SPECTRAL INVESTIGATIONS OF CM DRA

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ABSTRACT. We present an analysis of a high resolution (R=47000) echelle spectra of the low-mass eclipsing binary CM Draconis, which were obtained on the 4.2-m William Herschel Telescope. Spectra were obtained for various phases of the orbit. There are some difficulties in echelle spectra processing of cool stars, since it is hard to get energy distribution in a large scale in such spectra. We proposed an efficient method for making the continuum of spectrum of cool stars. We refined the parameters (effective temperature, rotational velocity and metallicity) of the components of the system CM Dra using the method of stellar atmospheres. The data that we obtained are in good agreement with the results obtained by other authors. It is indicate on efficiency of our technique. The errors of temperature and metallicity determinations is about 100 K and 0.3 dex respectively.

Key words: Stars: binary: eclipsing binary, fundamental parameters: stars, low-mass: stars; stars: individual: CM Dra

1. Introduction

The CM Dra is low-mass eclipsing binary system. It is classical double-lined spectroscopic binary. Period of the system is $P = 1.268$ day (Metcalfe et al. 1996). CM Dra is high proper motion object, it can be attributed to Population II (Lacy 1977). The orbits eccentricity of CM Dra is $e = 0.00051$ (Morales et al. 2009). This may indicate the presence of a third component in the system. Components of CM Dra are almost identical cool dwarfs. Their spectral types are estimated as dM4.5 (Metcalfe et al. 1996). Both components of CM Dra are metal poor stars (Viti et al. 2002). Masses and radii for the components are known with high accuracy. $M_1 = 0.23M_{sun}; M_2 = 0.21M_{sun}$;
$R_1 = 0.25R_{sun}; R_2 = 0.23R_{sun}$ (Morales et al. 2009) It makes CM Dra good test object for studying models of cool dwarfs atmospheres and spectra processing methods.

2. Observations and reduction

High-resolution spectral observations of CM Dra were carried out on the 4.2-m William Herschel Telescope using the echelle high-resolution spectrograph (UES). The spectra were obtained during queue observing runs from 20 to 23 May 1997 in different phase. In the course of this work we used 64 spectra of CM Dra. Resolution of obtained spectra is R=47000, spectral range is 4500 -10000 AA. In the observed spectrum we resolve spectral lines of both components. In case of the echelle spectra we lost information about energy distribution in a large scale in the spectra, which is important for analysis of cool dwarf spectra. It is possible to use only a few strong atomic lines which can be identified against the background of TiO bands in spectra M dwarfs. In fact, we can work here with pseudocontinuum formed by the haze of molecular lines. In the framework of this work we used spectra of divisor for determination of pseudocontinum level. We found the good enough agreement between synthetic and reduced observed spectrum.

3. Atmosphere models of components and synthetic spectra of CM Dra

Synthetic spectra were calculated for different T_{eff} and abundances. A rotational velocity $V sin(i)$ =10 km/s and microturbulent velocity V_{turv} =3 km/s was adopted. We used NextGen models (Hauschildt et al. 1999) as stellar atmospheres models. Synthetic spectra were computed by program WITA6 (Pavlenko 1997) for both components. We used the line list of atomic line from VALD (Kupka et al. 1999) and the line list of TiO from Plez et al. 1998.

To account the duality of the system, i.e. we composed synthetic spectra of the components according to their radial velocities. From the best fitting theoretical to observed spectra of CM Dra in regions of NaI (8185 AA, 8197 AA), RbI (7818 AA) and CaI (6719 AA) we determined T_{eff} =3100 K and metallicity $[M/H]$ =-0.5 dex for each component. The

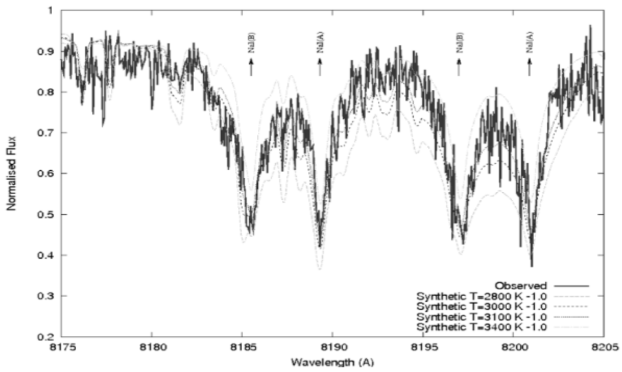

Figure 1: Fits of CM Dra synthetic spectra computed with different T_{eff} in the region of NaI 8185, NaI 8197 lines T_{eff}=2800 K; T_{eff}=3000 K; T_{eff}=3100 K; T_{eff}=3400 K; $Vsin(i)$=10 km/s; V_{turv}=3.0 m/s

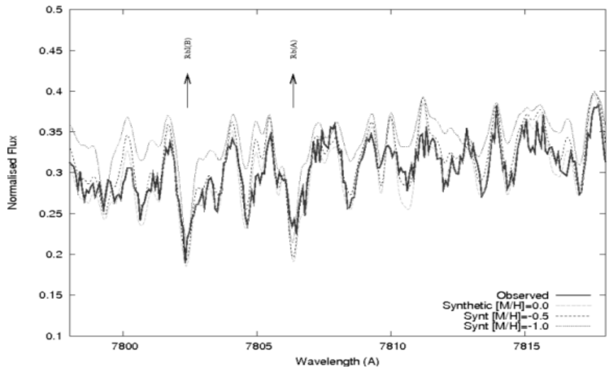

Figure 2: Fits of CM Dra synthetic spectra of computed with different [M/H] in the region of Rb 7802 line [M/H]=0.0; [M/H]=-0.5; [M/H]=-1.0

errors of temperature and metallicity determinations is about 100 K and 0.3 dex respectively. These results are in good agreement with previous studies.

4. Conclusions

We determined effective temperature and metallicity of CM Dra components. Effective temperature of both components is T_{eff} =3100 K $\pm$ 100 K and metallicity is $[M/H]$ =-0.5 $\pm$0.2 Our results are in good agreement with previous studies. Thus we can be confident of the effectiveness of our methodology for the analysis of stellar atmospheres of binary systems. In the near future investigations we investigate some interesting effects due to the interaction between the components, such as overheating of the the part of atmosphere of one component by the irradiation by the second component, etc.

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