The Art of Modelling Stars in the 21st Century
Proceedings IAU Symposium No. 252, 2008
L. Deng & K.L. Chan, eds.

doi:10.1017/S1743921308023181

Advanced test of the model stellar atmospheres: the nature of the light variability of magnetic chemically peculiar stars

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Abstract. The magnetic chemically peculiar stars exhibit both inhomogeneous horizontal distribution of chemical elements on their surfaces and the light variability. We show that the observed light variability of these stars can be successfully simulated using models of their stellar atmospheres and adopting the observed surface distribution of elements. The most important elements that influence the light variability are silicon, iron, and helium.

Keywords. stars: chemically peculiar, stars: early-type, stars: variables: other, stars: atmospheres, stars: magnetic fields

1. Magnetic chemically peculiar stars

Magnetic chemically peculiar stars belong to one of a few groups of variable stars whose light variations are not very well understood. These stars show inhomogeneous surface distribution of different elements, including helium, silicon or iron. Krtička *et al.* (2007), Krtička *et al.* (2008) showed that the redistribution of the emergent flux due to the bound-free (continuum) and bound-bound (line) transitions in the stellar atmosphere is a promising mechanism producing the observed light variations. Consequently, the comparison of observed and simulated light variations can provide an important new test of modern model stellar atmospheres.

2. Light curve calculation

The models of the stellar atmospheres are calculated using the code TLUSTY Hubeny & Lanz (1995), Lanz & Hubeny (2007) assuming a fixed stellar effective temperature and surface gravity. The abundance of chemical elements concerned is set in agreement with the maps of surface elemental distribution derived from spectroscopy.

The emergent fluxes from individual surface elements are calculated using the code SYNSPEC. From these fluxes the magnitudes of the star in individual filters of Strömgren photometric system are derived. Finally, these simulated light variations are compared with the observed ones. We stress that we do not use any free parameter to fit the observed light curves.

We use the ephemeris derived by Adelman (1997b) for HD 37776 and by Krtička *et al.* (2008) for HR 7224.

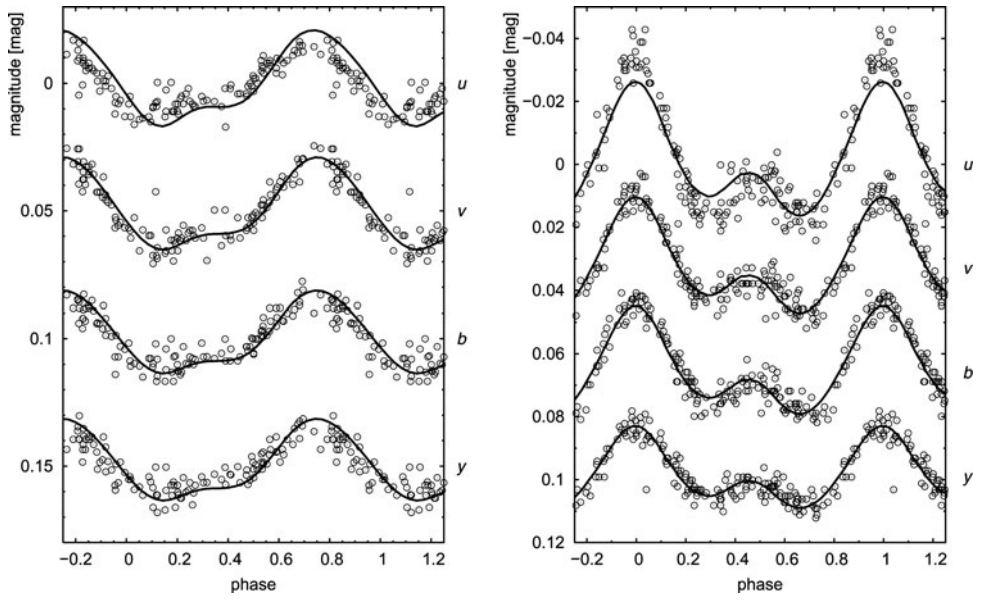

Figure 1. Left: Comparison of the predicted light variations of HD 37776 (calculated using the silicon and helium surface distribution according to Khokhlova *et al.* (2000)) and the observed one (Adelman & Pyper 1985, Adelman 1997b) in different colours. Right: Comparison of the predicted light variations of HR 7224 (calculated using the iron and silicon surface distribution according to Lehmann *et al.* (2007)) and the observed one (Adelman 1997a) in different colours.

3. Conclusions

We conclude that the observed light variations of HR 7224 and HD 37776 can be explained as a result of inhomogeneous distribution of helium, silicon and iron on the surface of these stars. This causes the redistribution of the flux from the ultraviolet to the visible part of the spectrum, and, due to the stellar rotation, the light variations.

A very good agreement of observed and simulated light variations serves as an independent test of modern model stellar atmospheres. The successful comparison of predicted and observed light curves would not be possible without using the calculations of radiative ionization cross-section done by the Opacity Project team Seaton *et al.* (1992).

Acknowledgements

Grants GA ČR 205/08/0003, 205/06/0217, and VEGA 2/6036/6.

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