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Theory of Dynamic Interactions: A Proposed Conceptual Framework for Celestial Mechanics Under Non-Coaxial Rotational Coupling

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ABSTRACT

This article presents the **Theory of Dynamic Interactions (TDI)** as a proposed extension of classical rotational dynamics and celestial mechanics [1-3]. The framework addresses a specific class of systems: **bodies with intrinsic angular momentum subjected to additional simultaneous rotational actions whose axes are not coaxial with the original spin**.

The central hypothesis is that, in this regime, the response of matter is not fully represented by a simple superposition of angular velocities or by the ordinary analytical separation of translational and rotational dynamics. Instead, TDI postulates an **induced coupling** between translational velocity, angular momentum, and the imposed non-coaxial angular action. This coupling is represented, at the operational level, by terms of the form $\Omega \times v$ and $\Omega \times L$, interpreted by the theory as **real dynamic contributions**, rather than merely coordinate effects.

The paper summarizes the conceptual motivation, generalized translational and rotational equations, an extended variational formulation, and a field-oriented interpretation intended to avoid the assumption of instantaneous propagation of rotational interactions. The result of our research project has been the book **New Celeste Mechanics** [4]. Possible implications for **precession, trajectory curvature, orbital-like motion**, and **disk-like celestial structures** are discussed in a cautious and testable form. The theory is not presented as a rejection of Newtonian or Eulerian mechanics, but as a restricted proposed extension, whose validity depends on independent quantitative replication and comparison with refined classical models.

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Introduction

Classical mechanics provides a powerful and extraordinarily successful description of rigid-body motion, gyroscopic precession, orbital dynamics, and a broad range of astronomical and engineering phenomena. The Newtonian and Eulerian formulations remain foundational because they have repeatedly yielded quantitatively precise predictions within their domains of application. The present work does not seek to replace this framework as a whole. Rather, it proposes that a restricted regime of rotational dynamics deserves separate formal treatment: **bodies possessing intrinsic angular momentum and subjected to simultaneous rotational actions whose axes are not coaxial**.

The **Theory of Dynamic Interactions (TDI)** was developed within a long-term private research program on rotational dynamics, and has been presented in the book **New Celestial Mechanics**. The theory argues that the usual separation between translation and rotation, while analytically effective in many ordinary problems, may become physically incomplete when a rotating body receives a new angular excitation around a different axis. In such circumstances, TDI proposes the emergence of **induced dynamic** responses that may include **transverse precession, curvature of trajectory**, and, under sustained excitation, **orbital-like motion**.

The contribution of this article is therefore conceptual and programmatic. It presents the theoretical structure in a form suitable for critical discussion in celestial mechanics and astrophysics, while explicitly recognizing the need for independent laboratory verification. The manuscript translates the main conceptual claims into cautious scientific language, distinguishes the proposed extension from standard mechanics, and identifies the experimental and astronomical contexts in which the theory could be tested.

A central requirement for the scientific assessment of TDI is the comparison of its predictions with those of refined Newton-Euler models, including all known torque, constraint, friction, aerodynamic, gravitational, and frame-dependent effects. Only if a reproducible discrepancy remains after such controls can the proposed coupling terms be interpreted as evidence for genuinely new physics.

Classical Framework and Restricted Scope of The Problem

In rigid-body mechanics, the evolution of **angular momentum** L is normally described by a **balance equation** relating its time derivative to the external torque τ. Euler developed a system of equations for the rotational dynamics of rigid bodies, and this formalism is standard in the study of gyroscopes, precession, nutation, and general rigid-body motion.

Classical mechanics also recognizes that finite rotations are not commutative [5]. It provides mathematical tools for treating complex rotational states, including body-fixed frames, inertia tensors, Euler angles, angular velocities, and torque balance equations. For this reason, the criticism advanced by TDI must be stated precisely. The point is not that classical mechanics lacks rotational dynamics, but that it does not identify, as a separate physical law, the response of matter when simultaneous non-coaxial rotational actions act on a body that already possesses intrinsic angular momentum.

The problem considered here can be stated simply. *Consider a rigid body moving with translational velocity v and rotating about one of its principal axes. Suppose that a second angular action is then applied about another axis, not coaxial with the original spin axis. The classical expectation is ordinarily formulated in terms of torque balance, angular momentum evolution, and reorientation of the body. TDI proposes that, under these conditions, this description* ***may not exhaust the physical response of the system***.

According to TDI, the mass does not respond solely through a simple vector recombination of angular velocities, nor only through the usual torque-balance scheme. Because the body possesses inertia and intrinsic angular momentum, the second non-coaxial rotational action may induce an additional dynamic response. This response is hypothesized to **couple translational motion and rotational state, modifying the direction of motion and the orientation of angular momentum**.

Fundamental Hypothesis of the Theory of Dynamic Interactions

The fundamental hypothesis of TDI may be stated as follows: **when a body with intrinsic angular momentum is subjected to a non-coaxial angular acceleration or rotational action, an induced dynamic interaction emerges** [6].

This interaction is not treated as a purely geometric recombination of rotational states. It is interpreted as a physical coupling between the pre-existing translational motion of the body and the new rotational action applied to it. In this framework, the response of the system is not represented by the simple algebraic expression

$$\omega_{resultant} \neq \omega_1 + \omega_2 \qquad (1)$$

because the theory assumes that **non-coaxial rotational actions generate induced transverse effects that cannot be reduced to such a direct vector addition**. TDI therefore proposes that, under these conditions, matter develops a **tendency to reorient its rotation** and **modify its trajectory** in a way that the theory interprets as a search for a more dynamically stable configuration. The equation (1) can be a sum of turns that are represented by their rotation speeds.

Rotation Reinterpreted as a Distributed Physical Process

A decisive conceptual step in TDI is the reinterpretation of rotation. Instead of treating rotation only as a kinematic descriptor associated with a rigid body, the theory treats it as a **distributed physical process**. The classical integral notion of angular momentum is not rejected; rather, it is reinterpreted as the global expression of an underlying distributed dynamic structure.

This reinterpretation leads TDI to question the strict independence often assumed between translation and rotation. In classical treatments, these two domains are frequently separated for analytical convenience. TDI argues that this separation becomes physically incomplete when a body has intrinsic spin and receives an additional non-coaxial angular action. The proposed coupling is therefore not merely a matter of coordinate transformation, but a hypothesized physical feature of the system.

The **field-oriented** interpretation also serves a methodological purpose. If rotational interactions are treated as physical processes distributed in space and time, then their propagation should not be implicitly assumed to be instantaneous. TDI therefore introduces the possibility of **rotational-field potentials** and a characteristic **propagation speed**, denoted $\mathbf{c_r}$, as part of a broader formal structure.

Emergence of the Coupling Term

The central mathematical proposal of TDI is that, when physical intrinsic rotation is present and when the additional **angular action Ω is not coaxial** with that **intrinsic rotation, a coupling term appears:**

$$\Omega \times v \qquad (2)$$

where v is the translational velocity of the body. In the interpretation proposed by TDI, this term corresponds to an **induced dynamic acceleration**, not simply to a coordinate artifact associated with a rotating frame. The operational postulate is therefore

$$\mathbf{a_{ind} = \Omega \times v} \qquad (3)$$

where aind denotes the **induced acceleration that changes the direction of the trajectory**. Since Ω × v is orthogonal to both Ω and v, it naturally contributes to curvature of motion without necessarily changing the magnitude of v. This geometric property is one of the reasons why TDI connects the **coupling term with orbital-like trajectories**.

The distinction from familiar inertial or Coriolis-type terms must be handled carefully. In classical mechanics, cross-product terms frequently arise from the use of rotating reference frames. TDI claims a different status for the term in Eq. (3): it is proposed as a **physical dynamic contribution in systems with intrinsic angular momentum and non-coaxial rotational excitation**. This claim is precisely one of the points that requires experimental discrimination.

Generalized Translational Dynamics

Starting from the preceding postulate, TDI proposes a **generalized form of Newton's second law** for the restricted regime under consideration. The ordinary expression for translational motion is

$$m\, dv/dt = F_{ext} \qquad (4)$$

where m is the mass of the body, and Fext represents the applied external force. TDI proposes that, **under non-coaxial rotational coupling**, this expression should be extended to

$$m\, dv/dt = F_{ext} + m\,(\Omega \times v) \qquad (5)$$

The added term is interpreted as the dynamic signature of **rotational-translational coupling**. Since the induced acceleration is transverse, the trajectory may curve even in the absence of an independently introduced central force, as the primary explanatory cause. This is one of the most ambitious and controversial consequences of the theory. The **flight of a boomerang** is often cited by the authors as an illustrative terrestrial case in which intrinsic rotation, aerodynamic action, and trajectory curvature are simultaneously present. It should be emphasized, however, that a boomerang also involves complex aerodynamic lift, drag, precession, and geometry-dependent effects, which should also be taken into account.

Generalized Rotational Dynamics

TDI extends not only translational dynamics, but also the angular momentum balance. For an external torque τ_{ext}, the proposed generalized rotational equation is

$$dL/dt = \tau_{ext} + \Omega \times L \qquad (6)$$

In this expression, $\mathbf{\Omega \times L}$ is interpreted as an **additional dynamic interaction** associated with **simultaneous non-coaxial rotational actions**. The conceptual objective is to describe **precessional behavior** not merely as the result of an externally imposed torque, but also as the natural manifestation of **internal dynamic coupling under non-coaxial rotational conditions**.

The theory therefore maintains that classical rotational mechanics is not false in ordinary contexts, but incomplete in this restricted regime. If Eq. (6) is correct, then the evolution of angular momentum in non-coaxial systems contains a contribution that is not reducible to the usual torque term alone. Whether this contribution is independent or can be absorbed into an appropriate classical description remains an open empirical question.

Variational and Field-Oriented Formulation

To provide a broader formal basis, TDI introduces an **extended Lagrangian** containing an explicit **translational-rotational coupling** term:

$\mathscr{L} = 1/2\ m\ v^2 + 1/2\ \omega \cdot I \cdot \omega + m\ v \cdot (\Omega \times r) - V(r)$

where $\mathscr{L}$ is the Lagrangian, I is the inertia tensor, r is the position vector, and V(r) is the potential energy. The crossed term

$$m\ v \cdot (\Omega \times r)$$

is interpreted as an **explicit coupling between translational and rotational dynamics** [7,8]. In a rigorous future derivation, this Lagrangian should be used to obtain the corresponding Euler-Lagrange equations, identify conserved quantities, specify symmetries, and clarify the conditions under which the standard equations of motion are recovered.

The theory also proposes a rotational-field description, including a representation through **vector potentials** and a **propagation equation** with a characteristic **speed** $\mathbf{c_r}$. The purpose of this extension is to avoid any hidden assumption of instantaneous propagation and to place rotational interactions within a field-like conceptual structure. This component of the theory requires further mathematical development, including dimensional analysis, boundary conditions, measurable field variables, and comparison with known formulations of continuum mechanics and field theory.

Recovery of Classical Mechanics as a Limiting Case

A necessary condition for any proposed extension of classical mechanics is the recovery of standard results in the **appropriate limit**. TDI claims to satisfy this requirement. When the body lacks relevant intrinsic rotation, when the additional rotational action is coaxial with the original spin, or when the coupling term is negligible compared with the dominant applied forces and torques, the additional terms $\Omega \times v$ and $\Omega \times L$ **vanish or become dynamically irrelevant**.

Under these conditions, Eq. (5) reduces to the ordinary Newtonian translational equation, and Eq. (6) reduces to the standard angular momentum balance. The theory is therefore framed as a restricted extension, not as a universal replacement. Its domain of possible novelty is **confined to systems where intrinsic angular momentum and non-coaxial angular excitation are simultaneously relevant**.

Experimental Motivation and need for Independent Replication

A theoretical proposal of this type cannot be sustained by conceptual ambition alone. The broader TDI research program refers to **experimental observations** involving different prototypes, including submarine-like devices, gyroscopic pendulums, rotating disks, anisotropic bodies, and suspended inertial systems [9]. The authors have interpreted the reported behaviors as evidence of dynamic responses not fully described by Newton-Euler mechanics, particularly when the systems involve simultaneous non-coaxial rotations and intrinsic angular momentum.

The project also reports **coherence between simulation and experiment**, and indicates that some prototypes were repeated by collaborators or third parties. Nevertheless, the decisive scientific step remains pending: **systematic independent replication** under controlled and quantitative laboratory conditions. Without such replication, the evidence should be treated as preliminary and motivating rather than conclusive.

A rigorous **validation program** should include calibrated instrumentation, systematic error analysis, uncertainty propagation, high-speed motion tracking, direct measurement of torques and angular velocities, controlled comparison with classical predictions, and clear reproducibility criteria. The experiment should be designed so that the predicted TDI contribution can be separated from known classical effects such as friction, constraints, aerodynamic forces, bearing asymmetries, gravitational gradients, internal vibrations, and reference-frame transformations.

Only through this process can it be determined whether the proposed coupling terms represent **genuinely new physics** or whether the observed effects can be absorbed into refined classical models. This methodological requirement is not secondary. It is the central condition for transforming TDI from a theoretical proposal into a validated physical theory.

Scientific Position

The scientific position of this paper should be expressed with precision. The authors do not claim that all of classical mechanics must be discarded. Nor do they claim that Euler's equations are useless for ordinary rigid-body analysis. Standard mechanics remains an effective framework for a very broad range of applications.

The claim is narrower: **the Newton-Euler framework may be insufficient as a complete general theory for bodies with intrinsic angular momentum subjected to simultaneous non-coaxial rotational actions**. In that restricted but potentially important domain, TDI proposes additional dynamic terms and predicts induced behaviors that are not fully captured, according to the theory, by the traditional separation between translation and rotation.

This position should make the theory testable. If the proposed coupling is real, then controlled experiments should reveal reproducible deviations from classical predictions under well-defined non-coaxial rotational conditions. If no such deviations are observed after careful testing, the theory would either require revision or would be reduced to a reinterpretation of already known classical dynamics.
Up to reaching these results, we have published more than one hundred seventy articles and presentations, and several books on the development of research:

- El Vuelo del Bumerán [10]
- Un Mundo en Rotación [11]
- El Señor Catalán
- Memoria Viva
- Imago Universi I y II
- New paradigm in Physics I y II [12]
- Siempre es posible… Un nuevo paradigma.
- New Celestial Mechanics [4]

More information about this theory can be found in the existing bibliography, or by accessing the portals:
https://advanceddynamics.net/
https://dinamicafundacion.com/

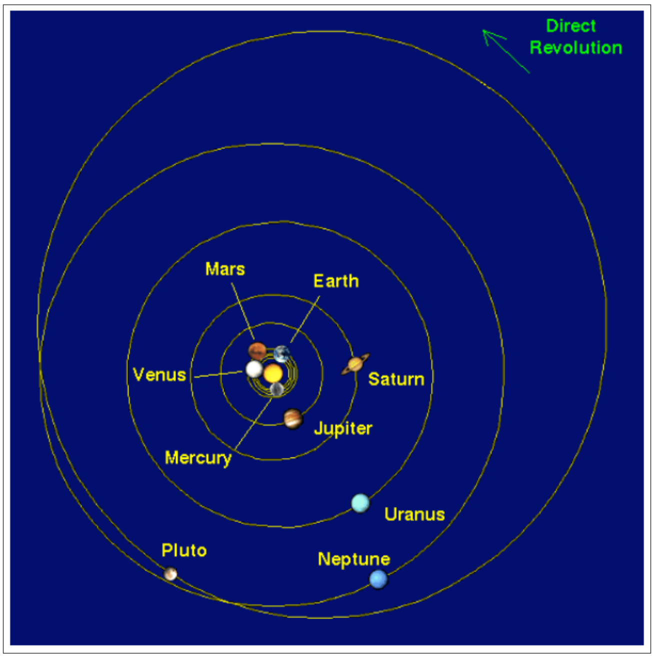

Figure 1: Schematic representation of the Solar System and the ecliptic plane [12]

Possible Application to Celestial Mechanics

TDI has been proposed not only as a theory of laboratory rotational dynamics, but also as a conceptual framework for celestial mechanics. Its authors argue that bodies in the cosmos often possess intrinsic spin and are simultaneously subjected to gravitational, collisional, and rotational interactions whose axes need not be coaxial. This makes celestial systems a natural domain in which the proposed coupling might be relevant.

The astronomical application must nevertheless be formulated cautiously. Planetary systems, rings, asteroid belts, debris disks, and trans-Neptunian populations are already studied within a sophisticated framework that includes gravitational dynamics, angular momentum conservation, accretion disk theory, resonances, collisions, various effects, migration, and dissipative processes. TDI should therefore be presented as a possible complementary interpretation or extension, not as a replacement for established celestial mechanics without quantitative evidence.

As a summary of our experiments, in September 2000 we proposed the following conclusions: …
The resulting movement, even though we are in three-dimensional space, will be planar orbiting, and all interaction movements of the same pair ***will lie in a plane that contains the pair****.*

Bodies endowed with intrinsic angular momentum and subjected to a single pair will not orbit in the space formed by possible spherical trajectories, but rather in the **space defined by the flat circles that contain the pair**. This same reasoning could also be applied to justify why our Solar System is also flat, or the common formation of multiple rings of satellites, like those of Saturn, and many other flat celestial systems, such as the Asteroid Belt, the Kuiper Belt, or the diffuse disk.

Therefore, we can infer that rotation and precession movements with closed trajectories and on a plane, which we can observe simultaneously in nature, may be due to dynamic interactions of an inertial nature (Corollary L10-C4) [13]. This means that if the variables remain stable, the orbital movement will stay in a plane. However, it's important to note that neither Kepler's nor Newton's mentioned laws refer to the intrinsic rotation of the planets, nor do they take this peculiar characteristic into account.

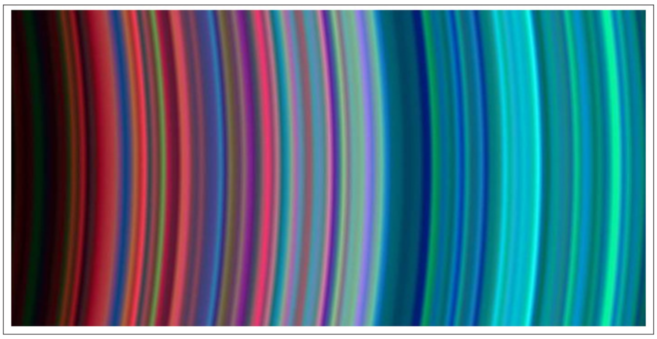

Figure 2: Saturn's Rings as an Example of A Highly Flattened Ring System Lying Close to The Planet's Equatorial Plane [14].

Our theory specifically proposes it: There is a physical correlation between rotational and orbital movements, which occur simultaneously in nature due to the inertial behavior of rigid solid bodies. Both movements will obviously be simultaneous, at least in the cases of rigid solid bodies with angular momentum, subjected to constant non-coaxial force pairs (Corollary L10-C2) [15].

All of this explains the flat structures we find in our three-dimensional universe, like the solar system or Saturn's rings [16].

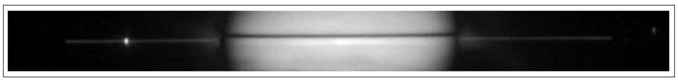

Figure 3: Saturn's rings [17]

The particular feature emphasized by the authors is **planarity**. Many celestial structures are approximately disk-like: the planetary orbits of the Solar System lie close to the ecliptic plane, Saturn's rings lie close to its equatorial plane, the asteroid belt is a flattened population between Mars and Jupiter, and the Kuiper Belt and scattered disk are disk-like trans-Neptunian structures with significant inclinations and dynamical subpopulations. TDI suggests that simultaneous rotational and precessional motions with closed or quasi-closed trajectories may be related to **inertial dynamic interactions** in bodies with angular momentum.

In the language of the theory, if the relevant variables remain stable, **orbital motion may tend to remain in a plane**. The authors connect this idea with previously formulated corollaries according to which bodies with intrinsic angular momentum subjected to a persistent non-coaxial torque, do not necessarily explore a spherical set of possible paths, but tend toward **planar circumferential motion**, associated with the **applied dynamic pair**.

This interpretation is suggestive, but it must be distinguished from proof. The flatness observed in many astronomical systems has so far been explained with different arguments: by the conservation of angular momentum during gravitational collapse, by the formation of dissipative disks, by damping through collisions, by resonance structures, or by long-term gravitational evolution. We understand that for the TDI to contribute independently to celestial mechanics, it must produce quantitative predictions that differ from these standard mechanisms, and can be tested observationally or numerically. We propose this possible alternative.

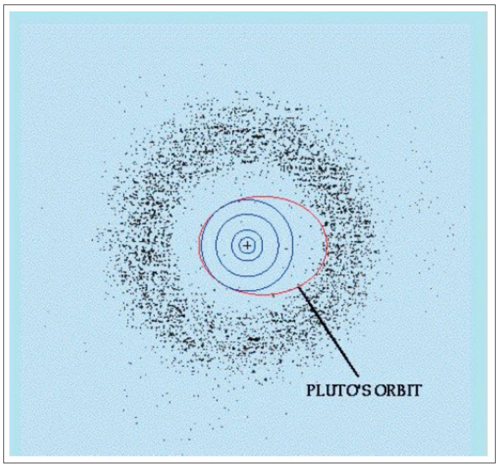

Figure 3: Schematic representation of the outer planets, the Kuiper Belt, and the scattered disk. The figure should distinguish flattened trans-Neptunian populations from the more distant Oort Cloud [18].

Disk-Like Structures and Boundary Cases

The **Solar System** provides several examples of flattened or approximately planar structures. The planetary system is organized close to the ecliptic plane; ***Saturn's ring*** system is a highly flattened disk; the ***asteroid belt*** occupies a broad but flattened region between Mars and Jupiter; and the ***Kuiper Belt*** is a trans-Neptunian population extending roughly from 30 to 50 astronomical units, with a concentration of objects in characteristic orbital families [19]. The ***scattered disk*** extends farther outward and overlaps dynamically with the Kuiper Belt in its inner region.

These structures can be used by TDI as candidate contexts to explore correlations between spin, orbital motion, and precession. However, a different case is the **Oort Cloud**, which is identified as a distant comet reservoir, not as a disk [20]. It is thought to be a thick ring or a bubble surrounding the Solar System, where the Sun's gravitational pull can be influenced by other celestial bodies. The Oort Cloud should be discussed separately, as a reservoir affected by galactic dynamic effects, stellar encounters, and the weak gravity of the Sun [21].

Proposed Observational and Numerical Tests

For TDI to become a productive research program in astronomy, it should generate predictions that can be compared with standard celestial mechanics. Several possible lines of inquiry are listed below:

- **Rotating-body laboratory benchmark:** Construct a rigid body with known inertia tensor and intrinsic spin, apply a controlled non-coaxial torque, and measure whether the trajectory exhibits a transverse acceleration beyond that predicted by Newton-Euler dynamics.
- **Gyroscopic pendulum benchmark:** Measure precession, nutation, and trajectory curvature under controlled torque conditions, using high-speed tracking and full uncertainty propagation.
- **Numerical comparison:** Implement Eq. (5) and Eq. (6) in a simulation and compare the resulting trajectories with those obtained from a classical rigid-body integrator under identical initial and boundary conditions.
- **Disk-formation sensitivity:** Explore whether a rotational-translational coupling term changes the stability, thickness, or precessional evolution of idealized disk-like systems compared with standard gravitational and collisional models.
- **Parameter estimation:** Identify whether a non-zero coupling parameter can be inferred from controlled data, or whether the best-fit value is statistically compatible with zero.

Limitations of the Present Work

This article is mainly conceptual and theoretical. It does not provide a new set of controlled experimental data, a complete derivation of all the field equations, or a full numerical comparison with celestial mechanics simulations.

A second limitation is that the proposed coupling terms resemble, in form, cross-product expressions that also occur in non-inertial frames. The differential interpretation of this text is that we understand them as physical coupling terms, in a specific regime of intrinsic angular momentum and non-coaxial rotational excitation. This is a falsifiable claim that can be confirmed through experiments and simulations, to distinguish it from the ordinary effects of a non-inertial frame. The theory must therefore be judged by its ability to produce quantitative predictions, not by qualitative similarity alone.

Figure 4: Kuiper telescope or alternative observational image [22].

Conclusions

The Theory of Dynamic Interactions proposes that rotational dynamics contains a **physically differentiated regime that classical mechanics** has not fully formalized: **the regime of multiple simultaneous non-coaxial rotational actions acting on bodies with intrinsic angular momentum**. In this regime, the theory proposes the emergence of induced interactions represented mathematically by coupling structures such as $\Omega \times v$ and $\Omega \times L$. These are interpreted as **dynamic effects**, rather than purely kinematic constructions. From this **perspective, precession, trajectory curvature**, and even **orbital-like motion** may emerge naturally from rotational-translational coupling.

The theory is best presented as a restricted extension of Newtonian and Eulerian mechanics, rather than as a rejection of them. Its strongest scientific formulation is also its most demanding: the proposed coupling **must be tested** through independent replication, controlled laboratory measurements, and quantitative comparison with refined classical models.

If confirmed, TDI could provide a new perspective on rotational dynamics, celestial mechanics, and space engineering. If not confirmed, the process of testing it would still clarify the limits of classical rotational modeling in non-coaxial systems. For these reasons, the theory merits critical attention, formal discussion, and direct experimental examination.

Declarations

Data availability: No new experimental dataset is included in this theoretical manuscript.
Experimental references cited by the authors should be made available to reviewers when requested.
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