Solar Wind Drag and the Kinematics of Interplanetary Coronal Mass Ejections

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Coronal mass ejections (CMEs) are large-scale ejections of plasma and magnetic field from the solar corona, which propagate through interplanetary space at velocities of $\sim$100--2500~km~s^{-1}. Although plane-of-sky coronagraph measurements have provided some insight into their kinematics near the Sun ($<$32~R$_\odot$), it is still unclear what forces govern their evolution during both their early acceleration and later propagation. Here, we use the dual perspectives of the Solar TErrestrial RElations Observatory (STEREO) spacecrafts to derive the three-dimensional kinematics of CMEs over a range of heliocentric distances ($\sim$2--250\,R$_{\odot}$). We find evidence for solar wind (SW) drag-forces acting in interplanetary space, with a fast CME decelerated and a slow CME accelerated towards typical SW velocities. We also find that the fast CME showed linear ($\delta=1$) dependence on the velocity difference between the CME and the SW, while the slow CME showed a quadratic ($\delta=2$) dependence. The differing forms of drag for the two CMEs indicate the forces and thus mechanism responsible for there acceleration may be different.

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