Long Duration Coronal Hole Observation

Proposers:
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Scientific Background:
We propose a long duration EIS observation of a coronal hole in order to better quantify the Alfvén wave energy flux at large heights. The observation can be a sit-and-stare using the full (512”) height of the 1” slit pointed from just below the solar limb to large heights above a polar coronal hole.

Previously, we performed an analysis of an archival EIS observation showing evidence that Alfvénic waves are dissipated at low heights in the corona of about 1.15 $R_\odot$ measured from Sun center, which is in contrast to theoretical predictions that such dissipation would only occur over much longer length scales (Hahn & Savin ApJ 776, 78, 2013). Our work was based on an analysis of line widths, which took into account many sources of systematic error. This wave dissipation likely accounts for much of the heating in coronal holes. However, the archival data we studied becomes noisy shortly above the onset of damping due to the low signal at large heights.

Some of the scientific results that these proposed new observations will enable include:

1. More precise characterization of the spatial variation of the damping, such as its functional form and damping length. This information will be useful for making comparisons with theoretical wave damping models.

2. Quantification of the remaining wave energy at large heights for comparison with fluid models for the solar wind, which predict that some Alfvén wave energy must be transmitted past the sonic critical point in order to produce a fast wind.

3. More accurate measurements of ion heating, especially if emission from a variety of different ion species can be included in the EIS data. This heating is believed to be due to wave-particle interactions, but the precise process is poorly understood. Various theories predict different dependencies of ion temperature on ion properties such as charge and mass.

Time Period of Proposed Observation:
Start and End Dates: No specific time period, whenever a suitable coronal hole appears and there is sufficient time to collect the data.
Number of Days: Sufficient time to collect the data, about 24 hours.
Continuity: Interruptions should be short enough that no major structural changes occur in the coronal hole.

Time Window in Day:
Minimum Duration: 24 hours. The archival observation had 2 hour total exposure time with the 2” slit. Assuming the 1” slit collects half as many photons and that the EIS sensitivity has remained constant over time, a 24 hour exposure time would reduce the counting statistical noise by a factor of 2.4.
Interruptions: Should not be a problem, as long as interruptions are short enough that the major coronal hole structures do not vary too greatly. This probably means collecting the 24+ hours of observations within a few day period.

Target of Interest:
Polar coronal hole from just below the limb to large heights. In Solar-Y, roughly 885” to 1395” and at Solar-X = 0”. Ideally, a large well-formed polar coronal hole that is centered over the pole so that there is minimal contribution from foreground and background quiet Sun regions.

Target of Opportunity: Yes.

Hinode Instruments and Observeables:
EIS – 1” slit with a fixed pointing at about Solar-X = 0” and vertically extending from about +/- 885” to +/- 1395” (From slightly below the limb to large heights above it).
Cadence is not important, as the intent is to integrate all the data in the end. In the archival data one often finds repeated observations with 10 minute cadences, and something like this would be suitable.
Wavelengths – many wavelengths are desireable in order to perform a DEM and separate coronal hole from quiet Sun contributions. A full CCD observation would be excellent. In case of telemetry limitations, the following is a prioritized list of lines, some of these can be picked up in a single window, even though we list the lines separately. Wavelengths are in Angstroms.
High Priority: Fe X 184.54, Fe VIII 185.21, Fe VIII 186.60, Fe XII 186.88, Fe XI 188.22, Fe XI 1883.0, Fe IX 188.50, Fe IX 189.94, Fe XII 195.12, Fe IX 197.86, Fe XIII 202.04, Fe XIII 203.79 & 203.82, Si VI 246.00, Mg VI 270.39, Fe XIV 270.52, Si X 271.99, Si VII 275.36, Si VII 275.68, Fe XV 284.16
Medium Priority: O VI 183.94, O VI 184.12, Fe XI 189.71, Fe X 190.04, Fe XII 192.39, Fe XII 193.51, Fe X 193.72, Fe VIII 194.66, Fe XII 196.64, Si VI 249.12, He II 256.32, Fe X 257.26, Si X 258.37, Si X 261.06, Mg VI 268.99, Si VII 272.65, Mg V 276.58, Si X 277.26, O IV 279.63, O IV 279.93
Lower Priority: Fe X 174.53, Fe XI 180.40, S X 264.23, Mg VII 276.15
Data Volume Estimate – ~8 Mb per exposure. This is based on the EIS data we used before, such as eis_l0_20090423_151714, for which the FITS file is 25 Mb for a full-CCD readout containing 3 exposures.