Li depletion of planet-host stars

A new and revealing homogeneous study

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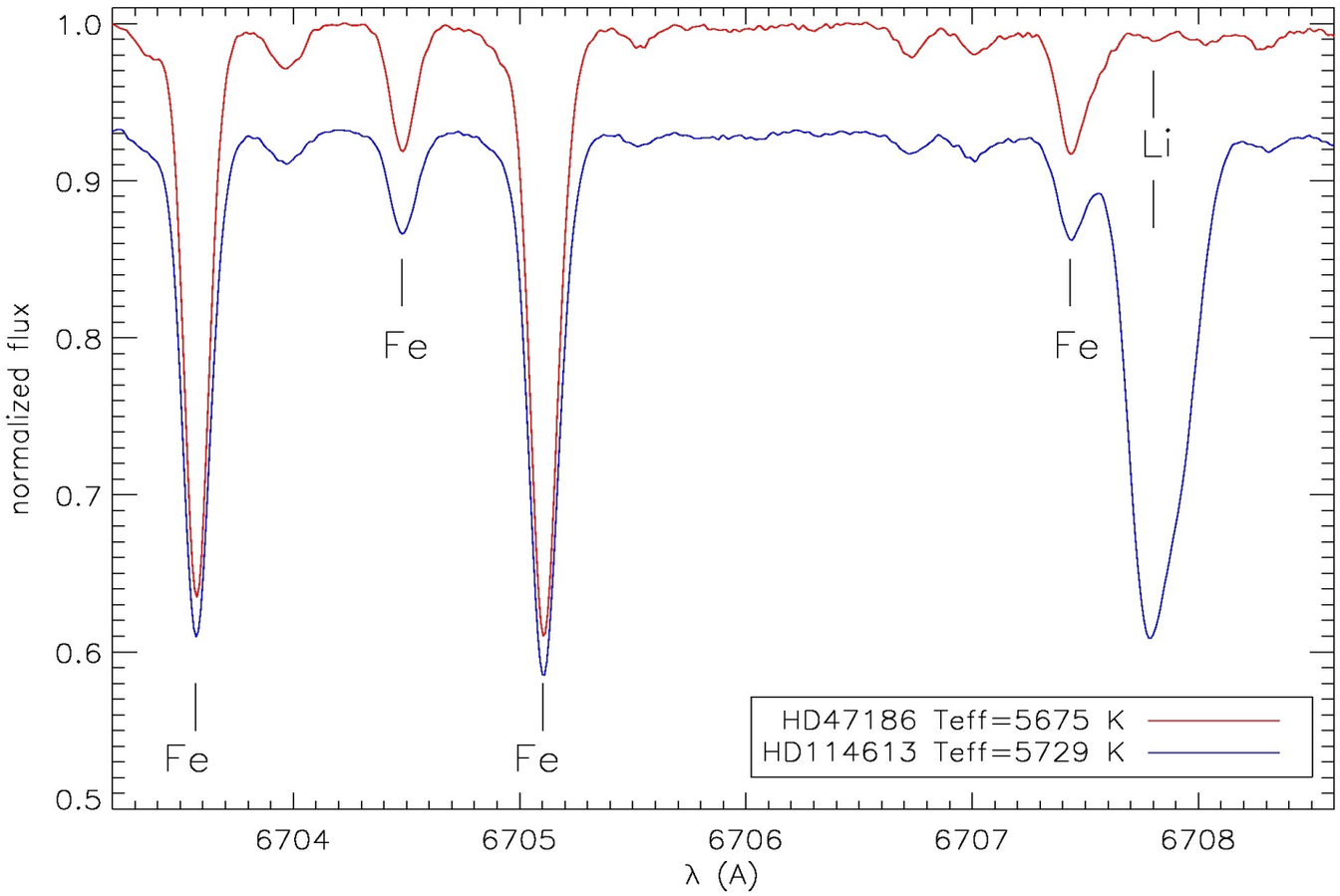
Lithium

The abundance of Lithium is known to vary significantly from one star to another, even for stars with very similar properties (as in open clusters)

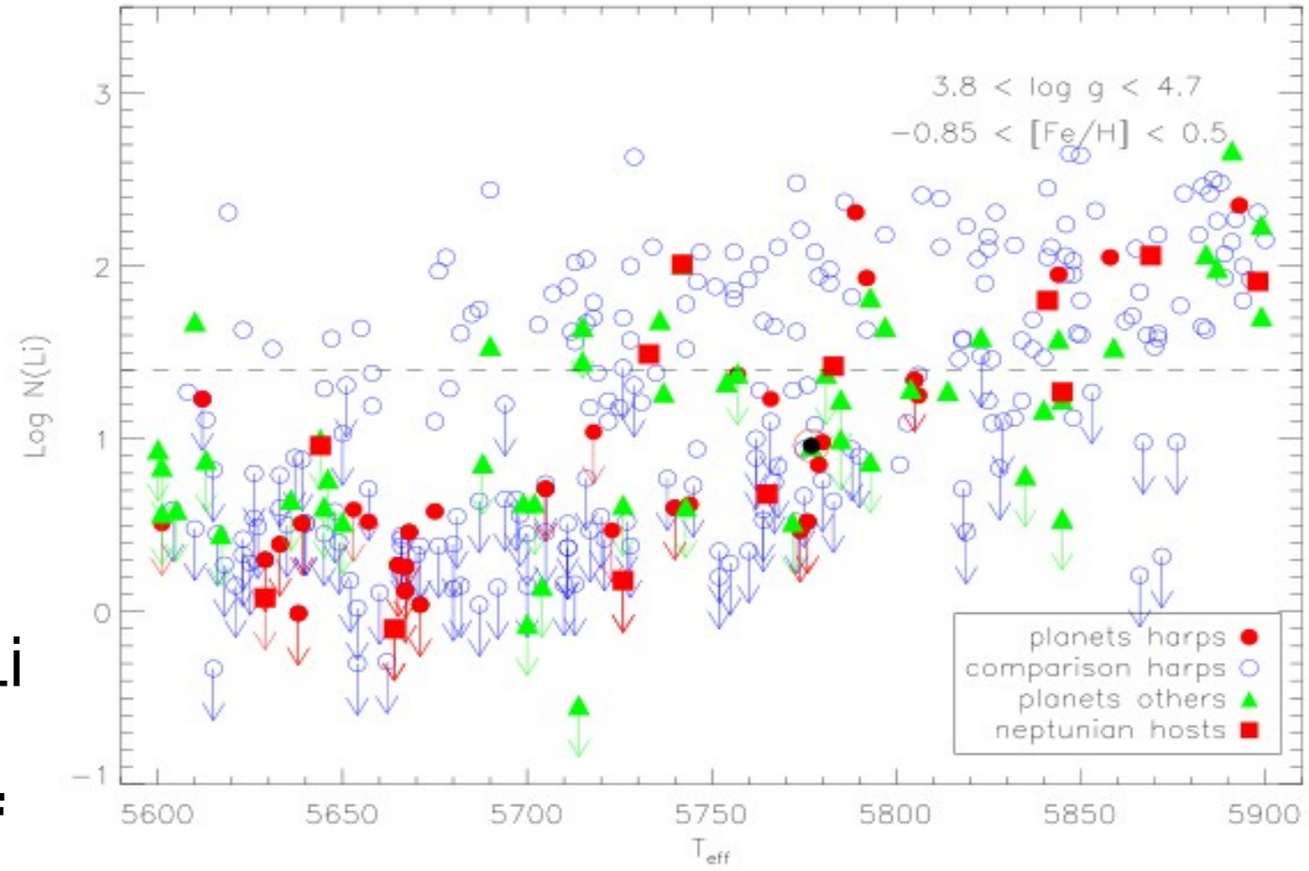


As an example, these two stars have very similar effective temperature and metallicity, and age

Lithium

Lithium is known to **depend** on several **fundamental Stellar parameters**:

- Effective temperature;
- Age;
- Metallicity;
- Surface gravity.



It has also been proposed that Li abundance of solar analogs **depends on the presence of planets** orbiting them.

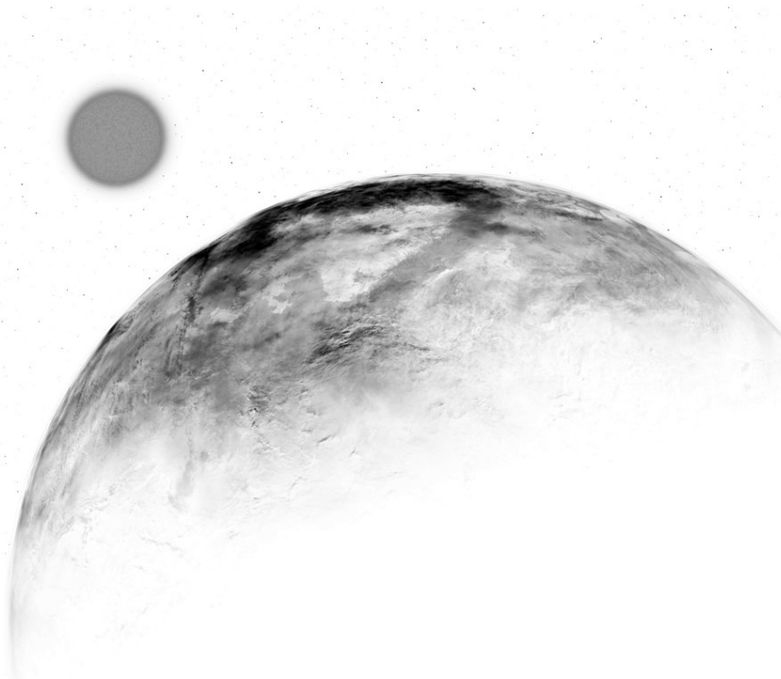
Testing for Li dependence

Until now there have been **two different** approaches to test depletion on solar-type stars:

• Restrict the range of parameters on which the comparison is done (e.g. Delgado-Mena et al. 2014)

• Postulate some dependence on the stars and weight the difference according to the dependence (e.g. Gonzalez 2014)

$$\Delta_{p,c} = 30\,|\log T_{\rm eff}^{c} - \log T_{\rm eff}^{p}| + |[Fe/H]^{c} - [Fe/H]^{p}| + 0.5\,|\log g^{c} - \log g^{p}| + |\log {\rm Age}^{c} - \log {\rm Age}^{p}|$$



Our approach

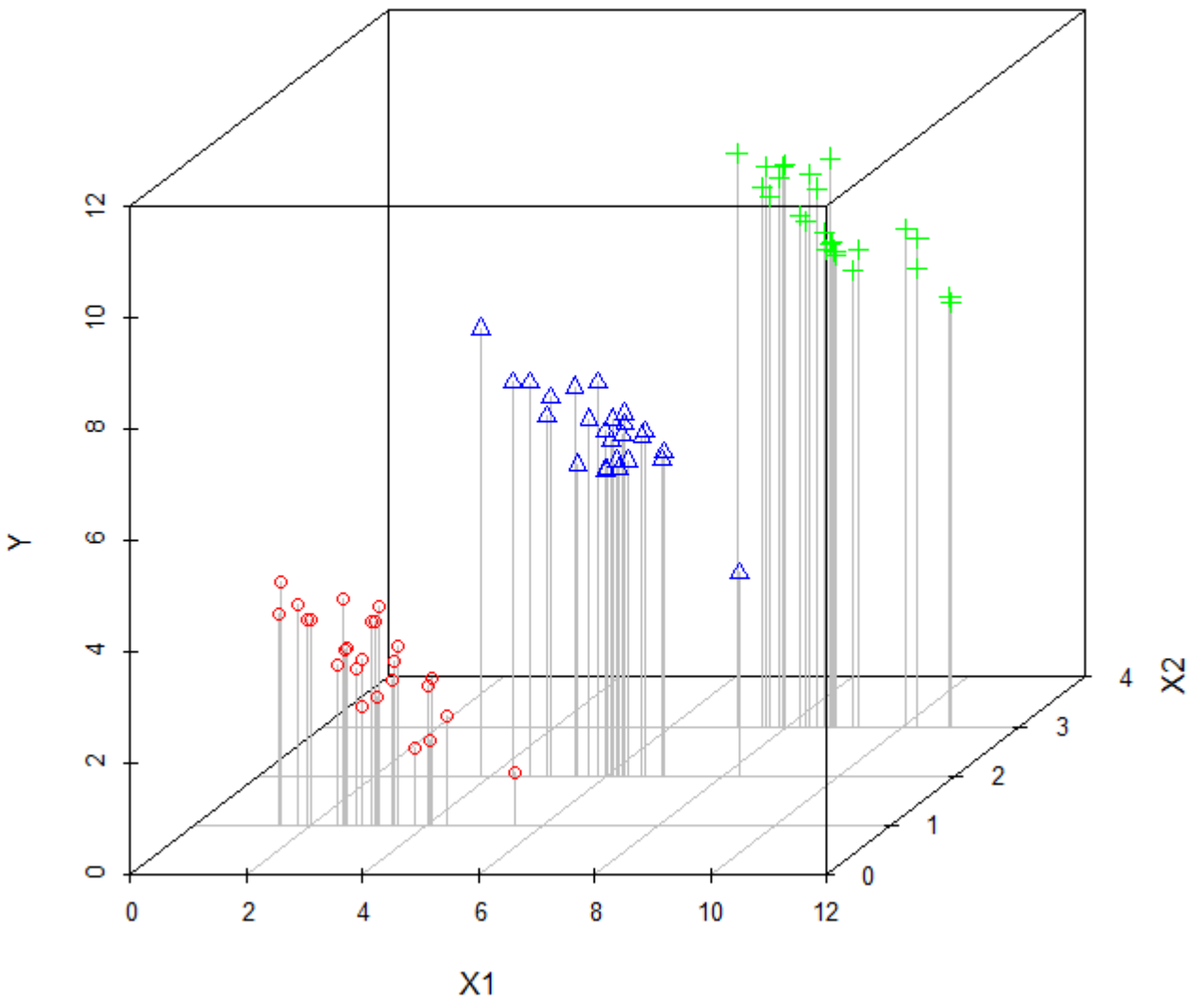
We decided to **control** for the different variables in a statistically meaningful sense.
We did a **multivariable regression** using a **moderator variable** to distinguish planet hosts and a non-planet hosts comparison sample.

$$\log(\mathrm{A(Li)}) = int. + \beta_1 \log(T_{eff}) + \beta_2 [Fe/H] + \beta_3 \log g + \\ + \beta_4 \log(\mathrm{Age}) + M \times \mathrm{offset}$$

Table 1. The parameters for each coefficient as resulting from Multivariable Linear Regression Analysis.

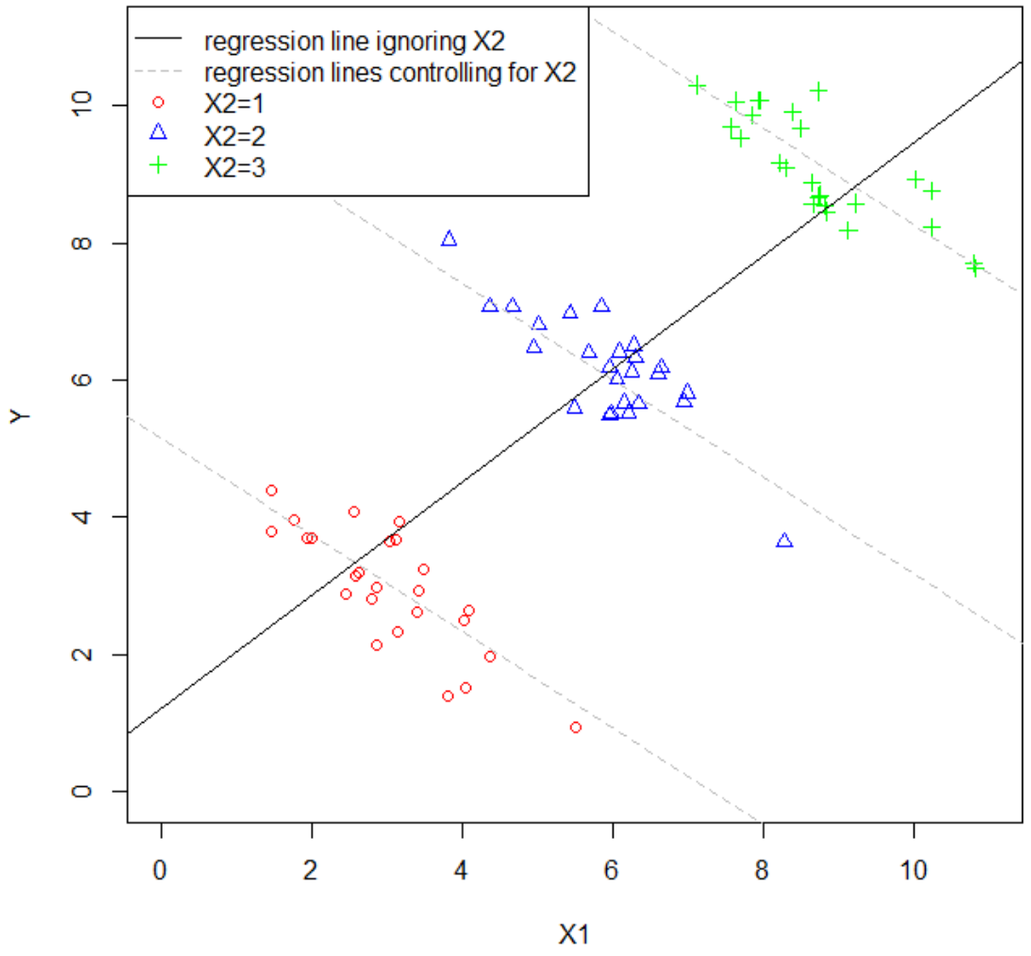
dataset	*int.*	β_1 ($\log(T_{eff})$)	β_2 ([Fe/H])	β_3 ($\log g$)	β_4 (log(Age))	offset
planet hosts sample	-163.24	45.49	-0.69	-1.37	-0.63	—
comparison sample	-73.49	21.27	-0.25	-0.99	-0.67	—
combined sample	-96.73	27.58	-0.38	-1.10	-0.70	-0.26
combined sample, Jupiter-mass only	-92.21	26.42	-0.37	-1.14	-0.71	-0.28

Our approach



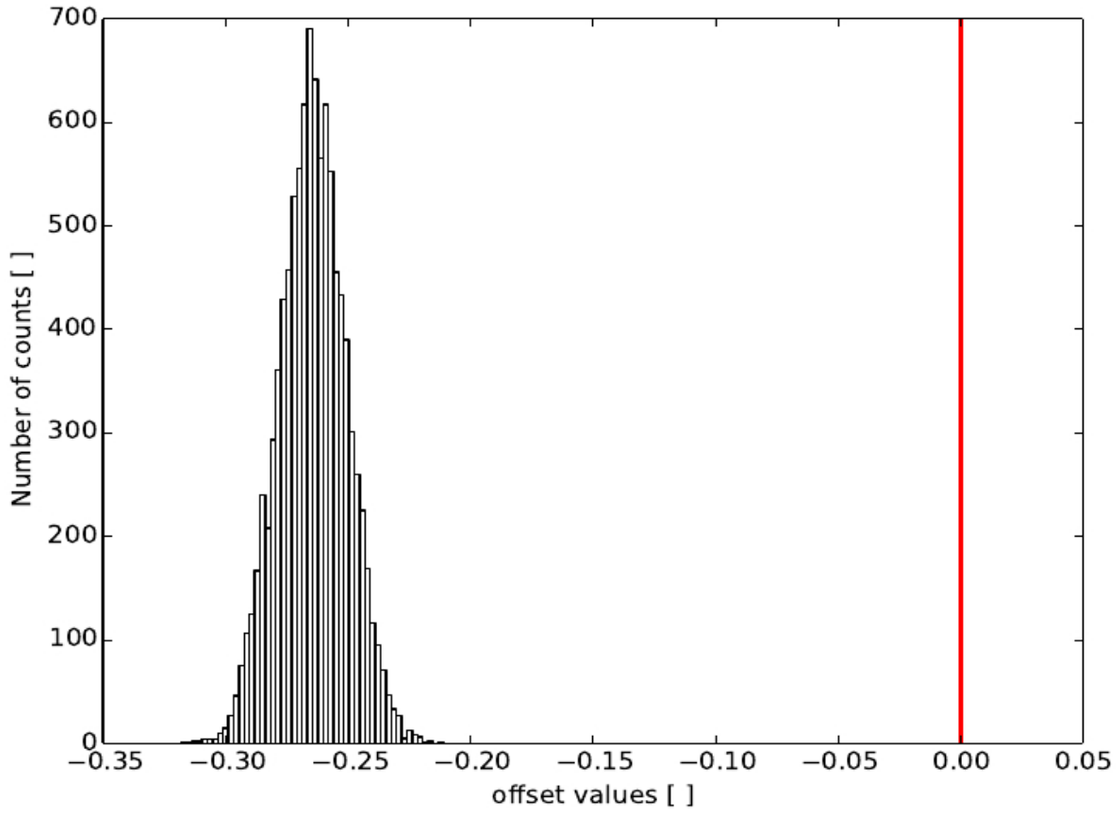
Problem made more complex due to high(?)-dimensionallity

Controlling is not something you can avoid by averaging



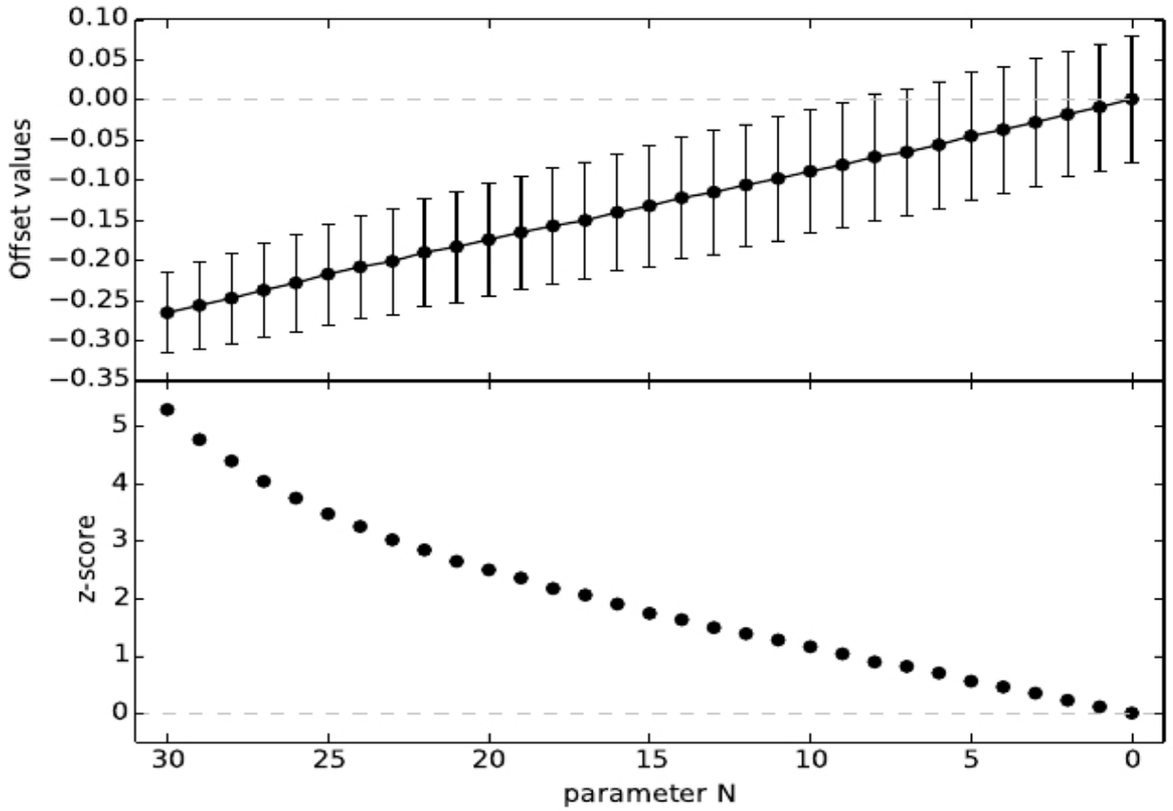
CrossValidated Community Blog

Robust result



The result is obtained with a **high significance**, and the Li error bars would have to be inflated by a factor > 5 for the result to be rendered insignificant.
The same is obtained with a Tobit-like analysis, including upper limits determinations.

Robust result II



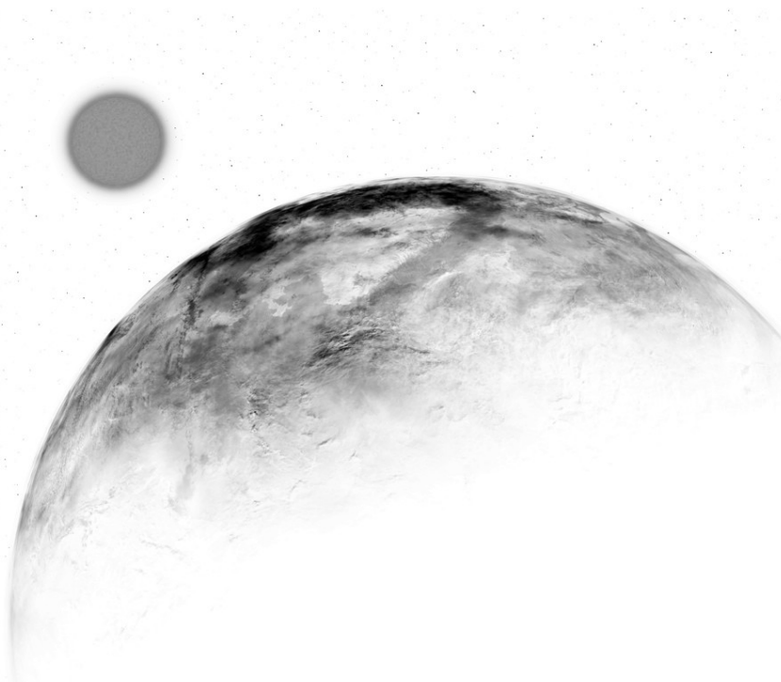
Several tests were performed to check the offset is not an artifact of the methodology.

1)The offset disappears, as expected, if host stars are swapped with comparison ones in a mock sample.
2)The offset also disappears if we consider shuffled tags
3) The offset is maintained for a several subsets of stars.

Conclusions

• **Planet-host stars show enhanced Li depletion**. When confounding variables are **controlled for** assuming a linear dependence, an offset of **-0.26/-0.28** is recovered.

• **The depletion** value is not the result of any kind of fine-tuning, withstanding several **statistical tests** and being **recovered for a very different sample selection criteria** (different limits on planetary mass, restricted temperature, and even upper-limits analysis).



Conclusions

And don't forget to check:

The paper:

- Figueira et al., accepted for publication in A&A, arxiv e-print ***1409.0890***

E. Delgado-Mena poster!

- *P3.14. Li depletion in solar analogues with exoplanets*