SPATIAL AND TEMPORAL CHARACTERISTICS OF MACROSPICULES

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Objective

To study the spatial and temporal characteristics of macrospicules, their temperature and density structure, and to explore their role in the solar wind flow. This joint observing program involves coordinated observations between the VLA (Very Large Array) and SOHO (SUMER, EIT, CDS).

Scientific Justification

Macrospicules often appear as columns of chromospheric material, reminescent of giant spicules, extending anywhere from 10" to 60" above the solar limb. Their characteristic lifetime ranges from 3 to 45 min (Dere et al 1989). Most prominent in spectral lines formed around 5×10^4 K, they are invisible in lines formed above 3×10^5 K (Bohlin et al 1975, Withbroe et al 1976, Dere et al 1989). Extreme ultraviolet (EUV) and radio observations suggest that they have cool 10^4 K plasma cores, with a thin outer sheath not exceeding 3×10^5 K (Withbroe et al 1976, Habbal and Gonzalez 1991). Observations at 6 cm (4.8 GHz) revealed, for the first time, evidence of ballooning at their top, with some pinching off, probably leading to the ejection of some plasma (Habbal and Gonzalez 1991). This phenomenon was also confirmed by Karovska and Habbal (1994) who showed that EUV observed macrospicules are the site of continuous interactions between the substructures forming them, with evidence for reconnection-type events and ejection of material. While H α macrospicules have been detected in polar and equatorial regions (Labonte 1979, Moore et al 1979), at EUV and cm radio wavelengths, they have been detected exclusively in polar coronal holes (e.g., Withbroe et al 1976, Habbal and Gonzalez 1991).

There are several outstanding questions associated with macrospicules: (1) Are these structures exclusive to coronal holes; (2) Is there a characteristic frequency for their appearance, and a characteristic spatial scale for their distribution; (3)

What are the characteristics of their temperature and density structures; and (4) Do they play any role in the solar wind flow?

The availability of the VLA — in a desirable configuration of its antennas for solar observations —, and the advent of a series of EUV instruments on SOHO, both at *solar minimum*, offer a new and unique opportunity to address these questions. With such an ideal coincidence we will be able to directly compare, for the first time, EUV and cm wavelengths emission from these structures, the wavelengths at which these structures have been best observed. The 6 cm observations will be made at the VLA. We propose to acquire EUV observations with EIT, CDS and SUMER from *SOHO*.

Description of Coordinated Observations

We have been allocated 4 days at the VLA: June 1, 2, 8, and 9, 1996. These two intervals offer a unique opportunity to explore both north and south polar coronal holes, with their adjacent bordering quiet regions.

VLA Observations

The VLA observations will be made primarily at 6 cm, the optimal wavelength for observations of macrospicules. These will be complemented by full disk observations at 20 and 90 cm. Observations have been allocated for 16:30 UT to 23:30 UT on June 1, 2 and 8, 9, 1996. The field of view at 6 cm is 10 arcsec. The spatial resolution in the DnC configuration is expected to be 5 arcsec, and the temporal resolution of a few minutes.

SOHO Observations

Earlier studies of macrospicules indicated that their temperature does not exceed 10^5 K. Therefore our observations will concentrate primarily on the cooler EUV lines. However, we will also make observations in hotter EUV lines to study the spatial distribution of these structures within the hotter (bright points and plumes) structures in coronal holes. Observations in the closed structures in quiet regions will also be made to find out if macrospicules exist outside coronal holes.

The advantage of the SOHO instruments is their superior spatial, temporal and spectral resolution. We propose to use the following three instruments: **EIT**, **CDS**, **SUMER**. Both spectral line observations and imaging are proposed: to compare between the radio observations and the EUV, and to obtain reliable temperature and density diagnostics of these structures. The comparison between radio and EUV emission can further yield limits on the magnetic field strength within these structures.

A high temporal cadence is also needed since the temporal variability of their emission is one of their outstanding characteristics. The highest cadence in the EUV from Skylab was 1 minute. A higher cadence would be desirable.

Other coordinated observations
These observations will also be supplemented by daily full disk x-ray observations from *Yohkoh*, the He I 10830 full disk spectroheliograms and magnetograms from Kitt Peak, as well as the Fe XIV daily coronal observations from Sac Peak.

References

Bohlin, J. D., Vogel, S. N., Purcell, J. D., Sheeley, N. R., Jr., Tousey, R., and VanHoosier, M. E. 1975, *Ap. J.*, **197**, L133.

Dere, K. P., Bartoe, J.-D. F., Brueckner, G. E., Cook, J. W., Socker, D. G. and Ewing, J. W. 1989, *Solar Phys.*, **119**, 55.

Habbal, S. R. and Gonzalez, R. D. 1991, *Ap. J.*, **376**, L25.

Karovska, M., and Habbal, S. R. 1994, *Ap. J.*, **431**, L59.

LaBonte, B. J. 1979, *Solar Phys.*, **61**, 283.

Moore, R. L., Tang, F., Bohlin, J. D. and Golub, L. 1977, *Ap. J.*, **218**, 286.

Withbroe, G. L., Jaffe, D. T., Foukal, P. V., Huber, M. C. E., Noyes, R. W., Reeves, E. M., Schmahl, E. J., Timothy, J. G., and Vernazza, J. E., 1976, *Ap. J.*, **203**, 528.