MINISTÉRIO DA CIÊNCIA, TECNOLOGIA E INOVAÇÃO
INSTITUTO NACIONAL DE PESQUISAS ESPACIAIS

RECOVERING Mg AND Ca ABUNDANCES AT MID-RESOLUTION FOR MILES STARS

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- MILES & Motivation
- [E/Fe] characterization of MILES' stars
  - methodology
  - Mg done (Milone et al. 2011)
  - Ca on going

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Stellar Evolution and Nucleosynthesis
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CNPq
CAPES
FAPESP

Mid-resolution **I**saac Newton Telescope **L**ibrary of **E**mpirical **S**pectra

- **985 optical spectra for 985 stars λλ3525-7500 Å**
(Sánchez-Blázquez et al. 2006)
  - FWHM = 2.5 Å ⟷ R=2,200 @ 5500Å
  - 0.9 Å sampling
  - well flux-calibrated

- **The photospheric parameters cover wide ranges in a uniform system with acceptable accuracy**
(Cenarro et al. 2007)
  - $2800 \leq T_{eff} \leq 50400$ K (±100 K, FGKM stars)
  - $0.0 \leq \log g \leq 5.0$ (±0.2)
  - $-2.7 \leq [Fe/H] \leq +1.0$ (±0.1 dex)

Motivation

In the current semi-empirical SSP models:

- **Fe** is the **only** metallicity tracer, [E/H]=[Fe/H] !!!???
- [E/Fe] are **not** considered
- some restriction due to the Galaxy's chemical evolution
  - distinct patterns of [E/Fe]-[Fe/H] among the components

  → *we can take some advantage from this aspect!*

If the individual element abundances were known…

→ great improvement to semi-empirically compute more realistic SSP models…at least for a range of age-[Fe/H]-[E/Fe]…

MILES resolution is comparable to many previous mid-resol. analyses (e.g. Chavez et al. 1995; Terndrup et al. 1995; Cook et al. 2007)

[Mg/Fe]: 2 features, 2 methods, MOOG, MARCS models

Milone et al (2012, JCIS, 3, 127)

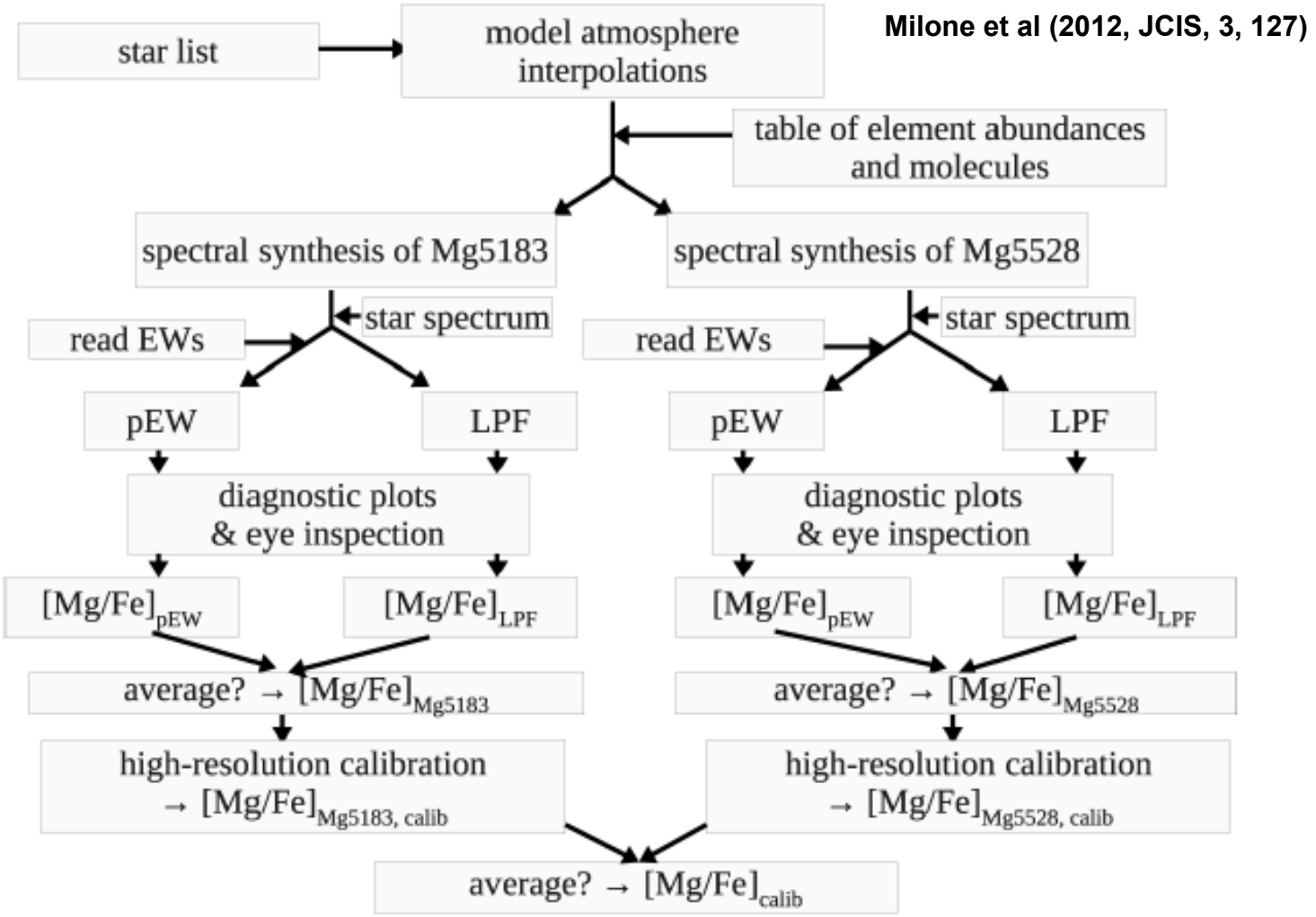


Figure 3 – Flux diagram for the spectroscopic analysis to derive the [Mg/Fe] abundance ratio at medium resolution.

Borkova & Marsakov (2005)'s High-Resol. homogenised [Mg/Fe] as calibration sample

[Mg/Fe]: Mg I λ5183Å feature for a metal-poor giant

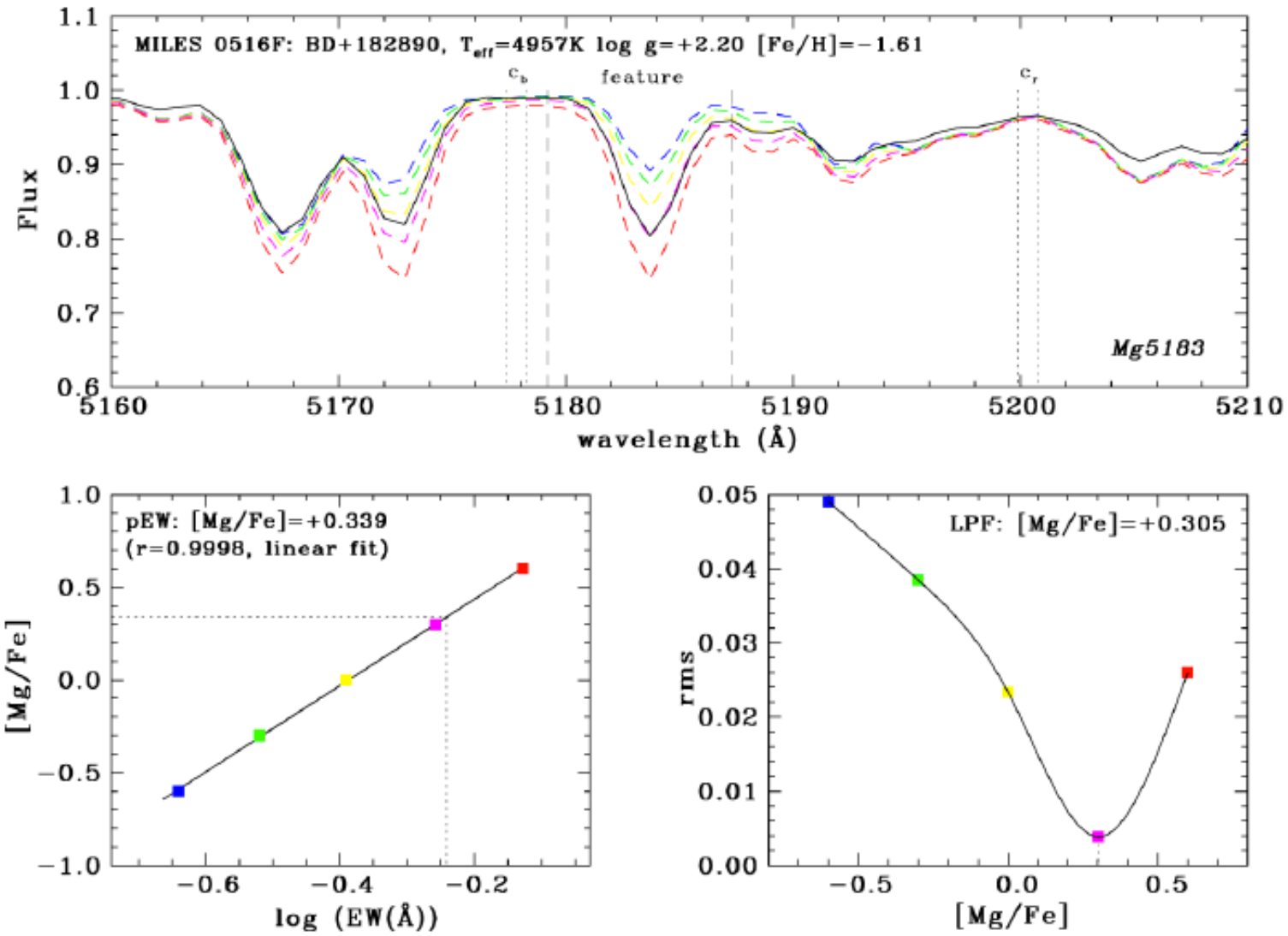


Figure 4 – Example of diagnostic plots, adapted from Milone et al. (2011), for the spectral synthesis of Mg5183 feature (top panel) and the correspondent methods employed to determine [Mg/Fe] (pseudo-equivalent width in the left bottom panel and line profile fit in the right one).

Milone et al. (2012)

[C/Fe]: C_2 (0,0) band head @ R=42,000

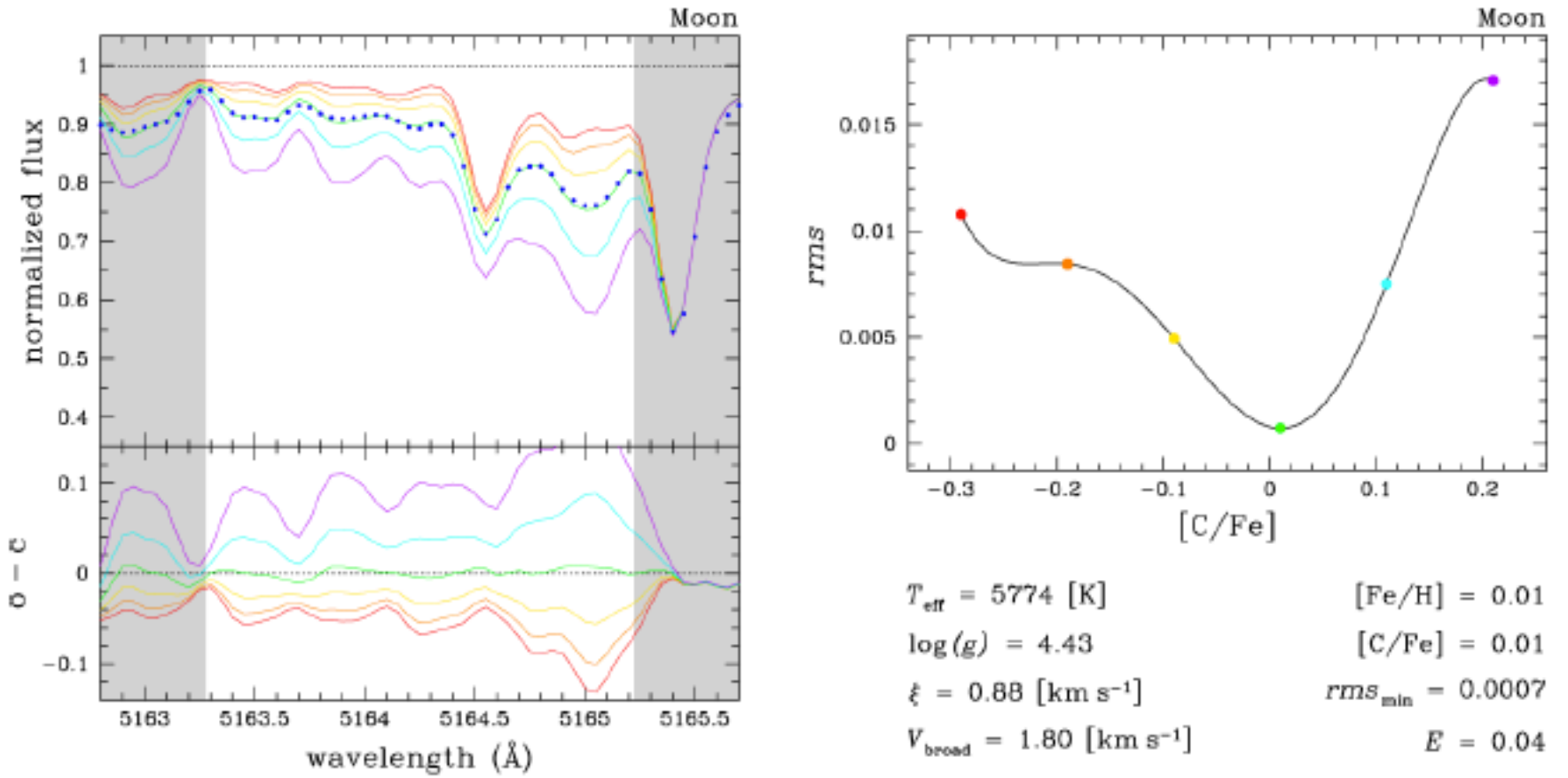


Figure 2 – Example of a spectral synthesis at high resolution of the C_2 band feature at λ5165Å (left panel, from Fig. 3 of Da Silva et al., 2011) and the diagnostic plot *rms* of theoretical and observed spectral comparisons versus [C/Fe] (right panel). The observed spectrum (blue points in the left panel) is the sunlight reflected by the Moon. The flux continuum normalization is checked in other plots.

Milone et al. (2012)

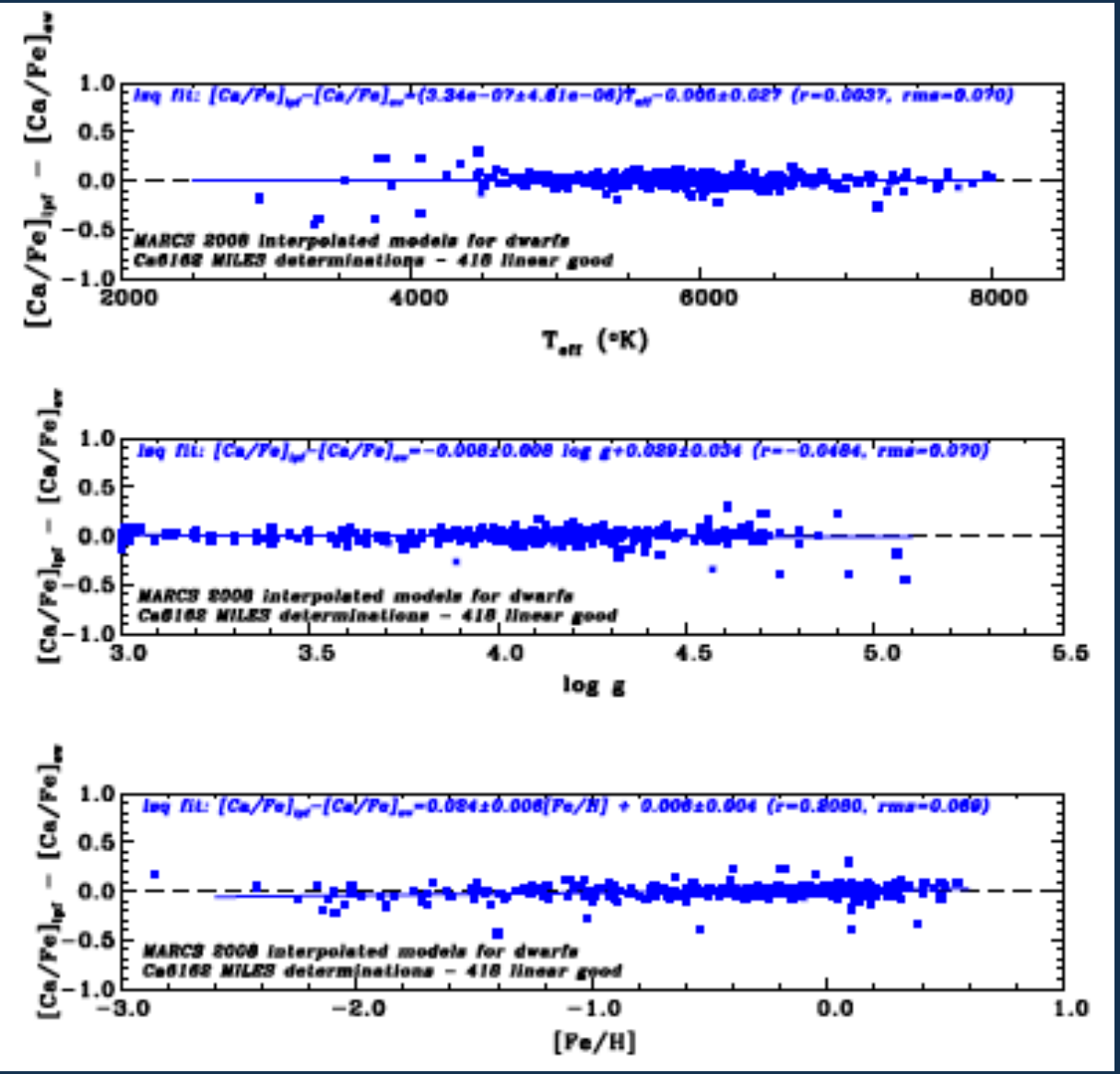
[Mg/Fe]: Mg I λ5528Å feature

Milone et al. (2011)

[Ca/Fe]: Ca I λ5513Å, λ6162Å, λ6169Å features

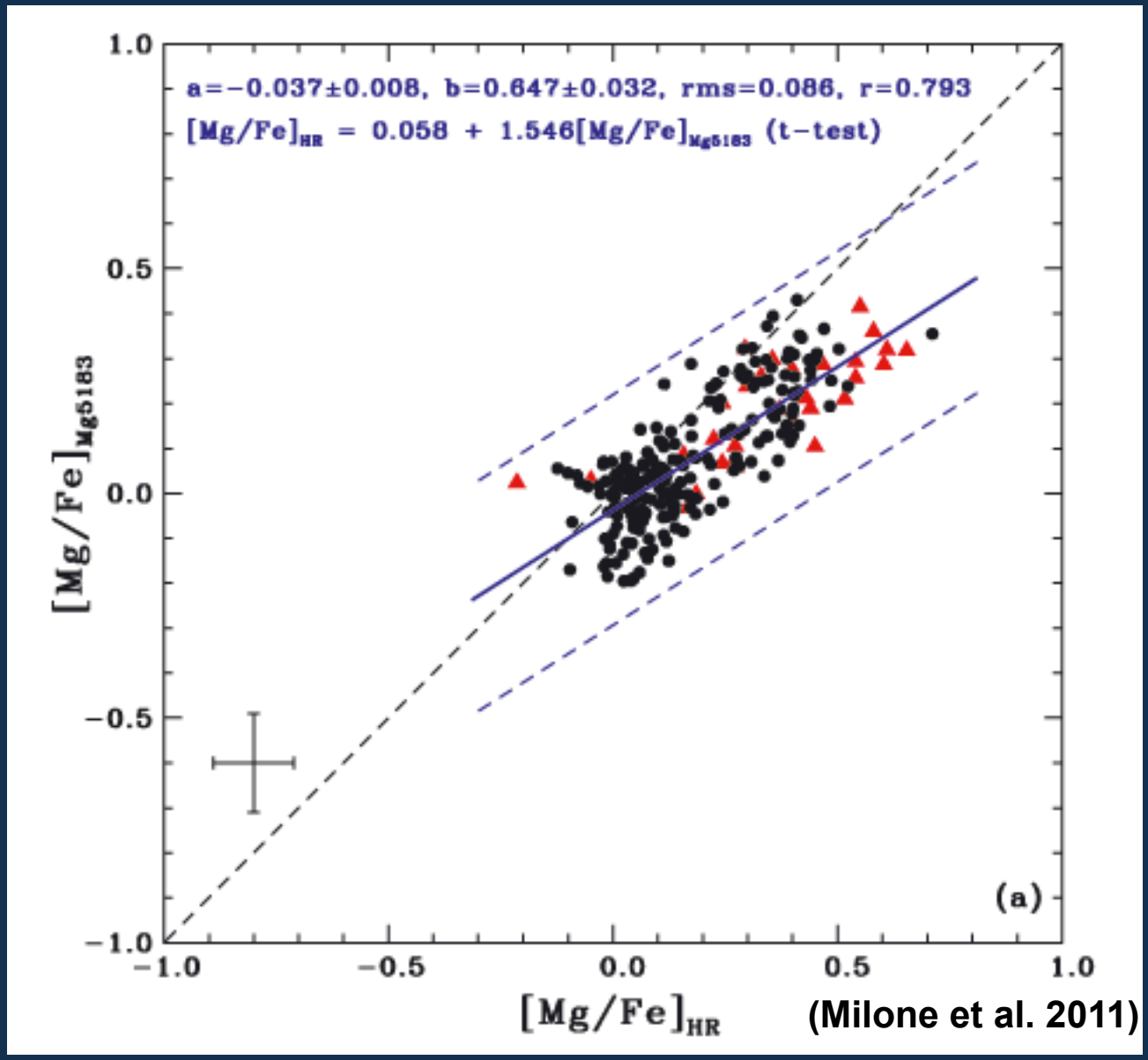
Milone et al. (in preparation)

Ca6162: both methods compared, dwarfs only



(Milone et al. in preparation)

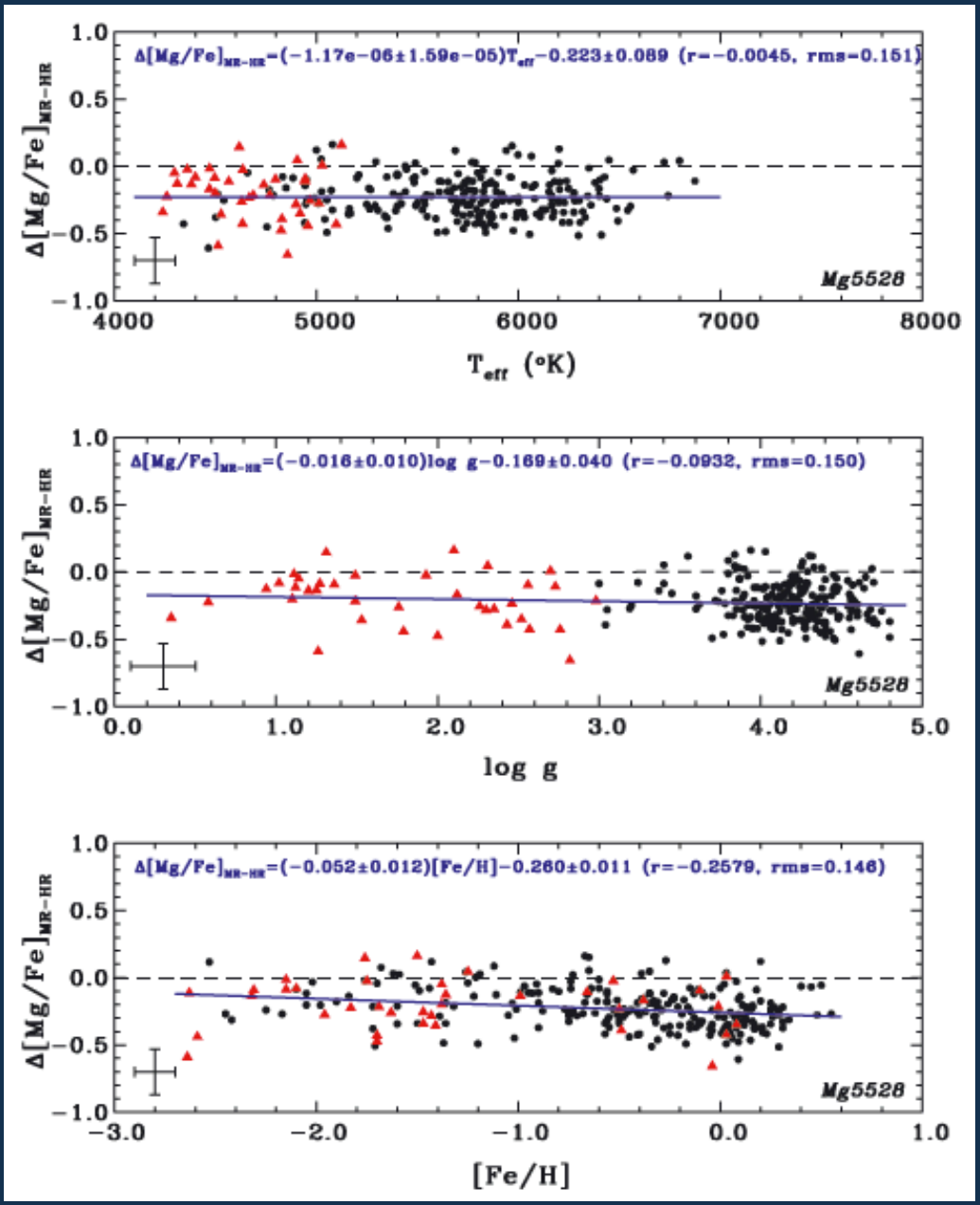
Mg5183: calibration to HR data



(Milone et al. 2011)

Borkova & Marsakov (2005)'s High-Resol. homogenised [Mg/Fe] as calibration sample

Mg5528: mr-HR non-dependence on parameters



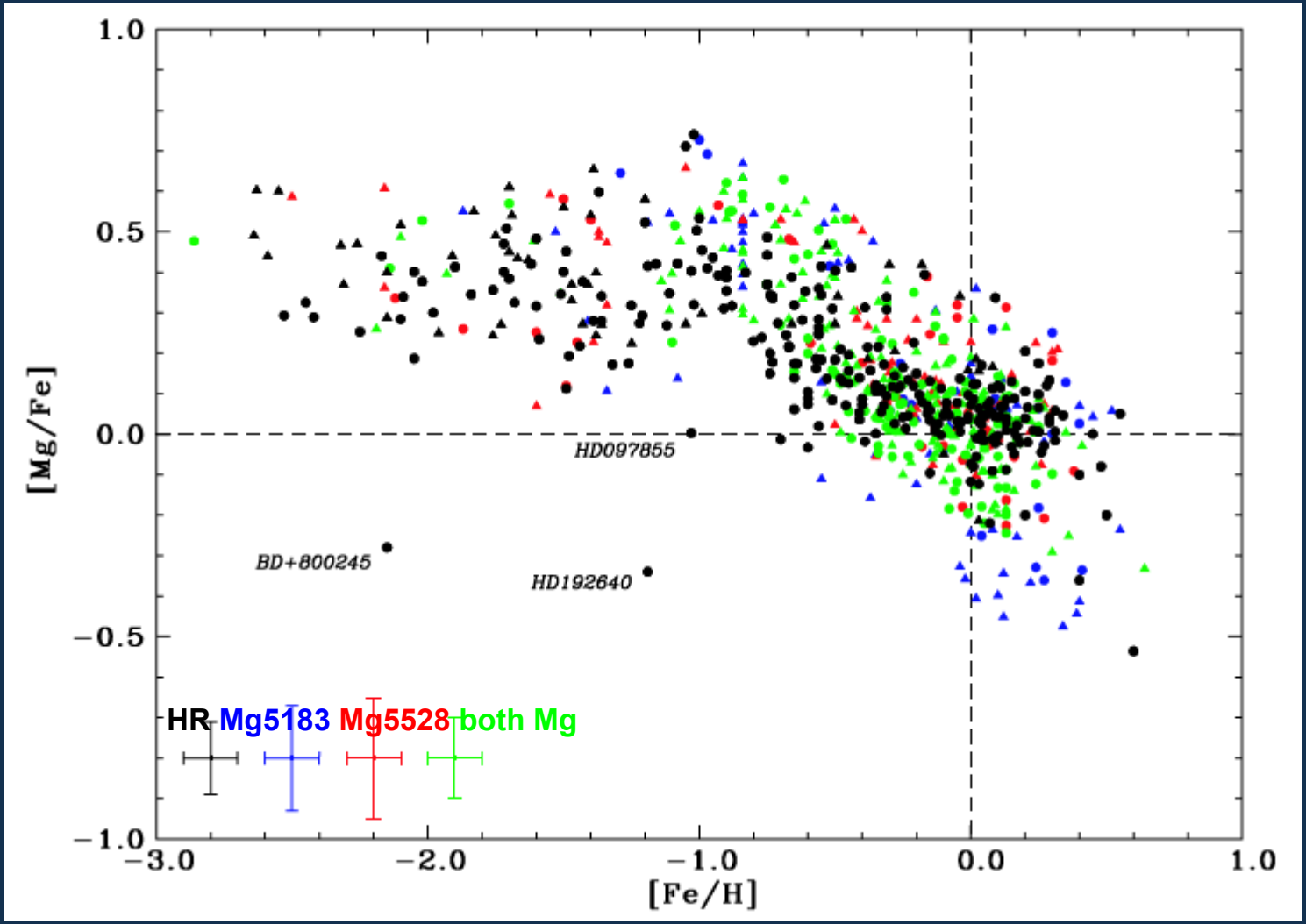
(Milone et al. 2011)

[Mg/Fe]: internal and systematic errors

No.		Mg5183 (dex)	Mg5528 (dex)	Both (dex)	Notes
1	$\sigma[Mg/Fe]_{EW}$	0.09	0.20	–	From the EW method
2	$\sigma[Mg/Fe]_{LPF}$	0.075	0.075	–	From the LPF method
3	$\sigma[Mg/Fe]_{method}$	0.06	0.11	–	From rows one and two variance averaged
4	$\sigma[Mg/Fe]_{atm}$	0.09	0.10	–	Due to the photospheric parameter errors
5	$\sigma[Mg/Fe]_{feature}$	0.11	0.15	–	Internal errors from rows three and four combined in quadrature
6	$\sigma[Mg/Fe]^{calib}_{feature}$	0.13	0.15	0.10	Systematic errors (from HR comparisons), variance averaged in the last column

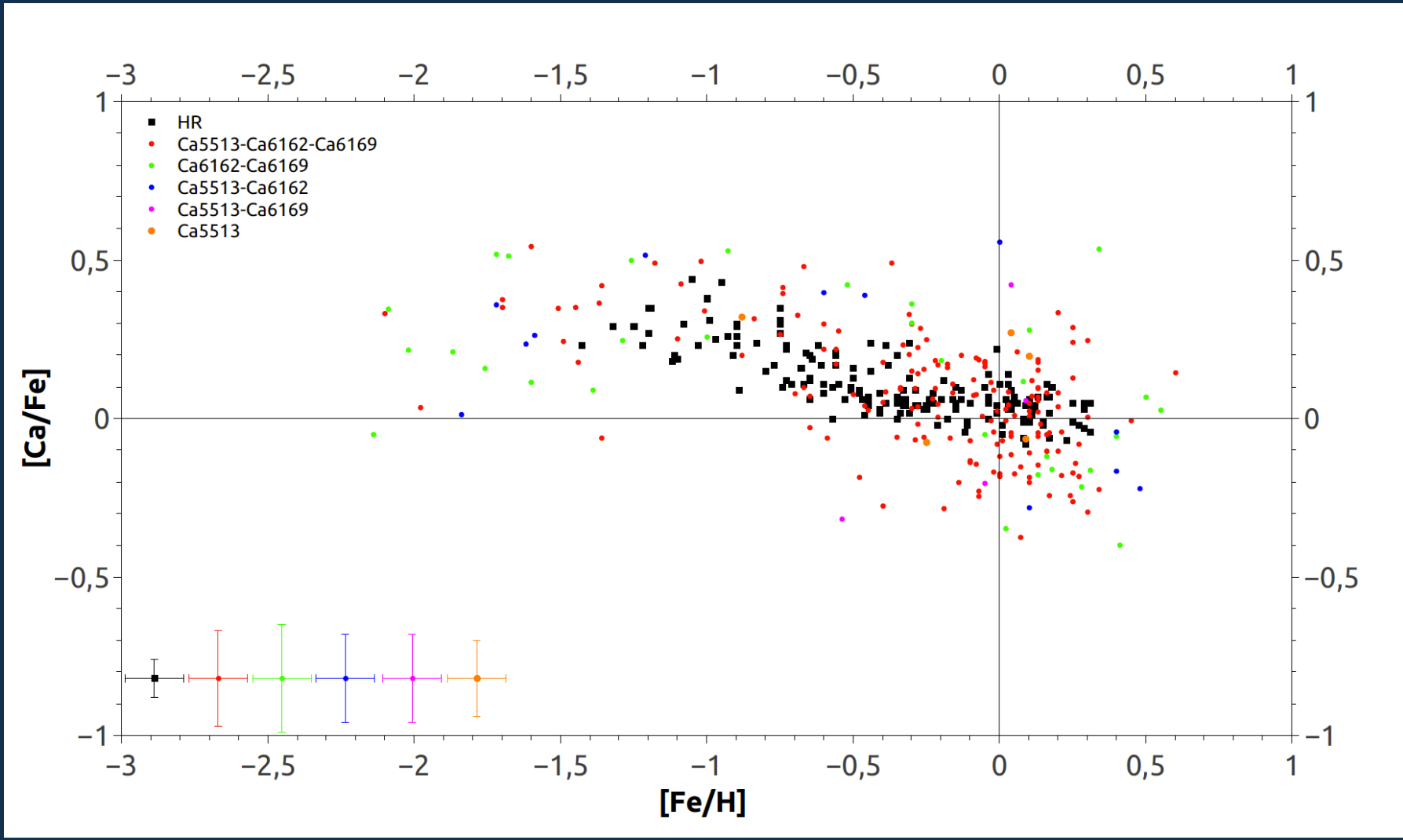
(Milone et al. 2011)

The new 4-D parameter space of MILES:
[Mg/Fe] *vs.* [Fe/H] plane



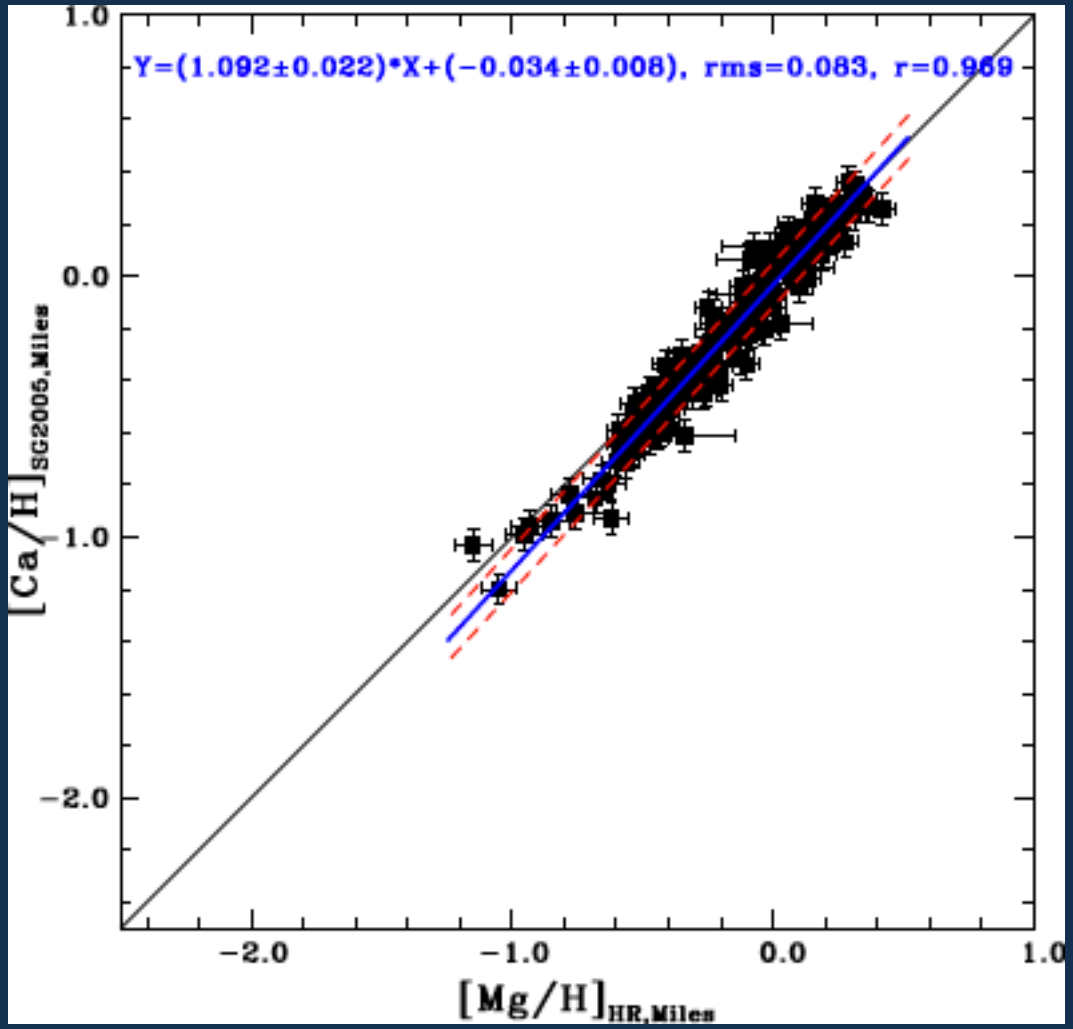
(Milone et al. 2011): 437 stars by mid-resol. & 315 stars from H-R

The further 5-D parameter space of MILES: [Ca/Fe] *vs.* [Fe/H] plane – dwarfs only!



(Milone et al. in preparation): 213 dwarfs by mid-resol. & 174 dwarfs from H-R

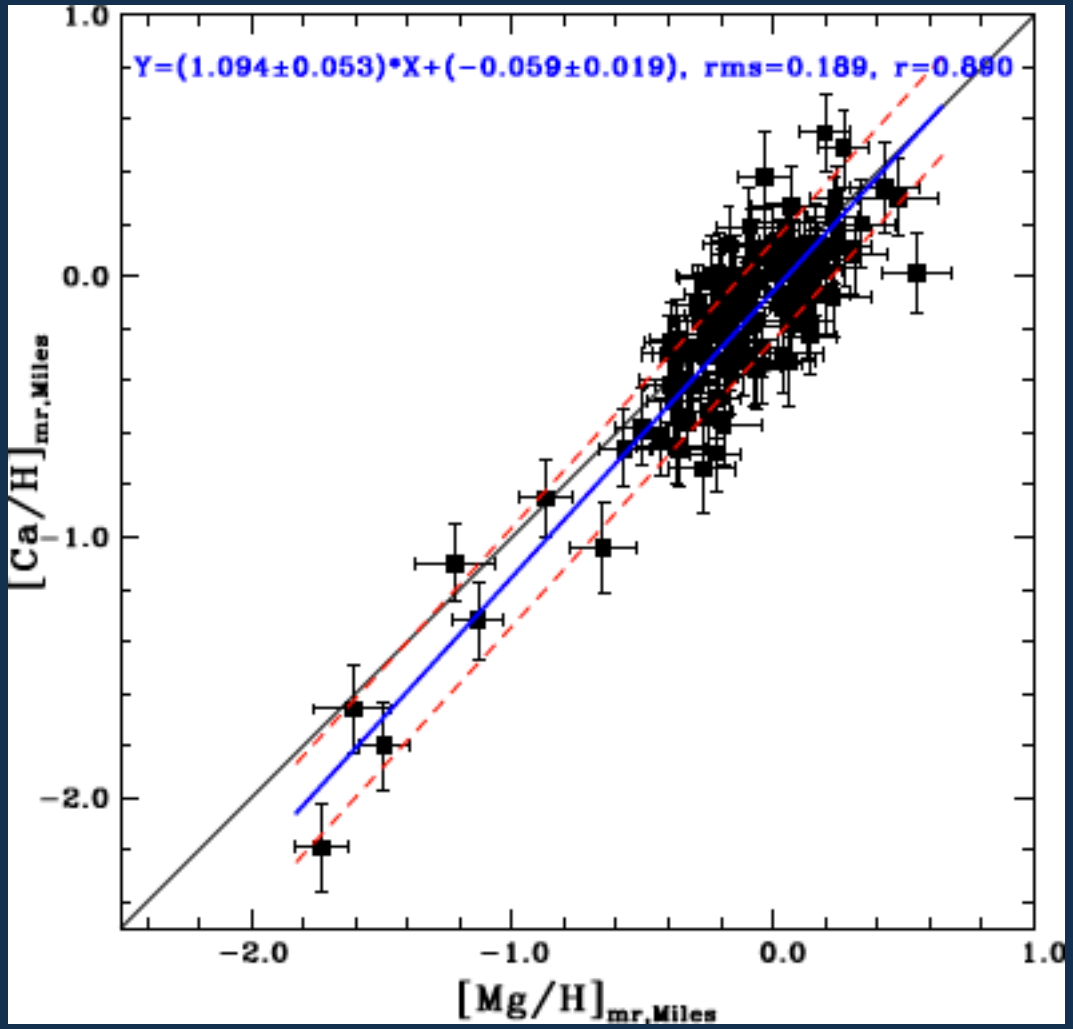
[Ca/H] vs. [Mg/H]: High Resolution data



(Milone et al. in preparation)

Soubiran & Girard (2005) High-Resol. Ca abund. compilation as calibration sample

[Ca/H] vs. [Mg/H]: mid-resolution data



(Milone et al. in preparation)

Summary

Mid-resolution chemical analysis is reliable

Mg and Ca abundances recovered in MILES stars

BUT that visual inspection MUST BE automatized

That’s it!

Thank you all