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OPTICAL PHOTOMETRY OF A0538-66 DURING QUIESCENCE\*

The periodic recurrent transient source A0538-66, which undergoes X-ray and optical outbursts every 16.6 days when it is in an active state [1-4] also shows extended periods of inactivity [5]. It has been in such an off-state since the end of 1982 [6].

We report here on photometric observations of this source which have been made since 1983, to detect the onset of a new cycle of activity, and to study its off-state behaviour, e.g., to detect possible orbital light variations.

The observations were made with the five-colour Walraven photometer [7] on the 90-cm telescope at ESO. Each observation consisted of 4 to 16 integrations of 32 seconds, preceded and followed by 4 such integrations of the sky background (taken  $\sim 15''$  east of A0538-66). A diaphragm of 11.6" diameter was used, which excluded contamination of the signal by a nearby 13.4 mag. star, located 13" south of A0538-66 (star R on the finding chart given in [3]). All measurements were taken relative to the Walraven standard star HD 39844; corrections for differential atmospheric extinction were applied. A total of 228 observations on 147 nights were made between 1983 (JD 2445656) and 1985 (JD 2446293). From the spread of the results of individual observations obtained during a single night we estimate the r.m.s. accuracy of a single observation to be  $\pm 0.09$  mag in V,  $\pm 0.03$  mag in V-B, and  $\pm 0.05$  mag in B-U.

An overview of the quiescent behaviour of A0538-66 is shown in Fig. 1, in which the long-term histories of the V magnitude (transformed to the Johnson system using the transformation formula (eq. 4) given in [8]), and of the Walraven colours V-B and B-U are displayed. In this Figure we have also included previously discussed off-state data [6].

It appears that the source remained near a quiescent magnitude  $V \sim 14.8$ , with small irregular brightness variations (with a total range of  $\sim$

\*Based on observations made at the European Southern Observatory

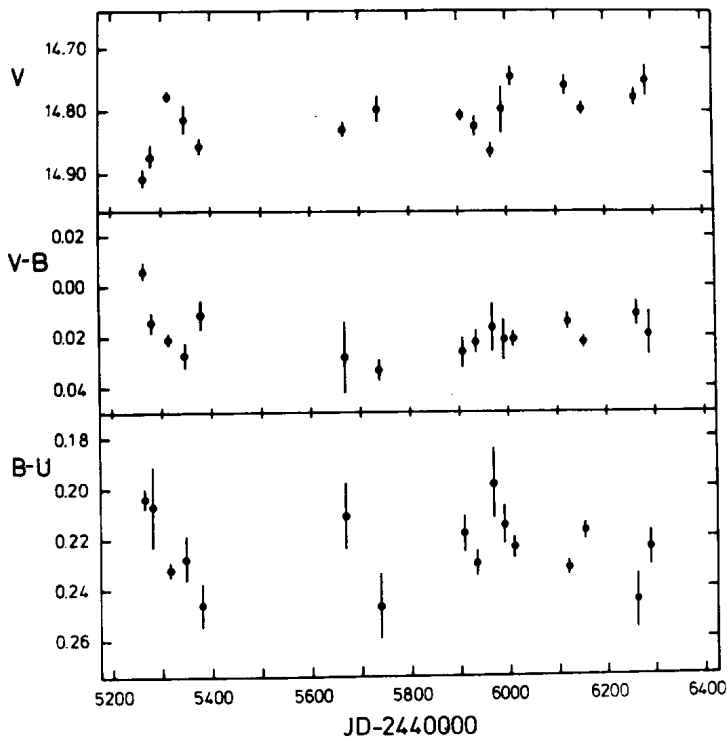


Figure 1: Long-term quiescent behaviour of A0538-66. The upper diagram shows the V-Johnson magnitude averaged over time intervals of  $\sim 20$  days. The middle and lower diagrams show the corresponding behaviour in the Walraven colours V-B and B-U respectively.

0.1 mag) occurring on a time scale of tens of days. Also on longer time scales the visual brightness (averaged over time intervals of  $\sim 200$  days) shows a small secular increase, from  $V = 14.85 \pm 0.01$  (m.e.) near JD 2445300 to  $V = 14.77 \pm 0.01$  near JD 2446300.

The off-state colours of A0538-66 show moderate variations over time scales of tens of days with r.m.s. deviations of the average colours of 0.015 mag in V-B, and 0.03 mag in B-U; except during the beginning of the off state (between JD 5225250 and 5225400 [6]) no significant correlation is present in the colour-magnitude, and colour-colour variations.

In order to look for the possible presence of periodic variations of

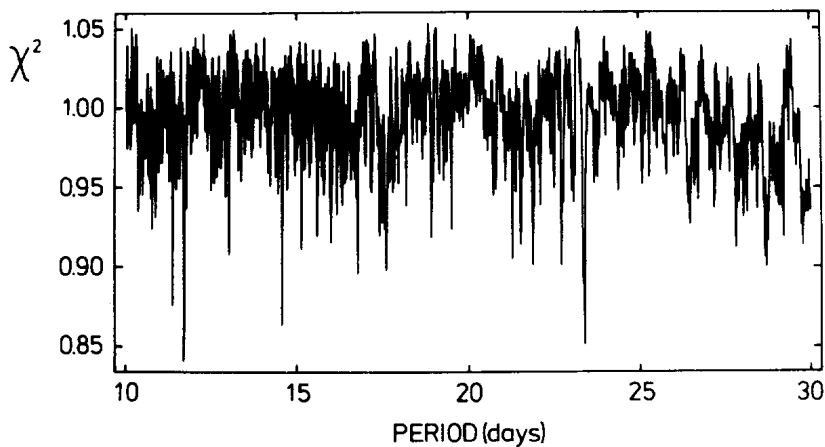


Figure 2: Periodogram of A0538-66 in the neighbourhood of the orbital period of the binary, 16.6515 days [4]. Residuals of the V magnitude, with respect to the long-term trend, are folded. Shown in the diagram is chi-square of the folded data with respect to the standard deviation of the unfolded data.

the brightness of A0538-66 at the 16.6 day orbital period we have made an epoch-folding period search in the residuals of the V, B, and U magnitudes with respect to the smoothed long-term trend, mentioned above. (In case of observations performed during an isolated period of about one month we have simply subtracted the average magnitude during that month).

The resulting periodogram for the V-band data (Fig. 2) shows that there is no evidence in our data for a modulation of the brightness of A0538-66 (at the 16.6 day outburst period) during its off state. By adding artificial sinusoidal signals, with various amplitudes between 0.01 and 0.10 mag., to the data we estimate that any periodic signal in the V-band has an amplitude less than  $\sim 0,02$  mag. Similar upper limits have been obtained for the B and U passbands.

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