

Comment: *A Solution to the Pioneer Anomalous Annual and Diurnal Residuals* by E. D. Greaves, et al., 2021 Progress in Physics, vol. 17, 2, p. 168

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Abstract

A comparison is made between Greaves, E. D., Bracho, C., Gift, S., and Rodrigues, A. N., 2021. *A Solution to the Pioneer Anomalous Annual and Diurnal Residuals*, Progress in Physics, vol. 17, 2, p. 168. and Hodge, J. C. 2006. *Scalar potential model of the Pioneer Anomaly*.arXiv: astro-ph/0612567v1. Both papers suggest the Pioneer Anomaly observation is due to the signal being modified by a characteristic of space that is influenced by the Sun and Earth. The papers differ by what that characteristic is and how it influences the signal. The former paper uses “energy density” (a scalar) which is proportional to distance (r^{-4}) from bodies. All the characteristics of the former paper were accounted in the original calculation of the Pioneer Anomaly. The latter paper used a vector proportional to r^{-2} , a gravitational force exerted on photons that was not accounted. The different treatment of r by the latter provides a more accurate treatment of the periodicities and all 10 anomalous characteristics of the Pioneer Anomaly. The conclusions of the former that the velocity of light is Galilean additive and the use of the “gravitational density” are not supported.

keywords: Pioneer Anomaly, STOE, Annual periodicity

1 Greaves (2021)

Greaves (2021) divides the calculation of the Pioneer Anomaly (PA) into two parts, the “constant” part and the annual and diurnal part. The “constant”

part attributes the anomalous acceleration a_P to differing speed of light at the Earth’s surface:

$$c_G = \frac{k}{\sqrt{\rho_G}} \quad (1)$$

where k is the proportionality constant and ρ_G is the energy density¹. The energy density due to a body is calculated as:

$$\rho_G = \frac{GM}{8\pi r^4} \quad (2)$$

where r is the distance from the center of mass of a body to a point in space, G is the Newtonian gravitational constant, and M is the gravitational mass of the body. Because of the r^4 in the denominator, the “... contribution of the moon and other planets was considered negligible.”

The gravitational field variation was accounted in the calculations (Anderson et al. 2002, section IV. A. “The programs treat the Sun, the Moon, and the nine planets as point masses in the isotropic, parameterized post-Newtonian, N-body metric with Newtonian gravitational perturbations from large, main-belt asteroids.”).

Further, energy density models were rejected (Anderson et al. 2002, section XI. A. “The effect of this interaction is a frequency shift that is proportional to the distance and the square root of the density of the medium in which it travels. ... However, these ideas have problems with known properties of the interplanetary medium that were outlined in Section VIII.”).

¹Both papers use ρ to represent a density. This paper uses a subscript G to indicate Greaves (2021) parameters and the subscript H to indicate Hodge (2006b) parameters.

Gravitational effects on the spacecraft were also considered and rejected (Anderson et al. 2002, section XI. B. “However, any universal gravitational explanation for the Pioneer effect comes up against a hard experimental wall. The anomalous acceleration is too large to have gone undetected in planetary orbits, particularly for Earth and Mars.”).

The annual and diurnal part attributes the variation to the Doppler residuals to Earth’s rotation and translation. However, the motion of the receiving stations and the Earth were included in the calculations (Anderson et al. 2002, section IV. F. “We included models of precession, nutation, sidereal rotation, polar motion, tidal effects, and tectonic plates drift. ”).

Therefore, Greaves (2021) is double counting the effect. The author of this paper suggests these effects were well known and accounted in the original work. That they were accounted is the reason the PA is so mysterious.

2 Hodge (2006b)

The Scalar Theory of Everything (STOE) explains many mysterious phenomena from diverse observational disciplines. The STOE is a self-consistent model that was devised based on observations including galaxy redshift (Hodge 2006a). Both Newtonian physics and General Relativity physics postulate a high level of a substance which bodies depress to cause gravity. The STOE suggests this is a plenum that is in the universe. All other galaxies and matter contribute to the plenum density ρ_H . The gradient of the ρ_H is the force of gravity that is a vector proportional to r^{-2} . This force and the Equivalence Principle describe the planetary orbits as Anderson et al. (2002) suggests. This force also modifies the energy of photons as the galaxy redshift model suggests. The gravitational effect on photons (gravitational redshift) was not modeled by Anderson et al. (2002).

Other models leave unanswered or poorly answered many characteristics of the PA such as the cosmological cH_0 connection, the Saturn encounter decrease, etc. Some predictions of the STOE in 2006 concerning the PA that no other model predicted have been published in 2009 and 2011 (Hodge 2013).

3 Conclusion

Both papers suggest the Pioneer Anomaly observation is due to the signal being modified by a characteristic of space that is influenced by the Sun and Earth. The papers differ by what that characteristic is and how it influences the signal. The Greaves (2021) paper uses “energy density” (a scalar) which is proportional to distance (r^{-4}) from bodies. All the characteristics of the former paper were accounted in the original calculation of the Pioneer Anomaly. The Hodge (2006b) paper used a vector proportional to r^{-2} , a gravitational force exerted on photons that was not accounted in the original calculation (Anderson et al. 2002). The different treatment of r by the latter provides a more accurate treatment of the periodicities and all 10 anomalous characteristics of the Pioneer Anomaly. The conclusions of Greaves (2021) that the velocity of light is Galilean additive and the use of the “gravitational density” are not supported.

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