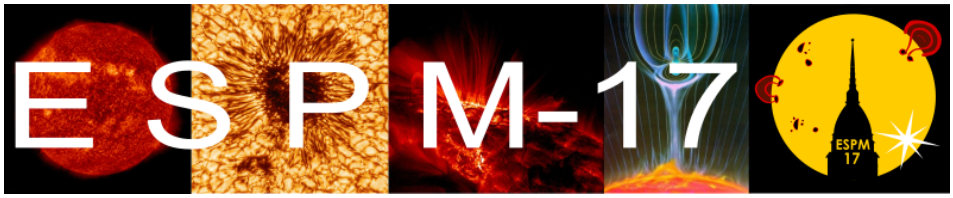

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Dimming Inferred Estimation of CME Direction - DIRECD

Coronal mass ejections (CMEs) are powerful solar events involving the expulsion of plasma and magnetic fields, significantly impacting Space Weather. Traditional coronagraphs face challenges in accurately measuring the early evolution of Earth-directed CMEs due to projection effects. Coronal dimmings, characterized by localized reductions in extreme-ultraviolet (EUV) and soft X-ray emissions, serve as crucial indicators of CMEs in the low corona. These dimmings arise from mass loss and expansion during the eruption. This study introduces DIRECD (Dimming InfeRred Estimate of CME Direction), a new method to estimate initial CME propagation direction based on dimming expansion. The approach uses 3D CME simulations with a geometric cone model, exploring parameters like width, height, source location, and deviation from the radial direction. The primary direction of dimming expansion is identified, and an inverse problem is solved to reconstruct a series of CME cones at different heights, widths, and deviations. The 3D CME direction is determined by comparing the CME projections onto the solar sphere with the dimming geometry. Validated through case studies on October 1, 2011, and September 6, 2011, the DIRECD method reveals the initial propagation directions of CMEs which are close to that derived from the 3D tie-pointing of the CME bubble observed in EUV (lower corona) and from the GCS 3D modeling of the white-light CME (higher corona). Additionally, these findings are consistent with the multi-viewpoint coronagraph observations of the CMEs from both SOHO and STEREO. The research highlights the potential of coronal dimming data for early estimation of CME direction.

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