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Modeling of Propagation of Coronal Mass Ejections Using Interplanetary Scintillation Data

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This talk reviews the interplanetary scintillation (IPS) technique, which allows for the determination of speed and density turbulence of the solar wind in the three-dimensional (3D) inner heliosphere. When sufficient number of scintillating sources are employed to suitably probe a given part of interplanetary space, IPS observations are powerful to study the ambient solar wind as well as to track coronal mass ejections (CMEs) in the distance range of Sun to Earth's orbit. A number of CMEs have been tracked over the entire Sun-Earth distance, by combining the white-light images from the LASCO/SOHO space mission and IPS measurements obtained from the Ooty Radio Telescope (ORT) and ISEE Multi-antenna system. Since the IPS observations at Ooty are on a grid of large number of radio sources, they provide image of disturbance associated with the CME at different distances from the Sun before its arrival at the near-Earth space. The results on the CME “speed-distance” evolution indicate a two-level deceleration: a low decline in speed at distances within or about 100 solar radii and a rapid decrease at larger distances from the Sun. However, the radial decline rates of speed, respectively within and above 100 solar radii, differ between different CMEs and suggest the involvement of input energy associated with the CME eruption in the propagation as well as the dynamics of the ambient solar wind. The typical linear size evolution of the CME with heliocentric distance suggests a pressure balance maintained between the CME driver gas and the ambient solar wind. Further, IPS estimates of density turbulence and speed have been used as inputs to the University of California, San Diego (UCSD) time-dependent tomography to reconstruct the full 3D distributions of both solar wind speed and density throughout the inner heliosphere. The usefulness of IPS measurements is discussed on the possibility of forming a basic model to forecast the arrival of CMEs at 1 AU.