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Study of solar wind using single-station interplanetary scintillation

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My Ph.D. thesis is based on the study of interplanetary scintillation (IPS) measurements using compact radio sources. In this study, I have shown for the first time that the solar-wind velocities may be estimated reliably and routinely from single-station IPS observations via careful modelling of the interplanetary medium. The single-station velocity estimates show an excellent agreement with results form the simultaneous three-station measurements made at Nagoya, Japan. Based on the method of single-station velocity estimation, the three-dimensional structures of the solar-wind velocity during the minimum and maximum activity of the current solar cycle have been determined, and their evolution with the solar activity has been studied.

Further, the scintillation-index measurements, obtained from a large number of radio sources distributed over a wide range of heliographic latitudes, have been used to obtain for the first time the contours of constant electron-density fluctuations (ΔN_e) in the heliospheric plasma for the solar minimum and maximum. The results show that the fluctuations of the electron density in the solar wind are spherically symmetric during the period of solar maximum, whereas at the time of solar minimum the density fluctuations decrease with heliographic latitude. For a distance of 40 $R_\odot$, the ΔN_e at the poles of the Sun is ~ 2.5 times less than the ΔN_e at the equator.

The modelling of the IP medium has also enabled the estimation of the 'inner-scale' sizes for the turbulence in the solar wind over the distance range 50-200 $R_\odot$. The 'inner-scale' size, S_i, shows an increase with the heliocentric distance for R ~ 50-100 $R_\odot$, which follows

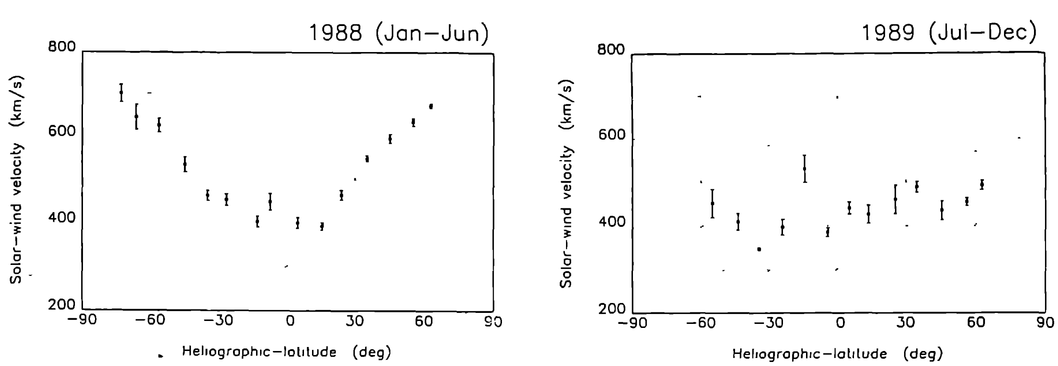

Figure 1. The solar-wind speed determined from the single-station IPS, averaged into 10° intervals of heliographic latitude for the periods near solar minimum and maximum phases.

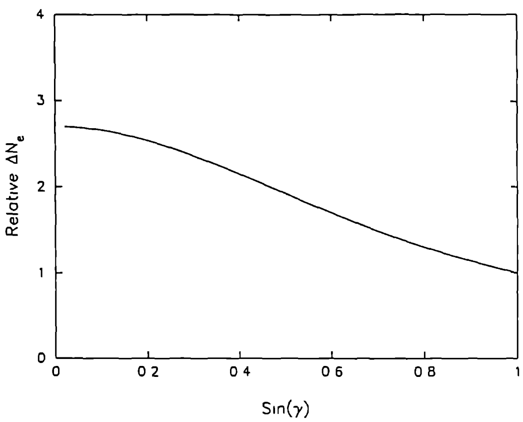

Figure 2. Relative density fluctuations (ΔN_e), at a distance of 45 solar radii, as a function of heliographic latitude (γ) for the period of solar minimum.

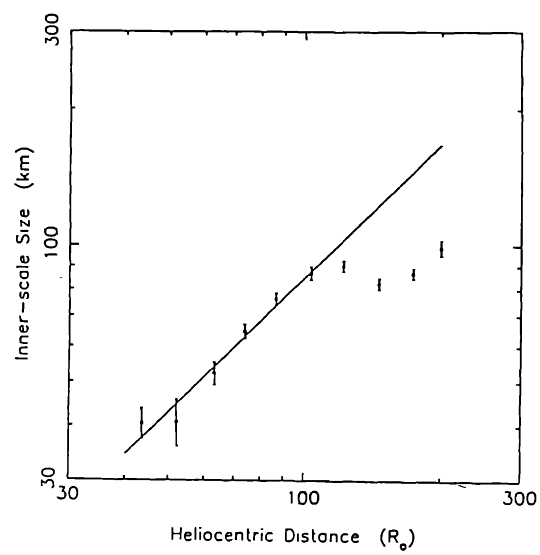

Figure 3. Inner-scale estimates using compact sources of size $\Theta_s < 150$ mas are plotted against the heliocentric distance. The straight-line fit is for measurements below 120 solar radii ($R_\odot$).

a power-law, $S_i \approx (R/R_\odot)^{1.0\pm0.2}$ km. However, for larger distances, 100-200 $R_\odot$, the estimates show a clear flattening with $S_i \approx 90 \pm 10$ km. The flattening of 'inner-scale' at distances > 100 $R_\odot$ suggests a physical difference in the solar-wind turbulence at distances farther from the Sun.