ABSTRACTS

54.08 High Resolution Spectroscopy of Penumbral Fine Structure
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The 50-cm Swedish Vacuum Solar Telescope (La Palma, Canary Islands, Spain) was used to obtain areal scans of sunspots and associated features under conditions of exceptional angular resolution. Simultaneously 0.04 s CCD exposures of both the spectra and slit-jaw images effectively freeze the atmospheric seeing motions and permit unambiguous identification of spectra of penumbral structures. Spectra were acquired in two lines of the Fe I multiplet 6301.5 – 6302.5 Å. A correlation tracking procedure was applied to the sequential slit-jaw images, allowing for reconstruction of the areal scans in spectrally derived quantities, and two-dimensional maps of line-of-sight (LOS) velocity and continuum intensity have been formed. An absolute velocity calibration was implemented with flanking telluric 02 lines. These highly resolved spectral maps reveal the following: (1) Limb side penumbral filaments display very fine structure in plasma motions, while the disc center side filaments lack in well-defined flows. A correlation (stronger on the limb side) exists between Doppler shift and filament intensity. (2) Darker structures exhibit larger relative outflow (due in part to the Evershed effect) from the sunspot. (2) There are regions of large downflow at the ends of penumbral filaments, particularly on the limb side. (3) Absolute LOS velocity magnitudes within the umbra are less than 150 m/s. This behavior extends well beyond the visible umbral-penumbral boundary. We believe that the observed Doppler shifts are strongly influenced by magnetic fields, and analysis of field strengths and inclinations by intensity fitting of the Zeeman splitting is currently underway.

54.09 Siphon Flows in Isolated Magnetic Flux Tubes: Equilibrium Paths and Standing Tube Shocks
John H. Thomas (U. Rochester) and Benjamin Montesinos (Oxford U.)
Siphon flows in arching, thin, isolated magnetic flux tubes offer a mechanism for producing intense magnetic elements in the solar photosphere. We have extended our earlier calculations of these siphon flows (Thomas 1988, Ap. J., 333, 407; Montesinos and Thomas 1989, Ap. J., 337, 977) to include the calculation of the equilibrium path of the flux tube in the external atmosphere. The large-scale equilibrium of the flux tube involves a balance among the buoyancy force, the net magnetic tension force, and the inertial force due to the flow along curved streamlines. The horizontal width of the equilibrium arch is generally limited to some five to ten density scale heights; however, much wider arches can occur if the uppermost part of the arch is held down by the magnetic canopy in the upper photosphere. We also present the results of calculations of critical siphon flows with standing tube shocks in the downstream leg of the arch. The flow accelerates smoothly from subcritical to supercritical speed across the top of the arch and then decelerates abruptly to subcritical speed across a standing tube shock at some point in the downstream part of the arch. The strength and location of this tube shock depend on conditions at the downstream footpoint of the arch. All flow variables and the curvature of the flux tube axis change abruptly across the shock.

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54.10 Video Magnetograms with Sub-Arcsecond Resolution
Magnetograms of an active region and filament were obtained in Hα, Mg b, and Fe I 6102 (chromosphere, T−minimum, photosphere), with spatial resolution ≤ 0.5″ and good S/N. The Vacuum Tower Telescope at Sac Peak was used with the Universal Birefringent Filter, an RCA CCD video camera, and a new real-time video processor ("CHIRP"), which integrated 20 frames at each polarization and subtracted the sums to give a magnetogram.

The spatial resolution of the magnetic field at three heights will be shown. Hα fibrils of opposite longitudinal field polarity appear to be nested. The apparent field strength differs in the blue vs red wings of each line: in 6102 (B−B), in b2 (R+R) and in Hα (R−R).

54.11 Capabilities of the MCCD System at Mees Solar Observatory
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The Mees CCD Imaging Spectrograph (MCCD) has recently become operational at Mees Solar Observatory on Haleakala, Maui. The system utilizes an existing 25 cm Coronagraph telescope; the beam is directed via an image scanning mirror into a Coudé spectrograph, equipped with a sensitive CCD detector to produce imaging spectroscopic data. The beam can be switched to a magnetic rowband filter and video rate Coronados CCD camera system to collect wide-field monochromatic images. A fast guiding system produces stable images for both of these purposes. The MCCD system provides enormous flexibility for both imaging and spectroscopic observations.

The MCCD spectroscopic data are collected as follows: slit spectra are exposed onto a Photometrics CCD camera employing a 384x576 Thompson chip, read into an ICR 6800-based microprocessor running a real-time operating system, and stored onto a fast writing, large capacity, Exabyte 8mm magnetic tape subsystem. The image scanning mirror then steps the image perpendicular to the spectrograph slit; in this way a three dimensional data cube is built. The instrument has a maximum spatial resolution of 0.6 seconds of arc, and can scan a region on the solar surface up to 230x230 seconds of arc. Problems with slow image motion have been corrected by realigning the image rotator, and adjusting other elements in the optical beam of the telescope. The highest dispersion spectrograph grating, the MCCD has a maximum spectral resolution of 14 milli-Angstroms, which gives a spectral coverage of about 84 in a single image. The spectral range of the optical system extends over 68004, from Ca K (λ=3934) to the near IR (He line at λ=10830). Problems with spectral drift remain in the instrument; spectral drifts of tens of milli-Angstroms per hour exist in most of the data. (Use of the MCCD for spectroscopic study of sunspot umbral oscillations will be discussed. Even with large wavelength drifts in the instrument, observational techniques are used which can push the velocity sensitivity of the MCCD to less than 10 meters per second.)

The wide-field imaging capability of the MCCD system is provided by a narrowband interference filter (chosen by the observer), a video rate COHU CCD camera, and a video frame grabber board operated by the same 68000 microprocessor. These images are written to a second Exabyte 8mm magnetic tape subsystem. The spatial resolution is adjustable from 0.4 to 1.5 seconds of arc; the field of view can cover more than 720x720 seconds of arc. Capabilities exist for real-time averaging or differencing of these images, or simple image accumulation. Excellent quality images have been obtained from this system.

54.12 A Lunar-Based Solar Observatory and the Human Exploration Initiative
J. M. Davis (NASA/MSFC), H. S. Hudson (UCSD)
The President’s Human Exploration Initiative envisions the establishment of a manned lunar base early in the next century. NASA plans an astronomical observatory within the framework of this program. This paper develops a rationale for including a capability for solar observations as a major part of this facility, proceeding from two perspectives. First, from an operational point of view, solar observations will help to satisfy the requirement for flare alert system. Astronauts depend upon prediction and warning of solar radiation events. Second, lunar facilities offer qualitative improvements in capability for fundamental research. We describe the objectives of these different missions and present various configurations for both optical and high-energy instruments. We also discuss the advantages and disadvantages of locating these instruments on the lunar surface as opposed to sites on Earth’s solar orbit.