THE EUV CONTINUUM EMISSION (1400–1960 Å) IN A SOLAR FLARE OBSERVED FROM SKYLAB

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Abstract. The total radiative output in the EUV continuum (1400–1960 Å) from the 5 September 1973 flare has been obtained from the EUV spectra of the flare observed with the NRL slit spectrograph (SO82B) on Skylab. The radiative energy in the EUV continuum is of the order of $10^{29}$ ergs, which is more than a factor of 2 greater than those radiated in soft X-rays (8–20 Å) and in Hα for the flare. Thus, the EUV continuum emission is an important radiative energy loss, and should be included in the consideration of the energy balance of the flare.

1. Introduction

Among the wide range of electromagnetic radiations emitted in solar flares, the EUV regions are important for the study of low-temperature plasmas in flares. Of particular interest are the continuum emissions in the wavelength region from 1400 to 1960 Å. These continuum emissions originate in the upper photosphere and lower chromosphere in the flares and therefore represent the response of the deeper layers in the flare to either the energy input from above in the corona (Najita and Orrall, 1971), or to local heatings due to energy release in situ (Machado and Linsky, 1975). Information on the total radiative flux in the EUV emissions and its time changes is important for the understanding of the heating, cooling, and dynamic behavior of the lower atmospheres in the flares. So far such information has not been available.

During the Skylab mission, a number of flares were observed in the EUV region by the NRL normal-incidence slit spectrograph (SO82B). We have studied the continuum emissions from 1400 to 1960 Å for the 1973 September 5 flare. We present here the absolute intensity in the EUV continuum, its temporal variations, and the comparison with the continuum intensity in a background region in the same active regions. Also the total radiative flux is obtained, including contributions from both the continuum and emission lines. The 5 September 1973 flare has been chosen for the thermal radiative output project in the Skylab Flare Workshop for the wide-range coverage available in the many wavelength regions from X-rays to near infrared. The purpose of the project is to determine the relative importance of energies emitted in different wavelength bands for the same flare.

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2. Observations

The 5 September 1973 flare was a Sn flare, which occurred in the McMath region 12510 at N 11 E 04 on the solar disk. The region, during its passage across the solar disk, was prolific in flare production. The soft X-ray (2–8 Å) in the flare, measured by the SOLRAD-9 satellite started to increase at 1828 UT, reached a broad peak at 1831 UT, and decayed in about 10 min to its preflare values (Dere, 1977). Observations of the flare were made with the many solar instruments on Skylab, and the results in XUV have been discussed by Cheng and Widing (1975) and by Dere et al. (1977) – in X-rays, by Vorpahl (1976). The EUV spectra of the flare were taken by the NRL slit spectrograph on Skylab. The analysis of the EUV emission line spectra of this flare has been presented by Cheng (1978). The NRL slit spectrograph had a resolution of 0.06 Å and a projected area of 2" × 60" (1450 km × 43 500 km) on the Sun. A complete description of the instrument has been given by Bartoe et al. (1977).

The first EUV spectra of the 5 September 1973 flare were taken at 1831 UT, at the soft X-ray maximum, and exposures were made subsequently with different exposure times through the decaying phase. For accurate determination of the intensities in the continuum, longer exposure times are required. For this reason, spectra with 40 s exposure taken at the flare maximum (1831 UT) and spectra with 40 s and 160 s taken 10 min after at 1841 UT in the postflare phase were chosen for analysis. In order to subtract the contributions from the background continuum emissions, spectra for a quiet region in the neighborhood of the same active region obtained on September 3 were used.

Figure 1, taken from Cheng (1978), shows the slit positions of Hα pictures when the spectra were taken. The Hα pictures were obtained with the on-board Hα telescope. As can be seen from the figure, the flare consists of two ribbons in Hα at 1831 UT. The two ribbons coincide with the two ribbons observed in the many emission lines in the XUV with temperatures from 5 × 10⁵ K to 2 × 10⁶ K (Cheng and Widing, 1975). As has been discussed by Cheng and Widing (1975), the two ribbons represent the two footpoints of a loop which is anchored on regions of opposite magnetic polarity. The EUV emissions therefore come from the deeper regions in one of the footpoints.

3. Absolute Intensities and Brightness Temperatures

The optical densities were converted into absolute intensities by employing absolute calibrations from exposures obtained with a calibration rocket flown on 1973 September 4. The calibration is estimated to give measured absolute intensities an accuracy of ±35% (rms). Detailed descriptions of the calibrations of the NRL spectrograph have been given by Brueckner et al. (1976) and by Kjeldseth Moe and Nicolas (1977).

As shown in Figure 1, the spectrograph slit, which is 60 arc sec long, covers large areas outside the Hα ribbon. Thus, in reducing the flare intensity, a filling factor of...