The chemical composition of very young open clusters

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OSSERVATORIO ASTRONOMICO DI PADOVA

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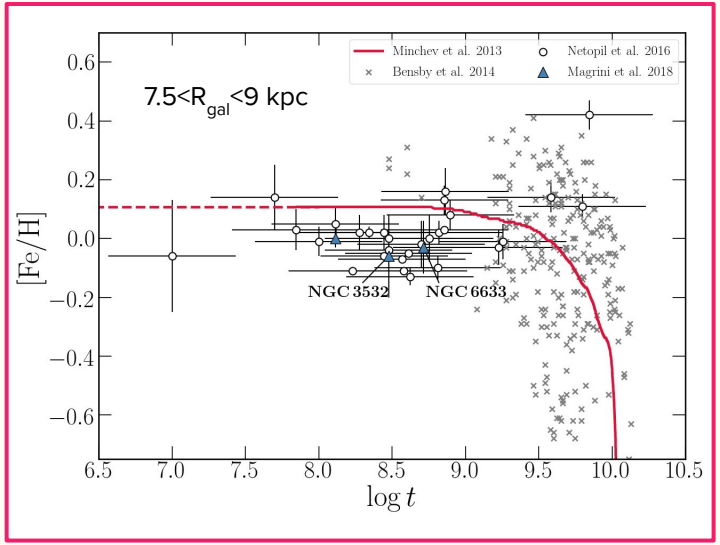
Lund Reference stars workshop

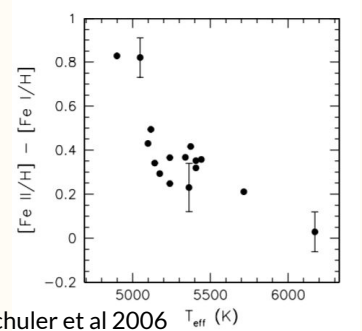
Virtual meeting, 31 March 2021

The challenges of the analysis of young open clusters

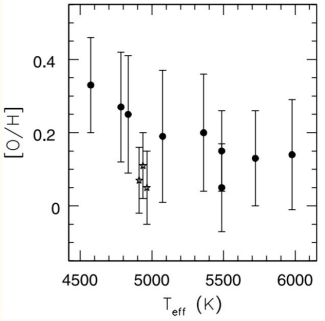
In the last 15 years, the spectroscopic analysis of young (τ < 200 Myr) stars (both in open clusters OCs and in field) has shown some interesting features:

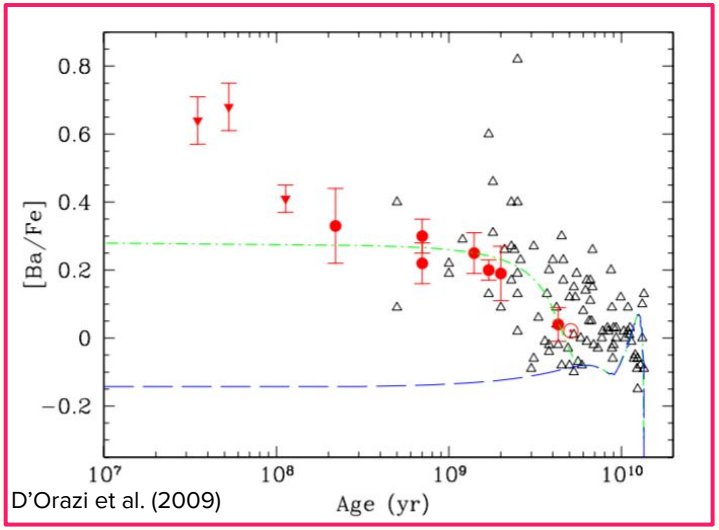
1. the (apparent) **local anaemia** of the ISM
2. the **ionisation balance problem** and the **over-excitation** effect (T_{eff}< 5400 K)
3. the **barium puzzle**





Schuler et al 2006





D'Orazi et al. (2009)

The challenges of the analysis of yo g open clusters

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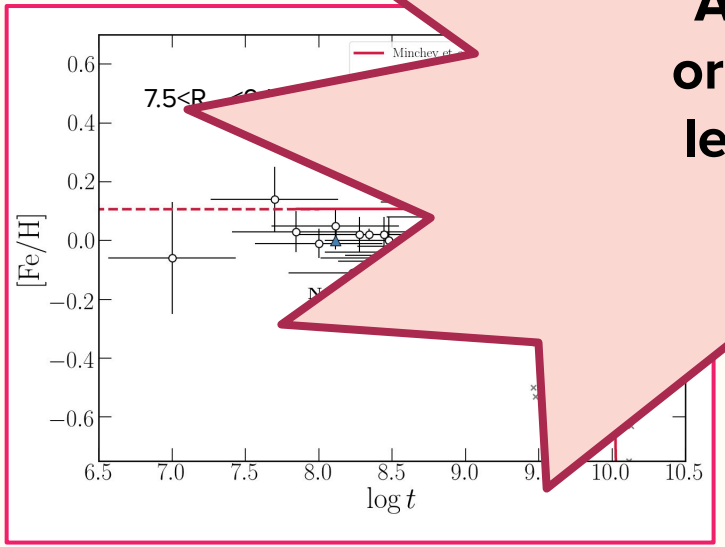
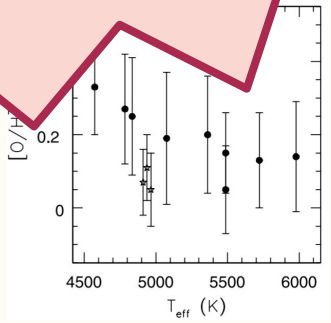
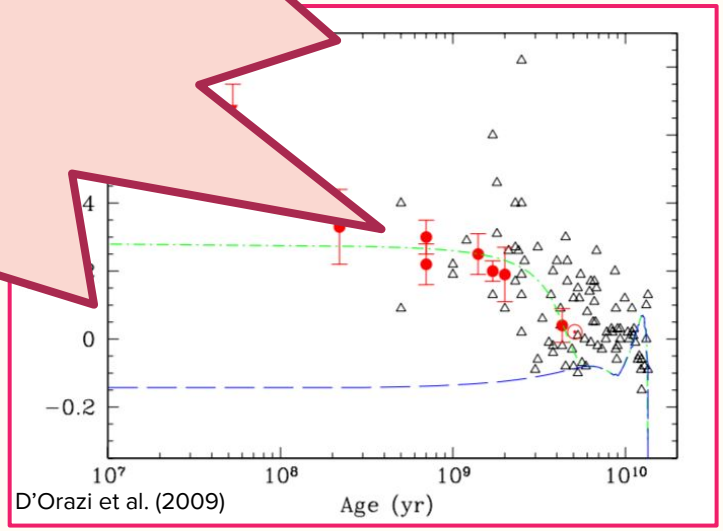
1. the (apparent) **local anae**
2. the **ionisati**
3. the **barium p**

The key could be the AGE of the star..... or better the higher levels of ACTIVITY





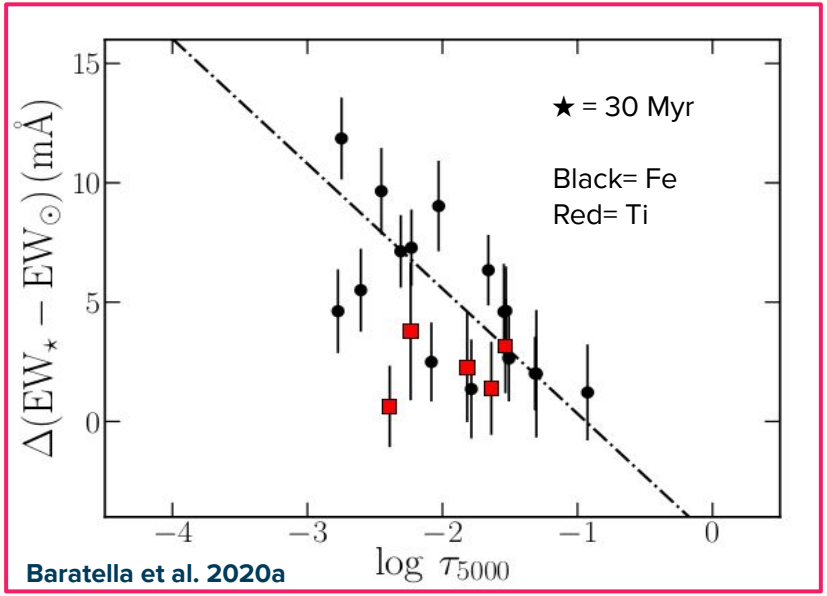


D'Orazi et al. (2009)

A new spectroscopic approach (Ti+Fe) -- Baratella et al 2020a

Active chromosphere and/or intense photospheric magnetic fields = alteration of strong lines forming in the upper layers of the photosphere

(Yana-Galarza et al. 2019, Baratella et al. 2020a, Spina et al. 2020)



Baratella et al. 2020a

ξ = WEAK AND STRONG FeI LINES HAVE SAME ABUNDANCE (maybe affected by magnetic intensification)

INCREASE ξ UP TO 2.0-2.5 KM/S (GIANT STARS)

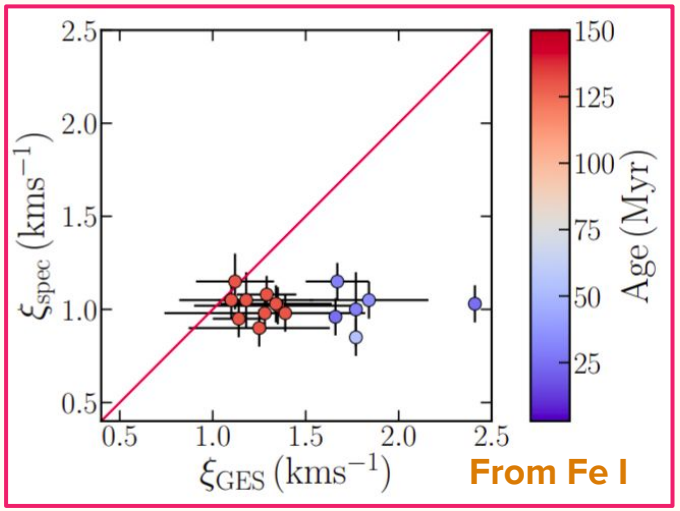
STARS HAVE ARTIFICIALLY LOW [Fe/H] AND [X/Fe] THAT RESCALE ACCORDINGLY!!!

A new spectroscopic approach (Ti+Fe) -- Baratella et al 2020a

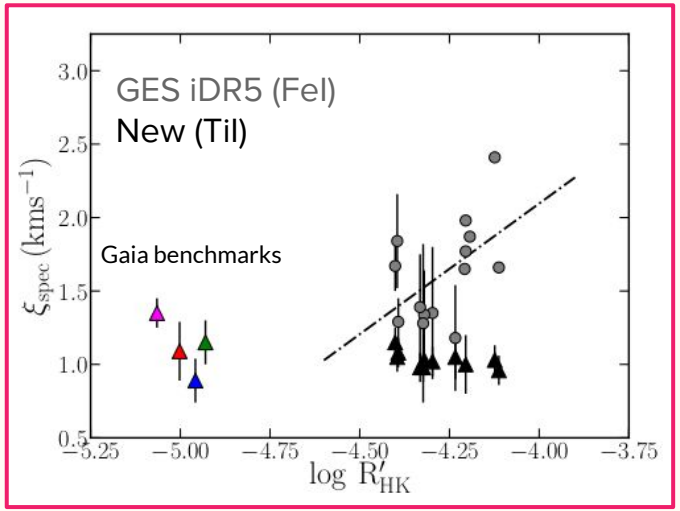
- T_{eff} from excitation equilibrium of **Ti+Fe lines**
- **log *g*** from ionisation equilibrium of **Ti lines**
- ξ by imposing that weak and strong **Ti I lines** have the same abundance

FGK **dwarf** stars

From Ti I



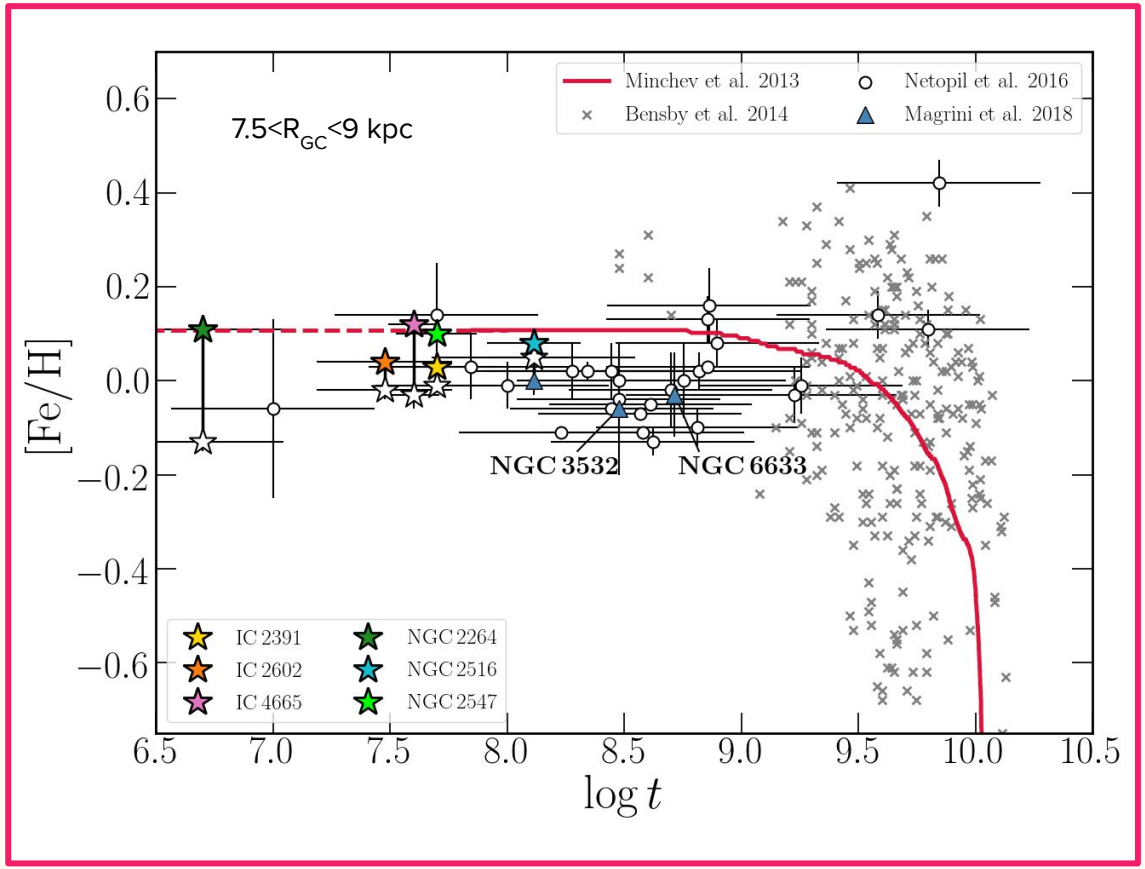
From Fe I



Baratella et al. 2020a

A new spectroscopic approach (Ti+Fe) -- Baratella et al 2020a

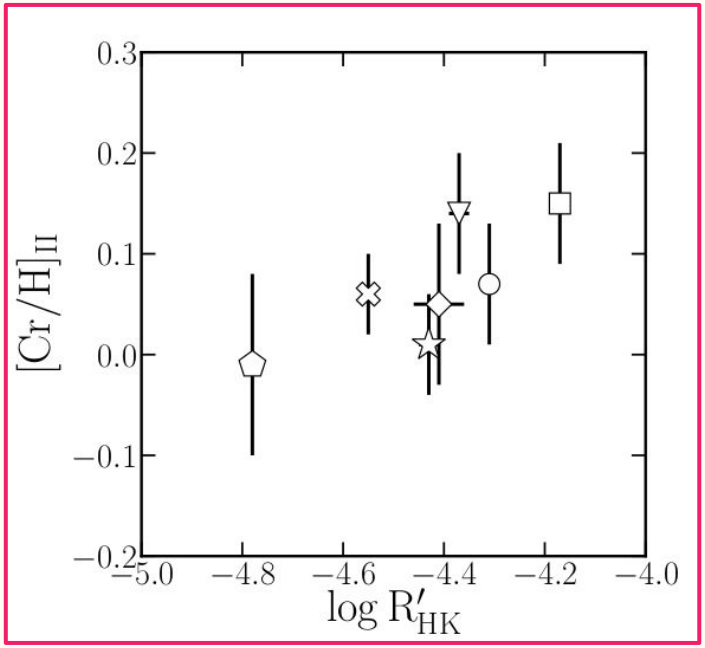
Apparent METAL-POOR nature of YOCs = results of fundamental issues in the spectroscopic analysis of young stars

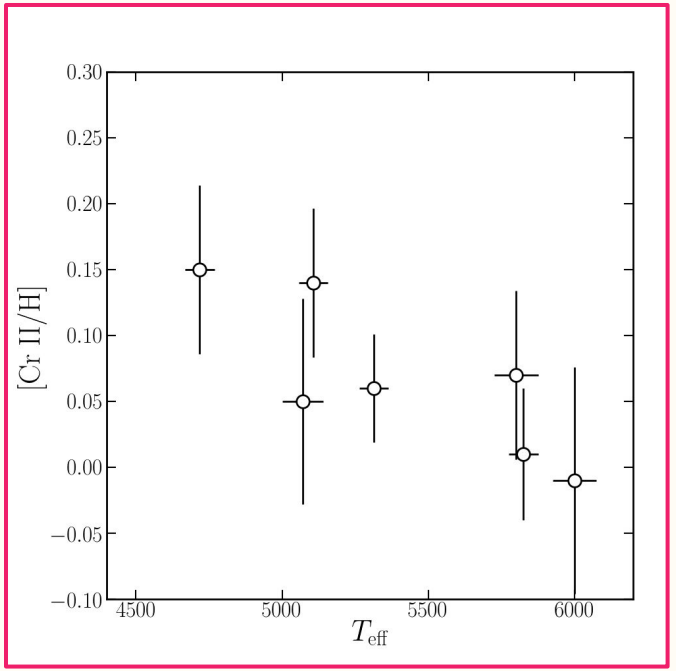


Trends of overabundances with $\log R'_{HK}$ -- Baratella et al 2020b

Main methodology used within the GAPS program (FGK **dwarf** stars)
(aim: monitor and study stars with ages less than 700 Myr to study hot and warm sub-Neptune planets in formation)

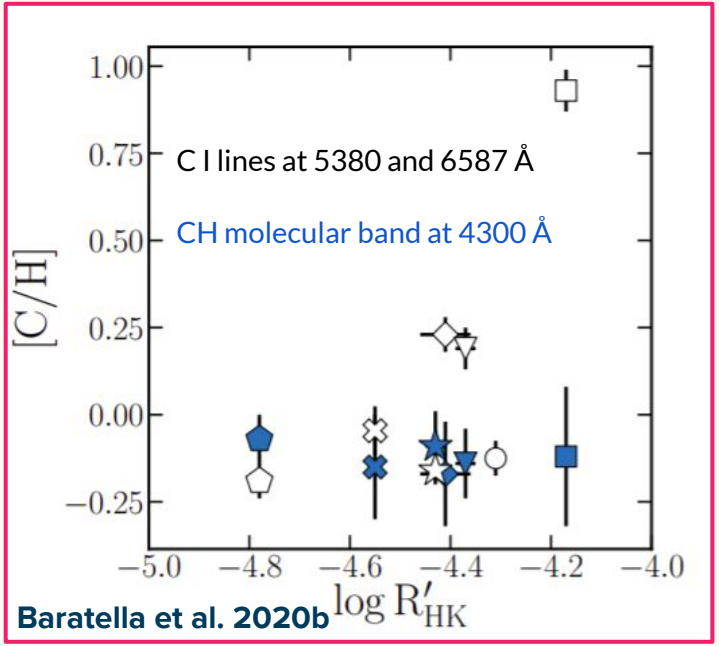
Teff = from 4718 K to 6000 K; log R'_{HK} from -4.17 to -4.78



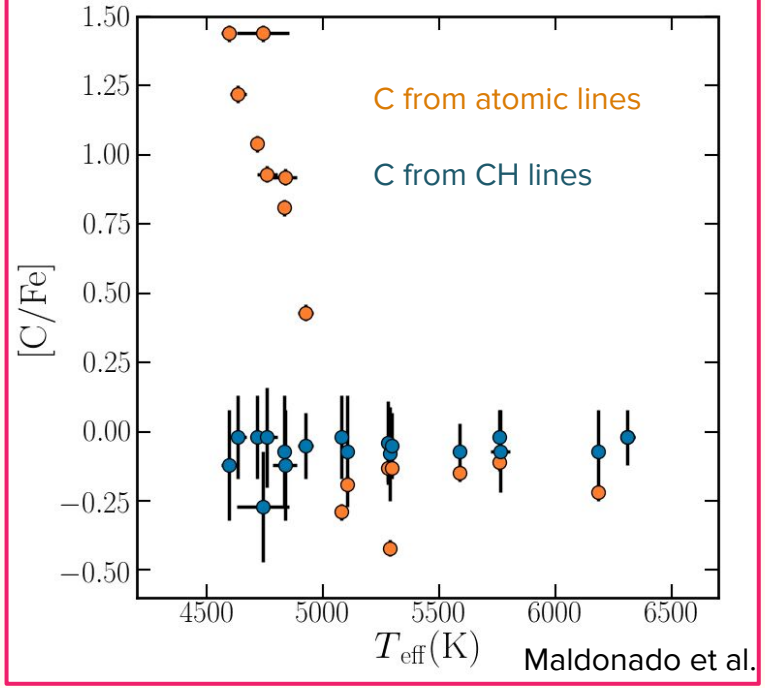


Trends of overabundances with $\log R'_{HK}$ -- Baratella et al 2020b

Use of CH features for C abundances in cool and young stars (as in **Maldonado, Micela, Baratella et al. 2020 -- HADES RV Programme:** derivation of M dwarfs abundances from FGK primary companion through PCA and sparse Bayesian methods)



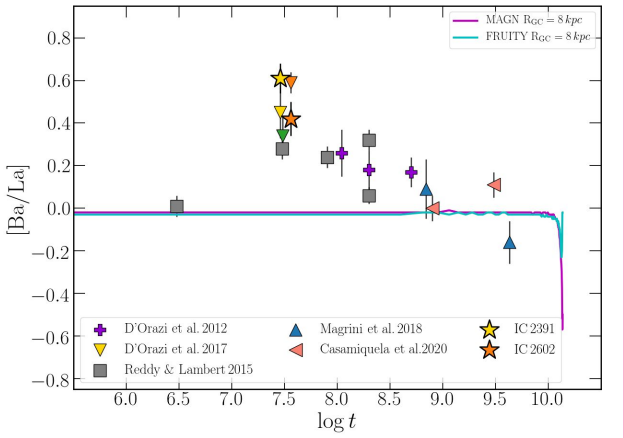
Baratella et al. 2020b

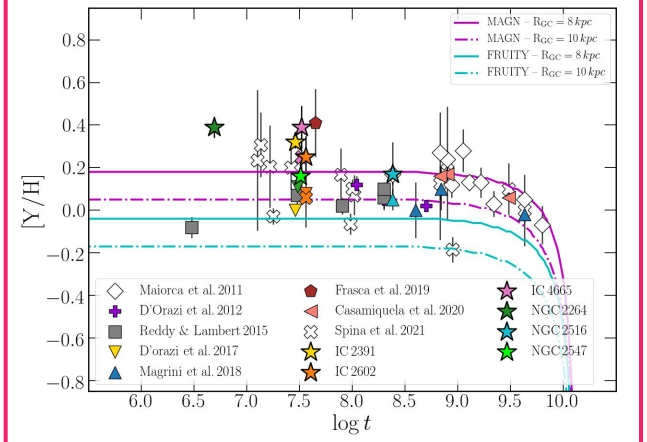


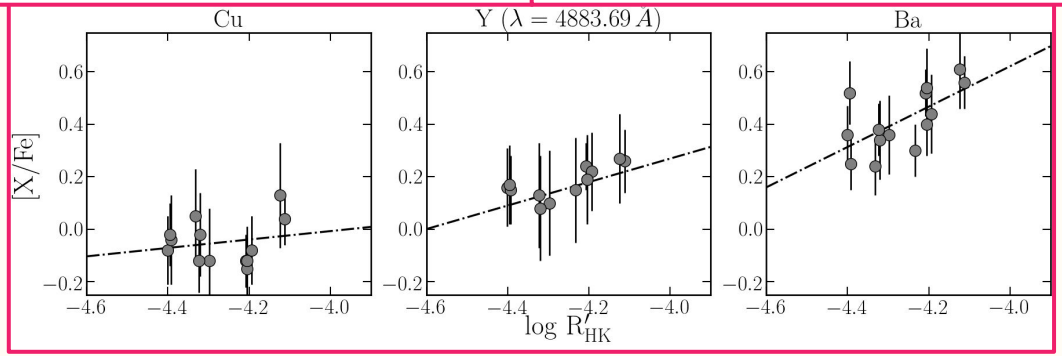
Maldonado et al. 2020

The abundances of n-capture elements -- Baratella et al, in prep.

CuI, SrI and SrII, YII, ZrII, BaII, LaII and CeII (FGK **dwarf** stars)







Shed light on the time-evolution of n-capture elements, in particular the s-process elements

Indication of a possible correlation with activity!!!

Predictions from nucleosynthesis and GCE models fail at reproducing the observed pattern

Implications on the use of chemical clocks at young ages, especially those based on Y and Ba

Conclusions

- Analysis of young stars is NOT straightforward
- Needs to revise the spectroscopic analysis techniques of stars with ages less than 200 Myr
- Poor knowledge of the main mechanisms behind these effects
- More observations needed to exploit all the spectral range and analyse in more details the link with the stellar activity
- Implications in different fields: GCE, study of linking relations host stars-planets, nucleosynthesis models ...

Thank you !!!