# HIGH–PRECISION CONTINUUM RECTIFICATION *

*Towards an Abundance Analysis of Be and Bn Stars*

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**Abstract.** We sketch a new method for the accurate flux calibration and normalization of stellar spectra. This is of particular importance for the analysis of rapidly rotating early–type stars. Some preliminary *log* g determinations by profile fitting of $H\gamma$ are presented.

## 1. Scientific Goals and Observations

Apart from the presence of emission lines in Be stars, the overall appearence of optical spectra of Be and Bn stars seems to be indistinguishable. We have therefore started a model atmosphere analysis of 42 bright stars (20 Be, 18 Bn, and 4 O(e) stars). The observations were carried with the ESO 1.52m telescope and two different instruments: The Boller & Chivens spectrograph at a resolving power of 4,000 between 380 and 510 nm and the Echelec spectrograph at a resolving power of 30,000 between 400 and 480 nm.

## 2. The Rectification Problem and the Solution Adopted

The limiting factor of measurements in line profiles is not the signal-to-noise ratio or the spectral resolution but residual curvature of the continuum. This especially affects gravity determinations, which depend sensitively on the wings of Balmer lines, and abundance analyses of rapidly rotating stars. Furthermore the crowding of circumstellar features in Be stars makes a reliable continuum rectification very difficult. The often used method of interactive interpolation of continuum regions is not objective or physical and especially problematic for echelle spectra, if the orders with their relatively short wavelength coverage shall be merged. Therefore we have developed a new technique, which iterates on spectra of the same objects but different resolutions, starting with low resolution spectra of flux standard stars.

The key to overcoming the problems arising from the presence of spectral lines is to find a good model for the line spread function (LSF) of the tabulated flux standard spectra. Then, the observed standard spectra are convolved with that LSF and devided by the tabulated data, yielding a smooth instrumental response curve. Residual spikes originating from spectral features can be further reduced by an advanced filtering procedure. Finally the spectra of

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the program stars are divided by the filtered curve, which yields spectra with a flux distribution closely resembling the tabulated data. This procedure can be iterated to flux-calibrate the spectra with the next higher resolution.

In order to approximate the instrumental profile we chose VOIGT–functions. Our experience shows that it is, in fact, *essential* to take the LORENTZ–component into account, since it approximates the instrumental straylight quite well, which appeared to be significant in all spectra analyzed by us (incl. the standards of HAMUY et al.: 1992, PASP 104, 533). The actual LSFs are computed by means of $\chi^2$–fitting. In the general case it is possible to minimize the residuals of spectral and other features in the instrumental response curve by optimizing the VOIGT–parameters Gaussian $\sigma$ and Lorentzian $\delta$. Alternatively, the lines in comparison arc spectra can be replaced with "DIRAC–$\delta$" functions and subsequently convolved with trial VOIGT profiles until an optimum match of the original spectrum is obtained.

## 3. Results

We have derived tertiary flux standard spectra of three bright southern stars (HR 718, HR 3454, HR 9087) with a resolution of 0.1 nm between 380 and 510 nm. They are available on request. Determinations of *log* g have been attempted for a subsample of our program stars by fitting NLTE, line–blanketed stellar atmosphere models of $H\gamma$ (K.BUTLER: 1993, priv. comm.). A simultaneous spectroscopic determination of $T_{eff}$ from the same line woud be possible with our data, if model spectra would predict line cores more accurately. Some preliminary results are compiled in the following table:

| HR | Name | MK | v *sin* i [km/s][1] | $T_{eff}$[K][2] | $log\, g_{ph}$ [3] | $log\, g_{sp}$ [4] |
|---|---|---|---|---|---|---|
| 779 | $\delta$ CET | B2IV | 22 | 21,000 | 3.5 | 3.70 |
| 1679 | $\lambda$ ERI | B2IVne | 345 | 23,000 | | 3.70 |
| 1899 | $\iota$ ORI | O9III | 130 | 30,500 | | 3.80 |
| 7121 | $\sigma$ SGR | B2.5V | 230 | 18,000 | 4.1 | 4.00 |
| 8858 | $\psi^2$ AQR | B5V | 341 | 15,000 | 3.6 | 3.65 |

[1] Source: P.L. BERNACCA, M. PERINOTTO (1973), *A Catalogue of Stellar Rotational Velocities*, Contr. Oss. Astrof. Padova, 239, 250.

[2] Calculated from Strömgen [u–b] indices (B. HAUCK, M. MERMILLIOD: 1980, A&AS 40, 1) and the temperature calibration of R. NAPIWOTZKI et al.(1993, A&A 268, 653). We adopt a standard error of ±2000 K, because the calibration is established only for slowly rotating main sequence stars. In Be stars, [u–b] is furthermore affected by the disk.

[3] Derived from Strömgen $\beta$, the calibration of T.T.MOON, M.M.DWORETZKY (1985, MNRAS 217, 305) – established for $T_{eff} \leq 20{,}000$ K – and the correction term introduced by NAPIWOTZKI et al.(1993).

[4] This paper. The errors of our method intrinsically are ±0.05 dex but together with the uncertain temperatures amount to ±0.25 dex.