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UBV PHOTOMETRY OF HR 1099 IN 1992

The chromospherically active binary HR 1099 (= V711 Tau= HD 22468) is one of the most interesting objects of RS CVn-type and has been observed intensively across the electromagnetic spectrum since its giant radio outburst was detected in 1978 (Feldman 1978). Recently, two extraordinarily strong optical flares were discovered independently by Zhang et al. (1990), Cutispoto (1990), as well as Henry and Hall (1991), on 1989 December 14/15 during the MUSICOS (Multi-site Continuous Spectroscopy) campaign. It gives not only the first strong indication that large broad-band flares do occur on these binary stars with evolved components more luminous than the Sun, but also shows that the star HR 1099 may happen to be in its current active phase. To monitor photoelectrically the variations of light curves and to detect possible flares over the years ahead are, therefore, of obvious importance in our effort to understand this active system better.

In co-ordination with the MUSICOS 1992 campaign, UBV photometry was carried out with the 60-cm telescope and the single channel photon-counting photometer at Beijing Astronomical Observatory from November 15 to December 15 in 1992. The star 12 Tau and 10 Tau were adopted as the comparison and check star, respectively. A total of 79 UBV observations were obtained on 7 nights. The observational data were transformed into the standard Johnson UBV system. The following ephemeris (Fekel 1983) was

$$T_{conj.} = J.D.(hel)2442766.080 + 2.^{d}83774 \cdot E$$

employed to combine all U, B and V observations into complete light curves as shown in Figure 1.

Despite their large scatter, the light curves did show some flare-like variation in U in excess of 0.055 mag on December 14/15, but exhibited no significant variation in B and V at or near the same phase. On the night of December 14/15 the accuracy of the differential photometry between the comparison and check stars was found to be $\sigma \sim 0.005$ mag in V,

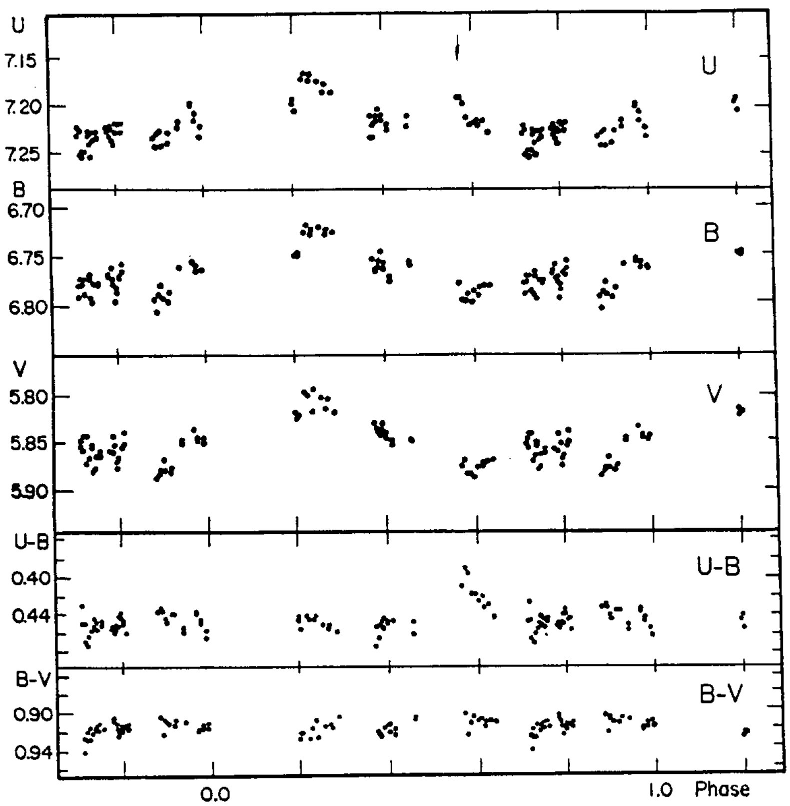

Figure 1. UBV light and color index curves of HR 1099 in 1992

0.009 mag in B, and 0.018 mag in U, respectively. On the remaining nights the sky was also good enough for the photoelectric observations. The large dispersion of the observations seems to be some special photometric behavior of HR 1099. It was found that, for the other binary systems observed for light variability during the same season, the results did not show such large scatter as was the case for HR 1099.

The amplitude of the distortion wave of HR 1099 was observed to be about 0.075 mag, only slightly smaller than that in 1989. However, there were two striking changes in the light curves of HR 1099 as compared with those secured in 1989. First, the average brightness of HR 1099 is derived to be V= 5.85, some 0.07 mag fainter than that in 1989 and approaching the faintest brightness recorded for HR 1099 in 1978 (cf. Dorren et al. 1986). As a result the maximum brightness

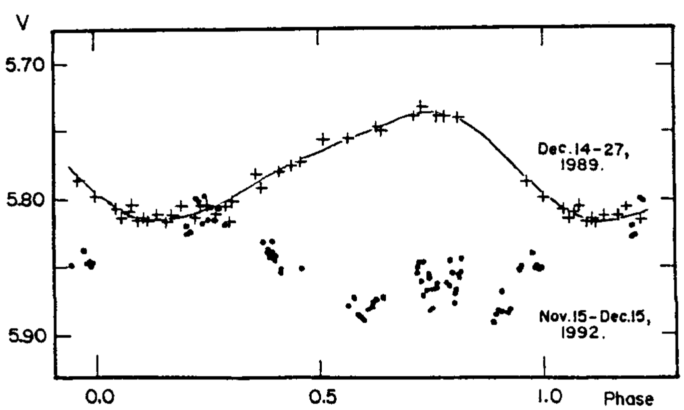

Figure 2. A comparison between the two V light curves of HR 1099 obtained in 1989 and 1992. The symbols '+' denote the combined points of observations in 1989 and the solid line is the theoretical light curve. Dots represent the observations in 1992.

of our 1992 light curve is found to be close to the minimum brightness in 1989. The second marked change is that, as is evident in Figure 2, both the maximum and the minimum light phases of the distortion wave in 1992 have shifted to some locations far away from those in 1989 . The 1992 V light curve looks indeed somewhat like a mirror image of the 1989 curve. Such major changes could be perhaps caused either by the migration of the distortion wave or by the possible large-scale re-distribution of spot-active region on stellar surface. As far as wave migration is concerned, it needs to be checked whether it has been moving towards decreasing or increasing phase. But the migration rate of distortion wave can be estimated simply by the phase differences between two minima or maxima of the light curves obtained in 1989 and 1992. It turns out to be ~ 0.17 phase per year, corresponding to a migration period of some 5.9 years. This indicates that the spot region was located in the latitude zone with a local rotation speed different from that of co-rotation. The striking decline of the average brightness of the system since 1989 may be due to the emergence of dark spots near the polar region. Because of the relatively low orbital inclination ($i = 33°$) of the binary, these polar spots had reduced substantially the average brightness of the system.

A detailed analysis of the 1992 UBV light curves based on spot model is in progress. The results will be published along with the spectroscopic observations made during the 1992 MUSICOS campaign.

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