ABSTRACT. We present some preliminary results of simultaneous monitoring of the two flare stars, UV Ceti and EQ Peg with EXOSAT and ground based optical spectroscopy. A strong correlation, found between the $\text{H}_\alpha$ emission and the soft X-ray flux, over several hours of observation of UV Ceti, suggests that much of the low level X-ray flux which has previously been considered 'quiescent', in fact derives from small flare events. The implication is that coronal heating in M type dwarfs may result directly from the frequent occurrence of micro-flares.

INTRODUCTION

As part of a coordinated campaign of multiband observations of stellar flares, (Rodono, et al. 1985), we observed UV Ceti and PQ Peg on 6 December 1984 and 7 December 1984 respectively with ground-based optical telescopes, and with the two satellites IUE and EXOSAT. Included amongst several optical telescopes, was the 3.6 metre of the European Southern Observatory, with which intermediate dispersion spectroscopy of the region 3600-4400Å was obtained, with the Image Dissector Scanner on the Roller and Chivens Spectrograph. Exposures were of 60 seconds duration with a short delay of approximately 10 seconds between spectra. Whilst this data has not yet been fully reduced it was possible to determine, in real time, an uncalibrated peak flux value at the wavelength of the $\text{H}_\alpha$ emission line. The variation of this peak value will be due, predominantly, to the $\text{H}_\alpha$ emission line, however, continuum variations will also be included. In the case of UV Ceti, although EXOSAT observations were made from 02.00 to 10.45 UT on 6 December 1984, only the first three hours were covered from ESO.

DISCUSSION

The X-ray photon counts detected by the CMA with the thick lexan (4000Å) filter have been extracted from the EXOSAT Final Observation Tape using the reduction package at Mullard Space Science Laboratory, University College London. In the upper panel of figure 1 we show the soft X-ray (0.1-2 KeV counts in 10 second bins. Some gaps are present in the data where data transmission, or small solar flares, have caused the exposure time to drop below 80 percent of the nominal value (10 secs).
In the second and third panels of figure 1 the X-ray data has been binned in 30 second and 60 second bins respectively, and in the lower panel, the peak HY flux is shown.

Several features are noticeable in figure 1. Firstly, the X-ray emission appears to be quite non-uniform, with frequent rises of a factor of two or three in flux, which last for periods of a few tens of seconds to several minutes. A number of isolated 10s peaks also occur but these are not more common than expected from Poissonian statistics. However, the rather longer duration 'events' are retained when the bin size is increased, implying that they are genuine fluctuations. Further evidence of the reality of these relatively small events is provided by the comparison with the times of HY events. It is evident that 5-6 of the X-ray events correspond to similar rises in HY peak flux. The correlation coefficient between the data points used to construct the two lower panels of figure 1 is 0.51, or a Student t value of 7.0. For 143 data points this implies a highly significant correlation, between the EXOSAT and HY data with a probability of occurrence by chance of less than one in 10^6.

Accepting that the events seen in the X-ray flux and HY are real, we conclude that they are in fact small flares, which like flares on the Sun, give rise to increased X-ray flux accompanied by Balmer line emission. However, in the Sun, both the soft X-ray events and the Balmer line enhancements, last rather longer than the events on UV Ceti. If we assume that the distance of UV Ceti is 2.62 parsecs (Pettersen, 1974), the energy emitted in low energy X-rays varies from around 0.5 to 5 x 10^30 ergs, which is similar to the energy of compact solar flares.

In figure 2 we show the dataset for EQ Peg obtained the following night. Here again we see evidence for an almost continuously variable soft X-ray flux followed by a substantial LE (soft X-ray) flare on EQ Peg which was detected by the ME (medium energy) experiment. This flare lasted for approximately 90 minutes with a gradual rise and fall in LE and a more sudden rise in ME. A preliminary analysis of the integrated ME data for the event gave, for effectively zero column density of hydrogen, a mean temperature of 2.2 x 10^7K. If we adopt the standard calibration of the EXOSAT detectors (EXOSAT Observers Guide, Part III), and a distance for EQ Peg of 6.41 parsecs, (Pettersen, 1974), the total integrated X-ray energy of the flare on EQ Peg is 6 x 10^32 ergs in LE (0.1-2 KeV). This corresponds to the energy of a large two-ribbon Solar flare.

In conclusion our data on UV Ceti and EQ Peg suggest that the soft X-ray emission of these stars is almost continuously variable with many surges or micro-flares lasting from tens of seconds to several minutes. These micro-flares, which have energies of approximately 2 x 10^30 ergs in the 0.1-2 KeV range, are similar to compact solar flares, but possibly more short lived. The fact that these micro-flares occur so frequently in the two dMe stars studied is suggestive that the concept of a 'quiescent' corona for these stars may be erroneous and that we are in fact seeing, not a quiet, unevent-