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Study of small-scale solar wind irregularities in the inner heliosphere from interplanetary scintillation at 140 MHz

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The interplanetary scintillation (IPS) is the observed flux fluctuation of astronomical radio sources when their signals are scattered by electronic density irregularities in the solar wind. These flux fluctuations are produced by the effect of a radiation pattern produced at Earth by the scattering the radio waves. By using IPS spectral analyses it is possible to explore solar wind characteristics as speed, density, turbulence level, and the evolution of small-scale solar wind irregularities whose scales range from tens to hundreds of kilometers. The understanding of these irregularities can improve models of the inner heliosphere for space weather purposes. In this work we find the evolution of the scales of the diffraction pattern observed at 140 MHz using the Mexican Array Radio Telescope (MEXART). We obtain solar wind speeds at different locations, which are defined by the parent positions of the radio sources in the sky, by fitting a theoretical power spectrum of IPS to the observed IPS power spectra. Then we use the autocorrelation function of IPS fluctuations to get the characteristic frequency of fluctuations and we obtain an estimation to the characteristic scale of the radiation pattern. We relate the radiation pattern scales with the scales of the solar wind irregularities that disperse the radio waves. To infer this relation we use IPS results at different frequencies and assuming isotropic and quiet solar wind, we use the scales of the radiation pattern as a key information to infer small-scale solar wind irregularities from 0.1 to 0.6 astronomical units. Also we show that the calibration of the the diffraction pattern with sources at different elongations can be an alternative tool to estimate solar wind speeds in a straight forward way.