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Volatiles and refratories in solar analogs: No terrestial planet connection

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Abstract. We have analysed very high-quality HARPS and UVES spectra of 95 solar analogs, 24 hosting planets and 71 without detected planets, to search for any possible signature of terrestial planets in the chemical abundances of volatile and refractory elements with respect to the solar abundances.

We demonstrate that stars with and without planets in this sample show similar mean abundance ratios, in particular, a sub-sample of 14 planet-host and 14 "single" solar analogs in the metallicity range $0.14 < [Fe/H] < 0.36$. In addition, two of the planetary systems in this sub-sample, containing each of them a super-Earth-like planet with masses in the range $\sim 7-11$ Earth masses, have different volatile-to-refratory abundance ratios to what would be expected from the presence of a terrestial planets.

Finally, we check that after removing the Galactic chemical evolution effects any possible difference in mean abundances, with respect to solar values, of refratory and volatile elements practically dissappears.

Keywords. stars: abundances, stars: fundamental parameters, planetary systems, planetary systems: formation, stars: atmospheres

1. Introduction

The discovery of more than 400 exoplanets orbiting solar-type stars by the radial velocity technique have provided a substantial amount of high-quality spectroscopic data (see e.g. Neves *et al.* 2009).

Recently, Meléndez *et al.* (2009) have obtained a clear trend [X/Fe] versus T_C in a sample of 11 solar twins, and claimed (see also Ramírez *et al.* 2009, 2010) that the most likely explanation to this abundance pattern is related to the presence of terrestial planets in the solar planetary system.

Here we summarize the analysis of very high-quality HARPS and UVES spectroscopic data of a sample of 95 solar analogs with and without planets (see González Hernández *et al.* 2010), with a resolving power of $\lambda/\delta\lambda \gtrsim 85{,}000$ and a mean $\langle S/N \rangle \sim 850$.

The stellar parameters and metallicities of the whole sample of stars were computed using the method described in Sousa *et al.* (2008). The chemical abundance derived for each spectral line was computed using the LTE code MOOG (Sneden 1973), and a grid of Kurucz ATLAS9 model atmospheres (Kurucz 1993).

2. Metal-rich solar analogs hosting super-Earth-like planets

We find no substantial differences in the abundance patterns of solar analogs with and without planets. In particular, the slopes of the abundance ratios [X/Fe] versus T_C in two metal-rich stars, HD 1461 and HD 160691, containing each of them one super-Earth-like planet, with 7-11 Earth masses, have the opposite sign to what one would expect if the amount of refractory metals in the atmospheres of planet hosts would depend only on the amount of terrestial planets.

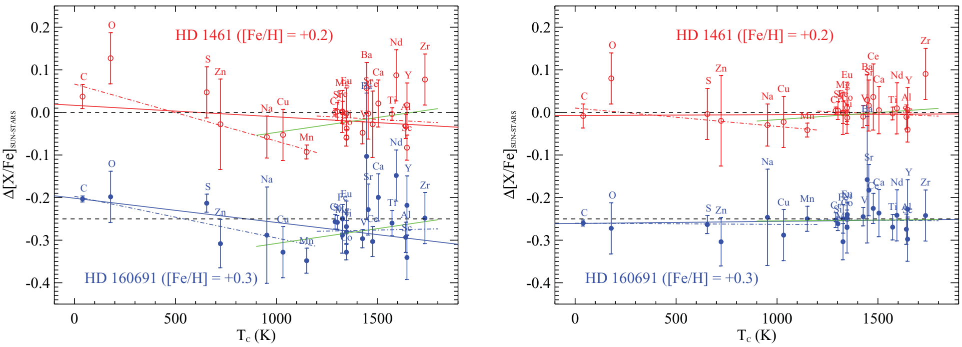

Figure 1. *Left panel*: Abundance differences, $\Delta[X/Fe]_{SUN-STARS}$, between the Sun, and 2 planet hosts with super-Earth-like planets. Linear fits for different T_C ranges to the data points weighted with the error bars are also displayed. We note the different slopes derived when choosing the range $T_C > 1200$ K (dashed-dotted line) as in Meléndez *et al.* (2009) and González Hernández *et al.* (2010), and $T_C > 900$ K (dashed-three-dotted line) as in Ramírez *et al.* (2009, 2010). An arbitrary shift of -0.25 dex has been applied to the abundances of the planet host HD 160691. *Right panel*: Same as left panel of this figure but after correcting each element abundance ratio of each star using a linear fit to the Galactic chemical trend of the corresponding element at the metallicity of each star.

In left panel of Fig. 1 we display the abundances of these two stars and some linear fits for different T_C ranges. The steep positive trend in the linear fit for $T_C > 900$ K is probably affected by chemical evolution effects on Mn, Na and Cu. In right panel of Fig. 1 we have already removed the Galactic chemical evolution effects and both stars do not seem to show any trend. We may conclude that it seems plausible that many of our targets hosts terrestrial planets but this may not affect the volatile-to-refratory abundance ratios in the atmospheres of these stars (see e.g. Udry & Santos 2007).

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