Deflection and distortion of CME internal magnetic flux rope due to the interaction with a structured solar wind

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The dynamics of CME propagation is strongly affected by the interaction with background solar wind. Wang et al. (2004) suggested that a fast CME that encounters a preceding slow wind stream subjects to eastward deflection due to parker spiral structure of the sola wind. This interaction strongly affects the arrival of a CME to the Earth, espeially the arrival of its internal magnetic flux rope.
To understand the interaction between a CME and background solar wind, we performed three-dimensional MHD simulations of the propagation of a CME with internal twisted magnetic flux rope into a structured bimodal solar wind. We compared three different cases in which an identical CME is launched into an identical bimodal solar wind but the launch dates of the CME are different. Each position relative to the boundary between slow and fast solar winds becomes almost in the slow wind stream region, almost in the fast wind stream region, or in vicinity of the boundary of the fast and slow solar wind streams, which grows to CIR. It is found that the CME is most strongly distorted and deflected eastward in the case near the CIR, in contrast to the other two cases. The maximum strength of southward magnetic field at the Earth position is also highest in the case near CIR. The results are interpreted that the dynamic pressure gradient due to the back reaction from pushing the ahead slow wind stream and due to the collision behind fast wind stream hinders the expansion of the CME internal flux rope into the direction of the solar wind velocity gradient. As a result, the expansion into the direction to the velocity gradient is slightly enhanced and results in the enhanced deflection and distortion of the CME and its internal flux rope. These results support the pileup accident hypothesis proposed by Kataoka et al. (2015) to form unexpectedly geoeffective solar wind structure.

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