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Determination of stellar parameters for FGK stars

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Abstract. This work aims to determine the atmospheric parameters of FGK stars, using FeI and FeII absorption lines, from a sample of high resolution spectra from the HARPS GTO program. From the spectra we measure equivalent widths with the ARES code. At this point, we obtained the semi-empirical astrophysical log(gf) from each line using the MOOG ewfind inverse analysis and tested them by calculating the solar parameters from the EWs of Kurucz (1984) Solar Atlas. The next steps will consist in the development of methods to select a stable iron line list in order to obtain accurate stellar parameters for FGK stars.

Resumo. Este trabalho visa determinar os parâmetros atmosféricos de estrelas FGK, utilizando linhas de absorção de Fe I e Fe II de uma amostra espectral de alta resolução provinda do programa HARPS GTO. Medimos as larguras equivalentes espectrais utilizando o código ARES. Até o presente momento, obtivemos o valor semi empirico da força do oscilador astrofísico log(gf) para cada linha utilizando o driver ewfind do MOOG, por meio de uma análise inversa testamos e calculamos os parâmetros solares a partir das EWs do Atlas Solar de Kurucz (1984). Os próximos passos consistirão no desenvolvimento de métodos para selecionar uma lista estável de linhas de ferro, a fim de obter parâmetros estelares precisos para estrelas FGK.

Keywords. Stars: atmospheres– stars: abundances – stars: fundamental parameters

1. Introduction

Determining stellar parameters with precision allows a more detailed study of the stellar evolution, considering that these parameters are the basis for the study of stellar astrophysical processes. The adopted method deals with the calculation of the stellar parameters from the study of the profiles of spectral lines of absorption from high resolution spectra. Predominantly, the effective temperature of the star is the most important factor shaping the line profiles Gray (2005), followed by metallicity (determined via Iron abundance), surface gravity, and microturbulence. The uniform determination of the parameters is based in the determination of the EWs of the spectral lines, an atmospheric model for solar-type stars, a radiative transition program in LTE (MOOG) and an algorithm for parameter convergence.

2. Methods

The procedure for determining the spectroscopic parameters is detailed as follows:

2.1. VALD

Using the extract stellar option from the Vienna Atomic Line Database (VALD)[1] it was possible to obtain the absorption lines of all elements in the wavelength range from 4500Å to 6910Å. We obtained 1442 initial Fe I and 72 Fe II lines.

2.2. ARES/IRAF

The EWs of Iron absorption lines from the Kurucz Solar Atlas Kurucz (1993) was obtained from the ARES program Sousa (2015) and was compared with the EWs obtained manually through the IRAF[2] spectroscopic data reduction and analysis software, in order to compare the EWs of the lines in common by the two processes,and exclude the lines erroneously measured by the automatic process. We then compared the EWs taken from a degraded Kurucz solar atlas spectral with a resolution equivalent to the HARPS spectra with the spectrum taken from the reflected light from Ganymedes and Ceres, available at ESO HARPS page, in order to simulate the spectrum of a distant star. In the end we obtained 927 Iron I and II lines with EWs within the range of one standard deviation between the three spectra.

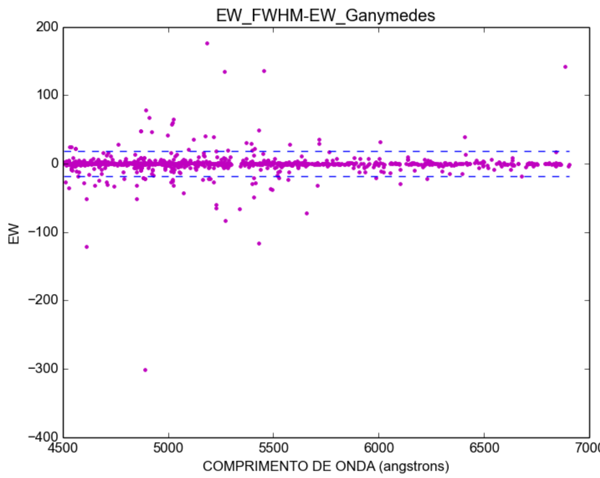

Figure 1. Graphic representing a first selection of lines. The lines within the standard deviation were selected for the next phase and the others were excluded. The authors, 2018.

[1] Available on:http://vald.astro.uu.se/
[2] Available on:http://iraf.noao.edu/

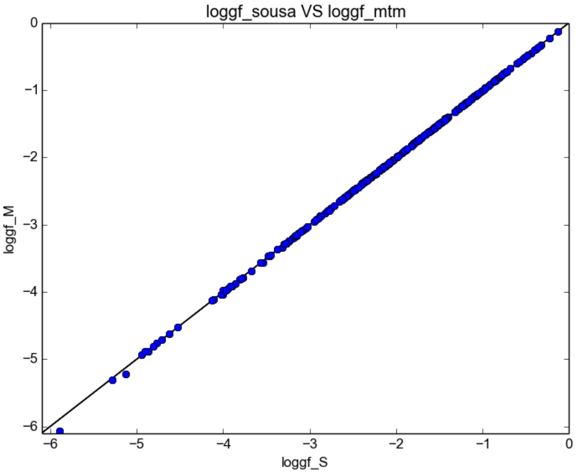

Figure 2. Graph of identity comparing the results obtained by Sousa (2008) and by the authors (2018).The authors (2018).

2.3. MOOG-EWFIND

Next, we obtained the astrophysical oscillator strength of each line, log (gf), from an inverse analysis, using the known parameters of the Sun (Teff = 5777 K, log g = 4.44 dex, log ϵ Fe = 7.47 dex, ξ_t = 1.0) as the MOOG input, using the ewfind driver. The convergence to the correct log(gf) value was made with an algorithm based on the bisection method, comparing, at each iteration, and for each line, the EW values provided by MOOG with the EW values measured in the Sun's spectrum until both EW values match, for a certain log(gf) value. Obtaining semi-empirical values for log (gf) is required because the values obtained in the VALD are not fully reliable because they do not reflect the stellar atmospheric conditions.

3. Discussion and conclusions

At the present time, we compare the results of the astrophysical loggf with the data obtained in Sousa (2008) that obtained the same sample analyzed. The results are consistent with those of the analyzed literature.

3.1. Next Steps

- Study selection methods for spectral lines in order to obtain a final list of stable lines across the region of FGK star temperatures
- Calculate stellar parameters using the Nelder Mead method Nelder et al. (1965)
- Study the relationship between stellar parameters and the presence or absence of planets

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