

General Relativity and Quantum Cosmology

The Pioneer Anomaly

Slava G. Turyshev, Viktor T. Toth

(Submitted on 20 Jan 2010)

Radio-metric Doppler tracking data received from the Pioneer 10 and 11 spacecraft from heliocentric distances of 20-70 AU has consistently indicated the presence of a small, anomalous, blue-shifted frequency drift uniformly changing with a rate of $\sim 6 \times 10^{-9}$ Hz/s. Ultimately, the drift was interpreted as a constant sunward deceleration of each particular spacecraft at the level of $a_P = (8.74 \pm 1.33) \times 10^{-10}$ m/s². This apparent violation of the Newton's gravitational inverse-square law has become known as the Pioneer anomaly; the nature of this anomaly remains unexplained. In this review, we summarize the current knowledge of the physical properties of the discovered effect and the conditions that led to its detection and characterization. We review various mechanisms proposed to explain the anomaly and discuss the current state of efforts to determine its nature. A comprehensive new investigation of the anomalous behavior of the two Pioneers has begun recently. The new efforts rely on the much-extended set of radio-metric Doppler data for both spacecraft in conjunction with the newly available complete record of their telemetry files and a large archive of original project documentation. As the new study is yet to report its findings, this review provides the necessary background for the new results to appear in the near future. In particular, we provide a significant amount of information on the design, operations and behavior of the two Pioneers during their entire missions, including descriptions of various data formats and techniques used for their navigation and radio-science data analysis. As most of this information was recovered relatively recently, it was not used in the previous studies of the Pioneer anomaly, but it is critical for the new investigation.

Comments: 163 pages, 40 figures, 16 tables; submitted to Living Reviews in Relativity

Subjects: **General Relativity and Quantum Cosmology (gr-qc)**

Report number: JPL-CL#10-0179

Cite as: [arXiv:1001.3686v1](https://arxiv.org/abs/1001.3686v1) [gr-qc]

Submission history

From: Slava G. Turyshev [[view email](#)]

[v1] Wed, 20 Jan 2010 21:37:13 GMT (2585kb)

[Which authors of this paper are endorsers?](#)

Download:

- [PostScript](#)
- [PDF](#)
- [Other formats](#)

Current browse context:

gr-qc

[< prev](#) | [next >](#)

[new](#) | [recent](#) | [1001](#)

References & Citations

- [SLAC-SPIRES HEP](#)
([refers to](#) | [cited by](#))
- [CiteBase](#)

Bookmark([what is this?](#))

[CiteULike logo](#)

[Connotea logo](#)

[BibSonomy logo](#)

[Mendeley logo](#)

[Facebook logo](#)

[del.icio.us logo](#)

[Digg logo](#)

[Reddit logo](#)