

A New Era of Solar Exploration: Parker Solar Probe and Solar Orbiter in the Inner Heliosphere

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Abstract

The magnetic field is fundamental to solar activity and shapes the inter-planetary environment, as shown by the full three dimensional monitoring of the heliosphere provided by measurements from many past and present interplanetary and remote sensing spacecraft. Magnetic fields are also the source for coronal heating and the very existence of the solar wind; produced by the sun's dynamo and emerging into the corona, magnetic fields become a conduit for waves, act to store energy, and then propel plasma into the Heliosphere in the form of Coronal Mass Ejections (CMEs). Magnetic fields are also at the heart of the generation and acceleration of Solar Energetic Particle (SEPs) that modify the space weather environment of the Earth and other planets.

Parker Solar Probe (PSP)'s launch in 2018, followed by Solar Orbiter (SO)'s launch in February 2020 have opened a new window in the exploration of solar magnetic activity and the origin of the Heliosphere. Together with other ground and space observatories dedicated to solar observations the upcoming decade promises to revolutionize our understanding of the magnetized outer solar atmosphere, corona and solar wind.

I will start with an introduction to our present knowledge of the magnetized solar corona and wind before describing the PSP scientific objectives, orbit, and instrument suites. I will then discuss the first direct measurements of the plasma in the closest atmosphere of our star that have already produced significant surprises including the observation of the predominance of Alfvénic turbulence in solar wind streams, the presence of folds in the magnetic field called switchbacks that come in patches, magnetic reconnection in the forming heliospheric current sheet, anti-correlation of measured electron temperature with solar wind speed, and small-scale energetic particle events. Finally I will also discuss how understanding the state of the solar wind all the way from the corona into interplanetary space provides a stepping stone for understanding the dynamics of active magnetized plasmas throughout the universe.