Confirmation of New Solar System Force Supports Universal Electrodynamic Force

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Abstract. Pari Spolter [1] has empirically confirmed the existence of a force $\mathbf{F} \propto \mathbf{RV}^2$ in our solar system, where **R** = planet semi-major orbital radius and **V** = planet semi-major orbital radius velocity. This dominant force term is accurate to 5 significant figures and determines the orbit of every planet, moon, and satellite in the solar system. Excel spreadsheets of the solar system data are presented along with graphical displays showing the quality and accuracy of the data fit. When Spolter's force is compared with the axiomatically derived universal electrodynamic force law [25-32], this new force is found to be represented in the 3rd and 4th terms of the universal force. (The 1st and 2nd terms represent the relativistic-like Coulomb force, the relativistic-like force of inertia, and the relativistic-like force of gravity.) The condition for stable orbits in the solar system is found to be due to a dynamic balance of all four terms in the universal force law. Thus Spolter's work contributes to the confirmation of all the terms in the axiomatically derived electrodynamic force law. The universal force law shows that previous extensions of linear forces to circular motion are theoretically invalid in that they miss some of the v^2/c^2 terms and the cross vector terms **R x (R x V)** and **R x (R x A)** which give the big picture of the solar system where the motion of planets about the sun is on the surface of a toroid centered on the equatorial plane of the sun with a combination of circular motions, i.e. one around the toroid and the other around the cross section of the toroid. Finally the universal electrodynamic force law is expected to produce quantum-like effects in the solar system, such as Bode's Law, due to the balance of force terms as the condition for stability or resonance.

Introduction. Johannes Kepler [2] published his first two laws describing the motion of the planets about the sun in 1609, having found them by analyzing the astronomical observations of Tycho Brahe [3]. Kepler did not discover his third law until many years later, and it was published in 1619 [4].

Almost a century later, Isaac Newton proved that relationships like Kepler's laws would apply exactly under certain ideal conditions approximately fulfilled in the solar system, as consequences of Newton's own laws of motion and his law of universal gravitation [5]. Because of the nonzero planetary masses and resulting perturbations, Kepler's laws apply only approximately to the motions in the solar system. Figure 1 is calculated from the table of data below, and it shows the deviations from Kepler's 2nd Law as a function

of eccentricity e of planetary orbits. Indirectly these also show the deviations from Newton's laws, from which Kepler's laws may be derived, as a function of eccentricity e.

Planet/ Asteroid	Semi-major S		Perihelion P		Aphelion A		Kepler's 1st Law Eccentricity e=(Ra-Rp)/ (Ra+Rp)	Check on Kepler's 2nd Law Ratio (Vp*Rp+Va*Ra)/ (2*Vs*Rs)
	Orbital Velocity V (m/sec)	Distance R (10^6 m)	Orbital Velocity V (m/sec)	Distance R (10^6 m)	Orbital Velocity V (m/sec)	Distance R (10^6 m)		
Venus	35017	108110	35256	107370	34780	108850	0.00684488	0.999982035
Neptune	5427.6	4499900	5472.3	4463000	5383.3	4536800	0.008200182	0.999969617
Earth	29771	149570	30272	147070	29278	152070	0.016714582	0.999855324
Uranus	6795.1	2870300	7116.1	2738300	6490.2	3002300	0.045988224	0.999066678
Jupiter	13052	7781`40	13700	740480	12435	815800	0.048397461	0.998842216
Saturn	9638.3	1427000	10177	1349500	9128.4	1504500	0.054309741	0.998539722
Ceres	17892	414100	19366	381400	16530	446800	0.078966433	0.99687154
Vesta	19376	353100	21184	321700	17722	384500	0.08892665	0.996029519
Mars	24121	227840	26490	206560	21964	249120	0.093398876	0.995631953
Achilles	13042	779300	15139	664000	11236	894600	0.147953291	0.989017724
Mercury	47828	57950	58921	46040	38824	69860	0.205522002	0.978659199
Eros	24665	217900	30912	169500	19681	266300	0.222120239	0.975032791
Pallas	17892	414100	22757	316400	14067	511800	0.235933349	0.971767807
Pluto	4736.5	5909000	6102.4	4443000	3676.3	7375000	0.248096125	0.968731552
Juno	18218	399400	23747	292000	13977	502800	0.265223956	0.959403728
Apollo	24431	222100	46408	96400	12861	347300	0.565472166	0.823825136
Hidalgo	12372	866000	27146	297900	5639	1434100	0.656004619	0.754781307
Icarus	28668	161300	93458	27700	8794	294900	0.828270304	0.560334223

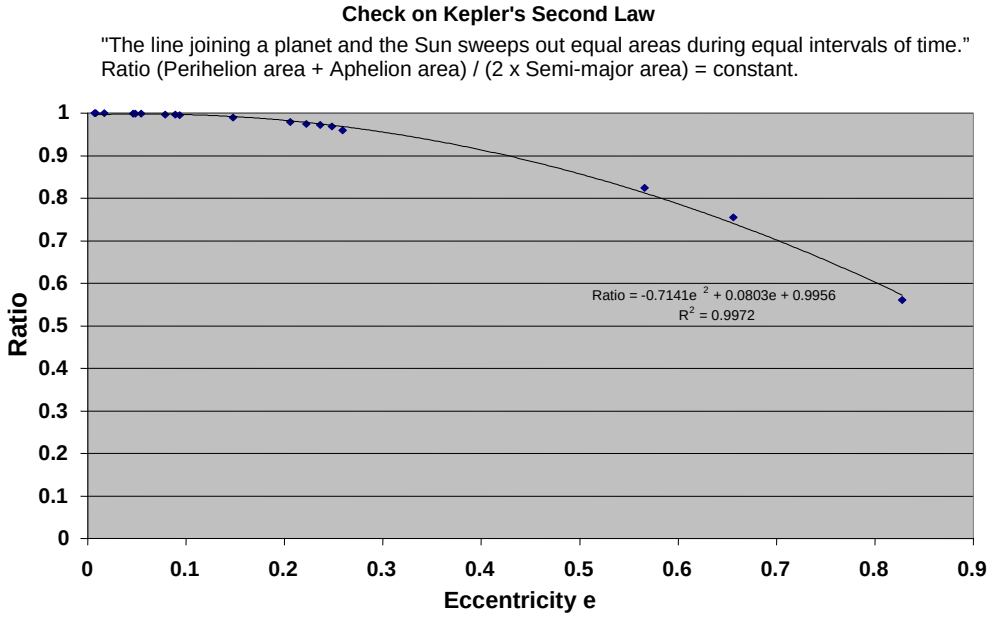

Figure 1. Deviations from Kepler's 2nd Law as a function of Eccentricity e

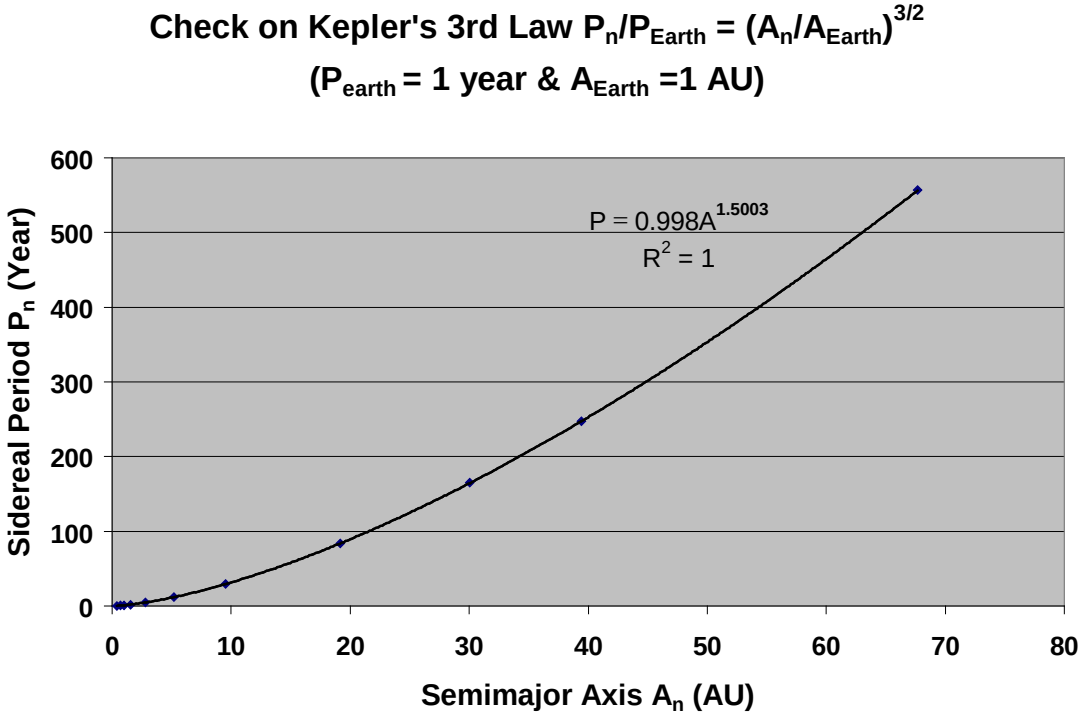

Figure 2. Fit of Solar system Data to Kepler's 3rd Law

Kepler's laws, which were based on an analysis of Tycho Brahe's observations, the assertion that the earth orbited the sun, the proof that the planets' speeds varied, and the use of elliptical orbits rather than circular orbits with epicycles, challenged the long-accepted geocentric models of Aristotle and Ptolemy, and generally supported the heliocentric theory of Nicolaus Copernicus [6]. However, Kepler's ellipses did away with Copernicus's notion of circular orbits in the equatorial plane of the sun.

The work of Newton dominated science for hundreds of years until the laws of mechanics were modified by the **Special Theory of Relativity** published by Albert Einstein in 1905 [7]. Ten years later Newton's **Universal Force of Gravitation** was replaced by the **General Theory of Relativity** published by Albert Einstein in 1915[8]. The General Theory of Relativity is a geometric theory of gravitation that incorporates some of the ancient notions of Euclid, Aristotle and Ptolemy that geometry was the key to understanding the universe.

General relativity differs from classical Newtonian mechanics in a number of predictions concerning orbiting bodies. It predicts a small contribution to the overall rotation (precession) of planetary orbits, a small orbital decay caused by the emission of gravitational waves and effects related to the relativity of direction of motion. General Relativity theory has been established based on these rather small effects in the solar system.

There are much larger effects in the orbits of the planets in the solar system that no previous theories have explained. None of the theories above have been able to predict the observed eccentricities of the elliptical orbits of the planets around the sun or the eccentricities of the elliptical orbits of the moons around the planets. None have been able to predict the tilt of the elliptical orbits of the planets with respect to the equatorial plane of the sun. None have been able to explain the quantization of the planetary orbits of the solar system as embodied in the modern version of Bode's Law $A_n = R_0 A_0^n$ where R_0 and A_0 refer to the sun.

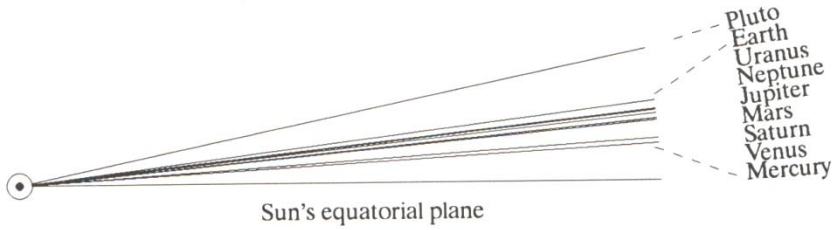

Figure 3.
Tilt of Elliptical Orbits of Planets with Respect to Equatorial Plane of Sun

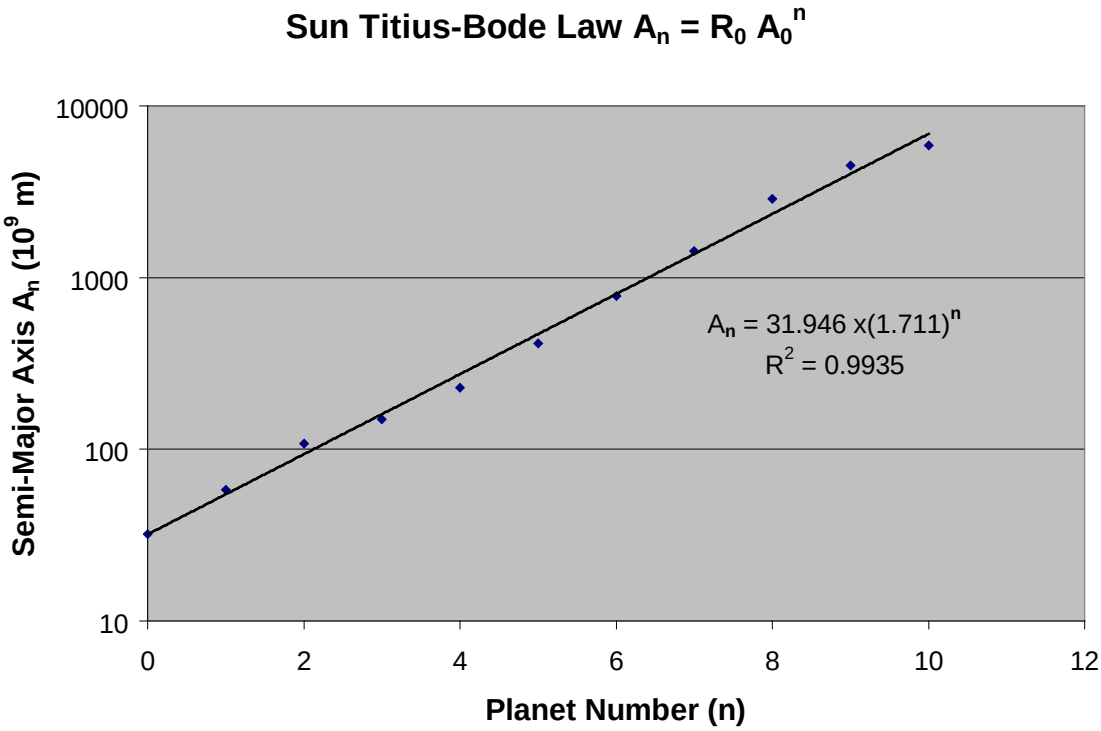

Figure 4. Fit of Modern Version of Titius-Bode Law to Solar System Data

Spolter's New Force Law in Solar System. At this point in history Pari Spolter began to analyze the solar system data. She confirmed that the approximate centripetal-like force law was more accurate than it should be [1]. The table below shows the solar system planetary orbit data and the very accurate force term discovered by Pari Spolter.

Pari used the form $F \propto$ Area x Acceleration where Area = πR^2 and Acceleration = V^2/R. The factor of π has been dropped here so that the term corresponds more exactly to the universal force 3rd and 4th terms.

New Planetary Force of the Sun from Planetary Orbits[9]

Planet Number n	Planet Name	Orbital Velocity V Semi-Major* x 10^3 m/s	R Semi-major Axis of Revolution* x10^9 m	Universal Force $F/(e^2/R^2c^2) = AR^2 = V^2R$ where $A=V^2/R$ x10^{21} m^3/sec^2
1	Mercury	47.828	57.95	1.32561644
2	Venus	35.017	108.11	1.325634321
3	Earth	29.771	149.57	1.325657518
4	Mars	24.121	227.84	1.325624705
5	Asteroids	17.892	414.1	1.325632093
6	Jupiter	13.052	778.14	1.325598094
7	Saturn	9.6383	1427	1.32563772
8	Uranus	6.7951	2870.3	1.325314641
9	Neptune	5.4276	4499.9	1.32561842
10	Pluto	4.7365	5909	1.325650602

From the table above see that the new planetary force term is proportional to a constant value of 1.3256 x 10^{21} m^3/sec^2 for all planets. Also all the known artificial satellites have a very similar value as shown in the table below.

New Planetary Force of the Sun from Satellite Orbits[10,11]

Satellite Name	Country	Launch Date	Mean Orbital Velocity V 10^3 m/sec	Mean Distance R 10^9 m	Universal Force $F/(e^2/c^2)=AR^2=V^2R$ 10^{21} m^3/sec^2
Luna 1	USSR	1/2/1959	27.8	172.03	1.329516652
Pioneer 5	USA	3/11/1960	31.40	134.54	1.326510584
Mariner 2	USA	8/27/1962	30.22	144.63	1.320831161
Ranger 5	USA	10/18/1962	29.74	149.67	1.323782657
Mars 1	USSR	11/1/1962	26.49	189.07	1.326742193
Mariner 4	USA	11/28/1964	25.72	200.60	1.32700591
Pioneer 6	USA	12/16/1965	31.43	134.56	1.329244097
Pioneer 7	USA	8/17/1966	28.82	159.69	1.326373004
Mariner 5	USA	6/14/1967	36.73	98.28	1.325888502
Mariner 6	USA	2/24/1969	26.23	192.83	1.326695275
Mariner 7	USA	3/27/1969	26.44	189.91	1.327610674
Mars 4	USSR	7/21/1973	26.27	191.48	1.321428181

An analysis of the moon and satellites of Earth gives a similar type constant result.

New Planetary Force of the Earth From Satellite Orbit Data[12,13]

Satellite Name	Country	Launch Date	Mean Orbital Velocity V m/sec	R = Semi-major Axis of Revolution 10^6 m	Universal Force $F/(e^2/R^2c^2)=AR^2=V^2R$ 10^{15} m^3/sec^2
Moon			1,017.60	384.403	3.980530583
Sputnik 1	USSR	10/4/1957	7,570.90	6.955	3.98650354
Sputnik 2	USSR	11/3/1957	7,382.30	7.314	3.98600956
Explorer 1	USA	2/1/1958	7,142.40	7.83	3.994386629
Vanguard1	USA	3/17/1958	6,779.70	8.687	3.992921529
ERS 12[a]	USA	10/17/1963	2,618.70	58.24	3.993860235
Proton 1	USSR	7/16/1965	7,678.30	6.764	3.987803516
S Model 1[b]	USA	8/11/1965	979.40	417.524	4.004991917
Diademe 2	France	2/15/1967	7,247.80	7.614	3.999680253
Heos 1	ESRO	12/5/1968	1,835.30	118.3	3.984729764
Skylab 1	USA	5/14/1973	7,654.50	6.811	3.990658228
Salyut 4	USSR	12/26/1974	7,770.50	6.61	3.991162304
Anik 3	Canada	5/7/1975	3,074.50	42.166	3.985762338
Lageos[c]	USA	5/4/1976	5,699.90	12.269	3.986058235
Seasat 1	USA	6/27/1978	7,457.20	7.166	3.98500055

(a) Environmental Research Satellite
(b) Surveyor Model 1
(c) Laser Geodynamic Satellite

An analysis of the moons and satellites of Mars gives a similar type constant result.

New Planetary Force of the Planet Mars From Satellite Orbit Data[10,14,15]

Satellite Name	Country	Launch Date	V = Mean Orbital Velocity m/sec	R = Semi-major Axis of Revolution 10^6 m	Universal Force $F/(e^2/c^2)=AR^2=V^2R$ 10^{13} m^3/sec^2
Phobos			2138.2	9.377	4.287069917
Deimos			1351.6	23.464	4.286456455
Mariner 9	USA	5/30/1971	1813.3	13.0565	4.293051478
Mars 2 Orbiter	USSR	5/19/1971	1608	16.584	4.288065178
Mars 3 Orbiter	USSR	5/28/1971	657.8	99.494	4.305113737
Mars 5 Orbiter	USSR	7/25/1973	1432.8	20.524	4.21340447
Viking 1 Orbiter	USA	8/20/1975	1454.5	20.551	4.347708421

An analysis of the orbital data for the moons of Jupiter gives a similar type constant result.

New Planetary Force of Jupiter From Satellite Orbit Data[16,17,18]

Satellite Name	Mean Orbital Velocity V m/sec	R = Semi-major Axis of Revolution 10^6 m	Universal Force $F/(e^2/R^2c^2)=AR^2=V^2R$ 10^{17} m^3/sec^2
metis	31567.6	127.96	1.275138508
Adrastea	31447.9	128.98	1.275574041
Amalthea	26421.6	181	1.263562713
Thebe	23922.6	221.89	1.269856036
Io	17330.2	421.6	1.266215868
Europa	13738.9	670.9	1.266373217
Ganymede	10875.9	1,070	1.265651649
Callisto	8205.1	1,883	1.267704631
Leda	3379.6	11,094	1.267122972
Himalia	3331.8	11,480	1.274382314
Lysithea	3287.9	11,720	1.266965567
Elara	3287.2	11,737	1.268263112
Ananke	2443.3	21,200	1.265579557
Carme	2375	22,600	1.27478125
Pasiphae	2325.1	23,500	1.270431152
Sinope	2273.7	23,700	1.225221671

An analysis of the orbital data for the moons of Saturn gives a similar type constant result.

New Planetary Force of Saturn From Satellite Orbit Data [18,19,20]

Satellite Name	Mean Orbital Velocity V m/sec	R = Semi-major Axis of Revolution 10^6 m	Universal Force $F/(e^2/R^2c^2)=AR^2=V^2R$ 10^{16} m^3/sec^2
Pan	16893.5	133.583	3.812329809
Atlas	16633.4	137.67	3.808915829
Promethus	16532.2	139.353	3.808707523
F Ring Braid	16488.8	140.185	3.811357146
Pandora	16395.6	141.7	3.80911846
Epimetheus	15862.4	151.422	3.810015764
Janus	15860.8	151.472	3.810505014
Mimas	14315.6	185.52	3.801980155
Enceladus	12632.5	238.02	3.798324499
Tethys	11350.9	294.66	3.796485799
Telesto	11350.9	294.66	3.796485799
Calypso	11350.9	294.66	3.796485799
Dione	10027.8	377.4	3.795012607
Helene	10027.8	377.4	3.795012607
Rhea	8484.2	527.04	3.793720863
Titan	5572.4	1,221.83	3.793982745
Hyperion	5062.3	1,481.10	3.795597388
Iapetus	3264.6	3,561.30	3.795495775
Phoebe	1711	12,952	3.791725199

An analysis of the orbital data for the moons of Uranus gives a similar type constant result.

New Planetary Force of Uranus From Satellite Orbit Data[21,22,23]

Satellite Name	Mean Orbital Velocity V m/sec	R = Semi-major Axis of Revolution 10^6 m	Universal Force $F/(e^2/R^2c^2)=AR^2=V^2R$ 10^{15} m^3/sec^2
Cordelia	10803.2	49.771	5.808730121
Ophelia	10393	53.794	5.81052927
Bianca	9901.8	59.172	5.801556802
Cressida	9691	61.776	5.801722754
Desdemona	9622.8	62.675	5.803597189
Juliet	9490.9	64.35	5.796466714
Portia	9365.2	66.09	5.796553716
Rosalind	9107.8	69.942	5.801830242
Belinda	8777.1	75.256	5.797532927
Puck	8209.8	86.006	5.796874584
Miranda	6680.4	129.847	5.794778696
Ariel	5509	190.929	5.794519686
Umbriel	4667.4	265.979	5.794252177
Titania	3644.3	436.273	5.794107897
Oberon	3151.3	583.421	5.793774076

An analysis of the orbital data for the moons of Neptune gives a similar type constant result.

New Planetary Force of Neptune From Satellite Orbit Data[18,24]

Satellite Name	Mean Orbital Velocity V m/sec	R = Semi-major Axis of Revolution 10^6 m	Universal Force $F/(e^2/R^2c^2)=AR^2=V^2R$ 10^{15} m^3/sec^2
Naiad	11914.6	48.2331	6.84705961
Thalassa	11689.6	50.0692	6.841793363
Despina	11415.2	52.5313	6.845185132
Galatea	10506.8	61.9451	6.8382959
Larissa	9642.7	73.5457	6.838401514
Proteus	7622.3	117.635	6.834529658
Triton	4389.9	354.7591	6.836641376
Nereid	1113.3	5,513.40	6.833511349

New Force Law Confirms Universal Force. The axiomatically derived universal electrodynamic force [25-32] is given below.

$$\vec{F}(\vec{R},\vec{V},\vec{A})=\frac{qq'}{\vec{R}^2}\left[\frac{(1-\vec{\beta}^2)\hat{R}+\frac{2\vec{R}^2}{c^2}\vec{A}}{\left[1-\frac{\{\vec{R}x(\vec{R}x\vec{V})\}^2}{\vec{R}^4}\right]^{1/2}}-(1-\vec{\beta}^2)\frac{\left[(\vec{\beta}\cdot\vec{R})\hat{R}x(\hat{R}x\vec{\beta})+\frac{\vec{R}^2}{c^2}\hat{R}x(\hat{R}x\vec{A})\right]}{\left[1-\frac{\{\vec{R}x(\vec{R}x\vec{V})\}^2}{\vec{R}^4}\right]^{3/2}}\right]$$

Note that the first and second terms are for linear motions. The third and fourth terms explicitly hold for circular type motion. Note that for circular type orbits the 3rd and 4th terms of the force above are proportional to V^2R and R^2A. For $A = V^2/R$ these terms just add together. In the past these centripetal type forces were not obtained following the axiomatic method, but by the use of approximations to extend the linear force laws. The extension of the linear force law to circular motion was not expected to be any more accurate than the linear force laws, but they are much better, because they happen to be separate terms in the universal force law. Note the different power or superscript of the denominator for these terms. Thus Spolter has identified a new force in the solar system.

For a stable solar system or any other dynamic system one would expect all the forces need to balance. That is exactly what we have here. If one plots the values of the new constant planetary force for each planet versus the mass of that planet from the table below, one obtains the result that this force exactly balances the usual force of gravity plus the constant electrical relativistic type Coulomb force. Note the relative strength of the forces from the fit of the data on the graph.

This may be the first evidence that the charge on the planets is not random but follows a systematic pattern. The Coulomb force is independent of the mass or size of the planets. It only depends on R^2 or the area of the planetary orbit.

Planet Name	**Mass Planet 10^{24} kg**	**Force/$(e^2/R^2c^2)=V^2R$ $10^{13}m^3/sec^2$**
Mercury	0.33022	
Venus	4.869	
Earth	5.9742	125
Mars	0.64191	4.28
Asteroids		
Jupiter	1898.8	12700
Saturn	568.5	3800
Uranus	86.625	580
Neptune	102.78	684
Pluto	0.015	
Sun	1989100	132560000

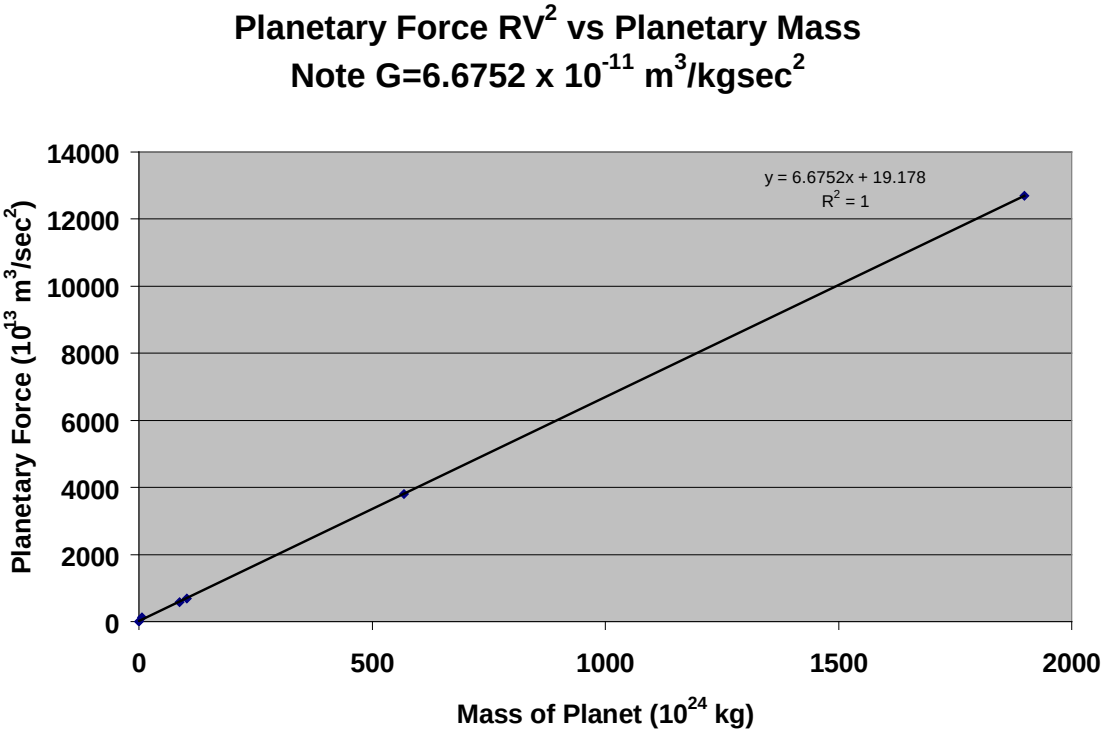

Figure 5. New Planetary Forces as a Function of Planetary Mass

Since all the terms of the universal electrodynamic force appear to play a significant role in the solar system, this evidence just further supports the claim of this axiomatically derived electrodynamic force as the leading candidate for the universal force.

Conclusions. A new planetary force has been discovered empirically by Pari Spolter that describes the solar system more accurately than Newton's Universal Law of Gravitation and Einstein's General Relativity Theory. Spolter's force balances out the effect of gravity and the Coulomb electrical force to allow stable solar system orbits. This is a major discovery that rivals Newton's Universal Law of Gravitation and Einstein's General Theory of Relativity in importance.

Previous extensions of the linear force of inertia to describe stable circular motion are found to be theoretically invalid, because they are not based on proper axiomatic proof. They miss factors of v^2/c^2 and the vector cross products **R x (R x V)** and **R x (R x A)** in the 3rd and 4th terms of the universal force. The extrapolation approach misses the big picture that the motion of planets about the sun is on the surface of a toroid centered on the equatorial plane of the sun with a combination of circular motions, i.e. one around the toroid and the other around the cross section of the toroid.

This new planetary force can be identified with the 3rd and 4th terms of the axiomatically derived electrodynamic force [25-32] that has been declared a candidate for the universal force. The first two terms correspond to the relativistic-like force of gravity, the relativistic-like force of inertia, and the relativistic-like Coulomb force. Thus all the

terms in the electrodynamic force have now been shown to play a significant role in the operation of the solar system. And it now appears that the solar system is governed 100 percent by the electrodynamic force.

This is a major discovery that rivals Newton's Universal Law of Gravitation and Einstein's General Theory of Relativity in importance and discredits both of them by showing that electrodynamics is the origin of gravity. It lends support to the model of Copernicus that all planetary motion is a result of circular motions about the sun centered on the equatorial plane of the sun.

From the viewpoint of the universal electrodynamic force law, the stability of the orbits of the solar system is due to the balance of electrodynamic forces in the solar system. This is what one might expect from a legitimate candidate for the universal force law. This balance allows stability equivalent to standing waves in electrodynamics. Thus one would expect quantum-like effects due to the balance of forces as a condition for stability such as Bode's Law in the solar system. (A future paper will predict the eccentricities of the orbits of the planets, angles of the tilts of the orbits with respect to the equatorial plane of the sun, and the modern version of Bode's Law which no previous theories have predicted.)

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