# The Inverse Problem of Celestial Mechanics

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**ABSTRACT**

A least squares fit is used to generate a symmetric coordinate system for the planets in the solar system. The movement of each planet is uniform about this plane, each being in simple harmonic motion. A sinusoidal forcing function is assumed. The resultant linearized system analysis shows two distinct orbital schemes, one for the inner planets and one for the outer. These are interpreted to be the upper and lower portions of a prolate cycloid. Known astronomical phenomena validate the system. The sun-Jupiter Lagrange point, at the Trojan asteroids, links the inner and outer waveforms. The unique earth-moon system is indicated, as are new stable quasi-satellite orbits centered on Earth and Venus, and the location of the "Trojan" orbit of Mars occupied by Eureka. Each body occupies a unique place on the system wave. The entire wavelength is occupied without duplication, indicating that the wavelength selected is ideal. Relative positions are indicative of the axial inclination and orbital ellipticity. Mathematical substantiation is developed by showing the system is a solution of the regularized three body problem. Reasonable assumptions made from the graphical study confirm this mathematical solution.

**The System Wave**

The first objective of the analysis is to create a more stable system by better explaining systematic deviations from the Invariant Plane. A stable solution set is one of the outcomes of the analysis of the regularized Three Body Problem. Thus, since this approach is from the opposite direction, to create a more stable system is the next logical step toward the mathematical solution sought. This is based on the premise that the more accurately the planetary motions can be defined in this fundamental context, the more stable they should be (ie the less will be their deviation from the norm).

The new plane has already simplified the motion of all the planets. In order to further define the motions, first introduce another variable: the planet's axis of rotation. This axis is known to always point to the same spot in the celestial sphere, throughout its revolution around the sun. During this movement, the planet moves evenly above and below the ecliptic plane.

These characteristics can be conveniently represented if the planet is considered to be associated with a longitudinal wave. If the axis of rotation is always tied to this sinusoidal wave, then as the planet moves about the sun the elliptical shape of the orbit causes the planet to move closer and farther away from the sun. If this motion happens on a sinusoidal wave, the axis will always point in the same direction. (Figure 1)

Otherwise, the choice of a sinusoidal waveform explains the three movements that occur simultaneously with respect to the new system plane: the elliptical shape of the orbit, the movement above and below the system plane, and the axial inclination of the planets pointing to a fixed spot in the heliocentric sphere while the other motions occur.

Table 1

| *PlanetInclination of Axis* | *X* | | |
|---|---|---|---|
| Mercury | 5.8 E7 | 0.0 degrees | 1.2 E7 km |
| Venus | 1.1 E8 | R179 | 6.7 E6 |
| Earth | 1.5 E8 | 23.5 | 2.5 E6 |
| Mars | 2.3 E8 | 25.2 | 2.1 E7 |
| Jupiter | 7.8 E8 | 3.2 | 3.8 E7 |
| Saturn | 1.4 E9 | 26.8 | 7.8 E7 |
| Uranus | 2.9 E9 | R98 | 13.2 E7 |
| Neptune | 4.5 E9 | 29.0 | 3.7 E7 |
| Pluto | 5.9 E9 | 90.0 | 1.5 E9 |

The data used in the analysis is listed in Table 1. The semimajor axis is an approximation of the planets' average orbital distance from the sun. A value "X" is the range of motion of the planet in its orbital plane.

**Linearization**

The next task is to find the wavelength of a common "system wave." After trying several solutions, it was evident that the outer planets would be the controlling elements, so the search focused on the lowest common denominator of their orbital range. This value, 23.3 E6 km also had to fit the entire range of movement of the inter planets.

Table 2

| *Planet* | *Division by 23.3 E6* | *Inclination of orbit to the ecliptic* | *Maximum distance from the ecliptic* |
|---|---|---|---|
| Mercury | 2 + 1.1 E7 km | 7.0 degrees | 7.0 E6 km |
| Venus | 4 + 1.7 E7 | 3.4 | 6.5 E6 |
| Earth | 6 + 1.0 E7 | 0.0 | - - |
| Mars | 9 + 2.0 E7 | 1.9 | 7.6 E6 |
| *Apollo Group* | *9 + 7.8 E6* | - | - |
| *Belt Asteroids* | *16 + 2.2 E6* | - | - |
| *Trojan Group* | *33 + 3.6 E6* | - | - |
| Jupiter | 33 + 1.1 E6 | 1.3 | 17.0 E6 |
| Saturn | 60 + 2.0 E6 | 2.5 | 61.0 E6 |
| Uranus | 124 + 1.0 E7 | 0.7 | 35.0 E6 |
| Neptune | 193 + 3.1 E6 | 1.8 | 141 E6 |
| Pluto | 253 + 5.1 E6 | 17 | 172 E6 |

The second column of Table 2 lists the aspect of each planet upon this wave – the remainder of division by the proposed wavelength. This value was used to situate each planet at the proper location upon the wave. Note that positions are only approximate in this two dimensional system: the wave is actually a spiral in three dimensions.

A possible presentation of the "system wave" is a family of curves called the Cochoids of Nichomedes, with the parametric equations:

$x = a + \cos t$ & $y = a \tan t + \sin t$

These generate a two-part curve: a loop similar to a prolate cycloid, and a shell. This solution will have some unique possibilities in the analysis of orbits.

The second objective of the analysis was to further develop the study to define the uniform deviations from the new system plane, so that a more stable system could be devised. This has been done for the original positions by simply introducing another variable and trying to match it. By seeking to close fit to this third variable, axial inclination, the affect was to more closely resolve the previously analyzed parameters. This affect becomes more pronounced as the analysis continues in greater detail.

**Gravity**

Figure 1 is a sketch of the planets situated upon either of the two parts of the cycloid, according to the average orbital distances in Table 1. The axis is shown as an arrow pointing according to the right hand rule for the planets' rotation. The positions of the various planets on the waveforms can now be fit to the wave.

First, the motion of Mars moves uniformly on either side of an inflection point in the wave, its axis inclined at about the right amount. Jupiter does the same thing on the lower wave, which arches less to correspond with the lesser axial inclination of Jupiter's axis. Uranus, also on the lower wave, moves through an entire wavelength, with an eight degree axial inclination off the vertical, slightly greater than Jupiter – since it traverses more of the wave.

Next, Saturn on the lower wave traverses two wavelengths, with a much greater axial inclination. The center point of the wave can be thought of as an inflection point, motivating the body to rotate in order to maintain rotational stability – a two dimensional vista of the singularity at the sun discussed earlier. It is interesting to note that all four planets (with the possible exception of Pluto) have almost the same rotational period – about ten hours. This would imply some similarity in the wave analogy, and it is there in the form of the inflection of the wave traveled. Back to the upper waveform, there is Mercury shown atop the loop, It moves back and forth on the waveform the distance of its ellipticity, maintaining its axis pointed in the same direction. Although the planet is known to have an axial inclination of zero, the wave may be inflected so that the pattern traced is less exaggerated. The geometry of that area of the plane fits this expectation.

Venus is not much farther from the zone where the entire pattern may be warped because of the close coincidence of the two waveforms.

The Earth-Moon system is the most striking aspect of the system, buttoning up the sides of the loop. They are unique in the solar system, the Moon being the largest satellite with respect to its host in the whole solar system. This may be a necessary prerequisite for matter to exist in dynamic stability at the cusp of the wave front as shown. In which case Earth occupies the upper portion of the loop, the moon the lower, in its own orbit. The moon's orbital plane is inclined at five degrees to the Ecliptic, as is indicated by the inflection of the lines (versus the much higher inflection of the upper cusp, indicative of Earth's 23° axial inclination).

Also indicated is a stable quasi-satellite orbit centered on earth, about 80 times the earth-moon distance in cross section. This is about two wavelengths of the system wave, which means the orbit is between two adjacent cusps of the pattern. The stable orbit varies at most 3 to 4 degrees off the ecliptic, which is approximately the extent of the cusp, or small loop in Figure 12. Another such stable orbit exists around Venus, with the same dimensions and aspect.
This assumes that the placement of the minor planets on the inner wave is not only unique, but that every portion of the wave must be occupied for overall stability of the solar system. Each

planet occupies a special location, which is not shared by any other. In atomic physics terms, the curve defines allowable (stable) orbits.

The Asteroids occupy the area at the beginning of the upper (inner) waveform. The locations of the Belt, Trojan and Apollo Groups of asteroids align closely with the average distances of the planets Saturn, Jupiter and Neptune, respectively. (The Trojan Asteroids are at the Lagrange Point of the Sun-Jupiter system.) This bilateral symmetry is like a zipper, linking the inner planets to the outer planets, and the respective waves by which each is identified.

Another notable phenomenon in the solar system is the "Trojan" orbit. This is a stable orbit that trails a planet. Only one such orbit has been confirmed, that of Eureka, aka Trojan 1990MB. The orbit is 60° behind Mars and inclined at 20° to the orbit of Mars. The nearest cusp on the "system wave" in Figure 12 is $1/6^{th}$ of the distance to the sun, or 60° . Since Mars is shown close to the axis of the wave, a body in the cusp indicated would follow an orbit indicated at the 20° angle to Mars' orbit.

Two more recent astronomical phenomena are worth noting, as further tests of the hypothesis as it presently stands. First, is a marked spiral characteristic recently noted to electromagnetic waves propagating from great distances away, for which there is no known explanation. The presumably gravity-based wave developed thus far has a spiral aspect. Second, the Hale-Bopp comet was seen to have a new type of tail, one that is straight as an arrow and electromagnetic in origin. This takes a far stronger force than a matter based tail. The system pattern traced thus far not only has a straight aspect (ie in the scale of a comet), but this aspect is presumed to be analogous to the strong gravitational force because it has the most affect on the most distant outer planets.

A final notable characteristic of the analysis is that the midpoint of each planet's motion (and also that of the motion of the y-intercept) is about 0.05 Au below the heliocentric plane calculated by the least squares fit. This fit was normalized to be symmetric about the known origin of the solar system, or the center of the heliocentric sphere. In order for the pronounced symmetry of both systems to be realized, that is:

the close symmetry of the least squares fit to a sinusoidal slope and a sinusoidal motion of the y-intercept, and the uniform displacement of the midline of the sinusoidal motion of the planets about this plane, then a two-part pattern such as that envisioned most closely realizes both conclusions.

In affect, the defining plane of motion then becomes the bottom half of the above parametric equations wave for the inner planets.

Table 3 Motion of the planets with respect to the new heliocentric plane

| Planet | Movement w.r.t. the system plane (Au) | Centerline | Radius (1/2 range) |
|---|---|---|---|
| Mercury | -0.30 + 0.21 = 0.51 | -0.05 | 0.26 |
| Venus | -0.27 + 0.17 = 0.44 | -0.05 | 0.22 |
| Earth | -0.19 + 0.17 = 0.26 | -0.06 | 0.13 |
| Mars | -0.19 + 0.09 = 0.28 | -0.05 | 0.14 |
| Jupiter | -0.10 + 0.02 = 0.12 | -0.04 | 0.06 |
| Saturn | -0.30 + 0.17 = 0.47 | -0.06 | 0.23 |
| Uranus | -0.77 + 0.74 = 1.51 | -0.03 | 0.75 |
| Neptune | -1.21 + 1.21 = 2.42 | 0.00 | 1.21 |
| Pluto | -1.10 + 1.60 = 1.70 | -0.25 | 0.85 |

**Reality Check**

The analysis so far is purposefully not rigorous. The data base itself is an approximation with many factors built in. Thus it would be inaccurate to make anything other than broad generalizations from analysis thereof. The intention of the study so far is to use fairly accurate information to develop a model. It is much easier to fit a model to data that is already a little bit normalized instead of trying to fit a model to the most exacting standards. In this respect the model is similar to the original Bohr model of the atom that worked for only a single atom and electron; nevertheless, it let to important developments thereafter.

The proposed model was shown to explain better than any existing model, several appealing characteristics of the solar system. These are intended to test the model, and to justify further analysis. Had there been no such heuristic proofs, then the model would have been rejected outright. As it is, the model can be considered an "engineering solution" to the situation, because of the following aspects:

The range of the inner planets elliptic orbits fill up the entire wavelength, with insignificant overlapping. The curve therefore represents the only available stable orbits around the sun, as discrete, quantized energy levels.

A newly discovered stable quasi-satellite orbit centered on Earth is indicated, moving between cusps on either side of the earth-moon system, inclined as calculated at a maximum 3° to 4° to the ecliptic.

A similar codependent orbit around Venus, of the same dimensions, matches known calculated values.

A stable node is indicated as a "Trojan" orbit behind the planet Mars, at the correct angular distance and inclination to the orbital plane of Mars.

The position of each planet is closely aligned to its axial inclination, especially considering the presentation is two dimensional and the wave is actually in three.

The outer planets occupy increments of half or full wavelengths, on the lower portion of the waveform. Again, this indicates the only available stable orbits for the outer planets.

The asteroid groups and the average position of the outer planets occupy the same positions, but on the upper and the lower waveforms respectively.

The Trojan asteroids and Jupiter are shown opposite one another, on the two waveforms. The Trojan asteroids are at the stable Lagrange Point of the Sun-Jupiter system.

The planet Mars is located at the junction of the two wave systems, in an area where the asteroids indicate great turbulence. The recent Mars mission showed evidence of huge tidal action by great bodies of water; but with no evidence of water being present in such quantity.

This analysis hints that gravitational wave motion may have caused such geological evidence. This three-body system exhibits many of the characteristics of the more traditional three-body system that actually has just three point-mass bodies. Most notably is the suggestion of a Lagrange Point, between the Sun and the outer planets being situated at the Trojan asteroids. In additional, various stable orbits are suggested, as might be surmised from the traditional three-body analysis.

This three-body analogy, if true, should be evidenced in a thorough mathematical analysis of the system. As such, the study thus far is a static one: no motion of the bodies is involved, or even implied. The following mathematical solution will introduce a dynamical element.

**Conclusion**

Most experts in Celestial Mechanics are horrified that yet another coordinate system has been proposed in this paper. With all due respect, it should be obvious that this is THE coordinate system. The planets are shown to move uniformly above and below the plane thus defined; and, in so doing, establish this plane as THE invariant plane of the Ten Bodies. Furthermore, many heretofore unexplanined phenomena in our Solar System are rationalized in a very simple and elegant context.

Subsequent papers will show further credence for this new coordinate system. Foremost is the ability that this "system wave" forms the first, and fundamental frequency in a Fourier Series model of the solar system. To expect this to fit all properties is inconsistent with the idea of series solutions - e.g. the first wave in a series solution to a square wave is a sine wave; that's not very close, but the model becomes closer and closer as more terms are added. So, it is unfair to criticize this method as inexact; at least not until more terms are added.

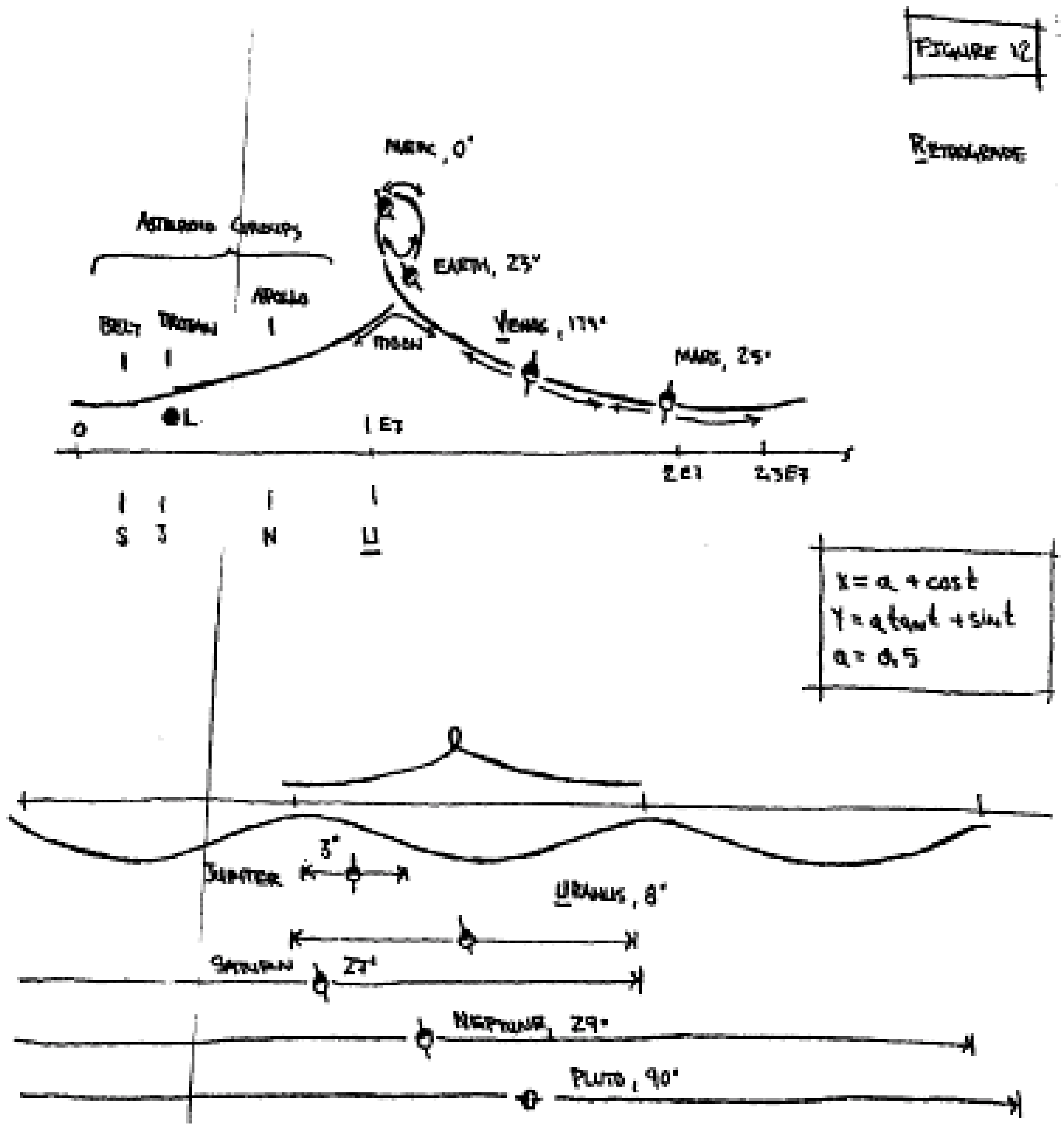
FIGURE 12
RETROGRADE
ASTEROID GROUPS
BELT
TROJAN
APOLLO
EARTH, 23°
MOON
VENUS, 177°
MARS, 25°
x = a + cos t
y = a tan t + sin t
a = 0.5
JUPITER
3°
URANUS, 8°
SATURN
27°
NEPTUNE, 29°
PLUTO, 90°