Fluid and Kinetic Properties of the Near-Sun Heliospheric Current Sheet

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Résumé

The heliospheric current sheet (HCS) is an important large-scale structure of the heliosphere, and, for the first time, the Parker Solar Probe (PSP) mission enables us to study its properties statistically, close to the Sun. We visually identify the 39 HCS crossings measured by PSP below 50 R during encounters 621, and investigate the occurrence and properties of magnetic reconnection, the behavior of the spectral properties of the turbulent energy cascade, and the occurrence of kinetic instabilities at the HCS. We find that 82% of the HCS crossings present signatures of reconnection jets, showing that the HCS is continuously reconnecting close to the Sun. The proportion of inward and outward jets depends on heliocentric distance, and the main HCS reconnection X-line has a higher probability of being located close to the Alfvén surface. We also observe a radial asymmetry in jet acceleration, where inward jets do not reach the local Alfvén speed, contrary to outward jets. We find that turbulence levels are enhanced in the ion kinetic range, consistent with the triggering of an inverse cascade by magnetic reconnection. Finally, we highlight the ubiquity of magnetic hole trains in the high-β environment of the HCS, showing that the mirror mode instability plays a key role in regulating the ion temperature anisotropy in HCS reconnection. Our findings shed new light on the properties of magnetic reconnection in the high-β plasma environment of the HCS, its interplay with the turbulent cascade, and the role of the mirror mode instability.

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