Alabama Plasma Internship Program

Project Title:
Space Plasma Physics: Solar wind, pickup ions, turbulence, and particle acceleration

Subproject 2:
To Reliably Map the Solar Wind's Magnetic Field from the Sun's Surface to 1 AU Using Parker Solar Probe Data.

Project Reference Code:
UAH-Tasnim

Host Facility:
The University of Alabama in Huntsville

Host Facility Location:
301 Sparkman Dr.
Huntsville, AL 35899
https://www.uah.edu/

Project Description:
The Sun plays an important role in space plasma physics. The surface of the Sun expands outward at a certain speed (called the solar wind), until the ram pressure of the solar wind is balanced by the interstellar medium pressure. The expansion of the solar wind stops, forming a bubble-like space area in the interstellar medium, called the heliosphere. Due to the rotation of the Sun, the solar wind forms a Parker spiral in the expansion process. Note that the magnetic field freezes in the solar wind plasma and convects with it. Solar wind provides a unique opportunity to study various processes in plasma. In the solar wind, waves and turbulence are everywhere. The dissipation of turbulence is thought to be responsible for the heating of coronal plasma to millions of degrees Kelvin, the acceleration of the solar wind, and the heating of the solar wind. Similarly, several theoretical (Zank et al. 2014, 2015; le Roux et al. 2015, 2016, 2018) and observational (Khabarova et al. 2015, 2016, 2017, 2018; Zhao et al. 2018, 2019; Adhikari et al. 2019) studies have found that when solar energetic particles (SEPs) propagate through the “sea” of magnetic islands, they accelerate in situ. In addition, some studies have also shown the presence of pickup ions (PUIs) in the solar wind (Zhao et al. 2019). PUIs are produced due to the charge exchange between solar wind protons and interstellar neutrals. Waves, turbulence, and PUIs have their own characteristics, and they can change the shape of the heliosphere, and the termination shock (TS).

We divide the project into six sub-projects. Our research project involves i) a parametric study of cowling resistivity, ii) mapping of the solar wind’s magnetic field, iii) evolution of turbulence in the inner heliosphere, iv) magnetic reconnection and plasma acceleration, v) the generation and propagation of interstellar pickup ions, and vi) hybrid simulation including neutrals. The student are feel free to choose any one of our project. Students will be involved with state-of-the-art research under the direction of Dr. Zank (and his research scientists Dr’s Lingling Zhao and Mehmet Yalim (Sarp) and postdocs, Dr’s Samira Tasnim, Masaru Nakanotani, Haoming Liang, and Laxman Adhikari).

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Description of Subproject:
The solar wind is the expanding outer atmosphere of the Sun, which fills interplanetary space with heated ions and electrons. Studying the solar wind offers unique opportunities to understand space plasmas better, and characterizing the solar wind's global three dimensional (3D) structure is becoming increasingly important for space weather forecasting.

In this project, the students will learn to access and utilize data from the Wind and Solar Probe Plus spacecrafts for different solar rotation periods. The project will also help the students to learn and extend the current solar wind models of Tasnim & Cairns, 2016 and Tasnim et al., 2018 to predict the magnetic field as a function of position between the Sun and the Earth. Using this magnetic field vector (B) and solar wind data, they will map magnetic field lines from the Sun to Earth, which is vital for predicting space weather caused by solar energetic particles (SEPs). To map the magnetic field, the student will combine the proposed solar wind model with the simple mapping algorithm of Li et al., 2016, and the Runge-Kutta method to predict magnetic field lines with the accelerating solar wind model.

Disciplines:
Physics, Math, Computer Science, Space Science

Is U.S. citizenship required to participate in this project?
Yes

Name(s) of Mentor(s) and contact information:
Samira Tasnim (samira.tasnim@sydney.edu.au)
Gary Zank (gpz0001@uah.edu)

Internship Coordinator/ HR manager:
Dana Waller (dsw0012@uah.edu)

The name and contact information of personnel at the host facility is provided for further assistance with questions regarding the host facility or the project.

Interns will not enter into an employee/employer relationship with the host facility. No commitment with regard to later employment is implied or should be inferred.