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LARGE SCALE STRUCTURE OF THE CORONA

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INTRODUCTION

Studies of large scale structures of the sun's corona are best done from synoptic observations. For the latter, we need dedicated imaging instruments. At the present time, we have two such instruments in the radio domain, both at meter-decameter wavelengths. The first one is the Nançay (France) one-dimensional radioheliograph at 169 MHz which produces two-dimensional solar images in about 10-12 hours by earth rotation aperture synthesis. The second one is the Clark Lake Radio Observatory multifrequency radioheliograph which produces two-dimensional images of the sun in the frequency range 15-125 MHz with a time resolution of ~ 1/2 second by aperture synthesis technique in the same manner as does the Very Large Array (VLA). We do not have any dedicated imaging instrument in microwaves, although at 20 cm wavelength some isolated studies of the large scale structure of the sun's corona can be made with the VLA.

In the optical domain, studies of large scale structure are done with several instruments: (1) Groundbased white light K-coronameter at Mauna Loa; (2) Solwind white light coronagraph on the satellite P78-1; (3) coronagraph polarimeter on Solar Maximum Mission satellite; (4) Kitt Peak magnetograph; (5) Kitt Peak He I spectroheliograph; and (6) Hα filtergrams.

In this chapter we present a brief description of some radio results obtained with meter-decameter radioheliographs (M.R. Kundu, 1986 and P. Lantos and C.E. Alissandrakis, 1986). An optical study based upon synoptic data of pB, Hα filtergrams and large scale B-fields is presented by M. McCabe. This is followed by two theoretical papers by R. Wolfson (1986) and T.J. Bogdan and B.C. Low (1986) on the interpretation of CME's and modeling of three-dimensional corona.

The studies of Kundu (1986) and Lantos and Alissandrakis (1986) are primarily concerned with a comparison of radio maps with white light pictures and He 10830Å spectroheliograms. These maps exhibit coronal streamers and coronal holes, and their evolution. The streamers appears as elongated lobes of enhanced brightness; the coronal holes appear as brightness voids in the radio-heliograms. The combined data (in radio and optical domains) can lead to determinations of electron temperatures and densities as a function of altitude in both streamers and coronal holes. When transient burst activity takes place, such as type III or type II bursts, one can trace the path of exciting electron streams or shock waves with respect to the streamer. Synoptic charts produced both from radio and optical data permit us to follow the evolution of streamers and holes, and to detect any abnormal feature when a transient, such as a coronal mass ejection (CME) event or radio burst, takes place.

McCabe used synoptic data during 18 solar rotations (1982-83): (1) daily polar plots of pB distribution (Mauna Loa); (2) low resolution synoptic B-field maps (Stanford); (3) Hα synoptic maps with inferred neutral lines; and (4) Hα filtergrams. The objective of her study was to investigate the relationship between the large scale photospheric magnetic field structure and the coronal polarized brightness (pB) distribution. The results obtained show a fairly good association between coronal structures and global photospheric neutral lines, which relate to heliospheric current sheets. However she finds that there are other neutral lines on a smaller scale which have no coronal counterparts. These neutral lines generally lie at the boundaries of unipolar field areas containing coronal holes or of mid-latitude unipolar regions within such areas.

Wolfson studied quasistatic evolution of magnetostatic coronal structures by developing a series of models that describe global magnetostatic equilibrium of an axisymmetric corona including gravity, gas pressure, and the Lorentz force. These models are based on the equation of Hundhausen, Hundhausen and Zweibel (1981) that includes a free function describing the distribution of coronal current. These models contain a parameter representing a deviation from a potential field and therefore related to amount of excess mass loaded into the corona. Wolfson (1986) studied four different models, and found interesting agreement between models and observations in several cases, in terms of the predicted amount of excess mass in the corona prior to a mass ejection.

Bogdan and Low (1986) worked on modeling three-dimensional corona by constructing a class of magnetostatic atmosphere in a $1/r^2$ gravity. Their solutions possess electric currents distributed continuously in space in the lower atmosphere and directed perpendicular to the gravitational force. They treat the problem in a fully 3-dimensional geometry, allowing for an arbitrary prescription of normal magnetic flux at the lower boundary of the atmosphere. The latter feature allows them to use KPNO magnetograms as observational inputs into their models. The coronal density structures predicted by the models can be compared with those given in the HAO C/P data.

FUTURE PROBLEMS

Several future problems have been identified by the group.

(1) Development of three-dimensional theoretical models including current distribution and prediction of density values and their comparison with the observed ones.

(2) Detailed comparison of synoptic radio and white light pictures; and determination of temperature distribution in the corona. Such comparison will also lead to detection of transients such as CME's and radio emission for which energetic electrons are of coronal origin (for example, as a result of streamer disruption phenomena).

(3) Synoptic soft X-ray and radio imaging of the corona and white light coronagraph measurements. Any other measurements that pertain to temperature and density structure of the corona should be undertaken.

REFERENCES

Bogdan, T.J. and Low, B.C., "Three-Dimensional Magnetostatic Model of the Large-Scale Corona", 1986 (This proceedings).

Hundhausen, J.R., Hundhausen, A.J., and Zweibel, E.G., 1981, J. Geophys. Res., 86, 1117.

Kundu, M.R., "Large Scale Study of the Sun's Radio Corona", 1986 (This proceedings).

Lantos, P. and Alissandrakis, C.E., "Synpotic Study of the Corona at Meter Wavelengths", 1986 (This proceedings)

McCabe, M.K., "The White Light Corona and Photospheric Magnetic Fields", 1986 (This proceedings).

Wolfson, R., "Quasistatic Evolution of Magnetostatic Coronal Structures", 1986 (This proceedings).