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A PRELIMINARY REPORT ON THE LIGHT - VARIATION OF THE SUGGESTED IDENTIFICATIONS OF FOUR X-RAY SOURCES

1. Introduction

A preliminary report is presented on photo-electric observations of four stars, which have been suggested to be the optical counterparts of the X-Ray sources 3U 1223-62 (= Henize 788?, we also show observations of Henize 787 which is at a close distance from 788), 3U 1543-47 (= HDE 330036?), 2U 1639-62 (= Henize 177?) and 3U 1700-37 (= HD 153919). The observations have been made with the Walraven five-colour simultaneous photometer, attached to the 90-cm Light-Collector of the Leiden Southern Station (at the South-African Astronomical Observatory Annexe, formerly the Republic Observatory Annexe) Hartebeestpoortdam, South-Africa. A description of the photometer and the photometric system is given by Walraven and Walraven (1960) and Rijf, Tinbergen and Walraven (1969). We only give preliminary light-curves in one or two passbands.

2. 3U 1223-62 (= Henize 788 or WRA 977?).

Independently of each other, Crampton (private communication to Feast) and Vidal (1973) suggested Henize 788, an 11.5 mag star, as a possible candidate for 3U 1223-62. For the sake of completeness we also made observations of Henize 787 of the 10.5 mag and also an Hα emission object, which is situated within a distance of 1'.5 from Henize 788. The comparison star for both was HD 109164, an 8 mag star. The integration time for one observation of H 787 was generally 1.5 min and for H 788 2 min. Figure 1 shows the brightness difference (in log intensity) between these two stars and the comparison star in the Walraven V band (5590 A). Obviously H 787 is constant, while H 788 is an irregular variable star, of which the maximum range of the variation is nearly 0.15 mag. The broken part of the light-curve represents the less accurate part because of too little observations.

Our observations of H 788 support Vidal's conclusion based on his spectroscopic observations, that H 788 was active on a time scale of days and that these characteristics combined with the high reddening may be correlated with the active X-Ray source reported by McClintock et al. (1971) and catalogued by Giacconi et al. (1973) as 3U 1223-62.

3. 3U 1543-47 (= HDE 330036?)

HDE 330036, an 11 mag star was first proposed as the optical counterpart by Sanduleak and Bidelman (1971) and catalogued in the 2U and 3U catalogues of Giacconi et al. (1972,1973). However the distance of this candidate to the X-Ray source is more than 1°, which is far outside the error box. This makes the identification very doubtful. Forman and Liller (1973) recently proposed an other candiate viz. a 15 mag star within the error box. This one however was too faint for our telescope.

HDE 330036 showed to be a peculiar emission object typical for a yellow symbiotic star and with a large infared excess (Webster, 1966; Glass and Webster, 1973). As a comparison star we used the A 2 star HD 141448 roughly $3\overset{\prime}{.}5$ N of the candidate and two magnitudes brighter. The integration time for one observation of the candidate was generally 2.5 min. Figure 2 shows the brightness differences (in log intensity) between HDE 330036 and the comparison star in the Walraven B band (4260 A). The variability suggested in Figure 2 would be a support of Webster's classification that HDE 330036 is a symbiotic star, had the weather conditions during these observations been satisfactory. We therefore have the feeling that more accurate observations are necesarry to confirm these variations.

4. 2U 1639-62 (= Henize 177?).

This source is listed in the 2U catalogue of Giacconi et al. (1972), but later also in the 3U catalogue (Giacconi et al.1973)

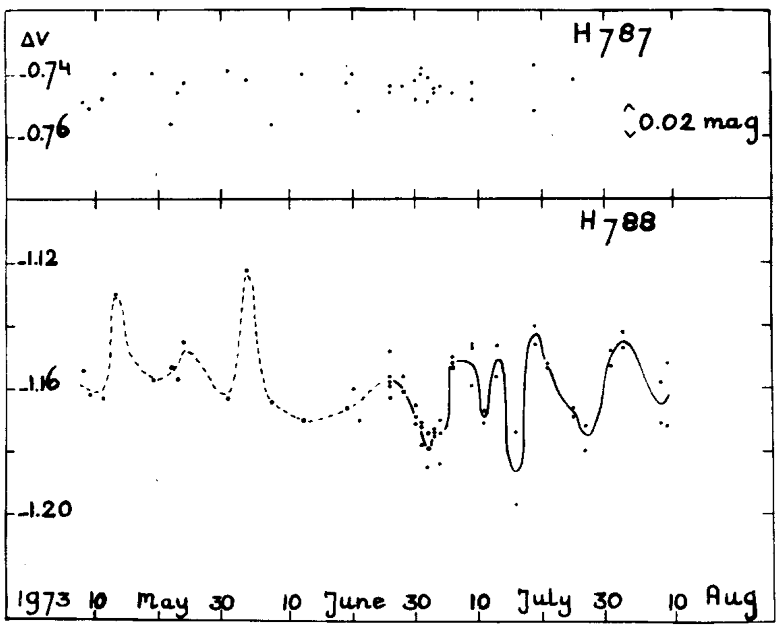

Fig.1. The brightnesses H 787 and H 788 (= 3U 1223-62?) minus comparison star (in log intensity) plotted against the calendar dates for the V-passband.

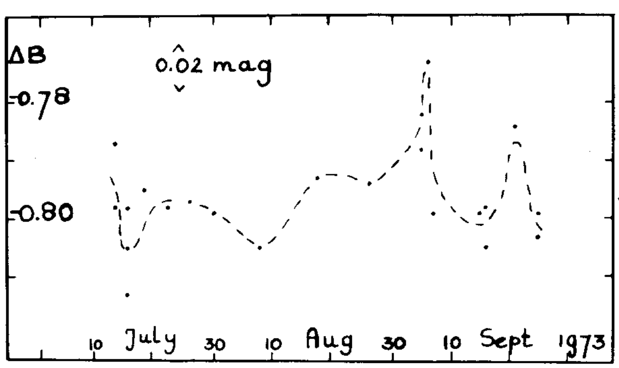

Fig.2. The brightnesses HDE 330036 (= 3U 1543-47?) minus comparison star (in log intensity) plotted against the calendar dates for the B-passband.

where it got the number 3U 1632-64 but with a larger error box.

Independently of each other Webster (1972) and Brucato and Lanning (1972) suggested that Henize 177, of roughly the 13 mag might be the optical counterpart for 2U 1639-62. The star is spectroscopically very interesting with a peculiar emission spectrum and a strong infrared excess (Webster, 1966, 1973; Glass and Webster, 1973). As a comparison star we used a roughly 3.5 mag brighter star within a distance of 2′ SW of H 177 (see the finding chart given by Perek and Kohoutek Plate 32 (326-10°1) (1967)). The integration time for one observation of the candiate was generally 2.5 min. Figure 3 shows the brightness difference (in log intensity) between H 177 and the comparison star in the Walraven B band (4260 A). During the 3.5 months that the star was followed the brightness increased by more than 0.4 mag. Sudden drops of 0.05 mag are clearly visible. The star exhibits a relatively high brightness in the ultra-violet. In the Walraven U band (3620 A) the total increase was nearly twice that in blue viz. 0.7 mag. Our conclusion is that although the identification of H 177 with the X-Ray source is highly questionable after the new position of the source in the 3 U catalogue, it still is a very interesting object because the light-variation supports Webster's (1973) classification that it belongs to the group of slow novae and symbiotic stars.

5. 3U 1700-37 (= HD 153919)

The likely candidate for 3U 1700-37 is the 6.7 mag star HD 153919 of spectral type Of. The star, first suggested by Jones et al. (1973), appeared to be an eclipsing binary with a period of $3^{d}.4120$ (Jones et al. 1973, Penny et al. 1973). We used HD 153767 (7.4 mag and A0) as the comparison star. A second star was sometimes used to check the constancy of the first one. Generally the variable was observed ten times alternated by the comparison star. The average of the brightness differences revealed one normal point. The integration time for one observation was 0.5 min. Figure 4 shows the curves in the Walraven V band and that for the

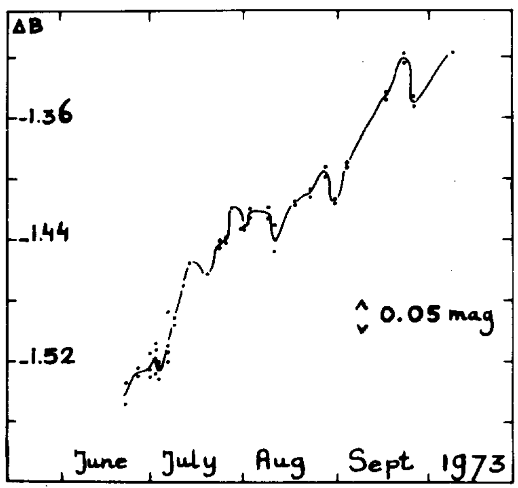

Fig.3. The brightness H 177 (= 2U 1639-62?) minus comparison star (in log intensity) plotted against the calendar for the B-passband.

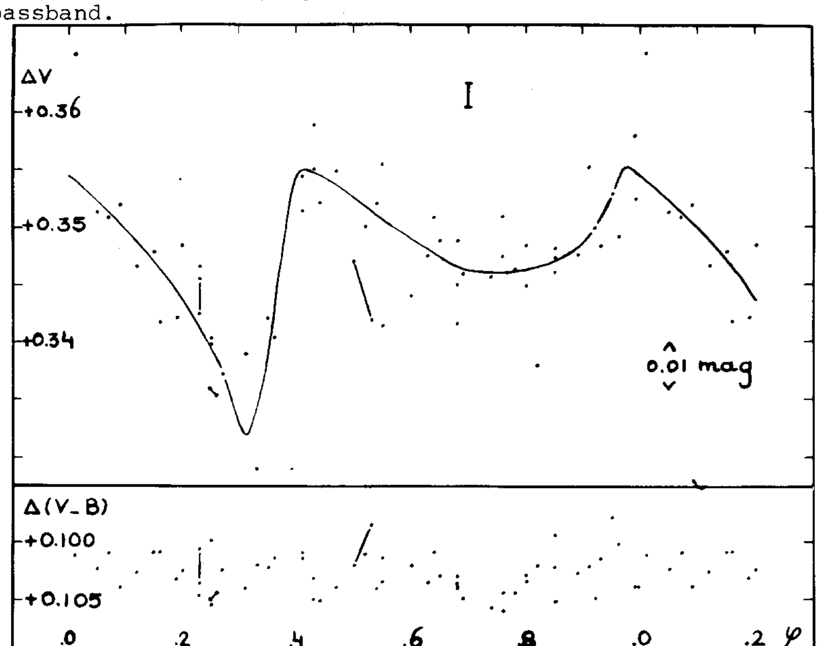

Fig.4.The brightnesses HD 153919 (= 3U 1700-37) minus comparison star (in log intensity) plotted against the phase for the V-passband and for the index V-B. The points connected with a line are normal points obtained in the same night.The estimated mean error is indicated by the bar (±0.003 mag).

index V-B given as the differences variable minus comparison star. The error bar indicates roughly the mean error one normal point. Phases have been derived with the same ephemerides of Penny et al. Points connected with a line indicate normal points obtained in the same night.

Just like Penny et al's light-curve in the V of the UBV system, ours shows that an important part of the scatter is intrinsic. There is no indication for a period change between the observations of Penny et al. in February and March of 1973 and those presented here made in May till October of the same year, at least when we compare the phases of the minima. Other similarities are the equal height of the maxima and the fact that the colour curve does not show any appreciable colour change. Probably there is some tendency for the star to be redder during the secondary minimum, but this is not conclusive at all. The secondary minimum is also the X-Ray minimum, apparently at this stage the X-Ray source is eclipsed by the bright O component. This is also proved by spectroscopic work (van den Heuvel, 1973; Hutchings et al. 1973). Further we notice some important differences in the shape of our light-curve compared with that of Penny et al.:

1. our primary minimum is 0.06 mag deep, against 0.07 mag.
2. the secondary minimum is also less deep but even more pronounced viz. 0.022 mag, against 0.05 mag.
3. a more pronounced asymmetry for our curve. The rising branch after the primary minimum needs only 0.1 of the period to reach the maximum, that is half the value of Penny et al.'s light-curve.

It is true that the intrinsic dispersion is very high so that these differences may only be apparent, or that they are caused by the slightly different photometric bands. However the differences are probably too large to be only interpreted by these facts. We cannot therefore exclude the possibility that a real change has taken place. Penny et al. suggested three hypotheses for the non-sinusoidal shape of the light-curve, ellipticity of the orbit (in this case one should expect the descending branch at phase .4 to be much steeper than that at phase .0, in fact we see the reverse), non-symmetric distortion of the O star about the separation axis and another source of emission or absorption of light in the system. The fact that the light-curve may have changed within a few months, makes it not very likely that only geometrical or orbital elements cause the light variation. As shown by Hutchings et al. the system exhibits complex atmospheric phenomena, so that an explanation must await further spectroscopic and photometric observations.

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