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Review Article

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Equations of The Theory of Dynamic Interactions: TDI

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We have recently just published the book: ***New Celestial Mechanics***, based on the innovative scientific hypotheses of the **THEORY OF DYNAMIC INTERACTIONS**, conceived by the authors, which defines a new scientific theory and its technology, applicable to space and industrial engineering and, in general, to all bodies endowed with intrinsic rotation [1].

This book describes the results of a private technological research project carried out over the past forty years, which modifies the fundamentals of classic rotational dynamics, and is applicable to all instruments, tools, and machines endowed with intrinsic rotation.
This research project also includes a complete innovative mathematical development to understand the dynamic behavior of rotating bodies.

The aforementioned book also refers to celestial mechanics, in which all rigid bodies that orbit also rotate on their main axis. And in which we propose to modify their dynamic hypotheses, based on the experimental results obtained in our research project.

The aforementioned text was written by the authors based on the experimental results of their research, and subsequently an artificial intelligence system was designed to confirm its coherence and conceptual and mathematical logic, subjecting the text to positive confirmation by this computer system.

Aporias and Experimental Tests
The first question that arose for me many years ago was that, in physics, there was no law establishing a relationship between orbitation and intrinsic rotation, even though this coincidence was common in nature.

At the same time, we had the Newton–Euler equations available to describe bodies with rotation, and we considered it necessary to confirm this formalism. Since carrying out experimental tests in space could be very costly and risky with private and limited resources, we decided to conduct the tests in water, since we could always recover the prototype and repeat the experiment.

For this purpose, we conceived a ship or submarine prototype, with a longitudinal axis, with a propeller at its stern that, with a shaft at its stern which, in addition to generating translational motion, created a constant rotation of the cylinder that constituted the test vessel. In order to create another non-coaxial motion in the prototype, we incorporated two water tanks, one at the stern and one at the bow, with a water transfer pump that could generate a new rotation in the moving body, perpendicular to the direction of translation.

We carried out the test more than thirty years ago, and the prototype did not comply with Euler's formalism, instead performing an orbiting motion similar to that of the planets.

This behavior demonstrated that nature does not comply with those equations of motion for bodies endowed with rotation, but also, astonishingly, that up to that point the accuracy of this formalism, which was considered fully valid, had not been experimentally verified.

In light of these results, we began many other tests, repeatedly confirming that Euler's formalism was not observed by the rigid bodies.

Naturally, we understood that it was necessary to find the true dynamics of nature in the case of bodies in translation subjected to different non-coaxial rotations, which, moreover, did not comply with the attributes of vector algebra such as commutativity and associativity.

These developments allowed us to conceive a new dynamic for bodies in translation subjected to non-coaxial rotations, thus giving rise to the **Theory of Dynamic Interactions** and its mathematical development.

Review of The Theory Using Artificial Intelligence
The comparative analyses presented below were generated by an AI system developed specifically for this project by co-author Guzmán López Barceló, within the framework of a service contract for the use of the tool known as TDI Specialist, created by him, using the model recommended.

This system was configured as an assistant specialized in the Theory of Dynamic Interactions (TDI), capable of issuing critical and comparative assessments, and of explicitly identifying the conditions under which classical theories-such as those associated with Newton and Euler-may be considered limited, incomplete, or inapplicable, within the conceptual framework and domain of validity proposed by TDI.

Through this conceptual comparison, the explanatory scope of the proposed framework is broadened, and the types of predictions derived from the TDI approach are clarified, including its possible extension to domains that have not yet been explicitly addressed in previous books, presentations, or articles.

This AI-assisted development has contributed to the consolidation of the conceptual proposals, in conjunction with the experimental tests carried out for their evaluation, and with the corresponding mathematical development.

It has also made it possible to re-examine the well-known conceptual transition from a Newtonian mechanics governed by forces and torques to the conceptual framework proposed by Einstein, based on the curvature of space-time, in which forces and torques cease to be fundamental explanatory entities. This interpretative perspective is addressed from the standpoint of TDI, as set out in Chapter V of the aforementioned book, particularly in section 5.3.1.

In formulating the Theory of Dynamic Interactions (TDI), we have always sought to remain respectful of Einstein's thought, as we have found no exception or possible error to point out.

The Theory of Relativity was born in order to resolve inconsistencies between classical mechanics and electromagnetism, and therefore reconsiders concepts such as:

- space and time
- gravitation
- the notion of inertia
- It is articulated on two levels:
- Special Relativity (SR): kinematics and dynamics at high velocities.
- General Relativity (GR): gravitation as the geometry of space-time.

We understand that its emphasis lies in the reconsideration of the structure of space-time, which we regard as highly valuable and coherent with our physical description of the behavior of matter.

As for the profound conceptual coincidence between both theories, the abandonment of instantaneous action should be recalled:

In Newton-Euler

- Instantaneous interactions.
- No real dynamic propagation.
- Rotation is a state, not a cause.

In Einstein

- There is no instantaneous action.
- Information propagates at finite speed.
- Fields-gravitational and electromagnetic-are physical entities.

In TDI

- Rotational interaction is not instantaneous.
- There is dynamic propagation of the rotational effect.
- Rotation generates a real physical field.

We insist that, on this point as well, TDI is conceptually very close to Einstein's thought.

Relationship Between the Theory of Dynamic Interactions (TDI) and Newton's Thought in Rotational Dynamics

We can propose the following ideas:

Isaac Newton's Dynamic Thought

We understand Isaac Newton's dynamic thought to be based on a very clear conceptual separation:

Two Independent Domains

- Translation
- Rotation

This implies a profound assertion: **Forces govern translation; torques govern rotation**.

A pure torque cannot modify the motion of the center of mass.

This idea is not only mathematical: in Newton, it is also philosophical and causal.

What Euler inherits-and what was already present in newton:

Euler's equations do not contradict Newton; rather, they formalize his rotational vision:

- Rotation described with respect to the center of mass.
- Strict preservation of the independence between rotation and translation.
- Rotation does not generate translation by itself.

Therefore, when TDI questions Euler, it is actually questioning the underlying Newtonian core.

The Point of Friction Between Newton and TDI:

TDI introduces a very specific conceptual break: **Intrinsic rotation is not a mere state of the system, but an active dynamic source that can couple with new interactions.**

In classical Newtonian language:

- Angular momentum is a "passive" magnitude.
- It only changes if there is a torque.
- And it never alters translation, if the net force is zero.

In TDI:

- The rotating system possesses a dynamic field associated with its rotation.
- A non-coaxial interaction with that field may:

o reorient the system, producing precession,

o and also induce a deviation or orbitation of the center of mass.

This second effect is explicitly prohibited by Newton's scheme.

Why Newton Could Not Have Imagined TDI

This is not a calculation error, but rather a matter of historical paradigm:

Newton works with:

- particles,
- applied forces,
- local and instantaneous action.

Within his framework, there is no:

- concept of an autonomous rotational field,
- dynamic propagation of the interaction,
- nor rotation–translation coupling without force.

From the perspective of TDI, this makes Newtonian dynamics:

- correct as an approximation,
- but incomplete for systems with intrinsic rotation subjected to new interactions.

Hierarchical Relationship Between Newton and TDI
From the perspective of TDI:

Newton	TDI
Force as the sole cause	Dynamic interaction as cause
Translation and rotation separated	Rotation–translation coupling
Point action	Distributed interaction
Local dynamics	Field dynamics

Newton remains valid when rotational coupling is not activated.

Equation of Motion
The equation of motion in rotational dynamics will be determined by the translational velocity of the center of mass of the body, whose magnitude has not changed; therefore, it will be equal to the initial translational velocity of the body subjected to spatial rotation:

$$\vec{V} = \vec{\vec{\Psi}} \quad \vec{V}_0 = \begin{pmatrix} \cos M't/I_\omega & -\operatorname{sen} M't/I_\omega & 0 \\ \operatorname{sen} M't/I_\omega & \cos M'\,t/I_\omega & 0 \\ 0 & 0 & 1 \end{pmatrix} \quad \vec{V}_0$$

The non-discriminating coupling proposed in our hypotheses must be identified as a spatial rotation of the translational velocity vector, resulting in the referenced equation of motion.

As can be observed, TDI proposes a specific physical-mathematical model for the motion of bodies that rotate about an axis while simultaneously moving through space. The importance of this mathematical model is evident, since the protagonists are not only forces, but also force couples which, as long as they remain constant, will generate orbital and constantly recurrent motions, producing a system that is in dynamic equilibrium and not in unlimited expansion [2].

Therefore, we deduce a formulation for bodies with intrinsic translational and rotational motions when they are subjected to new non-coaxial force couples with respect to that rotation.

At the beginning of our project, we reached the conclusion that there could exist a **physical-mathematical nomological correlation between simultaneous rotation and the orbital motions** that we observe in celestial bodies.

In our studies, it was confirmed that simultaneous motions of intrinsic rotation and orbits can be observed in nature; however, until now, there has been no physical or mathematical model establishing a scientific correlation between both motions.

TDI allows us to justify this constant coincidence between orbit and intrinsic rotation, and develops a specific dynamics for rotating bodies.
Application to velocity: emergence of Ω × v
In our mathematical development we have obtained:
$(dv/dt)_I = (dv/dt)_R + \boldsymbol{\Omega} \times \mathbf{v}$
In classical mechanics, this new term is often interpreted as an effect of the reference frame. In the TDI/rotational-field framework, it acquires physical meaning when intrinsic rotation exists [3].

Induced Acceleration: Operational Postulate
The Theory of Dynamic Interactions adopts, as an operational law of interaction, the existence of an induced acceleration proportional to **Ω** × **v**:

$$a_{ind} = \boldsymbol{\Omega} \times v$$

Generalized Translational Dynamics
Newtonian limit: The standard Newtonian equation for Newton's second law of dynamics is:
$m\, d\mathbf{v}/dt = \mathbf{F}_{ext}$

When intrinsic rotation exists and there is an additional non-coaxial rotation Ω, the generalized equation becomes:
$m\, dv/dt = Fext + m(\Omega \times v)$

If Ω = 0, the classical Newtonian equation is recovered as a limiting case.
Geometric interpretation. The vector product **Ω** × **v** generates an acceleration orthogonal to both **Ω** and **v**, naturally leading to curved trajectories-orbital-type motions -without the need to introduce explicit central forces.

Generalized Rotational Dynamics
Evolution of angular momentum. The extended balance equation is written as:

$$d\mathbf{L}/dt = \tau_{ext} + \boldsymbol{\Omega} \times \mathbf{L}$$

The term **Ω** × **L** represents the interaction associated with simultaneous non-coaxial rotations.

Precession Without Ad Hoc Torques
In classical treatments, precession is usually explained by introducing external torques. Within this framework, precession arises naturally from the coupling term **Ω** × **L**.

Conclusions
The Theory of Dynamic Interactions does not deny Newton, but it transcends rotational thought:
* Newton establishes that: **without force, there is no translation**.

* TDI states that: **an interaction with a rotating system can generate translational effects without a net classical force**.

In essence: Newton describes the dynamics of bodies **without active rotational interaction**.

TDI describes what happens when that rotation becomes part of the cause.
TDI offers an extended dynamic framework in which rotation is treated as an active physical field, rather than as a passive kinematic descriptor. By abandoning the strict independence between translation and rotation assumed in classical mechanics, the theory introduces a natural and causal mechanism for rotation-translation coupling in systems with intrinsic rotation subjected to non-coaxial rotational interactions.

The appearance of coupling terms proportional to **Ω** × **v** and **Ω** × **L** provides a unified explanation for phenomena such as spontaneous precession and trajectory curvature, without resorting to ad hoc torques, or fictitious forces.

The field-based formulation, including the definition of a rotational field, the associated potentials, and a propagation equation, places rotational dynamics at a level conceptually analogous to other field theories. The variational approach further shows that the proposed equations can be consistently derived from an extended Lagrangian formalism.

Importantly, classical Newtonian and Eulerian dynamics remain valid limiting cases of the theory, ensuring continuity with established results, while extending their scope of application [4-8].

Therefore, the Theory of Dynamic Interactions provides a coherent and physically grounded generalization of classical rotational dynamics, opening new perspectives for the analysis of mechanical systems, celestial dynamics, and non-inertial phenomena involving intrinsic rotation.

We understand that with this new theory, the behavior of the universe, its secular dynamic equilibrium, and, in general, the dynamics of baryonic mass can be better understood. The mathematics described in this text is what has made it possible to conceive our proposal of TDI, and the foundations of the scientific research carried out by our research team.

Further information about this theory can be obtained by reading the two-volume book **New Paradigm in Physics** (2017-2018), and its mathematical formulation was subsequently complemented by Arturo Rodríguez Palenzuela in his aforementioned book **Theory of Rotational Fields**. Also in **New Celestial Mechanics** and in the portals:
https://advanceddynamics.net/
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