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Spectral disentangling of the metallic-lined binary system WW Aurigae

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Abstract. WW Aurigae is doubled-lined eclipsing binary system. Both components show Am characteristics. Recently, Southworth *et al.* (2005) measured the properties of WW Aur with accuracies of 0.4% in mass and 0.6% in radius, making these among the most accurately known for any stars except the Sun. These properties are matched by theoretical evolutionary models only for a high (2.5 times solar) metal abundance. In a continuation of that study, we have reanalysed the time-series of 57 double-lined spectra (from the INT at La Palma) using spectral disentangling to obtain high-quality separated spectra of the two stars. Our goal is to further improve the determination of the effective temperatures and to study the peculiar chemical abundances of the two stars.

Key words: stars: binary – stars: Am – methods: spectroscopy

1. Introduction

Spectral synthesis is a powerful method to study the effective temperatures, surface gravities and chemical abundances of stars, but can be limited by a degeneracy between temperature and gravity. Accurate surface gravities can be measured for the components of eclipsing binary systems, but the composite nature of their spectra makes abundance analyses more difficult.

Here we present a solution to these problems: the study of eclipsing binaries using spectral disentangling. Using spectral disentangling algorithms it is possible to obtain the separate spectra of the components of binary and multiple systems from a set of phase-resolved composite spectra. The separated spectra can be analysed as single star spectra, but with two advantages. Firstly, they are calculated from the full set of input spectra so have a much higher signal to noise ratio than individual observations. Secondly, the surface gravity can be fixed at the values measured independently for each star.

Eclipsing binaries are fundamental tests and calibrators of theoretical stellar models, because it is possible to accurately measure the masses and radii of their components. Spectral disentangling naturally complements this by providing high-precision effective temperatures and chemical abundances (Hensberge *et al.*, 2000; Pavlovski, Hensberge 2005; Southworth, Clausen 2007).

2. Method

Spectral disentangling is a powerful technique which enables the separation of a time-series of composite spectra of a binary or multiple system into the spectra of the individual stars (Simon, Sturm 1994). This process is not compromised by blending, and the resulting spectra can be analysed in the same way as those obtained for single stars. Hensberge and Pavlovski (2007) have discussed spectral disentangling, successfully applied it to different types of binary and multiple systems, and investigated the error analysis for this procedure.

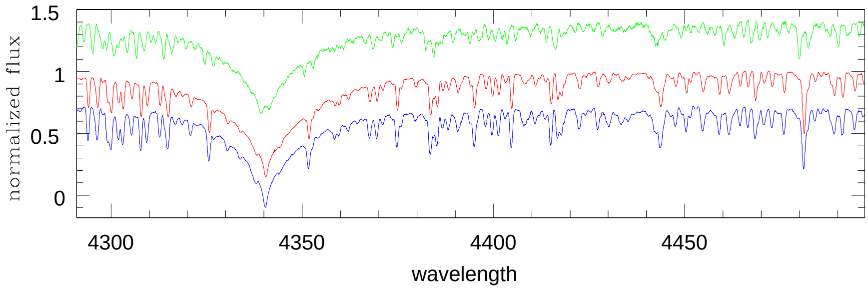

Figure 1. Disentangled spectra of the primary and secondary component of WW Aur (middle and bottom lines) renormalized to their own continua. An observed composite and highly blended spectrum is shown for comparison (upper line).

For WW Aur we have obtained a new spectroscopic orbit from radial velocities measured using spectral disentangling. To achieve this, a disentangling analysis was performed in velocity space on the set of 57 spectra which are centred on the Hγ λ 4340 line, using the code FDBINARY (Ilijić *et al.*, 2004).

The disentangled spectra are shown in Fig. 1, where the similarity between the spectra of the two stars is clear. A preliminary abundance analysis shows that both components have abundance patterns which resemble those of Am stars (a deficiency of Ca and Sc and overabundance of heavy elements). A detailed abundance analysis is in progress and will be published later.

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