Project Details

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Topic: Origins, Acceleration and Evolution of the Solar Wind

Project Title:
Heating of Ions in the Low-beta Compressible Solar Wind

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Summary:
The solar wind is the high speed plasma flow originated from the Sun, carrying magnetic field and energetic particles and propagating throughout the heliosphere. In-situ measurements have shown that solar wind is turbulent and ions are heated, though the heating mechanisms for solar wind ions are still under debate and a subject of active research.

We propose to study the solar wind ion heating in the regime when the turbulent Mach number is high (between 0.1 and 1) and the plasma beta is low (
1) Can PDI explain enhanced density fluctuations at the center of the preferential ion heating zone (10-20 solar radii)?

2) What are the heating rates of compressible and incompressible turbulences on protons and minor ions in the low-beta compressible solar wind?

3) How does the inclusion of ion heating from compressible turbulence improve global modeling of the solar wind?

Because LBCT have been observed in the heliosphere from tens of solar radii to a few AUs, with an increasing occurrence when approaching the Sun, our proposed investigation is very timely to address the long-standing ion heating problem in the solar wind because in-situ measurements in the close-to-Sun region will soon be made available by the Parker Solar Probe (PSP).

We propose to perform local 3D MHD and hybrid simulations to address the problem of solar wind ion heating in the low-beta compressible regime, using turbulence and plasma quantities provided by global MHD simulations. The local MHD simulations will enable us to examine the similarities and differences of properties between compressible turbulence and the well-studied nearly incompressible turbulence. Hybrid simulations will allow us to directly examine the detailed ion heating processes in the low-beta compressible regime. Specifically, we will use the background plasma conditions including magnetic field, plasma density, ion temperature and the solar wind speed in several typical regions: 1 AU, 0.3 AU and 10s R_s (solar radius) and