Discovery of the secondary star of the HgMn binary κ Cancri

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Abstract. A careful investigation of a CCD spectrum of the SB1 system κ Cnc in the spectral region 3800 Å – 8000 Å resulted in the discovery of the lines of the secondary star. We then analyzed several short-wavelength range Reticon spectra obtained at different orbital phases to find additional radial velocities. The mass ratio is $m_{\rm A}/m_{\rm B}$ = 2.2 $\pm$ 0.1 and, from binary spectrum-synthesis, the ratio of radii is $R_{\rm A}/R_{\rm B} \geq 2$.

Key words: stars: binaries: spectroscopic – Stars: atmospheres

1. Introduction

κ Cnc (= HR 3623 = HD 78316), one of the best known and studied HgMn stars, is an SB1 spectroscopic binary. Further, a note in the Bright Star Catalogue (BSC) indicates that κ Cnc is a triple occultation system with the primary having a rather bright companion (Δm =0.2 mag). A third star of 7.8 mag in V is at a distance of 0.3 mas from the primary.

During a study of κ Cnc's Mn II lines we noticed an asymmetry in the red wings of all Balmer lines on an echelle spectrum obtained at the 1m telescope of the Special Astrophysical Observatory (SAO). A careful reanalysis of all CCD and Reticon spectra available to us resulted in the discovery of the secondary's lines in them.

2. Observations and radial velocity measurements.

We used spectra of κ Cnc from several observatories, CFHT, DAO, OHP, CrAO and SAO. Most have S/N ratios greater than 200, and spectral resolutions between 35000 and 70000. In our initial search for the possible lines of the secondary, we carefully investigated our SAO spectrum and studied regions around

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the most prominent spectral lines including the Ca II K line, Mg II λ 4481, and strong Fe I and Fe II lines. We found a few rather broad, shallow features which all gave the same radial velocity as that estimated from the Balmer lines. Then we performed a similar search in other spectra of κ Cnc. Table 1 shows our results.

Table 1. A list of the observations of κ Cnc.

Midpoint (JD)		Radial Velocity (km s^{-1})		
2400000 +	Phase	Primary	Secondary	Observatory
44619.078	0.197	-15.10 ± 0.40		CFHT
44620.955	0.490	67.87 ± 0.20		CFHT
44621.042	0.504	78.32 ± 0.50		CFHT
44979.977	0.647	77.76 ± 0.40	-98.0 ± 5.0	CFHT
44981.104	0.824	28.25 ± 0.40	23.5 ± 5.0	CFHT
48378.695	0.824	12.48 ± 0.50	42.0 ± 5.0	DAO
48586.697	0.798	38.58 ± 0.20	-1.5 ± 5.0	OHP
48704.760	0.265	14.10 ± 1.00	60.0 ± 5.0	DAO
49278.051	0.937	-32.00 ± 1.00	115.0 ± 5.0	DAO
49472.372	0.332	33.08 ± 0.50		CrAO
50168.062	0.149	-44.85 ± 1.00	163.0 ± 5.0	DAO
50179.335	0.912	-13.60 ± 1.20	98.0 ± 3.0	SAO

Figure 1 shows the spectrum of κ Cnc near Mg II λ 4481 at three different orbital phases. The contribution from the secondary is shown by a dashed line for each spectrum.

3. Orbital elements and fundamental parameters of the components

Combining our radial velocity measurements with the values from Abt & Snowden (1973) and from Aikman (1976), we calculated the orbital elements for κ Cnc using a code by Tokovinin (1992). Due to the small number of the measurements for the secondary, the orbital parameters for the secondary are preliminary.

P(days) :	6.393190 ± 0.000013	$K_1(\mathrm{km\,s^{-1}})$:	67.64 ± 0.58
T(JD2400000+):	40001.936± 0.055	$K_2(\mathrm{km\,s^{-1}})$:	148.4 ± 10.6
e:	0.137± 0.008	$\gamma(\mathrm{km\,s^{-1}})$:	23.48± 0.37
$\omega(^\circ)$:	$156^\circ.3 \pm 3^\circ.0$	$m_A \sin^3 i(m_\odot)$:	4.45 ± 0.76
		$m_B \sin^3 i(m_\odot)$:	2.03 ± 0.20

Within the error limits our orbital elements coincide with those of Aikman.

The effective temperatures and the surface gravities of the components of κ Cnc were obtained by fitting the observed spectrophotometry (Adelman & Pyper 1979) and hydrogen line profiles, taking into account our mass ratio 2.2 ± 0.1.

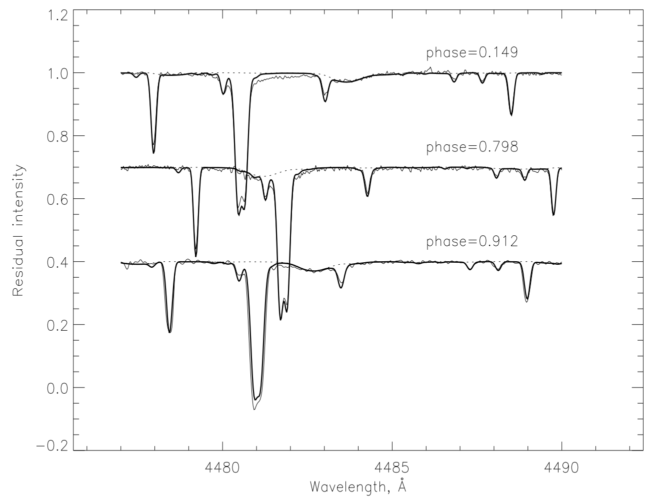

Figure 1. The spectrum of κ Cnc at different phases (thin line). The binary synthetic spectra are shown by thick lines. The spectra are offset by 0.3 in residual intensity.

Primary: $T_{\rm eff}$= 13200 K, log g= 3.7. Secondary: $T_{\rm eff}$= 8500 K, log g=4.0. R_B/R_A = 0.48

These atmospheric parameters together with the ratio of radii result in a flux ratio in the V band of about 11.5, which is equivalent to a magnitude difference of Δm=2.6 mag. It is in good agreement with the Δm=2.56 mag difference between the visual magnitude of κ Cnc and that of the third component mentioned in the BSC. The positions of both stars on their evolutionary tracks indicate that the primary has a mass of about 4.5 $m_\odot$ and is close to the end of its main-sequence life, while the secondary has a mass about 2 $m_\odot$.

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