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THE SOLAR EMISSION-LINE CORONA: CURRENT AND FUTURE GROUND-BASED OBSERVATIONAL RESEARCH

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ABSTRACT

This is a review of discussions on the status of ground-based solar coronal research, which took place during the Workshop on Solar and Stellar Coronal Structure and Dynamics. This workshop was held from 17 to 21 August 1987 at the National Solar Observatory at Sacramento Peak. Topics of discussion included current observational capabilities, research problems suitable for attack now and in the future, and possible future instrumentation, including the Advanced Reflecting Coronagraph.

1. INTRODUCTION

In August 1987, a workshop was held at the Sacramento Peak Observatory (SPO) facility of the National Solar Observatory in Sunspot, New Mexico. The topic of the workshop was Solar and Stellar Coronal Structure and Dynamics, and it attracted workers in coronal physics from around the world. On the afternoons of 18 and 21 August, those participants interested in ground-based observations of the solar corona in emission lines of highly-ionized elements met to discuss the status of knowledge in that area. Those present included R. Altrock, S. Koutchmy, V. Krishan, J.-L. Leroy, F. Meyer, W. Neupert, C. Nitschelm, J.-C. Noens, V. Rusin, H. Schmidt, R. Smartt, T. Tsubaki, W. Wagner, and J.-L. Wang. I summarize here only the highlights of those discussions, which lasted for a few hours. I apologize for any omissions, which may have occurred when I was caught up in the discussions myself.

2. DISCUSSION

Koutchmy noted that the Fe XIV 5303Å "green" line and the Fe X 6374Å "red" line display very different morphologies in the solar corona. The green line is highly correlated with the white-light "K" corona, which is controlled by the

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density structure of the corona. For example, the K- and green-coronas show coronal holes as lack of emission, whereas the red line may show holes as areas of enhanced emission.

Neupert stated that the low-temperature red line should be a better indicator of transient activity than the higher-temperature green line, since EUV observations in Fe XI (a relatively low-temperature ion) on the disk show transient activity very well.

Rusin described briefly the observational program at Lomnicky Stit in which the green line is recorded with a standard (non-CCD) television system, while chopping against the sky.

Wagner advocated continued ground-based green-line observations by pointing out that: (i) the inner corona, which is accessible observationally only from the ground, is the location and/or starting point for nearly all coronal activity; (ii) the green line outlines the magnetic field and is thus useful for studying the morphology of coronal magnetic fields; and (iii) these observations can be taken at very high spatial and temporal resolution.

Altrock noted that solar-cycle studies of coronal processes are best, and most cost-effectively, done from the ground.

Schmidt concluded that the application of CCD's to green-line observing systems is critical for future progress in determining the local physics of coronal heating, due to their superiority over film in obtaining digital observations at high spatial and temporal resolution that are immediately ready for analysis.

3. RESEARCH AREAS

The group listed those areas of observation and analysis that appear to be especially suitable for exploitation at this time.

1. The Extended, High-Latitude Equatorward-Moving Branch of Coronal Activity. The urgent questions here were: (i) Does this branch first appear at the exact pole or at some lower latitude? (ii) Is the branch continuous with the main "butterfly diagram" mid-latitude branch, or is there a gap? (iii) If there is no gap, what is the total lifetime of the high- and mid-latitude branches (currently thought to be between 18 and 22 years)?

2. The High-Latitude Poleward-Moving Activity Zone. Interest here centered on the connection with underlying activity, which is also an urgent question for the equatorward-moving branch.

3. What is the nature and cause of the double maximum of coronal activity during the solar cycle?

4. What is the nature and cause of asymmetries in coronal activity between the Northern and Southern hemispheres?

5. What important properties of the corona can be jointly studied with emission-line and K-coronameter observations?

6. What is the nature of coronal activity at the equator near the end of the solar cycle? Is there an "extended" solar-minimum branch?

7. Comparison of solar-cycle variations in green-line coronal activity should be made at the upper and medium coronal heights available from the ground (e.g., SPO observations at 1.35 and 1.15 radii), low coronal heights (e.g., 1.03 radii from Lomnicky Stit), and in the red and yellow lines.

8. What is the nature of the solar rotation of isolated regions near solar minimum in various lines?

4. SACRAMENTO PEAK SYSTEMS

Smartt discussed optical systems that have been used at SPO for coronal observations. He contrasted (i) the Lyot birefringent filter, which is restricted to a central on-line passband and two adjacent off-line passbands, with (ii) the mica etalon filter, which allows one on-line and one off-line bandpass to be placed at any arbitrary location. In either case, the off-line position is equated to the "sky" contribution, and this contribution may then be subtracted electronically from the line contribution. The on-line bandpass of the mica etalon filter is placed at the emission line center. A potential problem is the intrusion of absorption lines, as revealed in the scattered light, into the vicinity of the emission lines. To avoid the deleterious effect of this, the off-line bandpass may be set nearby in the same relative position to an absorption line of similar strength in an attempt to make the "sky" contribution match as closely as possible the background component present at the line position (cf. Smartt, 1982). The advantages of the mica etalon filter are obvious, and this technique is used in the SPO Emission-Line Coronal Photometer.

Smartt also described the SPO "One-Shot Coronagraph", which records full-limb filtergrams of the green and red lines, plus Hα limb and disk images on 70-mm film with a one-minute cadence. In the future, work will proceed on various sizes of reflecting coronagraphs, culminating with the large-aperture Advanced Reflecting Coronagraph (ARC) for both day and night use.

5. FURTHER DISCUSSION

In consideration of the One-Shot Coronagraph, it was suggested that adding or substituting infrared lines, such as Fe XIII 10747Å, with their smaller sky contributions, and converting from film to a CCD would be desirable upgrades. Since Fe XIII spans most coronal temperatures it could image all coronal structures. However, since a multiplicity of temperatures often exist along a given line of sight, Fe XIII might produce a confusing image by superposing fine structure from high and low temperatures. These structures are currently separated by observations of the green (high temperature) and red (low temperature) lines (as indicated earlier, the structure observed in these lines is often radically different at the same position angle).

In a discussion of the ARC, it was pointed out that a large aperture is needed to resolve fine structure. The large aperture also aids in increasing the flux sufficiently so that a long focal length can be employed to improve resolution on a CCD. The higher flux also allows improved temporal resolution and opens the possibility of obtaining polarimetric observations, if instrumental polarization can be kept low or compensated for. The group concluded that the ARC is an exciting prospect, and it should be supported by all those interested in the corona.

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REFERENCE

Smartt, R. N. 1982, *Proc. SPIE*, **331**, 442-447.

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