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On the Possible Anomaly of Asymmetric Weight Reduction of Gyroscopes under Rotation

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Abstract In this work, we discuss a theoretical model that can describe novel phenomena of induction of weak anomalous forces in gyroscopes under right rotations either in rest frame of the laboratory or in free-fall. The effect detected in the gyroscopes cannot be successfully associated to any conventional theory. So, we elaborated the theoretical description of such forces in both experiments by means of a model based on the generalized quantum entanglement framework, by considering as quantum witnesses the magnetic permeability and as macroscopic observable the angular momentum of the gyroscopes rotors. Our calculations indicate that there is a good agreement with the experimental data obtained from literature for most rotation frequencies measured.

Keywords: *anomalous forces; gyroscopes; magnetic dipoles; quantum entanglement; magnetic permeability; quantum witness*

1. Introduction

In 1989 it was reported the existence of an anomalous effect in gyroscopes, concerning to the reduction of its weight due to their right rotation around the vertical axis on the Earth [1]. In order to understand the phenomenon, one can observe a basic scheme of the device in the Figure 1, in which one can observe that the strong magnetic field produced by the magnets guide the magnetic dipoles in the horizontal direction.

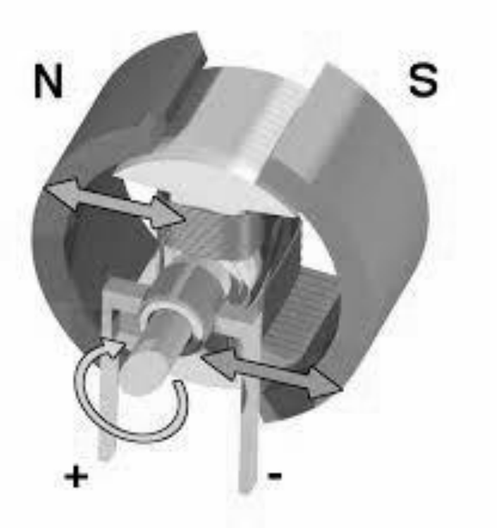

Figure 1. A simple scheme of a gyroscope (DC electric motor) with the detail of the rotor and the magnets that guide the magnetic dipoles of the rotor material.

The authors in [1] measured the weight of the device for different rotation frequencies and both clockwise and counterclockwise rotation motions. They found that there was reduction in the weight of the gyroscopes for right rotations but the effect did not occur for the opposite sense of rotation. Their experimental apparatus was constituted by a stator, a rotor and a rigid frame (gyroscopes); a chemical balance made of nonmagnetic material; a voltage amplifier and an oscillator that could switch the polarity in order to change the rotation frequency of the rotor and supplying the power to the gyroscope. All the setup was placed in a glass container under vacuum. The Figure 2 indicates a simplified scheme of the experimental setup used in the experiments. As one can see, the gyroscope was placed inside a vacuum container and it was fed by some electrodes through superfine wires so that the rotor frequency was achieved by providing an increase in the supply voltage and in the frequency of the oscillator. At left of the scheme, one can see a photo tachometer responsible for the measurements of rotor frequency (see Figure 2).

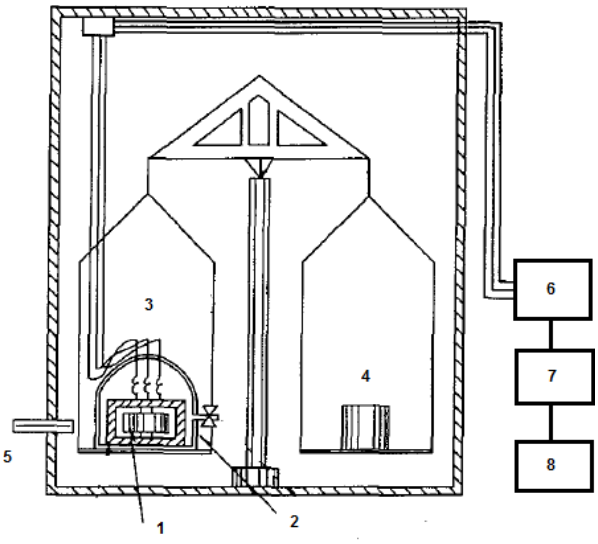

Figure 2. A simple scheme of the experimental setup implemented for the measurements of asymmetric reduction of weight of gyroscopes under right rotation, as published in more detail in Figure 1 of [1]. The main components indicated are: 1. Gyroscope rotor; 2. Vacuum container; 3. Electrodes; 4. Standard weights; 5. Photo Tachometer; 6. Ammeter with polarity switch; 7. Voltage amplifier; and 8. Oscillator.

So, they performed some sets of measurements of the device weight under right and left rotations, verifying that in the former there was always reduction of weight proportional to the frequency of rotation in both up- or downside configurations, but in the latter case there was no effect in any configurations considered. That break of symmetry has no classical explanation since that the magnetic coupling was not the responsible for the anomaly. In fact, measurements performed in the presence of some magnitudes of magnetic field and in the absence of that field showed no change in the values of weight reduction. Besides measurements of the japanese group for direct and reverse configuration of the setup indicated that the force measured did not change its upward direction, a feature which would be observed in case of magnetic influence.

After the report of the effect, there was interest of other groups in order to verify its real existence and similar experiments were implemented in order to reproduce the weight reduction, but there were null experimental results [2-4]. However, it is interesting to observe the reasons for that. For instance, in the specific cases of [2,4], it was used a rotor made of brass, with 2 inch-diameter, a precision balance with resolution of 0.1 mgf and operating at the same angular velocities than those adopted in the japanese experiments. The null values for the forces were measured for those experimental setups, but such a result can be seen as understandable in our model because the material constituting the rotors does not have high values of magnetic permeability as the silicon steel one, so that the liquid angular momentum is extremely weak. In fact, as known, brass is an alloy of copper and zinc, and their proportions can be varied to achieve different values of mechanical and electrical properties, but the relative magnetic permeability of brass is 8000 times smaller than the silicon steel one, therefore a null result would be more than expected if we consider that the effect can be explained by collective effect of magnetic dipoles.

Besides, in [2,3], although the two experiments were similar they differed from the experiments described in [1] in some other important features: the masses of the gyroscope rotors were substantially larger; the gyroscopes were spun in closed containers, but the devices were not evacuated; the maximum rotational frequencies were lower and the rotors were not electrically driven but air driven. Therefore, so many differences can obviously allow us to conclude that there were many factors to avoid that the results were reproduced.

Additionally besides those experiments with rotation of gyroscopes, it is important to describe that a similar effect was noticed in [5] and anomalies were also detected in another experiment from same group involving gyroscopes [6]. Basically the experiments comprised a spinning gyroscope inside a container in free-fall and the measurements of the fall-acceleration on the same gyroscope used in the earlier experiment (mass 175.504 g and radius 2.26 cm). They performed some runs of the experiments for right, zero and left spinning around the vertical axis. The Figure 3 shows details of a simplified scheme of the experimental setup implemented in order to verify if the anomaly also existed in that new configuration.

The impressive results were similar to the case of rotations without the free-fall. The effect on the device was a reduction of the fall-acceleration in the state of right spinning (24.94 mgf at 18000 rpm), whose values were significantly smaller than the value of the left spinning. The fall-acceleration of the latter was similar to the case of zero spinning. So, the symmetry of reflection or parity was completely broken due to the presence of that anomalous force reducing the weight of the device.

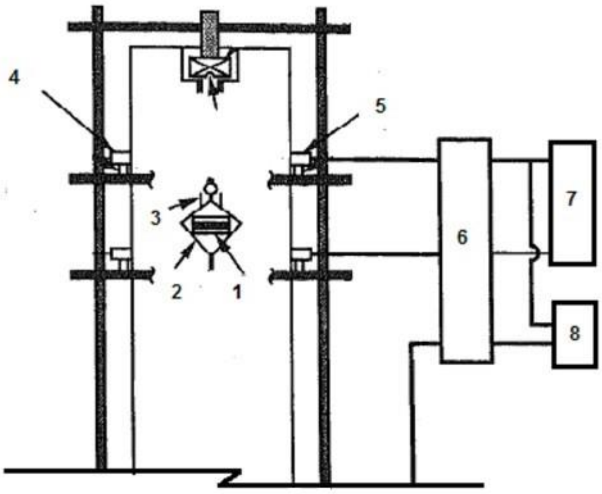

Figure 3. A basic scheme of a part of the cross-section of the experimental setup implemented for the measurements of asymmetric reduction of weight of gyroscopes under right rotation and free-fall, as drawn in more details and published in Figure 1 of [6]. In the apparatus, one indicates some main components which are: 1. Gyroscope; 2. Container or capsule containing the gyroscope; 3. Electrodes used to provide power to the gyroscope; 4. Laser emitter; 5. Laser receiver; 6. Gate circuit; 7. Frequency or time counter; 8. Time counter.

In order to explain such an anomaly by means of a traditional interaction or theory, since that magnetic coupling must be discarded due to the reason earlier mentioned, one could try describing the experimental results in the framework of Einstein-Cartan theory, which predicts the possible existence of a gravitational repulsive force produced by the parallel spin- spin interaction of the angular momentum of the Earth and the gyroscope [7,8]. In fact, as reinforced in a recent work, the coupling between the gravitational and the electromagnetic interactions was theoretically analyzed and the possibility of measuring the change in the gravitational energy was proposed [9]. This could indicate a possible physical mechanism to understand the effect in gyroscopes as a variation of the gravitational field due to its coupling to the electromagnetic interaction. However the magnitude of the repulsive force earlier cited is much smaller than the value obtained in the experiments reported in [1] and the coupling analyzed in [9] needs being analyzed in the context of the experimental setups here described.

It is relevant to emphasize that the verification attempts in other works failed and then contributed to the study of the effect to be abandoned. As we before discussed, beside the different material used in those tests, other relevant and possible reason or factor to the fail was the absence of vacuum in the surrounding environment, that is, there were not even partial vacuum created in the new experimental setups proposed to check the effect. As the effect is really weak, the hydrodynamic forces around the spinning gyroscopes could completely smear the effect. However here we claim that the main factor was the use of different materials, with very weak magnetic permeability, that led to the failure, as can be observed from the theoretical results provided by our model described in next section.

Then, due to the exposed, we studied the phenomenon and here proposed a simple model based on our theoretical framework as a possible description of the weight reduction effect. Such a model is described in details in next section.

2. Theoretical Model

2.1. Introduction

In this section, our objective is to describe the theoretical model conceived in order to explain the anomalous effect in gyroscopes analyzed in the introduction. We here show that a simple model whose basic framework is the generalized quantum entanglement (GQE) already successfully applied to other physical systems, as capacitors [10-12], magnetic cores [13], superconductors [14,15], laser diodes[16], piezoelectric devices [17,18] and electromagnetic drives [19,20], can also describe in an accurate way the anomalous weight reduction in gyroscopes. Basically, we assume that all the microscopic particles of a physical system are quantum entangled [21,22] and such a quantum property extends to the environment in the neighborhood of that system. This idea is reinforced by considering the hypothesis that all in universe is entangled, as proposed in [23]. The influence of GQE on the macroscopic world [24] is not realized because the effect is in general very weak, but in certain extreme conditions it is revealed, even still showing weak values, by means of macroscopic observables which are called in literature as quantum witness [25-28]. This is the case in the physical systems considered in the works earlier cited, in which there is a different quantum witness for each system considered: the magnetic susceptibility in magnetic cores, the electric permittivity in capacitors and the electric current in superconductors and lasers, for instance.

In the present work, we discuss from now on a simple model based on GQE from which one can describe the anomaly described in the case of gyroscopes.

2.2. Application to the Gyroscope Case

In the anomalous effects reported in [1,6] there was an unexplainable reduction of weight and asymmetry in their magnitudes depending on the state of spinning of the rotors, that is, if the gyroscopes were under right or left spinning. Experiments conceived by the Japanese group indicated inexistence of magnetic coupling, but a clear linear proportionality to the angular velocity or frequency of rotation of the device in the case of positive results, that is, right or clockwise rotation, with the spin vector pointing downwards.

We show from now on if it is possible to apply the generalized quantum entanglement framework in order to describe the phenomenon so in qualitative as in quantitative way. The angular momentum of iron atoms constituting the rotor (provided to the system by the magnetic dipoles in the rotor) are coupled and present a reaction to the inertial force that affect them in a collective way. The basic idea is that the reaction manifests itself in a macroscopic scale by the variation of weight. The effect generated by the magnetic dipoles also occurs due to the coupling between them and the environment around, as already reported in other works in literature for other physical systems [10-20].

The model for the description of the effect in gyroscopes is as follows. Consider the experimental evidences in both cases, that is, gyroscopes under right rotation and gyroscopes in free-fall and right-rotations. The reduction of weight is linear and it is directly proportional to the angular velocity, that is, to the angular momentum of the rotor.

The calculation involves the magnetization of the rotor with the coupling of all angular momenta of its internal magnetic dipoles. As the iron density is $\rho = 7.784$ g/cm^3 and its molar mass is $A = 55.845$ g/mol, we can estimate the value $n = 1.26 \times 10^{24}$ related to the quantity of the atomic magnetic dipoles considering their total mass as 2/3 of 175.504g rotor mass. So, as the magnetic moment per atom of the magnetic dipole of iron is $\mu_{\mathrm{Fe}} = 2.22\ \mu_{\mathrm{B}}$ [29], in which μ_{B} is the Bohr magnetron, one obtains $\mu_{\mathrm{Fe}} = 2.06 \times 10^{-23}$ Am^2.

We show in the Table 1 the values of the physical quantities used in our theoretical calculation.

Table 1. Experimental values of the physical observables used in the theoretical calculation.

Observable	Experimental Value
Electric charge of electron	1.6×10^{-19} C

Electron mass	9.11×10^{-31} Kg
Iron magnetic moment	2.06×10^{-23} Am^2
Number of iron atoms	$1.26\times10^{+24}$
Total magnetic moment	2.95542×10^{-10} Am^2
Maximum relative permeability	8000
Minimum relative permeability	200
Rotor radius	0.0226 m

By considering the relation between angular momentum and magnetic moment of a single iron atom, one can write the magnetic moment as:

$$\mu_{\mathrm{Fe}} = -\frac{e}{2m}L, \tag{1}$$

where the magnetic moment is μ_{Fe} = 2.06 x 10^{-23} Kg.m^2/s, the electron mass is m = 9.109 x 10^{-31} and e = 1.6 x 10^{-19} C is the electron electric charge, so that one can calculate the angular momentum as L = 2.346 x 10^{-34} Kg m^2/s.

For n = 1.26 x 10^{24} atomic magnetic dipoles (iron atoms) of the rotor, one can calculate the total angular momentum $L^{(1)}$ writing $L^{(1)}$ = n L = 2.9554 x 10^{-10} Kg m^2/s. It is supposed that these atomic magnetic dipoles of the rotor are coupled with outer particles in the environment via GQE and exchange their spin-orientating force to them but their huge magnitude cannot be just explained by the average magnetization. It means that the interaction force and energy between the magnetic dipoles (spins) in ferromagnetic materials are not explained only making the sum of their magnetic momenta as performed for diamagnetic materials, for example. As Feynman showed in his lectures [30], the product of a suitable term λ (dimensionless) by the mean magnetization M and the magnetic moment μ must be proceeded to calculate the spin interaction energy magnitude of ferromagnetic materials and consequently well explain the tremendous magnitude of the spin-turning force. The term λ is known as exchange term in quantum mechanics framework and its value is suitably determined accordingly. Other dimensionless term is used for calculation performing macroscopic quantities such as the relative permeability μ_r to determine the degree of magnetization that a material obtains in response to an applied magnetic field where its magnitude is tremendous (μ_r >> 1) in case of ferromagnetic materials. The relative permeability is also related to the magnetic susceptibility χ_m (a macroscopic observable considered a quantum witness that determines the degree of quantum entanglement in a system of spins) by means of the relation $\mu_r = (\chi_m + 1)$ [25]. In our model, as the rotor has the angular velocity ω = 183.34 rps (11000 rpm) its magnetic dipoles or spins are coupled with its angular momentum, therefore they have a precession. Considering that physical state, we suppose that the magnetic dipoles can interact out their spin-turning force via GQE, so that one can calculate the torque τ of the spins exchanged between the rotor and outward environment via the following equation

$$\tau = L^{(1)}G\omega\sin\theta, \tag{2}$$

in which $L^{(1)}$ is the total amount of angular momentum of the magnetic dipoles (spins) calculated before (2.9554 x 10^{-10} Kg m^2/s), ω is the angular velocity of the rotor (183.34 rps), θ is the angle between the angular momentum of the rotor and the angular momentum of the magnetic dipoles. We consider $\theta = \pi/2$ rad, such as sin θ = 1, considering that the radial magnetic field lines in the rotor are perpendicular to the angular momentum of the rotor positioned in its symmetry center. The dimensionless parameter G can be interpreted as a gain and it was suitably added in the equation in order to make compatible the spins response to the applied magnetic field, that is, to better fit the spins-orienting energy behavior and force, as explained before. The relation G = μ^{max} / μ^{min} between the maximum permeability of the typical silicon-steel ($\mu_r^{\max} = 8000$ or almost saturation) and the minimum permeability ($\mu_r^{\min} = 200$ or hysteresis residual) provides the value G = 40, considering the curve of permeability according to the magnetic field applied [31-33]. There is a relation between the variation of the permeability μ_r and the variation of the magnetic field applied according to the current going into DC electric motor. Therefore, considering G = 40 in Equation (2), we obtain the magnitude of the torque exchanged τ = 2.17 x 10^{-6} Kg.m^2/

s^2. As our simple empiric model is based on average classical quantities and the force generated by the effect and the rotor radius are perpendicular vectors, the magnitude of that force is $F = \tau / r$, in which r is the radius of the rotor with value r = 2.26 cm. Hence, by substituting the values earlier calculated, we obtain F = 9.78 mgf. This theoretical value is very consistent with the value of weight reduction measured at 11000 rpm, that is, F = 9.64 mgf. The earlier two equations show us that the force varies proportionally to the angular velocity ω of the rotor, such as measured in the experiments. The experiments also shows that the weight loss was measured even when the DC electric motor was switched off, that it, the rotor was in inertial rotation. In this situation, the DC electric motor becomes an AC electric generator ensuring that the permanent magnets of stator keep inducting an EM field to the magnetic dipoles of the rotor. In other words, while the rotor remains in rotation, the dipoles keep having precession and its dipoles (spins) aligned by the magnetic component of the induced EM field keep having precession and the force continue to be exchanged between the rotor and the environment. There is a direct proportionality between the rotation speed and EM field intensity. The angle between the angular momentum of the rotor and the magnetic component of the EM field induced also remains $\pi/2$ in this condition. The same procedure of calculation can be performed for different rotation velocities and for different rotors with different radius where it was always estimated 2/3 of their masses made by silicon-iron material mentioned in [1]. For example, the rotor with 139.863 g mass spinning in 4000 rpm lost around 2.5 mgf of weight and the theoretical calculation resulted in 2.56 mgf. It was really a good agreement between theory and experimental result. In the experiment of free fall of the 175 g rotor, at 18000 rpm rotation frequency and 5.8 cm diameter, the preliminary result was a 19.278 mgf weight variation. Ten further measurements made in different periods indicated an average weight variation between 12.07 mgf and 37.62 mgf. This experimental range of values is in accordance to our theoretical value (16 mgf).

The Table 2 shows, by considering the case of 175.504 g mass rotor, our theoretical results of weight reduction in the second column and different frequencies in the first column, beside the corresponding experimental average values measured in order to compare them.

The results presented in Table 2 are in good agreement with the experimental results reported in [1], as one can see in Figure 4. Even in the cases of higher errors our theoretical results are inside the error bars indicated in the plot of experimental data weight reduction versus frequency of [1].

Additionally, our simple model can also explain why the [2-4] indicated null results. In [4], the so-called null results were summarized in a table, in which there was no apparent weight reduction within experimental limits for right-rotating gyroscopes in any of the experiments. The values measured of the weight variation in [4] varied from (0.4 ± 0.1)mgf to (0.12 ±0.05) mgf, that is, at least two orders of magnitude lower than the one reported in [1]. Those values can be explained by the very weaker value of the magnetic moment.

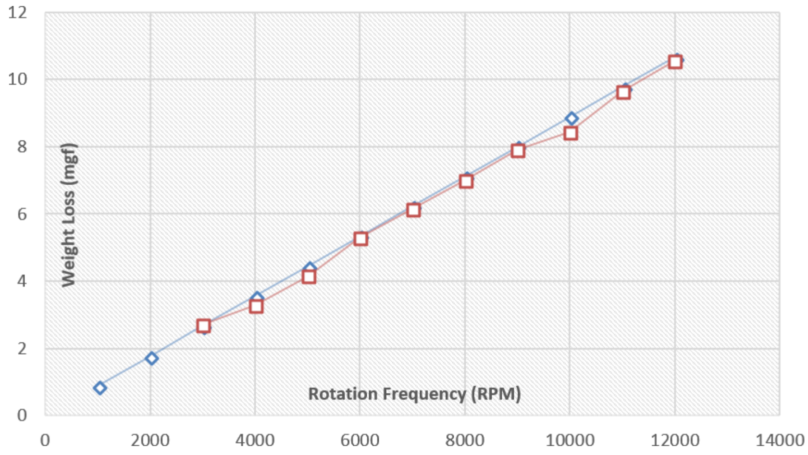

Figure 4. A plot of the experimental results (square) reported in more details in Figure 2 of [1] and the theoretical results (diamond) of our model. The comparison shows clear good agreement between the numerical results and experimental data. The square symbols correspond to the average values of the experimental measurements.

Table 2. Experimental and theoretical values of weight reduction of the 175.504 g rotor mass of the gyroscope under rotation. The labels N and R in the last column refers to the position in which the experiments were performed, that is, in the normal or reverse modes.

Rotation Frequency ω (rpm)	Theoretical Result (mgf)	Experimental Result (mgf)	Mode
1000	0.889239927	-	-
2000	1.778479853	-	-
3000	2.66771978	2.714285714	N
4000	3.5569 59706	3.285714286	R
5000	4.446199633	4.142857143	N
6000	5.335439559	5.285714286	R
7000	6.224679486	6.142857143	N
8000	7.113919412	7.0	R
9000	8.003159339	7.928571429	N
10000	8.892399265	8.428571429	R
11000	9.781639192	9.642857143	N
12000	10.67087912	10.57142857	R

Beside the quantitative explanation of the anomalous phenomena by the model proposed from GQE hypothesis, such a theoretical framework can also describe them in a qualitative way. An electron in orbital motion around the atomic nucleus is affected by the magnetic spin-orbit coupling or L-S coupling, in which L is the orbital angular momentum and S the spin momentum. The coupling represents an auto-induction, which can be seen in details in the scheme of Figure 5. The total angular momentum $\boldsymbol{J}$ is the sum of $\boldsymbol{S_i}$ and $\boldsymbol{l_i}$ for each particle i in the system, that is, the myriad of electrons or magnetic dipoles in orbital motion and the total angular momentum is the sum of the orbital angular momenta of all magnetic dipoles. The total spin momentum is also the sum of the spin momenta of all magnetic dipoles. So, we have:

$$\boldsymbol{J} = \boldsymbol{L} + \boldsymbol{S}, \tag{3}$$

$$\boldsymbol{L} = \sum_i \boldsymbol{l}_i \tag{4}$$

and

$$\boldsymbol{S} = \sum_i \boldsymbol{s}_i \tag{5}$$

In the GQE theoretical framework, it is supposed that there exists a preexistent state of generalized quantum entanglement among all the particles of the system, by considering all the magnetic dipoles and the external environment to the rotor as well. In this way, the huge quantity of magnetic dipoles in the interior of the magnetized rotor in rotation interact in a collective way with the ambient and with the interior of the Earth planet (downward surface), which concentrates the most part of the particles in the neighborhood of the experiments.

The rotor of the gyroscope is a magnetic nucleus composed by atomic magnetic dipoles of silicon steel, which are all aligned by an intense magnetic field and are also subjected to the same angular velocity around a common axis. The angle between the alignment direction of the magnetic dipoles in the horizontal plane and the direction of the angular momentum along the vertical axis is 90°. The non-local coupling among the dipoles and the interior of the Earth guarantees the generation of a force of reaction in the rotor in the opposite direction to the total angular momentum $\boldsymbol{J}$, of weak magnitude but detectable. Hence when the vector $\boldsymbol{J}$ points downwards, that is, when the rotor is spinning at clockwise sense, a reaction force points upwards and the device loses weight. In the opposite sense, that is, when the rotor is spinning in the counterclockwise sense and the vector $\boldsymbol{J}$ points upwards, the reaction force in the rotor is negligible in the opposite sense (downward) due to the interaction with the atmosphere above the surface of the planet and the device, much less dense than in the case of the nucleus of the planet. In such a condition, the weight of the rotor does not present any variation.

Therefore, the asymmetry measured in the experiments of Hayasaka et al., in which the gyroscope lost weight only when it was subjected to the right rotations, can be qualitatively well explained. In fact, the reaction force suffered by the rotor in such a concept was generated by the interaction of the microscopic magnetic dipoles with the huge mass of particles in the interior of the planet via generalized quantum entanglements (GQE theory), with the vector $\boldsymbol{J}$ pointing downwards.

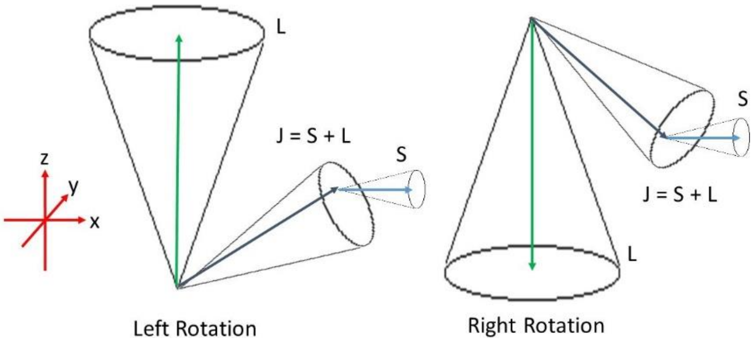

Figure 5. Scheme of the vector summation between the spin angular momentum and the orbital one, so in the case of right rotation as in the case of left rotation. The total angular momentum resulting from the microscopic and macroscopic coupling indicates the reason for the asymmetry in the reduction of weight of the gyroscope.

In summary, the atomic angular momenta align to the angular momentum of the rotor due to the phenomenon of generalized quantum entanglement. This is manifested by the macroscopic reduction in the weight of the rotor. From the exposed, we conclude that the weight reduction of the device occurs in function of its angular velocity and its density of atoms angular momenta.

In relation to the anomalous asymmetry in the measurements of weight reduction, the most probable explanation is related to the coupling of the microscopic angular momenta of all magnetic dipoles composing the rotor and the orbital angular momentum, which is affected by the quantum coupling of them among themselves and the external environment. In the right rotation, the generalized quantum entanglement of the magnetic dipoles with the Earth nucleus originates a weak force upwards, reducing the weight of the rotor.

From the exposed in last section, we conclude that it is possible to describe the anomalous phenomenon in the case of gyroscopes under rotation from a classical formulation by considering the angular momentum as macroscopic observable that represent the system, and as quantum witness of the systems the magnetic permeability of the rotor material. According to GQE, all particles are widely coupled and so that the atoms act in a collective and ordered way. As each atom is entangled with all internal and external particles, the effect occurs when the rotor is under rotation due to the collective manifestation in macroscopic scale. As the material presents a very high value of magnetic permeability, hence one can experimentally verify and quantify it. Besides, one can empirically describe it qualitative and quantitatively by means of macroscopic observables based on the concept of quantum witness, as in other cases earlier mentioned.

3. Conclusion

In this work, we present our theoretical investigations concerning to the existence of an anomalous force that reduces the weight of gyroscopes under right rotations. The nature of such forces is still unknown up to present date, but our work here proposes that GQE framework is consistent to explain the effect experimentally verified by means of a simple model that considers the magnetic permeability of the rotor as a quantum witness of the system.

We also show why there is a broke of symmetry in the effect - or, in other words, a variation of the weight of the motor only when it is under right rotation - by means of a vector analysis of the magnetic dipoles of the rotor and its interaction with the planet. It is interesting to note that the force which is opposite to the weight does not depend on if the gyroscope is in the north or south hemisphere because it depends on the direction of the angular momentum vector of the rotor and direction of magnetic spin vectors.

As indicated in our simple model, the magnitude of the anomalous forces can be calculated via equations using classical quantities as the total angular momentum of the system. At last, we show that the theoretical results are good enough to conclude the existence of the anomalous forces and the good accuracy of the theoretical model proposed for most values of rotation frequency and mass of rotors.

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