Los Rios Junior College

Final Report

The following studies were supported, at least in part, by NASA Grant NGR 05-084-002:

A study was made of the hard X-ray component in the impulsive phase of solar flares. In 36 randomly chosen events the value for the slope in differential electron power spectrum, $E^{-\delta}$ electrons $cm^{-2}S^{-1}keV^{-1}$, was related to the 20-32 keV spike rise time (e-folding) as $t_{rise} = 0.56 \exp (0.88\delta)$ in the thin-target model and $t_{rise} = 0.10 \exp (0.88\delta)$ in the thick-target picture. In the thin-target model, the above empirical relation would imply that the acceleration of electrons can last longer when the acceleration rate is smaller. An alternative interpretation would be that an impulsive hard X-ray burst is a superposition of two components emitted from thin and thick targets; when the former predominates the duration is longer and the photon spectral index is larger, and vice versa.

No center-to-limb effect was observed when 1094 soft x-ray flares (detected by OSO-7) and 766 soft events (from OGO-5) were plotted separately as a function of solar longitude. Some peaks were present in the longitude distribution of 360 hard events from OSO-7, but they did not prove to be statistically significant; all deviations were less than 3σ from the mean. A chi-square test was done comparing the hard x-ray empirical results with the distribution expected from Brown's thick target (including both scatter and scatter-free cases) and from the Compton backscattering models, but best agreement was obtained when the frequency of hard x-ray flares was assumed to be independent of longitude.

Hα flare coordinates were used to determine the type of sunspot group most likely to produce soft x-radiation. The most efficient x-ray flare producers at both hard and soft wavelengths were those regions having one polarity at least partially surrounded by bright plage of opposite sign and normally including several closely-spaced spots of mixed polarities, i.e., the Mt. Wilson $\beta\gamma$ and δ types. Although new isolated flux regions normally had several soft x-ray bursts per hour, the events were never large nor was there ever an associated hard x-ray flare with energy above 20 keV observed. Finally soft x-ray emission (long-lived but weak) was associated with variations in the Hα plage intensity of a region but was not observed at the time of a surge unless there was some accompanying bright Hα emission. Hard x-rays were never observed during a surge unless intense Hα flare kernels were present.

Coronal magnetic field characteristics resulting from new photospheric flux was determined. Data from the S-056 Marshall/Aerospace experiment on Skylab were compared with magnetograms from Sacramento Peak Observatory and from Kitt Peak National Observatory. Briefly, the instrument is an x-ray telescope which produced high resolution images of the sun in the soft x-ray region between 6 and 40A. The shape and location of the x-ray emitting structures strongly suggest a magnetic influence. For example, x-ray bright features are frequently linear, bridge and the local neutral lines, and often take the form of arcades or clusters of arches which suggest the matnetic field of a bipolar region. We show the change in x-ray structures associated with photospheric field growth and decay in several regions, including that near active region #209 on September 1-4, 1973. Analysis yields the following conclusions regarding soft x-rays and changing photospheric fields: 1) the emergence of new flux in the photosphere is followed within a few hours by significant soft x-radiation; the latter consist of one or more low-lying bright linear features positioned across the neutral line and enclosed by an envelope of higher, fainter loops at lower temperatures; 2) when the photospheric field decreases or polarities separate, the corresponding x-ray structures become diffuse and lose their sharp definition within hours after the photospheric change; and 3) although linear x-ray features connect active regions with bits of polarity in the surrounding photosphere, these x-ray striations are never as bright or as distinct as those associated with new, concentrated bipolar fields.

The following presentations were supported, at least in part, by the NASA grant:

1) "Electron Acceleration During the Hard Phase of Solar Flares," given at the Calif. Inst. of Tech., Solar Neighborhood Meeting, December 1973.

2) "Longitude Distribution of Solar X-radiation From OGO-5 and OSO-7: Hard and Soft Energies", given at American Astron. Soc. Solar Meeting, Hawaii, January 1974.

3) "Electron Spectrum Vs 20-32 Kev X-ray Spike Rise-Time," given at IAU/COSPAR Meeting in Buenos Aires, June 1974.