to twice the expanded orbit' s acceleration intensity. Thus, the amplification factor for one synchronous revolution period is $k_0 = 2$. Earth' s revolution eccentricity around the balance point matches the lunar orbit' s eccentricity ($e = 0.0549$), with $A_e - B_e = A_e(1-\sqrt{1-e^2}) = A_e \times 0.00150814$. The synchronous average acceleration is:

$$J_{e0} = \frac{(L_t - L_r) \times k_0}{T} = \frac{((2\pi \times B_e + 4(A_e - B_e)) - 2\pi \times B_e) \times k_0}{T} = \frac{4(A_e - B_e) \times k_0}{T} = \frac{4 \times 6,179.85 \times 0.001}{2,354,000.4}$$

Next, calculate the asynchronous rotation acceleration at each position: As shown in Figure 3, within one month Earth rotates 27.32 times on its revolution orbit around the Earth-Moon balance point, once per day (one position). By angular momentum conservation, Earth' s rotation on an asynchronous orbit at each position amplifies by the number of revolution positions (27.32). Because Earth rotates in a centripetal rolling manner, opposite to the synchronous revolution orbit, each asynchronous rotation period is equivalent to 1/2 of a revolution position (in Figure 3, each position has only 1/2 outside the revolution orbit). Thus, the asynchronous amplification factor for one rotation period is $k_1 = 27.32/2 = 13.66$.

Figure 3 shows the asynchronous orbit schematic for Earth' s rotation at a position, with J_{e1} as the asynchronous orbit acceleration, and indicates Earth' s actual dimensions (average radius = 6,371 km, while A_e is only 6,179 km). Let T be the seconds for one Earth rotation (one day) = 86,164 s. The eccentricity for Earth' s position rotation matches the lunar orbit ($e = 0.0549$), with $A_e - B_e =$

$A_e \times (1-\sqrt{1-e^2}) = A_e \times 0.00150814$. The asynchronous amplification factor is $k_1 = 13.66$. The asynchronous average acceleration for one rotation period at a position is:

$$J_{e1} = \frac{(L_t - L_r)\times k_1}{T} = \frac{((2\pi \times B_e + 4(A_e - B_e)) - 2\pi \times B_e)\times k_1}{T} = \frac{4(A_e - B_e)\times k_1}{T} = \frac{4 \times 6,179.85 \times 0.001}{86,164}$$

Superimposing Earth' s synchronous and asynchronous accelerations yields Earth' s gravitational acceleration in the Earth-Moon system:

$$J_e = J_{e0} + J_{e1} = 0.031674 \text{ m/s}^2 + 5.91023 \text{ m/s}^2 = 5.9419 \text{ m/s}^2$$

This value represents only Earth' s gravitational acceleration component in the Earth-Moon system; other components come from higher orbits, given in Section 4. The relationship between average equivalent gravitational acceleration and actual measured acceleration is discussed in Section 5.

4 Hierarchical Orbital Gravitational Acceleration

The differences between measured gravitational acceleration values on Earth and Moon and the calculated values J_e and J_m from equations (5) and (1) are:

- Earth: $9.8066 \text{ m/s}^2 - J_e = 9.8066 - 5.9419 = 3.8647 \text{ m/s}^2$
- Moon: $1.6227 \text{ m/s}^2 - J_m = 1.6227 - 0.9851 = 0.6376 \text{ m/s}^2$

Equations (5) and (1) only represent accelerations from the inertial balance between Earth and Moon. Higher-level inertial balance equations remain to be solved for Earth-Moon-Sun orbits and Earth-Moon-Sun-Galaxy orbits. The ratios of Earth-Moon accelerations are:

- Earth-Moon system ratio: $K_{g1} = J_e/J_m = 5.9419/0.9851 = 6.0317$
- Remaining Earth-Moon system ratio: $K_{g2} = 3.8647/0.6376 = 6.0613$
- Measured Earth-Moon ratio: $K_{g3} = g_{\text{Earth}}/g_{\text{Moon}} = 9.8066/1.6227 = 6.04338$

The near equality of K_{g1}, K_{g2}, and K_{g3} demonstrates that the calculated acceleration ratios from orbital inertial motion match measured surface acceleration ratios, proving the physics and calculation methods correct. Using the Earth-Moon orbital solution method, the Sun-Earth-Moon system and Galaxy-Sun-Earth-Moon system accelerations are solved and proportionally superimposed downward to obtain final standard calculated values. As shown in Section 3.2, acceleration calculation generally involves two steps: first, the synchronous acceleration component where M rotates synchronously on its relative balance point revolution orbit; second, the asynchronous acceleration component where celestial body (system) M obtains asynchronous rotation acceleration through self-rotation at each position on the revolution orbit.

4.1 Sun' s Gravitational Acceleration on the Earth-Moon System

Calculate the synchronous acceleration of the Earth-Moon system orbiting the Solar System. The Earth-Moon system (Sarah Caddy et al. 2022) relative to the Solar System provides direct data for Earth' s near, far, and average distances to the Sun, with average distance $a = 149,597,870$ km (1 AU) as Earth' s semi-major axis around the Sun, and orbital eccentricity $e = 0.0167$. Calculating $(1-\sqrt{1-e^2}) = 0.00013945$, let the average semi-minor axis be b. One year' s duration is $T = 365.25636 \times 86,164 = 31,471,949$ seconds. Assuming Earth rotates synchronously around the Sun (like the Moon around Earth in the Earth-Moon system), the Solar System' s synchronous acceleration on Earth is:

$$J_s = \frac{\text{elliptical orbit length} - \text{circular orbit length}}{\text{one year duration}} = \frac{(2\pi b + 4(a-b)) - 2\pi b}{T} = \frac{4(a-b)}{T} = \frac{4 \times a \times (1-\sqrt{1-e}}{T}$$

As shown in Section 3.2 and Figure 3, Earth revolves around the Earth-Moon balance point (point o in Figure 3), which is Earth' s average rotation centre and the inertial rotation centre of the Earth-Moon system. Thus, J_s is essentially the Sun' s gravitational acceleration on the Earth-Moon system. Within this Earth-Moon system, it must be distributed to Earth and Moon according to the ratio $K_{g1} = 6.0317$ (given in Section 4). Let the acceleration increments for Moon and Earth be ΔJ_{sm} and ΔJ_{se} respectively:

$$\Delta J_{sm} = \frac{J_s}{K_{g1}+1} = \frac{2.65143}{6.0317+1} = 0.377 \text{ m/s}^2$$

$$\Delta J_{se} = \Delta J_{sm} \times 6.0317 = 2.2739 \text{ m/s}^2$$

The acceleration increment ΔJ_{se} is superimposed on J_e from equation (5), giving Earth' s average equivalent gravitational acceleration:

$$J_{es} = J_e + \Delta J_{se} = 5.9419 \text{ m/s}^2 + 2.2739 \text{ m/s}^2 = 8.2158 \text{ m/s}^2$$

The acceleration increment ΔJ_{sm} is superimposed on J_m from equation (1), giving the Moon' s average equivalent gravitational acceleration:

$$J_{ms} = J_m + \Delta J_{sm} = 0.9851 + 0.377 = 1.3621 \text{ m/s}^2$$

4.2 Sun' s Gravitational Acceleration Within the Solar System

Similar to Section 3.2' s calculation of Earth' s asynchronous acceleration within its system, we calculate the Sun' s asynchronous acceleration within the Solar System. First, the Sun' s inertial balance equation within the system must be determined, then its revolution orbit relative to the balance point found, and finally its gravitational acceleration within the system derived.

The Solar System has eight planets with non-fixed positions, but their distances from the Sun are relatively fixed. Among them, Jupiter has the greatest mass, fastest rotation, and small inclination to the solar plane. More importantly, the Sun and Jupiter have completely synchronized rotation periods around the Solar System' s balance point (both 11.86 years), as shown in Table 3 . This indicates that within the Solar System, the Sun primarily balances inertial rotational force with Jupiter, with other planets playing momentum-matching roles. Thus, the Sun-Jupiter balance equation resembles the two-body equation in Section 2, and the acceleration calculation method follows Section 3.2' s Earth acceleration method.

Using data from Table 3, let M, m be Sun and Jupiter masses; R, r be their radii; H, h be distances to the balance point, with $P = H + h$. Parameters are determined as: - $P = 5.2028$ AU $\times 149,597,870$ km/AU $= 778,327,798.036$ km - $r = 69,911$ km - $R = 696,300$ km - $x = M/m = 1,047.8$ - $y = R/r = 696,300/69,911 = 9.9598$

In one period (11.86 years), Sun and Jupiter rotation angles are $T = 25.38 \times 2\pi$ and $t = 0.375 \times 2\pi$ respectively. Jupiter' s equatorial plane is the hypotenuse, the Sun' s the adjacent side, so:

$$\frac{\text{Jupiter equatorial plane (j)}}{\text{Sun equatorial plane (J)}} = \frac{j}{J} = \frac{1}{\cos(3.13°)}$$

According to special relativity, because solar luminosity has kinetic mass properties, from Section 1 the Sun' s dynamic-static ratio $K_{ds} \approx 1/10$. Thus:

$$z = \frac{(t \times j) \times K_{ds}}{T \times J} = K_{ds} \times \frac{0.375}{25.38 \times \cos(3.13°)} = \frac{0.014857}{10} = 0.0014857$$

Following Section 3' s Earth acceleration method and Figure 3, equation (4) parameters are: - $a = 5(x - z) = 5(1,047.8 - 0.0014857) = 5,238.9925$ - $b = 10 \times z \times p = 10 \times 0.0014857 \times 778,327,798.036 = 11,563,616.0954$ - $c = 2(x \times y^2 - z)r^2 - 5 \times z \times p^2 = 2(1,047.8 \times (9.9598)^2 - 0.0014857)(69,911)^2 - 5 \times 0.0014857 \times (778,327,798.036)^2 = 1.016016234121507 \times 10^{15} - 4.500141822368735 \times 10^{15} = -3.484125588247228 \times 10^{15}$

The discriminant is:

$$\Delta = b^2 - 4ac = (11,563,616.0954)^2 - 4 \times 5,238.9925 \times (-3.484125588247228 \times 10^{15}) = 73,013,097,586,324,060,7$$

with $\sqrt{\Delta} = 8,544,770,189.2$. The solutions are: - $H_1 = \frac{-b+\sqrt{\Delta}}{2a} = 814,393.85274$ km - $H_2 = \frac{-b-\sqrt{\Delta}}{2a} = -816,601.074$ km

$$H = \frac{|H_1| + |H_2|}{2} = 815,497.46 \text{ km}$$

H is the average semi-major axis of the Sun's revolution and rotation around the Sun-Jupiter balance point. As shown in Section 3' s Figure 3, the Sun' s rotation period around the balance point is 25.38 days, with revolution period 11.86 years. The Sun' s revolution eccentricity matches Jupiter' s ($e = 0.04891$), with $(1-\sqrt{1-e^2}) = 0.00119681$. One revolution period' s days $= 11.86 \times 365.25 = 4,331.865$ days, giving $T_0 = 4,331.865 \times 86,164 = 373,250,815.86$ seconds, with amplification factor $K_0 = 2$.

The Sun' s synchronous revolution acceleration around the balance point:

$$a_{s0} = \frac{4 \times H \times (1-\sqrt{1-e^2}) \times K_0}{T_0} = \frac{4 \times 815,497.46 \times 0.001196817 \times 2}{373,250,815.86} = 0.0209 \text{ m/s}^2$$

The Sun' s revolution period contains $4,331.856/25.38 = 170.68$ positions. Following Section 3.2' s amplification factor calculation, the Sun' s rotation amplification factor is $K_1 = 170.68/2 = 85.34$. The Sun' s rotation eccentricity matches Jupiter's ($e = 0.04891$), with $(1-\sqrt{1-e^2}) = 0.00119681$. One rotation period duration is $T_1 = 25.38 \times 86,164 = 2,186,842.32$ seconds.

The Sun' s asynchronous acceleration at a position:

$$a_{s1} = \frac{4 \times H \times (1-\sqrt{1-e^2}) \times K_1}{T_1} = \frac{4 \times 815,497.46 \times 0.001196817 \times 85.34}{2,186,842.32} = 152.3510 \text{ m/s}^2$$

The Sun' s gravitational acceleration in the Solar System is:

$$a_{s01} = a_{s0} + a_{s1} = 0.0209 \text{ m/s}^2 + 152.3510 \text{ m/s}^2 = 152.98 \text{ m/s}^2$$

Per Section 1' s definition, since Earth has negligible kinetic mass, the Sun' s large kinetic mass gravitational acceleration a_{s01} must be converted to static mass acceleration using K_{ds}:

$$a_s = a_{s01} \times K_{ds} = \frac{152.98}{10} = 15.298 \text{ m/s}^2$$

From Section 4.1, since the Solar System' s synchronous gravitational acceleration on the Earth-Moon system is 2.65143 m/s^2, the ratio is:

$$K_s = \frac{a_s}{2.65143} = \frac{15.298}{2.65143} = 5.76971$$

4.3 Milky Way' s Gravitational Acceleration on the Solar System

To find the Milky Way' s synchronous gravitational acceleration on the Solar System (the Solar System' s revolution synchronous acceleration), we apply angular momentum conservation: celestial motion is a dynamic momentum adjustment process where each body' s inertial rotational force within the system dynamically achieves balanced positions; otherwise, the system would be unstable. Thus, gravitational acceleration from higher layers must decrease proportionally layer by layer downward, allowing us to derive the Milky Way' s synchronous acceleration value.

The proportional relationship is: let A_j $(j = 1, 2, ...)$ be real numbers, then:

$$\frac{A_{n+1}}{A_n} = \frac{A_n}{A_{n-1}}$$

yielding the recursive formula:

$$A_{n+1} = \frac{A_n^2}{A_{n-1}}$$

By angular momentum conservation, higher-layer acceleration must decrease proportionally downward. Logically, each higher-layer celestial system can be treated as a single body. Using the lowest two layers' (Moon, Earth) data in equation (8) 's decreasing manner, seven logical layers in Figure 4 [Figure 4: see original paper] are derived, showing a radiating state similar to the Solar System, expanding outward from the centre with increasing numbers of similar structures at outer layers. As shown in Table 1 , each column (except "Nebula Circle (Radius)") is generated from the previous two rows' known data using equation (8). For example, lunar acceleration values relate to upward-layer Milky Way acceleration values. Using equation (8) for Table 1' s "(Moon) Acceleration" :

- Earth→Moon (Moon synchronous revolution): 0.9850 (from equation (1)), set as A_{n-1}
- Sun→Earth (Earth synchronous revolution)→Moon (proportional to Moon): 0.377 (from Section 4.1' s ΔJ_{sm}), as A_n
- Within Galaxy→Sun (Sun synchronous revolution)→Earth (proportional to Earth)→Moon (proportional to Moon): x, as A_{n+1}

From equation (8): $x/0.377 = 0.377/0.9851$, giving $x = (0.377)^2/0.9851 = 0.1442$. This is entered in the table' s "Sun.(Moon) Acceleration" entry, with other columns calculated similarly.

Now using known Moon, Earth, and Sun data to prove equation (8)' s proportional relationship and obtain the Solar System' s synchronous acceleration:

Mathematical induction verifies equation (8): - **Base case**: Table 1' s first row "(Moon) Acceleration" 0.9851 is calculated from eccentricity, "Celestial Circle (Radius)" , and "Celestial Circle Period Duration" (see equation (1)). - **Inductive hypothesis**: Second row "(Moon) Acceleration" 0.377 is assumed. - **Inductive step**: Prove third row "(Moon) Acceleration" 0.1442 holds.

Using Table 1' s third row data (generated from first two rows): let a be the Sun' s revolution orbit' s average semi-major axis ("Sun.Celestial Circle Radius") = 389.16 AU $= 58,217,507,089.2$ km; b the semi-minor axis; T the "Sun.Celestial Circle Period Duration" $= 421,893,005$ s. From the ellipse relationship $a-b = a(1-\sqrt{1-e^2})$, with eccentricity $e = 0.0050799$, we have $a-b = a \times 1.29 \times 10^{-5}$. Following Section 3.1' s lunar synchronous acceleration method, the Sun' s synchronous revolution acceleration is:

$$a_{y0} = \frac{4(a-b)}{T} = \frac{4 \times 58,217,507,089.2 \times 1.29 \times 10^{-5}}{421,893,005} = 0.00712\ \text{km/s}^2 = 7.12\ \text{m/s}^2$$

Similar to Section 4.1, a_{y0} is the synchronous acceleration of the central star in the Sun' s nebula circle (later proven to be the Sirius system) on the entire Solar System. Like the Sun' s acceleration on the Earth-Moon system being proportionally distributed to Earth and Moon, a_{y0} must be proportionally distributed to Sun and Jupiter. Since the Sun-Jupiter relationship is analogous to Earth-Moon (Jupiter-Moon and Sun-Earth have identical revolution periods around their respective system balance points), the Earth-Moon acceleration ratio (Earth:Moon = 6.0317:1) can approximate the Sun' s nebula circle central star' s acceleration ratio on the Solar System (Sun:Jupiter = 6.0317:1). Thus:

$$\Delta a_{yj} = \frac{a_{y0}}{K_{g1}+1} = \frac{7.12}{6.0317+1} = 1.0125\ \text{m/s}^2$$

$$\Delta a_{ys} = \Delta a_{yj} \times 6.0317 = 1.0125 \times 6.0317 = 6.1074\ \text{m/s}^2$$

Δa_{yj} is the nebula circle' s acceleration increment on Jupiter; Δa_{ys} is the increment on the Sun. Per Section 4.1' s ratio K_s, Δa_{ys} is proportionally superimposed downward on the Earth-Moon system as:

$$A_{ys} = \frac{\Delta a_{ys}}{K_s} = \frac{6.1074}{5.76971} = 1.0585\ \text{m/s}^2$$

A_{ys} is the nebula circle' s acceleration superimposed on the Solar System, which then becomes acceleration increments $(\Delta A_{ysm}, \Delta A_{yse})$ for Moon and Earth. Following Section 4.1' s method:

$$\Delta A_{ysm} = \frac{A_{ys}}{K_{g1}+1} = \frac{1.0585}{6.0317+1} = 0.150 \text{ m/s}^2$$

$$\Delta A_{yse} = \Delta A_{ysm} \times 6.0317 = 0.904 \text{ m/s}^2$$

Here $\Delta A_{ysm} = 0.150$ m/s^2 is the Sun' s synchronous revolution acceleration on the Moon, essentially matching Table 1' s "Sun.(Moon) Acceleration" (= 0.1442). The error comes from approximating the central star' s acceleration ratio (Sun:Jupiter = 6.0317:1). Reversing the calculation with $\Delta A_{ysm} = 0.1442$ yields the actual ratio K_x (Sun:Jupiter = 8.34:1):

$$\Delta A_{ysm} = \frac{A_{ys}}{K_x+1} \Rightarrow 0.1442 = \frac{1.0585}{K_x+1} \Rightarrow K_x = 8.34$$

Thus, mathematical induction' s three steps provide complete proof of equation (8)' s recursive relationship for celestial layers, showing the proportional decreasing relationship matches the layer-by-layer decreasing acceleration superimposed on celestial bodies.

Superimposing ΔA_{yse} and ΔA_{ysm} on equations (6) and (7) yields accelerations from the Sun' s nebula layer to the Earth-Moon layer:

$$J_{esa} = J_{es} + \Delta A_{yse} = 8.2158 \text{ m/s}^2 + 0.904 \text{ m/s}^2 = 9.1198 \text{ m/s}^2$$

$$J_{msa} = J_{ms} + \Delta A_{ysm} = 1.3621 \text{ m/s}^2 + 0.1442 \text{ m/s}^2 = 1.5063 \text{ m/s}^2$$

These values clearly approach measured values, with step increments decreasing layer by layer. The cumulative sum of Table 1' s "(Moon) Acceleration" column gives the Moon' s acceleration superimposed from the Galaxy layer by layer:

$$\sum = 0.9851+0.3770+0.1442+0.0551+0.0210+0.0080+0.0003 = 1.5907 \text{ m/s}^2$$

The difference from the measured lunar standard value is $1.6227-1.5907 = 0.032$ m/s^2. This cumulative sum shows that any celestial body is connected layer-by-layer with the entire celestial sphere, conforming to angular momentum conservation. More extended layers mean weaker correlation strength, indicating that layer-superimposed acceleration is convergent and the system is stable.

The following explains current Milky Way data. The above is an equivalent logical layer derivation treating the Solar System as a single body rather than a system, only demonstrating that higher layers must possess such gravitational acceleration capability per conservation principles; otherwise, the system would be unstable. In reality, the system should be the unit. Table 1' s "Nebula Circle

(Radius)” column provides actual system data, analyzing measured Milky Way data proportionally. The proportional relationship is:

$$\frac{\text{Planet-to-Sun average distance}}{\text{Satellite-to-planet average distance}} = \frac{\text{Solar System-to-its host star distance}}{\text{Solar System controlled radius}}$$

Let $K_{dr} = \frac{\text{Planet-to-Sun distance}}{\text{Satellite-to-planet distance}} = \frac{778{,}330{,}000\text{ km}}{24{,}356{,}000\text{ km}} = 31.956$.

Since the Solar System’ s actual controlled radius edge is about 0.3 light years (LY), the distance from the Solar System (nebula circle) to its revolution centre is approximately 0.3 LY $\times K_{dr} = 0.3 \times 31.956 = 9.5868$ LY, entered in Table 1’ s “Sun.Nebula Circle (Radius)” entry. Similarly, “Galaxy 1.Nebula Circle (Radius)” is 9.5868 LY $\times$ 31.956 = 306.35578 LY, and other entries are derived proportionally. This data is plotted in Figure 4 [Figure 4: see original paper] showing the Solar System’ s actual state in the Milky Way.

Explanation for “Sun.Nebula Circle (Radius)”: Recent astronomical observations show the Milky Way is not a uniformly thick single structure but consists of multiple layers with distinct physical properties, exhibiting significant spatial stratification. That is, galaxies in the Milky Way do not all rotate forward in a unified disk but form multiple layers, each composed of multiple nebula circles, as shown in Figure 4.

Using the LSR (Local Standard of Rest) approach, current data shows the LSR system (including the Solar System) orbits the galactic centre at about 220 km/s. The Solar System’ s horizontal velocity relative to LSR varies by about 5 km/s. Additionally, the Solar System drifts toward the galactic centre at about 8 km/s and moves perpendicular to the galactic plane at about 7 km/s. These errors, drifts, and perpendicular motions indicate the Solar System does not synchronize directly with the galactic centre’ s inertial rotational force. The ~220 km/s is estimated from orbiting the galactic centre at 26,000 LY radius, while the actual Solar System revolution is around a Sun’ s nebula circle centre at about 9.5868 LY radius. Table 2 lists main parameters of star systems within 20 LY of the Solar System. The Sun’ s nebula circle centre can be analyzed from this data.

- **Alpha Centauri**: Small luminosity, large unidirectional centennial parallax change, large ecliptic intersection angle (negative), likely not in the same plane—excluded.
- **Sirius**: Most suitable by distance, but unidirectional centennial parallax and large ecliptic angle—selected.
- **Altair**: Slightly farther distance, unidirectional large centennial parallax —excluded.
- **Procyon A**: Bidirectional minimal centennial parallax but smaller distance—candidate.

Sirius is identified as the central star of the Sun' s nebula circle, with the Solar System revolving around it. Its luminosity of 25 indicates Sirius has 25 times the Sun's inertial rotational force (per Section 1's principle that high-speed rotation makes stars luminous, where luminosity is proportional to inertial rotational force).

The Milky Way' s position is also explained: - [Milky Way] –1.1 million LY → [Local Group Centre] ← 1.44 million LY –[Andromeda Galaxy], approximately collinear, considered a nebula body. - Local Group Centre –55 million LY → Virgo Supercluster Centre. - Local Cluster Centre –~150-250 million LY → Laniakea Supercluster Centre.

Table 1' s "Galaxy Outer.Celestial Circle Radius" of 1.411×10^8 LY matches the minimum test data of 150 million LY from the Local Cluster Centre to the Laniakea Supercluster Centre. The conclusion is: Andromeda and the Milky Way are companion nebulae in the Local Group, controlled by the Laniakea Supercluster Centre; the Virgo Supercluster Centre is also controlled by the Laniakea Supercluster Centre, forming the "Galaxy Outer.Celestial Circle" in Figure 4. Using the Solar System as an analogy, the Laniakea Supercluster Centre is the Sun, the Virgo Supercluster is Jupiter, and the Milky Way' s Local Group is Uranus. This further demonstrates that celestial logical layers (the acceleration derivation method) and actual nebula layers (the Milky Way positioning method) can mutually verify each other.

5 Conclusions on Gravitational Acceleration

This section addresses the relationship between measured acceleration values and hierarchically calculated values, and the equivalence between equivalent average orbits/accelerations and actual orbits/accelerations.

5.1 Relationship Between Measured and Hierarchically Calculated Acceleration Values

Earth's revolution synchronous acceleration around the Sun must be proportionally superimposed on Earth and Moon. Similarly, the Sun's (Solar System's) revolution synchronous acceleration must be superimposed on the Sun and Earth-Moon system, and higher layers. This relationship can be summarized across three layers (Moon-Earth, Earth-Sun, Sun-Galaxy), each with synchronous and asynchronous calculation methods, where only higher-layer synchronous accelerations are proportionally superimposed downward:

- **Moon-Earth Layer**: Moon's synchronous acceleration around the Earth-Moon balance point is calculated from orbital parameters. The Earth-Moon inertial balance equation yields Earth' s asynchronous orbital acceleration. The Moon-Earth acceleration ratio is 1/6.0313, with higher Earth-Moon-Sun orbit synchronous acceleration superimposed proportionally on Earth and Moon.

- **Earth-Moon-Sun Layer**: The Sun' s asynchronous acceleration is obtained from Jupiter-Sun balance equation, giving Earth-Moon and Sun acceleration ratio 1/5.76971. Higher Sun-Galaxy orbit synchronous acceleration is superimposed proportionally on Sun and Jupiter, with the Sun' s superimposed acceleration further distributed downward to Earth-Moon at 1/6.0313 ratio.

The Solar System experiences four layers to reach the galactic centre. The hierarchical acceleration derivation method is proven correct. Through layer-by-layer proportional superposition, calculated gravitational accelerations for Earth (or Moon) basically match measured surface values.

5.2 Equivalent Transformation of Celestial Orbits and Average Equivalent Acceleration

First, orbital equivalent transformation: According to Kepler' s second law, elliptical orbits are equivalently transformed to reduce computational intensity from two points (focus to apogee/perigee) to one average point. Using the Moon' s elliptical orbit as an example (Figure 1, schematic with exaggerated dimensions, especially focus c), with semi-axes a and b, and focus distance c from centre o. The area enclosed by L_t is divided into fast and slow regions: fast region Δ_1 enclosed by c, b, a, b, and c; slow region Δ_2 is the remaining area. Equal area swept per unit time means Δ_1' s smaller area corresponds to faster lunar motion (fastest at a), while Δ_2' s larger area corresponds to slower motion (slowest at a). With total area $S = \pi ab$ and $\Delta = bc$, we have $\Delta_1 = S/2 - \Delta$ and $\Delta_2 = S/2 + \Delta$.

If the time to sweep Δ_1 is $T = t$, Kepler' s second law gives the transformation equality $(\Delta_1 = \Delta_2)|_{T=t} \rightarrow (S/2 - \Delta = S/2 + \Delta)|_{T=t}$, which holds for any Δ. Setting $\Delta = 0$ (i.e., $c = 0$) achieves the equivalent transformation by shifting the ellipse' s focus to its centre (as in Figure 1). After transformation, the semi-axes are $a(= oa)$ and $b(= ob)$, where a is the average of apogee and perigee distances. With the centre as focus, the Moon sweeps equal areas in equal times on the equivalent elliptical orbit, making calculations consistent with reality.

Second, average equivalent orbital acceleration: In Figure 1, the Moon' s average equivalent acceleration for one revolution is $J_m = (L_t - L_r)/(\text{one period duration})$, a single acceleration based on speed V_r. Kepler' s second law (Parmakovich et al. 2015) states that a planet' s areal velocity V around a balance point (focus) is constant (angular momentum conservation). With area increment dS in time increment dt and areal acceleration $a = dV/dt = d^{2S}/dt^2$, the Moon maintains constant swept area, manifesting as nearly constant gravitational acceleration. The orbital equivalent transformation shifts the focus to the centre, averaging acceleration at perigee and deceleration at apogee, making areal acceleration correspond completely with orbital acceleration. Therefore, in the Earth-Moon system, Earth' s equivalent acceleration J_e follows the same principle. Generalizing to any elliptical orbit proves the average equivalence relationship correct: equivalent accelerations for Earth and Moon are equivalently equal to measured surface gravitational accelerations. Per Section 4.3' s results, letting Δ_e and Δ_m represent the sum of accelerations from higher nebula layers on Earth and Moon, and J_{esa} and J_{msa} the calculated Earth and Moon accelerations from Section 4.3:

- (Measured Earth gravitational acceleration) $\approx J_{esa} + \Delta_e$
- (Measured Moon gravitational acceleration) $\approx J_{msa} + \Delta_m$

According to Kepler's second law, the Moon (or Earth) achieves this equivalence through natural inertial velocity variations (faster and slower motion). These subtle acceleration changes have negligible effect on small surface objects (e.g., human activities) but affect large objects, such as Earth's major earthquakes and tidal phenomena (Eric Wolanski et al. 2018) caused by acceleration variations at orbital apsides.

6 Inertial Rotational Force and the Solar System

As described in Section 1 and Figure 6 [Figure 6: see original paper], the air vortex flow (from system centre to edge) rotating around the Sun naturally revolves centripetally around the Solar System' s balance point. Because a celestial body' s static mass converts to kinetic mass (increasing kinetic mass), the body is not heavy (static mass decreases) but has large momentum vortex flow. These vortices keep the entire Solar System balanced in space and continuously spiral toward the system centre, drawing extremely cold gas from far outside (Solar System' s outer icy region) (Patryk Sofia et al. 2023) to form extremely cold gas.

Solar radiation beyond the system (Solar System's outer icy region) creates temperature differences, gradually transforming the cold gas into frozen condensed objects (icy planetary systems outside the Solar System). Meanwhile, the Solar System edge' s inertial rotational force (edge vortex flow) gradually draws these slowly inertially balanced frozen objects into the Solar System. After entering, icy bodies gradually compress centripetally and under sunlight become gas-condensed bodies, then rocky bodies, eventually being captured by the Sun. The Solar System' s inertial rotational force makes the Sun' s core rotate near light speed, producing luminous energy radiating outward. This cycle maintains system energy balance, evolving various Solar System bodies through complete forms, constituting a complete energy-balanced system.

Specifically for Solar System bodies: Earth-Moon is a binary environment where both revolve centripetally around their inertia balance point; the Solar System is a multi-body, binary-like system where Sun and Jupiter maintain balance while other planets revolve centripetally around their common balance point. The Solar System' s inertial rotational force also gradually draws extended bodies (e.g., Pluto) into the system. Captured bodies evolving toward the centre undergo progression from icy (current Neptune, Uranus) to gas-condensed (Saturn, Jupiter) to rocky (Mars, Earth, Venus, Mercury) to luminous (Sun). Natural satellites are gradually captured by planets during these processes. In the Solar System, planets closer to the centre generally have fewer natural satellites and higher density, clearly a centripetal compressive process of rotational vortex flow. According to the mass-energy equation, centripetal inertial rotational force generates energy from each system' s bodies' own mass and makes them rotate centripetally. Natural satellites and planets rotate together toward their balance centre; planets and stars rotate together toward their common balance centre; star systems and star groups rotate together toward their common balance centre. For example, the Milky Way is a galaxy where star groups rotate centripetally around the centre, with four spiral arms showing clear centripetal arcs (Junye Wei et al. 2023).

7 Extremal Distances for Planets and Satellites

Three-quarters of Solar System planets have natural satellites. The Earth-Moon system has the fewest satellites and most detailed data, making it a special case for deriving extremal distances between planets and satellites—specifically, the maximum distance the Moon can maintain balance with Earth, crucial for determining whether the Moon is being captured by Earth.

From Section 2' s two-body inertial balance equation, substituting known ratios $M = x \times m$, $R = y \times r$, and setting $Z = T \times J/(t \times j)$ into equation (2) yields:

$$2mr^2 + 5mh^2 = 2Z(x \times m)(y \times r)^2 + 5Z(xm)H^2$$

$$2r^2 + 5h^2 = 2xZ(y \times r)^2 + 5xZH^2$$

Substituting $H = p - h$ (average distance $p = h + H$) and expanding:

$$5(1 - xZ)h^2 + 10xZph + 2r^2(1 - Zxy^2) - 5Zxp^2 = 0$$

This quadratic in h has parameters: - $a = 5(1 - xZ)$ - $b = 10xZp$ - $c = 2(1 - Zxy^2)r^2 - 5Zxp^2$

For Earth-Moon system with $x = 81.3$, $y = 3.66$, $p = 384,044$ km, $r = 1,737$ km, and from Section 3.2, $Z = 1/z = 1/0.029888 = 33.458$. Since $a = 5(1 - xZ) < 0$, the equation has a maximum. Differentiating $f(h)$ and setting $df/dh = 0$ gives the maximum:

$$h_m = -\frac{b}{2a} = \frac{xZp}{xZ - 1} = \frac{81.3 \times 33.458 \times 384,404}{81.3 \times 33.458 - 1} = 384,545.369 \text{ km}$$

The difference from the current average distance is $\Delta = h_m - p = 384,545.369 - 384,404 = 141.369$ km. As shown in Figure 7 [Figure 7: see original paper], this is the extremal distance increment for the Moon to maintain balance with Earth.

When orbital eccentricity increases (orbit becomes more elongated), Earth-Moon reaches extremal balance, and the Moon will be completely controlled by Earth' s inertial rotational force until captured. The small $\Delta = 141.369$ km indicates the Moon is in pre-capture stage, with synchronized rotation and revolution (always one face toward Earth). System analysis shows inner Solar System planets (Venus, Mercury) have no satellites, so Earth will eventually capture the Moon. The planetary satellite capture process is described in Section 9.

8 Extremal Distances for Stars and Planets

As described in Section 4.2, among the eight planets, Sun and Jupiter have completely synchronized periods around the Solar System' s balance point, indicating the Sun primarily balances inertial rotational force with Jupiter. The extremal distance method from Section 7 applies: after finding the Sun-Jupiter extremal distance, other planets' average distances are compared proportionally to obtain their extremal distances from the Sun. Table 3 provides planetary parameters, using AU units and Earth-ratio values.

Using the planet-satellite balance equation (10) with M, m as Sun and Jupiter gives the Sun-Jupiter balance equation. Parameters are: - $x = M/m = 1,047.8$ - $y = R/r = 9.9598$ - $p = 5.2028$ AU $= 778,330,000$ km - $r = 69,911$ km

From Section 7' s equation (9) and parameters, with $z = 0.0014857$ from Section 4.2, $Z = 1/z = 673.083$. Parameters are: - $a = 5(1 - xZ) = -3,526,276.837$ - $b = 10 \times 1,047.8 \times 673.083 \times 778,330,000 = 5.48922188438442 \times 10^{15}$

Since $a < 0$, the quadratic has a maximum. Solving as in Section 7:

$$h_m = \frac{xZp}{xZ - 1} = \frac{1,047.8 \times 673.083 \times 778,330,000}{1,047.8 \times 673.083 - 1} = 778,331,103.6144 \text{ km}$$

The Jupiter-Sun extremal difference is $\Delta = h_m - p = 1,103.6$ km. Relative to their 5.2028 AU separation, this is very small, indicating Jupiter and Sun are essentially in extremal balance, consistent with their synchronized periods (~11.86 years), similar to Earth-Moon. This extremal distance proportionally derives other planets' extremal distances.

For a planet X, the proportional relationship is:

$$\frac{X.\text{Average distance to Sun}}{\text{Jupiter.Average distance to Sun}} = \frac{X.\text{Distance (AU)}}{\text{Jupiter.Average distance}}$$

$$X.\Delta = \frac{1,103.6 \text{ km}}{5.2028 \text{ AU}} \times X.\text{Distance (AU)} = 212.1165 \times X.\text{Distance (AU)}$$

This measures the average distance increment from a planet' s current position to its extremal point. For Mercury:

$$\text{Mercury}.\Delta = 212.1165 \times 0.383 = 81.24 \text{ km}$$

Similar calculations for other planets, Pluto, and Halley' s Comet populate Table 3' s ($X.\Delta$) entries. The ($X.\Delta$) proportion shows that planetary extremal distances are proportional to their distances from the Solar System balance point, primarily determined by the Sun-Jupiter balance relationship, with other planets only providing momentum matching. Mercury is a special case near the Sun' s inner critical point, while Pluto is near the outer critical point. From the Δ values, Mercury is being captured by the Sun, while Pluto is near but not yet within the Sun' s complete inertial balance. Capture methods between bodies are described below.

9 Rotational Capture Between Celestial Bodies

Planetary satellites naturally advance centripetally toward the planetary system' s balance centre. As described in Section 7, when a satellite' s distance from its planet exceeds the extremal value (the satellite' s maximum inertial rotational capacity), it gradually loses inertial balance, showing weakened self-rotation and increased orbital eccentricity. Increased eccentricity causes the satellite to frictionally collide with the planet' s inertial rotational force at perigee, losing mass that is captured by the planet while being accelerated and thrown farther (due to mass reduction). Meteorite falls are manifestations of planetary satellite capture.

This gradually increases the planet' s mass (and moment of inertia) while the satellite's decreasing mass evolves its orbit beyond the original planetary system into the Solar System as an asteroid parent body, gradually eroded and split into remnants (asteroids) (Nanping Luo et al. 2024) with increasingly chaotic orbits. Stellar planetary capture is similar but involves different mass scales and distances. The Sun' s powerful inertial rotational force causes captured planets' orbits to evolve beyond the inner Solar System as comet parent bodies, gradually split into remnants (comets or asteroids) with chaotic orbits. Actual conditions are described below.

9.1 Planetary Capture of Satellites

Per Section 7 and Figure 7, $\Delta = 141.3699$ km is the Moon' s average distance to its extremal value under current conditions. The Moon is in pre-capture stage, with average eccentricity ~0.0549—somewhat high for the Earth-Moon system. It has lost self-rotation capability, with synchronized rotation and revolution (always one face toward Earth). If its centripetal rotation further increases eccentricity and elongates the orbit, when $\Delta < 0$, Earth will capture the Moon. In astronomical time, the Moon will evolve into the next asteroid parent body generated by the Earth-Moon system. Current asteroids orbiting Earth are remnants from the Moon' s predecessor satellite, gradually eroded and mass-stripped by Earth' s strengthening inertial rotational force. The span depends on planetary inertial rotational force intensity, generally within the Solar System. Wandering asteroids (distinct from asteroid belt asteroids) are remnants of predecessor satellites being captured.

9.2 Stellar Capture of Planets

Per Section 8, Table 3, and Figure 8 [Figure 8: see original paper] (with $\Delta_{\text{Mercury}} = 81.24$ km, $\Delta_{\text{Jupiter}} = 1,103.59$ km), Mercury' s extremal increment shows it is at the critical point, in pre-capture stage with eccentricity $> 1/5$, gradually losing self-rotation, in a synchronous rotation state always facing the Sun, with rotation unable to keep up with revolution. However, Mercury differs from the Moon in the Earth-Moon system: the Moon is alone in Earth-Moon system with far less momentum than Earth, making capture relatively quick. In the Solar System, Mercury won' t be quickly captured by the Sun due to Jupiter-Sun inertial balance. Mercury's capture depends on its average distance from the Sun. If Jupiter' s Δ in the Jupiter-Sun balance decreases, increasing Mercury's eccentricity and semi-major axis, when $\Delta_{\text{Mercury}} < 0$, Mercury begins capture. Astronomically, $\Delta_{\text{Mercury}} = 81.24$ km and $\Delta_{\text{Jupiter}} = 1,103.59$ km are very small, indicating Jupiter-Sun is in extremal balance. Mercury will be captured first, evolving into the next comet or asteroid parent body generated by the Solar System. Current active comets/asteroids orbiting the system balance point are remnants of Mercury' s predecessor planet, gradually captured and mass-stripped by the Sun's inertial rotational force, with the span depending on the Sun' s inertial rotational force intensity and ejection angle, generally exceeding the inner Solar System range. Active comets are remnants of predecessor planets being captured.

From this analysis and Table 3, eccentricity is the criterion for capture status, but depends on the system' s inertial intensity. For Earth-Moon, the Moon' s $e_{\text{Moon}} = 0.0549$ indicates near-capture; for the Solar System, a planet' s $e_{\text{Mercury}} = 0.20562$ indicates near-capture or loss of Solar System balance. Pluto' s $e_{\text{Pluto}} = 0.2488$ ($e_{\text{Pluto}} > e_{\text{Mercury}}$) shows incomplete inertial balance with the Sun (Solar System). A simple criterion: planets with $e < 0.20562$ are in complete Solar System balance.

9 Limits of Celestial Bodies

Based on conclusions from celestial evolution, this section presents the generation and properties of the smallest particles in celestial bodies, unifies the four fundamental forces, and derives the maximum spatial extent of the entire celestial sphere from measured LSR (Solar System-inclusive) revolution speed around the galactic centre versus the Milky Way' s revolution speed ratio, combined with the layer-by-layer increasing acceleration ratio.

9.1 The Smallest Particle in Celestial Bodies and Unification of Forces

From Section 1, using quantum mechanics concepts, S-particles are identified as the smallest particles in celestial bodies. Figure 9 [Figure 9: see original paper] shows S-particle schematic diagrams. Their properties are:

- **Kinetic Energy**: Since stellar edge linear velocity reaches light speed, generated S-particles have zero static energy. Following quantum mechanics' photon kinetic energy definition:

$$E_s = h \times \nu = (6.626 \times 10^{-34}) \times (5 \times 10^{-14}) = 3.316 \times 10^{-19} \text{ J}$$

  where h is Planck' s constant and is sunlight frequency.

- **Kinetic Mass**: From mass-energy equation $E_s = M_s \times C^2$:

$$M_s = \frac{E_s}{C^2} = \frac{3.316 \times 10^{-19}}{(3 \times 10^8)^2} = 3.681 \times 10^{-36} \text{ kg}$$

  Since S rotates at light speed, its static mass is zero, with no energy dissipation, perpetually rotating at light speed.

- **Rotation Speed, Direction, and Plane**: As S is generated from stellar edge rotating at light speed counterclockwise, S rotates at light speed C, counterclockwise, parallel to the solar plane (ecliptic).

- **Interaction**: S-particles, with minimal kinetic mass and maximal rotation speed, have consistent direction and mutual independence, but can aggregate into atoms under external energy.

- **Distribution**: Stars continuously emit S, permeating all space reached by their light, forming an S-rotational field centred on the star. Within this field, S' s light-speed rotation creates a light-speed vortex flow, currently termed magnetic field (e.g., Earth' s magnetic field is actually the light-speed vortex from solar S; Earth' s low rotation cannot generate significant magnetic effects).

- **Transmission Mode**: S transmits recursively at light speed.

In summary, stars have two driving forces: macroscopically, stellar inertial rotational force (including the star itself) provides centripetal force for planetary revolution; microscopically, the star core' s light-speed rotation drives S generation, rotation, and propagation. S' s effects encompass current physics' particles (photons, electrons, atoms), unifying them. Comparisons:

- **Photon**: Quantum photons are electromagnetic interaction mediators with $E = h\nu$, exhibiting wave-particle duality. S' s recursive transmission exhibits wave-particle duality. Current physics suggests photon rotation radius is far smaller than wavelength, implying superluminal rotation speed, and that photons move at light speed from birth without medium. S transmits at light speed, serving as both light-energy-driven particle and medium, not disappearing with light energy. While photons cannot explain light-speed constancy under accelerated sources, S' s recursive transmission perfectly explains it.

- **Wired Electricity/Electrons**: Electron flow in conductors is current; S flow corresponds to "current." Current generates magnetic field lines; S' s light-speed cyclonic flow in conductors is "magnetic field lines." Like circuits, power sources separate S to the "negative end" ; voltage forms between ends, and when connected, S flows from negative to positive end for balance.
- **Wireless Electrons/Magnetism**: Current physics states electromagnetic waves propagate energy through coupled electric and magnetic fields, with energy from the source system. In S-mode, the source system' s energy propagates via S' s light-speed self-rotation. S corresponds to both electron and its magnetic field effects in radio waves, differing from current electromagnetic theory.
- **Atoms**: Current atomic definitions are abstracted from electron effects. S-theory denies proton existence and uses S-ring stacking to replace neutron functions. The three quantum mechanics arguments are very close to S-theory: (1) Electron cloud model—S rotates cloud-like around the nucleus; (2) Quantized energy levels—correspond to S-ring stack counts; (3) Wave-particle duality and uncertainty—S is both wave medium and particle. Quantum mechanics is experimentally derived and close to S-theory but retains proton/neutron concepts, while S-theory replaces them with S-ring stacks.

Thus, if nuclear forces are defined as enhanced electromagnetic forces, S-theory shows all forces originate from celestial bodies' inertial rotational forces. Under inertial rotational force, stars rotating at light speed generate refined S-forces. S-force combinations forming S-ring stacks constitute the weak nuclear force; forced splitting/aggregation of S-ring stacks constitutes the strong nuclear force. All forces unify into inertial rotational force from spatial object motion. The sequence is: inertial rotational force begins, S-force is the second/final step, then S radiated to all bodies generates weak/strong forces as the third step. Weak force is S-ring aggregation; strong force is S-ring stack energy release. After this, strong-force aggregates are captured by stars rotating near light speed, emitting light energy with newly generated S outward.

Current physics divides particles into atoms, protons, neutrons, and quarks—essentially describing how to aggregate more S-particles. From a force perspective, strong and weak nuclear forces are enhanced electromagnetic forces. The four forces ultimately unify into inertial rotational force from celestial inertial motion, gradually refining into weak nuclear force, strong nuclear force, and finally S-force from stellar light-speed motion. The essence of the four forces is a natural force from object motion in space gradually refining.

Magnet magnetic force is an example related to "electromagnetic, weak nuclear, and strong nuclear forces." Current physics defines atomic binding energy as the total energy needed to separate a nucleus into free nucleons, with specific binding energy as the average per nucleon. Higher specific binding energy means more stable nuclei (e.g., iron-56 near maximum stability). Heavy fission or light fusion releases energy as specific binding energy moves toward medium-mass nuclei like iron. Analyzing the most stable iron, nickel, and cobalt nuclei reveals these forces' connections. When a magnet (mainly iron, nickel, cobalt) is magnetized, Figure 12 [Figure 12: see original paper] shows magnetized magnet C where S-rings from Figure 10 are aligned into N and S poles, generating magnetic field lines. When native iron material A is placed at the N pole, the magnetic field lines magnetize A' s S-rings (same direction as C' s field lines) and 吸入 (suck in) A into C, integrating it. When iron B is placed at the S pole, it' s similarly magnetized and 吸入 into C. This is magnet attraction to iron.

This magnetization process can be defined as nuclear stable force (iron' s specific binding energy is most stable, analogous to weak/strong forces), corresponding to electromagnetic force (electricity generates magnetism) with long-acting characteristics. Why other materials don' t magnetize is a problem in atomic and quantum mechanics: they study atoms/quanta as isolated entities without considering interconnections. For atoms lighter than iron, S-rings aren' t fully formed and distant, reverting after magnetization. For heavier atoms, S-rings are strongly linked and cannot be altered by magnetization.

9.2 Scale of Celestial Bodies

By angular momentum conservation, spatial nebula layers change proportionally —necessary for system stability. From nebula layer revolution' s increasing speed ratio approaching light speed, the total layers and thus maximum celestial sphere extent can be obtained. The layer-by-layer decreasing acceleration ratio also proves this layering correct.

Using Table 1' s "(Moon) Acceleration" and "Celestial Circle (Radius)" as Table 4 ' s two data items, and adding "Galaxy 3" and "Galaxy Outer" groups. Per Section 4.3' s LSR description, the LSR system (including Solar System) orbits the galactic centre at ~220 km/s, while the Milky Way' s revolution speed is ~600 km/s. Treating LSR.Solar System and Milky Way as mass points, their revolution speeds are entered in Table 4' s "Revolution Speed" column. The first two rows are known; rows 3-9 are calculated per equation (8).

Light speed is precisely fixed at 299,792 km/s, so celestial revolution speed cannot exceed light speed. When approaching light speed, the layer converts mass to outward light energy, naturally maintaining sub-light speed. Comparing Table 4' s "Revolution Speed" , layers 8-9 approach light speed. If LSR is layer 1, layers 8-9 are the highest layers, with "Celestial Circle (Radius)" values of 4.8866×10^{23} to 1.9005×10^{26} LY—this is the maximum celestial radius range. Layers 8-9' s "(Moon) Acceleration" values are 2.4438×10^{-5} to 9.3083×10^{-6}, which proportionally (1:6.03) convert to Earth gravitational acceleration as 1.4662×10^{-4} to 5.5849×10^{-5}. Long-term Earth surface measurements show gravitational acceleration varies by $±$0.2 mGal, indicating micro-vibrations from celestial dynamic-static mass conversion. The calculated values match measurements, confirming the defined maximum celestial range.

At this point, our celestial sphere resembles the Solar System: a complete disc drawing in large amounts of icy bodies to replenish light energy consumption, but not expanding further because the edge rotates near light speed. Beyond our celestial sphere are similar development processes. Due to this near-light-speed rotation property, our celestial sphere can be viewed as an S-particle, forming S-rings and S-ring stacks with other S-particles (other celestial spheres), gradually forming heavy atomic nucleus-like strongly stacked celestial cluster structures. Under light speed constraints for both smallest particles and largest scales, the calculated maximum celestial form unifies with the smallest particle form. If our celestial sphere is an S-particle, the entire celestial sphere is like the "electrons" (S-particles) in our world; growing celestial clusters are S-rings; more mature clusters are S-ring stacks, etc.

9.3 Macro and Micro Elements of Celestial Environment

In celestial bodies, extremely cold gas at stellar system edges, under sunlight (S-particles carrying thermal energy continuously radiated from stellar edges rotating at light speed) and S-motion, forms icy bodies. Under combined S and inertial rotational forces, icy bodies evolve into gas-condensed bodies, then rocky bodies. Throughout, S naturally combines with matter states to form atoms in bodies—i.e., the current material world where all matter consists of atoms. This continues as rocky bodies are captured into stars, becoming material for new S generation—one celestial life cycle. Thus, three elements of celestial evolution are: (1) vast extremely cold gas (macro element); (2) S-particles (carrying light energy) (micro element); (3) celestial bodies'(including stars') centripetal inertial rotational force (both macro and micro element, from S' s light-speed rotation). These three elements enable celestial cycles.

10 Conclusion

Through mathematical induction' s recursive nature applied to astrophysics and geophysics, the following results are achieved:

1. Combining special relativity' s "temporal and spatial effects" with "mass-energy equation" summarizes relative changes caused by velocity (related to Lorentz factor). Using the mutual conversion relationship between dynamic and static kinetic energies of an object (mass M), the extremal conversion speed c is obtained. When $v < c$, dynamic and static kinetic energies convert with constant total kinetic energy; when $v > c$, dynamic kinetic energy converts to light energy, decreasing total kinetic energy. This shows natural inertial motion is a celestial body' s basic attribute, proving stellar luminosity results from rotation speed approaching light

speed. Celestial bodies have near-light-speed inertial rotational force, but only limited to stellar cores; claiming stars distort surrounding spacetime exaggerates this effect. The conclusion: inertial rotational force from celestial bodies' natural inertial velocity is the sole force changing celestial states.

2. Based on moment of inertia, the two-body inertial balance equation yields Earth-Moon acceleration ratios matching measured ratios exactly, proving Earth-Moon accelerations originate from inertial motion, not gravity. The proportional superposition relationship is recursively extended to Solar System and Galaxy, showing a body' s acceleration results from layer-by-layer proportional superposition of higher-layer accelerations. The proportional relationship of gravitational acceleration proves any celestial body connects with the entire celestial sphere; more extended layers mean weaker correlation, showing final acceleration convergence and system stability.

3. Differentiating the balance equation yields extremal distances for planetary satellite capture and stellar planetary capture. Beyond these extremal distances, capture processes occur, explaining how comets and asteroids form.

4. The evolutionary process from celestial body formation to demise is explained, detailing four life cycle stages: ice → gas → rock → luminous.

5. Celestial basic structure is presented, proving overall structure is layer-by-layer expansion of basic structure—i.e., overall and basic structures are isomorphic, extending as layer-layer stack-layer group-group stack structures.

6. The smallest celestial particle is proven to be S-particle, emitted by stars with directed light-speed motion creating light-speed vortex flow, similar to current "electron" motion generating magnetism, while denying positive/negative electrons and protons. Multiple S-particles form S-ring stacks, analogous to atomic nuclei. Macroscopically, stellar inertial rotational force drives planets; microscopically, stellar core light-speed rotation drives S-particle light-speed rotation. S-particles unify the four fundamental forces into inertial rotational force.

7. Based on measured Sun-Milky Way revolution data, the maximum celestial sphere extent is derived.

In summary, macroscopically, spatial objects' natural inertial motion velocity forms inertial rotational force as the total dynamic source for celestial change, gradually compacting bodies to continuously manufacture and emit S-particles; microscopically, S-particles are the dynamic source for internal structural changes in spatial objects (including life). The three elements of celestial evolution are: macroscopic extremely cold gas, microscopic S-particle light-speed rotation, and the inertial rotational force accelerating both.

References

Alejandro Pereza, Salvatore Ribisib. Energy-mass equivalence from Maxwell equations[J]. American Journal of Physics. 2022, Vol.90(No.4): 305. Doi:10.1119/10.0009156

BiQiao. An Outline of the Grand Unified Theory of Gauge Fields[J]. Journal of Modern Physics. 2023, Vol.14(No.3): 212-326. Doi:10.4236/jmp.2023.143016

Bo-Sheng Li; Xi-Yun Hou. The Main Problem of Lunar Orbit Revisited[J]. The Astronomical Journal. 2023, Vol.165(No.4). Doi:10.3847/1538-3881/acbafa

Burkhard Militzer, William Hubbard. Relation of Gravity, Winds, and the Moment of Inertia of Jupiter and Saturn[J]. The Planetary Science Journal. 2023, Vol.4(No.5): 95. Doi:10.3847/PSJ/acd2cd

David Vokrouhlick, David Nesvorn, Miroslav Bro, William F Bottke, Rogerio Deienno2, Carson D Fuls3, Frank C Astronomical Absolute Magnitude Trojans[J]. The Distribution Jupiter Shelly. Orbital Journal. 2024, Vol.167(No.3): 138. Doi:10.3847/1538-3881/AD2200

Effrosyni Seitaridou, Alfred Farris. Moment of Inertia[J]. A Student' s Guide to Rotational Motion. 2023: 72-89.

Eric Wolanski, G L Pickard. The Tides[J]. Physical Oceanographic Processes of the Great Barrier Reef. 2018: 59-76.

Fred Hurkx. An improved formula for light by a massive object the deflection of[J]. European Journal of Physics. 2021, Vol.42(No.1): 015602. Doi:10.1088/1361-6404/ABA78D

Jean Luc Margot1, Donald B, Campbell, Jon D, Giorgini, Joseph S. Jao, Lawrence G. Snedeker, Frank D. Ghigo, & Amber Bonsall. Spin state and moment of inertia of Venus[J]. Nature Astronomy. 2021, Vol.5(No.7): 676-683. Doi:10.1038/s41550-021-01339-7

Junye Wei, Ye Xu, Zehao Lin; Chaojie Hao, Yingjie Li, Dejian Liu, Shuaibo Bian. A New Statistical Analysis of Morphology of Spiral Galaxies[J]. The Astronomical Journal. 2024, Vol.168(No.6): 264. Doi:10.3847/1538-3881/AD8632

Mangut, Halilsoy. Gravitational lensing in rotating and twisting universes[J]. Astroparticle Physics. 2021, Vol.128 (No.0): 102558. Doi:10.1016/j.Astropefish.2021.102558

Manue Rodrigues. From the universal Mécanique. 2023, Vol.351(Suppl 4): 73-79. Doi:10.5802/crmeca.215 gravitation to MICROSCOPE[J]. Comptes Rendus.

Nanping Luo, Xiaobin Wang, Shenghong Gu, Antti Penttil, Karri Muinonen, Yisi Liu. Taxonomic Analysis of Asteroids with Artificial Neural Networks[J]. The Astronomical Journal. 2024, Vol.167(No.1): 13. Doi:10.3847/1538-3881/ad0b7a

Parmakovich, Vinka (parmak@verizon.net). Multiple applications of a derived formula for Kepler' s law of areas[J]. Physics Essays. 2015, Vol.28(No.1): 63-72. Doi:10.4006/0836-1398-28.1.63

Patryk Sofia Lykawka, Takashi Ito. Is There an Earth-like Planet in the Distant Kuiper Belt?[J]. The Astronomical Journal. 2023, Vol.166(No.3): 118. Doi:10.3847/1538-3881/aceaf0

Roberto Rojas. Moment of inertia through scaling and the parallel axis theorem[J]. Revista Brasileira de Ensino de Fisica. 2019, Vol.41(No.1): 1. Doi:10.1590/1806-9126-RBEF-2018-0146

Rosser, J.D, Bauer, J.M., Mainzer, A.K, Kramer, E, Masiero, J.R, Nugent, C.R, Sonnett, S, Fernandez, Y.R, Ruecker, K; Krings, PWright, E.L. Behavioral Characteristics and CO+CO2 Production Rates of Halley-type Comets Observed by NEOWISE[J]. Astronomical Journal. 2018, Vol.155(No.4): 164. Doi:10.3847/1538-3881/aab152

Sarah Caddy, Lee R Spitler, Simon Ellis. Toward a Data-driven Model of the Sky from Low Earth Orbit as Observed by the Hubble Space Telescope[J]. The Astronomical Journal. 2022, Vol.164(No.2): 52. Doi:10.3847/1538-3881/ac76c2

Sean N. Raymond, David Nesvorny, Simone Marchi, Carol A. Raymond, Christopher T. Russell. 15. Origin and Dynamical Evolution of the Asteroid Belt[J]. Vesta and Ceres. 2022: 227-249.

Slava G Turyshev1, Viktor T Toth. Evolving Morphology of Resolved Stellar Einstein Rings[J]. The Astrophysical Journal. 2023, Vol.944(No.1): 25. Doi:10.3847/1538-4357/acaf4f

Spolter Pari. Kepler' s second law and conservation of angular momentum[J]. Physics Essays. 2011, Vol.24(No.2): 260-266. Doi:10.4006/1.3572227

Vincent F Giangaspero, Vatsalya Sharma, Johannes Laur, Jan Thoemel, Alessandro Munafò; Andrea Lani1, Stefaan Poedts. D for communication blackout analysis in atmospheric entry missions[J]. Computer Physics ray tracing solver Communications. 2023, Vol.286(No.0): 108663. Doi:10.1016/j.cpc.2023.108663

Wang Y., Li X., Chen Z. Recursive Verification of Network Protocol Stability Using Mathematical Induction[J]. IEEE Transactions on Communications, 2024, 72(8): 102-115. Doi:10.1109/tcom.2024.3098765

Yoshio Matsuki, Petro Bidyuk. The proof of hypothesis regarding distortion of time and space using the nuclear fusion model[J]. Sistemnì Doslìden ta Informacìjnì Tehnologìi. 2022, (No.1). Doi:10.20535/SRIT.2308-8893.2022.032.03

刘帅，杜翠花（中国科学院大学物理科学学院）．基于 LAMOST 对银河系晕星轨道偏心率的研究 [J]. 中国科学院大学学报, 2019, 36(3): 326-330. Doi:10.7523/j.issn.2095-6134.2019.03.00

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