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THE ACTIVE STAR RE0041+342

The sky was surveyed in the extreme ultraviolet by the satellites ROSAT (Pounds et al. 1993) and EUVE (McDonald et al., 1994) and from the catalogues of these sources I have been looking for brightness variations in the F, G, and K spectral type stars. This is a report about one of these stars namely RE0041+342=BD+33°94.

The automated 0.5-m. telescope, R filter and CCD camera of the Climenhaga Observatory of the University of Victoria was used to make these photometric observations (Robb et al., 1992).

The frames had the bias subtracted and were flat-fielded in the usual manner using IRAF. The magnitudes were found from aperture photometry using the PHOT package of DAOPHOT (Stetson 1987). The coordinates of each star for photometry were found from inspection of a few frames taken at the beginning, middle and end of the night. These positions were used as initial positions for the Gaussian centering option which precisely centered the 6 arc second aperture on each star for each frame.

The mean and standard deviation of the comparison=BD+33°95 minus check star R magnitude differences are 3.437 ± 0.017 ensuring the constancy of both stars at this level. Due to the small field of view first order extinction effects were negligible and no corrections have been made for them. No corrections have been made for the colour difference between the stars to transform it to a standard system.

A spectrum of RE0041+342 was obtained using the Dominion Astrophysical Observatory's 1.8-m. telescope and 2131B spectrograph on the 6 January 1994 UT, with a dispersion of 1.5 Angstroms per pixel. It is shown in Figure 1 with a spectrum of HR 1099, a well known RS CVn star of spectral type K0V, and a spectrum of Beta Cancri, classified as K4III (Yamashita et al. 1978). Pounds et al. (1993) report a spectral type of Ge. RE0041+342 has obvious emission in the Ca H and K lines indicating an active chromosphere. This emission would tend to make one cautious about using the hydrogen lines to make a classification, since such an active star often has some hydrogen emission as well. Inspection of the G-Band and the Fe I 4272 and Cr I 4290 lines lead me to classify the star as a K3Ve.

Photometric observations of RE0041+342 were begun on Julian Date 2449315 and are plotted in Figure 2. It is obvious that there was a large brightening of the star at 4 hours UT. This star was monitored on 23 nights and at no time was a similar brightening observed. The cause of the brightening then must be a large flare. UV Ceti type flare stars have a spectral type of late K or M and flares generally of a few minutes duration but small amplitudes in the red region of the spectrum.

Very energetic flares have been seen on the close binary star V711 Tau = HR 1099, by Zhang et al. (1990) reporting an amplitude of 0.18 in V and a duration of 4.5 hours and by Henry and Hall (1991) reporting an amplitude of 0.424 in V and a duration of 6 or 7

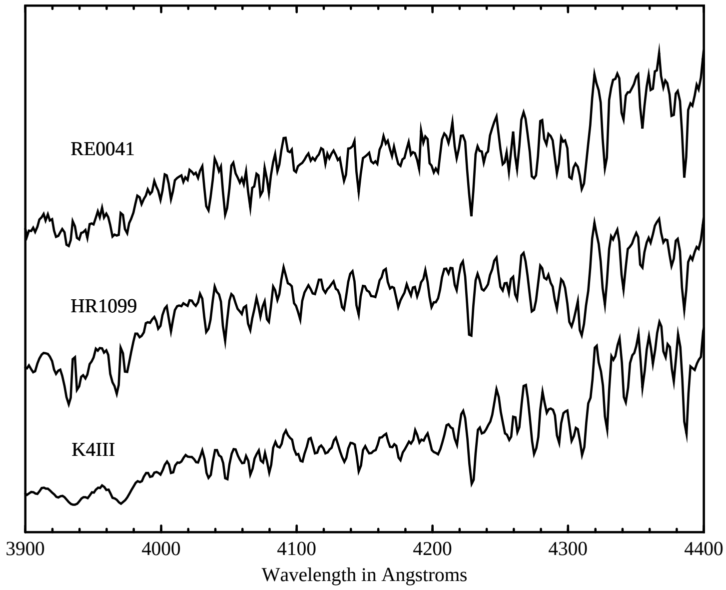

Figure 1. Spectra of RE0041+342, HR1099, and Beta Cancri

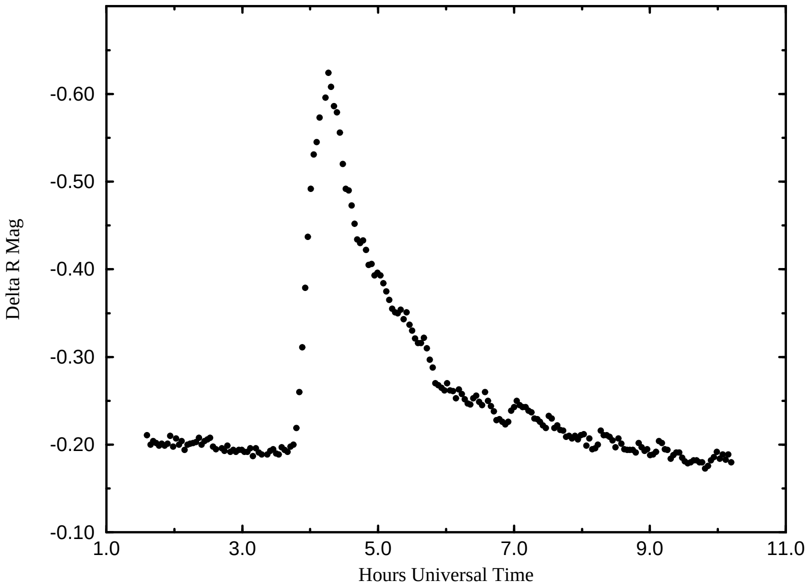

Figure 2. Differential R magnitude as a function of Universal Time for RE0041+342 on 24 Nov 1993

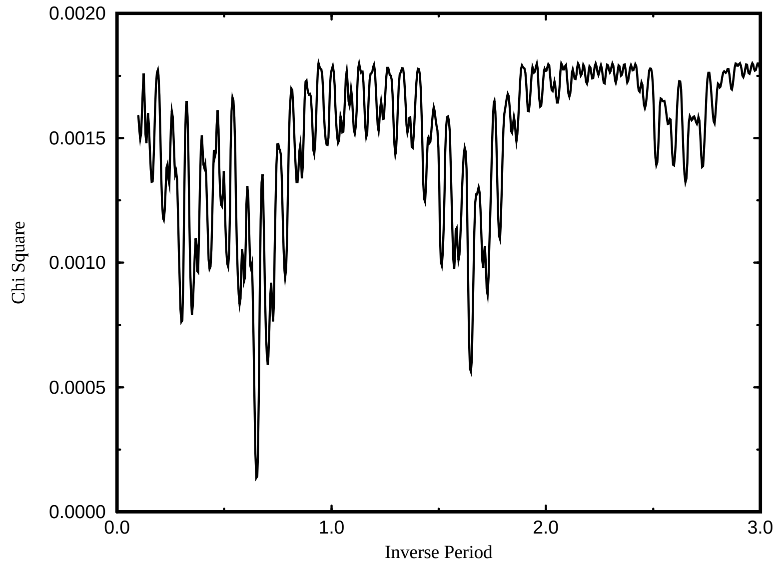

Figure 3. Periodogram of the August 1994 data

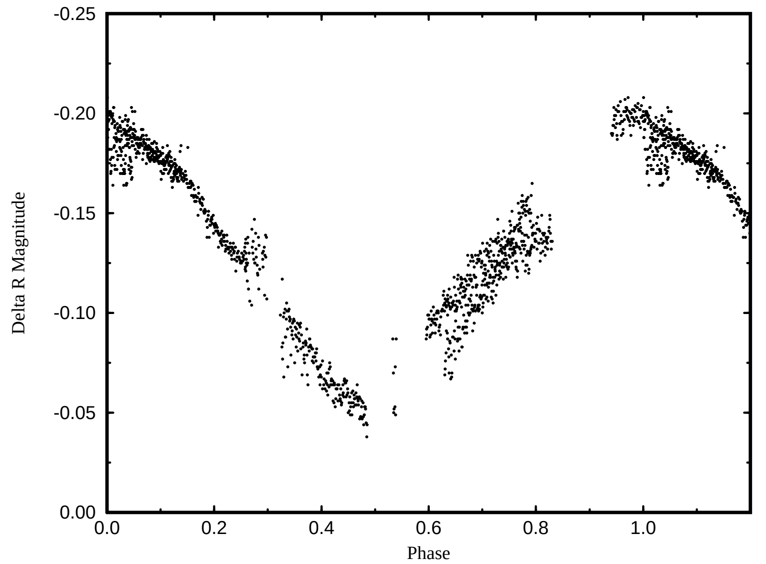

Figure 4. Differential R magnitude phased on a period of 1.536 days for August 1994

hours. An even larger flare may have been the one seen on FK Comae (G2III) reported by Morris and Milone (1983). The R band amplitude of the flare on RE0041+342 was 0.39 magnitudes and its duration was about 3 hours. Thus the flare observed on RE0041+342 was exceptionally large but not unique.

During the winter of 1993-1994 variations of brightness from night to night were obvious and the few long nights showed that the period of the variation must be more than a few hours. However periodograms of this data were inadequate to reveal a believable period. Observations were made on eight more nights in the summer of 1994 and a sine curve fit to this data reveals a minimum chi squared at a period of 1.536 ± 0.025 days as seen in Figure 3.

A plot of the differential R magnitudes for the summer 1994 data phased at this period is shown in Figure 4. In spite of six of the nights being observed in one week, there is some variation in the mean brightness from night to night. The winter data phased on this period show a similar light curve with a slightly different shape. Three more nights were observed in September 1994 and showed no detectable variation and a mean difference in R magnitude of -0.14. So the variations are probably caused by starspots and differential rotation or spot evolution cause the brightness variations to change on a monthly time scale. Since the brightness variations are not strictly periodic, the period found is only approximately that of the rotation of the star.

RE0041+342 is a rapidly rotating K4V star with active regions on its surface causing brightness variations, EUV emission, Ca H and K emission, and flares. The author wishes to thank David Balam for assistance in obtaining the spectra at the DAO.

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