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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 H_β 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

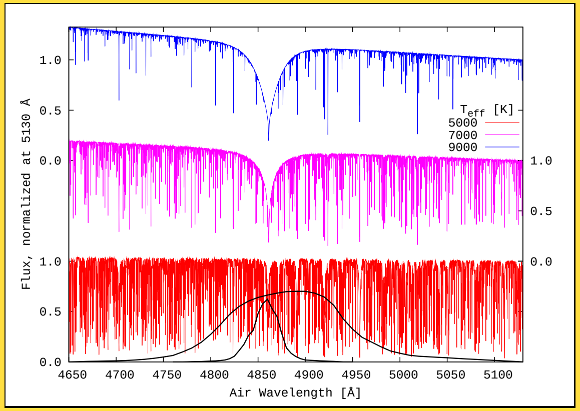

Figure 1 - *Synthetic fluxes (LL models, CM) for* $\log g = 4.0$, $[M/H] = 0.0$ *and* $\xi_t = 2.0$, *and β filter transmissivity.*

- Several different grids of stellar atmosphere models for B to K dwarfs and giants at a range of metallicities: **CGM** and **MLT**(α, y) 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

- β_{Inst} indices calculated from **observed medium-resolution spectra** for 414 A,F,G stars and 95 O,B stars from Valdes et al. (2004).
- β_{Std} indices from Hauck & Mermilliod (1998).
- $\beta_{Std} = 0.159(10) + 1.366(6) \cdot \beta_{Inst}$ (A,F,G)
  $\beta_{Std} = 0.288(24) + 1.303(13) \cdot \beta_{Inst}$ (O,B)

Variation of β with parameters

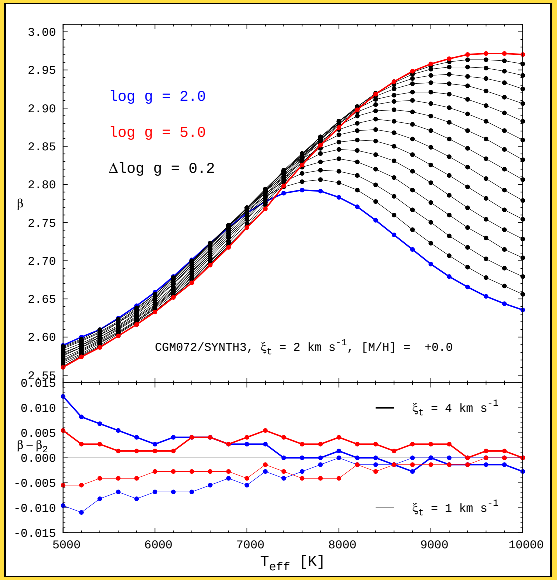

Figure 2 - *β indices as a function of* $T_{\rm eff}$, $\log g$ *and* ξ_t *(microturbulence).*

- Variation for other metallicities very similar to **Figure 2**: spread of β at low $T_{\rm eff}$ smaller for metal poor models; all β values increase towards higher metallicity.

Test with binary systems

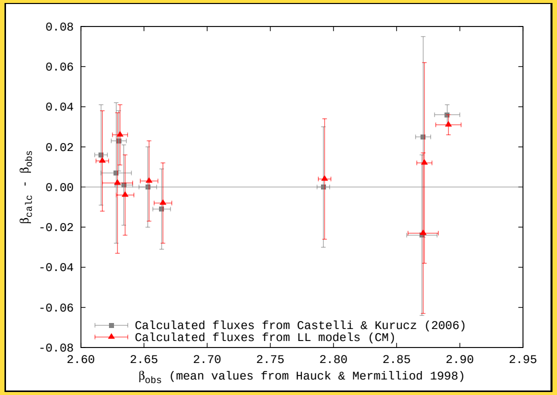

Figure 3 - *Calculated and observed β indices for ten binary stars from Smalley et al. (2002).*

Modelling differences

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

$T_{\rm eff}$	LL−LL/S3	CK−CK/S3	S3p−S3	M−M/S3
5000				−0.015
6000	−0.010	−0.009	−0.005	−0.011
7000	−0.007	−0.009	−0.004	−0.005
8000	−0.001	−0.003	−0.001	

$T_{\rm eff}$	MLT(1.2,0.5) −CGM	MLT(1.5,0.076) −CGM	LL/MLT −LL/CM
5000	−0.002	−0.001	−0.003
6000	−0.008	−0.004	−0.007
7000	−0.013	−0.007	0.000
8000	−0.004	−0.001	0.004

References

Castelli, F. & Kurucz, R. L. 2006, A&A, 454, 333
Crawford, D. L. & Mander, J. 1966, AJ, 71, 114
Gustafsson, B., Edvardsson, B., Eriksson, K., et al. 2003, in ASP Conf. Ser. 288: Stellar Atmosphere Modeling, 331
Hauck, B. & Mermilliod, M. 1998, A&AS, 129, 431
Heiter, U., Kupka, F., van't Veer-Menneret, C., et al. 2002, A&A, 392, 619
Piskunov, N. & Kochukhov, O. 2002, A&A, 381, 736
Shulyak, D., Tsymbal, V., Ryabchikova, T., Stütz, C., & Weiss, W. W. 2004, A&A, 428, 993
Smalley, B., Gardiner, R. B., Kupka, F., & Bessell, M. S. 2002, A&A, 395, 601
Valdes, F., Gupta, R., Rose, J. A., Singh, H. P., & Bell, D. J. 2004, ApJS, 152, 251