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A Study of the Orbital and Intrinsic Variability of the Double-Lined Spectroscopic Binary β Centauri

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Abstract. We introduce our observational study of the orbital motion of β Cen. Using 463 high signal-to-noise, high-resolution spectra obtained over a timespan of 12 years it is shown that the radial velocity of β Cen varies with an orbital period of 357.0 days. We derive for the first time the orbital parameters of β Cen and find a very eccentric orbit ($e = 0.81$) and similar component masses with a mass ratio $M_1/M_2 = 1.02$. Both the primary and the secondary exhibit periodic line-profile variations.

1. Introduction

As long ago as the beginning of the twentieth century, β Cen (HD 122451, B 1 III, $m_V = 0.6$) was exposed as a star with a variable radial velocity. Breger (1967) suggested that β Cen is a β Cep star in a binary system but it was only three years ago that conclusive evidence for binarity was found by Robertson et al. (1999): interferometric observations with the 3.9m AAT (Anglo-Australian Telescope) showed two components having similar brightness and the 50 spectrograms taken in May 1988 by C. Waelkens revealed β Cen to be double-lined.

In order to determine the orbital parameters we have intensively monitored β Cen with the CAT/CES and Euler/CORALIE equipment at La Silla during the periods January – June 1998 and October 1999 – August 2000. The observed spectral domain was centered on the Si III triplet at 4567.8Å.

2. Determination of the orbital parameters

We applied the Léhmann-Filhés method (1894) to the first velocity moments of the λ 4552Å and λ 4567Å line of the primary. We find an orbit with a very large eccentricity of 0.81 and an orbital period of 357.0 days. This model explains 98.5 % of the variability present in the data, which is a very high percentage, taking into account that there is still variability due to the pulsations of the primary in the first moment.

By making an effort to determine also the orbital elements of the secondary component, we were able to derive a mass ratio $M_1/M_2 = 1.02$. This result is in agreement with the similarity of brightness and effective temperature (Robertson et al., 1999) of the two components.

The radial velocity curves of β Cen are shown in Fig. 1. Since β Cen is relatively nearby, with a parallax of $\pi = 6.21 \pm 0.56$ mas, further interferomet-

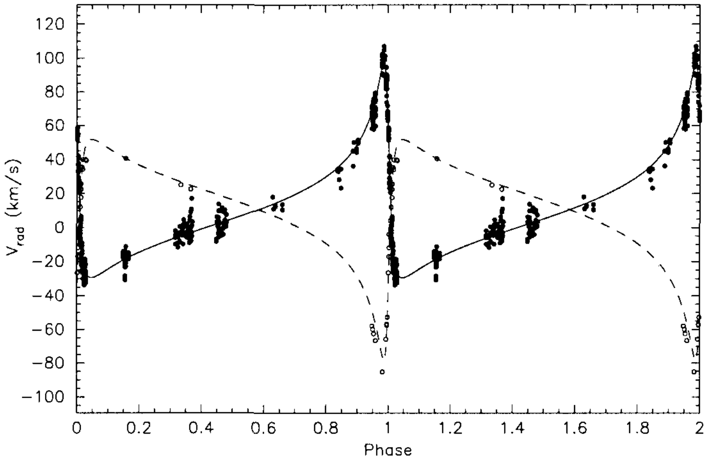

Figure 1. The radial-velocity curves of the binary β Cen. The filled and open dots represent the observed radial velocities of the primary and secondary components, respectively, around the center of mass. The full and dashed line represent the best fitting orbits.

ric observations should allow the determination of the orbital inclination, and subsequently of the individual masses and radii.

3. Intrinsic variations

The ongoing frequency analysis reveals periodic variations in the radial velocity, after subtraction of the orbital motion, with an amplitude of some 13 km s^{-1} on a timescale of a few hours. Because photometric variability is absent in the primary, this indicates the excitation of pulsation modes with a relatively high degree only.

Furthermore, we notice clear variations in the line profiles of both the primary and the secondary. This confirms the earlier speculation that the secondary also exhibits pulsations (Robertson et al., 1999). We refer to our forthcoming study for a detailed analysis of the short-period line-profile variability due to pulsation.

References

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