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WW VULPECULAE - LIGHT VARIATIONS FOR 1929 TO 1992

Recently, Friedemann et al. (1993) studied the light variations of the evolutionarily young Isa variable WW Vul. Conspicuous features in the lightcurve are the irregularly occurring Algol-like minima being up to 1.5 mag deep. For a number of them UBV and $UBVR$ observations are available (for references see Friedemann et al., 1993). A thorough investigation of these data resulted in the conclusion that the Algol-like minima are caused by circumstellar dust clouds occulting the star incidentally. For the first time this hypothesis was put forward by Wenzel (1969) as an interpretation of the light variations of the related variable SV Cephei. In the case of WW Vul our discussion of the $UBVR$ data led to the conclusion that the extinction properties of the dust grains confined to the individual clouds differ both from each other and the interstellar mean. The dust cloud hypothesis is strongly supported by the finding that WW Vul coincides with the infrared point source IRAS 19238+2106. The infrared fluxes measured by IRAS as well as available NIR data (see Gezari et al., 1987) can be interpreted as thermalized stellar radiation from circumstellar dust. Using the radiative transfer code by Chini et al. (1986), we found that thermal emission from a spherically symmetric circumstellar dust shell matches the observed IR spectrum surprisingly well. The amounts of circumstellar extinction inferred from the optical and infrared data agree satisfactorily (for further details see Friedemann et al., 1993).

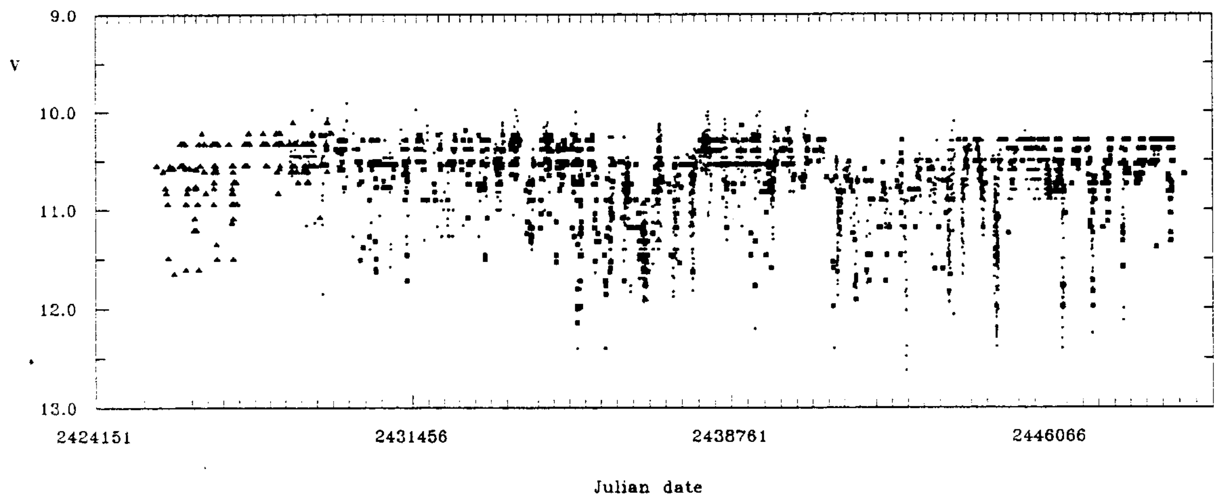

Figure 1: Long-term behaviour of the lightcurve of WW Vul. The different symbols have the following meaning: triangles–Bamberg plate archive; squares–Sonneberg plate archive; dots–data from different authors.

Besides an analysis of individual photoelectrically observed Algol-like minima we tried to collect as many photometric data as possible in order to investigate the long-time behaviour of WW Vul. References to the data used can be found by Friedemann et al. (1993). In addition to these data sets we made use of the plate collections at Bamberg and Sonneberg observatories. Brightness estimates (by C. F. and H.-G. R. at Bamberg and J. H. at Sonneberg), mainly on sky patrol plates, enlarged the data base for the last 60 years considerably. For our brightness estimations the sequence of comparison stars published by Rössiger and Wenzel (1972) has been used. In order to combine the different data sets into a common lightcurve we calculated linear brightness transformations for each of them. The individual data are available upon request from the authors.

The lightcurve of WW Vul in Figure 1 combines our estimates with those of Tsesevich and Dragomiretskaya (1973) and photoelectric measurements of Zaytseva (1983) and Kardopolov and Filip'ev (1985). The V magnitudes have been computed by first transforming the original photographic magnitudes $m_{\rm pg}$ to B magnitudes using equation (8) in the paper by Ažusienis (1965) and then into V magnitudes according to the colour index $E(B-V)$ of the star. The light variations seem to consist of at least two different components: (i) longer lasting wavelike variations with a small amplitude and (ii) aperiodically occurring short-lived Algol-like minima with amplitudes up to 1.5 mag. This rough characterization agrees with an earlier description of the lightcurve given by Rössiger and Wenzel (1972).

The long-time variations of WW Vul outside the Algol-like minima seem to follow a wavelike pattern. It can be approximated formally by a sinusoidal term, i.e.

$$m(JD) = m(JD_0) - \Delta m_A sin 2\pi((JD - JD_0)/P). \qquad (1)$$

A discrete Fourier analysis of the whole data set shown in Fig. 1 revealed no clear periodicities. The highest peak in the Fourier spectrum corresponds to a period of $P \approx 5200$ d. With this period a visual fit gave for the values of the other constants $m(JD_0) = 10^{\rm m}\!.6$, $\Delta m_A \approx 0.15$ mag, and $JD_0 = 2440500$. A quasi-periodicity with $P = 404$ d for the Algol-like minima as reported by Zaytseva (1983) is not confirmed by the analysis of our considerably increased data base. As an explanation of the Algol-like minima, obscurations by orbiting circumstellar dust clouds seem to be evident (Friedemann et al., 1993). Contrary to this, the origin of the slight wavelike changes in maximum light is yet unknown. Both the small amplitude and the lack of accurate $UBVR$ data over a sufficiently long time interval make an interpretation difficult. At present a stellar (due to a variation of the effective temperature) or circumstellar (varying extinction by dust) origin seems to be conceivable (For further details see Friedemann et al., 1993).

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