Precession of the Planetary Perihelia Due to the Co-ordinate Time

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1 Introduction

The first of the two Fundamental Postulates of the Reciprocal System from which Larson derives every aspect of the physical universe is:

> "The physical universe is composed entirely of one component, motion, existing in three dimensions, in discrete units, and with two reciprocal aspects, space and time."[1]

The primary implication of the Postulate is that the properties of either space or time are the properties of both space and time, except that space and time are reciprocally related as motion. This means, *inter alia*, that space is a progression like time is, and that time is three-dimensional. While the space progression is observable as the recession of distance galaxies, the three-dimensionality of time is not so directly apparent.

It is essential to note that the three dimensions of time are not the spatial dimensions: nor is there anything space-like in them. In any situation, the total time comprises of two components: (i) the clock time, which is a uniform progression and (ii) the three-dimensional *coordinate* time (analogous to the three-dimensional coordinate space of a stationary reference system).

Besides other things, the concept of coordinate time in the *Reciprocal System* explains and derives the characteristics of supernovae, the white dwarfs, the pulsars, the quasars, the compact X-ray sources and the cosmic rays—without taking recourse to concepts like degenerate matter, the curvature of space-time, etc… All the so-called Relativistic effects come out, in the *Reciprocal System*, of the existence of this additional time component.

In fact, the effect of the excess advance of the perihelion of an orbiting planet arises out of the accumulation of the coordinate time from its orbital motion. "As long as the orbital velocity is low, the difference between the clock time and the total time is negligible, but the velocity of Mercury is great enough to introduce an appreciable amount of coordinate time and during this added time the planet travels through an additional distance."[2]

2 The Theoretical Evaluation

According to the Reciprocal System, an independent motion (like gravitation) of speed v has associated with it an increase of coordinate time amounting to v^2/c^2 unit per each unit of clock time (c being the speed of light).[3] In order to calculate the excess orbital movement, Larson argues like this: "Since the gravitational motion is inward, the scalar space-time direction of the orbital motion is outward, and the computed time increase is radial. To obtain the circumferential space equivalent of this linear time

1 Larson, Dewey B., *Nothing But Motion* (North Pacific Publishers, Portland, OR, 1979), page 30.
2 Larson, Dewey B., *Beyond Newton* (North Pacific Publishers, Portland, OR, 1964), page 85.
3 Larson, Dewey B., *Nothing But Motion*, *op. cit.*, pages 99-100.

increase, we must multiply by π."[4]

Thus, according to Larson the total coordinate time increase is $\pi\ v^2/c^2$ sec/sec. In the quotation just cited, what Larson states regarding the scalar direction of the orbital motion as being outward, is understandable. But what the expression "the computed time increase is radial" is expected to connote is difficult to see. For, "...no matter how many dimensions it may have, time has no direction in space."[5] To be sure, it is true that time has a property called 'direction in time,' but this is a purely temporal property and 'directions in time' are not in any way determined by directions in space. Consequently, the coordinate time increase associated with gravitation (or with any independent motion) is a scalar addition. The words "…to obtain the circumferential space equivalent of this linear time increase, we multiply by π," do not, therefore, depict the truth, except pointing out that the necessity of having to include in the calculations a factor amounting to π has been recognized.

The true state of affairs can be understood if we recall that gravitation is a three-dimensional scalar motion. If *v* is the gravitational speed, then the coordinate time increase per each scalar dimension is v^2/c^2. The total coordinate time increase, therefore, is $3\ v^2/c^2$. The orbital motion of the planet is one-dimensional (scalar). As such, the effective coordinate time increase, as applied to the orbital motion, is $3\ v^2/c^2$. The same is true in any other case where the motion is one-dimensional, like, for example, that of a photon grazing the sun. On the other hand, if we are considering the effect of the coordinate time increase due to gravitation on an atom situated in the gravitational field, the result is different. Since the atomic rotation is three-dimensional, the coordinate time increase effective per dimension is $3\ v^2/c^2\ /\ 3 = v^2/c^2$ only. This is the value which causes the gravitational redshift, for instance.

Thus, the rate of coordinate time increase at any speed *v* is given by:

$$\frac{dt_c}{dt} = 3\,\frac{v^2}{c^2}\quad sec/sec \tag{1}$$

where t_c represents the coordinate time and t the clock time.

Consider the elliptical orbit of a planet around the sun, with the sun situated at the focus. The equation of the ellipse in polar coordinates, with the center at the focus is given by

$$l = r\left(1 + e\cos(\theta)\right) \tag{2}$$

where

r = the radial distance of the planet, at any angle θ measured from the perihelion

l = the semi-latus rectum = $a\,(1 - e^2)$ (2-a)

e = the eccentricity of the ellipse

a = the semi-major axis

In an earlier article[6] I have pointed out that the gravitational speed, *v*, at any distance *r* outside of a mass *M* is given by

4 Larson, Dewey B., *Beyond Newton*, *op. cit.*, page 126.
5 Larson, Dewey B., *Nothing But Motion*, *op. cit.*, page 73.
6 K.V.K. Nehru, "Gravitational Deflection of Light Beam in the Reciprocal System," *Reciprocity* XI (1), Spring 1981, page 28.

$$v^2 = \frac{G\,M}{r} \tag{3}$$

where G = the gravitational constant.

Using Equations (1), (2), & (3), we have the rate of coordinate time increase at a given location on the orbit as

$$\frac{dt_c}{dt} = \frac{3\,G\,M}{r\,c^2} = \left(\frac{3\,G\,M}{lc^2}\right)(1+e\cos(\theta)) \tag{4}$$

in units of sec/sec or radians/radians. The increase over an angle of $d\theta$ radians is

$$\frac{dt_c}{dt}\,d\,\theta = \left(\frac{3\,G\,M}{l\,c^2}\right)(1+e\cos(\theta))\,d\,\theta \quad \textit{radians} \tag{5}$$

Therefore, the total increase from $\theta = 0$ to 2π radians (that is, one revolution) is

$$\begin{aligned} d &= \int_0^{2\pi} \frac{dt_c}{dt}\,d\,\theta = \left(\frac{3\,G\,M}{l\,c^2}\right)\int_0^{2\pi}(1+e\cos(\theta))\,d\,\theta \quad \textit{radians} \\ &= \left(\frac{3\,G\,M}{l\,c^2}\right)2\,\pi \quad \textit{radians/revolution} \end{aligned} \tag{6}$$

$$d = \frac{3\,G\,M}{l\,c^2} \quad \textit{revolution/revolution} \tag{7}$$

(Note that Equation (7) is applicable to parabolic, as well as hyperbolic orbits with l as the semi-latus rectum). Finally, using relation (2-a), the perihelion advance, according to the Reciprocal System, is given by

$$d_{RS} = \frac{3\,G\,M}{a\,c^2(1-e^2)} \tag{8}$$

The corresponding formula from the General Relativity is

$$d_{GR} = \frac{12\,\pi^2\,a^2}{P^2\,c^2(1-c^2)} \tag{9}$$

where P = the orbital period of the planet.

In order to compare the two formulae, we use the relation

$$G\,M = \frac{4\,\pi^2\,a^3}{P^2} \tag{10}$$

for the solar system. Then Equation (8) becomes identical to the Relativity expression, given in Equation (9).