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ON THE EQUIVALENCE PRINCIPLE

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Our investigation team has been developing an independent research programme on *field theory of Rotational Dynamics*, which specifically applies to rigid rotating physical systems and which, in our opinion, has numerous and significant scientific and technological applications.

We believe that the achieved results allow us to obtain a new perspective in dynamics, perhaps unknown to date, making it possible to turn given trajectories which, until now, have been considered as chaotic, into deterministic terms. After a deep analysis of the Equivalence Principle, we have come to the conclusion that there still exists an unstructured scientific area in the present general assumptions and, specifically, in the analysis of rigid bodies exposed to simultaneous non-coaxial rotations.

For this purpose, it is necessary to analyze the velocity and acceleration fields that are generated in the body, and assess new criteria in these speeds coupling. In this context, reactions and inertial fields take place, which cannot be justified by means of the classical mechanics.

It is the aim of this Paper to briefly inform of the surprising results obtained, and to attract the interest towards the investigation of this new area of knowledge in *field theory of rotational non-inertial dynamics,* and of its multiple and remarkable scientific and technological applications.

I. INITIAL SPECULATIONS AND CONJECTURES

The Equivalence Principle refers to several related concepts dealing with the equivalence of gravitational and inertial mass, and to Albert Einstein's assertion: "We (...) assume the complete physical equivalence of a gravitational field and a corresponding acceleration of the reference system[1]."

It is possible to find new fields of research in the Equivalence Principle, and violations, in new rotational dynamics of non-inertial systems. The foundations of rotational dynamics might be relevant to unsolved significant problems in physics.

This physical principle, fundamental in the current relativistic physics has been found reliably in a free-fall system. However, a free falling observable in a gravitational field is only a very specific case.

Systems in the universe are in motion, in constant dynamic equilibrium, being the free-fall an exceptional example. In the real universe, the general dynamic behaviour of rigid solids is characterized by its dynamic equilibrium. Through time, orbitation coexists with the intrinsic rotation. This aporia, and also Professor Miguel A. Catalán’s[2] conjectures were initial speculations.

In this scenario and not in the free-fall one, a significant exception may arise, if the starting points are non-inertial systems with specific dynamic assumptions: An observer could identify the nature of body motion and also identify if it is in a gravitational field, or if it is in an accelerated non-inertial system.

According to the proposed hypotheses, we can conceive a universe in constant dynamic balance, in which a force momentum, with a zero resultant, will, as long as it operates, generate a movement of constant orbiting, within a closed path.

The importance of this mathematical model is obvious. In this model not only the forces are leading players, but also the momentums of those forces which, while staying constant, will generate orbiting and constantly recurrent movements, generating a system in dynamic balance, and not being in unlimited expansion. This new dynamics theory will give us a better understanding of how universe and matter behave.

We would suggest a detailed and deep analysis of these dynamics hypotheses and propose continuing experimental testing necessary for confirmation. This would require the tests with models in orbit and with intrinsic rotation.

II. INVESTIGATION PROJECT

We have been involved in an investigation project of non-inertial systems, to know the behaviour of rigid bodies exposed to simultaneous non-coaxial rotations. As a result of this investigation we have proposed new hypotheses in order to explain the dynamic behaviour of these bodies, insisting on the need of extending our studies on field theory.

We define the inertial reactions that are manifested in the matter, when it is subjected to accelerations, such as *Dynamic Interactions* (ID). These are manifested in nature at any scale of magnitude. Any physical system and boundary conditions can be represented by a Lie group. The phase space of this dynamic is described in a quaternionic Kähler variety of 8-dimensional symplectic geometry. This would have two types of fields simultaneously: one corresponding to the actual applied forces and the other corresponding to inertial forces due to the *Dynamic Interactions* (DI) generated.

According to the *Relativity Principle of Galileo*, physical laws are identical in any system of *inertial reference*. Classical Mechanics, and even the majority of modern physical theories, have been formulated for inertial reference frames, their validity having been proven in said systems.

Nevertheless, beyond these limits there are other assumptions in nature whose laws of behaviour are currently still unknown to us. An example of this is the analysis of rigid solid bodies equipped with rotational movement. It is necessary in these cases to take into account possible inertial reactions.

Several experiments can be used for these assumptions, and the resulting observations are taken into account. We would propose the following:

1. **Multiple rotations.** A moving body exposed to two successive non-coaxial torques can react with two simultaneous non-coaxial turns. In this assumption, the co-ordinate system defined by a position vector and the Euler angles determining the orientation, does not identify the evolution of the position of each point of the moving element in a bi-univocal and coherent way with the movement of the body. It is therefore necessary to find a new suitable reference system for these assumptions.

2. **Gyroscopic momentum**. In the assumption of a body equipped with intrinsic rotation, the action of a new non-coaxial momentum generates an inertial reaction which is known as a *gyroscopic momentum*, which does not follow the laws of Classical Mechanics, and which finds itself clearly unstructured within. It is then necessary to incorporate this phenomenon and, in general, inertial reactions, into a logical and scientific structure within the scope of the mechanics.

These experimental references, and many others which can be suggested, infer the existence of a different non-Newtonian rotational dynamics, which is necessary for identifying the behaviour of rotating bodies, when they are exposed to new non-coaxial stimulations, and the behaviour of which is nowadays often interpreted as anomalous, paradoxical or chaotic, as the laws at our disposal do not allow to identify and predetermine it.

III. DEDUCTION

This new non-inertial and non-Newtonian rotational dynamics of accelerated rigid solid bodies can be inferred in different ways:

- Relativistic deduction.
- Rational deduction.

Relativistic deduction. Abstractly, one can mathematically infer a system of equations, which allows the comprehension of the fundamental interactions generated in nature. These equations show how the matrix of a tetra-dimensional rotation of a reference frame is associated with the inertial field T^{i}_{jk} originated by the rotation, and new motion equations can be deduced, hence a general expression of the motion equations in the gravitation theory of Einstein.

Rational deduction. In the assumptions of simultaneous non-coaxial rotations, the rigid body experiences non-homogeneous speed fields. These fields generate anisotropic acceleration fields. These acceleration fields can be interpreted as fields of inertial forces, created in space through the effect of simultaneous non-coaxial rotations.

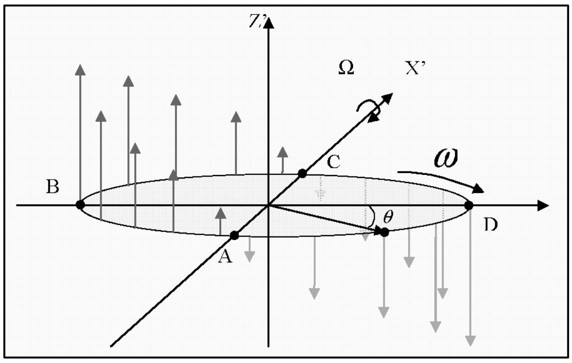


Fig. I. In a body with $\vec{\omega}$ speed rotation on its principal axis, when it is subjected to a new non-coaxial rotation $\vec{\Omega}$, a non-homogeneous field of speeds is generated.

This rational deduction can be amplified via an analysis inside the Fields Theory and its equations.

IV. INITIAL PARADOX

We express a paradox that allows us to introduce the concept of rotational inertia. When a body, with rotating intrinsic movement, is not submitted to external forces (or to its moments), according to the equations of Newton-Euler's mechanics:

$$d/dt\,(I\boldsymbol{\omega}) = 0 \quad (1)$$

Result: $\boldsymbol{\omega} = Const.$,

Where I is the moment of inertia of the body, and $\boldsymbol{\omega}$ is its angular speed.

The angular speed will be kept constant eternally due to its inertia.

Any rotation is an accelerated motion, since the linear velocity of every particle of the rigid body, though it remains constant in module, will be constantly changing position. But being ω constant, we find the contradiction of having the example of a rotating movement accelerated by inertia, without any external force. This allows us to suppose the existence of one **Rotational Inertia**, fundamentally different from the Translational Inertia.

Rotational Inertia, which would correspond to the inertia of the body when it has a movement of rotation. It will tend to maintain this rotation, despite the cessation of forces acting on it.

From the concept of rotational inertia, it is easy to infer a dynamic model based on constant rotation. A system maintains a constant angular speed when two points of the system remain in time, in the same dynamic state. In this case the system is in a state of **constant rotation** on a fixed axis.

V. AXIOMS

This rotational dynamics is based on the principles of conservation of certain measurable quantities: **the motion quantity, the total mass and total energy**. And also on these concepts: Dynamics interactions, speed coupling, rotational inertia and constant rotation.

From these principles of conservation of measurable magnitudes, and after the observation of the inertial reactions that occur in nature, we can deduce certain specific axioms:

1. **The rotation of space determines the generation of fields.**
   From a relativistic point of view, an intrinsic rotation can be interpreted as a fixed moving element plus a turn of the space of events which contains it. Two intrinsic non-coaxial rotations might be interpreted as two turns of the space of events around different axes.
   We can observe in a body two intrinsic non-coaxial simultaneous rotations around different axes. In this case, the rotation of space determines the generation of anisotropic speeds and accelerations fields.

2. **Result of the action of non-coaxial moments**
   When a solid is subjected to non-coaxial successive moments, non-homogeneous distributions of speeds and accelerations are generated. These can be identified as inertial fields.

3. **Inertial fields cause dynamic interactions.**
   The anisotropic speeds fields generated, interact with other fields of the rigid body, changing its dynamic state. For instance, <u>the non-homogeneous velocity field that is generated is coupled to the field of translation speeds.</u>

4. **The action of successive non-coaxial torques on a rigid body cannot be determined by algebraic addition or calculated by the resultant force or torque.**
   This axiom reminds us of the impossibility of the use of vector algebra to solve these phenomena.

We understand that the inertial behaviour of the mass of the rigid solid body, when exposed to these movements has not been studied thoroughly.

VI. MOTION EQUATION

Based on the **Principle of Conservation of the Motion Quantity,** we can obtain the motion equation. The fields of speeds determine the behaviour of the body.

We can interpret that the gyroscopic momentum does not exist physically, as it simply is the observable effect of a field of inertial forces generated by the simultaneous, non-coaxial, rotation of space. In any case, the gyroscopic momentum **D** will be equivalent to the one acting from the outside **M´**:

$$\mathbf{M'} = \mathbf{D}$$

Nevertheless, the referred gyroscopic momentum has been quantified through multiple methods of the classical mechanics with the following formula:

$$D = I\,\Omega\,\omega \tag{2}$$

Therefore we can infer that the field of inertial forces generated in the rotating space by a new non-coaxial momentum M', upon a moving body with a rotatory movement $\vec{\omega}$ and an inertial momentum I upon that rotation axis, and thus with an angular momentum $\vec{L}$, will oblige the moving body to acquire a precession speed $\vec{\Omega}$ defined by the scalar quotient:

$$\Omega = M' / (I\,\omega) = M' / L \tag{3}$$

The precession speed $\vec{\Omega}$ can be observed simultaneously with the initial $\vec{\omega}$, which remains constant within the body. Instead of the discriminating Poinsot[3] hypothesis, in the case of translation movement of the body, we propose the dynamic hypothesis which states **that the field of translation speeds couples to the anisotropic field of inertial speeds generated by the second non-coaxial momentum**, forcing the center of masses of the mobile to modify its path, without an external force having being applied in this direction.

We obtain an **orbiting movement, which is simultaneous with the constant intrinsic rotation of the moving body**. This new orbiting movement, generated by a non-coaxial momentum, is defined by **the rotation of the speed vector**, the latter staying constant in module.

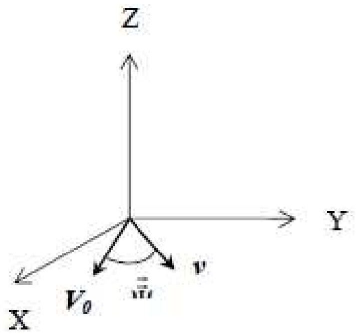


Fig. II: The rotational operator $\vec{\vec{\Psi}}$ transforms, through one rotation, the speed vector $\vec{V}_0$ into the speed vector *v*, both always situated on an identical plane, in this example on the XY plane.

In the assumption of figure II, the new external momentum *M´*, which is supposed to be located on the *X* axis, will generate an inertial rotation around the *Z* axis, so that if M` and the initial translation vector $\vec{V}_0$ was located on the *XY* plane, the resulting speed *v* will stay on that plane after the rotation. Therefore, the special rotation matrix $\vec{\vec{\Psi}}$ will be as follows:

$$\begin{pmatrix} \cos\alpha & -\text{sen}\,\alpha & 0 \\ \text{sen}\,\alpha & \cos\alpha & 0 \\ 0 & 0 & 1 \end{pmatrix}$$

And will, in our assumption, generate a turn of the referred translation vector $\vec{V}_0$ in that *XY* plane. As **motion equation** we then obtain:

$$\vec{v} = \vec{\vec{\Psi}}\ \vec{V}_0 . \qquad (4)$$

But, as:

$$\alpha = \Omega\, t, \qquad (5)$$

And, according to equation (3):

$$\alpha = M'\, t/\,(I\,\omega) \qquad (6)$$

The motion equation finally can be written:

$$\vec{v} = \vec{\vec{\Psi}}\ \vec{V}_0 = \begin{pmatrix} \cos\ M'\,t/\,I\omega & -\text{sen}\,M'\,t/\,I\omega & 0 \\ \text{sen}\,M'\,t/I\omega & \cos M'\,t/I\omega & 0 \\ 0 & 0 & 1 \end{pmatrix} \vec{V}_0 \qquad (7)$$

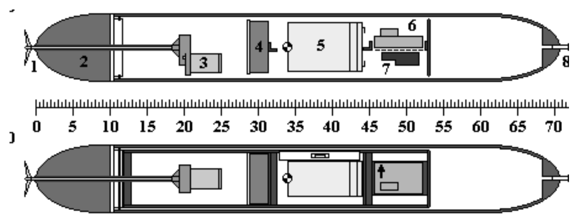
The rotational operator $\vec{\vec{\Psi}}$ transforms, through one rotation, the initial speed vector $\vec{V}_0$ into the speed vector v, both always situated on an identical plane.

So we can associate **dynamic effects to speed and a clear mathematical correlation between rotation and translation**. This mathematical connection allows us to identify a physical relation between **transfers of kinetic rotational energy to kinetic translation energy, and vice-versa.**

VII. EXPERIMENTAL TESTS AND PHYSICAL-MATHEMATICAL SIMULATION MODEL

The starting hypotheses as well as the mathematical model were confirmed by a series of experimental tests and also by a physical-mathematical simulation model of this behaviour.

LATERAL VIEW



UPPER VIEW

Fig. III: Design of the remotely controlled submarine: 1. Propeller; 2. Stern; 3. Motor; 4. Ballast; 5. Battery; 6. Velocity changer; 7. Radio control receptor; 8. Pressure valve

The challenge was to find a mobile with simultaneous angular momentum and linear speed. Because of the difficult availability of a device with these characteristics in space, it seemed sensible to continue the experiments with bodies floating in water. In this hypothesis, a cylinder or "Torpedo submarine" could be designed rotating around its longitudinal axis while at the same time driven by a propeller on its stern, provided as well with a gravitational torque perpendicular to the rotation axis. We make two different prototypes:

I Fixed torque Torpedo submarine, with constant unbalance.

II Variable torque Torpedo submarine, with pump and two deposits for water.

In accordance with the proposed dynamic hypotheses, a simulation of the behaviour of this solid in space, with intrinsic rotation and simultaneously submitted to an external momentum non-coaxial with its intrinsic angular momentum was realized, obtaining open or closed traces, equivalent to the trajectories of real bodies in space.

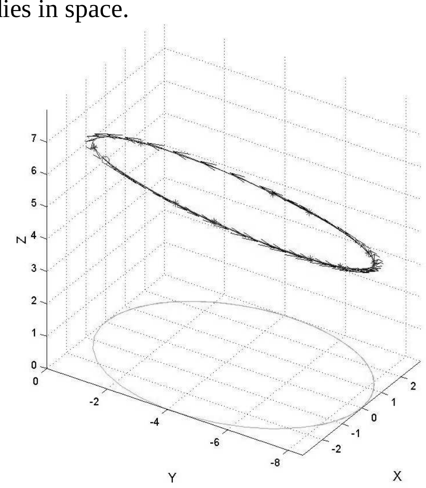


Fig. IV. Path of the mass center of a mobile with intrinsic rotation and simultaneously submitted to a non-coaxial external momentum with its intrinsic angular momentum, obtained via computer simulation, in the supposed case that both, the applied moment and the translational linear speed of the mobile are constant. Simulating conditions: Tangential speed 5 m/s.

Also, quite a number of examples can be thought of for checking these dynamic hypotheses, which would allow us to interpret many, in our opinion, still unexplained assumptions in nature, using the interactions which result from rotating the space of events, as for example, the behaviour of so many rotating solid elements like the boomerang, the hoop or the wheel.

In the case of the hoop or the wheel, one can observe that a non-homogeneous field of speeds is generated as a result of the overturn momentum. The variations of this non-homogeneous field of speeds also generate an anisotropic field of accelerations, which we can identify through its inertial effects. But it has to be stressed that, according to the proposed theory, **the non-homogeneous field of speeds couples to the field of translation speeds, generating a new trajectory of the mass centre**.

The same phenomenon occurs in the case of balls with spin effect, where non-homogenous speed and acceleration distributions are generated, which can be represented in a section of the mobile body. In the assumption of a football with intrinsic rotation, like the *Jabulani*, when being kicked eccentrically, a new non-coaxial momentum with the existent rotation can be generated. The speeds' distribution of which couples, according to our hypotheses, to the field of translation speeds, causing a curvilinear trajectory.

Another example of the theory is the feared *roll coupling* of aeroplanes. It happens when a plane, which is flying a screw or any other kind of air acrobatics which implies, for example, a turn around its main inertia axis, starts a new steering manoeuvre with curved trajectory. According to the supported dynamic hypotheses, **the non-homogeneous distribution of speeds, generated by the new non-coaxial rotation of the plane mass, couples to the field of translation speed**, causing an unintentional deviation of the trajectory as well as a possible loss of the plane control. This, and many other examples, can be easily explained with the hypotheses of our *Theory of Dynamic Interactions (TID).*

This new non-inertial rotational dynamics is developed in laws and corollaries, allowing a number of new, unknown scientific and technological applications. These *Rotational Dynamic Laws* are based on the inertial impossibility of matter to change their dynamic state in certain cases and propose the concept of ***rotational inertia*** as an *invariant of mass*. These laws are understood as a negation of nature to selective and discriminating couples established by Poinsot, and allow developing an alternative and specific *Theory of Dynamic Interactions (TID)* for bodies with angular momentum.

VIII. GENERALIZATION OF A NEW CONCEPT OF ROTATIONAL MECHANICS

As we expressed in the beginning, the Classical Mechanics has been formulated for inertial reference frames, and not for rotating spaces of events. Nevertheless, it is possible to think of a new mechanics for any type of space, adding their inertial reactions and defining a *Dynamics of Inertial Fields*. So the inertial phenomena would also get rationally structured and incorporated into a unified mechanics.

In order to incorporate the inertial phenomena into the structure of physical knowledge, we propose to analyze the motion in **non-holonomous coordinates** and the resulting axial reactions, in the understanding that this mechanics, as the classical mechanics, based on holonomous coordinates and polar reactions, will only represent a limited and partial view of nature.

The proposed generalization does not say that classical mechanics is obsolete or wrong, but simply that it is partial and limited, as it refers to the specific assumption of inertial systems. We are aspiring to be more ambitious, looking for more general dynamic laws, which establish the behaviour of moving bodies when rotating, or even when they are exposed to multiple non-coaxial rotations of the space of events.

The *Theory of Dynamic Interactions (TID)* generalizes the concept of gyroscopic momentum and of other inertial phenomena, incorporating them into the unified structure of a new non-inertial rotational dynamics.

Initially we proposed an “imaginary nature”. This has led to a new rotational physics theory over time, once the initial dynamic hypotheses were sufficiently checked by means of experimental tests, observing the behaviour of the physical nature, and once the designed computer simulation model qualitatively coincided with numerous real examples. This was the way how the theory was designed, which helps us to understand a universe in constant dynamic equilibrium, in which a force momentum, with a zero resultant, will generate, as long as its action lasts, a movement of constant orbiting within a closed trajectory.

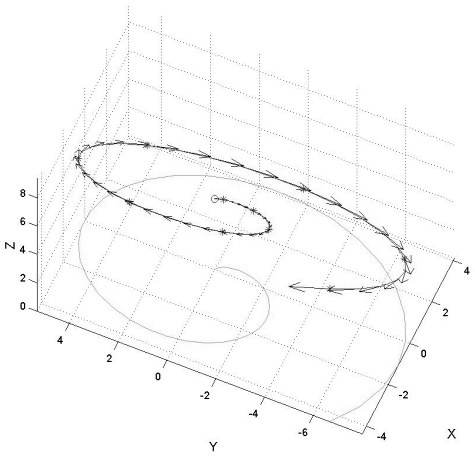


Fig. V: Path of the mass center of a mobile, obtained via computer simulation, in accordance with the mathematical model of dynamics interaction, in the supposed case that the applied moment is constant, but the translational linear speed of the mobile is variable.
Variable tangential speed according to S = 5 + 0,2* t(m/s). Constant torque, always perpendicular to the tangential speed vector.

We can compare results and confirm this similarity, as for the case of the boomerang, or the dynamics of the galaxies. Hence we can propose that, in the assumption of dynamic systems in which simultaneous movements of intrinsic rotation and orbitation can be observed, one can infer the possibility of the existence of *Dynamic Interactions* and a mathematical model composed of that new and simple motion equation:

$$\vec{v} = \vec{\vec{\Psi}} \ \vec{V}_0 . \qquad (4)$$

We analyze the inertial forces, including the **inertial reactions** and, specifically, the concepts of **rotational inertia** and **speed coupling** into the structure of a new rotational dynamics of non-inertial accelerated systems. Apart from allowing us a better understanding of the equilibrium of the universe, it makes it possible to conceive, for instance, the dynamics of the galaxies, and to explain the ecliptic or the rings of Saturn. We deduce that the rings may respond to the effect of a constant external momentum, within the scope of this theory.

Through multiple experiments we can confirm the supported hypotheses of our rotational dynamics theory, and we can propose numerous behaviours as tangible examples of the theory, arguing that the laws of classical mechanics, fully valid and tested, exclusively refer to assumptions of translation movements in inertial systems, non-accelerated by rotation, when in the universe and in nature the movement occurs with accelerations, especially in the assumptions of rotational dynamics.

We wish and are able to look for general dynamic laws, aiming to establish the behaviour of moving bodies when rotating, or even when they are exposed to multiple non-coaxial rotations of the space of events. Therefore, these general dynamic laws will allow us to predetermine the inertial reactions that will occur and their true dynamic effects.

The theory also allows to give an answer to an initial aporia: to be aware and to understand the **physical and mathematical correlation between orbitation and intrinsic rotation**, and therefore, the rational causality that we have day and night on earth, as our theory reflects a clear correlation between the intrinsic turn of earth and the route within its orbit.

In our opinion, the dynamic anomalies observed in the Pioneer space probes might be a consequence of inertial interactions due to the action of an external torque, according to the *Rotational Dynamics* which derives from the proposed theory. The space probes had intrinsic angular momentum, and therefore the action of any non-coaxial external torque, under the defended hypotheses, would generate an apparently anomalous acceleration on the probes.

Within the technological scope, the *Theory of Dynamic Interactions (TID)* allows many innovating applications, as for example the analysis of internal strains in moving bodies, due to internal efforts, or the term of coupling which suggests an energetic conversion in both senses, i.e. from rotational kinetic energy into translation kinetic energy or vice-versa, which leads us, for example, to the concept of dynamic lever. We can think of a dynamic lever with technological uses and practical effects. This dynamic lever would allow to design mechanisms in which the result of its action could be obtained without any energy consumption, thus the provided energy being recoverable.

Apart from designing a dynamic lever or energy conservation devices, the theory gives way to applications in the steering of mobiles in space, e.g.

aircrafts or submarines, or also on surfaces, like ships or land vehicles. In this case, the steering devices would be of very easy design and handling. The technological development of this theory allows many uses, including those for leisure and recreation or even the determination of the devastating effect of hurricanes.

IX. ON THE EQUIVALENCE PRINCIPLE

We have already proposed the aporia that through time, orbitation coexists with the intrinsic rotation and that in this scenario and not in the free-fall one, a significant exception may arise, with specific dynamic assumptions: An observer could identify the nature of the body motion, if the body has intrinsic rotatory movement.

Let´s suppose that an observer, apparently, remains in a stationary position in relation to the observed rigid body. If this body is subjected to a new non-coaxial torque with intrinsic rotation, two different observations may occur:

- The rigid body assumes a new intrinsic rotation, coexisting with the existing non-coaxial one, but does not change its relative position in space, or
- The observed body diverts its path in relation to the observer, not assuming new intrinsic rotation.

In the first case, the observer can infer that the observed body does not move in space: has zero intrinsic translational speed.

In the second case, the observer may conclude that the observed body has travel speed, and therefore, both are moving in space. Also the observer can even infer that travel speed is constant, if the moment remains constant and the body launches a closed orbital path (Fig. IV). And instead, we can infer that its own translation movement is accelerated, if the observed body begins a spiral path (Fig. V). And this is true even if it is able to distinguish their decelerated or accelerated movement, depending on whether the trajectory of the body observed is in a downward or upward spiral.

These deductions may be inferred from the hypothesis of coupling of the velocity field of translation with the velocity field generated by the new torque acting, non-coaxial with the intrinsic rotation previously existing in the observed body.

X. CONCLUSIONS

With the field theory it is possible to find new areas of research in new rotational dynamics of non-inertial systems. The foundations of rotational dynamics might be relevant to unsolved significant problems in physics. In this case, we obtain a non-relativistic **rational field theory.**

The present text is only a brief referential summary of the works carried out during the last twenty years in order to propose a *field theory of Rotational Dynamics of Interactions* applicable to bodies submitted to multiple successive non-coaxial torques. The initial hypotheses are based on new criteria about **speed coupling and rotational inertia**, and have been confirmed by experimental tests and by a mathematical model allowing the simulation of the real behaviour of bodies submitted to these excitations. A clear correlation between the initial speculations, the starting hypotheses, the mathematical simulation model, the axioms and deduced behaviour laws, the realized experimental tests and the mathematical model corresponding to the movement equations resultant of the proposed dynamic laws, have been obtained.

This research can be extended with other formulations of the Field Theory and with a relativistic deep analysis, according to the Moshe Carmeli criteria[4], and may allow the physical knowledge of new space systems and bring potential applications for the future, along with numerous relevant technology developments to prepare the future orbital infrastructure.

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We want to suggest that interest should arise in physics in the exploration of non-inertial accelerated systems, and also to express a call for the need to develop scientific investigation projects for their evaluation and analysis, as well as technological projects based on these hypotheses. In our opinion, these hypotheses suggest new keys to understanding the dynamics of our environment and the harmony of the universe. A universe composed not only of forces, but also of their momentums, and when these act constantly upon rigid rotating bodies, with an also constant translation speed, the result is a closed orbiting movement, thus a system which is moving, but within a constant dynamic equilibrium.

The application of these dynamic hypotheses to astrophysics, astronautics and to other fields of physics and technology possibly allows new and stimulating advances in investigation.

The result of this project is the conception of an innovative dynamic theory, which specifically applies to rigid rotating physical systems and which has numerous and significant scientific and technological applications, especially in orbital dynamics, orbit determination, and orbit control. For instance:

- Variation of the affecting torque, arises when subjecting intrinsic angular momentum bodies to new non-coaxial momentums.

- To conceive an intrinsic rotating mobile solid, which could be exclusively controlled due to Dynamic Interactions.

- To calculate the trajectory of any intrinsic angular momentum solid in space.
- To propose a new steering system independent from a rudder or any other external element.

We can suggest advances in the studies and application related to orbital mechanics, guidance, navigation, and control of single or multi-spacecraft systems as well as space robotics and rockets.

Anyone interested in cooperating with this independent investigation project is invited to request additional information at:

gestor@advanceddynamics.net

Or to go to:

www.advanceddynamics.net.

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1 Albert Einstein, "Über das Relativitätsprinzip und die aus demselben gezogene Folgerungen," *Jahrbuch der Radioaktivitaet und Elektronik* (1907); translated "On the relativity principle and the conclusions drawn from it," in *The collected papers of Albert Einstein. Vol. 2: The Swiss years: writings, 1900–1909* (Princeton University Press, Princeton, NJ, 1989), Anna Beck translator. This is Einstein's first statement of the equivalence principle.

2 Professor Miguel A. Catalán Sañudo. Spectroscopist. (Zaragoza 1894-Madrid 1957). Referred to *Un Mundo en rotación.* (Gabriel Barceló) Ed. Marcombo 2008, page 56.

3 Poinsot, L. *Théorie nouvelle de la rotation des corps*, 1834, referred to Gilbert: *Problème de la rotation d'un corps solide autour d'un point solide*, Annals Société Scientifique de Bruxelles, 1878, page 258 and by G. Barceló: *El vuelo del Bumerán*. Ed. Marcombo 2006, page 121.

4 Moshe Carmeli (Ben Gurion University, Israel). *Rotatory relativity*, 1986