THE NATURE OF RW SEXTANTIS

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ABSTRACT. Photometry and first results of extensive CCD-spectroscopy of the UX UMa system RW Sex are presented. The period is found to be P = 0.24486 days and the semi-amplitude of the radial velocity is K_1 = 101 km s^{-1}. The mass of a Roche-lobe filling secondary is $M_2 = (0.54 \pm 0.09)\ M_{\odot}$ and, for $M_1 \gtrsim M_2$, the mass ratio is $M_1/M_2 = 1.5 \pm 0.5$. The accretion rate is about (2-3) 10^{17} g/s. The model for RW Sex by Greenstein and Oke is discussed and rejected.

1. INTRODUCTION

RW Sextantis (=BD-7°3007) is a V = $10^{m}_{\cdot}6$ UX UMa system, which shows little optical variations. Neither eclipse nor signs of a hot spot have been detected. The optical spectrum shows broad, shallow Balmer and HeI absorption lines with emission cores and weak CaII K in absorption (Cowley and MacConnel, 1972; Cowley, Crampton, and Hesser, 1977; Hesser, Lasker, and Osmer, 1972). The UV (Greenstein and Oke, 1982) shows P-Cygni profiles indicating the presence of a hot wind.

2. OBSERVATIONS

We performed simultaneous UBVRIJHKL photometry on 1981, December 20. using the 1.2m and 2.2m telescopes on the Calar Alto, Spain. The photometric results show little variability and are consistent with earlier observations (Hesser, Lasker, and Osmer, 1972; Haug and Drechsel, 1985).

Table I: Mean values of photometric observations on Dec. 20.,1981

	U	B	V	R	I	J	H	K	L
	9.88	10.62	10.66	10.49	10.48	10.38	10.21	10.17	9.83
+/-	0.02	0.02	0.02	0.02	0.02	0.03	0.03	0.03	0.17

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CCD-spectroscopic observations of RW Sex were performed by one of us using the MPI/ESO 2.2m telescope at La Silla, Chile, for four nights. A total of 54 spectra were collected which cover the wavelength range of 4200Å to 5100Å at a reciprocal dispersion of 59Å mm^{-1} and a resolution (FWHM) of 2.8Å. The integration times were 15 minutes. Two single spectra with reciprocal dispersions of 450Å mm^{-1} and 114Å mm^{-1} were obtained, in addition.

The spectra show broad, shallow absorption lines of H, HeI, MgII λ4481 and CaII, all of which display emission cores or at least filled-up centers. HeII λ4541, λ4686 and the CIII/NIII λ4650 complex are observed weakly in emission (Fig. 1).

The high-resolution spectra were used to determine the orbital period of RW Sex. Using Multiple-Gaussian fits the central position of the broad Hβ absorption was determined. A sinusoidal fit to the radial-velocity variation of this absorption line resulted in a period of $P = 0.24486 \pm 0.00062$ days and a radial-velocity amplitude of $K_1 = 101 \pm 10$ km s^{-1}. This confirms the period suggested by Cowley, Crampton and Hesser (1977), determines it more accurately, and safely excludes aliases.

3. A PHYSICAL MODEL FOR RW SEXTANTIS

In this section, we show that the observations of RW Sex are consistent with the standard accretion disc model for a non-magnetic system and that the masses M_1 and M_2 of the primary and the secondary, respectively, are consistent with the typical values appropriate for the period of the system as suggested by Patterson (1984). To this end, we calculated model flux distributions and determined the parameters of the system which best reproduce the observations. The flux distribution of the accretion disc was first calculated with a code similar to that used by Williams (1980) and Tylenda (1981). This result permitted to distinguish between optically thick and thin regions of the disc. For the optical thick region, the flux distribution was then represented as a sum of about 10 stellar-atmosphere spectra (Kurucz, 1979; Wesemael et al., 1980) for values of T_{eff} and log g, appropriate to the different radial sections of the disc. In addition to the disc spectrum, the overall flux distribution included the contributions by the primary and secondary, taken to be a pure-hydrogen white dwarf spectrum (Wesemael et al., 1980) and a blackbody, respectively. The secondary was assumed to follow the M_2-R_2 relation for main sequence stars, to fill its Roche lobe, and to obey an M_2-T_{eff} relation as suggested by Veeder (1974). The range of acceptable parameters was determined from the fits with two additional assumptions, $M_1 \gtrsim M_2$ and r_1 (inner disc radius) = R_{wd}:

$$M_2 = 0.54 \pm 0.09\ M_o$$
$$M_1/M_2 = 1.5 \pm 0.5$$
$$\dot{M} = (2\text{-}3)\ 10^{17}\ g\ s^{-1}$$
$$r_2 = (3\text{-}4)\ 10^{10}\ cm$$
$$T_{eff}(wd) \lesssim 50\ 000\ K$$
$$i = 32°\text{-}54°$$
$$d = 120\text{-}200\ pc$$

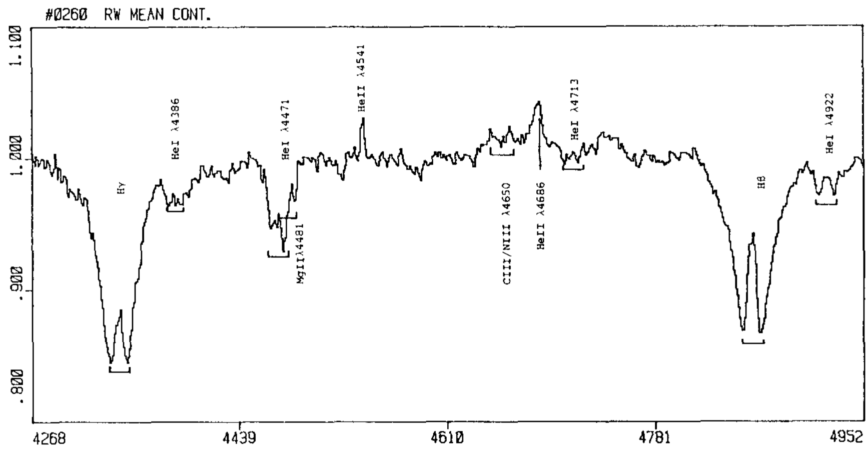

Fig. 1: Normalised mean blue spectrum of RW Sex. Resolution is 2.8Å FWHM.

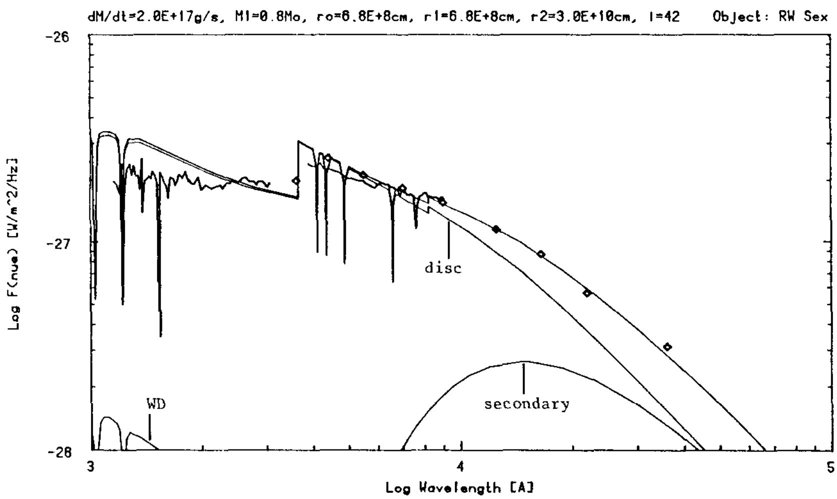

Fig. 2: Comparison of observed and calculated overall flux distributions. Data shown are our simultaneous optical and IR photometry, our spectrophotometry and an UV spectrum from Greenstein and Oke (1982). The parameters assumed for the model spectrum are $M_1 = 0.8\ M_o$, $M_2 = 0.53\ M_o$, $r_1 = 6.8\ 10^8$ cm, $r_2 = 3\ 10^{10}$ cm (outer and inner disc radius), $\dot{M} = 2\ 10^{17}$ g s^{-1}, $i = 42°$, $d = 140$ pc, T_{eff}(sec) = 3500 K, and T_{eff}(wd) = 40 000 K.

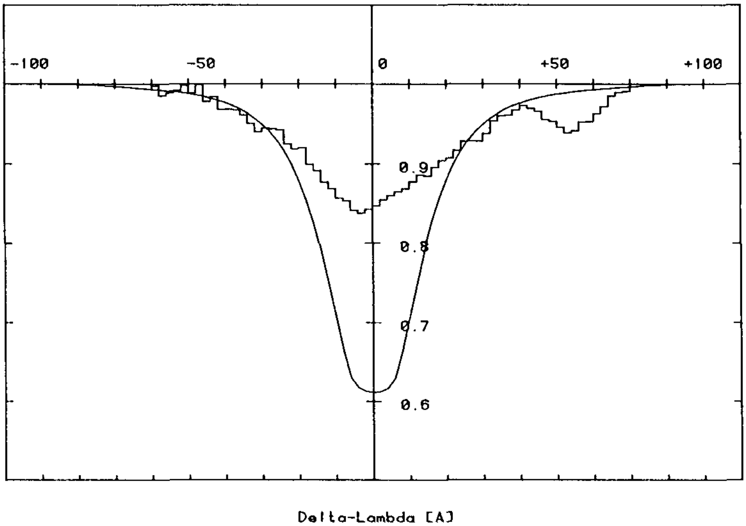

Fig. 3: Rotationally broadened Hδ-Line. Parameters used for the model are the same as in Fig. 2.

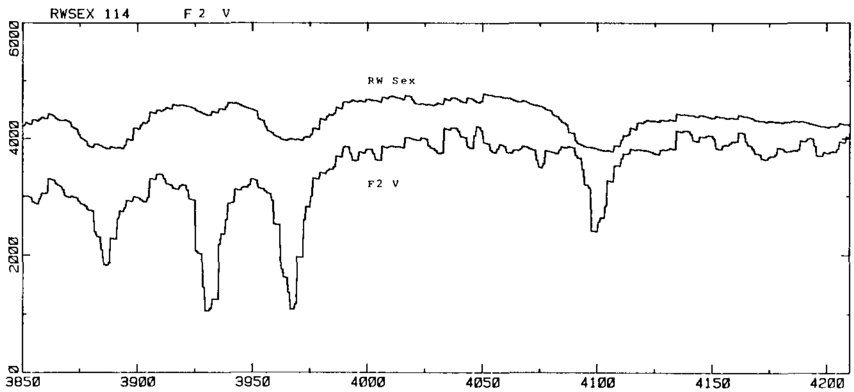

Fig. 4: Comparison of the spectra of RW Sex and the F2V-Star HD 126686. Resolution is 6Å (FWHM).

The disc was found to be optically thick at all radii. Rotationally broadened line profiles of Kurucz (1979) and Wesemael et al. (1980) fit the wings of the observed lines but not the line centers (Fig. 3). The observed narrow emission cores suggest the existence of an optically thin region which does not take part in the rapid Kepler rotation of the inner disc. This region may also be responsible for the observed small height of the Balmer jump.

4. THE MODEL OF GREENSTEIN AND OKE

Based on spectroscopic similarities in the UV, Greenstein and Oke (1982) suggested that RW Sex possesses a small disc similar to that of the doubly-degenerated system AM CVn. In order to fit the observed flux distribution of RW Sex they added a 7000 K bb-spectrum which simulates an F-star secondary.

Such a model is inconsistent, however, both with the observed flux distribution and the spectrum. Calculations with a 7000 K Kurucz model spectrum for the secondary give no acceptable fit to the observed flux distribution. Furthermore the weakness of the observed CaII K line argues against the existence of an F-star in the system. Fig. 4 compares the spectrum of RW Sex with that of an F2V star. The expected equivalent width of CaII K is 20 times stronger than observed in RW Sex. This leads us to the conclusion that an F-star can not be present. Finally, the observed orbital period also contradicts the model of Greenstein and Oke. Kepler's law and the expression $R_2 = a(0.38-0.2\log(M_1/M_2))$ yields

$$P = 2\pi R_2^{3/2} G^{-1/2} (M_1+M_2)^{-1/2} (0.38-0.2\log(M_1/M_2))^{-3/2}$$

Solved for M_1 with the above period and an F-Star as secondary we obtain $M_1 = 0.06\ M_\odot$ which is obviously impossible. The model of Greenstein and Oke can, therefore, be safely excluded.

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