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SH 2-71: NEW VARIABLE CENTRAL STAR OF A POSSIBLE
PLANETARY NEBULA

Nebula Sh 2-71 ($36-1^{\circ}1$) was discovered by Minkowski (1946) who classified it as a diffuse or peculiar nebulosity. Sharpless (1959) included this object ($AR_{1950} = 18^h59^m28^s.0$, $D_{1950} = +2^{\circ}04'56''$; Milne, 1973) in his catalogue of H II regions and considered it as a possible planetary nebula. Our UBV photoelectric photometry from 1977, 1978 and 1979 shows the nucleus of this very little known nebula to be variable with an amplitude of at least 0.7 mag.

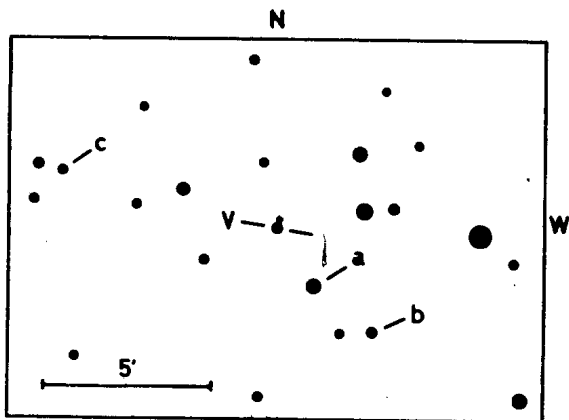


Fig.1 Finding chart for the central star of Sh 2-71 (V) and for comparison stars a, b, c

Our measurements of the planetary central star during eight nights are presented in Table 1. We observed in 1977 with the 1 m-telescope and a pulse counting photometer (RCA 8850 photomultiplier) of the Wise Observatory at Mitzpe Ramon,

Table 1

UBV observations of Sh 2-71 in 1977-1979

JD 2443000+	V	B	U	Dia. [arcsec]	m_{pg}
364.2986	13.96	14.71	15.09	14.5	14.66
.3070	13.89	14.67	15.06	21.8	14.68
.3143	13.95	14.74	15.08	14.5	14.69
.3229	13.93	14.69	14.99	21.8	14.70
365.3140	13.92	14.74	15.10	14.5	14.69
.3238	13.81	14.63	15.00	21.8	14.64
.3321	13.92	14.73	15.04	14.5	14.68
.3488	13.80	14.56	14.96	21.8	14.57
607.8724	13.24	14.03	14.40	22	14.04
.8771	13.27	14.09	14.44	16	14.04
608.8700	13.38	14.20	14.61	22	14.21
.8750	13.39	14.24	14.64	16	14.19
609.8381	13.45	14.22	14.63	22	14.23
.8404	13.43	14.22	14.61	22	14.23
.8454	13.45	14.26	14.72	16	14.21
.8829	13.51	14.31	14.80	22	14.32
.9034	13.45	14.29	14.74	16	14.24
963.8831	13.73	14.55	14.85	22	14.56
.8906	13.77	14.59	14.92	16	14.54
964.8806	13.77	14.55	14.94	22	14.56
.8892	13.81	14.61	14.99	16	14.56
965.8898	13.82	14.62	14.96	22	14.63
.8992	13.84	14.67	15.09	16	14.62

Israel. In 1978 and 1979 we used the 1 m-telescope and a pulse counting photometer (EMI 6256) of the European Southern Observatory at La Silla, Chile. As photometric standards we measured in 1977 the stars near IC 4665 (Johnson, 1954) and in several open clusters (Hoag et al., 1961), and in 1978-79 stars in E-regions (Cousins, 1973). The following standard deviation can be expected for the individual magnitudes given in Table 1: $\sigma_V = 0^m.03$, $\sigma_B = 0^m.03$, $\sigma_U = 0^m.04$.

Several local standards in the vicinity of Sh 2-71 were observed in order to investigate the interstellar extinction in this region. The photometrical results will be published in a separate paper in more detail. In Table 2 we give the magnitudes and their r.m.s. errors of three comparison stars together with the average UBV magnitudes of the central star of Sh 2-71 for 1977, 1978 and 1979.

Whereas the stellar magnitudes in Table 1 were affected by the nebula, the data in Table 2 represent the brightness of the central star only. We have eliminated the contribution of the nebula by comparing the stellar + nebular brightness

Table 2

Mean UBV magnitudes of the central star of Sh 2-71
and of three comparison stars

Star	V	B-V	U-B	n
Sh 2-71 in 1977	13.95 ±2	+0.82 ±1	+0.36 ±1	8 m.e.
1978	13.45 ±3	+0.85 ±1	+0.41 ±2	9 m.e.
1979	13.85 ±1	+0.84 ±1	+0.36 ±2	6 m.e.
Comparison a	11.400 ±2	+0.747 ±2	+0.239 ±5	4 m.e.
b	13.169 ±9	+0.921 ±5	+0.630 ±15	10 m.e.
c	13.944 ±10	+0.799 ±3	+0.222 ±8	4 m.e.

in two different diaphragms assuming that the nebula was homogeneous near the central star.

The variability of the nucleus of Sh 2-71 was confirmed on 28 plates (1897 - 1947) found in the plate files of the Harvard Observatory. Table 3 gives the visual estimates of the

Table 3

Photographic magnitudes of the central star of Sh 2-71 from

Harvard plates

Plate No.	JD 2400000+	m_{pg}	Plate No.	JD 2400000+	m_{pg}
A 2572	14129.626	14.36	MC 21990	24686.756	14.10
A 2573	14129.658	14.30	MC 22525	25009.827	14.30
A 4443	15179.661	14.46	MC 22558	25037.759	14.32
A 10451	19241.696	13.96	MC 22649	25110.585	14.44
A 10460	19249.709	14.38	MC 22702	25147.526	14.00
MC 1226	19268.588	14.52	MC 23442	25408.771	13.96
A 10488	19292.584	13.83	MC 23500	25443.656	14.63
MC 1265	19293.541	13.82	MC 23596	25479.575	13.88
A 10493	19299.580	14.24	MC 24328	25796.753	14.63
MC 5706	20301.763	14.44	MC 24391	25826.629	14.10
MC 6407	20397.525	13.97	MC 24990	26155.713	14.29
MC 8861	20696.694	14.63	MC 35473	32379.773	14.33
A 13526	24404.619	13.90	MC 35477	32380.750	14.36
MC 21956	24670.753	13.84	MC 35493	32387.745	14.63

photographic magnitudes of this star: the internal error of one estimate lies between ± 0.05 and 0.1 mag. In order to compare the values from Table 3 with the photoelectric observations from 1977-1979 we transformed our observed B magnitudes into m_{pg} (see last column in Table 1): $m_{pg} = B_* - 0.11$, where $B_* = B + 0.06$ was found for observations made through diaphragm 14.5 and 16 arcsec, and $B_* = B + 0.12$ for dia. 21.8 and 22 arcsec.

The following conclusions can be made concerning the variability of the central star of Sh 2-71:

1) The extreme values of m_{pg} from Harvard plates, 13.82 and 14.63, suggest an amplitude of about 0.8 mag. The UBV data from 1977-1979 show a value somewhat lower (about 0.7 mag), but very probably they do not cover the whole light-curve.

2) The existing data do not allow to describe the shape of the light-curve. Nevertheless, the distribution of the individual values of Table 3 favours a smooth sine-like curve.

3) According to the UBV data the period should exceed two days substantially as only a change of about 0.2 mag has been recorded within two days. We could estimate P between 17 and 22 days from the photographic data. Our observations, however, cannot exclude short periods between about 0.5 and 1 day.

4) There is no evidence for a secular change in the brightness of the central star. The mean value of its photographic magnitude was 14.24 from 1897-1915, and 14.23 from 1925-1947. In 1977-1979 we observed $\bar{m}_{pg} = 14.46$, but this lower mean brightness can be explained by an unequal distribution of the observed data.

The observed central star of Sh 2-71 cannot be responsible for the radiation of the surrounding nebula. The nebula is of very high-excitation (Glushkov et al., 1975) and the presence of He II $\lambda 4686$ emission line in its spectrum requires a radiation source of $T_* \geq 60000^\circ\text{K}$. On the other hand, the mean colours of the central star, $B-V = 0.84$, $U-B = 0.38$, lead to spectral type B8 (and to visual interstellar absorption $A_V = 3.2$, $E_{B-V} = 3.0$). This contradiction can be explained, as in case of some other planetary nebulae (NGC 1514, NGC 2346, NGC

3132, He 2-36), using a binary hypothesis for the central star: the visible B8 star should be accompanied by a hot sub-dwarf. The observed light changes of Sh 2-71 support this consideration.

This study is only preliminary. More photometric observations are planned in order to obtain the complete light-curve of Sh 2-71.

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