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Evolution of Plasma Discontinuities from Sun to Earth

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Interplanetary discontinuities (IDs) are abundant in space plasmas, characterized by abrupt changes of the magnetic field and particle parameters [1-3]. IDs are believed to be closely related to the Alfvénic turbulence and are host to many dynamic processes, including magnetic reconnection, wave-particle interaction and Fermi acceleration.

In MHD framework, IDs are classified into four categories, i.e. shocks and rotational/tangential/contact discontinuities (RDs/TDs/CDs), corresponding to four analytical solutions of the Rankine-Hugoniot conditions. RDs and TDs are the most common types observed in the solar wind, and thus have attracted much interest.

Previous studies of IDs by Ulysses-1, Voyager-2, Wind, etc. covering the heliocentric distances from 0.3 AU to 19 AU, mainly focus on their statistical characteristics and spatial evolutions. Theoretically, the spatial evolutions of IDs at different distances partly reflect their dependence on the local solar wind conditions. Since the radial gradients of the solar wind parameters are pretty small at large heliocentric distances, the investigation of IDs based on the measurements therein has considerable uncertainties.

By combining the data from PSP and MMS together, we make a comprehensive statistical study of IDs in the inner heliosphere. The characteristics and spatial evolutions of IDs within 0.3 AU are first revealed. The anomalous decrease of RD occurrence rate and the RD-pairs appearing in abundance imply that there may be a loss channel for RDs. Then we focus on the IDs in the near-Earth solar wind and magnetosheath. Figure 1 illustrates the impact of the terrestrial bow shock on different types of IDs. We find that the IDs with small field rotation angles are more likely to be affected and dissipated during the crossing of the bow shock. Further investigation also demonstrates that a lot of IDs in the magnetosheath are generated locally by turbulence. These results can improve our understanding of the nature and properties of IDs in space. This work is supported by NSFC grants 41821003, 42125403, and 41874188.

References

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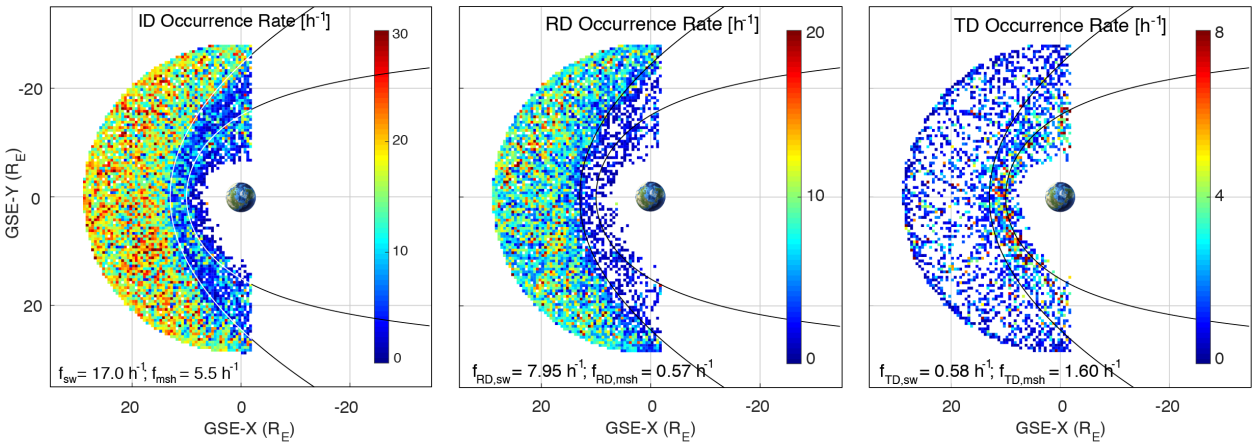

Figure 1. The spatial distributions of the occurrence rates of IDs, RDs and TDs in the X-Y plane of the Geocentric Solar Ecliptic coordinate system. The black curves indicate the locations of the bow shock and magnetopause.