Tracking the progress of propagating waves from the Chromosphere to the Upper Transition Region and Corona

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The simultaneous coverage of so many chromospheric, transition region and coronal lines offered by EUS has not been possible with previous spectrometers. With this instrument it will be possible for the first time to simultaneously measure the variation of flux and velocity measurements with time over the entire chromosphere/ transition region/ corona temperature range. This will allow the tracking of waves from the chromosphere right up into the corona, with the waves taking the form of oscillations in the measured flux and velocity measurements. In this way, the precise origin of the waves at low chromospheric temperatures, from locations in different solar structures (active regions, quiet Sun structures, etc.), can hopefully be identified for the first time, due to the high spatial resolution of the new instrument. The EUS instrument is the only possible instrument in the future that will have the spectroscopic and spatial resolution capabilities needed to carry out this task, i.e., possessing chromospheric and transition region spectroscopy capabilities.

The use of the Bands 5,6, and 7a would allow us the coverage of the oxygen lines, O I to O VI (from log T=4.0 to log T=5.5), while also, for example, allowing the use of O V lines at 760.1/760.4 (Band 6) to obtain time series in this density diagnostic (O'Shea et al., Solar Phys., 2000, 196, 321). Band 5 would provide the lines that give information at coronal temperatures, e.g., Si XII 520 (log T=6.3), Mg X 624 (log T=6.1), etc.

EUS instrument requirements

1. Emission line requirements

A range of lines covering the chromosphere, transition region and the corona. Specifically, lines are needed that cover the chromosphere/transition region, as this temperature range is poorly served in other instrument, e.g., EIS on Solar B which mainly observes lines at coronal temperatures.

2. Spectral resolution requirements

The different lines in the O V 760 multiplet need to be resolved so Sumer resolution (or better) is required, i.e., pixels of ≤44mÅ, to, if possible, remove the blending of the 760.2 and 760.4 lines.

3. Spatial coverage

The observing slit should be able to adequately cover a reasonably sized active region. A 300 arcsec (at 1 AU) slit, as in Sumer, would be ideal. However, in order to increase the number of lines observed (to say 6-10), while maintaining a good time cadence, a 100 arcsec slit would be an acceptable length.

4. Time resolution (incl. count rates)

A time resolution of 10 seconds would be ideal for the expected sit-and-stare-type time series observations planned here. However, time resolutions of up to 50s would be acceptable

depending on the weakness of the lines being observed. For a 10 second exposure, we would require, as an absolute minimum, a count rate of at least 5 counts/second to give us 50 counts in 10 seconds, i.e., a S/N of ≈7 assuming Poisson conditions. Similarly for a 50s exposure a count rate of 1 count/second may be sufficient.

5. Requirements for other instruments

High resolution images at chromospheric and transition region temperatures will be important in placing the spectroscopic measurements in context, and for locating the origin in solar structures (magnetic loops in active regions, etc.) of the waves being detected. There is a great need for an imaging capability at transition region temperatures as no instrument currently planned (e.g., SDO, Solar-B) has this capability.
Similarly, the locations of the wave can be related to underlying magnetic field using photospheric magnetograms.

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

Measurements of waves from the chromosphere to the corona, undertaken in these observations, should provide information on the links between the possibility of wave propagation (and therefore energy transfer) between the lower heights near the Sun's surface, the Chromosphere, and those heights further up in the transition region and corona.

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

By measuring the presence of magnetic waves (magnetoacoustic waves, Alfvén waves) at all heights, from the chromosphere to the upper transition region we will be providing new information on dynamics in the Sun's atmosphere. With the fine-scale resolution of EUS the origin of these waves from different spatially small solar structures can be investigated. In terms of energetics, these magnetic waves are one of the principal ways by which it is considered that the Sun's outer atmosphere is heated

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

N/A