Simultaneous Hard and Soft X-Ray Observations of Impulsive Flares: Evidence For Acceleration by Quasi-Static Electric Fields


Simultaneous observations of hard X-ray and soft X-ray line emissions at high time resolution (1.5 sec) from SMM are used to determine the interaction between the acceleration and heating of electrons and ions during impulsive solar flares. The study involves five flares (three disk and two limb flares). It is shown that for all the flares, the hard X-rays have a two-slope power-law spectrum which breaks downward at about 100 keV during the rise phase and beginning of the decay phase, after which the spectrum changes to either a single-power-law or a power law which breaks-up at about 100 keV. These characteristics of the hard X-ray spectra can be accounted for by assuming that quasi-static electric fields are in part driving the electron acceleration with the break energy being fractionally smaller than the potential drop between the corona and chromosphere. Additional evidence for the presence of such fields comes from the evolution of the soft X-ray line emissions. For the three disk flares, the line emissions show a blue-shifted component (arising from upward acceleration of ions into the corona) with the maximum inferred velocity reaching its peak value during the decay phase when the hard X-ray spectrum changes from one which breaks down to one which breaks up. The outflow velocity is not correlated with the hard X-ray flux, contrary to predictions from evaporation models. For limb flares, the soft X-ray line emissions show only a non-thermally broadened stationary component (arising from acceleration and heating perpendicular to the magnetic field); this broadening reaches a maximum at the hard (\( \geq 30 \) keV) X-ray peak rather than during the decay phase. This difference in timing relative to the hard X-rays of the strongest broadening and blue-shifts can most easily be explained by assuming that the same electric field producing the downward acceleration of the electrons is also driving the ion acceleration both along the magnetic field, to produce the blue-shifted component seen in the disk flares, and across the magnetic field, to produce the broadening seen in limb flares.

66.03

Velocity Distribution within a Jet and the Ca XIX Line Profiles Observed by SMM's EBS

P. L. Bornmann (NOAA/SEL and Univ. Colo.)

During the rise of the soft X-ray flare emission, the resonance line of Ca XIX exhibits a strong blue shift and excess line broadening. Although these line profiles can be reproduced using multiple blueshifted gaussians, alternate fluid flows are considered. The simple fluid models representing the flow of material in a jet and through a pipe are considered. In both models, the velocity at each location in the flow is calculated from analytic expressions, which are then convolved to velocity distributions and convolved with a thermal Maxwellian distribution to produce theoretical line profiles. These theoretical profiles are then compared with Ca XIX line profiles observed by SMM's Bent Crystal Spectrometer. Reasonable agreement is found with the jet model, while the pipe model is unable to reproduce the observed line profiles. The optimal values for the free parameters in the jet model are found to lie within the ranges expected for solar flare conditions.

66.04

Coronal Dark Lanes and the Location of Transition Region Explosive Events

D. Moses (BSEC), J.W. Cook, J.-D.F. Bartoe, G.E. Brueckner, J.F. Dere (WPL) and J.H. Davis (NASA/MSFC)

On 11 December 1987 collaborative sounding rocket flights of the AS& E X-Ray Imaging Solar Sounding Rocket Payload with the NRL High Resolution Telescope and Spectrograph (HRTS) instrument simultaneously observed coronal and transition region structures. Coronal regions of reduced brightness within quiet areas, which are physically distinct from filament channels or well-developed coronal holes, were recognized in soft X-ray images. These coronal dark lanes are associated with weak magnetic field regions of apparently mixed polarity. In contrast, filament channels are associated with magnetic neutral lines and well developed coronal holes are associated with unipolar magnetic regions. The dark lanes are narrow, elongated structures. No Si or He I 10830 Å filament was observed at the location of the coronal dark lanes. Network weakening is observed in the He I 10830 Å images at the location of the coronal dark lanes, but to a lesser extent than the weakening observed at the location of the polar and mid-latitude coronal holes present on the same day. Attention was drawn to the coronal dark lanes during comparison of the coronal X-ray images and the transition region data obtained by the NRL HRTS instrument. The HRTS spectrograph raster area included a region identified as a coronal dark lane in the X-ray image. The transition region C IV 1550 Å explosive line identified in the spectrograph raster are preferentially clustered within the coronal dark lane.

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66.05

ComSTOC I: Physical Properties of an Active Region Loop Observed at the Solar Limb


The results of an analysis of simultaneous soft X-ray, 6-cm and 20-cm microwave, and magnetograph observations of an active region loop on the solar limb are presented. These observations were taken as part of the Coronal Magnetic Structures Observing Campaign (ComSTOC), a collaboration designed to study the magnetic field in the solar corona. The ~100,000 km long loop is found to be strongly asymmetric, with the magnetic field in the northern leg ~2 times stronger than in the southern leg. The 6-cm emission most likely arises from a combination of hot (~2 x 10^6 K) and cool (~900,000 K) plasmas, while the 20-cm emission becomes optically thick in the cooler plasma. A potential field extrapolation of the photospheric magnetogram gives a coronal field strength which is somewhat lower than that required to explain the observed polarization of the 6-cm emission. We estimate an Alfven speed ~7,000 km/sec and ratio of electron gyroradius to plasma frequency ~1.0 in the northern leg of the loop.

66.06

The Ultra High Resolution XUV Spectroheliograph


We describe a space borne solar observatory, the Ultra High Resolution XUV Spectroheliograph (UHRXS), which has been selected by NASA for flight among the initial scientific instruments to be placed on the space station "Freedom". The principal instruments are nine XUV multilayer Ritchey-Chretien Telescopes covering the spectral range from ~70 Å to ~350 Å; each telescope is able to isolate line multiplets within a narrow wavelength interval which are excited over a narrow temperature range, providing full disk images of diagnostic quality covering structures in the solar atmosphere ranging in temperature from T = 50,000 K (He II λ 304 Å) to 20,000,000 K (Fe XXV λ 193 Å). These images are recorded on high resolution 70 mm format film, allowing resolutions as high as 0.1 arc sec to be achieved for a 1.0° field. The XUV images will be supplemented by (i) full disk high resolution (~0.1") far ultraviolet images in H I Ly-α (1216 Å) and