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1988 AND 1989 UBV PHOTOMETRY OF BD+61°1211

BD +61°1211 (=DM UMa = #75 in the catalog of Strassmeier et al. 1988) is a very active long period (7.492 days) RS CVn system. This noneclipsing system displays rapid changes in its light curve on time scales from about a year to a few months in 1987 (Kimble et al. 1981, Mohine et al. 1985, Heckert et al. 1988). The evolving light curves indicate both a high level of chromospheric activity and rapid changes in the level of this activity. To follow the continued evolution of this system, I performed UBV photometry during 1988 and 1989.

I made the observations in May 1988 and in March, May, June, and July 1989 on the 24" telescope operated by San Diego State University at Mt. Laguna, CA. I used the same instrument, techniques, and comparison stars as Heckert et al. (1988). The data are in the Johnson UBV system.

Figures 1 and 2 show the 1988 and 1989 ΔV light curves. Figures 3 and 4 show the 1988 and 1989 color curves ($\Delta B-V$ and $\Delta U-B$). The differential magnitudes are in the sense comparison - star. Errors are typically less than 0.01 mag in ΔV, about 0.015 mag in $\Delta(B-V)$, and about 0.02 - 0.04 mag in $\Delta(U-B)$. The higher $\Delta(U-B)$ errors are in 1989. Observations of the check star show no evidence for variability in the comparison. I computed the orbital phase using ϕ=JD 2443881.4+7.492E (Crampton et al. 1979).

The 1988 and 1989 ΔV light curves (Figs. 1, 2) show the single peaks similar to the 1979, 1980, 1983, 1984, 1986, and 1987 curves rather than the double peaks of the 1981 and 1982 curves. The 1988 ΔV curve varies with an amplitude of a little over 0.15 mag; however, a gap at minimum light makes an accurate estimate of the amplitude difficult. The amplitude of the 1989 light curve (0.16 mag) is roughly the same but easier to estimate reliably. These amplitudes increase with decreasing wavelength to about 0.25-0.3 mag at U. The 1988 and 1989 amplitudes of the ΔV curves are larger than the historic minimum amplitude of 0.05 mag during June and July 1987 (Heckert et al. 1988), but not as high as the historic maximum amplitude of 0.32 mag observed in 1979 (Kimble et al. 1981).

The phases of minimum brightness during 1988 and 1989 are roughly 0.00 and 0.03. These phases compare to 0.57 during 1986 and about 0.6 during 1987. Gaps in the light curves make these estimates difficult for 1987 and 1988. Mohin et al. (1985) tabulate the phase of minimum light for the years from 1979 to 1984. They find the phase of minimum light migrating from 0.47 in 1979 to 0.03 in 1982. A second phase of minimum light migrates from 0.7 in 1981 to 0.32 in 1984. The overlap in 1981 and 1982 represents the double peaked light curves in those years. At this time, the spot visible from 1979 to 1982 broke up and a new spot formed that was visible between 1981 and 1984. The phase of minimum light during 1986 and 1987 is not consistent with the trend between 1982 and 1987. Hence, the spot group visible in 1986 that spread out during 1987 was a different shorter lived group than that visible between 1982 and 1984. Unfortunately, I have no 1985 data.

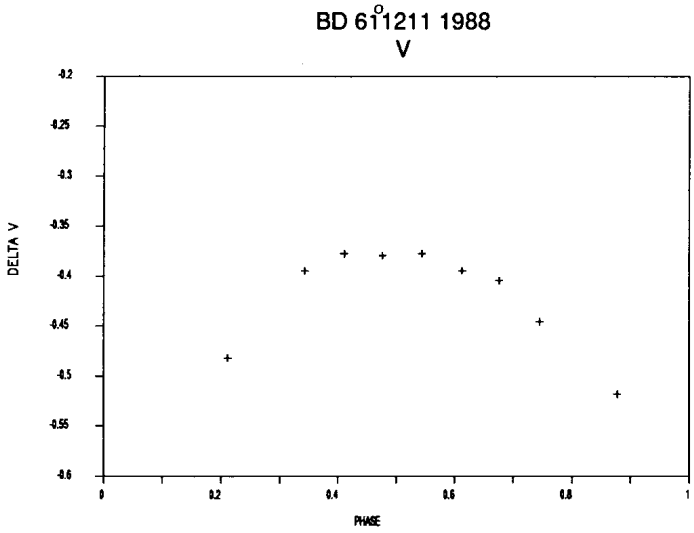

Figure 1

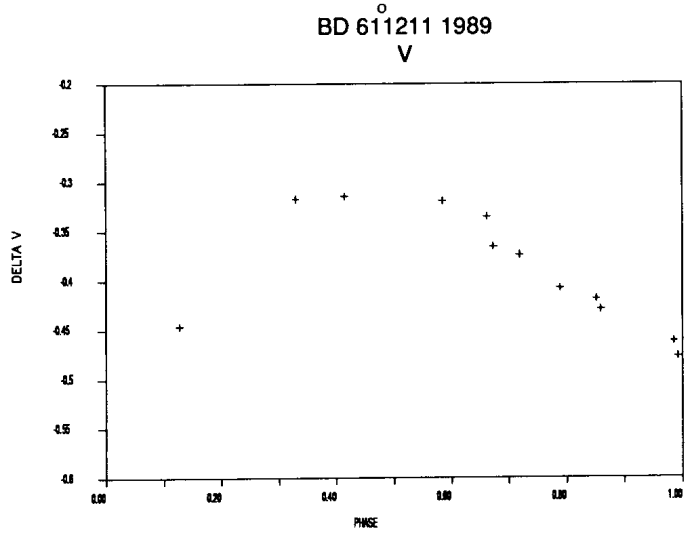

Figure 2

The 1988 and 1989 data show that a new spot group formed at a different phase, and that the same spot group was visible these two years. The migration rate for this spot group is much smaller than for the two spot groups seen by Mohin et al. (1985). As the spot migration is likely caused by differential rotation, the 1988, 1989 spot group is

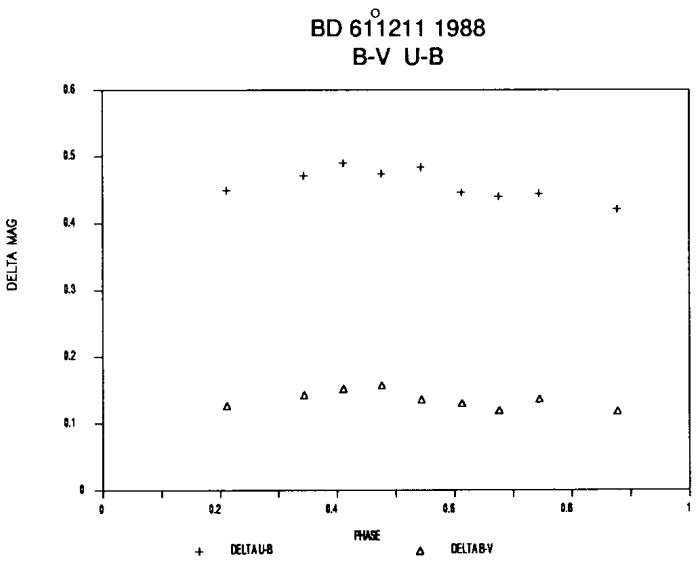

Figure 3

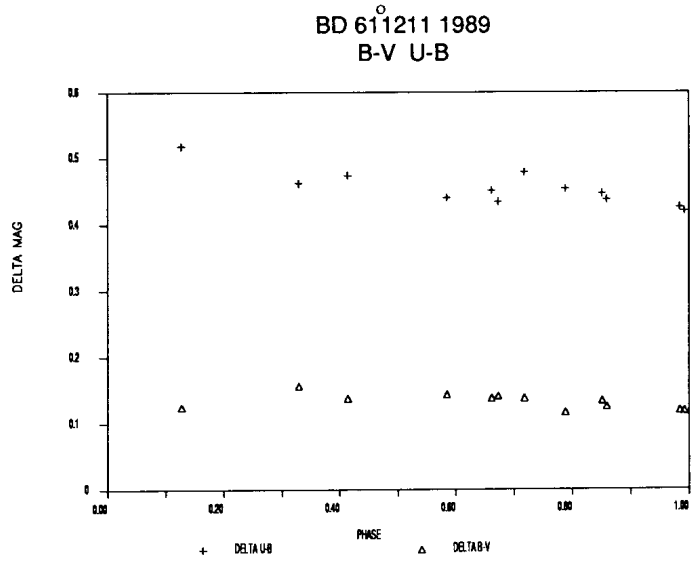

Figure 4

at a different latitude than the previous groups. Note that from 1988 to 1989 the phase of minimum light appears to increase with time rather than decrease as observed by Mohine et al. (1985). However the change is so small that additional data are needed to verify this trend. In

any case the different migration rates for the 1979 - 1982, 1981 - 1984, and 1988 - 1989 spot groups suggest a latitudinal drift from one spot group to the next as well as a longitudinal drift for each group.

Between 1988 and 1989 ΔV at maximum light brightened from roughly 0.37 to 0.30 while the amplitude variability changed minimally. During late 1987, the spots were spread out over the star rather than clustered at one longitude (Heckert et al. 1988). The 1988 data show that in addition to the new spot group there were residual spots from 1987 spread out over the surface. During 1989 the spot cluster remained roughly the same but the residual spots either disappeared or decreased significantly.

The 1988 and 1989 color curves show roughly the same behavior as the 1979 color curve (Kimble et al. 1981) and the 1986 curves (Heckert et al. 1988). As for the ΔV curves the 1988 color curves are of intermediate amplitude. They are at maximum when ΔV is at maximum indicating that BD+61°1211 is bluest at maximum light. This color behavior is consistent with the hypothesis that the brightness variations are caused by spotted regions at a lower temperature than the rest of the star. The 1989 $\Delta(B-V)$ curve appears consistent with this trend, but has more scatter in the data. The 1989 $\Delta(U-B)$ curve does not appear to follow this trend. However, owing to slightly less stable atmospheric conditions in 1989, there is more scatter in the data for both the variable and check star. The larger errors make this curve difficult to interpret.

BD+61°1211 continues to display rapid evolution in its light curves. During 1988 and 1989 the starspots that spread out during 1987 regrouped at a different longitude. The changing migration rate also shows a latitudinal drift between different spot groups. I plan to continue monitoring this system to look for long term cycles in the starspot activity.

Ron Angione scheduled very generous amounts of time on the Mt. Laguna 24" telescope for this work. Western Carolina University provided travel funds for this work through a faculty research grant and additional funds. Mary Ann Hickman helped collect the May 1989 data.

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