CME Expansion as Revealed by Joint Measurements by STEREO, Wind, MESSENGER and Venus Express

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Abstract and Objectives
The radial expansion of magnetic ejecta (CME) has been investigated through the analysis of remote observations, the variation of their properties with radial distance and from local in situ plasma measurements showing a decreasing speed profile, at first discussed almost 20 years ago. However, little is known on how local measurements compare to global measurements of expansion and what causes the different expansion properties of different CMEs. Here, we take advantage of 42 CMEs being measured by two spacecraft in radial conjunction to determine how the magnetic field decreases with distance, as a measure of their global expansion. As it is to be expected, the field of the CME on the left, expansion contributes to driving the shock (Mσ < 1), whereas for the one on the right the small expansion speed resulted in no shock (but a wave at 1 AU). From Lugaz et al., ApJ, 2017

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We take advantage of a recent study (Salman, Winslow, Lugaz, JGRA, 2020) identifying 45 CMEs measured in conjunction by two spacecraft in the inner heliosphere (MESSENGER, VEX, ACE/Wind, STEREO). For 42 events, there are plasma measurements near 1 AU that allow us to derive the expansion speed and the magnetic field in the ejecta at 0.31 AU. We can also estimate the ratio of the magnetic field at 1 AU to the field at 0.31 AU, and compare these two measurements with the local measurements. From Lugaz et al., submitted.

Case Study: 2013 July 13 CME: How do Different Measures of CME Expansion Compare?

We take advantage of a great conjunction event between Mercury and Earth in 2003 July 14-15 (longitudinal alignment within 3°) to highlight our approach of comparing global measures of CME expansion with local measures. The CME on the left, expansion contributes to driving the shock (Mσ < 1), whereas for the one on the right the small expansion speed resulted in no shock (but a wave at 1 AU). From Lugaz et al., submitted.

Different Measures of CME Expansion

Past studies reveal that a local measure of the CME expansion, ζ is typically ~ 0.8 for isolated CMEs (Gulisano et al., 2010). Global measures of CME expansion involve the radial distance, as a measure of their global expansion. As it is to be expected, the field of the CME on the left, expansion contributes to driving the shock (Mσ < 1), whereas for the one on the right the small expansion speed resulted in no shock (but a wave at 1 AU). From Lugaz et al., submitted.

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