Comparison of Helicity Signs in Interplanetary CMEs and Their Solar Source Regions

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Abstract

If all coronal mass ejections (CMEs) have flux ropes, then the CMEs should keep their helicity signs from the Sun to the Earth according to the helicity conservation principle. This study presents an attempt to answer the question from the Coordinated Data Analysis Workshop (CDAW), "Do all CMEs have flux ropes?", by using a qualitative helicity sign comparison between interplanetary CMEs (ICMEs) and their CME source regions. For this, we select 34 CME–ICME pairs whose source active regions (ARs) have continuous SOHO/MDI magnetogram data covering more than 24 hr without data gap during the passage of the ARs near the solar disk center. The helicity signs in the ARs are determined by estimation of cumulative magnetic helicity injected through the photosphere in the entire source ARs. The helicity signs in the ICMEs are estimated by applying the cylinder model developed by Marubashi (Adv. Space. Res., **26**, 55, 2000) to 16 second resolution magnetic field data from the MAG instrument onboard the ACE spacecraft. It is found that 30 out of 34 events (88 %) are helicity sign-consistent events, while four events (12 %) are sign-inconsistent. Through a detailed investigation of the source ARs of the four sign-inconsistent events, we find that those events can be explained by the local helicity sign opposite to that of the entire AR helicity (28 July 2000 ICME), incorrectly reported solar source region in the CDAW list (20 May 2005 ICME), or the helicity sign of the pre-existing coronal magnetic field (13 October 2000 and 20 November 2003 ICMEs). We conclude that the helicity signs of the ICMEs are quite consistent with those of the injected helicities in the AR regions from where the CMEs erupted.

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Keywords: Coronal mass ejections – Magnetic cloud – Photospheric helicity – Solar surface magnetic field – Interplanetary magnetic field