JOP054: CDS, EIT, MDI

Empirical Scaling Laws for a Range of Temperatures

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Scientific justification

Scaling laws, i.e. simple relations between fundamental properties of quasi-steady coronal loops (temperature, length, pressure and heating rate) have been theoretically postulated and partly tested using Skylab data two decades ago (Rosner et al. 1978). Recently Yohkoh has provided stringent tests of such scaling laws for high-temperature loops (e.g. Tsuneta 1996). Since the soft X-ray telescope (SXT) on Yohkoh is relatively insensitive to plasmas below $\approx$ 2–3$\times10^6$ K the Yohkoh result must be considered incomplete. We propose to extend tests of scaling laws to lower temperatures, but also to directly confirm Yohkoh results at higher temperatures. In this manner we can check whether the same scaling laws apply to all loops, or if cooler loops exhibit different dependences between their various parameters.

We propose to utilize the images in a group of spectral lines constructed by scanning the CDS NIS slit across the solar surface. In addition, we plan to use EIT images obtained in the three spectral lines of iron ions recorded by that instrument. We shall concentrate on the central half of the solar disk, in order to keep the geometry as simple as possible. Since sufficient statistics are required, i.e. a statistically significant number of loops needs to be observed, these observations need to be repeated a few times (e.g. 1–2 times per week for 3 weeks). CDS "images" are to be obtained in spectral lines with different temperature, but also different density sensitivities. From a set of spectral lines with different temperature sensitivities within the range log T = 5.5–6.4 (Fe VIII 370.4Å, Mg VIII 313.7Å, Mg IX 368.1Å, Fe XII 364.5Å, Fe XIII 348.2Å, Fe XIV 334.2Å, Fe XVI 335.4Å, Fe XXI 335.9Å) lines we can determine the temperature of the plasma. The density in principle follows from the emission measure. However, the use of density-sensitive line pairs (Fe XII 338/364, Fe XIII 348/359, Mg 315/335) should allow the true density of the emitting plasma to be determined even if unresolved fine-scale structure is present in the spatial-resolution element.

One of the parameters entering the empirical scaling laws is the length of the loop. Although the good spatial resolution of the SOHO instruments is an advantage, there may nevertheless be considerable uncertainty if the footpoints show little contrast relative to the surrounding plasma. In such cases it may sometimes help to use magnetograms to find the exact location of the footpoints. We propose to use MDI magnetograms for this purpose.

As a bonus of this study we expect to present statistics of loop properties, such as the distribution of loop lengths, temperatures, densities, etc. We also expect to learn more about the variation of temperature and density along the loop.

References

Rosner R., Tucker W., Vaiana G., 1978, *Astrophys. J.* **220**, 643–665.

Tsuneta S., 1996, in *Solar and Astrophysical Magnetohydrodynamic Flows*, K.C. Tsinganos (Ed.), Kluwer Academic Publishers, p. 85–108.

Observing sequence

Ideal time for observations: last week of November and first two weeks of December 1996.

In order to be certain that a sufficient number of loops can be sampled we propose that the following sequences be repeated 1–2 times per week for 3 weeks. If in this period the sun remains extremely quiet it may be better to reduce the number of observations for this JOP and repeat them at a later date when more loops are visible.

CDS sequence

Initial pointing	To location selected from EIT image
Spectrometer	NIS
Slit	2×240 arc sec^2
Raster area	240×360 arc sec^2
Raster step size	2 arc sec
Number of raster steps	180
Dwell time	60 s
Number of rasters	2 per observing day
Re-pointing	To a new location selected from EIT image after end of raster
Compression	16 bits $\rightarrow$ 12 bits
No. of spectral lines	11
Spectral lines	Fe XVI 335.4Å, Fe XIV 334.2Å, Fe XIII 348.2Å, 359.6Å, Fe XII 364.5Å, 338.3Å, Fe VIII 370.4Å Mg IX 368.1Å, Mg VIII 313.7Å, Mg VIII 315.0Å, 335.2Å
Co-operation	With EIT (images for identifying loops)

EIT sequence

Full-disc images at full resolution in all 4 spectral lines at the normal rate throughout the period of these observations.

MDI sequence

Magnetograms at the normal resolution and at the usual rate during the whole period of observations.