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NEW SPECTROSCOPIC ELEMENTS FOR RX Cas

RX Cas is a strongly interacting close binary system belonging to the W Ser-type. It consists of a K1 giant and the primary star is hidden in a geometrically thick and optically dense accretion shell or disk. Despite repeated attempts by different investigators, the analyses of the orbital light and radial velocity curves have so far given contradictory results.

Therefore, orbital radial velocity curves of RX Cas were constructed from 52 moderate dispersion spectrograms (44 Å/mm) obtained by V. Alduseva and P. Todorova. The methods of measurement and analysis were described by Alduseva (1987).

We believe that the difficulty in deriving a reliable spectroscopic solution is due chiefly to the complex line profiles in spectrum of RX Cas. In the orbital phases at quadratures many lines of FeI, FeII, TiII, SrII and ScII arising in the envelope are divided into two components like the Balmer lines. The line profiles are clearly disturbed by emission. By moderate resolution (~1 Å) most of absorption lines develop into blends. On the other hand, in previous studies Todorova (1990, 1993) showed that the envelope around primary imitates a pseudo-photosphere of a giant G2-3 star. Obviously by measuring of these sort of lines, assuming an early spectral type for primary (Struve, 1944; Alduseva, 1987) really will result in measuring blends from lines of the K-giant and the envelope. This will result in the decreased amplitude of the radial velocity curves.

For the radial velocity curve of K-giant we measured the lines:

FeI: 4045.827, 4063.607, 4071.751, 4191.555, 4250.466, 4260.429, 4325.777, 4383.659, 4415.137, 4427.319 and 4494.575; FeI, CaI 4092.512; FeI, TiI 4404.745; FeI, NiI 4202.093; FeI, TiII 4307.914; FeI, MnI 4030.673; FeI, CoI 4118.702; CrI 4254.330; TiII: 4314.979, 4501.232, 4522.634 and 4571.971; TiII, FeII 4549.560; SrII 4215.524 and ScII 4246.879. For the primary star were used listed lines of FeI and CaII 3933.684, ScII 4246.829 and CrII 4558.66.

A correlation was found between the radial velocities of primary and the stage of physical activity which has a period of 516 days. All lines of envelope are subject of periodic Doppler blue shifts which reach a maximum during the transition stage to maximum light. It is of interest that the lines of CaII, ScII and CrII remained constant during the transition stage to the minimum of the physical activity (i.e. minimum of light). The mean velocity determined from these lines in the first half of orbital periods is -7.0 ± 0.9 km/s, identical with system's γ-velocity. Possibly periodic ejection of the outer layers of the envelope forms an extensive common envelope around the system. The results are shown in Figure 1.

After all of these considerations had been taken into account, we derived solutions in two models: a circular orbit and an elliptical orbit (see Table 1a, b).

Table 1

a. circular orbit solution

secondary		primary		
		FeI	Ca, Sc, Cr	all lines
γ(km/s)	−5.7 ± 0.3	−10.0	−2.2	−6.4 ± 0.7
K(km/s)	96.6 ± 1.5	29.2	31.5	30.3 ± 1.1
ϕ	0.^{P}252 ± 0.^{P}001	0.^{P}237	0.^{P}274	0.^{P}257 ± 0.^{P}001

b. elliptic orbit solution

secondary		primary		
		FeI	Ca, Sc, Cr	all lines
γ(km/s)	−6.0 ± 0.3	−7.7	−0.2	−4.3 ± 0.5
K(km/s)	97.4 ± 1.0	29.8	33.1	31.3 ± 1.0
ϕ	0.^{P}979 ± 0.^{P}001	0.^{P}251	0.^{P}084	0.^{P}200 ± 0.^{P}001
ω	260.°1 ± 2.°5	179.°1	57.°2	154.°2 ± 3.°0
e	0.097 ± 0.02	0.191	0.155	0.163 ± 0.112

The high eccentricity of primary's orbit is most likely the result of the absence of observations near ϕ_{orb}=0.^{P}9 to 0.^{P}0.

For deriving the absolute elements, we used photometric elements from Andersen et al. (1989) in which the secondary K1 III star fills its critical Roche lobe and there is an accretion disk around primary: i= 80°, R_{sec}=0.28, size of disk r_d=0.16 and z_d=0.03 in minimum of the physical activity and r_d=0.15 and z_d=0.04 in maximum.

The absolute elements are listed in Table 2. In view of the facts mentioned above we believe that an amplitude of 30 km/s for primary is a mean value or a lower limit. From these we derive lower limit for the masses.

Since the spectrum of primary was not observed (because it is completely obscured by the envelope), its radius must be smaller than ~2.5$R_\odot$. If it is a main sequence star with mass ~5$M_\odot$ it should have a spectral type of ~B5−A0.

Table 2. Absolute elements

		primary (+envelope)		secondary
		min	max	
R($R_\odot$)	z_d	2.5±0.03	3.3±0.04	23.0±0.28
	r_d	13.2±0.16	12.3±0.15	
M($M_\odot$)		5.3±0.34		1.7±0.17
a($R_\odot$)		19.65±0.97		62.65±0.97
q			0.31±0.05	

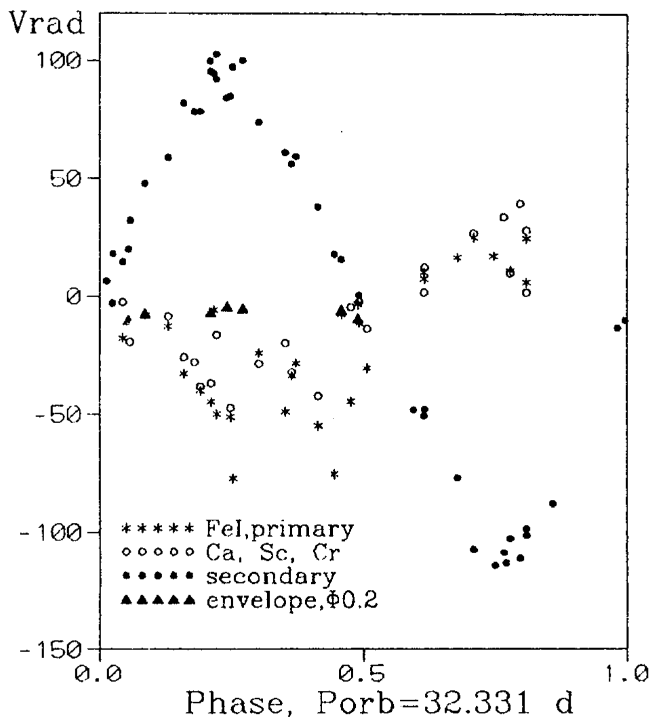

Figure 1. Curves of radial velocities

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