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OPTICAL AND UV OBSERVATIONS OF SPOTTED STARS

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A programme of optical and UV study of flare stars has been going on at Armagh Observatory over the past few years in collaboration with JILA, University of Colorado and Catania Observatory, Italy. Some early results were previously reported at one of these meetings (Byrne, Butler and Andrews 1980 and references therein). As an extension of this work observations have been made both optically and with the IUE satellite of a number of the closely related BY Draconis variables.

The BY Dra variables are all known to be flare stars. Their characteristic feature is that they exhibit periodic photometric variations, usually on a timescale of a few days. The phase, amplitude and even the mean brightness of the photometric waves are variable from season to season. The usual interpretation is in terms of starspots, analogous to sunspots, which rotate with the body of the star and thereby cause the observed variability (for more details see the review by Vogt 1983). Using sunspots as a model for the starspots, we expect them to have large associated magnetic-
field structures. As in the Sun, these fields will give rise to enhanced heating of the overlying chromospheres, transition regions and coronae. Therefore, strong line emissions are to be expected in the X-ray and UV parts of the spectrum.

From 3rd–6th August 1980 a coordinated series of optical and satellite UV observations were made of the flare/BY Dra star AU Mic over most of its 4.8 day period. Spectra were taken alternatively in each of the IUE satellite’s two sensitive regions i.e. SWP(1150–1950Å) and LWR(1900–3200Å). Exposure times were mostly 180 and 30 minutes respectively. The spectra were time-resolved however, with between 3 and 6 discrete exposures being made in SWP and a continuous trail in LWR. This was in an attempt to detect any flares which might occur during the exposures.

Figure 1. Optical light curve of AU Mic (a) in 1971 (Torres et al 1972), (b) in 1979 (Byrne, unpublished) and (c) in 1980 (Rodonò, unpublished); open circles are derived from IUE FES measurements.
Groud-based optical observers in a large number of countries cooperated in an effort to achieve complete coverage. The actual coverage achieved was remarkably poor however, illustrating the difficulty of achieving such an aim. The resulting optical light curve is shown in Figure 1 along with those at two previous epochs. The upper curve is due to Torres, Ferraz-Mello and Quast (1972) and that in the middle is from unpublished work by the present author. A dramatic evolution of the light curve is evident between the two epochs. The lower curve is a combination of ground-based photometry (Rodonó, private communication) and magnitudes derived from an unfiltered photometer on board the satellite (FES). The vertical lines through the

![Graph](image)

**Figure 2.** Variations in AU Mic UV line fluxes as function of photometric phase.
ground-based points in the 1980 data are error bars. It will immediately be seen that the photometric behaviour of AU Mic during the satellite run was far from the simple rotational modulation recorded in 1971. Four optical observers achieved a total of only 21 hours of monitoring for flares and in that time recorded at least 9 flares. Thus at the time of our observations AU Mic flared approximately once every 2.3 hours.

Figure 2 shows the variation in line strengths of some of the principal chromospheric lines with phase. As in the optical curve, there is no clear evidence for cyclic behaviour. Indeed the fluctuations about the mean for the lines CIV(λ1549) and HeII(λ1640) are larger than we would expect from errors of measurement. In addition, a number of larger excursions are visible. We interpret this as follows. From optical flare monitoring we recall that AU Mic flared at least once every two hours during the scant optical coverage available. So on the time scale of the IUE SWP exposures (∼3 hours) AU Mic could be regarded as in a state of continual flaring activity. Thus the fluctuations in the strengths of the chromospheric lines can be interpreted as due to this activity, masking any underlying 4.8-day, spot-related variation.

Further details of this work will be found in Linsky et al (1982) and Butler et al (1983) and analysis of the data is continuing.

References


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