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THE PRECESSION OF THE ROTATION AXIS OF A SPHERE ROLLING ON A ROUGH SURFACE EXPLAINS THE ONE OF EARTH EQUINOXES: BY HIS DISPLACEMENTS IN ORBIT AND ROTATION IN AN ENERGY SPACE-TIME TRIQUANTIC EVTD^2

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Abstract: *The paper extends the theoretical and experimental researches on the mechanical behaviors of a sphere rolling on a rough surface [1]. Experimentally, the ball is initially animated in a rotation movement around an axis parallel to the surface, and then gently dropped to evolve following its initial rotation on the rough surface. The findings show perfectly a precession movement of the rotation axis during a linear trajectory. This behavior agree with the approach in theoretical mechanics which is proposed in [1], so it is the roughness on the surface that is the cause of this precession in such cases. By analogy, the very long duration of precession of the equinoxes of Earth (almost spherical and slightly rough) recommends that Earth, in contact with a space-time EVTD2 quantum sorting, creates by its rotation mechanical effects due to an equivalent of roughness between its surface and space energetic Substratum (dark matter and energy).*

Key words*: sphere mechanical precession, equinoxes' precession, EVTD^2 entities theory, quantic Substratum, tri quantic space-time.*

1. INTRODUCTION

The theoretical mechanical study of movements resulting from the rotation on a rough surface of a sphere in free, is in perfect correlation with the experimental results which has been jointly made over the same work [1].

This leads to findings and highlighted to a mechanical behavior of precession for the initial axis of rotation of the sphere who makes a pseudo free trajectory; but subject to the effects of the surface roughness. It is mainly, from an initial rotation, the spherical symmetry of the body and surface roughness that cause the effect observed precession [1].

The roughness is in this case resembles a slight brake on the free rotation of the ball. This has as effect to gradually tilt the circumference of spherical body, initially on a side or on another of the vertical.

Thus, the immediate consequence is a slight displacement of the rotation axis orientation. Initially, the inclination of this axis is evolving in a sense to a maximum displacement. Then this tilt is reversed until up to another maximum which is the symmetrical position of the first maximum compared to horizontal position initial. Then the process switches back to reverse, which finishes first precession etc.

The study of this process in theoretical mechanics, as it will be, summarized here, from [1], shows the exact compliance with the experimental results.

Further, the problem will be to integrate, at best, the facts and the conclusions of this major study in important physical phenomena that prevail in the precession movement of the Earth equinoxes.

Thus a new explanation will be delivered on a virtually spherical celestial body (Earth) somehow "rolling" along its orbital trajectory around the Sun, in a certain space-time EVTD[2].

The classic explanation of the Lunar and the solar gravity influences on the equatorial bulge will be, here, not taken into account.

The space-time, in which evolves the Earth is considered in this study, as quantum in dimension, time and also in diffuse energy EVTD[2] [2-9]. Specifically, the latter is due to the vibration of the Substratum: this one being the representative common substrate of dark matter and energy [10]. This energy of Substratum is the result of actions in vibratory phases, at Planck frequency, of EMW (electromagnetic mother wave) whose propagation is longitudinal [2-9].

Therefore, the orbital travel of the Earth takes place in a space structured into EVTD[2] entities that are all small cubes very energetic, comparable to a very fine roughness by their quantum grainy texture and in a permanent state of vibration.

2. SUMMARY DEMONSTRATION IN MECHANICS FOR THE ROTATION AXIS PRECESSION OF A SPHERE ON A ROUGH SURFACE

Considering a rolling sphere on a rough surface, it is known that the speed of contact point and the friction force have the same direction. In the absence of other forces, the sphere will be under the action of its own weight and the friction force.

From dynamic equations of motion are derived that a trivial solution of the system will match to ***zero value of the component of the instantaneous speed of rotation parallel to the rolling plane*** (given a fixed coordinate system with vertical O_1y_1 and the O_1x_1 direction parallel to the direction of the instant speed and the friction force, it will be *the nutation component,* $\dot{\theta}$).

Therefore, the instantaneous speed of rotation will be formed by the components perpendicular to the running surface (precession, $\dot{\psi}$ and own rotation, $\dot{\varphi}$, for the studied case of configuration described above).

If the nutation component is zero, both fixed and mobile Euler *xOy* plans will become parallel and line of nodes will be more determined. A differential equation in the instant rotation angle, of second degree with constant coefficients will describe the movement in this case. From here, it is easy to demonstrate a linear variation in time of the rotational speed and a straight trajectory of the sphere’s center.

This observation leads to an important conclusion: there is a moment after which, theoretically, the sphere will evolve in a movement of rolling without slipping.

Under the same conditions of sphere rotation on a real plane (rough), it can be posed the problem of the movement stability. We just have seen that the trivial solution is regarded as zero the rate of change of the angle of nutation.

Taking into account the possibility of the existence of a small perturbation in this direction, we consider that the sphere moves at a small constant angle of nutation.

Further, by analyzing the equations of motion of the body of Euler as well as by taking into account relatively simple transformations, we arrive to the conclusion that this small perturbation introduced small oscillations around the given position. Therefore, it can consider that ***the movement is a result of the superimposition of the initial movement with small oscillations, and it is remaining stable***.

For this type of movement, of a sphere on a rough surface, under its own weight the instantaneous speed of its center can be determined.

For this purpose are considered loading forces: the weight, the normal response of the support plan and the force of friction in the configuration described above. At the same time, another hypothesis has been imposed: for an enough high instant speed, the nutation component can be considered to be negligible (zero).

Through the impulsion and kinetic momentum theorem, applied on the analyzed sphere, it was found that its instantaneous rotation speed is described by an elliptic function, i.e. it is pseudo-periodical. In the same study we arrive at the conclusion that ***the speed of the mass center of the sphere rolling on a rough plan is periodic in time, by an elliptic cosine function***.

This theoretical study and its conclusions are based on the assumption that in the case of a sufficiently high rotational speed, variation of nutation can be neglected compared to the other of its components.

But a problem arises: does the true variation of nutation could not influence in a decisive way the theoretical results such as these are no more conclusive?

It was therefore necessary to experimentally verify the theoretical results. It resulted of theoretical studies, that components of precession $\dot{\psi}$ and own rotation $\dot{\varphi}$ are periodic over time by an elliptic cosine function, while the component of nutation is considered zero. This is equivalent to the instantaneous rotation speed is periodic during a certain interval of time.

To highlight this behavior, experiments have been developed to show the periodicity of a meridian marker drawn on the sphere and which had at the beginning a vertical position, in the direction along of travel.

If the theoretical conclusions are true, then meridian mark would perform a periodic movement on one side and on the other of this position. Therefore, it is necessary to highlight, during experimentation, a succession of meridian mark positions that will oscillate gradually on both side of the launch position.

The analyzed phenomenon was evolving in real time and, therefore, a visual, qualitative method of analysis of continuously successive positions was chosen.

The phenomenon was monitored at a greater speed than the discrimination speed of the human eye, of the moving body's successive positions.

Then, the images were processed by filtration, reduction to the contours, return to the initial dimensions, and reassembled in order to highlight the periodicity of the position of the meridian marker and the straight trajectory.

Multiple recordings of several sphere's trajectories, as well as the images treatment, also followed by statistical processing experimental data ***allowed to highlight a very good agreement between the theoretical findings and experimental results***.

3. THE PREVIOUS APPROACH IN THE UNDERSTANDING OF THE EARTH EQUINOXES PRECESSION

The Earth, in its orbital path, follows an elliptical trajectory around one of the foci occupied by the Sun. This path is located in the plane of the ecliptic which is linked to the movement of the sun itself.

This journey, in the context of the solar system, is due to the resultant between the force of gravity with the Sun and the centrifugal force due to natural space speed of the Earth around the Sun. In addition, it doubles with a permanent movement of intrinsic rotation around the axis of its poles.

We can assimilate the orbital as being a linear displacement on a long ride curved up to be finally closed. The "rolling surface" of the Earth during its orbital path around the Sun can be assimilated as a plan including the tangent to the orbit, in the considered point, and the perpendicular to the plane of the ecliptic. This is in order to integrate analogous the sphere movement (recalled in paragraph 2) on a rough surface for a short ride.

The similarity between the rotation of the sphere of the reference case and those of the Earth poses no problem in this context. It is the same for the precession of each of their axes of rotation only the length of Earth period is very long (about 25800 years). But this is apparently mechanically in agreement with a very low effect of equivalence to roughness between space-time in quantum energy and (rough) the Earth relief "rolling" on its orbital journey. But for such a long time, compared to the case of referenced ball in free rotation on a rough surface, it must be mentioned that *the linear and rotational speeds of Earth are maintained all times by EMW* [11-14].

They act by strongly lengthening the duration of the precession of the equinoxes compared to the period of precession of the ball that is in non-maintained rotation and, more in equivalence, on a surface much rougher. We should also mention, in EVTD[2] entities theory, the interactions between the (discontinuous) grainy structure of tri-quantic energetic space-time sorting with the gravitational potentials of the Earth [15] and [16], which are also of quantic energetic nature.

Especially during the rotation of the Earth, its potential of quantic distributions, structured following the Earth's surface relief will interfere, in front of the planet, with the identical structure but much more uniform of spatial organization of the orbital path. Then, it is logical to think that interactions are generated over time.

In addition they will serve in reaction towards the cause of the disturbance caused by movements of the Earth and its potential. These last intercept this uniformly structured space (Substratum, here, in form of dark matter) and which is, furthermore, maintained permanently by the vibration of the EMW. Indeed, the Earth and its potentials represent only a set of energy singularities in report with the well-established structure of this space-time $EVTD^2$. Therefore this reaction and the mechanical roughness will have similar effects on the spherical Earth and ball, in rotation on each of their rolling bands (orbit and flat surface). In regards with the Earth, this brake effect, ultimately very low, will cause a very slow trend to change the terrestrial sphere rolling circumference in its orbital path. This will therefore induce a certain inclination of its polar axis of rotation which will oscillate in a very long time between two maximum positions of its orientation.

The problem then, is to understand the basic phenomenology which induces the why of the maxima opposed the deviation of the axis during the orbital journey: this being done, step by step, in a nearly straight motion. This is to give an alternative evolutionary configuration that is balanced around an axial average position.

It is better to reason about the experience of the ball because it is human in scale and of short duration. First we must *try to understand why the initial tilt of the axis of rotation is caused*.

As soon as his contact, surely with a certain momentary shift, in free rotation on the surface with its axis parallel to it, the ball starts rolling along a circumference determined on its spherical surface. But moments later, under the disruptive effect and the light brake caused by the surface roughness, the initial rolling circumference of the ball will be changed and will encounter rough bumps that will change this rolling circumference.

The continuity of the ball rolling will tend to evolve into circumstances that enable its rotation to keep its initial speed as long as possible, and its axis to maintain at best its orientation.

Reviewing, more specifically, the area surrounding the contact of the sphere with the surface we understand that if the ball tilt to one side or the other in pursuit of the rolling, it will permanently change the circumference.

So, in this situation, *there will be less contact length followed on the sphere* and therefore the initial rotational speed can be better maintained despite the roughness brake. But in return, *the axis of rotation will be more inclined* as to continue of the initial momentum ***that imposes, by inertia, a linear trajectory*** on the rough surface.

It is this linearity of the trajectory and the high enough speed of the sphere which imposes a limitation on the evolution to too large increases in the speed of rotation because of axial tilt. Indeed, if the initial displacement velocity was very low, the tilt of the axis would become too great, during the phenomena and, so, the ball would follow a more curved trajectory (not straight) and she would eventually stop anywhere on the surface. Obviously, such is not the case here and, there must happen another phenomenon that manages to be at least equal in prevalence, at a given moment (where maximum tilt) compared to the tilt phenomenon. Then, it is the strength of this other phenomenon that takes the whole dominance to initiate a major reverse effect. So, the resultant of the effects first allows the balance of this observed deviation of the axis and then it initiates a behavior of compensation to previous disturbance. This logically must promote the progressive approach of the rotation axis in a horizontal direction. But this situation will continue beyond its momentum and by a new tilt to the symmetrical maximum of the first, where the mutual effects of compensation will be back to work for the same reasons. Thus, these different mechanical effects allow this phenomenon of precession to become periodic. Under this understanding and in conclusion, we can say that ***it is linear inertial motion of the ball who opposes more strongly to the amplitude of the ongoing rotation axis tilt***. This implies that this precession is permitted, periodically, in the limits between two maximal values that are defined by the mechanical characteristics of the case taken into account. We can even say that over time, the evolution of the angular value of the rotation axis inclination, describes an oscillation whose two extreme amplitudes are two maxima observed by experiments. Therefore, the specific period to this type of precession depend on the mechanical conditions for each of the considered cases: especially, the effect of roughness or its equivalent as well as maintained or not rolling movements of concerned bodies.

As it been already mentioned for the Earth, its *two movements are maintained, which minimizes the effect of roughness of EVTD^2 space with the Earth's surface rough and extends its precession period*.

4. CONCLUSION

This study, which takes as an example the mechanical behavior, theoretical and experimental, of a sphere rolling on a rough surface as to understand the behavior, in celestial mechanics, the Earth in its precession of the equinoxes, shows that this mechanism of the stars must be as possible attached to the general mechanics.

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Precesia axei de rotație a unei sfere în rostogolire pe o suprafață aspră o explică pe aceea a axei Pământului: prin mișcarea pe orbită și rotația în jurul axei proprii într-un spațiu-timp energetic tri cuantic EVTD²

Această lucrare prelungeşte teza referitoare la comportamentul mecanic teoretic și experimental a unei sfere în mişcare de rostogolire pe o suprafață aspră [1]. Experimental, sfera este antrenată de o mişcare de rotație în jurul unei axe paralele cu suprafața de rulare și apoi este lansată uşor spre a se rostogoli pe suprafața aspră. Observațiile arată perfect o mişcare de precesie a axei de rotație de-a lungul unei traiectorii liniare. Aceste fapte verifică demersul mecanic teoretic ce este, de asemenea, prezentat în [1] și astfel, rugozitatea pe suprafața de rostogolire este cauza acestei precesii în cazul studiat. Prin analogie, preconizează că foarte lunga precesiei Pământului (aproape sferic și uşor aspru), în contact cu un spațiu-timp tricuantic EVTD², este produsă prin rotația acestuia, rugozitatea între suprafață și *Substratumul* (materie și energie întunecată) energetic al spațiului.

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