Eclipsing binaries as a test for synthetic photometry

Summary

- Narrow band photometry is a useful tool to characterize large numbers of stars, but observed colors and indices must be connected to astrophysical parameters by synthetic photometry.
- We present synthetic Hβ indices calculated from 1D model atmospheres implementing different convection treatments.
- The calculated indices are transformed to the standard system using observed medium-resolution spectra.
- We test the synthetic photometry with observed indices of eclipsing binary systems.
- The computed indices agree with the observed ones up to an amount expected from the observational errors, the accuracy of the atmospheric parameters, and computational uncertainties.

Synthetic β indices

- Several different grids of stellar atmosphere models for B to K dwarfs and giants at a range of metallicities: CGM and MLT(α,γ) models from Heiter et al. (2002), LL models from Shulyak et al. (2004) with CM and MLT convection treatment, MARCS models from Gustafsson et al. (2003, M), ATLAS9 models from Castelli & Kurucz (2006, CK).
- High-resolution synthetic spectra with SYNTH3 code (S3, see Piskunov & Kochukhov 2002) or as included in model atmosphere codes above.
- Transmission functions for β filter set from Crawford & Mander (1966) as shown in Figure 1 (black lines).

Transformation to standard system

- βInst indices calculated from observed medium-resolution spectra for 414 A,F,G stars and 95 O,B stars from Valdes et al. (2004).
- βStd = 0.159(10) + 1.366(6)·βInst (A,F,G)
- βStd = 0.288(24) + 1.303(13)·βInst (O,B)

Variation of β with parameters

- Variation for other metallicities very similar to Figure 2: spread of β at low T_eff smaller for metal poor models; all β values increase towards higher metallicity.

Test with binary systems

- We test the synthetic photometry with observed indices of eclipsing binary systems.

Modelling differences

- Differences in model structure, radiative transfer algorithms and line lists lead to the following differences in β values (p̃… including predicted lines) for log g = 4.0, [M/H] = 0.0 and ξ = 2.0:

<table>
<thead>
<tr>
<th>Teff</th>
<th>LL–LL/S3</th>
<th>CK–CK/S3</th>
<th>S3p–S3</th>
<th>M–M/S3</th>
</tr>
</thead>
<tbody>
<tr>
<td>5000</td>
<td>−0.015</td>
<td>−0.019</td>
<td>−0.005</td>
<td>−0.011</td>
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<tr>
<td>6000</td>
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<td>−0.009</td>
<td>−0.004</td>
<td>−0.005</td>
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<tr>
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<td>−0.001</td>
<td>−0.003</td>
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<td>−0.004</td>
<td>−0.001</td>
<td>−0.007</td>
<td>0.000</td>
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</table>

References