Department of Physics & Astronomy

UTSA

Dissertation Defense

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Tuesday, April 30, 2013

Time: 11:00am

PNB 2.106

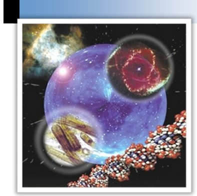
Abstract

The Three Dimensional Structure of Corotating Interaction Regions and Modeling of the Heavy Ion Sensor

Corotating Interaction Regions (CIRs) are compression regions that form in interplanetary space at the interfaces between slow and fast solar wind streams. This dissertation studies the three-dimensional orientation of planar magnetic structures within CIRs near Earth, how their orientation evolves, and the implications for the structure and properties of parent coronal holes. This dissertation also shows our work of modeling the response of the Heavy Ion Sensor (HIS) for the Solar Orbiter mission. We will discuss the methods and results below.

The shape of CIRs has been thought of as well understood, and discussed in theory and observations since the 1970's. Here we analyze the orientation of planar magnetic structures in CIRs and compare these observations with predictions of existing models of CIR formation, such as the analytical model of Lee [2000] and Enlil. Specifically, we identified and studied 153 CIRs that passed near the Earth between Jan. 1995 and Dec. 2008. We also performed case studies on the evolution of 3 CIRs that were observed by ACE and Ulysses, when the two spacecraft were near radial alignment with the Sun. We find that the observations are similar to qualitative expectations of CIR formation and evolution. However, model results were generally unable to quantitatively predict the observations. These results suggest that current models may over-simplify conditions near the Sun that lead to the formation of CIRs.

We are also involved in the development of the Heavy Ion Sensor (HIS) for Solar Orbiter. We have characterized the response of HIS to solar wind ions using a Monte Carlo simulation. Our simulation uses realistic count rates, interactions of ions with a carbon foil, the dispersion in the time-of-flight of the secondary electrons, and the pulse height defect within the solid-state detectors. Our results show that HIS is capable of resolving the masses and charge-states of He, C, O, Ne, Mg, and Fe. Results also show that there is some overlap between S and Si, but it is likely that we will be able resolve these ions by integrating these measurements over longer time periods.



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