SOLAR EUV PHOTOELECTRIC OBSERVATIONS FROM SKYLAB

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Abstract. Most of the atomic species originating in the solar atmosphere between the upper chromosphere and the corona have their strong characteristic wavelengths in the extreme ultraviolet region of the spectrum. A simple normal-incidence spectrometer system with solar blind detectors such as the Harvard instrument operating between approximately 250 Å and 1350 Å is ideally suited for observing in this most interesting range of the solar atmosphere where the temperature rises outward from 10^4 to 3×10^6 K. The temperature range represented by the various atomic and ionic species in the extreme ultraviolet is associated with many types of solar structure, prominences and filaments, the supergranulation cells and network, active regions and their associated loop structures and other features. Simultaneous observations in lines of different characteristic temperatures provide a three-dimensional probe of the solar atmosphere. In the instrument, the principal polychromatic position observes the Lyman continuum, Lα, C II, C III, O IV, O VI, and Mg X with seven detectors simultaneously from the same spatial image element, 5″ in size. Approximately 60 additional polychromatic positions are used routinely to carry out specific observing programs, for example, covering several lines of a given stage of ionization, observing lines or continuum from specific species of interest such as helium in prominences, comparing combinations of lines from a given ionic species such as O V where the relative intensities give a rather direct measurement of the density at a given temperature, or measuring differing positions in the Lyman continuum providing intensity measurements which can be interpreted in terms of the departure from ionization equilibrium.

There are a diversity of experimental modes available both through remote instrument operation from the ground and through astronaut operation at the ATM control console. The modes include wavelength scans of selected solar features, and rasters covering fields of view of 5″ × 5′, 1′ × 5′, and 5′ × 5′. Time resolutions from 0.040 s to 5.5 m are provided in the range of modes.

Figure 1 shows a set of observations in the first polychromatic grating setting covering the excitation range from the Lyman series to Mg X, taken near the center of the Sun on May 29, 1973. The photographic presentations are converted to a 64-level grey scale from the numerical data. The chromospheric network can easily be seen

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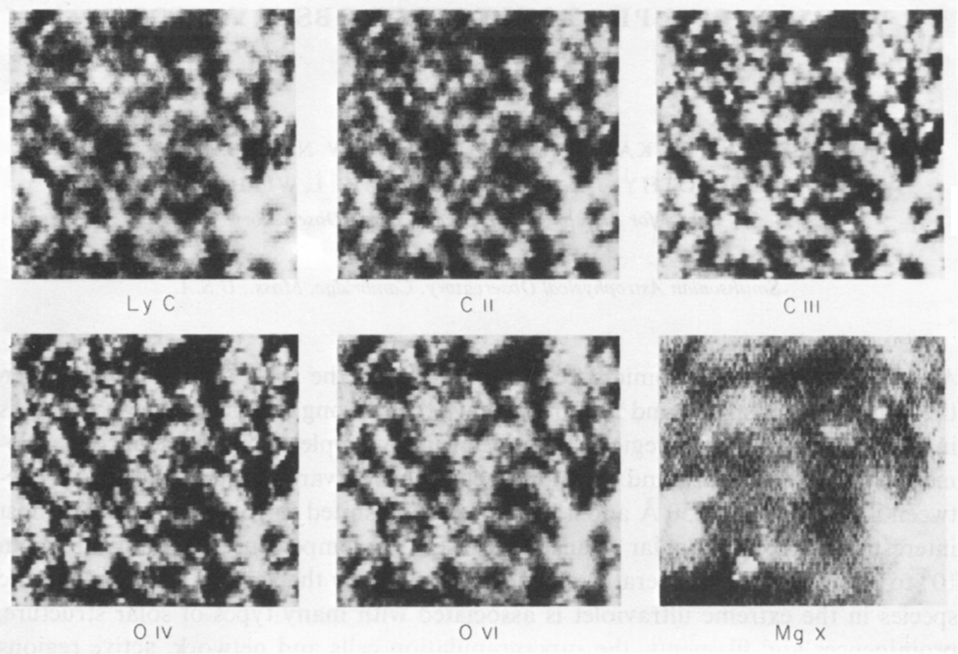
Gordon Newkirk, Jr. (ed.), Coronal Disturbances, 497–500. *All Rights Reserved.*



Ly C C II C III

O IV O VI Mg X

Fig. 1.

extending almost unchanged, except in contrast, from the Lyman continuum at 10^4 K through the resonance lines of C II, C III, O IV, and O VI. Between the temperature of 3×10^5 K characteristic of O VI and the 1.5×10^6 K temperature of formation of Mg X there is an abrupt change in the observed network structure with height. In Mg X the chromospheric network is almost totally unrecognizable, although in some places remnants can be seen to remain if the network is followed up the temperature sequence from below. The similarity in structure observed from the middle chromosphere through the transition zone lines suggests that the magnetic field pattern in the network must be essentially vertical through temperatures as high as 3×10^5 K. After this temperature, there is a rapid onset of some change, markedly affecting the progression of intensity with height in the solar atmosphere and smearing the structure laterally. Examination of the data shows that the network observed in the chromosphere and transition zone exhibits a strong correlation with the CaK network observed from the ground, and that the contrast between the network and the centers of the supergranulation cells increases with excitation energy, reaching a maximum in lines such as C III, O IV and O VI where the enhancement between the network and the central portion of the cells is a factor of 10 to 15.

Figure 2 shows a photographic presentation of the data obtained during a raster made at the northeast limb of the Sun on June 10, 1973, at approximately 1146 GMT in the light of Fe XV 417 Å, formed at a temperature of about 2.5×10^6 K in the solar corona. Both the solar disc and the corona some 4′ above the limb are quite low in intensity while the lower corona and the active region loop appear more intense. The active region under these loops did not appear on the limb until the following day. The loops are persistent structures, frequently interconnecting active regions or other magnetic regions of opposite polarity. While the loops can be seen most clearly on the limb from O VI to Fe XV they can also be seen on the disk in many EUV lines, perhaps the most clearly in Ne VII 465 Å, formed in the chromosphere to corona transition zone. In the coronal loop the enhancement in Fe XV is about 5 times the corona at the same height. Assuming that the loop has cylindrical symmetry, it is possible to imply a density increase of about an order of magnitude over the quiet corona. Even in the farthest regions of the corona at the edge of the raster, the average coronal intensity, while still a factor of 30 below the corona at the height of the loop, is at least 10 times the background scattered light and detector noise level in the instrument. The Fe XV line at 417 Å is optically thin and it can immediately be seen from the picture that the

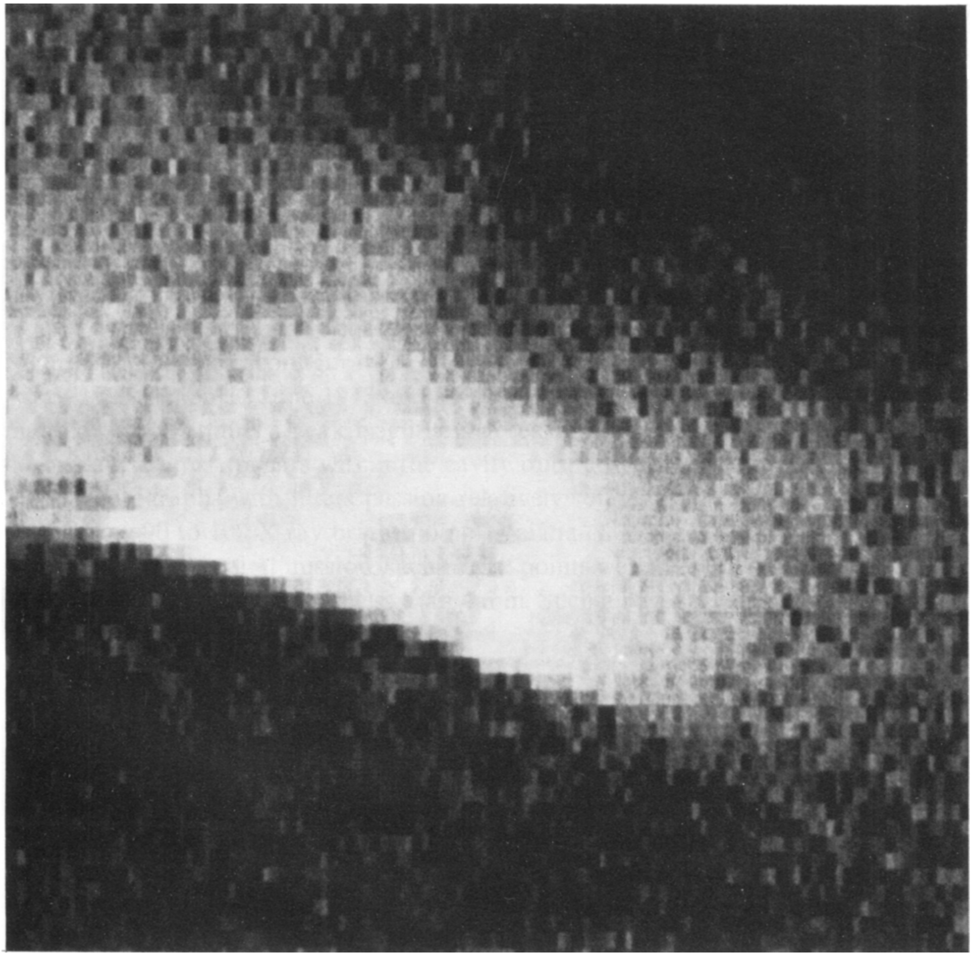


Fig. 2.

Fe XV does not exist as a thin shell surrounding some cooler material but rather is of almost uniform density. Analyses are in progress to differentiate the density structure for different types of loops observed, determine their temperature, and observe the way in which the feet of the loops are imbedded in the active regions.

The use of photoelectric detection and the availability of accurate intensity data from a series of calibration rocket flights will enhance the capability to interpret the data in terms of physical parameters in the solar atmosphere. The resolution of the HCO instrument together with the simultaneous observations of the other ATM instruments covering a wide range of excitation energies, when coupled with the supporting ground-based observations frequently undertaken in the Coordinated Observing Program, should provide a number of new insights into some of the outstanding problems of the solar atmosphere. The Harvard instrument will also acquire data on Comet Kohoutek, absorption properties of the upper atmospheric layers of the Earth, and observations during the transit of Mercury on November 10, 1973.