Formation, Detection, and Characterization of Extrasolar Habitable Planets
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Quantitative Stellar Classification with Low-Resolution Spectroscopy

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Abstract. Low-resolution spectroscopy (R ≈ 1000) is used to efficiently characterize faint stars suspected to host planets. Stellar parameters, i.e. effective temperature, surface gravity, and metallicity can be assessed from these spectra by methods of quantitative classification. For this purpose, more than 130 template stars have been observed with the faint object spectrograph at the Tautenburg 2m telescope, Germany. A large number of lines are measured and the dependence of line depths on stellar parameters is studied.

Keywords. stars: fundamental parameters (classification), planetary systems

1. Characterization of stars with planets

The detection and characterization of extrasolar planets requires good knowledge of the parent stars which is usually obtained by spectroscopy with high resolution and high signal-to-noise ratio. CoRoT searches for transiting planets in stellar fields in the Galactic center and anti-center. Therefore, candidate stars are faint so that spectra with high resolution and good signal-to-noise ratio cannot be taken for all of them. However, good spectra with low resolution (≈1000) can still be taken quickly with the faint object spectrograph at the Nasmyth focus of the 2m telescope in Tautenburg, Germany (Fig. 1). For a similar project on CoRoT targets, see Sebastian *et al.* (2011).

2. Quantitative classification

The target spectra are compared to template spectra of stars with well-known stellar parameters (Fig. 2). This way, we can infer effective temperature, surface gravity, and metallicity. For previous similar work and reviews, see e.g. Cayrel *et al.* (1991a), Cayrel *et al.* (1991b), Gray & Johanson (1991), Stock & Stock (1999), Malyuto *et al.* (2001), Bailer-Jones (2002), Singh *et al.* (2002).

3. Line depth ratios

Spectral classification commonly relies on the strength of individual lines sensitive to stellar parameters (Fig. 1). The line depth is measured and divided by the depth of a neighbouring line with different sensitivity. Line depth ratios are very useful spectral indices since they are independent of rotational broadening, macroturbulence broadening, and instrumental resolution (Gray & Johanson, 1991). Figures 3 and 4 discuss examples.

4. Conclusions and Outlook

- All indices depend on all stellar parameters but in different ways.

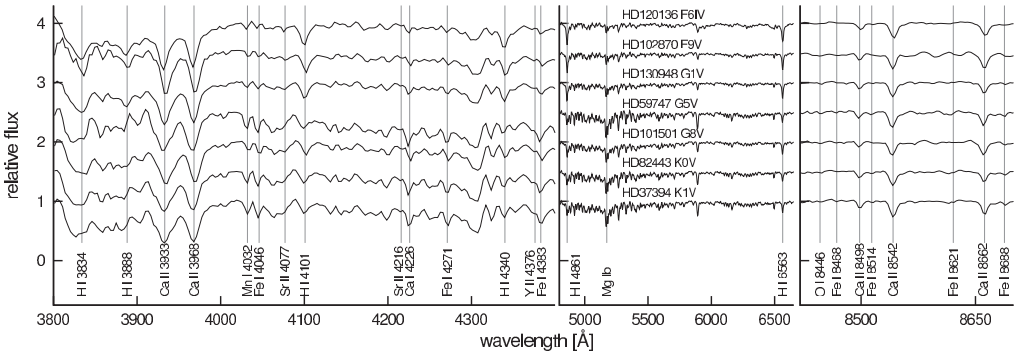

Figure 1. Temperature sequence of FGK stars. These spectra of cool main-sequence stars were taken with the TLS spectrograph at a resolution of ≈1000. Even at this low resolution, there are lines useful for classification (Gray & Corbally, 2009). The spectra cover the full range from the blue to the red, from Ca II H&K to the Ca II near-infrared triplet.

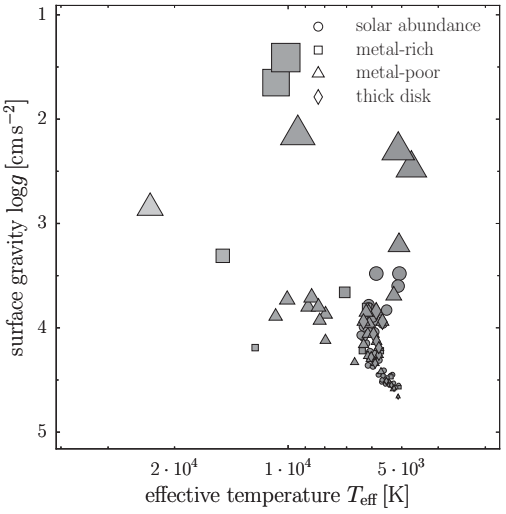

Figure 2. The template stars in the Kiel diagram. We observed more than 130 bright O-K template stars chosen from Döllinger (2008), Fuhrmann (1998-2011), and Wu *et al.* (2001) to be able to classify most CoRoT candidates.

• All stellar parameters have to be considered when inferring stellar properties from a particular index.

• The best-matching set of stellar parameters should be searched for in the full grid of templates via tools of multivariate statistics.

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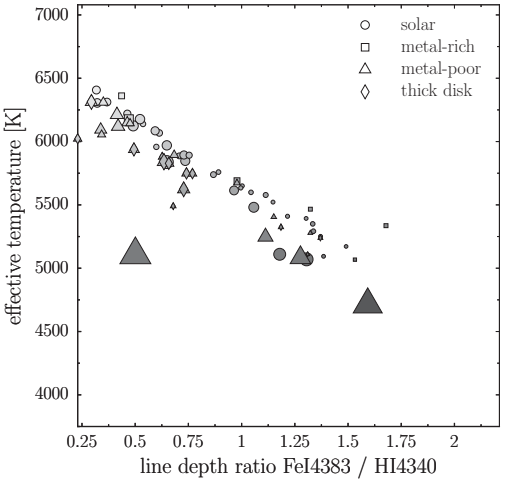

Figure 3. Line depth ratio of Fe I 4383 and H I 4340 for the FGK templates. The Sun-like main sequence stars form a tight correlation with effective temperature. Therefore, this spectral index is a useful thermometer. However, evolved stars and stars with a different abundance pattern are offset.

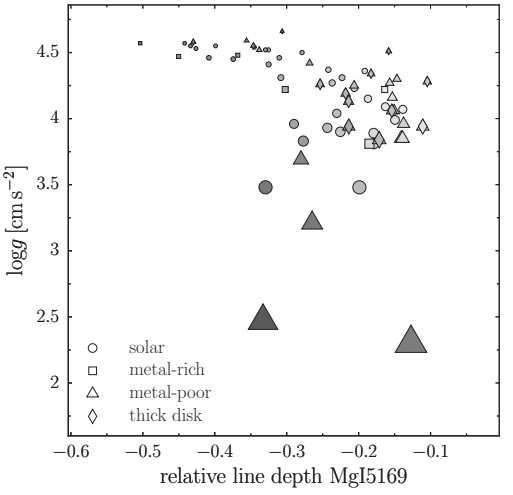

Figure 4. Relative line depth of Mg I 5169. Although the Mg Ib triplet is a well-known indicator of surface gravity, the behaviour of this triplet member is complicated. Indices other than line depths or line depth ratios might be more appropriate in this case.

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