Chemical abundances in solar analogs

Ricardo López Valdivia

Dr. Miguel Chávez

Dr. Emanuele Bertone

Objetive

Make a detailed analysis of chemical abundances in G0-G3 main sequence stars (solar analogs) with the purpose of study trends between stellar properties and abundances.

Identify more suitable candidates for giant planet searches.

Low-resolution (1 700)

Atmospheric parameters
metal rich stars

+

High-resolution (80 000)

Chemical abundances
[Ref] index

Motivation

Gonzalez (1997) suggested a correlation between presence of planets and metallicity.

Santos et al. (2001); Gonzalez (2001); Fischer & Valenti (2005); Sousa et al. (2011) confirmed the planet-metallicity correlation.

Gonzalez (2009) defined a new metallicity index ([Ref] index) which include abundances of Fe, Mg and Si

Gonzalez (2014) suggested that [Ref] index is more sensitive to the presence of giant planets

Data

2.1 meters telescope
Guillermo Haro Astrophysical Observatory + CanHiS

40 Å-wide intervals (5005, 5890, 6300, 6705)

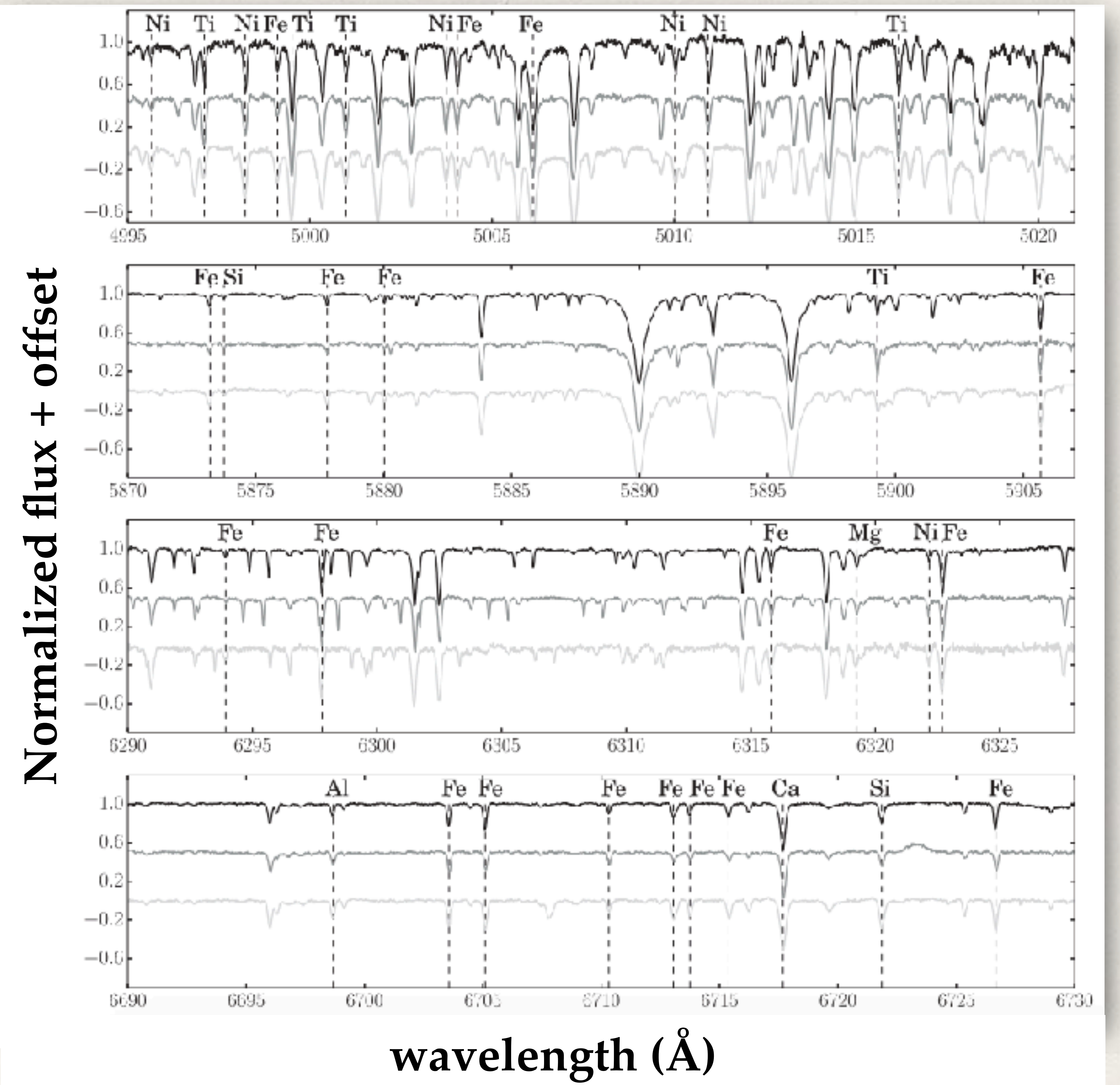
$\lambda/\Delta\lambda \sim$ 80 000; S/N > 100

52(12) solar analogs in Li (López-Valdivia et al., 2015)

38(11) solar analogs in Mg, Al, Si, Ca, Ti, Fe, Ni (López-Valdivia et al., 2017)

Data

Vesta
HD 12699
BD+60 600



Methodology

INPUTS

ATLAS12 models (Kurucz 1993)

log gf from VALD and modified by us

EW measurement by a Gaussian fit

MOOG (Sneden 1973)

Abundances for 34 lines Mg, Al, Si, Ca, Ti, Fe, Ni

OUTPUTS

error budget

$\sigma_T^2 = \sigma(\text{param})^2 + \sigma(\text{EW})^2$

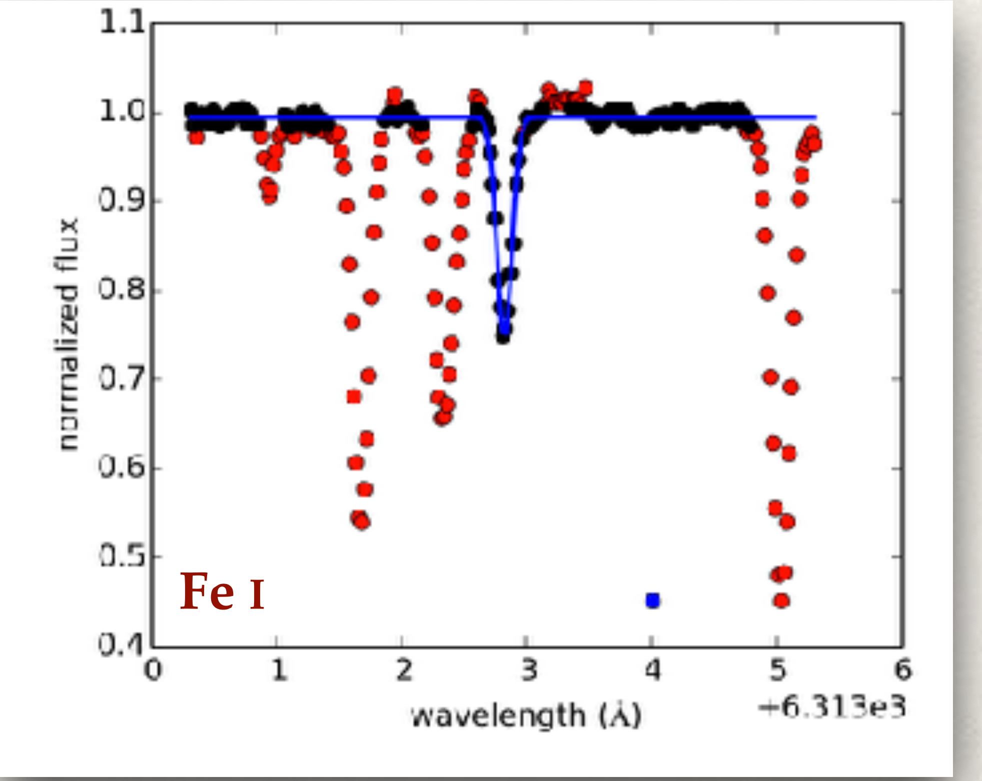
Methodology: error budget

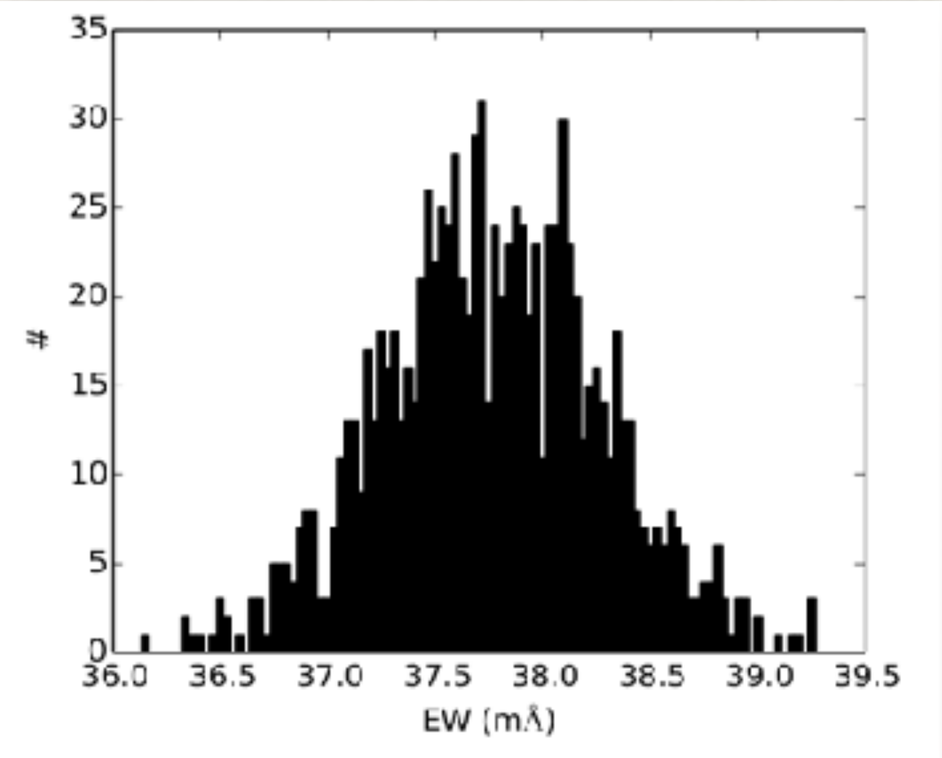
Gaussian + C fit to identify and remove the spectral line ($\lambda_0 \pm 3\sigma$) **(neighboring lines + noise)**

Iteratively discard points above ±2σ their average value **(noise level)**

Re-fit the spectral line considering the noise level obtained before **(EW)**

Randomly added the noise level to the spectrum and repeat the process 1000 times





Methodology: error budget

Parameter variation	- var	+ var
T_{eff} 300 (100) K	0.21 dex	0.20 dex
log g 0.50 (0.10) dex	0.19 dex	0.20 dex
[M/H] 0.30 (0.05) dex	0.07 dex	0.06 dex
ξ (0.5 - 2.0 km s^{-1})	0.05 dex	0.17 dex

Matrix of abundance variations for the Ca I line (6717.681 Å)

For each absorption line j:

$$\Delta[X/H]_j = [X/H] - [X/H]_{j,\odot}$$

Vesta EWs + param. variations

Varying one parameter at time other fixed to 5777 / 4.44 / 0.0 / 1.0

Linear interpolation of the error on the parameters

Methodology: error budget

Parameter (variation)	- var	+ var
T_{eff} (100 K)	0.07 dex	0.06 dex
log g (0.30 dex)	0.11 dex	0.12 dex
[M/H] (0.10 dex)	0.02 dex	0.02 dex
ξ (0.5 km s^{-1})	0.05 dex	0.08 dex

Matrix of abundance variations for the Ca I line (6717.681 Å)

For the star BD+60 600:

σT_{eff} = 70 K → 0.031 dex
σlog g = 0.30 dex → 0.073 dex
σ[M/H] = 0.09 dex → 0.014 dex
σξ = 0.27 km s^{-1} → 0.035 dex

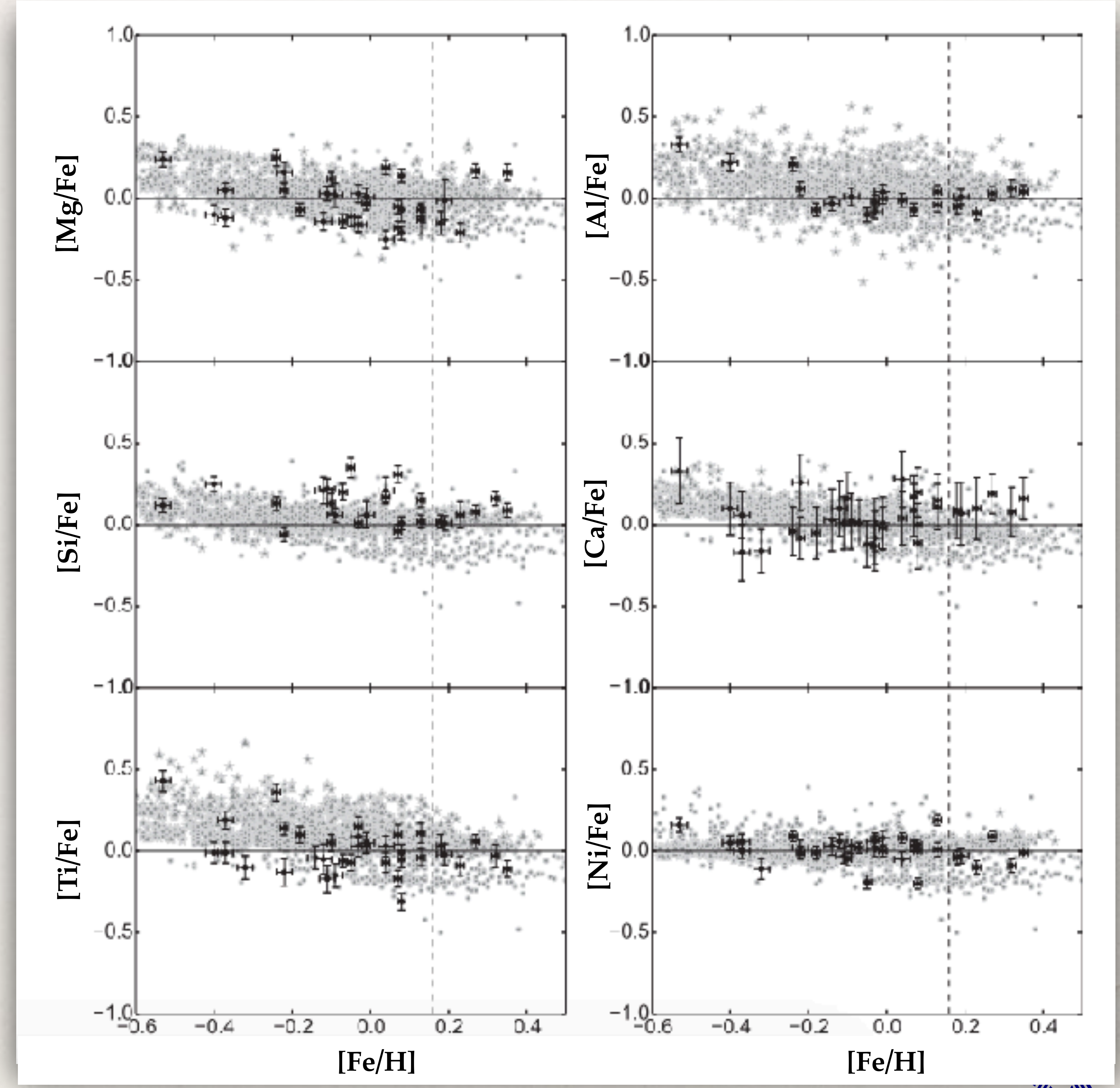
σ(param) = 0.09 dex

Results: [X/Fe] vs [Fe/H] ratio

Super metallicity confirmation for 6 solar analogues

Good agreement with literature abundances (Neves et al. ,2009; Adibekyan et al. , 2012; Hinkel et al. , 2014)

Ca abundance with higher errors much sensitive to log g



(López-Valdivia, Bertone & Chávez, 2017)

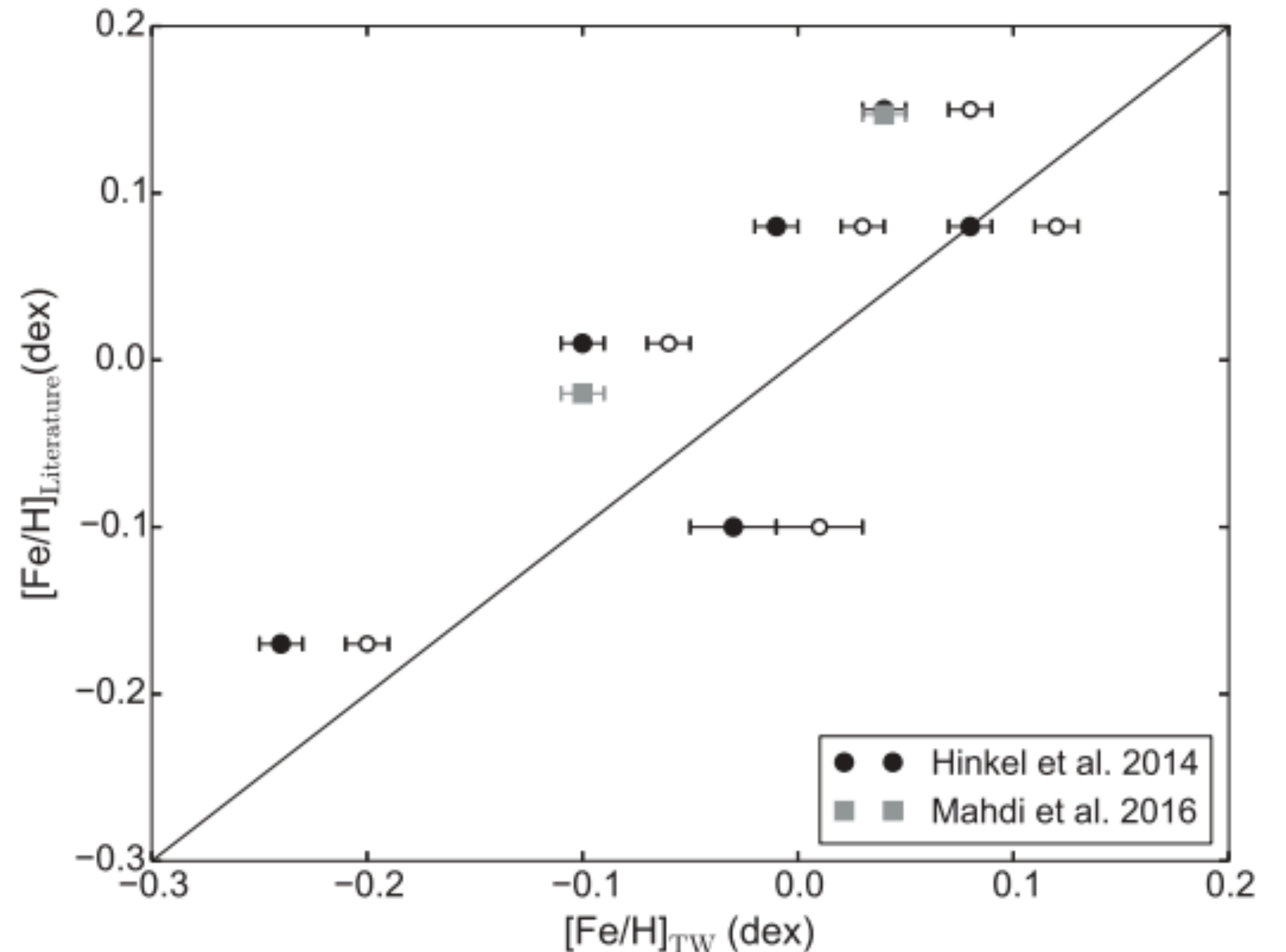
Results: [X/Fe] vs [Fe/H] ratio

Good agreement with literature abundances

Hinkel et al. 2014
+0.20 (-0.02) dex

Different abundance scale
Lodders, Palme & Gail 2009

[Ref] index for 25 stars
BD+60 600 (39%)
BD+28 3198 (22%)



(López-Valdivia, Bertone & Chávez, 2017)

Thanks

Questions