Coronal Hole Densities

K. J. H. Phillips
Mullard Space Science Laboratory, UK

Contact: kjhp@mssl.ucl.ac.uk

One of the chief advantages of Solar Orbiter over other spacecraft, including Solar-B and SOHO, will be the ability to observe the Sun's polar regions in more detail than previously possible. At the final part of the cruise phase, the inclination of Solar Orbiter's orbit will be ~ 30º, so allowing an unprecedented view of features in the polar regions.

If the launch is 2015, Solar Orbiter will be ready for operations in around 2020, only about 2 years after solar minimum, so an ideal time for viewing the properties of polar coronal holes, with possible consequences for fast solar wind stream models. A particular parameter of interest will be electron densities, so a selection of lines with sensitivity to densities is of interest here. Lines will relatively low coronal temperatures (log T = 6.0 to 6.3) are particularly relevant.

Among these are the well-known lines of Fe IX and Fe X at 171Å, 175/177 Å which have emitting temperatures of about log T = 6.0 and which are also density-sensitive.Viewing small structures such as bright points in coronal holes should be possible with the proximity of Solar Orbiter to the Sun, far closer than has hitherto been possible with spacecraft-borne spectrometers. Studies of these lines in lower-latitude bright points could also be carried out and comparisons made with the high-latitude sources. Bright points should be followed for several hours to catch flaring events which are of possible importance in the energy balance of coronal holes. Changes in density can be determined from lines of hotter ions such as Fe XIV at ~210Å.

EUS instrument requirements

1. Emission line requirements

The lines of Fe IX and Fe X in the 171--177Å region, i.e. Band 1, are needed for this case. Other lines near by will be of interest too for bright points present in the coronal hole structure, particularly if flaring, with temperatures of up to log T = 6.3. Thus, lines of the hotter (log T = 6.3) ion Fe XIV at ~210Å (also in Band 1) should be included.

2. Spectral resolution requirements

The density-sensitive line pairs need to be well resolved. High resolution is also required for information on possible wavelength shifts that will be important for polar plumes or other open-field structures where the high-speed solar wind is thought to emanate from.

3. **Spatial coverage**

The coronal hole needs to be covered reasonably well, i.e. 3-4 arcmins at 1 A.U., more when SO is at perihelion.

4. **Time resolution**

Fast time resolution is not of particular importance for this Science Case, apart from following flaring bright points occurring within the coronal hole.

5. **Requirements for other instruments**

Magnetogram information is necessary for examining the nature of the region being observed on the Sun – e.g. bright points, open field structures, polar plumes.

6. **Other requirements**

Relation to Solar Orbiter science goals

1. **Determine the properties, dynamics and interactions of plasma, fields and particles in the near-Sun heliosphere**

N/A

2. **Investigate the links between the solar surface, corona, and inner heliosphere**

The relation of electron densities determined from Fe IX (etc.) line ratios close to the surface at the poles and the particle densities at the spacecraft at closest approach may give information about the high-speed solar wind.

3. **Explore, at all latitudes, the energetics, dynamics, and fine-scale structure of the Sun's magnetized atmosphere**

The possibility of high-density, localized structures, particularly flaring bright points, explored by Fe IX (etc.) ratios in polar coronal holes may be of major importance for the energetics of the high-latitude regions. Examining equivalent features at lower latitudes to see whether densities are lower or higher will be of interest to see whether there is a latitude-dependent energizing of the solar atmosphere.

4. **Probe the solar dynamo by observing the Sun's high-latitude field, flows, and seismic waves**

The observation of the properties of high-latitude features will assist in the determination of the nature of the solar dynamo, particularly at solar minimum.