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Three-Dimensional Dynamics of Solar Coronal Mass Ejections: Radial and Transverse Expansion in an Asymmetric Ambient Flow Field[1]
VALBONA KUNKEL, George Mason University, JAMES CHEN, Plasma Physics Division, Naval Research Laboratory — The magnetic field structure underlying coronal mass ejections (CMEs) is that of a 3D magnetic flux rope with its fixed footpoints anchored in the photosphere. The momentum of an expanding flux rope is coupled to the ambient plasma via drag. The corona and solar wind plasma is characterized by a radially outward flow field so that the dominant flow is parallel to the motion of the apex of an expanding CME flux rope but is orthogonal to the expansion in the transverse direction. The gravitational force is also parallel to the apex motion and orthogonal to the transverse expansion motion. Thus, the apex and the flanks experience significantly different drag and gravity forces and therefore different net force. We have extended the existing erupting flux rope (EFR) model of CMEs, which assumes the toroidal axis of the expansion flux rope to be a segment of circular arc with two fixed footpoints, to self-consistently calculate the forces acting on the apex and the flanks. This extension allows one to calculate the coupled expansion for the apex and flanks. We characterize the resulting structure with a semi-major axis and semi-minor radii, i.e., as an ellipse. It is shown that the 3D dynamics are critically determined by the inductance of the new geometry.

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