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Investigating the Role of Turbulence in Coronal Mass Ejections Using Empirical Mode Decomposition

Coronal mass ejections (CMEs) are intense bursts of light and plasma eruptions originating from active solar regions, accompanied by large amounts of matter and magnetic flux. CMEs do not remain local in space; they are transported by the Sun's dynamic magnetic field into interplanetary space, where they can significantly impact the time-varying conditions of the inner solar system. Previous studies have established the turbulent nature of CMEs, where energy is transferred in a cascade process from larger structures to smaller ones, forming eddies. This study aims to investigate the role of turbulence at different stages of a CME to better understand factors that can potentially influence the strength of a CME. The stages considered in this study are characterized by the time of the shock arrival and the magnetic cloud region in a timeseries data set. We applied the technique of empirical mode decomposition (EMD) to break down the magnetic field signal into intrinsic mode functions (IMFs), which represent inherent oscillation modes within the data signal. The IMFs are analyzed for each component of the magnetic field (Bx, By, Bz) at different CME stages to generate Fourier power spectra and Hilbert-Huang spectra, therefore, aiming to establish a link between turbulence and CME strength.

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