9. MERCURY'S PERIHELION

Let's consider first the classical point of view on Mercury perihelion movement. As it orbits the Sun, this planet Mercury - follows an ellipse...but only approximately: it is found that the point of closest approach of Mercury to the sun does not always occur at the same place but that it slowly moves around the sun. This rotation of the orbit is called a precession. The precession of the orbit is not peculiar to Mercury, all the planetary orbits precess. In fact, Newton's theory predicts these effects, as being produced by the pull of the planets on one another. The question is whether Newton's predictions agree with the amount an orbit precesses; it is not enough to understand qualitatively what is the origin of an effect, such arguments must be backed by hard numbers to give them credence. The precession of the orbits of all planets except for Mercury's can, in fact, be understood using Newton's equations. But Mercury seemed to be an exception. As seen from Earth the precession of Mercury's orbit is measured to be 5600 seconds of arc per century (one second of $arc = \frac{1}{3600}$ degrees). Newton's equations, taking into account all the effects from the other planets (as well as a very slight deformation of the sun due to its rotation) and the fact that the Earth is not an inertial frame of reference, predicts a precession of 5557 seconds of arc per century. There is a discrepancy of 43 seconds of arc per century. This discrepancy cannot be accounted for using Newton's formalism. Many ad-hoc fixes were devised (such as assuming there was a certain amount of dust between the Sun and Mercury) but none were consistent with other observations (for example, no evidence of dust was found when the region between Mercury and the Sun was carefully scrutinized). In contrast, Einstein was able to predict, without any adjustments whatsoever, that the orbit of Mercury should precess by an extra 43 seconds of arc per century should the General Theory of Relativity be correct. As we saw above we need slightly change Kepler's first law with probabilistic situation consideration. And after that Newton Kepler approach in Observer's Mathematics explains Mercury perihelion phenomena. Let's consider the details.

Mercury orbit's parameters are:

$$R_{+} = 69.8 * 10^{6} km = 69.8 * 10^{3} (t - km)$$

aphelion of Mercury orbit $(r' = 0, r = max)(t - km = 10^{6} m)$

$$R_{-} = 46.0 * 10^{6} km = 46.0 * 10^{3} (t - km)$$

perihelion of Mercury orbit $(r' = 0, r = min)$

$$M_{Sun} = 2.0 * 10^{30} kg$$

$$G = 6.67408(31) * 10^{-11} m^{3} kg^{-1} s^{-2}$$

$$G * M = 13.349662 * 10^{19} m^{3} s^{-2} = 133.49662 (t - km)^{3} s^{-2}$$

Mercury completes 415.2 revolutions each Earth century.

General planet's orbit equation

(NK16")

$$(h^2 +_n t \times_n (2 \times_n \mathbf{h}), \Delta_1 +_n \Delta_2)) +_n (t \times_n (\Delta_1 +_n \Delta_2), t \times_n (\Delta_1 +_n \Delta_2)) =$$

$$= r \times_n ((G \times_n M +_n (\mathbf{u}), \mathbf{p}))) +_n t \times_n (\mathbf{u}), \Delta_{14})) +_n \Delta_{21}$$

As a first approach (without any Δs) we have

(NK16)

$$h^2 = r \times_n ((G \times_n M) +_n (\mathbf{u}), \mathbf{p})))$$

$$r = min$$

if

$$(\mathbf{u}, \mathbf{p}) = max$$

i.e.

$$(\mathbf{u}, \mathbf{p}) = |\mathbf{p}|$$

$$r = max$$

if

$$(\mathbf{u}, \mathbf{p}) = min$$

i.e.

$$(\mathbf{u}, \mathbf{p}) = -|\mathbf{p}|$$

So, we have 2 equations system with variables h and $|\mathbf{p}|$:

$$h^2 = (46, 000) \times_n (133.49662 +_n |\mathbf{p}|)$$
$$h^2 = (69, 800) \times_n (133.49662 -_n |\mathbf{p}|)$$
$$h^2 = (46 \times_n 10^3) \times_n (133.497 +_n |\mathbf{p}|)$$
$$h^2 = (69.8 \times_n 10^3) \times_n (133.497 -_n |\mathbf{p}|)$$

Rough solution (mean values):

$$|\mathbf{p}| = 27.437(t - km)^3 s^{-2}$$
$$h^2 = 7, 402, 964(t - km)^4 s^{-2}$$
$$|\mathbf{p}|, h^2 \in W_n, n = 10$$

And we can't see a discrepancy of 43 seconds of arc per century.

But if we go to equation **(NK16")** we can see that distance r between Sun and planet depends on time t and unit vector $\mathbf{p}$) with any given possible W_n.

For $t = 100$ Earth years

$$t = 75 * 365 * 24 * 60 * 60 + 25 * 366 * 24 * 60 * 60s == 3,155,760,000s(n = 10)$$

, we have

$$r_{min}(3,155,760,000) \neq r_{min}(0)$$

With any fixed $\mathbf{u}$ and n distance r is not a constant function of time t. This is not “the rotation of the planet's orbit - a precession”, but cardinally another situation. It's general law for all planets of Sun system. And Mercury perihelion movement is connected with not precession, but with spatial (not a planar) orbit and changing distance between Sun and this point.

From another side General relativity approach to Mercury problem also has probabilistic character (from Observer's Mathematics point of view). Really, the general relativistic calculation considers the motion of a test particle in the gravitational field of a massive body. The test particle's mass is assumed to be so small that it has no effect on the massive body. Fortunately, the Schwarzschild solution to Einstein's field equations describes precisely this case. Since the test mass (Mercury) moves along a timelike geodesic, the Lagrangian is identical to kinetic energy.

So, the Lagrangian L is as follows: $L = \frac{m \times_n v^2}{2}$ After that with using the Schwarzschild solution, Euler-Lagrange equation and NASA's Mercury data it is possible to calculate Mercury orbit perihelion shift of 42.9 seconds of arc per century. But we proved that statement $L = \frac{m \times_n v^2}{2}$ in Observer's Mathematics has probability less than 1. So, General relativity calculations of Mercury orbit and it's perihelion have probabilistic character from Observer's Mathematics point of view and requires to be reconsidered.