HD 202664: a new HgMn star?

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Abstract

I report the discovery of a new SB2-type system consisting of two early-type stars orbiting each other in 11.27 days on a circular orbit. From the radial velocity solution, estimated projected masses ($M\sin^3 i$) of the components are 2.0 and 1.9 $M_\odot$. Neither of the components has a measurable longitudinal magnetic field. Slow rotation and similar chemical composition of the components as well testify to the HgMn nature of HD 202664.

Introduction

About 15% of the upper MS stars, also known as CP stars, show the presence of anomalies in their spectra [1]. There is a fraction of CP stars hosting strong, well-organized magnetic fields which remain stable over time. The magnetic and non-magnetic CP stars share the same ranges of the effective temperature and mass, but the origin of the observed dichotomy is still unclear. Hence, in the studies of the magnetic CP stars, it is important to properly select the chemically "normal" and non-magnetic control stars.

HD 202664 is a $V = 7.^{m}81$ purely studied star in Cygnus. It was selected as a comparison star to HD 201174: a CP star with strong magnetic field. The stars have similar spectral classes (B9 and A0 for HD 202664 and HD 201174, resp.) and brightness ($7.^{m}8$ and $8.^{m}77$). Placed close and having similar parallaxes (2.0 and 3.76 mas, resp.) HD 202664 and HD 201174 seem to undergo the same interstellar reddening.

From the very first observations at the Special Astrophysical Observatory, it was clear that the spectrum of HD 202664 has the lines of two components. Further observational campaign of the star was aimed to search for its magnetic field and determine its orbital parameters.

Observations

Observations have been carried out since 2013 with the use of a medium-resolution ($R = 15,000$) long-slit spectrograph MSS [2] mounted at the 6-m BTA. It was used in spectropolarimetric mode to search the magnetic field in 2013, 2015, and 2017. Overall, 16 individual spectropolarimetric observations took place. Table 1 summarizes the moments of spectropolarimetric observations.

Raw images were reduced in a common for spectroscopy way. All stages of data reduction, except the continuum normalization, were performed using the ESO-MIDAS context Zeeman [3]. A hollow-cathode Th-Ar lamp acts as a reference source for the wavelength calibration.

Spectropolarimetry

Previous to this study, there was no provided information about magnetic properties of HD 202664. For the first time, the search for a magnetic field was carried out with the use of 16 individual observations obtained with the MSS.

Zeeman spectra cover two overlapping wavelength windows from 4140 to 4495 Å and from 4420 to 4975 Å. Spectra of HD 202664 are rich in very weak lines. This motivates the selection of a method described in [4] for measuring the longitudinal magnetic field of the star. Following analysis has not indicated a significant signal of the field (see Figure 1 and Table 1).

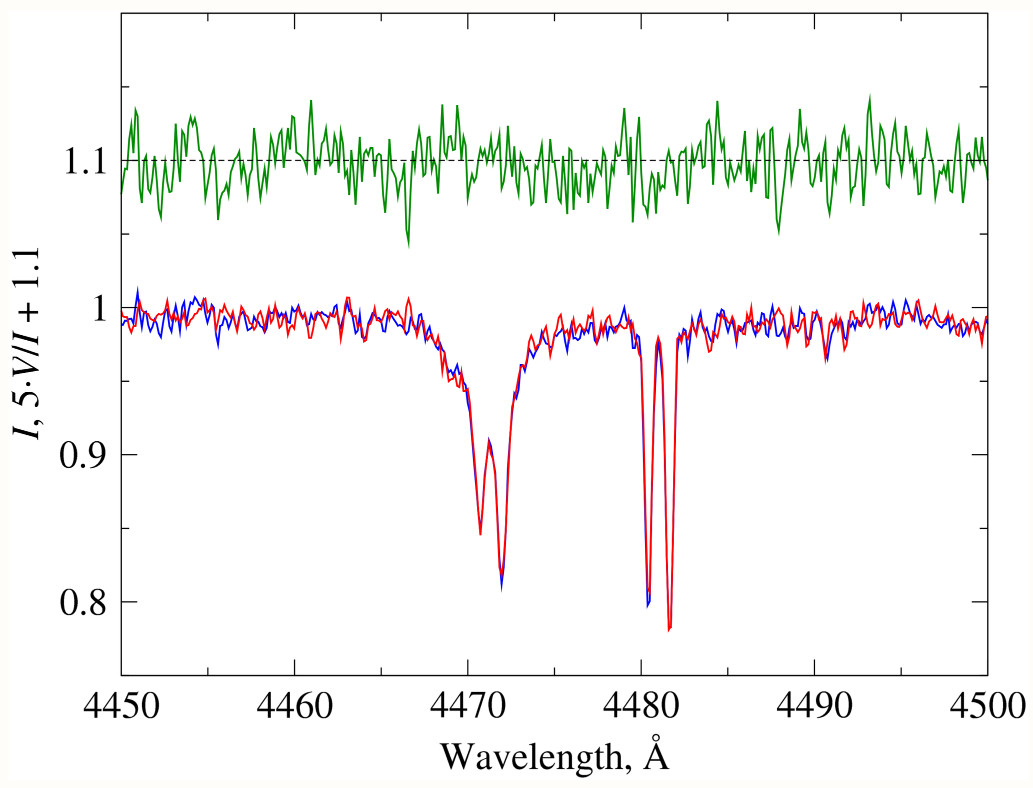

Figure 1: A sample of polarized spectra of HD 202664.

Table 1: Measured longitudinal field of HD 202664.

HJD	B_z, G	σ, G
2456590.284	200	100
2457241.461	−30	50
2457242.352	−300	120
2457242.505	−10	70
2457244.320	70	60
2457244.447	0	60
2457245.333	−50	60
2457245.464	125	60
2457245.488	−40	70
2457246.345	40	70
2457246.544	−40	70
2457261.414	0	60
2457823.595	−60	60
2457825.570	20	50
2457827.559	100	60
2457829.515	−70	60

Spectroscopy

HD 202664 is a SB2 binary system of two almost identical stars. Radial velocities of the components are derived with high accuracy since the spectral lines are narrow and significantly shifted due to the Doppler effect (Figure 2).

RV solution results in a circular orbit with the following parameters:

$$P = 11.27140 \pm 0.00035 \text{ days}$$
$$T_p = 2457209.923 \pm 0.205 \text{ HJD}$$
$$e = 0.007 \pm 0.005$$
$$\omega = 327.32 \pm 6.61 \text{ deg}$$
$$\gamma = -8.1 \pm 0.3 \text{ km/s}$$
$$K_1 = 73.01 \pm 0.48 \text{ km/s}$$
$$K_2 = 77.85 \pm 0.50 \text{ km/s}$$

Given the parameters, the projected masses ($M\sin^3 i$) are 2.07 $M_\odot$ and 1.94 $M_\odot$ for the primary and secondary star, respectively. Hence, the components are physically equal.

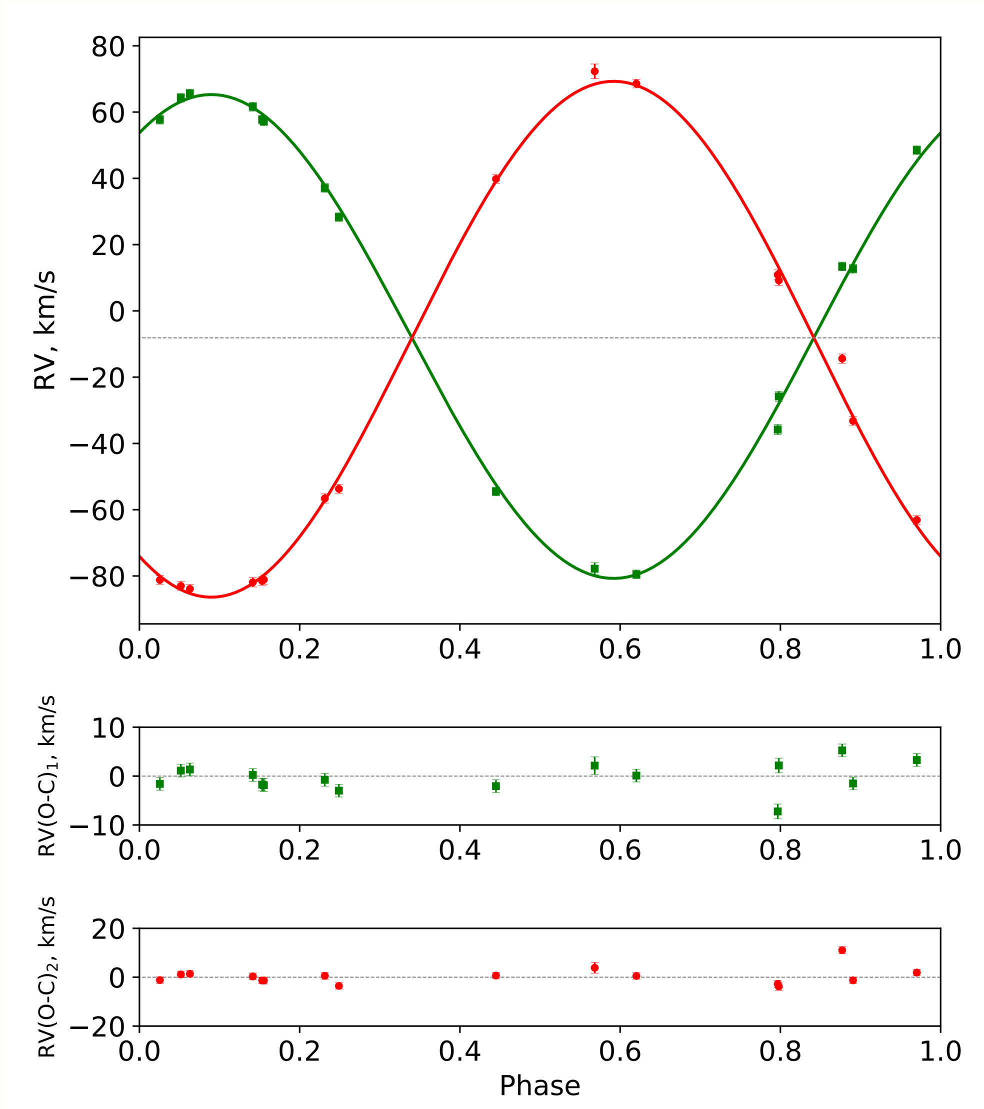

Figure 2: Measured radial velocity of the primary and secondary components.

Assuming that the components are similar, the observed spectra were fitted with the model. The effective temperature $T_{\rm eff}$ around 13,000 K and the surface gravity $\log g = 3.9$ give a satisfactory agreement with the observations. The primary component looks slightly hotter with $T_{\rm eff} = 13,300$ K, though it is still within the errors. All other parameters excepting individual abundances seem to be the same for both stars. The value for the projected rotational velocity was adopted as 20 km s^{-1} according to the MSS resolving power. The real values of $v_e \sin i$ may be lower.

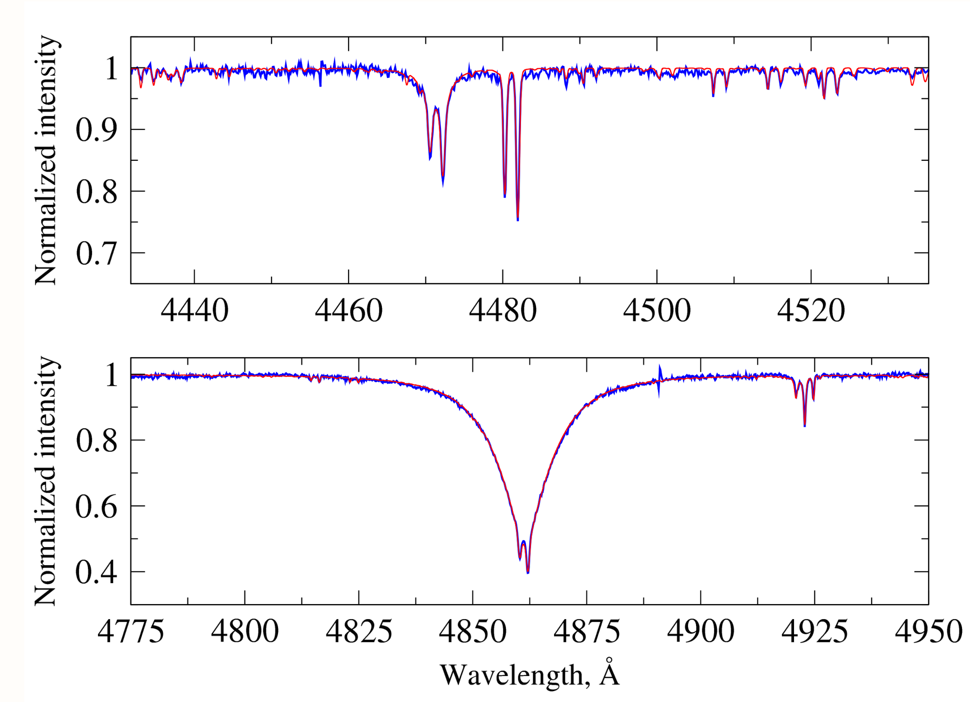

Figure 3: A sample of observed spectrum compared to the model.

The individual profiles of Fe and Cr lines are best fitted with an assumption of weak underabundance. At the same time analysis of He and Ti lines corresponds to solar chemical composition of both components. To quantify the composition more accurately spectra of the components must be disentangled, which requires exceptionally high in SNR spectra covering the full orbital phase.

Acknowledgements

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