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The NOW of time and the Pioneer Anomaly

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Abstract This paper takes another look at the Pioneer anomaly with the NOW theory of time: Two recent papers by Longo, "The NOW of time and how it impacts physics" and "Theories affected by Time Flow." This new concept of time-flow changes the foundation of the physics of time defined by Newton and has impacted the main evidence for dark matter, which shows that galaxies rotate at a speed consistent with gravitational theory. This work demonstrates that the confused state of the pioneer's anomalous acceleration is also likely due to Newton's definition of time. With the NOW theory of time, the theoretically calculated value of the pioneer anomaly is $7.2 \times 10^{-10} m/sec^2$ within the reported measurement error. When adding to this a few onboard contributions that seem to be the most reasonable, the final value is $8.12 \times 10^{-10} m/sec^2$ compared to the reported observed value of $(8 \pm 3) \times 10^{-10} m/sec^2$.

Keywords Now of Time, The Fow of Time, Pioneer Anomalous Acceleration

1 Introduction

As a preface: The premise of this paper is to look at anomalous phenomena that are hard to explain with the present paradigm of physics, which might support the hypothesis that the basic foundation of physics defined by Newton is an oversimplification of nature regarding space and time. In the original paper, Longo[1] introduced a different time, the NOW of time, that controls the time flow, which controls the tic rate of Newton's mathematical time, independent of the time dilation discovered by Einstein. The NOW of time's initial application was to look at the concept of dark matter. The rotation of the Andromeda galaxy was used, and a positive result was found, suggesting that dark matter may not exist. This paper looks at the Pioneer 10 spacecraft's anomalous acceleration, which has not been satisfactorily explained, and here again, a positive result is found using the NOW of time.

The Pioneer spacecraft (SC) was designed to probe the outer planets of our solar system, Anderson et al.[2-4]. Pioneer 10 was launched on March 2, 1972, followed a year later by Pioneer 11; they are now beyond the boundary of the solar system. The design of the pioneer 10/11 SC with their spin stabilization reduced the need for many Earth-attitude re-orientation maneuvers, thus allowing for the detection of small perturbations in flight dynamics, which was one of the purposes of the mission, to detect other perturbing planets, radiation pressure, and the effects of interplanetary media. Pioneer 11 had a spin-control thruster failure soon after launch and will not be considered further in this work. Pioneer 10 is at this point in time outside the bounds of the solar system.

To obtain Doppler data for the Pioneer SC, the Deep Space Network (DSN) was used to send a reference frequency to the SC that was then sent back to the DSN by an onboard transponder and then compared to the shift in frequency due to the Doppler shift expected from theoretical calculations of the speed and velocity of the SC, basically to test how well we understand all of the effects in the solar system.

In 1998, Anderson[2] reported when the solar radiation pressure had decreased sufficiently at about 20 AU from the Sun, an unexpected constant acceleration of $(8 \pm 3) \times 10^{-10} m/s^2$ directed toward the Sun was found to be the biggest systematic error. There have been numerous attempts to explain the effect, but the constant acceleration has not yet been convincingly explained. See Anderson et al. [4]. and the references therein.

In this paper, we shall take the approach that I do not believe has been tried. We will assume the basic foundation of physics defined by Newton is an oversimplification. In particular, the time part of the foundation will be addressed here and will be shown to account for the anomalous acceleration. The space part of the physics foundation has not been fully addressed, but a preliminary sketch by Longo[5] has been given. The definition of time appears to be the problem. In a recent paper, Longo[1] introduced a new theory of time titled "The NOW of time and how it impacts physics." In that work, a new time theory was introduced and was used there to examine the rotation of galaxies. It showed galaxy rotation follows the expected behavior predicted by gravitation theory, thus eliminating the main evidence for dark matter. In a separate follow-up paper, Longo[6] showed that this new time theory impacts all the main theories of physics. The basic property of the NOW theory is controlling the fundamental flow rate of time, which

determines the "tic" rate of Newton's mathematical time independent of the time dilation described in Einstein's special and general relativity. Further, The NOW theory of time is in opposition to Newton's concept that the flow of time is a constant throughout the universe and independent of external influences; the NOW is a local, not global, phenomenon controlled by external influences. The NOW theory of time in this paper is applied to the Pioneer anomaly.

There have been many attempts to explain the anomaly, ranging from new physics to engineering anomalies on the spacecraft. Dittus[7] and Turyshev [8] and references therein reexamine all measured data from Pioneer's mission. Anderson[9] critiqued many possible explanations; see the references therein. This paper adds to the new physics category as a possible explanation; I will look to a reexamination of space and time, the foundation of all physics, particularly the time part of that foundation, instead of adding modifications to existing theories, see Longo[1]. I believe it is important to keep in mind there may be multiple overlapping explanations.

2 Implementation

To set the conditions for the calculation, consider the following imagined scenario: It is imagined that the engineering development of the SC after manufacturing went through a series of checkout steps. Only communication is considered.
1.) The SC receiver and transponder are checked while the SC is at rest and communicating with the DSN. A reference frequency ν is sent to the SC and then returned to the DSN to ensure the DSN gets the same frequency back.

2.) The relativistic theoretical calculations are modeled containing all known masses and other conditions in the solar system, such as the expected solar pressure.

3.) With these tests satisfactorily finished, and if we assume the theory models the solar system correctly, the descriptive mathematical equation can be written as

$$[\nu_{obs}(t) - \nu_{model}(t)]_{DSN} = 0 \tag{1}$$

If we know all effects that influence the SC, we can set $\nu_{obs}(t) = \nu_{model}(t)$. However, observing $\nu_{model}(t)$ is not correct, let us write $\nu_{obs}(t) = \tilde{\nu}_{model}(t)$, where $\tilde{\nu}_{model}(t)$ is the observed frequency in which something is missing, this is indicated by a $\sim$ over a quantity. Then (1) can be written in terms of an unknown constant acceleration integrated over time

$$[\tilde{\nu}_{model}(t) - \nu_0]_{DSN} = \nu_0 \frac{2a_p\ t}{c}, \tag{2}$$

where the Doppler frequency is given by

$$\tilde{\nu}_{model}(t) = \nu_0(1 - 2\frac{\tilde{v}_{model}(t)}{\tilde{c}}). \tag{3}$$

Inserting (3) into (2) yields

$$-\nu_0 \frac{2\ \tilde{v}_{model}(t)}{\tilde{c}} = \nu_0 \frac{2a_p\ t}{c}. \tag{4}$$

The LHS is a quantity at the distant location of the SC, thus needing the NOW correction. The RHS is constructed on Earth after the information is returned to the DSN; the NOW correction factor on Earth is 1 and does not change the quantity. Time, t is the mathematical time, defined by Newton and determined by a clock; the difference between the Newton-defined time and the NOW-defined time is the rate that the clock moves. The difference is determined by the brightness at the location of the NOW. Finally, the anomalous acceleration can be expressed as

$$a_p = -\frac{\tilde{v}_{model(t)}}{t}\frac{c}{\tilde{c}}. \tag{5}$$

Approaching the problem this way gives the correct sign, i.e., the anomalous acceleration is pointed toward the Sun opposite to the direction the SC is traveling.

3 Applying the NOW theory

Before the NOW theory can be applied, it must be clarified. As the NOW theory was developed by Longo[1], the concept was to apply it to astrophysics and cosmology. The flow rate of time was linked to the flow rate of time on Earth, providing a way of transforming what we observe, measure, or theorize on Earth to other locations. Thus the flow rate of time became relative to Earth-based time flow. Therefore, we compared the bright objects at a distant location to the bright Sun to make the transition. In this work, we are faced with a situation where only the Sun is involved. Thus the comparison of two bright sources does not exist, and there is no way to determine the NOW flow rate of time, as described in Longo[1]. In this application, the Sun is unchanging, but we need to know the physical process on a distant SC; thus, the local NOW on the SC needs to be determined as compared to the NOW on Earth. As developed in Longo[1], the external influence that controls the time flow rate at the NOW is the brightness at the NOW location in space. Therefore, instead of determining the peak frequency of the distant Spectral Energy Distribution (SED), the brightness directly will be used. As the SC moves further from the Sun, the Sun's relative brightness, as measured by the Flux at the NOW position, can be used, bypassing the need to determine the peak frequency of the SED. The brightness, as obtained from the Flux, diminishes by the distance from the Sun. The angular radius of the Sun viewed at a distance r can be obtained by a simple ratio of that seen on Earth to that seen at a distance r from the Sun and is given by

$$\theta(r) = sin^{-1}(\frac{R_{Sun}}{r}). \tag{6}$$

The Sun radius and the distance to the SC are expressed in astronomical units, $R_{Sun} = 4.7 \times 10^{-3} Au$, therefore, $sin(\theta(r)) = (4.7 \times 10^{-3})/r$. The Flux from the Sun at a distance r is obtained from the intensity, I_ν, which is the SED of the Sun, by integrating the solid angle.

$$F(r) = I_\nu \int_0^{2\pi} d\phi \int_0^{\theta(r)} sin(\theta)cos(\theta)d\theta. \tag{7}$$

Let $x = sin(\theta)$ and $dx = cos(\theta)d\theta$,

$$F(r) = 2\pi I_\nu \int_0^{sin(\theta(r))} xdx, \tag{8}$$

$$F(r) = \pi I_\nu sin^2(\theta(r)), \tag{9}$$

$$F(r) = \pi I_\nu (\frac{4.7 \times 10^{-3}}{r})^2. \tag{10}$$

The intensity I_ν is an intrinsic property of the Sun and does not depend on distance. Therefore, the intensity cancels out when the transforming factor, B, is formed,

$$B = \frac{F(r)}{F(1)} = (\frac{\frac{4.7\times10^{-3}}{r}}{\frac{4.7\times10^{-3}}{1}})^2 = \frac{1}{r^2}. \tag{11}$$

Where $F(1)$ is the Flux on Earth at $1Au$ from the Sun. Applying the transform factor to both the velocity and the speed of light in (5), see Longo[6] for the speed of light transform

$$\tilde{v} = \ v\ B, \tag{12}$$

$$\tilde{c} = \ c\ B^{-1}. \tag{13}$$

Combining (12) and (13) with (5) gives the final result, (14), which is the anomalous acceleration in the NOW theory of time instead of the Newton theory of time

$$a_p = -\frac{v_{model}}{t} B^2. \tag{14}$$

3.1 Tables

Table 1. Data from HelioWeb

Year	ΔDay	Δr AU	t $10^6 sec$	v_{rot} $10^4 m/sec$	v/t 10^{-3} m/sec^2
(1)	(2)	(3)	(4)	(5)	(6)
1985	50.	0.38.	4.32.	1.31	3.03
1990	50.	0.36.	4.32	1.25	2.89
1995	50.	0.35.	4.32	1.21	2.80
2000	50.	0.35	4.32	1.20	2.78

3.1.1 Table 1, Data from HelioWeb

The data used in the calculation are: The year is given in column (1), in (2) the interval in days, column (3) the distance in AU traveled in the interval distance given in (2), and (4) the time in seconds to travel the distance listed in (3). In column (5), the SC velocity in meters per second, and column (6); is column (5) divided by column (4), is a measure of anomalous acceleration in the Newtonian time system.

Table 2. Transform-factor

Year	r AU	B^2 10^{-8}	$a_p = vB^2/t$ $10^{-10} m/sec^2$
(1)	(2)	(3)	(4)
1985	34.68	69.14	20.94
1990	48.37	18.27	5.28
1995	61.37	7.05	1.97
2000	74.52	3.24	0.901

3.1.2 Table 2, Transform-factor

Column (1) is the year, (2) is the distance from the Sun in AU, and (3) is the transform factor, in column (4) is the anomalous acceleration at each position.

Table 3. Onboard effects

Onboard Accelerations	10^{-10}
Radio beam reaction force	0.11
RTG heat reflected from the SC	0.55
He expelled from RTG	0.16

3.1.3 Table 3, Onboard effects

Effects generated by the operation of the SC that seem most reasonable. Each effect is assumed to contribute a positive effect to the anomalous acceleration.

The pioneer 10 data given in Table 1 were obtained from HelioWeb[10]. The transformation factor for the NOW time theory, see Longo[1,6], and the anomalous acceleration are given in Table 2. The average of column 4 of Table 2 gives the value for the anomalous constant acceleration, $7.3\times10^{-10} m/sec^2$, which compares well with the excepted value of $8.\times10^{-10} m/sec^2$ given by Anderson[2]. Suppose we assume a few of the onboard contributions, which seem reasonable, as are listed in Table 3, assuming positive values. In that case, they average to $0.82 \times 10^{-10} m/sec^2$, thus bringing the total to $8.12 \times 10^{-10} m/sec^2$ well within the given uncertainty for the anomalous acceleration.//

4 Conclusion

The foundation of physics applies to all sciences and rests on Newton's definition of space and time. An edifice built on an incorrect foundation can not last forever. The "time" part of the foundation is the part that is of interest in this work; the "space" part has been briefly sketched in another work, Longo[5]. Others have considered time, e.g., It was found by Laing[11], using CHASMP, that a steady frequency drift of about $-6 \times 10^{-9} Hz/sec$. *Rañada*[12] has considered time acceleration as a possible answer to this anomaly linking it to the expansion of the universe. Anderson[4] ruled out this possibility because if there were a steady drift in the atomic clocks of the DSN or time reference standard, all clocks would change with constant acceleration. This is true with Newton's time since he defines the time to flow constantly throughout the universe independent of external influences. In Anderson[4] figure 8, a careful look at the graph's large "day end" of the graph shows two distinct oscillations, each a year-long, suggesting the orbital motion of the Earth. This suggests the atomic clocks may be affected by the NOW time, but it can't happen in Newton's time. Also, in Anderson[4] Figure 18, daily oscillations are suggested in the rotation of the Earth, possibly explainable in the NOW time theory. The NOW theory of time depends on external influences and is a local time, not a global time. The premise of the NOW theory of time rests on the impression that all conscious beings understand that space and time are different properties of Nature; for example, one can stand still in space but can not stand still

in time. The results presented therein are a test of the NOW theory of time. Thus with this paper, two independent measurements of physical anomalies have been tested, Galaxy rotation that leads to dark matter and the anomalous acceleration of the pioneer 10 spacecraft. More successful applications of the NOW theory must be made to change the time paradigm. As a final observation, the widespread values in Table 2, column 4 needs to be understood; they may be due to the effect of solar wind. Are there other effects that need to be modeled?

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