THE EFFECT OF THE INTERPLANETARY MAGNETIC FIELD ON SIDEREAL VARIATIONS OBSERVED AT MEDIUM DEPTH UNDERGROUND DETECTORS

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1. Introduction. It has been known for some years that the intensity variations in sidereal time observed by muon detectors at moderate underground depths are sensitive to the polarity of the interplanetary magnetic field (ipmf) near the earth (1-5). There are differences in the response to these anisotropies as observed in the northern and southern hemispheres (6, 7). When fully understood, the nature of the anisotropy seems likely to provide information on the 3-dimensional structure of the heliomagnetosphere, its time variations, and its linking with the local interstellar field - difficult to obtain by other means.

2. Data. The data were obtained from vertically-pointing wide angle (semi-cubical) G-M counter muon telescopes at the underground station near Hobart, located at a depth of 46hg cm^{-2} below the top of the atmosphere (geographic coordinates 42.9°S, 147.4°E). The inferred ipmf data used in the analysis were mainly those published in 1972 by Svalgaard (8), Wilcox et al in 1975 (9) or from Solar Geographical Data Bulletins. Unfortunately, in recent years the inferred field directions have been based only on the southern polar station at Vostok, whereas previously data from Thule were also included. This has led to a decrease in the percentage of days for which ipmf data are available.

3. Results. At the time of writing, analysis for the years 1983 and 1984 has not been completed, due to delays in acquiring the ipmf data; however, the results for the period 1958-1982 are unlikely to be altered dramatically by the addition of these two years, or by the re-analysis of data for the whole period. To date, the main results are as follows:

(i) The summation harmonic dials for the sidereal diurnal variation during 1958-1982 show that there is a strong dependence on whether the ipmf near the earth is directed outwards (away, A) from the sun or inwards (towards, T) it (see Figure 1).

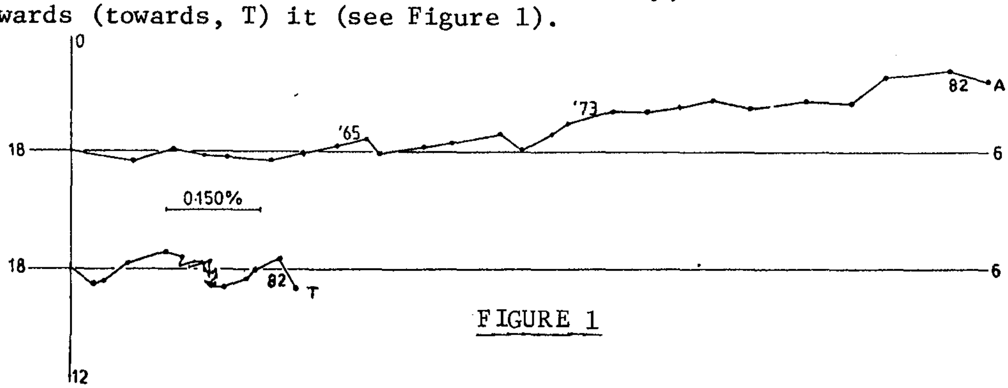

FIGURE 1

(ii) There are significant differences in the amplitude of the sidereal daily variation within the two data sets if these are divided into regimes based on the solar activity cycles (5). For example, before solar minimum in 1965 and after 1977 the amplitudes were relatively large, whereas between 1965 and 1977 the amplitudes were small.

(iii) The variation in anti-sidereal time is significant, but seems to be independent of the ipmf direction.

4. Discussion. The results for the whole period do not seem to agree with those obtained in the northern hemisphere nor are they consistent with some of the interpretations. For example, Thambyahpillai (10) concluded that the shift in position of the viewing cone on the celestial sphere accompanying solar polar field reversals accounts for the London 60 mwe observations. However, the Hobart results group better according to solar minimum years than to the times of solar magnetic field reversals. A more recent explanation of the observations in both hemispheres by Nagashima et al (11, 12) seems to be more satisfactory at the present time. The basis of this model is that the solar semi-diurnal variation undergoes an annual modulation due to the excursions in heliolatitude made by the earth; this in turn leads to a diurnal variation in anti-sidereal time which can be used to correct the observed sidereal variation. After such correction, the London and Hobart sidereal variations are more consistent. A more detailed investigation of the Hobart results is in progress.

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6. References.

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