

NOTE

FIVE-COLOUR PHOTOMETRY OF THE X-RAY SOURCE SCO X-1

In September 1966, photo-electric observations of the possible optical counterpart of the X-ray source Sco X-1 identified by SANDAGE *et al.* (1966), have been made during four nights with the Walraven five-colour photometer attached to the 90-cm light-collector of the Leiden Southern Station near Hartebeestpoortdam, South Africa.

The star could be followed only for $1\frac{1}{2}$ hour each night because of its already large zenith distance. Two comparison stars have been used, $c_1 = \text{BD}-15^\circ 4300$ and $c_2 = \text{BD}-15^\circ 4301$. During the four nights the differences $c_1 - c_2$ did not show any significant variations. Colours were measured in the system of WALRAVEN and WALRAVEN (1960). For c_1 and c_2 they followed from a comparison with three of their standard

stars, measured each night after the programme star. The colours for Sco X-1 were then obtained from a comparison with c_1 . Corrections for differential extinction were negligibly small. Because of the large $\sec z$ values (from 1.3 to 2.2) of c_1 , c_2 and Sco X-1 compared to those of the standard stars, the zero-point error in the colours may amount from 0.01 to 0.02 (in log intensity). (A fourth standard star close to Sco X-1 proved to be variable and was therefore omitted.)

The variations of V (in log intensity) for Sco X-1 have been plotted in figure 1. Each point is the mean of mostly four observations. The colours $V-B$, $B-U$, $U-W$ and $B-L$ did not change much; the mean values with their mean errors are given in table 1.

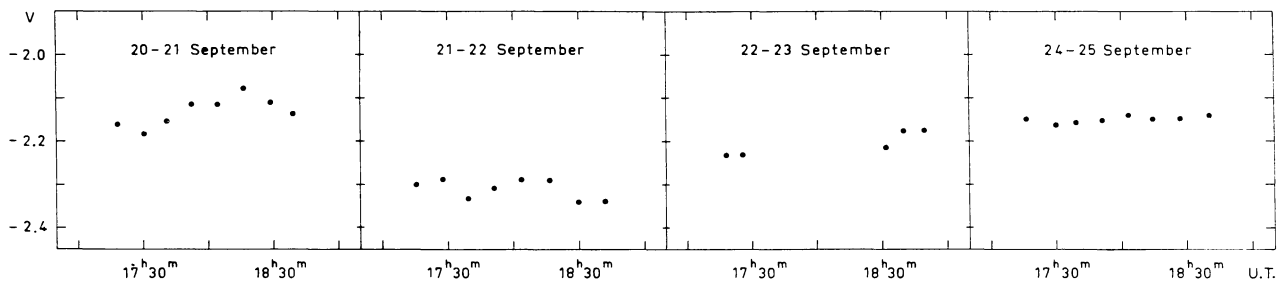


Figure 1. The light-variation in V (log intensity) of Sco X-1 in four nights of September 1966. Each point is the mean of mostly four observations.

TABLE 1
Photometric data for c_1 , c_2 and Sco X-1

Date 1966	Star	V	$V-B$	$B-U$ (log intensity)	$U-W$	$B-L$	V_J	$(B-V)_J$ (mag)
20-21 September	c_1	-0.642	+0.085	+0.520	+0.129	+0.201	8.47	+0.20
	c_2	-1.192	+0.128	+0.558	+0.183	+0.232	9.85	+0.31
	Sco X-1 min.	-2.160					12.26	
	mean		+0.064	+0.006	-0.004	+0.021		+0.15
21-22 September	max.	-2.065	± 3	± 3	± 8	± 3	12.03	± 1
	mean	-2.310	+0.081	+0.025	+0.037	+0.030	12.63	+0.19
		± 6	± 6	± 6	± 18	± 5	± 2	± 2
22-23 September	mean	-2.202	+0.055	+0.003	+0.013	+0.016	12.37	+0.13
		± 10	± 7	± 9	± 25	± 7	± 3	± 2
24-25 September	mean	-2.149	+0.067	+0.007	+0.001	+0.019	12.23	+0.16
		± 4	± 5	± 5	± 9	± 4	± 1	± 1

The Johnson V magnitude has been computed with the formula $V_J = 6.87 - 2.5 [V + 0.05 (V - B)]$, given by WALRAVEN *et al.* (1964), and $V - B$ has been transformed into $(B - V)_J$ with the aid of their table 7.

In the first night, the brightness increased quickly

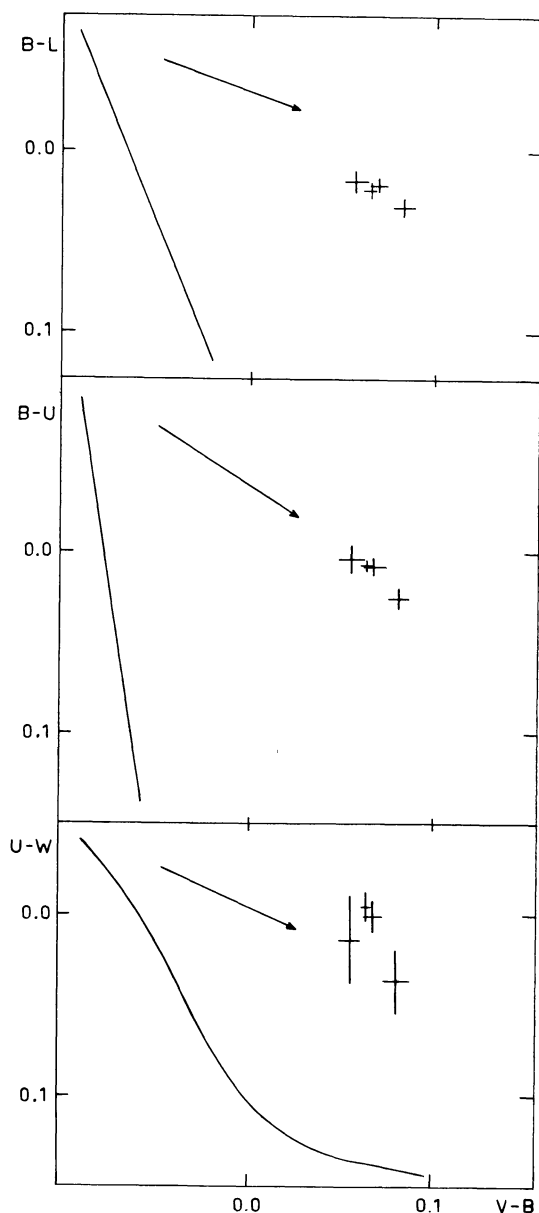


Figure 2. The two-colour diagrams in the photometric system of Walraven. Colours are expressed in log intensity. The four crosses represent the four mean values of the colours in the four nights. The length of the arms of the crosses represents the mean error. A part of the main sequence is shown together with the reddening path for O-type stars.

by 0.23 mag, the second night it dropped slowly and in the last night it remained constant. The gap in the third night is due to passing clouds. The brightness in the first and the last two nights agrees quite well with the maximum brightness observed by Sandage *et al.*, while that of the second night agrees with a brightness about half-way between maximum and minimum. The limited number of observations and the irregularity of the light-variation made it impossible to search for a period.

In figure 2, Sco X-1 has been plotted in the three two-colour diagrams. The position in these diagrams suggests it to be a reddened normal main-sequence O-type star, but because of its large galactic latitude ($+24^\circ$) and its faintness this seems quite unlikely. A dwarf-like star is much more likely. Sandage *et al.* and MUMFORD (1966) suggested that it might be an old nova. Because of its apparent position in the neighbourhood of the Sco II association it is tempting to consider Sco X-1 as a member of this aggregate, the distance of which is 170 pc (cf. BRAES and HOVENIER, 1966). Its absolute visual magnitude will then amount to about $+5$, corresponding to that of some old novae. However, an old nova does not seem to fit into an association with respect to population type and age.

As in the two-colour diagrams all sequences of different classes converge at the top of the diagrams, an estimate of the amount of reddening cannot be much in error. It is in good agreement with the value found by Sandage *et al.* from the photometry of nearby field stars, namely $E_{B-V} \approx 0.25$ mag.

A more detailed description of these observations will be given in a next paper, when more observations from the 1967 observing season become available.

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References

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