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Spectral separation of two pulsating non-single stars

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Abstract. θ^2 Tau and RS Cha are 2 binary systems also showing δ Scuti-type pulsations. θ^2 Tau is a Hyades "single-lined" spectroscopic binary with an orbital period of 140.7 days. Its secondary component, though of similar temperature, is less evolved and fainter than the primary and is therefore difficult to detect spectroscopically. RS Cha is a double-lined pre-main-sequence eclipsing spectroscopic binary orbiting with a short 1.7 days period. Since both systems address several interesting issues related to stellar evolution, metallicism, binarity and pulsation, we explore in the present contribution the possibility to study their spectra using the Fourier disentangling technique developed by Hadrava (1995) for extraction of reliable and accurate component properties.

Key words. Stars: abundances – Stars: fundamental parameters – Stars: binaries: spectroscopic

1. Introduction

The study of a pulsating star which is a true member of a binary system presents the advantage that independent information on the physical properties and chemical composition of the individual components can be derived, thereby allowing to explore in an empirical way the interactions that may exist between pulsation, diffusion, rotation and multiplicity. Many pulsating stellar systems are however hard to resolve with average-sized (2-4 m) telescopes, even spectroscopically. The observed spectra are composite and these introduce bias effects when analyzed for individual properties. Using the spectral disentangling technique developed by Hadrava (1995) and incorporated into the KOREL computer code, we initiated a spectroscopic study of two binaries with a δ Scuti component: the well-detached binary θ^2 Tau and the eclipsing binary RS Cha.

2. θ^2 Tau

θ^2 Tau (HD 28319), the brightest member of the Hyades cluster, is a component of a quadruple system as well as an interesting δ Scuti

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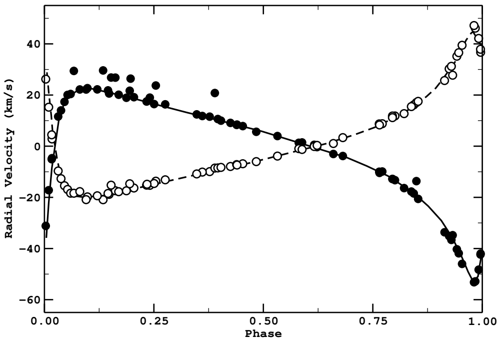

Fig. 1. Radial velocities derived with KOREL for θ^2 Tau A (open circles) and θ^2 Tau B (filled circles).

star (Breger et al. 2002). θ^2 Tau is also a single-lined spectroscopic binary (SB1) with an orbital period of 140.7 days and an eccentricity of 0.7 which was resolved by long-baseline interferometry. The primary component, θ^2 Tau A, was classified A7III and rotates with V sin i = 70 km/s. The secondary, θ^2 Tau B, is difficult to detect spectroscopically (Torres et al. 1997).

In order to test whether application of the disentangling technique would be succesful in extracting the contribution of the fainter component, we made use of the spectra gathered by Torres et al. (1997). 65 spectra, uniformly distributed over the whole orbital phase, were fed into KOREL. We furthermore fixed the luminosity ratio and the orbital parameters to the values derived by the same authors because of the narrow spectral window (45 Å only). Fig. 1 illustrates the individual radial velocities obtained by cross-correlation of the observations with the component spectra which have thus been obtained for the first time.

3. RS Cha

RS Cha is a PMS Algol-type eclipsing binary with a very short orbital period (P_{orb} ~1.67 days), and with two similar components (both have spectral type A7 V) undergoing δ Scuti-type pulsations (Alecian et al. 2005). The target is thus most suitable to test whether radiative diffusion can occur in an early stage of stellar evolution.

The spectroscopic observations were collected at the SAAO by means of the GIRAFFE fibre-fed echelle spectrograph attached to the 1.9-m Radcliffe telescope. Excepting those phases corresponding to the partial eclipses, all the spectra were used as input for KOREL. We applied the procedure of spectral separation using the well-known orbital parameters and obtained the component spectra from which we derived effective temperatures using LTE model atmospheres. Our results are in good agreement with those previously obtained, especially in the case of the secondary component ($T_{\rm eff}$ = 7330 ± 100 K). For the primary component ($T_{\rm eff}$ = 7926 ± 150 K), the value is different at the level of 1-σ from that of Ribas et al. (1998) ($T_{\rm eff}$ = 7687 ± 180 K). Therefore, further analysis using spectral disentangling is warranted.

4. Conclusions

We applied the procedure of spectral separation in order to resolve the component spectra of two interesting pulsating non-single stars with the aim to explore the feasibility of spectral disentangling. New spectra extending on a larger spectral domain (e.g. including hydrogen lines) are however needed in the case of θ^2 Tau. We are therefore in the process of gathering well-distributed high-resolution echelle spectra at OHP and at Ondrejov Observatory. In the future, we plan the detailed chemical analysis of these two systems.

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