Analysis of the Variation of Energetic Electron Flux with Respect to Longitude and Distance Normal to the Magnetic Equatorial Plane for Galileo Energetic Particle Detector Data

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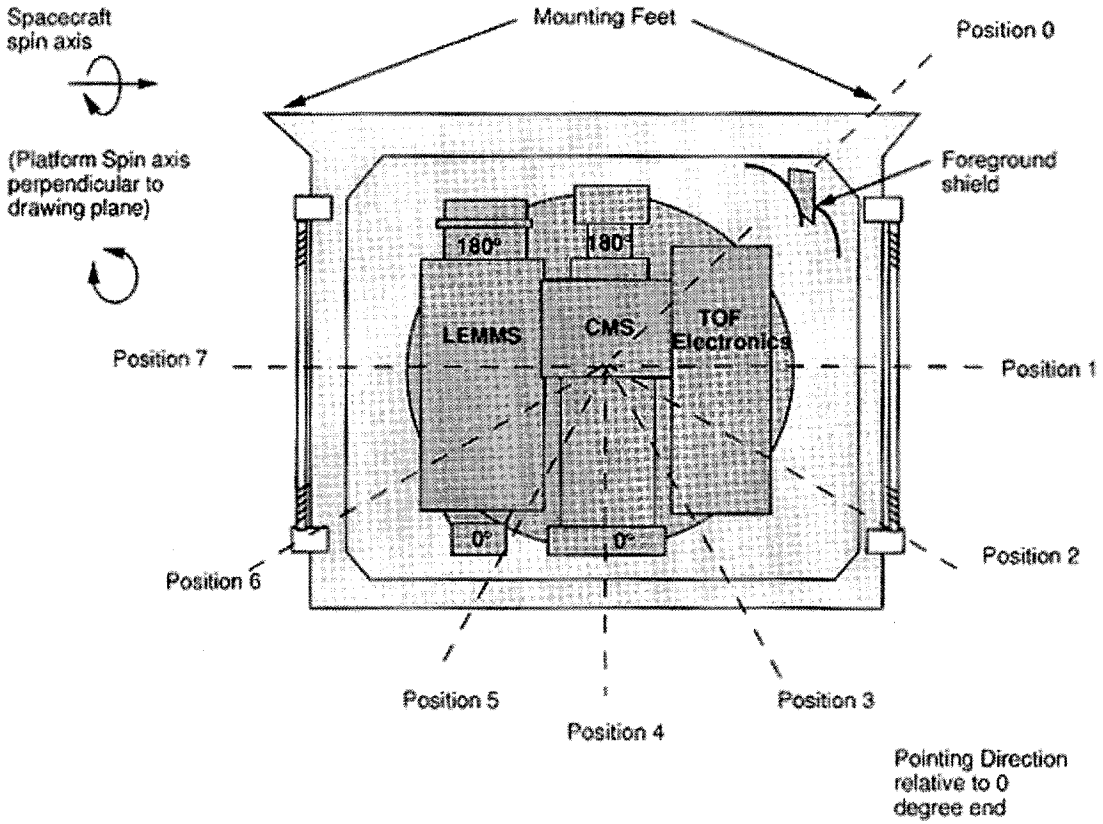
Abstract

In this study we examine ten-minute omni-directional averages of energetic electron data measured by the Galileo spacecraft Energetic Particle Detector (EPD). Count rates from electron channels B1, DC2, and DC3 are evaluated using a power law model to yield estimates of the differential electron fluxes from 1 MeV to 11 MeV at distances between 8 and 51 Jupiter radii. Whereas the orbit of the Galileo spacecraft remained close to the rotational equatorial plane of Jupiter, the approximately 11 degree tilt of the magnetic axis of Jupiter relative to its rotational axis allowed the EPD instrument to sample high energy electrons at limited distances normal to the magnetic equatorial plane. We present a Fourier analysis of the semi-diurnal variation of electron fluxes with longitude.

Introduction

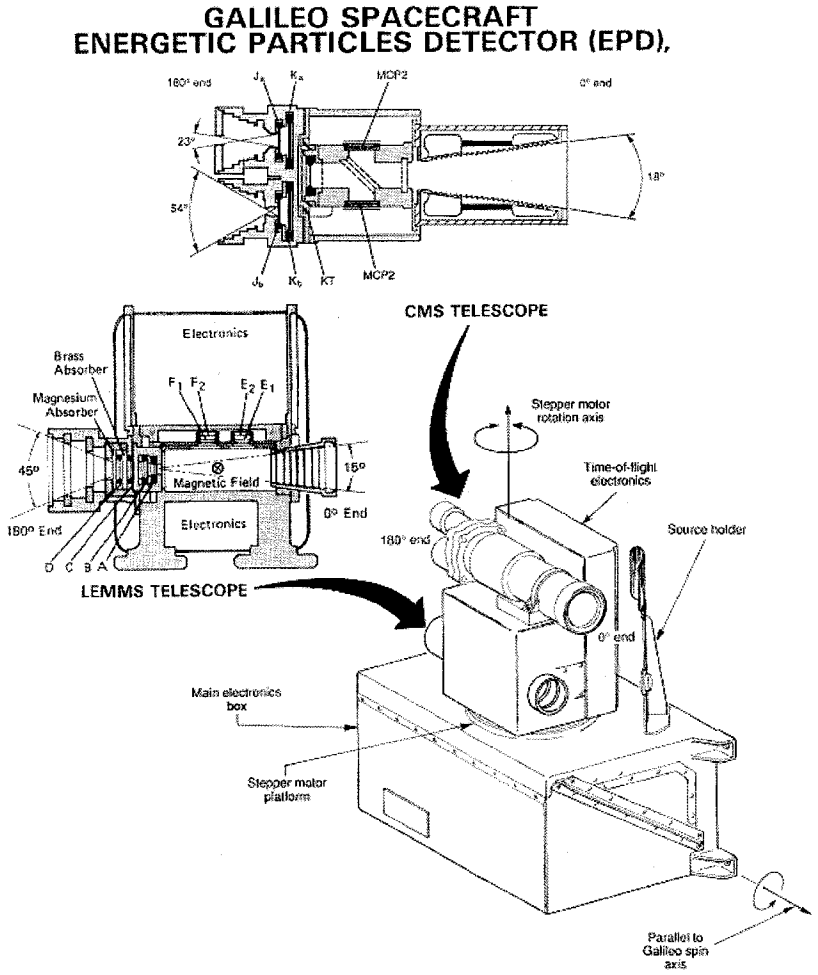
- Energetic particle data were recorded by the Galileo spacecraft between 1995 and 2003.
- High-energy electron flux data were evaluated for three channels at MeV energies for distances from Jupiter from 8Rj to 51Rj.

Top Down View of EPD Detector Assembly



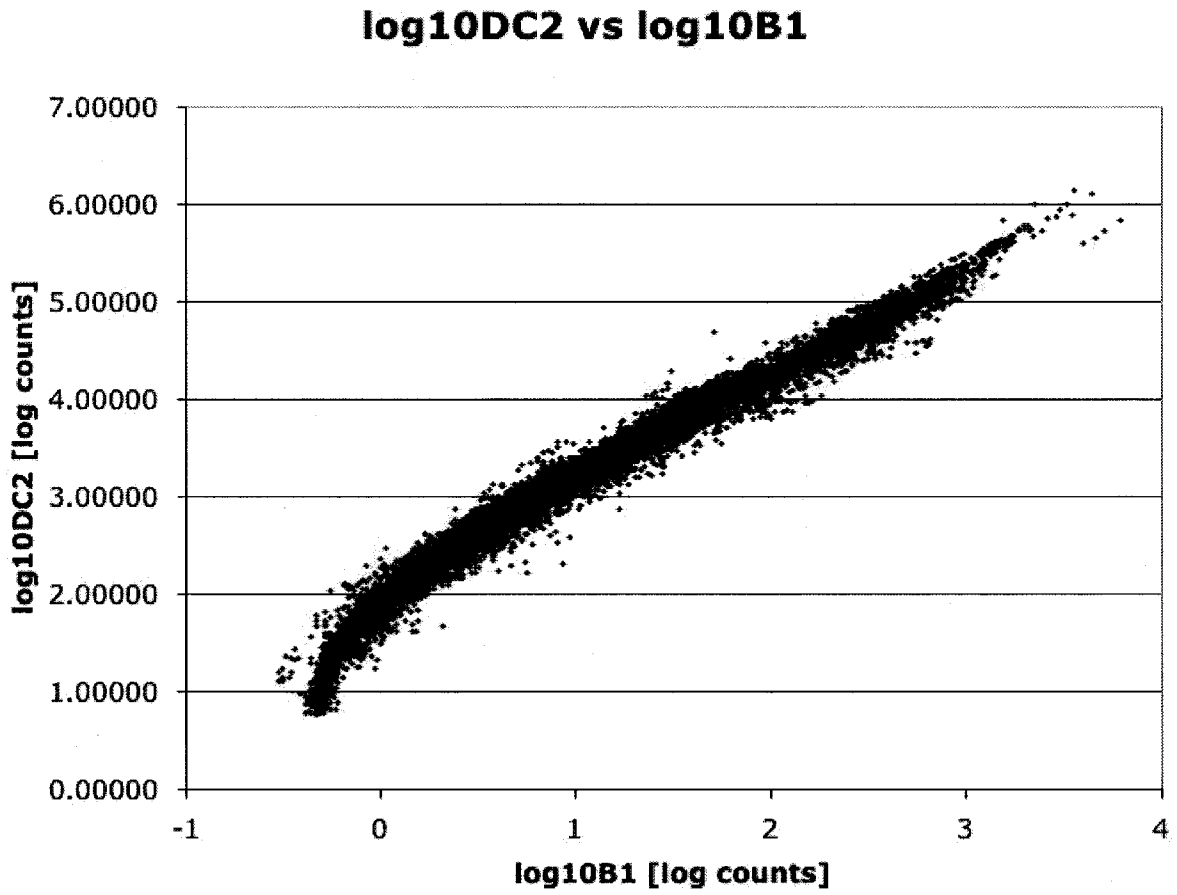
EPD instrument shown as Fig. 3 in Williams, et. al.[1] showing telescope positions.

Cross Sectional Views of EPD



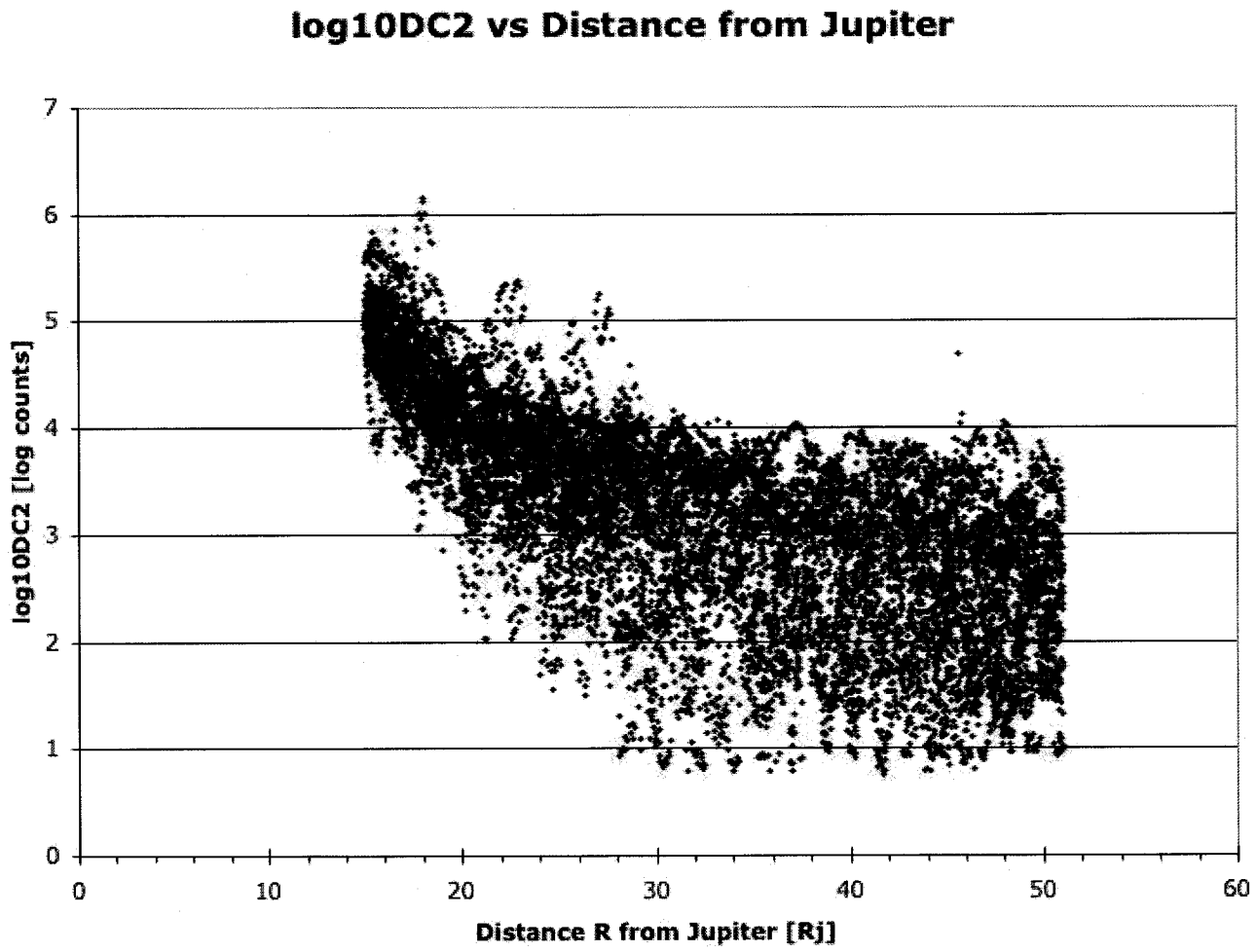
EPD instrument shown as Fig. 2 in Williams, et. al.[1] showing LEMMS telescope.

10-Minute Count Averages [15-51Rj]



Channels B1 and DC2, with similar energy threshold, reveal nearly constant count ratio.

10-Minute Count Averages [15-51Rj]



Count averages encounter noise floor beyond ~28Rj

Power Law Model

$$F = F_0(E/E_0)^{-X}$$

Where:

F equals particle flux (n#/cm^2-s)

E equals particle energy (MeV)

F_0 equals flux at E_0

E_0 equals 1 MeV

X is of the order of 1 to 5.

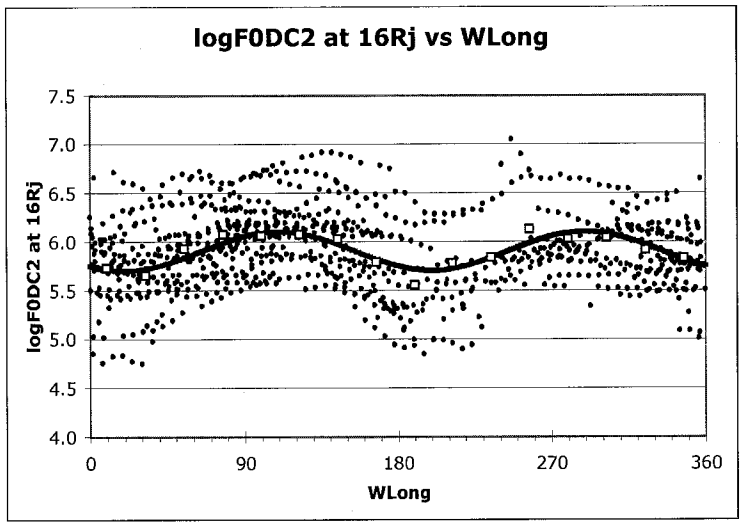
Procedure

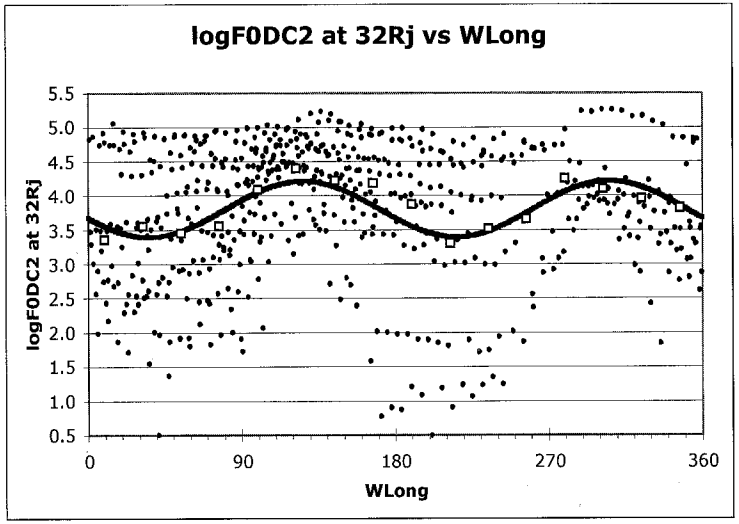
- Ten-minute count averages were evaluated using a power law model to yield flux values.
- Modeled flux values were binned in 2Rj radial bins.

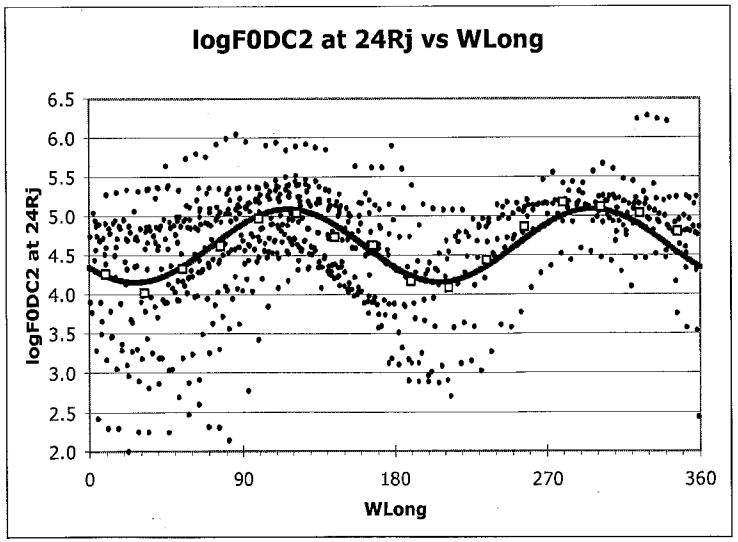
Data Considerations

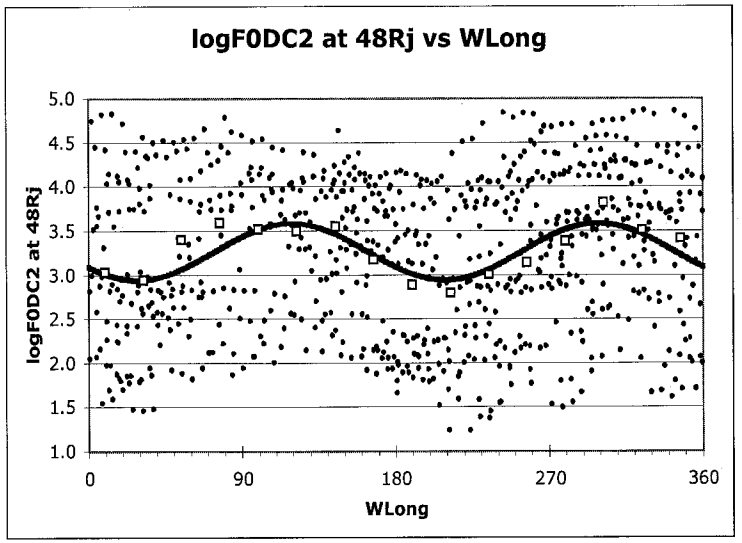
- Data from 15Rj to 41Rj were found to be the most valuable in examining flux variation with longitude.
- 2Rj radial bins were analyzed by Fourier analysis and also averaged in sixteen longitudinal bins within each radial bin.
- The semi-diurnal Fourier component was examined at a point of fixed phase to identify evidence of co-rotation lag.

Flux Modulation with Longitude

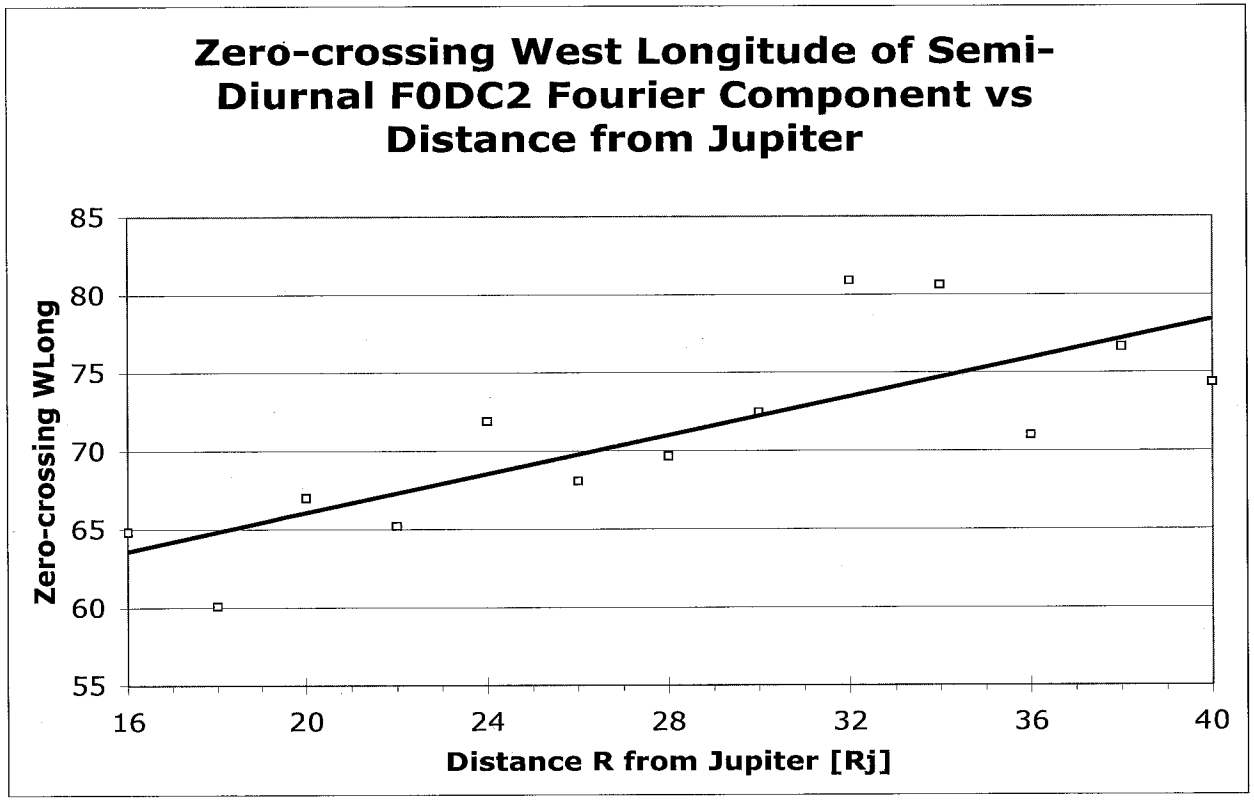








Co-Rotation Phase Lag



- A co-rotation phase lag at constant phase was observed, of the order of 0.6°/Rj in interval from 15 to 41 Rj from Jupiter.

Conclusion

- Galileo EPD electron flux data at MeV energies were examined at distances from Jupiter from 7Rj to 51Rj.
- Longitudinal variations in 2Rj radial bins revealed co-rotation lag of the order of 0.6°/Rj in the interval from 16 to 40 Rj.

References

- The Galileo Energetic Particles Detector, D. J. Williams, R. W. McEntire, S. Jaskulek, and B. Wilken, Space Science Reviews, 60, 385-412, 1992.
- Galileo Interim Radiation Electron Model, H. B. Garrett, I. Jun, J. M. Ratliff, R. W. Evans, G. A. Clough, and R. W. McEntire, JPL Publication 03-006, February 2003.
- Charged Particle Distribution in Jupiter's Magnetosphere, Neil Divine and H. B. Garrett, J. Geophys. Res. 88, 6889 – 6903, 1983.