Project Details

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Program Element: Physics of the Inner Heliosphere

Topic: Physics-based methods to predict connectivity of SEP sources to points in the inner heliosphere, tested by location, timing, and longitudinal separation of SEPs

Project Title:
Revisiting In-Situ Helios data for a Multi-Instrument Investigation of Inner-Heliospheric Plasma Thermalization Processes

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Summary:
We propose to revisit the in-situ Helios data for a multi-instrument investigation of inner-heliospheric plasma heating and thermalization processes.

From 1974 to about 1985, the Helios 1 and 2 spacecraft explored the inner heliosphere between 0.3 and 1 AU and have thereby provided a unique set of in-situ measurements that remains of paramount scientific value. There is however no comprehensive public repository of Helios in-situ data. Currently, most of the highest resolution data can be obtained from a variety of places, although with very little documentation, especially on calibration. Analysis of this data set requires overcoming a number of technical and instrumental issues, knowledge and expertise of which is only possessed by the original PIs of Helios experiments. Therefore there is a sense of urgency to revisiting and reanalyzing this valuable, unique dataset now, before this detailed knowledge is lost, in order to assure its long-term preservation and availability to the community.

First, we plan to gather, reprocess and reanalyze all fluxgate and search coil magnetic field measurements, plasma wave data, and ion and electron data (distribution functions and associated moments) from Helios 1 and 2 with the goal of creating a single archive of Helios in-situ data along with documentation and software tools for data analysis, which we will make publicly available.

On its own, this archive will be an asset to the community. However, we will also jointly analyze magnetic fields, plasma wave and particle data to investigate heating and thermalization processes of inner-heliospheric solar wind ions and electrons and their radial evolution as the solar wind expands. Of particular interest is the relative roles of Coulomb collisions, waves and instabilities in influencing the micro-kinetic evolution of the plasma and regulating non-thermal features in solar wind ions and electrons.

We will make systematic fits of the proton and alpha particle distribution functions and determine accurate densities, velocities, temperatures, anisotropies and drifts associated with the core and the beam populations. Similarly, the electron distribution functions will be analyzed to characterize core, halo and strahl populations and determine their respective anisotropies and heat fluxes. The magnetic-field and plasma-wave data will be used to quantitatively characterize the measured electromagnetic wave power and thus relate the ion and electron non-thermal features to the coupled electromagnetic fluctuations. This will allow us to directly search for signatures of instabilities and assess their contribution to the total wave power at kinetic scales.

The proposed work will be a tremendous asset to the the entire heliophysics community but especially to the instrument and science teams of the Solar Probe Plus and Solar Orbiter missions.

Publication References:

no references