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The Incorrect Theory of Mercury's Anomalous Precession

and Correct Orbit Computations

By

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1. Introduction In 1859, U. J. Le Verrier presented his Theory of the Movement of Mercury [1], based on analytical hand fitting of planetary orbit measurements taken over a century. Corrections were made for the influence of several other planets. As observed from Earth, the total of 5600 arcsec/century was mostly made up by the 5026 arcsec/century precession of the equinoxes, while 531 arcsec/century was fit to the other planets, leaving a discrepancy of 43 arcsec/century that was unaccounted for. Le Verrier obtained 39 arcsec/century and explained the discrepancy as the influence of an undiscovered planet called Vulcan. It must be commented that the entire discrepancy is less than a 1% uncertainty in the total measurement, or 8% of the other planets effect, requiring an almost unheard of accuracy for a measurement described as, "One of the most difficult in experimental Astronomy."

Although several other evaluations were made up to about 1950, the discrepancy only moved from 39 to 43 arcsec/century. This was because Einstein, in a 1915 paper [2], explained the entire difference by introducing a General Relativity (GR) correction to a pure elliptic orbit. He said that the experimental value at that time was 45 ± 5 arcsec/century, and thus his theory was in complete agreement with experiment. Schwarzschild, in a 1915 letter [2], warned Einstein that he had made an error in his GR approximation such that the answer would not converge. Schwarzschild's general solution [3] also does not lead to a singularity. Nonetheless, the Einstein GR correction has been accepted as being true, and current JPL computer codes contain a numerical GR correction that cannot be turned off. The numerical multi-body solutions [4], covering no more than a century, show tortuous advances and fallbacks, not at all like a linear advance in the Perihelion motion predicted by the Einstein correction.

Vancov [2] subsequently demonstrated that Einstein only computed the correction term as a perturbation to an elliptic integral, and assumed that the rest of the integral orbit was unchanged. In fact, the limits changed and the GR correction canceled out. Vancov [5] subsequently solved Einstein's orbit equations with correction numerically and has shown that it gives unstable orbits for Mercury. For heavier bodies such as stars near the central black hole of a galaxy, it leads to orbits that become superluminal and do not ever reach the origin. It is thus proven that Einstein's Mercury correction is completely false, and fails for planets as well as black holes!

2. Numerical Mercury Solution The JPL solutions [4] have a built in linear GR correction that cannot be turned off, and they probably contain aspects of data fitting as well to minimize deviations from experimental measurements. One can question whether the objective is to obtain accuracy or to obtain precision, which are two different things. Nonetheless, the solution shown below in Fig. 1 is anything but a linear advance in the Perihelion of Mercury, and the amount of change seems to depend on where the solution starts and ends. Of course, this results because the various planetary orbits have a time dependent relationship with one another, and the net effect is different when they are out of phase, and when "Jupiter aligns with Mars."

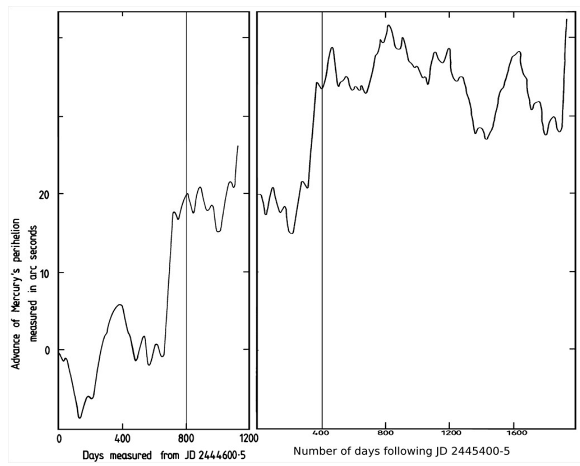

Figure 1. JPL Numerical Solution for Mercury Perihelion Advance

This behavior alone should give reason to suspect the correctness of the simple Einstein linear orbit advance correction. He was trying to make a linear time correction to an inherently nonlinear multi-body dynamics problem.

3. Einstein Solution The orbit for a single planet around the Sun, with no interference from other planets, is an ellipse as derived by Kepler. The solution comes out in an elliptic integral, which contains a quadratic term in the denominator under a square root. What Einstein did was to add an extra cubic term, so that the denominator contained the expression,

$$\alpha x^3 - c_1 x^2 + c_2 x + c_3, \quad (1)$$

where α was Einstein's correction value.

He then *assumed* that the small added extra αx^3 term did not affect the two solutions of the original quadratic equation. So, although the problem solution now became the sum of two elliptic integrals, he *assumed* that the first integral was unchanged by the extra small term and represented the original elliptic orbit. Thus, he *only* calculated the second integral, and was able to extract the effect of the extra term so an analytic solution was possible. That term, correctly evaluated, led to the value

$$I_2 = \delta = 43 \qquad (2)$$

arc seconds per century advance given in the 1915 paper.

However, a cubic equation [2] has three roots that are connected by a characteristic equation. The net effect was a small change in the limits of the elliptic integral that Einstein did not calculate. When correctly done, the solution to the first integral was,

$$I_1 = \text{Elliptic Orbit} - \delta \ , \qquad (3)$$

and the total was

$$I_1 + I_2 = \text{Elliptic Orbit} \ , \qquad (4)$$

Hence, Vankov proved that there was *no* correction at all! This result is clearly in agreement with Schwarzschild, who said that a term was left out by Einstein, and that, although the term was small, its effect was to make the solution indeterminate!

4. Numerical Orbit Solutions For the following, I must acknowledge Anatoli Vankov, for giving me permission to show his numerical results prior to publication of a full paper [5]. Since various controlled error numerical methods are now available to solve nonlinear problems, it is no longer necessary to put the orbit solution in the form of an elliptic integral. Instead, the Einstein correction term αx^3 was simply added to the differential orbit equation, and solutions were computed for several cases.

The first case is like a planet such as Mercury, near its Sun. Depending upon the exact details of where the planet is located relative to its mass, the numerically computed orbits evolve in such a way as to either expand or contract from the initial position as shown in Fig. 2. They do this in an erratic way around the Sun at the origin, such that the change per quadrant is not constant, as shown in Table 1.

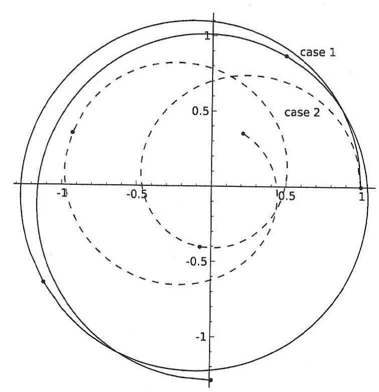

Figure 2: Results of numerical integration. Shown two GR orbits for 3 half periods (here in counter-clock rotation) for $(r_g/r_0) = 0.05$. Case 1: Over-circle, $\sigma_{rg} = 0.809$, $\beta_0^2 = 0.065$, relative advance 16.8 %. Case 2: Sub-circle, $\sigma_{rg} = 1.316$, $\beta_0^2 = 0.040$, relative advance 44.3 %.

This is clearly not the linear advance expected by Einstein as the effect of his small GR perturbation term! Hence Einstein's reasoning was faulty, and small changes can have unexpected consequences.

Table 1: **Non-uniformity of GR angular advance**

Angular advance additives	Over-circle	Sub-circle
Half a period, $[\theta - \pi]$, *rad*	3.67	4.53
Half a period, $[\theta/\pi - 1]$, %	16.8	44.3
First quarter, $[\theta_1 - \pi/2]$, *rad*	1.85	2.05
First quarter, $[\theta_1/(\pi/2) - 1]$, %	17.9	30.8
Second quarter, $[\theta_2 - \pi/2]$, *rad*	1.81	2.48
Second quarter, $[\theta_2/(\pi/2) - 1]$, %	15.6	57.8

The results of corresponding calculations for the plotted over-circle and sub-circle orbits are presented in Table 1. It illustrates the law "the closer to the center, the greater the advance" in its local action. Indeed, if a particle is launched into the over-circle (moving farther from the center), the second quarter advance is less than that in the first quarter, and reversely in the sub-circle launch (moving closer to the center). Notice, the parts in radians and in their percentages are proportional and additive. It means that the law (13) is a differential one that is, it is valid for small angular increments.
This is a non-uniform GR precession leading to the corresponding left-

The next set of computations was made for a more massive body like a star near a very large mass like the central Black Hole of a galaxy. One would expect that the Black Hole would draw the star directly in, where it would be gobbled up. But using Einstein's GR orbit correction, the star approaches the Black Hole, but never gets there! Again, the orbit is not linear but irregular, as shown in Fig. 4.

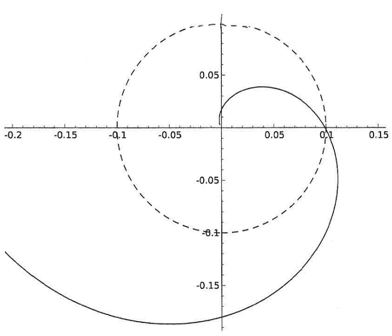

Figure 4: Spiral fall onto the center: crossing the Schwarzschild surface. The picture in Fig. 3 is enlarged to show proximity of a spiral sharp-dive onto the point center $r = 0$. The trajectory shown from some point before crossing of the Schwarzschild surface (dashed line). A particle crosses the Schwarzschild surface at the speed $\beta_{sch} = 1.982$, and, as shown in the picture, ended up deep inside the Schwarzschild sphere, at $r = r_g/15$, having a speed $\beta = 285$. The spiraling particle keeps accelerating and asymptotically approaches the center but never hits the point.

Finally, since there is no SR correction in the equations for mass as velocity changes, the computed velocities and velocity components exceed the speed of light as they approach the origin! This is clearly a non-physical behavior brought about by using the Einstein GR correction!

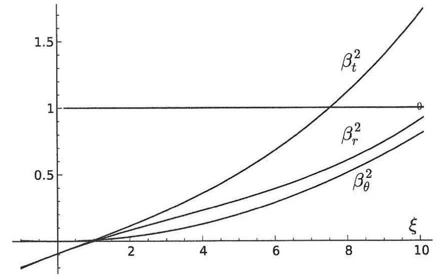

Figure 5: Example of over-edge motion: a spiral fall onto the center; $\rho_0 = 0.050$, $\beta_0^2 = 0.008$. Shown squared relative velocities of the test particle $\beta_r^2(\xi)$ (radial) (9), $\beta_\theta^2(\xi)$ (angular) (10), $\beta^2(\xi)$ (total, their sum); a conserved (squared) total energy $\epsilon_0^2 = 0.907$ (that is, a bounded motion). The particle crosses the Schwarzschild surface $\xi_{sch} = 10$ ($r_{sch} = 0.10$) at the resultant speed $\beta = 1.304$ (faster than light) with the kinetic energies $\beta_r^2 = 0.907$. The angular component of speed is $\beta_\theta^2 = 0.800$ (in this example, it is less than the speed of light), and the resultant (squared) one $\beta^2 = 1.707$ (faster than light). The particle reaches the resultant speed equal to the speed of light

5. Conclusions The only possible conclusion to be made is that the Einstein GR correction is completely false. Thus, one of the *only* proofs that GR is valid has been shown to be incorrect, and invites GR to be discarded as a valid theory!

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