Comments on the Thermal Origin of the Pioneer Anomaly

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Abstract

In this paper, I'll introduce some comments regarded to the paper "support for the thermal origin of the Pioneer anomaly" Turyshev [3]. These comments introduce the lack of the thermal origin of the Pioneer anomaly, and may refute it. My comments also support the proposed explanations fall into new physics.

1. Introduction

Radio metric data from Pioneer 10/11 indicate an apparent anomalous, constant, acceleration acting on the spacecraft with a magnitude $\approx 8\times10^{-10} m/s^2$ directed towards the Sun [1]. Turyshev [2] examined the constancy and direction of the Pioneer anomaly, and concluded that the data a temporally decaying anomalous acceleration $2\times10^{-11} m/s^2/yr$ with an over 10% improvement in the residuals compared to a constant acceleration model. According to Turyshev [2], the authors claim they find no support in favor of a Sun-pointing direction over the Earth-pointing or along the spin-axis directions, and they concluded also in Turyshev[2]&[3] their findings support the thermal origin of the Pioneer anomaly. Anderson, who is retired from NASA's Jet Propulsion Laboratory (JPL), is that study's first author. He finds, so "it's either new physics or old physics we haven't discovered yet." New physics could be a variation on Newton's laws, whereas an example of as-yet-to-be-discovered old physics would be a cloud of dark matter trapped around the sun[4].

2. Data Analysis of the Pioneer Anomaly

Figure 1 which represents fig. 1 in Turyshev[2], which illustrates the observed deceleration of the Pioneer 10/11 as a function of time of launch, not as the radial distance of the spacecrafts from the Sun or Earth. From the figure, top panel: Estimates of the anomalous acceleration of Pioneer 10 (dashed line) and Pioneer 11 (solid line) using an exponential model. Second panel: Stochastic acceleration estimates for Pioneer 10 (open circles) and Pioneer 11 (filled circles), shown as step functions. Bottom two panels: Doppler residuals of the stochastic acceleration model. Note the difference in vertical scale for Pioneer 10 vs. Pioneer 11. According to Turyshev papers [2] &[3], the authors concluded the most likely cause of the Pioneer anomaly is the anisotropic emission of on-board heat. The proposed solution in Turyshev[3] illustrates the Pioneer anomalous accelerations are depending on time of launch, not on the radial distance of the spacecrafts from the Sun or Earth. That means the Pioneer 10/11 must be equal over the time. But what is observed in fig 1, the Pioneer 11 anomalous acceleration was slightly higher than Pioneer 10 at the first time of launch. The proposed solution in Turyshev[3] has not answered why Pioneer 11 anomalous acceleration was slightly higher than Pioneer 10 at the beginning of launch, and it is approaching - but not equal - to Pioneer 10 as the time increasing. NASA data [5] show that in the very middle part (1983-1990) of the whole observation period of Pioneer 10 its radial distance from the Sun changes from $r \cong 28.8AU = 4.31 \times 10^{12} m$ to $r \cong 48.1AU = 7.2 \times 10^{12} m$. Full time of observation of Pioneer 11 is shorter so observational period is taken from 1984 to 1989, with observational data from the same source [5]. Radial distances for beginning and end of the period are $r \cong 15.1AU = 2.26 \times 10^{12} m$ to $r \cong 25.2AU = 3.77 \times 10^{12} m$. We find from theses data, in 1984 Pioneer 11 was at a radial distance $2.26 \times 10^{12} m$ from the Sun, which is much closer to the Sun than Pioneer 10 which was at a radial distance $4.31 \times 10^{12} m$ from the Sun in 1983. This will lead us to think and ask the question, if the anomalous accelerations of Pioneer 10/11 are connected with the radial distance of the spacecraft from the Sun, and since Pioneer 11 was much closer to Sun than Pioneer 10, was Pioneer 11 affected by a higher deceleration because of that? While in 1989 at the end of observation of Pioneer 11, it was at a radial distance $3.77 \times 10^{12} m$ from the Sun, which is still more closer to the Sun than Pioneer 10 at the beginning of observation in 1983. Subsequently, is the radial distance of the spacecraft from the Sun is responsible for the mismatch of the anomalous accelerations of Pioneer 10/11 as seen in fig. 1? Furthermore, the decaying rate of the Pioneer 10 anomaly as estimated by Markwardt [6], he obtained an improved fit of Pioneer 10 data when estimating a jerk of $\dot{a} = -0.18 \times 10^{-11}$ m/s^2/yr;. Also Toth [7] obtained $\dot{a} = (-0.21 \pm 0.04) \times 10^{-11}$ m/s^2/yr, $\dot{a} = (-0.34 \pm 0.12) \times 10^{-11}$m/s^2/yr for Pioneer 10 & 11, respectively. The higher decaying rate of the Pioneer 11 deceleration than Pioneer 10 is given more support that the radial distance of the spacecraft from the Sun is affecting on the anomalous accelerations of Pioneer 10/11. Since the proposed solution of the thermal origin of the Pioneer anomaly in Turyshev [3] is referring the deceleration of the spacecrafts depending on time, not on the radial distance of the spacecraft from the Sun, that lead to the deceleration of the spacecrafts must be the same over time, and the decaying rate must also be the same. But the collected data in Turyshev[2] illustrate that there is a slight increase of the deceleration of Pioneer 11 than Pioneer 10, also a slight increase in the decaying rate of the deceleration of Pioneer 11 than Pioneer 10.

Although the difference between the observed anomalous accelerations and the decaying rates for Pioneer 10/11 are too small and may be hidden within the range of errors and the systematic errors, scientists must scrutinize the collected data more precisely. This slight difference deducts if the origin of the Pioneer anomaly is due to mundane causes or new physics that is still unknown for scientists.

3. Discussion & Conclusion:

In the case of confirming that the deceleration and the decaying rate of the deceleration of the Pioneer 11 was slightly higher than of the Pioneer 10, and since the Pioneer 11 was much closer to the Sun than Pioneer 10, thus the Pioneer anomalous accelerations is affected by the radial distance of the spacecraft from the Sun. From that I refute the proposed solution in Turyshev[3].
Before Turyshev[2] published his paper, scientists were thinking an apparent anomalous, constant, acceleration acting on the spacecraft with a magnitude $\approx 8 \times 10^{-10} m/s^2$ directed towards the Sun[1]. This magnitude of the Pioneer effect a_p is numerically quite close to the product of the speed of light c and the Hubble constant H_0, hinting at a cosmological connection. After Turyshev[2], the authors examined the constancy and direction

of the Pioneer anomaly, and concluded that the data a temporally decaying anomalous acceleration $2\times10^{-11} m/s^2/yr$ with an over 10% improvement in the residuals compared to a constant acceleration model. According to that, all the proposed solutions which are depending on the constancy of the Pioneer anomalous acceleration are falling down, and one of these proposed solutions which indicates the Pioneer effect a_p is numerically quite close to the product of $H_0.c$ hinting at a cosmological connection, because $H_0.c$ is constant. Since the Pioneer anomalous accelerations numerically quite close to a constant value which is decaying with very small rate. And if we propose the Pioneer anomaly is affected on the radial distance of the spacecraft from the Sun, and since the two spacecrafts were located very far from the Sun. From that I can propose an abstract solution depending on the previous discussion for the anomaly as; there are two terms that are affected on the Pioneer anomaly, the first term is constant a_0 which is not depending on the radial distance of the spacecraft from the Sun. The second term $a(r)$ is depending on the radial distance of the spacecraft from the Sun. Where, $a(r)$ is small compared to a_0. The sum of the two terms accounts for the Pioneer anomaly a_p where,

$$a_p = a_0 + a(r)$$

and since $a(r)$ is depending on the radial distance of the spacecraft from the Sun, and because the two spacecrafts are going far away from the Sun during their motion, a_p must be decaying depending on $a(r)$. And since Pioneer 11 was closer to the Sun than Pioneer 10, then $a_{p11} > a_{p10}$ depending on $a(r)$ and $\dot{a}_{p11} > \dot{a}_{p10}$.

Whatever a_0 is, it is H_0c hinting at a cosmological connection or not, also, whatever $a(r)$ is, it is resulted from the relativistic motion of the spacecraft through the gravitational field of the Sun, which described by the general theory of relativity or not, it is new physics undiscovered by scientists yet. I wonder! was Anderson right by his statement “it’s either new physics or old physics we haven’t discovered yet.” New physics could be a variation on Newton’s laws, whereas an example of as-yet-to-be-discovered old physics would be a cloud of dark matter trapped around the sun[4].

References

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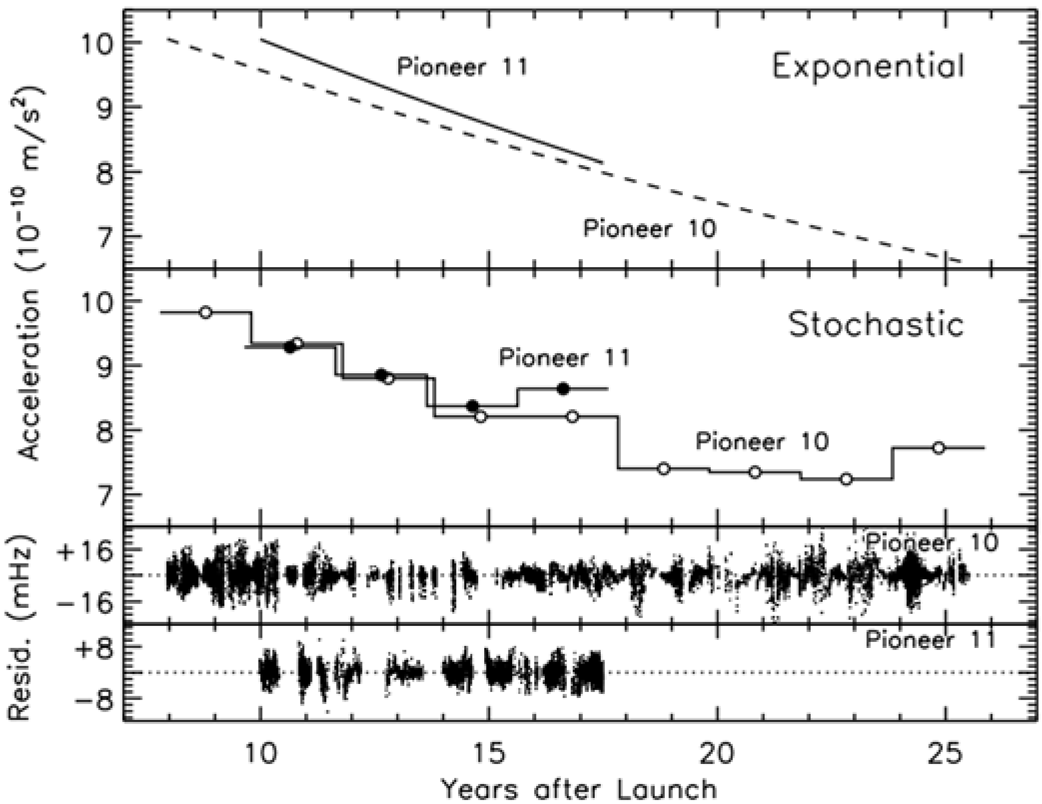

FIG. 1: represents figure 1 in Turyshev[2];top panel: Estimates of the anomalous acceleration of Pioneer 10 (dashed line) and Pioneer 11 (solid line) using an exponential model. Second panel: Stochastic acceleration estimates for Pioneer 10 (open circles) and Pioneer 11 (filled circles), shown as step functions. Bottom two panels: Doppler residuals of the stochastic acceleration model. Note the difference in vertical scale for Pioneer 10 vs. Pioneer 11.