MEASURING DENSITY IN THE QUIET SUN TRANSITION REGION

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The quiet Sun density in the transition region has never been accurately measured by previous spectrometers, yet is a crucial parameter for modelling quiet Sun structures and finding the filling factor of the highly structured transition region.

Solar Orbiter is the only future mission with the possibility of simultaneously measuring the C III λ977 and λ1176 density sensitive lines at a spatial resolution capable of resolving quiet Sun structures.

EUS instrument requirements

1. Emission line requirements

C III 977 and C III 1176 are *essential*. These lines provide by far the best density diagnostic in quiet Sun condition and are sensitive in the range 10^9-10^{10} cm^{-3}.

A secondary choice is O V 629.7 and O V 760.5, whose ratio is sensitive to higher densities (10^{10}-10^{11} cm^{-3}), and thus would probe more intense quiet Sun events.

Combined transition region and coronal densities allow the density to be tracked into the corona. The average quiet Sun coronal density is $10^{8.6}$ cm^{-3} (Young, 2005, A&A, 439, 361), and the best diagnostic is Fe X 175.3/174.5.

Placing the C III structures in context is important, and so both cooler and hotter lines are desirable. For example C II, C IV, O II-VI, Ne VI-VIII.

With regard to the wavelength selection document, Bands 7a and 7b are essential. Band 6 is preferable for context information and would also yield the O V density diagnostic (assuming 629.7 is in Band 7b in 2nd order). Band 1 would yield the coronal density diagnostic.

2. Spectral resolution requirements

The lines in the C III 1176 multiplet need to be resolved, for which SUMER resolution is good enough, i.e., pixels of 44 mÅ and instrumental resolution of ≈ 90 mÅ.

3. Spatial coverage

A supergranule cell is the typical scale on which to observe.

4. Time resolution (incl. count rates)

At least 100 counts in the C III λ1176 and λ977 lines should be obtained in quiet Sun conditions within an exposure time of 10 seconds.

5. Requirements for other instruments

Imaging capability at transition region and/or chromospheric temperatures is important for placing the spectroscopic measurements in context. Magnetograms allow structures to be related to magnetic features.

6. Other requirements

N/A.

Relation to Solar Orbiter science goals

Indicate how your science fits in with the four Orbiter science goals. Simply type "N/A" if it's not applicable to a science goal.

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 transition region is the route through which energy flows from the photosphere to the corona, and is where the initial acceleration of the fast solar wind takes place in coronal hole regions.

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

The electron density is a vital parameter for modelling energy flow and dissipation in solar structures. These observations will not only provide the first accurate measurements of the quiet Sun transition region density, but also show how the density varies on timescales ~ 10's of seconds or less. At high latitudes, the observations will yield measurements in coronal holes, vital for modelling the solar wind.

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

N/A