Project Details

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Topic: Origins, Acceleration and Evolution of the Solar Wind

Project Title:
Observational Constraints on the Origin and Acceleration of Solar Wind from Coronal Holes

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Summary:
Science Goals and Objectives:

Understanding the solar wind requires determining the source regions for different types of solar wind and the physical processes that accelerate them. We propose to investigate the solar wind from within and near coronal holes (CHs). These open field regions are the source of fast solar wind. Their boundaries are thought to be a source slow solar wind. Theories propose that at CH boundaries reconnection occurs between open and closed magnetic field, releasing stored plasma onto open field lines to form the slow solar wind. Many characteristics of this interchange reconnection process are unknown.

We propose to use elemental abundances as a diagnostic to understand interchange reconnection. The abundances of elements with a low first ionization potential (FIP) grow over time on closed loops. This FIP effect does not occur on open field lines. Thus, the FIP effect can be used to determine how recently a closed field line has undergone reconnection with an open field line. We will study the FIP-effect at the boundaries of CHs and use our results to infer the length and time scales over which interchange reconnection occurs at the CH boundary.

Reconnection is driven by random convective motions and by large scale flows, such as differential rotation. CHs are known to not be sheared by differential rotation of the photosphere. Theories suggest that this is because reconnection at the boundary maintains the CH's shape. We will study differences in the FIP effect gradients on the leading and trailing edges of CHs to determine whether they are consistent with this theory for CH rigid rotation.

A well-known empirical property of the solar wind is the inverse correlation between the wind speed and the expansion factor describing the divergence of magnetic field lines in the low corona. It has been argued that the expansion factor is just a proxy for the solar wind source distance from the coronal hole boundary (DCHB). These different correlations are related to different physics as the expansion factor is important for wave-turbulence driven solar wind models, whereas the DCHB is important for reconnection-driven models.

We will measure the solar-wind outflow velocity at low heights in the corona and determine the correlation between velocity, expansion factor, and DCHB. This will show whether the correlation observed in the solar wind is present at low heights and whether expansion factor/wave-driven models or DCHB/turbulence-driven models are more important.

Methodology:

We will use spectroscopic data from EIS on Hinode, as well as magnetograms and images from SOHO and SDO, to study low latitude CHs. Many suitable public archival datasets already exist. From the EIS data, we will derive the elemental abundances and Doppler velocities and produce maps of these quantities throughout the field of view. We will determine how the FIP effect varies across the CH boundary. We will also study how the abundances vary as a function of latitude at the leading versus trailing edges of the CH in order to observe the effects of differential rotation.

From the magnetograms we will extrapolate the coronal magnetic field using magnetic field models. Potential field models are expected to be sufficiently accurate, but we will use other models to quantify systematic uncertainties. These results will allow us to de-project the line-of-sight velocities to measure the flow velocity along the field. From the model, we will also obtain the expansion factors and find the correlation of flow velocity.

Imaging data will be used to specify the boundary of the CH. In reality, the boundary is gradual and so different conventions and algorithms have been proposed in order to specify a particular location. We will use different conventions in order to quantify systematic uncertainties. Then we will find the correlation between flow velocity and DCHB.

Publication References:

no references