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PHOTOMETRY OF THE VV CEPHEI-TYPE STAR V641 Cas (=BD+63°0003)

During a photometric study of the peculiar O8fe star HD108, the nearby red star BD+63°0003 was discovered to be variable in brightness by Guinan, McCook and Weisenberger (1982). Subsequently, its light variability has been independently verified by Berthold (1983) from sky-patrol photographic plates taken during 1959-1982. Recently BD+63°0003 appears in The 67th Name-List of Variable Stars as V641 Cas (Kholopov, et al. 1985). Shortly after the publication of our photometry, Dr. William Beidelman of Warner and Swasey Observatory pointed out that V641 Cas previously had been identified spectroscopically by Barbier (1971, 1975) as a VV Cephei-type star. As shown by Barbier, the optical spectrum of the star shows emission lines chiefly of [Fe II] and hydrogen superimposed on the absorption spectrum of a M3 Iab star. As discussed by Cowley (1969), VV Cephei-type stars are long period interacting binary systems consisting typically of a M supergiant and an O- or early B-type companion. Although the orbital period of V641 Cas is still unknown, the presence of the hot component of the system has been ascertained from ultraviolet observations made with the International Ultraviolet Explorer satellite by Shaw and Guinan (1985, 1986).

Photoelectric photometry of V641 Cas has been carried out at Villanova University Observatory on 67 nights from late 1979 until early 1986. A description of the instrumentation has been given elsewhere (e.g. Guinan, et al. 1982). A pair of narrow- and intermediate-band interference filters, centered near the rest wavelength of the Balmer H alpha line at 6563A was used along with an intermediate band blue filter with λmax = 4530A. The characteristics of the filters are given by Guinan and Wacker (1985). However, only the observations made with

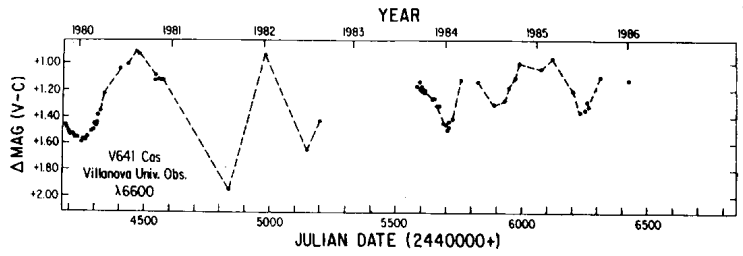

Figure 1. The intermediate-band red observations of V641 Cas are plotted against Julian Date and calendar year. The observations were made with respect to the comparison star HD 371. The points are nightly means.

the H alpha intermediate-band filter cover the entire ≈ 6 year observing interval. The bandwidth of this filter is broad enough (FWHM = 260A) so that the included H alpha emission line feature does not contribute significantly to the flux measure. Thus, the red intermediate bandpass measure is essentially that of the continuum centered at 6600A.

Differential photometry of V641 Cas was made relative to a nearby comparison star, BD+62°0005 (HD 371; V = +6.42 mag; B-V = +1.03; G2 II). The observing procedure and data reduction are the same as discussed earlier by Guinan, McCook, and Weisenberger (1982). Nightly mean differential magnitudes were formed from the data, and the intermediate band red observations are plotted in Figure 1. As shown in the figure, the light variation is semi-regular both in amplitude and period. The interval of time between successive light minima or light maxima ranges from a maximum of 500-600 days during 1980-1982 to 200-350 days during 1983-1985. The range in brightness was as large as ≈1.0 mag during 1980-1982 and ≈0.2-0.4 mag during 1983-1985. From the limited amount of data, it appears that the light amplitude is largest when the period is longest. Blue observations obtained during 1983-1984 indicate that there is little or no wavelength dependence of the light variation. Since the M supergiant of the system dominates the light at visible wavelengths, the observed light variations arise chiefly from this star. All VV Cep-type stars that have been investigated photometrically show semi-regular light variations of a few tenths of a magnitude and with characteristic periods of one

hundred to several hundred days (Cowley 1969). The light amplitude of ≈1.0 mag found for V641 Cas during 1980/1981, however, is the largest reported for any VV Cep-type star. These semi-regular light variations observed at optical wavelengths appear to arise from pulsational instabilities and possible surface activity of the red supergiant component. Similar light variations are observed for single M supergiants such as Alpha Ori (e.g. Guinan 1984) and Mu Cephei (e.g. Polyakova 1974, 1975).

VV Cephei has been monitored photometrically at Villanova since 1975 and it shows semi-regular light variations similar to those observed for V641 Cas, but with smaller light amplitudes (e.g. Guinan, et al. 1982). VV Cep is an eclipsing binary with an eccentric orbit (e = 0.35), however, and it appears that the light variations of the M supergiant are strongly influenced by the tidal effects of its hot companion near periastron passage (Guinan, et al. 1986). The change in the period and amplitude of the light curve of V641 Cas observed from 1979 through 1985 could, in part, be produced from binary system interaction effects as in the case of VV Cep. Unfortunately, the orbital period and elements for V641 Cas have yet to be determined. Observations of V641 Cas made with the other filters are less numerous and cover the interval from 1979-1984. Color and H alpha indices were computed from all the data when possible to study possible correlations with the brightness changes and also to search for possible eclipse effects. These results will be presented in a separate study (see Dombrowski and Guinan 1986).

We plan to continue to observe V641 Cas at Villanova for the next few years. It would be valuable, however, to obtain radial velocity measures of the star and from these to determine its orbital parameters. The large light variations exhibited by the M supergiant component of the system could indicate large pulsationally induced mass outflows which would interact strongly with the hot companion.

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