

# **Stellar atmospheric parameters from full spectrum fitting of intermediate and high-resolution spectra against PHOENIX/BT-Settl synthetic stellar atmospheres**

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## **Abstract.**

We present a new technique implemented in IDL for determination of the parameters of stellar atmospheres using PHOENIX and BT-Settl synthetic stellar spectra. The synthetic spectra provide good coverage in the  $T_{\text{eff}}$ ,  $\log g$ ,  $[\text{Fe}/\text{H}]$ ,  $[\alpha/\text{H}]$  parameter space over a wide wavelength range and allow to fit observed spectra of a vast majority of stars. Our procedure also determines radial velocities and stellar rotation, and it takes into account flux calibration imperfections by fitting a polynomial continuum. Thanks to using pixel fitting, we can exclude certain spectral features, which are not present in the models, such as emission lines (chromospheric emission in late-type stars or discs around Be stars). We perform a non-linear  $\chi^2$  minimization with the Levenberg-Marquardt method that is applied to the entire spectrum, with the exception of areas with peculiarities: emission lines, model shortcomings (incompleteness of the spectral line lists used for the atmospheric model calculation). We take into account systematic errors of the surface gravity estimates introduced by synthetic atmospheres by applying a correction computed from the comparison of our results with those obtained using asteroseismology. We present the comparative statistical analysis of optical spectral libraries ELODIE, INDO-US, MILES, UVES-POP, and a new near-infrared Las Campanas Stellar Library and discuss prospective applications of our technique.

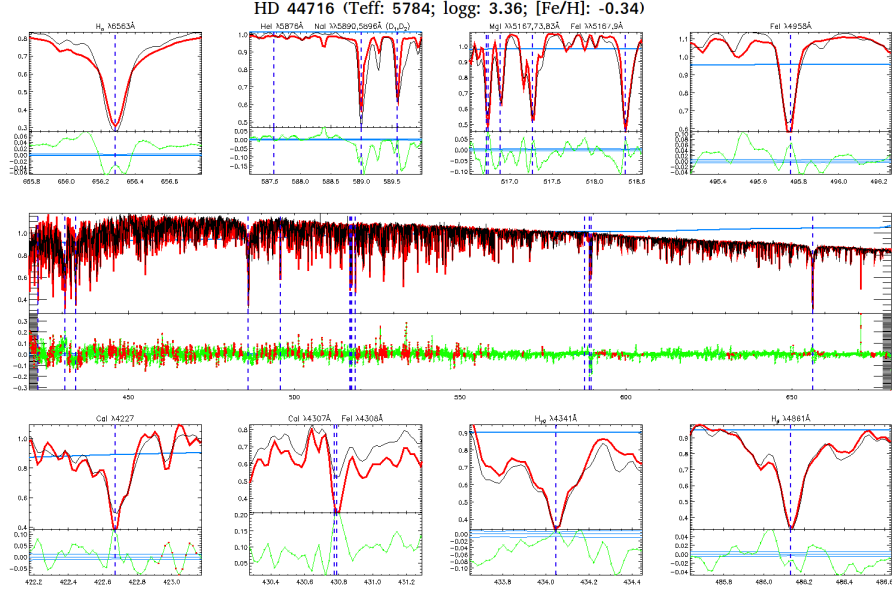


Figure 1. Example of pixel fitting technique for HD44716 from the ELODIE library. Central panel shows observed spectra (black line), the best-fitting model (red line) and fitting residuals (green line) with some pixels masked (red points in the residuals). Small panels demonstrate profiles of several spectral lines.

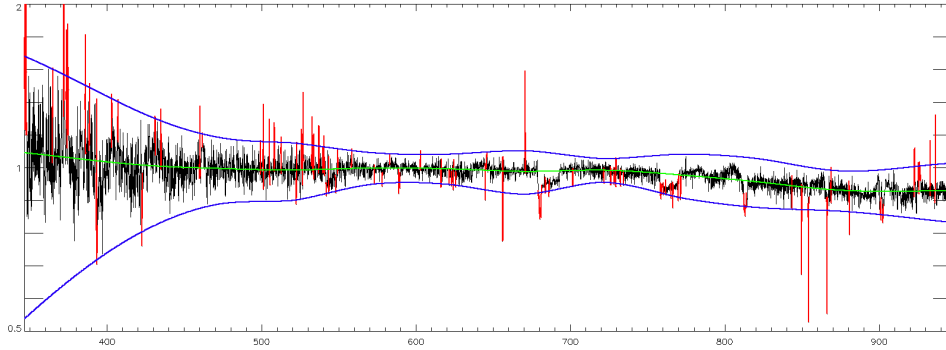


Figure 2. Mask building procedure (INDO-US, temperature 4000-5000 K). The black line shows the RMS of the relation between the original flux and the best-fitting model in all spectra in some range of effective temperatures. The green line is the interpolated median values defined in 50 nm bins. The blue lines mark the 3-sigma range. Red indicates areas beyond 3-sigma used as a mask.

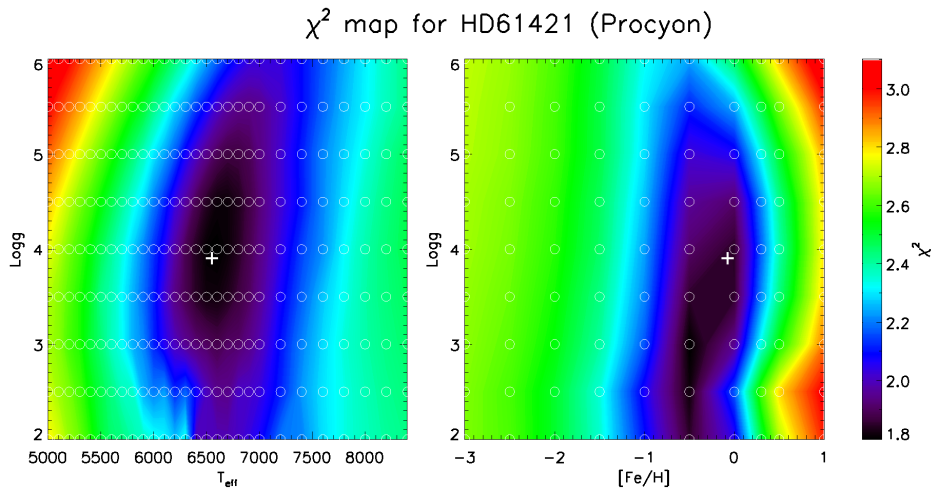


Figure 3. Example of  $\chi^2$  map for HD61421 (Procyon) from ELODIE. Left panel: layer of  $[\text{Fe}/\text{H}] = 0$ ; right: layer of  $T_{\text{eff}} = 6400$  K. White circles are grid nodes, the minimum of  $\chi^2$  statistic is marked by the white cross.

1. Introduction
2. Description of technique
3. Preparation of spectral libraries
  - 3.1. Polynomial continua
  - 3.2. Masks
4. Fit results and comparison
5. References

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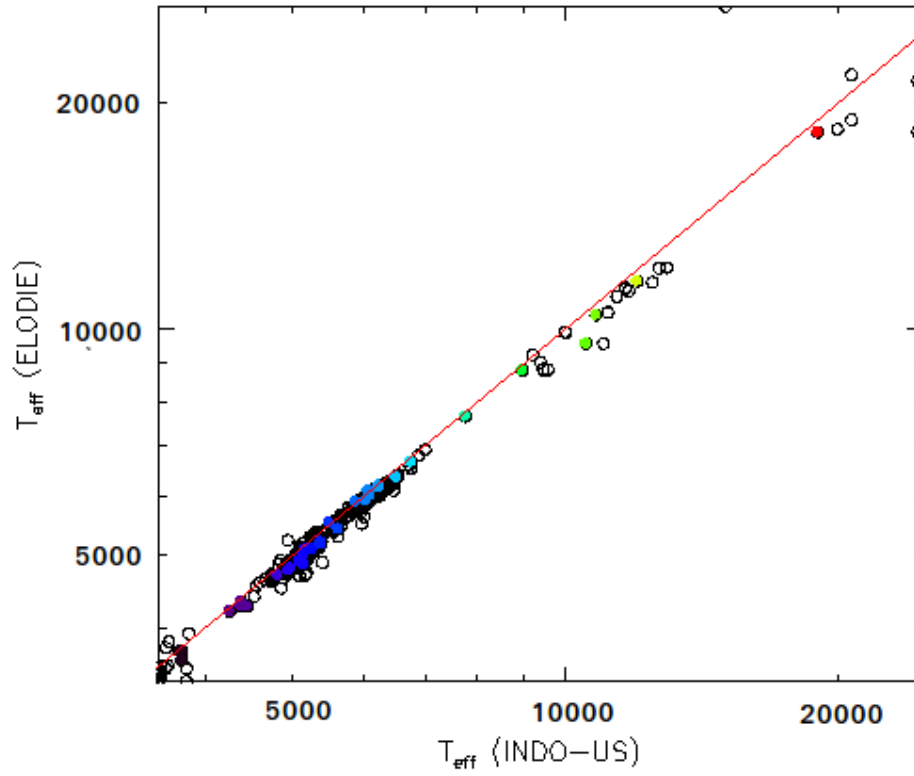


Figure 4. Comparison of the fitting results between ELODIE (1959 spectra,  $R=10000$ ) and INDO-US (1273 spectra,  $R=5000$ ) stellar libraries. The left panel shows comparison of effective temperature, central panel - surface gravity and right - metallicity. Empty circles show all crossmatched stars between ELODIE and INDO-US (408 spectra). Colored circles show subset of stars for which CDS Simbad reports the object type  $\text{II}^*$  (35 spectra).