Atmospheric Stellar Parameters from Numerical Cross-Correlation Functions

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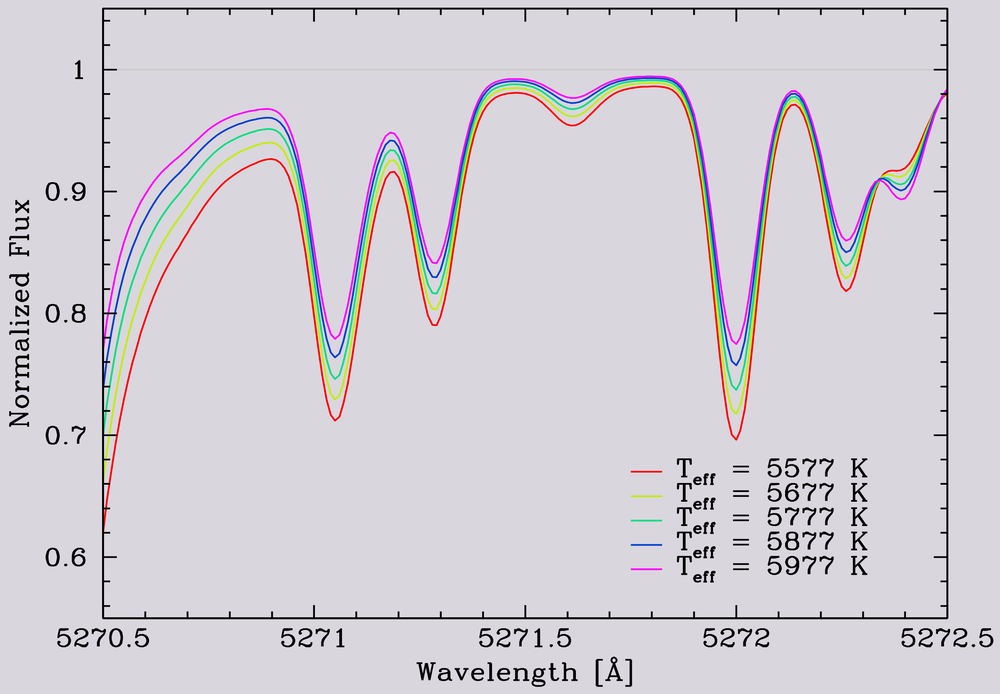
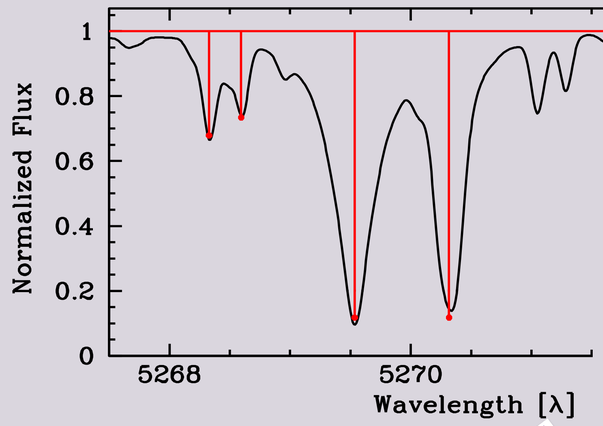
Spectral lines store information about the stars

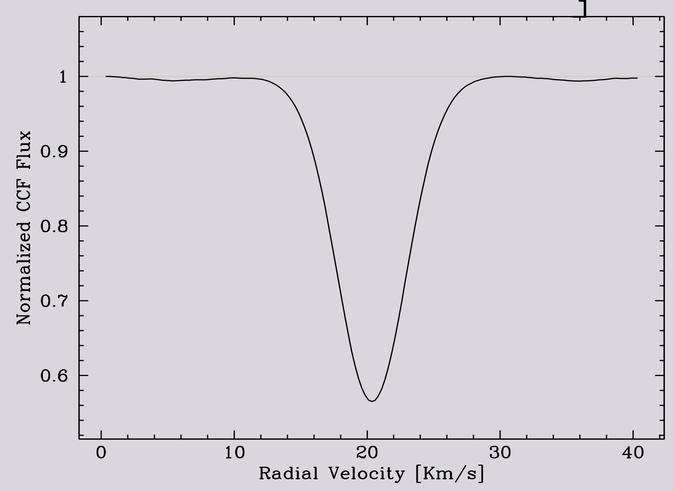
The equivalent width of a line depends on the atomic line parameters and on temperature, metallicity (content of Iron), gravity and microturbulent velocity of the photosphere



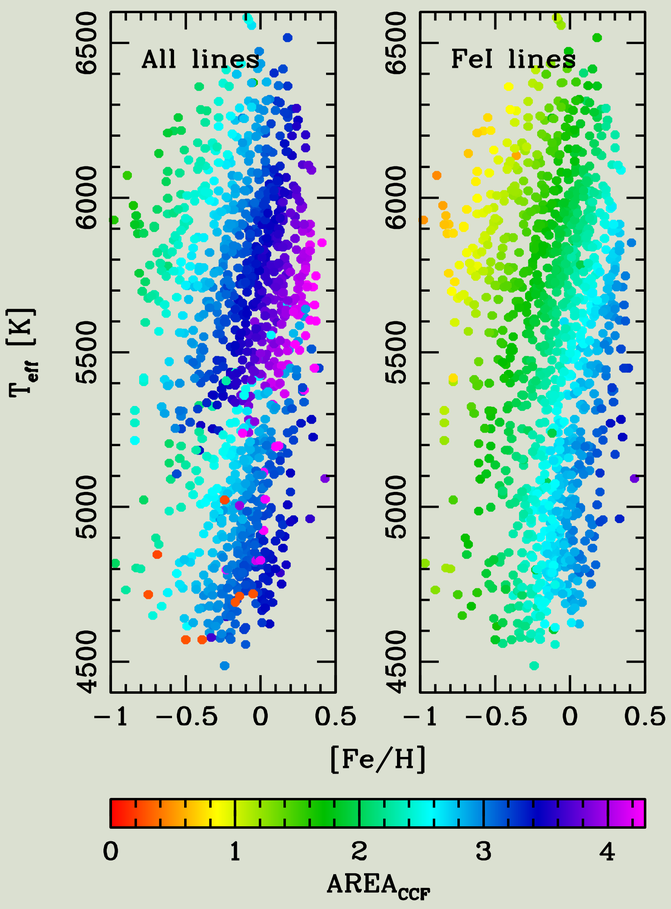
A numerical Cross-Correlation Function is an average of lines

The spectrum is cross-correlated against a binary mask containing all the spectral lines that will compose the CCF





Can we determine the stellar atmospheric parameters using CCFs?



An extensive set of stars

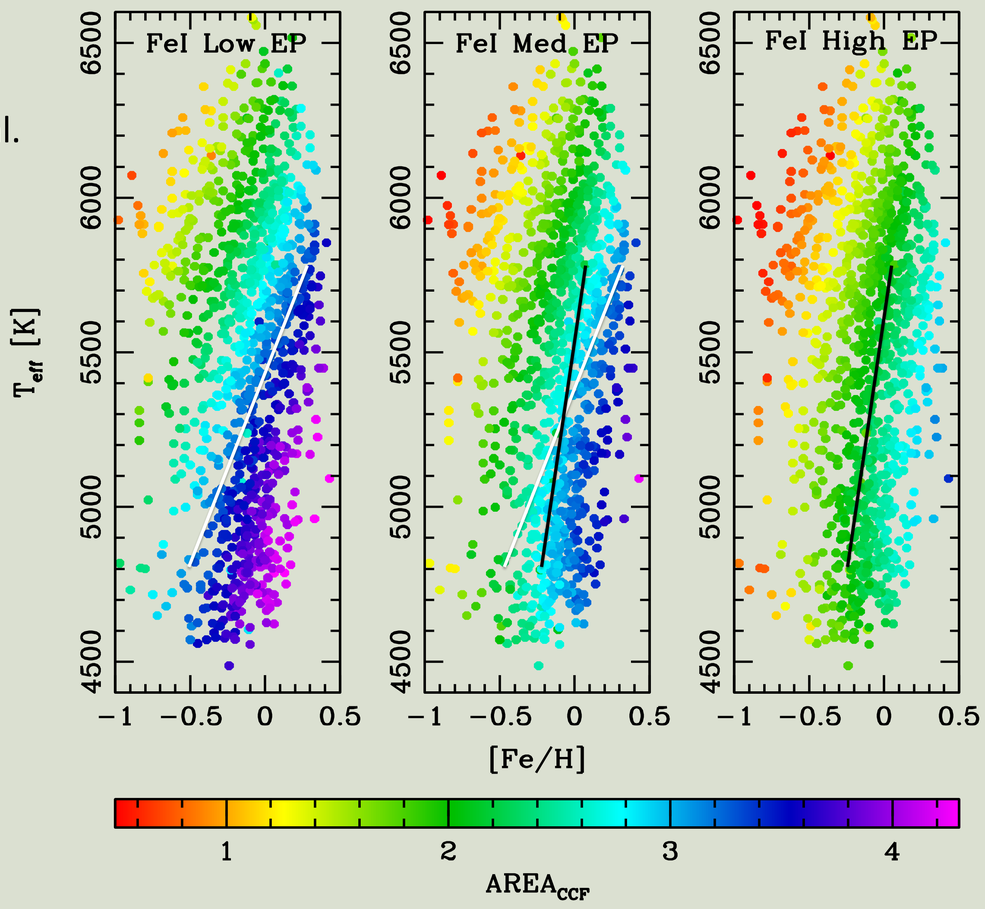
Our study is based on a set of 1111 FGK dwarf stars from several HARPS programs (Mayor et al. 2003, Lo Curto et al. 2010, Santos et al. 2011)

A good spectral line selection

Default CCF masks include lines from different elements and ionization status. Even by using only Iron lines however it is not possible to determine univocally temperature and metallicity from CCF areas

How to break the temperature-metallicity degeneracy

Several masks are built using lines selected by their Excitation Potential (EP). For a given star, the CCF area values corresponding to each mask will draw lines with different slopes in the T_{eff}-[Fe/H] plane. Their intersection point gives temperature and metallicity.



Temperature and metallicity: determined by using the stars in the sample to build the functions f_1 and f_2

Gravity: Expected CCFs areas for different combinations of T_{eff}, [Fe/H] and log(g) are derived from theoretical EWs . The mask is built using only FeII lines

$$T_{eff} = f_1(A_{low}, A_{med}, A_{high})$$
$$[Fe/H] = f_2(A_{low}, A_{med}, A_{high})$$

$$EW = \frac{\sqrt{(2\pi)}}{2.3548}\frac{\lambda_0}{c}\frac{a_{RV} FWHM_{RV}}{c_c(\lambda_0)\ \delta\lambda}$$

a_{RV} = absolute depth of the CCF
δ_{RV} = size of the "hole" in the mask
$c_c(\lambda_0)$ = continuum level of the line

Results

With a Signal-to-Noise Ratio = 50 @550nm in the extracted spectra:

- **σ T_{eff} = 85 K** (calibrators: 30 K)
- **σ log(g) = 0.17 dex** (calibrators: 0.06 dex)
- **σ [Fe/H] = 0.04 dex** (calibrators: 0.03 dex)

Advantages: quick computation of atmospheric parameters at observing time

***Measuring ETA_EARTH:** Characterization of Terrestrial Planetary Systems with Kepler, HARPS-N, and Gaia P.I: Dr. Alessandro Sozzetti

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