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V3903 SAGITARII: A MAIN-SEQUENCE (O7V+O9V) DETACHED ECLIPSING BINARY *

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ABSTRACT Photometric and spectroscopic observations of V3903 Sgr are analyzed, and absolute dimensions (masses and radii) are determined to a precision better then 3%.

1. INTRODUCTION

The eclipsing character of V3903 Sgr was discovered by Cunha *et al.* (1990). Cousins (1973) and Clariá (1976) have reported variations in the system brightness, but no light curve has been published. The system is a spectroscopic binary (Conti and Alschuler 1971, Niemela and Morrison 1988), very possibly a member of the R association Simeis 188 (Herbst *et al.* 1982). High precision photometric (*uvby*) and spectroscopic observations are used in the present work. No sign of orbital eccentricity or period variation was found in our analysis.

2. SPECTROSCOPIC ANALYSIS

V3903 Sgr was observed from 1989 to 1991 with the 1.6 m telescope and coudé spectrograph at LNA-CNPq (Brasópolis, MG, Brazil) at a mean dispersion of 18.1 Å/mm (projected slit width of 1.4 pixel). The radial velocities were measured by adjusting double lorentzian and/or gaussian curves in order to find the observed center of the lines used. More than 20 interstellar lines can be identified close to H_α. The measured radial velocities (Cunha *et al.* 1993) are shown in Fig. 1, together with data by Niemela and Morrison (1988). Our solution, given in Table I and shown in Fig. 1 as a solid line, indicates that the orbit is circular, which is confirmed by the photometric observations. The observations by Niemela and Morrison (1988) were also taken into account in this solution. Our results yield the mass ratio q ($= M_B/M_A$) $= 0.713 \pm 0.014$.

TABLE I Spectroscopic orbital elements for V3903 Sgr

fixed parameters	component A	component B
$P = 1^d.744204$	$K_A = 234.3 \pm 3.2$ km/s	$K_B = 328.6 \pm 4.7$ km/s
$T_0 = 2\,447\,754^d.4713$	$\gamma_A = 4.2 \pm 2.6$ km/s	$\gamma_B = 7.6 \pm 3.7$ km/s
$\omega_A = 90°$	$a_A \sin i = 11.32 \pm 0.16$ $R_\odot$	$a_B \sin i = 8.07 \pm 0.11$ $R_\odot$
$\omega_B = 270°$	$M_A \sin^3 i = 18.86 \pm 0.62$ $M_\odot$	$M_B \sin^3 i = 13.45 \pm 0.41$ $M_\odot$
$e = 0.00$	$\sigma_A = 16.4$ km/s	$\sigma_B = 23.1$ km/s

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3. PHOTOMETRIC ANALYSIS

3.1. Observations and Ephemeris

The photometric observations were obtained from 1989 to 1991, also at LNA-CNPq, with the 60 cm telescope and a mono-channel photometer equipped with a photon counting system and using a diaphragm of 39.″2 diameter (Cunha and Vaz 1993, Cunha et al. 1993). The light curves u (506 points), v (532), b (544) and y (537) have the typical rms errors of one magnitude difference between the constant comparison stars: $\sigma(\Delta u) = 0^m.009$, $\sigma(\Delta v) = 0^m.006$, $\sigma(\Delta b) = 0^m.005$ and $\sigma(\Delta y) = 0^m.005$. By using the least-squares method to minimize the O–C between the predicted and observed (Cunha *et al.* 1993) times of minima, we find the new ephemeris:

$$\begin{array}{rl} \text{Min I at: HJD } 2\,447\,754.4713 & + \; 1^d.744204 \\ \pm 5 & \pm 6 \end{array}$$

3.2. Photometric elements

The light curves were solved initially with the WINK (Wood 1971; Vaz 1986) model and the final solutions for the four colours, which yield the results of Table II, were found with the WD (Wilson 1979) model. The system configuration turned out to be detached, consistently in the two models, with both components still well inside their Roche Lobes.

TABLE II Mean elements for V3903 Sgr

i	$65^\circ.1 \pm 0^\circ.1$		
Ω_A	3.71 ± 0.07	Ω_B	3.56 ± 0.04
r_A mean	0.341 ± 0.009	r_B mean	0.300 ± 0.002
T_B/T_A	0.896 ± 0.006	($T_A = 38\,000$ K assumed)	
L_B/L_A	0.633 (y)	0.630 (b)	0.628 (v) 0.594 (u)

4. ABSOLUTE DIMENSIONS AND CONCLUSIONS

By using the observed standard indices, the luminosity ratios for the components of V3903 Sgr (Table II) and non-reddened indices for O7V and O9V stars (Crawford 1975), we find a colour excess of $E(b-y)=0^m.31$. This is slightly lower than $0^m.33$ (Herbst *et al.* 1982), but is in better agreement with colour excesses determined for other member stars of the association R Simeis 188. The absorption A_V is then $1^m.33$. Taking into account, together with bolometric corrections estimated from Popper (1980), we calculate the absolute dimensions of the system and estimate its distance from us. The relevant results are shown in Table III.

Combination of the spectroscopic and the photometric solutions indicates that this is one of the rare detached systems in this spectral range, with the components still close to the ZAMS: the evolutionary models by Claret and Giménez (1989) yield an age of $3 \cdot 10^6$ yrs, with the chemical composition (X=0.70, Z=0.02). The absolute parameters for the non-interacting components of V3903 Sgr should then be representative for single stars of the same mass. More spectroscopic observations are being performed and a comprehensive analysis should appear soon (Cunha and Vaz 1993).

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TABLE III Astrophysical data for V3903 Sgr

	Pri	Sec		Pri	Sec
Absolute dimensions:			Photometric data:		
M ($M_\odot$)	25.27 ± 0.84	18.02 ± 0.54	T_e (K)	$38\,000 \pm 1\,000$	$34\,000 \pm 1\,000$
R ($R_\odot$)	7.29 ± 0.21	6.42 ± 0.08	M_{bol}	$-7^m.80 \pm 0^m.13$	$-7^m.05 \pm 0^m.13$
log g (cgs)	4.115 ± 0.032	4.079 ± 0.017	log $L/L_\odot$	4.997 ± 0.052	4.696 ± 0.052
			B.C.	$-3^m.40$	$-3^m.40$
			M_V	$-4^m.40 \pm 0^m.13$	$-3^m.65 \pm 0^m.13$
			$E(b-y)$	$0^m.31$	
			D(pc)	1450 ± 70	

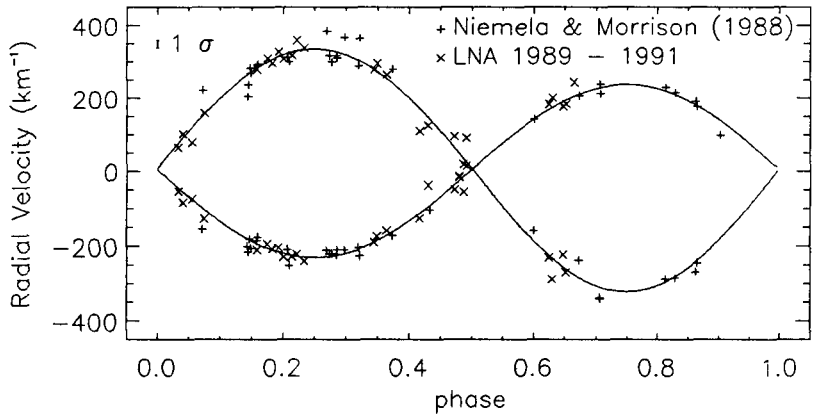

Fig. 1. Observed and theoretical radial velocity curves of V3903 Sgr. The bar at the upper left part of the figure is the mean error (σ) of 1 observation in our measurements.

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