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ON THE NATURE OF V915 SGR AND OF THE NEBULAR OBJECT IN ITS VICINITY

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RESUMEN

Se presentan resultados de fotometría *uvby-β* y espectroscopía de V914 Sgr y de un objeto nebuloso cercano a éste. Los resultados indican que el primero puede ser una estrella eclipsante mientras que el segundo, una nebulosa de reflexión aún no reportada.

ABSTRACT

uvby-β photometric and spectroscopic results of V915 Sgr and a close nebular object are presented. The results indicate that the first might be an eclipsing star whereas the second, a not previously reported reflection nebula.

Key words: **REFLECTION NEBULAE — STARS-VARIABLE — TECHNIQUES-PHOTOMETRIC — TECHNIQUES-SPECTROSCOPIC**

1. INTRODUCTION

The star V915 Sgr (R.A. $18^h\ 41^m\ 33^s$, Dec $-29°\ 4.8'$, 2000) was reported as a Mira star by Kholopov (1985), with an amplitude range between 11.0 and (17 mag and a period of 281.8 d. (In Kholopov's general catalogue the open parenthesis indicates that the variable in minimum light is fainter than the magnitude following this sign). Later, Peña, Campos, & Peniche (1987) discussed its appearance in the photographic collection of the Instituto Nacional de Astrofísica, Optica, y Electrónica (INAOE) archive. Since no photographic photometry was carried out, Peña et al. (1987) merely reported if it was visible or not, being the limit of detectability around magnitude 14; the data were then adjusted to a proposed period of seven years in disagreement with the period of 281.8 d reported by Kholopov (1985). The data points adjusted, in general, equally well to both periods (Figure 1), but there are points occurring close enough in time that do not adjust adequately to either period due to the rapid change shown in magnitude. An example is presented in Figure 2

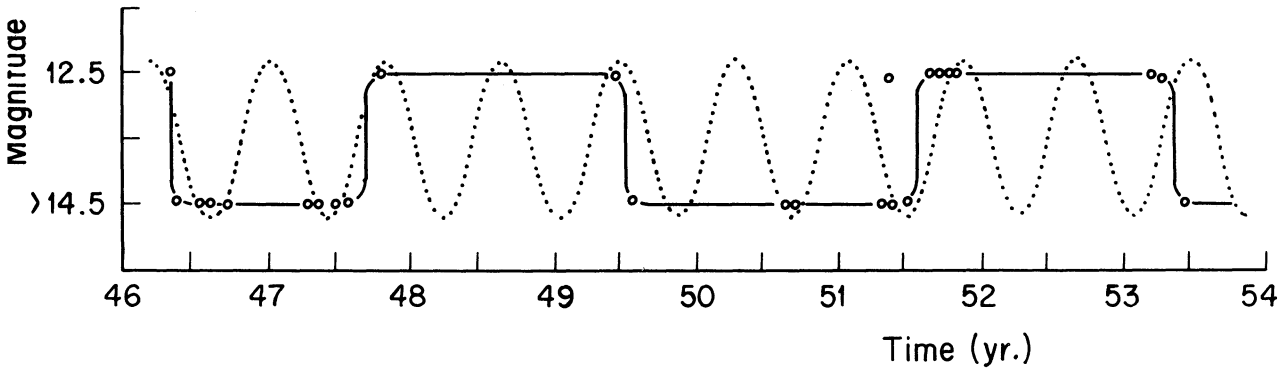


Fig. 1. Superposition of the figure presented by Peña et al. (1987) on which it is indicated whether the star was visible or not, being the limit of detectability around magnitude 14. A continuous line indicates the period of seven years proposed by Peña et al. (1987). A sinusoidal curve, dashed line, of period 280 days, the reported period by Kholopov (1985), has been overlapped to emphasize the existence of a visible point "phase" in either proposed period.

Fig. 2. Sequence of two photographs of V915 Sgr from the INAOE archive. The dates of observation are: July 9–10, 1947 and September 16–17, 1947 with an elapsed time between them of 67 days.

which consists of two photographs taken 67 days apart in which the sudden appearance of V915 Sgr is quite remarkable.

In view of the discordances with respect to the two proposed periods, new observations of this object were planned.

2. OBSERVATIONS

Photoelectric photometry was obtained at the 1.5-m telescope in the *uvby-β* system at the Observatorio Astronómico Nacional at San Pedro Mártir, México. The system, telescope and procedures

TABLE 1

LOG OF OBSERVATIONS

Date	Type	Object
Sep. 5, 1987	spectroscopy	V915 Sgr
Sep. 10, 1987	spectroscopy	nebula
Jun. 1987	photometry	V915 Sgr, C1, C2, nebula

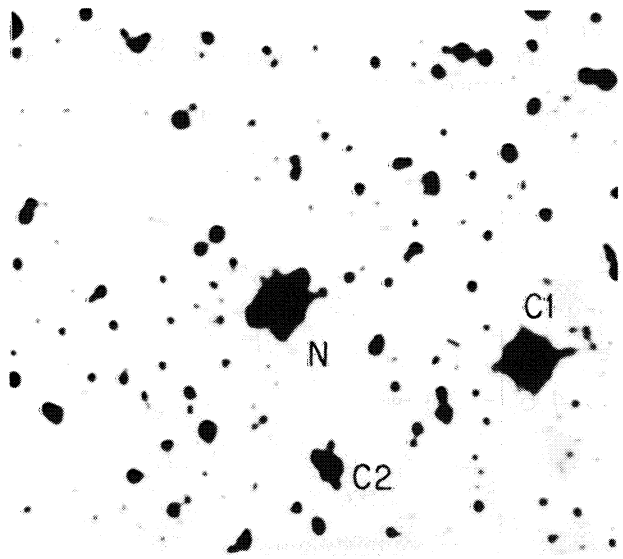


Fig. 3. Enlargement of an INAOE Schmidt plate of the non-stellar appearance of the proposed newly determined reflection nebula. The stars C1 and C2 have been taken as references.

or reduction, as well as uncertainties, have been eported elsewhere (Peña, Díaz, & Peniche 1990). Table 1 and Figures 2 and 3 show the log of observations and relative positions of the observed objects. It should be mentioned, however, that the errors in the photometry of these stars are higher han the reported uncertainties due to the large air-nass (sec z = 2.0). An entrance diaphragm of size .2 mm was used; this, at the telescope, corresponds o 12 arsec. The photometric values obtained in the absolute system are presented in Table 2.

The spectra were obtained with the 1-m tele-cope and a Boller & Chivens spectrograph at the Observatorio Astronómico Nacional at Tonantzintla, México. The emulsion was IIaO and the dispersion, 25 A mm^{-1} centered at Hγ λ4340.

3. DISCUSSION

By means of *uvby-β* photometry it is possible to determine the physical and geometrical characteristics of the observed objects. The method has already been utilized by the authors (Peña et al. 1993). It can be briefly summarized as follows:

First, we ascertained whether the stars were part of the main sequence and the broad spectral regions to which they belonged by constructing a $[m_1] - [c_1]$ diagram. Three main spectral regions were considered: *i)* early type stars of class B and early A, *ii)* A and F stars and, *iii)* late type stars. Different calibrations to determine the reddening and absolute magnitudes have been applied to each group. The reddening for the first group follows a method proposed by Shobbrook in 1984.

TABLE 2

uvby-β PHOTOMETRY OF THE OBSERVED STARS

Id.	V	$b-y$	m_1	c_1	β	HJD 2446900+
V915 Sgr	10.588	1.001	0.811	0.156	2.556	61.895
	10.552	1.006	0.836	0.301	....	62.888
	10.516	0.944	0.676	0.088	....	63.885
⟨V915 Sgr⟩	10.552	0.984	0.774	0.182	2.556	....
σ	0.036	0.034	0.086	0.109	....	....
V915 Sgr	12.461	0.492	0.186	0.454	2.663	67.884
	12.481	0.461	0.222	0.450	....	68.878
⟨V915 Sgr⟩	12.471	0.477	0.204	0.452	2.663	....
σ	0.014	0.022	0.025	0.003	....	....
Nebula	9.146	0.163	0.223	1.039	2.774	60.877
	9.298	0.175	0.157	1.128	2.914	61.885
	9.279	0.171	0.157	1.128	....	62.880
	9.275	0.169	0.159	1.123	....	63.877
	9.333	0.169	0.158	1.131	2.897	67.870
	9.342	0.167	0.161	1.130	2.891	67.889
	9.312	0.167	0.155	1.145	....	68.870
	9.310	0.168	0.155	1.138	....	68.874
⟨Nebula⟩	9.307	0.169	0.157	1.132	2.869	....
σ	0.025	0.003	0.002	0.007	....	....
C1	9.286	0.237	0.169	1.200	....	62.882
	9.274	0.234	0.172	1.188	....	63.880
	9.327	0.237	0.171	1.199	2.829	67.876
	9.307	0.235	0.172	1.208	....	68.872
⟨C1⟩	9.299	0.236	0.171	1.199	2.829	....
σ	0.023	0.001	0.001	0.008	....	....
C2	12.609	0.682	0.487	0.389	....	62.886
	12.374	0.509	0.369	0.349	....	63.883
	12.585	0.728	0.468	0.348	2.510	67.874
	12.536	0.760	0.422	0.346	....	68.869
⟨C2⟩	12.526	0.670	0.436	0.358	2.510	....
σ	0.106	0.112	0.053	0.021	....	....

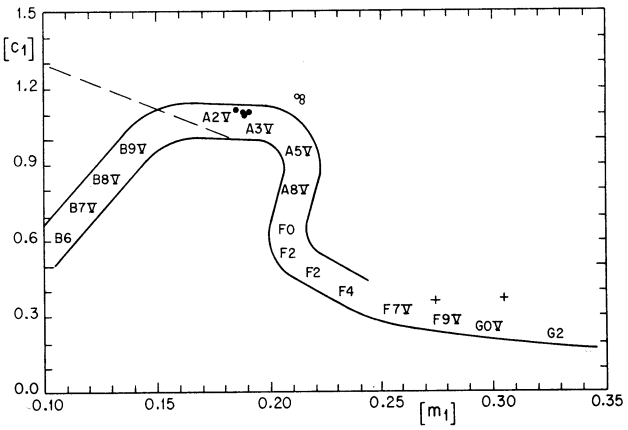


Fig. 4. $[m_1]-[c_1]$ diagram. It defines three main spectral regions as well as the membership of the stars to the main sequence. Filled circles correspond to the nebular object; open circles to the reference star C1 and + sign to the possible eclipsing star.

The determination of the absolute magnitude was obtained by means of a prescription proposed by Balona & Shobbrook (1984). For the intermediate group of A and F stars, the calibration follows a procedure proposed by Nissen in 1988 which is based on Crawford's (1975, 1979) calibrations. The temperature and gravity of each object were determined from their positions in the dereddened theoretical grids of Relyea & Kurucz (1978).

The main results derived for each object are presented:

3.1. V915 Sgr

From the photometric values obtained in June 1987 of V915 Sgr, a sudden change of two magnitudes in a time span of four days was encountered. This large change cannot be due to any observing errors as can be seen from the photometry of the other observed objects, all of which are in the neighborhood of this star and in the same magnitude range. The dereddened indexes $[m_1], [c_1]$ fix it as a main sequence star of spectral type F7-G0 at the maximum brightness observed and of a much later spectral type at the minimum brightness observed (Figure 4). This conclusion is supported by the spectrum obtained. However, due to the relative faintness of the star for the instrumentation employed, the spectrum was not widened, difficulting its analysis. In view of the sudden changes in apparent magnitude a plausible explanation might be that this is an eclipsing binary star.

3.2. The Nebular Object

While the study of the photographic materia was being carried out, a fuzzy object (Figure 4) wa discovered. We tentatively interpreted this objec as a previously unreported planetary or reflectio nebula. Hence, to discriminate between these tw possibilities, we observed it at both observing sites o the Observatorio Astronómico Nacional, San Pedr Mártir and Tonantzintla, with the previously de scribed instrumentation . The photometric value obtained are listed in Table 2.

Its position in the dereddened $[m_1], [c_1]$ diagran presented in Figure 4 indicates that it belongs to th main sequence and its spectral type corresponds t an A star of early spectral type. The reddening wa determined and unreddened values were obtaine following the techniques already discussed by th authors (Peña et al. 1993) for the mean values o Table 2 for each star of early spectral type belongin to the main sequence. These mean values ar presented in Table 3. From these values the follow ing can be inferred:

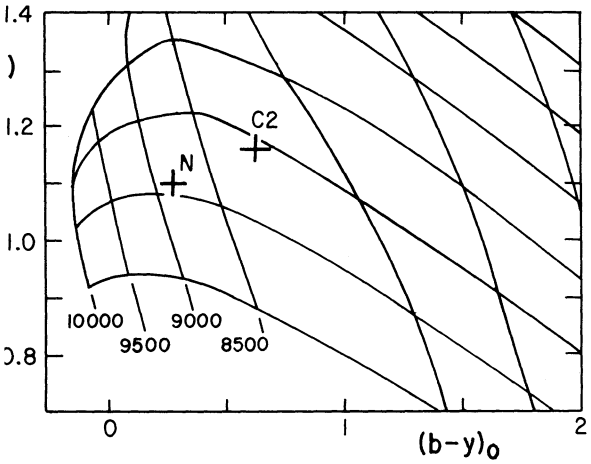
The photometric spectral type is in agreemer with the spectrum obtained (with the same observa tional characteristics as for V915 Sgr, but widene to 150 μm). It has conspicuously broad Balmer ab sorption lines together with a Ca II K line fainte than Hδ. No emission lines were detected.

Its derived absolute magnitude is $M_V = 0.87$ i agreement with the spectrum for an early A typ main sequence star. A distance of 365 pc and a $E(b-y)$ value of 0.145 mag were determined. Th temperature and gravity were determined from th theoretical grids of Relyea & Kurucz (1978) fro the unreddened indexes shown in Figure 5. Onc the main physical characteristics are known th determination of the nature of this object implie that it is a reflection nebula.

TABLE 3

MEAN REDDENING AND UNREDDENED PARAMETERS OF THE OBSERVED OBJECTS

Id.	$E(b-y)$	$(b-y)_0$	c_0	m_0	M_V	DM
V915 Sgr	0.339	0.442	0.222	0.648	5.27	4.59
Nebula	0.145	0.024	1.104	0.205	0.87	7.81
C2	0.175	0.061	1.166	0.229	0.29	8.25



g. 5. Position of the stars in the theoretical grids of elyea & Kurucz (1978).

4. CONCLUSIONS

The variable star V915 Sgr shows relatively rapid anges that suggest it might be an eclipsing star. n the other hand, the nebular object in its vicinity, om both *uvby-β* photometry and spectroscopy, has been found to be a previously unreported reflection nebula.

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