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Original Paper

Spin: Ubiquitous, Fundamental, Purposeful: Its Complementary Interactions with Gravity

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Abstract

In a prior article we explained how axial spin of celestial bodies interact with mutual gravitation in the phenomenon of synchronous rotation of our moon and the major moons of the gas giants. We also showed how the same complementary interactions could explain both the nonsynchronous (regular orbits) and the negative rotations in Venus, Uranus and Pluto, as well as in the peripheral small satellites of the gas giants. This paper expands on that theme and identifies the various other areas in which these two fundamental and ubiquitous forces cooperate to bring about many other phenomena in the larger universe. Prominent among these phenomena is the role played by the mother bodies' axial rotation in determining the direction of the orbital motion of their satellite bodies. The other effects include the appearance and maintenance of the spherical shape of large celestial bodies, generation of magnetism in planets, their respective roles in the formation of solar nebulae and proto-planetary disks, and the flattened profile of spiral and elliptical galaxies. Another important finding reported in this paper is the close relationship that exists between the size of planets, as well as the stars, with their axial rotation speeds. This increase of axial rotation speed of celestial bodies in direct proportion to the mass of those bodies, we believe serves to counteract the inward thrust of gravity, in exact proportions and thus help maintain the roughly spherical contour of those bodies. This finding even extends to spiral galaxies, where the axial rotation speed seems to be positively related to the size of the galaxy. This phenomenon and others suggest that spin is a fundamental and purposeful property of matter. Thus, in this paper we stress the important contributions made by the collaborative interactions between the ubiquitous gravity and spin in matter at the level of the fundamental particles, as well as in large celestial bodies, including the largest units in the universe, the galaxies.

Keywords

Axial rotation, celestial bodies, fundamental particles, galaxy, gravity, spin

1. Introduction

Current cosmology does not assign any purpose to the universally observed phenomenon of spin (rotation) in matter at all levels. Instead, it is relegated to being the result of a "conservation of the angular momentum" and as such having no role in any structural, orbital or other functional attributes of the bodies or the systems they form parts of. The validity of this notion can be questioned simply on the basis that this axial rotation is displayed by matter at the smallest scale (e.g., electrons, neutrinos, nuclei of atoms) as well as all free-standing celestial bodies, the stars, planets and their satellites and the largest units of the universe, the galaxies. It will be impossible to assign the axial spin of even elementary particles to a spillover from the formation of "solar" nebulae. Also, since galaxies are collections of billions of stars, it will be equally unreasonable to postulate that the axial spin of a single star then transfers to the spin of its parent galaxy a "conservation of the angular momentum" phenomenon.

While it is widely recognized that the almost spherical shape attained by planets and most of their satellites and the stars is due to the inward pull on matter by the bodies' own gravity, the slight bulge in the equator cannot be explained by this phenomenon alone. This has been acknowledged as being due to the outward shearing force exerted by the body's own axial rotation; as the mid-portion of these bodies travel faster, compared to the poles, they will experience larger shearing forces in this location (Gould, 1997; Soon, Frick, & Baliunas, 1999). The notion that the stars attain their nearly spherical shape by the nuclear fusion reactions counteracting the incessant inward pull of matter by gravity is erroneous; otherwise the shape stars attain might be highly irregular. Our idea of complementary interactions between gravity and spin will explain the above observations adequately. The generation of magnetism in planets is another good example of cooperation between gravity and axial spin of these bodies; this relationship will be explored in more detail in sections below.

In a prior paper (Raghuprasad, 2020) we proposed that the "rotational" influence from the mother body to the satellite bodies, combined with the progressively diminishing gravitational pull will explain both the longer orbital periods of satellites that are situated farther away and the direction of the orbits (which is the same as that of the axial rotation of the mother). We noted that this combined effect is a continuum, with at one end "synchronous rotation" in the large satellites that are situated near the mother, changing to non-synchronicity, from the progressively diminishing gravitational/rotational effects due to the distance from the mother in more distant satellites. The same rotational influence in those bodies that are essentially inverted due to axial tilt, for example Venus and many of the peripheral satellites of the gas giants, lead to the "reverse or negative" rotation and extreme slowing of the axial rotation of these bodies.

Beyond the solar system, this complementary relationship of gravity and spin will continue to be operational. The stellar and galactic motions are also governed by the same principles; the axial rotation combined with the mutual gravitation of the stars and the star systems that make up the galaxies, behave similarly to the individual stellar systems, except at a commensurately larger scale.

Finally, one could extend such observations to predict that the transit of all matter in the universe as a whole will also be rotational, and in the same counter-clockwise direction. This is contrary to the current belief in cosmology, of expansion **outwardly** from a fictional "Big Bang" (Hubble, 1929), of the galaxies themselves, although, up to the realm of the galaxies, axial rotation and orbits are the norm (i.e., a circumferential, rather than a radial motion). We think this notion is erroneous and that the galaxies themselves would be moving in a circumferential direction and not radially. We will explain this concept in more detail, in later sections.

Thus, we propose that just like the mutual gravitation, the axial spin of matter, which is also ubiquitous, is a fundamental property of it and that its presence is purposeful. The complementary interactions of these two fundamental properties of matter are the subject of this paper.

2. Materials and Observations

We made extensive searches of the astronomy literature in preparation for this paper. Also included are data we gathered from the websites of NASA and the European Space Agency (ESA). The extensive literature available online was also searched and a significant amount of corroborative data was found. Much of the data we found strongly support the ideas that formed the basis of this paper; in fact, none was found that contradicted our hypotheses.

Table 1. Equatorial Radii Compared to Polar Radii of Planets, and Axial Rotation Rates, as well as Gravitation and the Presence of Magnetism in the Solar System Bodies

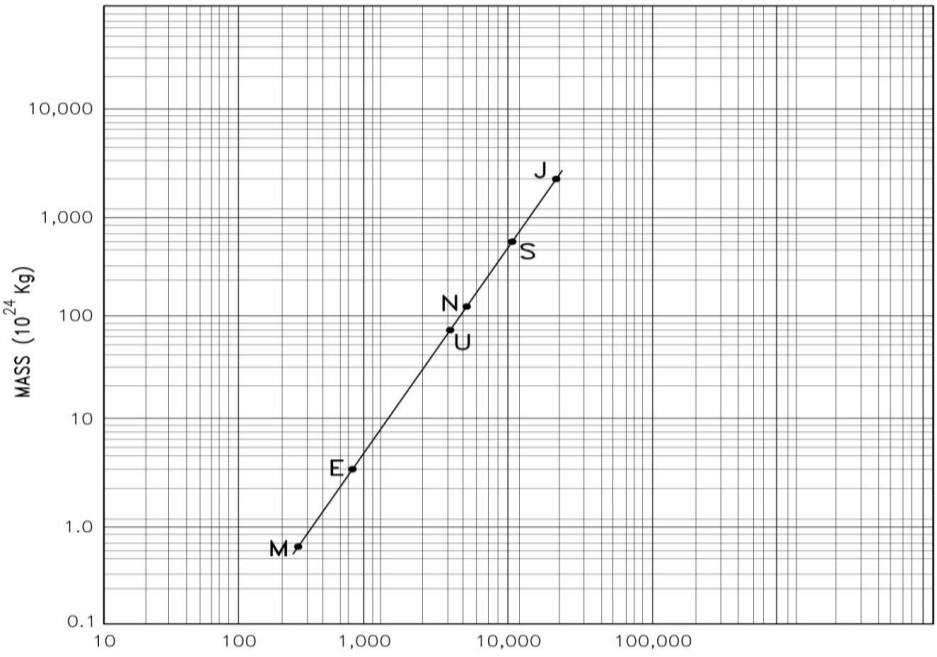
	MERCURY	VENUS	EARTH	MARS	JUPITER	SATURN	URANUS	NEPTUNE	PLUTO
Eq. Rad (Km)	2439.7	6051.8	6378.1	3396.2	71,492	60,268	25,559	24,764	1188
Polar Rad (Km)	2439.7	6051.8	6356.8	3376.2	66,854	54,364	24,973	24,341	1188
Sidereal Rotation (Hrs.)	1407.6	-5832.6*	23.9	24.6	9.93	10.7	-17.2*	16.1	-153.3*
Axial Rotation Speed (Km/H)	10.88	6.52	1,677	867	45,255	35,550.6	9319	10,231	49
Gravity (m/s2)	3.7	8.9	9.8	3.7	24.8	10.44	8.7	11	0.7
Magnetism	Yes	No	Yes	No	Yes	Yes	Yes	Yes	Unknown

* = "Negative rotation" means axial rotation opposite in direction to most of the planets and the sun.

Adapted from http://www.nssdc.gsfc.nasa.gov/planetary/factsheet.htm (Aug. 2018/Oct. 2019)

An examination of Table 1 reveals a good correlation between the speed of axial rotation and shapes of the bodies. Those bodies that rotate on their axes slowly regardless of pro-grade or retrograde in direction, (Mercury, Venus and Pluto) are almost spherical in shape and those bodies that spin fast, (all the other planets) display equatorial bulges, the degree of which has a close correlation with the speed

of rotation. Table 1 also documents that rapid axial rotation is necessary for the generation of magnetism in planets. The obvious exception is Mercury, but its magnetism may be explained by the amount of iron in its interior and its proximity to the sun. Why Mars, which does rotate normally, nevertheless does not display magnetism is mysterious, but recently NASA's exploration has suggested that magnetism did exist on Mars in the distant past, as identified by magnetism detected in rocks. This table also shows that the degree of equatorial gravity has a rough positive relationship to the speed of axial rotation.

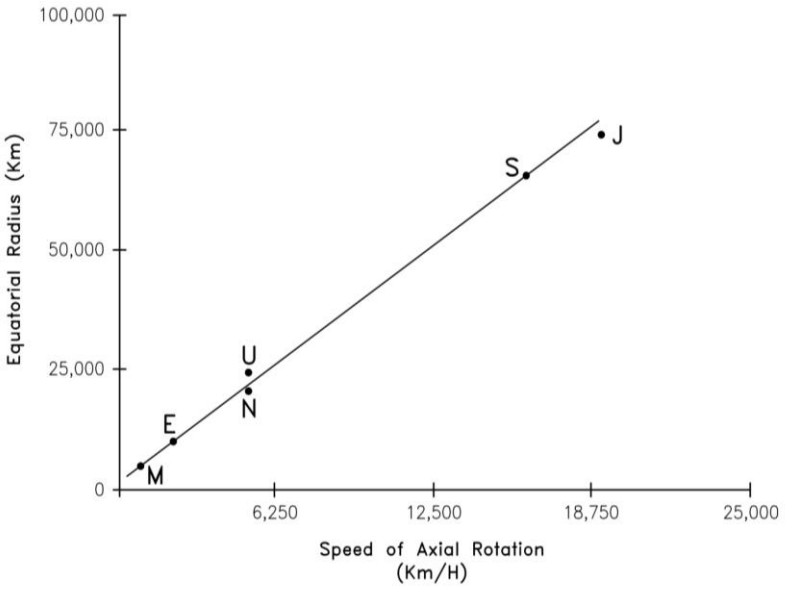


	Mass	Speed
M=MARS	0.642	432.9
E=EARTH	5.97	836.9
U=URANUS	86.8	4655
N=NEPTUNE	102	4824
S=SATURN	568	17,752.5
J=JUPITER	1898	22,607

Figure 1. Correlation between Mass and Speed of Axial Rotation

Adapted from http://www.nssdc.gsfc.nasa.gov/planetary/factsheet.htm

This figure shows that the speed of axial rotation in celestial bodies is directly proportional to the mass of the body. For example, in the solar system, the smallest regularly rotating planet, Mars, with a mass of 0.642 x 10^{24} Kg rotates at 432.9 Km/H and whereas the largest, Jupiter, with a mass of 1898 x 10^{24} Kg, rotates at 22,607 Km/H. The other planets rotate at rates commensurate with their own masses. The figure shows that the relationship is linear. This feature in itself attests to the fact that the ubiquitous axial spinning of bodies is an inherent property and serves a crucial function, which will be discussed at a later section.



	Equatorial Radius (Km)	Speed of Axial Rotation Km/H
M=MARS	2,440	433
E=EARTH	6,378	837
N=NEPTUNE	24,764	4,827
U=URANUS	25,559	4,655
S=SATURN	60,268	17,753
J=JUPITER	71,942	22,607

Data derived from:
http://nssdc.gsfc.nasa.gov/planetary/factsheet.htm

Note the linear relationship between the axial rotation rate and the equatorial radius of the fast–rotating planets. Taken together with the data presented in Fig–1 which shows that the larger the planets, faster they rotate, and wider the equatorial bulge; these show the dominant effect of mass of a body on both the equatorial radius and the speed of axial rotation. Please refer to the text for our explanations.

Figure 2. Comparison of Equatorial Radius with Speed of Rotation of Fast Rotating Planets

This figure shows that the speed of axial rotation of the fast-rotating planets also has a linear relationship to the equatorial radius. **Those bodies that rotate but slowly are spherical**; these are Mercury, Venus and Pluto. In stark contrast, the planet with the fastest axial spin (Jupiter) has the largest equatorial diameter. While this explains why most bodies are not spheres, the most important take home message is that spin contributes to the shape of rotating bodies in a fundamental way. We discuss the nature of the interaction of gravity and axial spin that produces this effect also at an appropriate section.

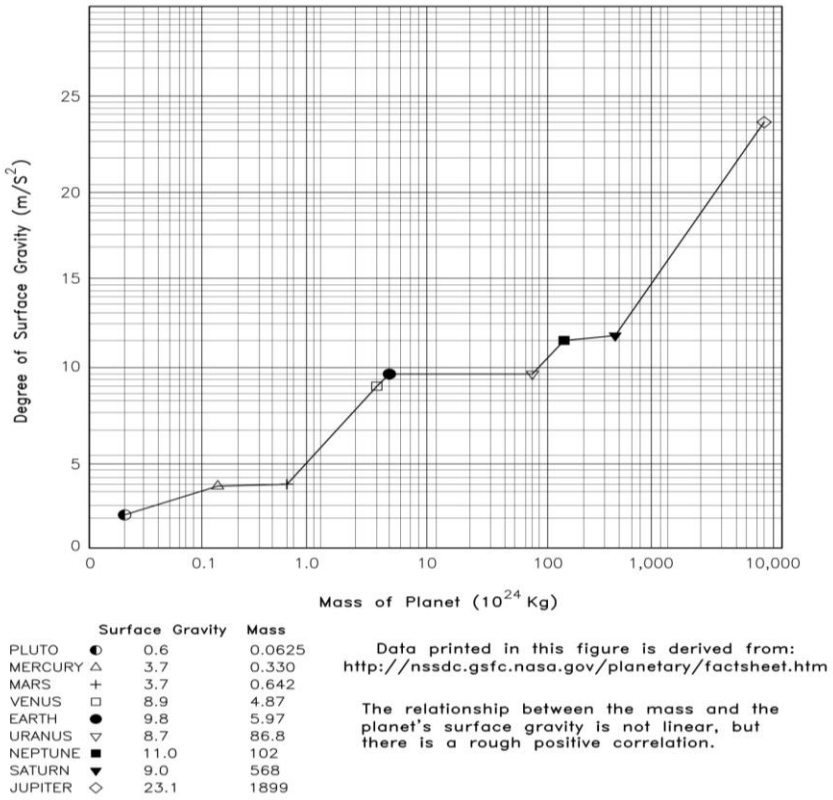


Figure 3. Comparison of Masses of Planets and the Degree of their Surface Gravity

The observation that the larger the celestial body, the higher the gravitation, as well as the axial spin rate seems to assign vital functions to the ubiquitous axial spin, that of counter-balancing the inward pull of gravity and help in maintaining the shape(s) of bodies.

Table 2. Selected Orbital Parameters of Planets*

	MERCURY	VENUS	EARTH	MARS	JUPITER	SATURN	URANUS	NEPTUNE	PLUTO
Orbital Period (Days)	88	224.7	365.2	687	4331	10,747	30,589	59,800	90,560
Orbital Velocity (Km/S)	47.4	35	29.8	24.1	13.1	9.7	6.8	5.4	4.7
Distance From Sun (10 6 Km)	57.9	108.2	149.6	227.9	778.6	1433.5	2872.5	4495	5906.4
Aphelion (10 6 Km)	69.8	108.9	152.1	249.2	816.6	1514.5	3003.6	4545.7	7375.9
Perihelion (10 6 Km)	46	107.5	147.1	206.6	740.5	1352.6	2741.3	4444.5	4436.8

*The direction of orbits of all planets is counterclockwise as viewed from the North Poles.

This Table is adapted from http://www.nssdc.gsfc.nasa.gov/planetary /factsheet.htm (18/7/2018 -30/8/2019)

This Table gives selected orbital parameters of the planets of the solar system. All planets display increasing orbital periods with increasing distances from the sun, thus obeying the "inverse square law" (Seeds, 1999). This attests to the rapidly diminishing effect of the gravity emanating from the mother bodies. However, the orbital motions of the satellites in only the direction of the axial rotation of the mother bodies mean that this axial rotation of the mother (sun) has the net effect of assuring the motions of the satellites only in that direction.

Table 3. Comparison of Selected Parameters of Stars

STAR	RADIUS	MASS	DISTANCE (Light years)	RAD. VEL (Km/sec)	ROT. VEL (Km/sec)
1) Sirius A	1.711	2.063	8.60	-5.5	16
2) Vega	2.5	2.14	25.04	-13.9	20.4
3) Pleione	3.2	3.4	392+-6	-13.9	20.4
4) Alpha Arae	4.5	9.6	270+-20	0	375
5) Achernar	7.3x11.4	6.7	139+-3	16	250
6) VV Cephei	13	8	4,900	N/A	N/A
7) CV Cephei	25	18.2	N/A	N/A	N/A
8) VFTS 102	N/A	~25	164,000	228	600+-100
9) Arcturus	25	1.08	36.7	-5.19	2.4
10) Aldebaran	44.13	1.16	65.3	54.26	3.5+-1.5
11) Polaris	37.5	5.4	323-433	-17	14
12) Canopus	71	8	310_-20	20.3	8
13) Epsilon Aurigae	143-358	2.2-15	653-1,500	10.40	N/A
14) Beta Carinae A	~240	~150	113.2	-5.2	-25
15) Rho Cassiopeiae	~450	40	~3,400	-47	25
16) V382 Carinae	700+-250	20	8.9	6	N/A
17) PZ Cassiopeiae	1190	N/A	2,810	-45.68	-45
18) VY Canis Majoris	1420	17	~3,820	41	300
19) KY Cyngi	1420	25	~5,000	N/A	N/A
20) UY Scuti	1708	7-10	~5,100	18.33	18

The data for this table were derived from published material online, mainly from Wikipedia.org but, some were confirmed or corrected by values posted in other sites, as well as from nasa.gov website. For explanations of the findings on this table, please refer to the text. The radii of stars are in multiples of solar (our sun's) radius and the masses are in multiples of the solar mass. The distances are in light years from earth. The stars are listed according to their increasing radii and masses and numbered from 1-20.

The table compares the equatorial radius, mass, distance from earth, radial velocity (of the stars' movement across the galaxy), and the speed of the axial rotation of a selection of stars in the Milky Way Galaxy). The negative values for radial velocity indicate that the motion of the star is towards the earth. Although there is a definite suggestion of increased radial rotation rates with the mass and radii, it is not strictly linear and there are many outliers. Stars 1-5 and 8 do show some increase in rotational velocity with increasing radii and/or masses. However, stars 6, 7, and 9-20 do not show the same relationship or values are not available. We are not certain why the latter do not show the expected close relationships, however, since these stars are also considerably farther away from the earth, we suspect the values we obtained from the literature about these very far away bodies may not be accurate. This idea is bolstered by the finding of some incongruity between the values of radii and masses in some stars. Some examples of these are: stars 9-11, 13, 14-20. In them, the radii are substantially higher than their masses. In those stars where the values for equatorial radii and masses were closer in value, there seems to be a good correlation with increase in axial rotation speed and the values for both radii and masses. Clearly, this issue will be solved only when more accurate data become available. We are optimistic that future studies will yield such data and then we can make definitive assessment of this matter; the planetary and galactic values, where the data are more reliable, do confirm our ideas. Therefore, we hasten to point out that, since individual planets and galaxies of stars tend to rotate on their axes faster the larger they are, but the intervening stars do not seem to obey this arrangement, this finding is an aberration brought about by inaccurate data that deal with those stars that are situated at such unimaginable distances.

3. Discussion

In this paper we have explored the ways in which spin and gravity interact in congregations of matter of all sizes. We show that this spin is a continuum from the axial spins of fundamental particles, to the axial spin/orbital movements of planets and their satellites, to stars and their large congregations, the galaxies. We also discuss how the combination of the effects of spin and gravity, in conjunction with centrifugal force of objects in circular motion can explain almost all planetary orbital movements. The other areas in which spin and gravity interact in a complementary fashion are in forming the shapes of the bodies and in the generation of magnetism in spinning bodies, as discussed below.

3.1 Axial Rotation is Ubiquitous and is a Continuum from the Elemental Particles to all Celestial Bodies Including Galaxies

The fundamental units of matter, both structural (fermions, such as quarks and leptons) as well as the force particles, (bosons such as photons) display axial rotation (Padgett & Allen, 2000; Allen, Beijersbergen, Spreeman, & Woerdman, 1992; Coutial, Robertson, Dholakia, Allen, & Padgett, 1998; Liu et al., 2005; Fernandez, 2006; Harris, Becker, Cabral de Menezes, Goodfellow, 2001). This fact alone should serve to remind us about both the origin, and importance of this property of matter. It is easy to argue that since all bodies are made up of these fundamental building blocks, freestanding bodies such as stars, planets and their satellites will also display this phenomenon. Current authors

extend this to galaxies as well, as they are made up of stars and star systems. Thus, we suggest that this is the true "conservation of angular momentum", as opposed to the conventional, conservation of the spin tendency of the planetary nebulae and their descendants, the proto-stars and the planetary systems. Otherwise, one could not explain how this spin will appear in the elementary particles as well as in the galactic axial motions. Since the axial spin and orbital motion are in the same counter-clockwise direction, the current author proposes that this property of matter has the important function of bringing order to the motion of all bodies in the universe, by ensuring that orbits follow this counterclockwise direction.

3.2 Shape of Celestial Bodies

1) Under the influence of gravity, (with few exceptions) all stars, planets and their satellites assume an almost spherical shape. However, the diameter of most bodies along the equator is more than that through the poles (www.cleonis.nl/physics/phys256/equatorial_bulge.php, www_spof.gsfc.nasa.gov/stargaze/srotfram1.htm, www.ourSolarsystem.fandom.com/wiki/Equatorial_bulge, www.arxiv.org/pdf/1803.09629.pdf). In the case of stars, the current explanation is that the intense inward pull of the star's own gravity is counteracted by the outward thrust of the fusion reactions. However, the above explanation cannot apply to the equatorial bulge in the case of planets and their satellite; evidently, they do not have fusion reactions and, unopposed gravitational pull should lead to an exact spherical shape. An explanation for the slight bulge in the equatorial regions of celestial bodies is as follows: The spherical shape is attained by the effect of gravity; however, the shearing force imparted on the body due to its own axial rotation will lead to relatively more outward displacement in the equatorial region as the rate of rotation in the equator will be faster, to keep pace with the polar rotation rate (Bohlin & Gilliland, 2004; Tanaka, Sadakane, Narusawa, Naito, Kambe, Katahira, & Hirata, 2007; Chesneau et al., 2005). An extreme example of this is the "burger star" (the star is "VFTS 102" nick-named "Burger Star" (Dufton et al., 2011), located 160,000 light years away, in the Large Magellanic Cloud, a satellite galaxy of Milky Way Galaxy) which spins at the astonishing rate of ~600km/sec or 2,000,000 km/hr, and it has attained a very flattened configuration around the middle so that it resembles a burger! There is one notable exception to the unique relationship between the axial rotation rates and the shapes of stars. That is the case of Neutron stars. These remnants of large stars that are left behind after supernova explosions, spin on their axes extremely rapidly, ranging from several times a second to as much as >700 times a second, and has also extreme degrees of gravitation and magnetism (Hissels, Rasnom, Stairs, Freire, & Ka, 2006; Ozel, Psaltis, Narayan, & Santos, 2012; Reisenegger, n.d.). However, they do not attain any flattening of their contour; they are perfect spheres. Why? We believe this is due to the fact that they are made of protons and neutrons that are compacted tightly and the strong nuclear force is a commanding presence, even to the extent that the shearing force of the extreme rapidity of spin cannot impart any bulging around the equators of these star remnants.

Similarly, in planets and most of their satellites, a tendency for this spherical shape is found. However,

in those planets that rotate on their axes rapidly, the equatorial region attains a somewhat flattened contour; those planets that rotate very slowly (Mercury with its pro-grade rotation, and Venus, Pluto, both of which display retrograde rotation) have the same equatorial and polar diameters. The inference is clear: the equatorial bulge is a direct effect of the axial rotation. One "problem" that has puzzled astronomers for some time is the recognition that, when stellar nebulae condense to form the central star, with its satellite planets and their respective satellites, and the nascent star starts to rotate very rapidly, how they maintain their shapes. A prevailing explanation is a "magnetic disk braking system" that purportedly slows the star down (http://www.news.wisc.edu/5732). However, this is another phenomenon that will be easy to explain, once one understands how gravity and axial rotation interact. In the current authors' explanation, the whole planetary nebula/disk condense due to gravity but the inherent tendency to spin is acting continuously, as well. When the star is formed, the extreme axial spin is counter-balanced in exact degrees by the gravitational pull. Thus, a perfect balance is struck, which leads to the star burning matter in fusion reaction, turning in just the right degree to counter the shearing force of the axial rotation and, the gravity and spin working together and with centrifugal force, to orchestrate the orbital movements of the satellite planets.

3.3 Axial Rotation Speed is Dependent on the Mass of the Body

This is an extremely interesting finding identified by this study. As noted in Figure 1, there is a linear relationship between the mass and the axial rotation speed of planets in our solar system. Of course, this can only be demonstrated in those planets that are oriented in the normal north-south direction, which is the case with most of the planets. This exact relationship between the size of a body and its axial rotation speed parallels the increase in the equatorial gravitation (Figures 1 & 3). Both the increased gravitation and the increased axial rotation speed will be counter-balanced in exact measures by the increase in centrifugal force. Thus, an exact balance is struck; this is thus a sound arrangement that assures proper orbits of all bodies, at all levels in the universe. As discussed below, in the stars and galaxies also there seems to be a positive relationship between the size of the body (or the congregation of bodies, as is the case with galaxies). This close relationship between the size/mass of the body and the speed of its axial rotation, without regard to the composition of the body or the ambient circumstances or distance from the mother bodies hint at the autonomous nature of the axial rotation. This argues against the conventional thinking of the axial rotation as being a remnant of the rotational effect from the solar system formation; otherwise, one would expect the smaller bodies to rotate faster and the larger ones to take more time to rotate or, at least all bodies to rotate at the same rate. Our idea of the origin of the axial rotation of bodies and the way in which such rotation combined with mutual gravitation results in the orbital motions of satellites, goes a long way to explain not only why such motions originate, but also why they remain perpetual.

3.4 The Role of Spin and Gravity in the Generation of Magnetism in Planets

In our solar system, all rapidly rotating planets generate magnetism. Venus, with an axial tilt of -177.4 degrees and an extremely slow axial spin, displays no magnetism (Table 1). However, even with very

slow axial rotation, Mercury does have magnetism; this anomaly is probably because of the high iron content in Mercury and its closeness to Sun. We believe this is another area in which gravity and spin work in tandem to generate another common feature of the planets. The gravity of these bodies help heat up the interior of the planets so that the iron in the core is molten and thus, the rest of the planet, the solid inner core and the outer mantle, that are in constant motion, with the molten iron remaining relatively static, helps generate the magnetism. Venus, with its very slow axial rotation fails to generate sufficient magnetism to be detected, although, structurally, earth and Venus are almost identical.

3.5 Rings of Planets

The rings of some planets illustrate the effect of the confluence of gravity and spin elegantly. The alignment of the rocks and debris that form the rings, the most spectacular of which are those of Saturn, neatly along the equator of the planet, cannot be explained by gravity alone. Further, the rings themselves, much like all the satellites of Saturn, orbit the planet, also in the same direction as the planet's axial rotation. The orientation of the rings of the other planets is also in the same equatorial location. One special situation that highlights the importance of the major body in the vicinity, is that of the somewhat sparse rings of Uranus. Although Uranus is tilted over 90 degrees and lies on its side, the rings are situated at the "right" location, along the equator of Uranus. It is worth noting that, just like the direction and location of orbits of the satellites of all planets, one never finds the rings being situated in any orientation other than along the equator of the mother planet. One is tempted to predict that, if we humans continue to send more satellites in orbit around the earth, some day in the future, we might actually witness the formation of 'rings' around the earth as well, again, only roughly along the equator.

3.6 Stellar Nebulae and Protoplanetary Disks

Stellar (or solar) nebulae are the vast accumulations of dust and particles that condense under the influence of gravity and form the central stars and their "stellar" systems. As can be predicted by our observation that all systems rotate on their axes and orbit the larger object in their vicinities, the central nascent star is observed to rotate on its axis, the remainder of the star system that will form the planets and other bodies of the star system form a vast disk around the star, the proto-planetary disk that is already orbiting the star, in the same direction as the star's axial rotation. Thus, the stellar nebulae are excellent examples of our ideas about how gravity, axial spin and centrifugal force collaborate in the formation of and the orderly motions of all systems in the universe.

3.7 Motion Mechanics of Stars

Table III attempts to examine the axial rotation and the radial velocities of a selection of stars in the Milky Way Galaxy, from data available to us in the literature. It shows that when the mass of the star is roughly parallel to its radius, there seems to be a positive correlation between the axial rotation speed and radial velocity. However, when the two parameters are not in agreement, the axial rotation speed and radial velocity are unpredictable. We believe this anomaly to be due to the difficulty in obtaining accurate data on stars from such extreme distances and that in the future, better technology will help us

with more accurate data and then the stars will also be found to follow the same pattern as the planets.

3.8 Galactic Spin Parameters

The most numerous of the galaxies, the spiral galaxies, such as our Milky Way galaxy attain their shapes through the movement of the stars that they are composed of, orbiting the center of the galaxies. While superficially, the structure of spiral galaxies might resemble the progression of the stellar nebulae to proto-stars and their satellites, the resemblance is very superficial. The most obvious difference is, of course, the scale; the galaxies have billions of star systems. Another peculiar feature is the finding that the stars in a galaxy orbit its center at approximately the same speed regardless of where in the galaxy they are situated, unlike the predictably slower pace of orbits of the outer planets in a solar system. This feature has baffled scientists for a long time (Miller et al., 2019; Benjamin et al., 2005; Lin & Shu, 1964; Francis & Canderson, 2009). Yet another unique feature is the flaring appearance of the spiral arms (Miller et al., 2019; Benjamin et al., 2005; Lin & Shu, 1964; Francis & Canderson, 2009; Jog, 2002). We suggest that both of these features are the result of the unique make-up of the spiral galaxies. To understand this, one needs to free oneself from the restrictions imposed by the meager data presented to us by a mere solar system and consider the true grandeur of the spiral galaxies. The tens of billions of stars that crowd the whole structure of the galaxy impart to the whole "disc" unique properties; the disc behaves much like a spinning tabletop. When a tabletop spins, every part of the table spins as one; so does the disc of the spiral galaxy. We are suggesting here that this effect is due to the overlapping gravitational fields from the multiple billions of stars. However, unlike the tabletops, the most peripheral elements of the spiral arms take proportionately more time to traverse the vast distances, even though the rate of transit is the same as that of the stars near the center of the galaxy. This is at least part of the reason why the arms flare out; the more peripheral the stars and clusters of stars, the more flared out that part of the arm is. It may also be due to a centrifugal force effect that throws the peripheral stars outward, more than the proximal stars in a spiral. It is also well known that the spiral arms rotate at different rates and therefore, the axial rotation times reported for the arms are usually an average of all the arms (Jog, 2002).

The axial rotational speeds of spiral galaxies also appear to display the same positive relationship with the size of the "body". Even with the sparse information that is available, there is a suggestion that the larger the galaxy, the faster the rotation. Our Milky Way Galaxy, a medium-sized galaxy, approx. 100,000 light years across, rotates on its axis at the rate of 130miles (210 Km) per second. "Super Spirals", spiral galaxies that are much larger, for example 450,000 light years across, are known to rotate at around 350 miles (579 Km) per second! (http://www.hubblesites.org/contents/news-releases/2019/news-2019-547news=true). It will be interesting to see if future explorations yield data on many more spiral galaxies and if this positive relationship is prevalent in all galaxies.

4. Conclusion

In this paper we have presented clear correlation between the sizes and masses of the planets in our solar system to both the speed of axial rotation, the degree of gravitation, the presence or absence of equatorial bulge and of magnetism. Combining these findings with the observation that the orbital speed diminishes with the distance from mother bodies, while all satellites (with only a few rare exceptions) orbit the mother bodies in the counterclockwise direction, one could conclude that the mother bodies' axial rotation in the same counterclockwise direction plays a crucial role in determining the **direction** of the orbits of their satellites. All elementary particles also rotate on their axes, and in the case of the atoms, the electrons spin on their axes and orbit the nucleus, pointing to the fundamental nature of spin in nature. While evidence pointing to the direction of orbit of electrons is not available, one could safely conclude that even at this level it is counterclockwise; it would be highly unlikely the fundamental building blocks will function differently from the visible congregations of matter, such as the planets, stars and galaxies. Taken together with data presented in our prior papers, in this paper we are proposing that this inherent and autonomous property of matter to spin on its axis, in collaboration with its inherent gravity and the ever-present centrifugal force of moving objects explain how the celestial body motions begin and remain perpetual in nature. We also propose that this combination of physical properties of matter connects the events at the micro level with those happening in the macro world. Thus, we can assert that the operation of the universe had always depended on these interactions at the micro and macro levels and will continue to be so, forever. This hypothesis incorporates readily detectable factors in explaining the structure and function of the various elements that form the universe and the behavior of the whole universe itself; there is no need for searching for esoteric agents such as "dark matter, "negative energy", "dark energy" and so on.

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