MHD Numerical Simulation of Two CMEs Event: Acceleration and Deceleration of CME Propagation

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Abstract

A major challenge to the space weather forecasting community is accurate prediction of Coronal Mass Ejections (CMEs) induced Shock Arrival Time (SAT) at Earth’s environment. In order to improve the current accuracy, one of the steps is to understand the physical processes of the acceleration and deceleration of a CME’s propagation in the heliosphere. We employ our previous study of a three-dimensional (3D) magnetohydrodynamic (MHD) simulation for the evolution of two interacting CMEs in a realistic ambient solar wind during the period March 28-31, 2001 event to illustrate these acceleration and deceleration processes. The forces which caused the acceleration and deceleration are analyzed in detail. The forces which caused the acceleration are the magnetic pressure term of Lorentz force and pressure gradient. On the other hand, the forces which caused the deceleration are aerodynamic drag, the Sun’s gravity and the tension of magnetic field. In addition the momentum exchange between the solar wind and the moving CMEs can cause acceleration and deceleration of the CME which are now analyzed. In this specific CME event March 28-31, 2001 we have analyzed those forces which cause acceleration and deceleration of CME with and without interaction with another CME. It shows that there are significant momentum changes between these two interacting CMEs to cause the acceleration and deceleration.