Planetary spin-orbit attributes in the solar system and their wider implications

Puthalath Koroth Raghuprasad[a)]
2400 E. 8th Street, Odessa, Texas 79761, USA

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Abstract: The Sun and most of the planets and the vast majority of their satellites spin on their axes in an anticlockwise direction, as observed from the Northern Hemisphere. Interestingly, the orbital motion of the planets around the Sun and the satellites around the planets is also anticlockwise. Further, the orbital velocity of all planets decreases with the distance from the Sun, the so-called "inverse square law." The latter clearly implicates the gravitational pull from the Sun. However, since the bodies are not falling into the Sun, there is another force at work; this is probably a counterbalancing centrifugal effect from a "rotational influence" from the Sun. Thus, an orderly motion by all bodies is assured. The closest large moons of the gas giants and the earth's moon display "synchronous rotation" (i.e., the rotation period is the same as the orbital period of these satellites). While the proximity with the mother body assures unimpeded gravitational influence, the proximity alone does not explain the synchronicity. This appears to be a rotational influence from the mother to the satellite. The axial tilt of these satellites is very low (most are less than 1°). Those planets (Venus, Uranus, and Pluto) and the peripheral satellites of the gas giants that have excessive axial tilt, over 90°, display "negative rotation" (axial rotation opposite to that of the majority of the planets and satellites). Many also rotate on their axes very slowly. This aberrant behavior of these bodies appears to be because their intrinsic tendency is to rotate in an anticlockwise fashion. However, since they are essentially tilted upside down, they run afoul of the mother bodies' rotational influence and thus suffer excessive slowing of their rotation. Thus, this "negative" rotation also helps formulate my hypothesis. Taken together, all of the above support a view that, in concert with gravity, the axial spin of bodies has the important function of imparting order in the universe. © *2013 Physics Essays Publication*. [http://dx.doi.org/10.4006/0836-1398-26.2.331]

Résumé: Le Soleil et la plupart des planètes et la grande majorité de leur satellites tournent sur leurs axes dans le sens antihoraire, vu de l'hémisphère Nord. Fait intéressant, le mouvement orbital des planètes autour du Soleil et les satellites autour des planètes est également antihoraire. En outre, la vitesse orbitale de toutes les planètes diminue avec la distance du Soleil, la soi-disant "loi inverse du carré." Ce fait implique clairement l'attraction gravitationnelle du Soleil. Cependant, comme les corps ne tombent pas dans le Soleil, il ya une autre force à l'œuvre, probablement un effet de contre-équilibrage centrifuge à partir d'une 'influence de rotation" du Soleil. Ainsi, un mouvement ordonné par tous les corps est assuré. Les plus proches grandes lunes des géantes gazeuses et la lune de la terre montrent une "rotation synchrone" (c'est-à-dire, la période de rotation est la même que la période orbitale de ces satellites). Pendent que la proximité avec le corps mère assure l'influence gravitationnelle sans entrave, la proximité ne suffit pas à expliquer la synchronicité. Il semble être une influence de rotation de la mère vers le satellite. L'inclinaison de l'axe de ces satellites est très petite (la plupart est moins de 1 degré). Ces planètes (Vénus, Uranus et Pluton) et les satellites périphériques des géantes gazeuses qui ont une inclinaison très forte de l'axe, plus de 90 degrés, ont une "rotation négative" (c'est-à-dire, rotation axiale opposée à celle de la majorité des planètes et des satellites). Beaucoup aussi tournent sur leurs axes très lentement. Ce comportement aberrant de ces corps semble être parce que leur tendance intrinsèque est de tourner de façon antihoraire. Toutefois, étant donné qu'ils sont essentiellement inclinés à l'envers, ils ne sentent pas l'influence de rotation des corps mère et, conséquemment, souffrent un fort ralentissement de leur rotation. Ainsi, cette rotation "négative" permet aussi de formuler mon hypothèse. Pris ensemble, tous ci-dessus sert à appuyer l'idée selon laquelle, de concert avec la gravité, la rotation axiale des corps a la fonction importante de donner ordre à l'univers.

Key words: Spinning; Orbit; Polarity; Gravity; Axis; Retrograde.

[a)]pkrp@aol.com

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I. INTRODUCTION

Planetary motion is thought to be the result of all bodies obeying Newton's first law of motion, acting in concert with the inward pull of gravity. Einstein's modification of the above teaches that the orbits of satellites follow a "space–time warping" around the parent body.[1] This is touted as the way in which gravity makes the satellites orbit the parent body. Big Bang and the expanding universe theory[2–9] attempt to explain the motion of the bodies by an ongoing expansion of the space itself, from the time of the supposed bang.

All of the above fail to account for some common observations: (1) None fully explains why the bodies usually orbit around the equator of the parent body; (2) none explains why they orbit in the direction of rotation of the parent; (3) no theory even attempts to explain why all celestial bodies rotate on their own axes. This phenomenon is exhibited not only by the planets and their satellites but also by all stars and galaxies as well as, even the protostars. Clearly, this is a fundamental and purposeful property of congregations of matter; (4) both Newton's and Einstein's theories do not explain who started these apparent perpetual motions; (5) Einstein's theory explains only why satellites may be situated at particular locations but does not explain the orbital motions or the axial rotation of bodies; (6) the "expanding universe" completely ignores all orbital/axial rotational motions. Many of the new conjectures such as "vacuum energy," "negative energy," "dark energy," and "quintessence" have been put forward to explain why the mutual attraction of bodies does not lead to collapse of all matter inwards.

This paper will describe how, by assigning a role for the rotation (spin), many of the phenomena observed in the solar system and the universe can be explained. One is awestruck simply contemplating the rapidity of rotation of the planets around their axes as well as their orbital velocity; but even these pale in comparison to the rapidity of rotation of the infinitely dense bodies, the neutron stars. All these point to the fundamental nature of spin in the makeup of our solar system and the universe. When appropriate, reasonable extrapolations will be made from known observations to explain phenomena in the whole universe.

II. MATERIALS AND METHODS

In gathering data for this paper, articles published in astronomical literature as well as other relevant peer-reviewed scientific journals were reviewed. Special attention was paid to information about orbits of planets and some of their satellites but landmark articles of current cosmological teaching were also studied. A significant portion of the other data that support this paper's thrust were obtained from National Space Science Data Center (NSSDC) fact sheets published on the Internet.[10]

The influence of Sun on the orbital velocity of the planets is well established[11] and is known as the "inverse square law." As this law is dependent only on the distance from the Sun, those special circumstances that may influence the rotation period and the length of day were scrutinized carefully. In this endeavor, the "odd-balls," those planets that do not seem to obey the general rule, were found to be particularly illuminating. These "special" features are distilled into Table I. Axial tilt, the amount of iron in the core (the latter especially in combination with distance from the Sun), positive or negative rotation and the rotation and orbital periods, and the length of day offer useful information.

III. RESULTS

Table I presents data on all the known planets in our solar system. A scrutiny of the table identifies the following interesting features:

(a) Orbital velocity diminishes with the distance from the Sun; this is the basis of the inverse square law. Orbital period increases with the distance, as one would predict, as a consequence.
(b) The perihelion and aphelion increase with the distance from the sun.
(c) The terrestrial planets and the dwarf planet Pluto rotate on their axes slower than the gas giants. In general, the length of day follows closely the rotation period.

TABLE I. Planetary fact sheet—metric (adapted from http://nssdc.gsfc.nasa.gov/planetary/factsheet/index.html).

	Mercury	Venus	Earth	Mars	Jupiter	Saturn	Uranus	Neptune	Pluto
Mass (10^{24} kg)	0.330	4.87	5.97	0.642	1899	568	86.8	102	0.0125
Diameter (km)	4879	12,104	12,756	6792	142,984	120,536	51,118	49,528	2390
Density (kg/m^3)	5427	5243	5515	3933	1326	687	1270	1638	1750
Gravity (m/s^2)	3.7	8.9	9.8	3.7	23.1	9	8.7	11	0.6
Distance from sun (10^6 km)	57.9	108.2	149.6	227.9	778.6	1433.5	2872.5	4495.1	5870
Orbital period (days)	88	224.7	365.2	687	4331	10,747	30,589	59,800	90,588
Orbital velocity (km/s)	47.9	35	29.8	24.1	13.1	9.7	6.8	5.4	4.7
Axial tilt (degrees)	0.01	177.4	23.4	25.2	3.1	26.7	97.8	28.3	122.5
Rotation period (h)	1407.6	−5832.5[a]	23.9	24.6	9.9	10.7	−17.2[a]	16.1	−153.3[a]
Length of day (h)	4222.6	2802	24	24.7	9.9	10.7	17.2	16.1	153.3
Magnetic field	Yes	No	Yes	No	Yes	Yes	Yes	Yes	Unknown
Perihelion (10^6 km)	46	107.5	147.1	206.6	740.5	1352.6	2741.3	4,444.5	4435
Aphelion (10^6 km)	69.8	108.9	152.1	249.2	816.6	1514.5	3003.6	4545.7	7304.3

[a]Negative rotation means axial rotation opposite to that of the Sun.

TABLE II. Comparison of planets with negative rotation (Venus, Uranus, and Pluto) to Earth and Jupiter (adapted from http://nssdc.gsfc.nasa.gov/planetary/factsheet/index.html).

	Venus	Uranus	Pluto	Earth	Jupiter
mass (10^{24} kg)	4.87	86.8	0.0125	5.97	1899
Diameter (km)	12,104	51,118	2390	12,756	142,984
Rotation period (h)	−5832.5[a]	−17.2[a]	−153.3[a]	23.9	9.9
Length of day (h)	2802	17.2	153.3	24	9.9
Orbital inclination (degrees)	3.4	0.8	17.2	0.0	1.3
Axial tilt (degrees)	177.4	97.8	122.5	23.4	3.1
Magnetic field	No	Yes	Unknown	Yes	Yes

[a]Negative rotation means axial rotation opposite to that of the Sun.

(d) The rotation period and length of day are inordinately long in Mercury and Venus. However, the relationship between these two parameters in these two bodies is different, as outlined later in this article.
(e) Three planets, two of them solid and one gaseous, exhibit "negative" rotation (i.e., they rotate on their axes opposite in direction to the Sun's axial rotation). These are Venus, Uranus, and Pluto.
(f) These same planets also exhibit an axial tilt of over 90°; this seems to be the only other consistent similarity between these three bodies.
(g) With the exception of Mercury, in general, the lower the axial tilt, the faster the rotation of the solid bodies; when the tilt exceeds at least 90°, they rotate not only much slower but also "negatively." Venus and Pluto are examples. Uranus, a gas giant, with axial tilt of 97.8° is not slowed but rotates negatively.
(h) Mercury has almost no axial tilt, is closest to Sun, and has 70% iron content in its core. All these facts and the Sun's intense magnetism may play a role in both the excessively slow rotation period and possibly help explain the odd precession of its perihelion. Newtonian gravity failed to explain this phenomenon, by itself; perhaps, adding the effect of magnetism to this may help solve this puzzle. In short, Mercury behaves like a bar magnet in close proximity to another (albeit much larger) bar magnet, the Sun.

Table II compares some features of those planets exhibiting negative rotation with earth, a typical terrestrial planet, and Jupiter, a typical gas giant. A careful scrutiny of the data will confirm that the excessive tilt (>90°) as the only consistent feature that distinguishes the planets with negative rotation.

Table III compares Mercury and Venus (two planets with the longest days and rotation periods) with earth and makes the point that the interplay of axial rotation and length of day/rotation is complex. Notice that the rotation period of Venus is almost twice as long as the day whereas an almost opposite relationship exists in Mercury, a small, solid, terrestrial planet close to the Sun. One way to understand the latter is to remember that Mercury, being located very close to the Sun, orbits twice during one of its long axial rotations. Also noteworthy is the fact that, while greatly slowed, Mercury's axial rotation is still positive.

TABLE III. Rotation period, axial tilt and orbital period compared with length of day, in Mercury, Venus, and Earth (adapted from http://nssdc.gsfc.nasa.gov/planetary/factsheet/index.html).

	Mercury	Venus	Earth
Rotation period (h)	1407.6	−5832.5[a]	23.9
Length of day (h)	4222.6	2802	24
Axial tilt (degrees)	0.01	177.4	23.4
Orbital period (days)	88.0	224.7	365.2

[a]Negative rotation (Venus) means axial rotation opposite in direction to the Sun's rotation.

Table IV outlines the orbital parameters of the satellites of Jupiter, the largest family in our solar system. The most noticeable features are that the larger "Galilean" moons and a few of the smaller moons exhibit rotation periods that are equal to the orbital period, the so-called "synchronous rotation." The table also outlines the radius of the individual satellite, its semimajor axis radius, and the orbital inclination in degrees (? also the axial tilt). One will notice the very low inclination, in this case of less than 0.6° in all the satellites exhibiting synchronous rotation. As the inclination increases, this synchronicity disappears and when it goes over (presumably) 90°, the orbits become "retrograde," denoted in this table by "R" next to the orbital period. It should also be noted that all these bodies are in general much smaller and farther out than those that show synchronicity and than those with regular orbits. NASA's tables do not yield information as to the axial tilt or otherwise of these peripheral bodies but one could argue that they are highly tilted and thus compete with the rotational influence from the parent.

The satellites of Saturn and Uranus behave almost identically to those of Jupiter (Tables V and VI). The closest large moons have the least inclination, shorter orbital periods and many exhibit synchronous rotations. Again, as the inclination increases, so does the orbital period and when it (the inclination) exceeds a certain level, the retrograde motion takes over. The reason for "chaotic rotation" in Hyperion (a moon of Saturn) is not known; I could not determine the nature of this "chaos" as it has not been defined in the data posted by NASA.

The orbital parameters of satellites of Neptune are harder to determine, simply because the data are so sparse (Table VII). Therefore, it is harder to draw conclusions. For example, with the exception of Triton, the "rotation period" data are simply not available for the satellites and thus synchronicity or otherwise of the closest satellites is not known. However, the largest moons are closest and display the least degree of inclination. Thus, when the data become available, one could predict that they will conform to the pattern in satellites of the other gas giants. Two of the farthest satellites (3/2002 N4 and S/2003 N1) are known to display orbital periods that are retrograde (denoted by "R"). A notable exception to the rule is that Triton, a large moon that is situated rather close-by (354.76×10^3 km), has retrograde orbit but has synchronous rotation and >157° of inclination. This is thus an oddity among all the satellites of all the planets. Please refer to the paragraph devoted to Triton in Sec. IV.

TABLE IV. Orbital parameters of satellites of Jupiter (adapted from http://nssdc.gsfc.nasa.gov/planetary/factsheet/joviansatfact.html).

Satellites:	Radius (km)	Orbital period (days)	Rotation period (days)	Inclination (degrees)
(A) Galilean				
Io	1821.6	1.769138	S	0.04
Europa	1560.8	3.551181	S	0.47
Ganymede	2631.2	7.154553	S	0.21
Callisto	2410.3	16.689018	S	0.51
(B) Lesser				
Metis	20	0.294779	S	0.06
Adrastea	13 × 10 × 8	0.298260	S	0.03
Amalthea	131 × 73 × 67	0.498179	S	0.40
Thebe	55 × 45	0.6745	ND	0.8
Themisto	4	132.02	ND	45.67
Leda	5	240.92	ND	27.47
Himalia	85	250.5662	0.4	27.63
Lysithea	12	259.22	ND	27.35
Elara	40	259.6528	0.5	24.77
S/2000 J11	2	287.0	ND	28.3
Euporie	1	553.1 R	ND	147.0
Euanthe	1.5	620.6 R	ND	148.9
Harpalyke	2.2	623.3 R	ND	148.7
Praxidike	3.4	625.3 R	ND	148.7
Orthosie	1	622.6 R	ND	145.9
Iocaste	2.6	631.5 R	ND	159.7
Ananke	10	629.8 R	ND	148.9
Hermippe	2	633.9 R	ND	150.7
Thyone	2	627.3 R	ND	148.5
Arche	1.5	723.9 R	ND	165.0
Pasithee	1	716.3 R	ND	165.4
Kale	1	729.5 R	ND	165.0
Chaldene	1.9	723.8 R	ND	165.4
Isonoe	1.9	725.5 R	ND	165.0
Eurydome	1.5	717.3 R	ND	150.3
Erinome	1.6	728.3 R	ND	164.9
Taygete	2.5	732.2 R	ND	165.2
Carme	15	734.2 R	ND	164.9
Kalyke	2.6743 R		ND	165.2
Aitne	1.5	730.2 R	ND	165.1
Pasiphae	18	743.6 R	ND	151.4
Megaclite	2.7	752.8 R	ND	152.8
Sponde	1	748.3 R	ND	151
Sinope	14	758.9 R	ND	158.1
Callirrhoe	4	758.8 R	ND	147.1
Autonce	2	762.7 R	ND	152.9
(C) Newly discovered satellites S/2003 J1 to S/2003 J23 all have orbital periods from 504 to 982.5; all exhibit reverse "motion" and orbital inclination from 141 to 165. The sole exception is the following:				
Carpo (S/2003 J20)	3	456.1	51.4	No retrograde motion

S = synchronous rotation (rotation period is the same as the orbital period); R, retrograde motion (orbit); ND, no data available.

IV. DISCUSSION

The generally accepted explanation for the axial rotation of celestial bodies is the "conservation of angular momentum." This contends that when matter condenses into "protostars" and the star and its satellites are formed, this conservation of angular momentum is what makes the bodies rotate. It is difficult to suggest that all bodies in a solar system (with negligible few exceptions) rotate in the same direction, and that rotation also happens to be in the same direction as the axial rotation of the centrally located star, all by chance. Instead, all these observations hint at a predetermined, purposeful motion (s), rather than random occurrences.

Finding factual evidence to support the contention that the ubiquitous spin has an important role in the solar system was surprisingly easy. The most obvious, of course, is the fact that the vast majority of planets and their satellites orbit their parent bodies in the same direction as the parent's axial rotation. This, coupled with the fact that the **orbital velocity** of satellites diminishes proportionately to their distance from the parent body (not simply orbital period, which is also affected by the larger orbits, the more distant planets/satellites have to traverse), the inescapable conclusion is that the rotation of the parent is directing the motion of its satellites. The orbital period is thus lengthened not only by the increasing orbital circumference but also by the slower orbital motion. Clearly, the question one needs to answer is how the mother body is able to wield this influence on its satellites. The equatorial location of orbits of satellites probably adds another dimension to this equation; this is also purposeful in bringing order to the solar system.

Information pertaining to the various bodies' axial rotation was available for the planets. A scrutiny of this reveals the following: For axial tilts less than approx. 90°, the rotational rates are fairly rapid, especially for gas giants, but beyond 90°, rates decline dramatically for solid bodies. Examples of these are Venus (Tables I and II) and the dwarf planet, Pluto. Uranus, a gas giant, with axial tilt of 97.8°, displays no slowing of the rate of rotation. The attempts to extend these observations to the planets' satellites were hampered by lack of information regarding axial tilts in those bodies. However, mention is made of "orbital inclination" for most bodies. Here, in general, nearby satellites (such as the "major or Galilean" satellites of Jupiter) with orbital inclination of <1° have "synchronous rotation." The bodies that are farther out and having orbital inclinations less than 90° have an intermediate orbital period and nonsynchronous rotation period. When the inclination is (presumably) over 90°, the orbital period is dramatically delayed and "negative" (Tables IV–VI).

In these examples, one could propose that the real feature to be noted is the axial tilt and that axial tilt will parallel orbital inclination. If that is the case, one can see how closest large satellites with negligible axial tilt will rotate and orbit rapidly, whereas in those with axial tilts of such a degree that the satellites are essentially upside down, the rotation is "negative" and the orbits are slow. The negative orbit is harder to explain. However, as these bodies are also far out and perhaps at a location of equivalent gravitational influences from the mother and a neighboring planet (for example, Saturn in the case of satellites of Jupiter), the satellite may be held in one place. Then the "retrograde orbit" may simply be an illusion created by the stationary position of the satellites, viewed against the rotation of the mother planet (please refer to the explanation for Triton's orbit below).

TABLE V. Orbital parameters of satellites of Saturn (adapted from http://nssdc.gsfc.nasa.gov/planetary/factsheet/saturniansatfact.html).

Satellites	Radius (km)	Semimajor axis (10^3 km)	Orbital period (days)	Rotation period (days)	Inclination (degrees)
(A) Major					
Mimas	208 × 197 × 191	185.52	0.9424218	S	1.53
Enceladus	257 × 251 × 248	238.02	1.370218	S	0.0
Tethys	538 × 528 × 526	294.66	1.887802	S	1.86
Dione	563 × 561 × 560	377.40	2.736915	S	0.02
Rhea	765 × 763 × 762	527.04	4.517500	S	0.35
Titan	2575	1221.83	15.945421	S	0.33
Hyperion	180 × 133 × 103	1481.1	21.276609	C	0.43
Iapetus	746 × 746 × 712	3561.3	79.330183	S	14.72
(B) Lesser					
Pan	17 × 16 × 10	133.583	0.5750	ND	0.0
Atlas	20 × 18 × 9	137.670	0.6019	ND	0.3
Prometheus	68 × 40 × 30	139.353	0.6130	ND	0.0
Pandora	52 × 41 × 32	141.7	0.6285	ND	0.0
Epimetheus	65 × 57 × 53	151.422	0.6942	S	0.34
Janus	102 × 93 × 76	151.472	0.6945	S	0.14
Methone	1.6	194	1.01	ND	ND
Pallene	2.9 × 2.8 × 2.0	211	1.14	ND	ND
Calypso	15 × 12 × 7	294.66	1.8878	ND	1.473
Telesto	16 × 12 × 10	294.66	1.8878	ND	1.158
Helene	22 × 19 × 13	377.40	2.7369	ND	0.0
Polydeuces	1.5 × 1.2 × 1.0	377.40	2.74	ND	ND
Kiviuq	~7	11,110	449	ND	48.7
Ijiraq	~5	11,120	451	ND	49.1
Phoebe	109 × 109 × 102	12,944	548 R	0.4	174.8
Paaliaq	~10	15,200	687	ND	47.2
Skathi	~3	15,540	728 R	ND	148.5
Albiorix	~13	16,180	783	ND	34
Erriapo	~4	17,340	871	ND	34.6
Siarnaq	~16	17,530	896	ND	45.6
Tarvos	~7	17,980	926	ND	33.8
Mundilfari	~3	18,690	953 R	ND	169.4
Narvi	~3	19,010	1004 R	ND	145.8
Suttungr	~3	19,460	1017 R	ND	175.8
Thrymr	~3	20,470	1094 R	ND	175
Ymir	~9	23,040	1312 R	ND	173.1
(C) Newly discovered					
S/2000 S1	~9	23,040	1312 R	ND	173.1
S/2000 S2	~10	15,200	687	ND	47.2
S/2000 S3	~16	17,530	896	ND	45.6
S/2000 S4	~7	17,980	926	ND	33.8
S/2000 S5	~7	11,110	449	ND	48.7
S/2000 S6	~5	11,120	451	ND	49.1
S/2000 S7	~3	20,470	1094 R	ND	175
S/2000 S8	~3	15,540	728 R	ND	148.5
S/2000 S9	~3	18,690	953 R	ND	169.4
S/2000 S10	~4	17,340	871	ND	34.6
S/2000 S11	~13	16,180	783	ND	34
S/2000 S12	~3	19,460	1017 R	ND	175.8
S/2003 S1	~3	19,010	1004 R	ND	145.8
(D) Other newly discovered satellites (S/2004 S7–S10 and S12–S18) have "negative" orbits and orbital inclination from 147.4 to 168. The exceptions are the following:					
Bebhionn (S/2004 S11)[a]	~3	17,120	835	ND	35
Daphnis (S/2005 S1)[a]	4.3 × 4.1 × 3.2	136.5	0.594	ND	0

S, synchronous rotation = (rotation period is the same as the orbital period); R, retrograde motion (orbit); ND, No data available, C, chaotic motion.
[a]As noted above, both have normal orbital parameters and low orbital inclination.

TABLE VI. Orbital parameters of satellites of Uranus (adapted from http://nssdc.gsfc.nasa.gov/planetary/factsheet/uraniansatfact.html).

Satellite	Radius (km)	Semimajor axis (10^3 km)	Orbital period (days)	Rotation period (days)	Inclination (degrees)
Major					
Miranda	240 × 234.2 × 232.9	129.39	1.413479	S	4.22
Ariel	581.1 × 577.9 × 577.7	191.02	2.520379	S	0.31
Umbriel	584.7	266.3	4.144177	S	0.36
Titania	788.9	435.91	8.705872	S	0.14
Oberon	761.4	583.52	13.463239	S	0.10
Lesser					
Cordelia	20	49.77	0.335034	ND	0.08
Ophelia	21	53.79	0.3764	ND	0.10
Bianca	26	59.17	0.434579	ND	0.19
Cressida	40	61.78	0.46357	ND	0.01
Desdemona	32	62.68	0.47365	ND	0.11
Juliet	47	64.35	0.493065	ND	0.07
Portia	68	66.09	0.513196	ND	0.06
Rosalind	36	69.94	0.55846	ND	0.28
Belinda	40	75.26	0.623527	ND	0.03
Puck	81	86.01	0.761833	ND	0.32
Mab	5	97.7	0.923	ND	ND
Caliban	36	7230	579.5 R	ND	140.88
Stephano	16	8002	676.5 R	ND	144.06
Sycorax	75	12,179	1283.4 R	ND	159.4
Prospero	25	16,418	1992.8 R	ND	151.91
Setebos	24	17,459	2202.3 R	ND	158.17
Trinculo	9	8571	758.1 R	ND	166.33
Perdita	10	76.4	0.638	ND	ND
Ferdinand	10	20,900	2823.4 R	ND	169.8
Francisco	11	4276	266.6 R	ND	145.2

S, synchronous rotation (rotation period is the same as the orbital period); R, retrograde motion (orbit); ND, no data available.

TABLE VII. Orbital parameters of satellites of Neptune (adapted from http://nssdc.gsfc.nasa.gov/planetary/factsheet/neptuniansatfact.html).

Satellite	Radius (km)	Semimajor axis (10^3 km)	Orbital period (days)	Rotation period (days)	Inclination (degrees)
Naiad	48 × 30 × 26	48.227	0.294396	ND	4.74
Thalassa	54 × 50 × 26	50.075	0.311485	ND	0.21
Despina	90 × 74 × 64	52.526	0.334655	ND	0.07
Galatea	102 × 92 × 72	61.953	0.428745	ND	0.05
Larissa	108 × 102 × 84	73.548	0.554654	ND	0.2
Proteus	220 × 208 × 202	117.647	1.122315	ND	0.04
Triton	1353.4	354.76	5.876854 R	S	157.345
Nereid	170	5513.4	360.13619	ND	7.23
S/2002 N1	30	15,730	1879.7 R	ND	134.1
S/2002 N2	20	22,420	2914.1	ND	48.5
S/2002 N3	20	23,570	3167.9	ND	34.7
S/2002 N4	30	48,390	9374 R	ND	132.6
S/2003 N1	20	46,700	9115.9 R	ND	137.4

S, synchronous rotation (rotation period is the same as the orbital period); R, retrograde motion (orbit); ND, no data available.

The essential explanation for the findings presented in this paper is that much depends on the special property of spin exhibited by all bodies floating freely in space. An important related observation is that almost all bodies in our solar system spin in a counterclockwise direction as observed from the North Pole. The Sun's axial rotation is also in the same direction, thus hinting at a direct relationship between Sun's rotation and its satellites' orbital direction. The curious observation of some bodies exhibiting excessive rotation period (for example, Venus, Pluto) can be explained as follows: These satellites are still attempting to spin in their inherent (anticlockwise) direction but, as their axes are so far tilted, they run foul of the parent's (i.e., sun's) rotation; the conflict also delays the spin rate of the satellite. Uranus, which is tilted by 97.8° and is rotating negatively, is not slowed; this may imply that the inversion has to exceed a certain degree beyond 90° before the competition with Sun will delay their spin. The lack of delay may, on the contrary, be due to the fact that Uranus is a gas giant, and like Jupiter and Saturn, the spin rate is inherently rapid.

Two special observations shown in Table I, the inordinate delays in both the rotational period and the length of day in both Venus and Mercury demand explanation. More importantly, these observations offer even more clues to the basic arguments articulated in this paper. At first glance, it is difficult to fathom what would make Mercury's days take almost three times as long as its axial rotation. One could argue that the rotation period is delayed so much in Mercury by its proximity to the Sun, due to the sun's highly magnetic nature and the planet's high content of iron. The almost nonexistent axial tilt of Mercury perhaps is due to its close proximity to Sun, much like two bar magnets situated side by side. An almost inverse relationship exists between these two properties in the case of Venus, in addition to its negative rotation. As explained in an earlier paragraph, the rotation of Venus is delayed by competition with the Sun's rotation, because of the excessive tilt of its axis. But, being somewhat farther from the Sun and its absent magnetism, an almost inverse situation applies in this planet, between the rotation period and the day, as compared with Mercury. Once again, in spite of all the delay in the rotation of both Mercury and Venus, the **orbital velocity** only depends on the distance from the Sun; one more important clue for the Sun's axial rotation orchestrating all behavior of these small planets.

In addition to the inordinate delay in its axial rotation, one finding that continues to baffle observers of Mercury is the precession of its perihelion. At least in part this is due to its proximity to the neighbors Venus and Earth, which tug on Mercury as they are closer to it, those influences tending to affect whatever influence the other close-by body, the Sun wields. One could explain the discrepancy in the calculated value according to Newtonian gravity and the observed one as being due to the fact that the magnetism imparts further delay. Thus, one might arrive at a closer value by factoring in this influence from magnetism, to the effect from the gravity.

Another oddball in the solar system, whose orbit had been hard to explain, is Triton, the large moon of Neptune. Situated reasonably close to its parent Neptune, this satellite shows both "synchronous" and negative rotation. Triton's synchronous rotation is probably related to the proximity of this rather large moon (much like the large satellites of Jupiter and Saturn). Negative rotation is probably due the excessive orbital inclination (which may well mean excessive axial tilt as well). Its most strikingly odd behavior, however, is that of **orbiting** in a direction opposite to the **spin** of its parent. One explanation, if one employs the tenets of this paper, is that an extraneous influence, perhaps Uranus or another close-by body is constantly tugging at Triton enough to keep it almost stationary, while Neptune's rotation makes Triton appear to be orbiting in the opposite direction.

An important function of the axial rotation may be the generation of magnetism in these bodies. There is no agreement in the scientific literature as to the principles behind such magnetism. It is contended that the intense gravitational pull of matter toward the center of these bodies leads to heat of such a degree that the metallic core (of mostly iron) is molten and as such it will not rotate with the rest of the planet. Thus, when the body as a whole rotates on its axis, the matter that makes up the outer layers of the planet is rotating around this nonrotating core and this is what generates the magnetism. This is consequently another purpose of the intrinsic property of axial rotation; the fact that the magnetic poles correspond to the axis of the planet attests to this assumption. Another way to explain the source of magnetism in the planets is the axial rotation alone; this is analogous to the generation of charge (electromagnetism) in even the elementary particles that display axial rotation, such as the electrons. As one would expect, the absence of magnetism in Venus can be explained by its extremely slow pace of axial rotation alone. Whether the negative rotation, as well as the extensive axial tilt, has roles to play in this aberration is unknown. Although Mercury also rotates very slowly, its large iron core and the proximity to the intensely magnetic Sun may explain its magnetism.

To summarize, the strange behavior of Mercury, Venus, Uranus, and Pluto as outlined in this paper helps support my hypothesis that the dominant force that imparts order in the solar system (by aligning the planets neatly in the equatorial plane and making them orbit only in one direction) is the ubiquitous property of matter to spin. It plays a supporting role to gravity in this process in that the influence of the gravitational pull is "transmitted" to the satellites through it. Thus, a perfect balance is struck; the inward pull of gravity and the centrifugal force of the spin moving in exactly opposite directions. This removes the need for postulating a "space–time warping" effect around all bodies to explain why the satellites are situated where they are. Further, it also explains the perpetual motion of the bodies whereas the warping will not explain why the satellites move around the parent in only one direction, along the ecliptic and at diminishing velocity, further away from the parent they are situated.

As the magnetic axis closely parallels the geologic axis of the vast majority of planets and their moons, one is tempted to assign a role also to magnetism in bringing order to the solar system. It is proposed that the satellite bodies are held at a certain distance and at the axial position by repulsion of like-poles of the mother and the satellite (Sun and its planets or the planets and their moons). Then, it is not surprising that the planetary/satellite motions lie along the ecliptic, a location that enjoys the most gravitational pull and is the most neutral with respect to the magnetic pull/repulsion. What a logical arrangement!

V. CONCLUSION

In this paper, it has been proposed that, by assigning purpose for the ubiquitous property of matter to spin, many a phenomena in the solar system can be explained. However, one needs to theorize how gravity (a relatively weak force) and rotation orchestrate motion of lesser (but still very substantial) bodies, by the dominant body from considerable distance. To understand this essential interrelationship, one needs to free oneself from our earth-bound biases. In the context of the vacuum and the near zero gravity in which all of them exist, all bodies no matter how massive are essentially weightless; the stars and galaxies are no exception. The weight observed by objects situated on or in close vicinity of large objects is an artifact of the intrinsic gravity of the body and the size (mass) of the objects stationed on them. Thus, the dominant body in the vicinity will find it very easy to influence the motion of all its satellite bodies, the weightlessness aiding the gravitational influence to be imparted adequately. This explains why the relatively feeble force of nature, the gravity, is able to move even very massive bodies. One just needs to consider the speed with which earth and other planets move around the sun to be awestruck by this process. Even the speed of rotation is mind-boggling; consider the fact that Jupiter, a body almost a thousand times the size of the earth rotates on its axis once every 9.9 h! What a wonderful natural phenomenon this spin really is!

The diminishing orbital speed in direct proportion to the distance from Sun (the inverse square law) implicates the diminishing gravitational pull directly. This is another exquisite phenomenon, without which order would not have been possible in the solar system. One could propose that the closer to the Sun (or another mother body) a satellite is, the increased inward pull of gravity that prevails is counterbalanced by sufficiently increased centrifugal force generated by the rotation. This strikes a perfect balance; the closer the object is, the faster the orbit and greater the centrifugal force to counterbalance it! One could summarize then, that the location of the bodies (the distance from the mother body) is determined by the combined forces of gravity and rotation, aided by the magnetism exerting a degree of repulsion (like-poles). The ecliptic location of all the major satellite bodies is determined by both the increased gravity and the magnetically neutral location of this plane. The motion of the bodies in relatively orderly manner is determined by the combined effects of gravity, rotation, and the consequential centrifugal force.

The extremely fast pace of rotation of a neutron star is an excellent example of how a body that exists in a frictionless state but empowered by its inherent property of spin unleashes this power. A neutron star is the remnant left after supernova explosions of large stars, during which all electrons have departed and protons and neutrons have combined into one body; thus, the neutron star behaves like a single nucleus. Although condensed into the diminutive size of a small city, this remnant of a star is still substantial, and it is astonishing that they are able to rotate on their axes at speeds of several times to hundreds of times a second! The nuclei (of atoms) will probably also rotate on their axes many hundreds of times a second, if only they can exist free of the confining influence of electrons and neighboring atoms! Of all the phenomena that have been described in this paper, this is the most elegant example of this fundamental property of matter to spin.

From the disk of matter that forms around the equator of a protostar, to the rings of Jupiter, Saturn, Uranus and Neptune, to the disk shape of most galaxies and their spin around their axes as well as the rotation in the anticlockwise direction, all are derivatives of this fundamental property of spin of matter. Most of the galaxies are also known to rotate around their axes and in my paper written in 2000 (and published on my website spinninguniverse.com, entitled "Spinning Universe…A Hypothesis"[12]), I theorized that they are probably orbiting the center of the universe in one direction and that the increased red-shifts that Hubble observed were probably the faster (circumferential) motion of the more distant galaxies. A recent paper in Physics Letters[13] supports this contention. In their study of 15,158 spiral galaxies with red-shifts of <0.085, Longo and his collaborators observed an anticlockwise motion (as observed from the Northern Hemisphere) of the galaxies and a clockwise motion when viewed from the Southern Hemisphere. Of course, any such property must have a function; it is proposed that the function of spin is to bring order to the universe and when coupled with the other universal property, that of universal gravity, and the magnetism that is very prevalent, it powers the engine that drives all bodies.

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