The origin of the slow solar wind

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Our knowledge about slow solar wind (≈400 km/s) and especially its origin is very limited. Theoretical models suggest that coronal holes boundaries (CHBs) are the main source of the slow solar wind. The helmet-streamer loops are also considered as a possible source but with the major component still coming from the CHBs. Because of the different rotational profiles in the corona and at photospheric level and the fact that coronal hole boundaries separate two topologically different magnetic field configurations, CHBs are presumably the region where a continuous opening and closing of magnetic field lines takes place. This reconfiguration is believed to happen through magnetic reconnection between the open magnetic flux of the coronal hole and the closed one of the quiet Sun. Madjarska, Doyle & van Driel-Gesztelyi (2004, ApJ, 603, 57) found the first evidence for magnetic reconnection along coronal hole boundaries using SUMER observations in spectral lines formed at transition region temperatures. This suggests that low lying loops which are abundant along CHBs are continuously evolving and reconnecting with the open magnetic flux of the coronal holes as predicted recently by Fisk (2005, ApJ, 626, 563). Therefore, spectroscopic studies of both polar and equatorial coronal holes are needed to explore further this problem which is also one of the main goals of the Solar Orbiter mission.

EUS instrument requirements

1. Emission line requirements

The spectral band 7b (1163 – 1265 Å) will provide a few strong transition region lines such as C III 1175 Å, N V 1238 Å and 1242 Å together with O V 629 Å and the coronal line M X 625 Å in second order. If this band is registered together with spectral band 7a (970 – 1040 Å) we can have a pair of strong density sensitive lines such as C III 977 Å and C III 1175 Å, already used with SUMER to derive the electron density in solar prominences (Cirigliano, Vial & Rovira 2004, Solar Phys., 223, 95).

An alternative choice are bands 6 (700 - 800 Å) and 7b (1163 – 1265 Å) , with band 6 providing N IV 765 Å and Ne VIII 770 Å. The O V multiplet between 758 Å and 762 Å is suitable for density diagnostics. However, it is too weak to be used in the quiet Sun and coronal hole region.

1. Spectral resolution requirements

The profiles need to be resolved in order to study line widths and shifts.

2. Spatial coverage

300" spatial coverage which will permit simultaneous registration of both quiet Sun and coronal holes and facilitate magnetic field extrapolations.

3. Time resolution (incl. count rates)

Time resolution better than 20 sec, using a rastering mode is required.

4. Requirements for other instruments

Simultaneous imaging at similar temperatures and spatial and temporal resolution is essential, plus vector magnetograms.

5. Other requirements

Relation to Solar Orbiter science goals

The study is part of the science goal '2.2.3 What are the sources of slow solar wind, and what is its temporal and spatial resolution?'.

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

N/A

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

The slow solar wind is probably originating from magnetic reconnection of open magnetic flux and low lying loops and it is later accelerated into the corona and the inner heliosphere.

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

We will be able to explore the dynamics of the small-scale evolution along coronal hole boundaries and its possible contribution for the generation of the slow solar wind.

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

N/A