Understanding fluxrope entanglement in the solar wind with observations and simulations

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Abstract

The Interplanetary Field Enhancement (IFE) is characterized by a cusp-like (nearly symmetric) enhancement of the magnetic field strength and a sharp current sheet near the peak field strength. It is detected by multiple missions in the solar wind with variable occurrence rate (a few to tens of cases per year) and durations (minutes to hours). The magnetic field strength in an IFE is similar to a flux rope signature, but the field components of a flux rope typically rotate gradually across it while the IFE has most of the field rotation at the central current sheet near the peak field strength. In addition, central current sheet of an IFE has some similarities to a tangential or rotational discontinuities, but the cusp-like enhancement in the field strength dis-like both types of continuity. Thus we categorize the IFEs as a unique structure and try to investigate the possible generation mechanisms. One possible mechanism is that the IFE structure being formed by interaction or entanglement of flux ropes in the turbulent solar wind, and the sharp current sheet in the IFE can be formed at the interface of the two flux ropes pulling against each other or entangled with each other. This hypothesis is supported by MMS observations of similar structures in the Earth magnetosphere as entangled flux ropes due to time-varying reconnections at the magnetopause, and also by the fact that near the solar corona there are frequent interchange reconnections and formations of entangled flux ropes which may extend into the solar wind. Thus we compare observations and simulations to understand the dynamics process of the fluxrope entanglement.

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