near-IR stellar libraries: a new tool for stellar populations

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Outline

- Ivanov´s library (Ivanov et al. 2004): HK band spectra

- UCM library: K band library focused in the empirical calibration of CO band at 2.3 _m

Why to look at the near-IR?

- Each observational window is dominated by different stars
- The near-IR is dominated by RGB and AGB stars: spectral features sensitive to giant/dwarf ratio

- Different elements have distinct time scales
- Carbon (in CO) is produced in intermediate age stars

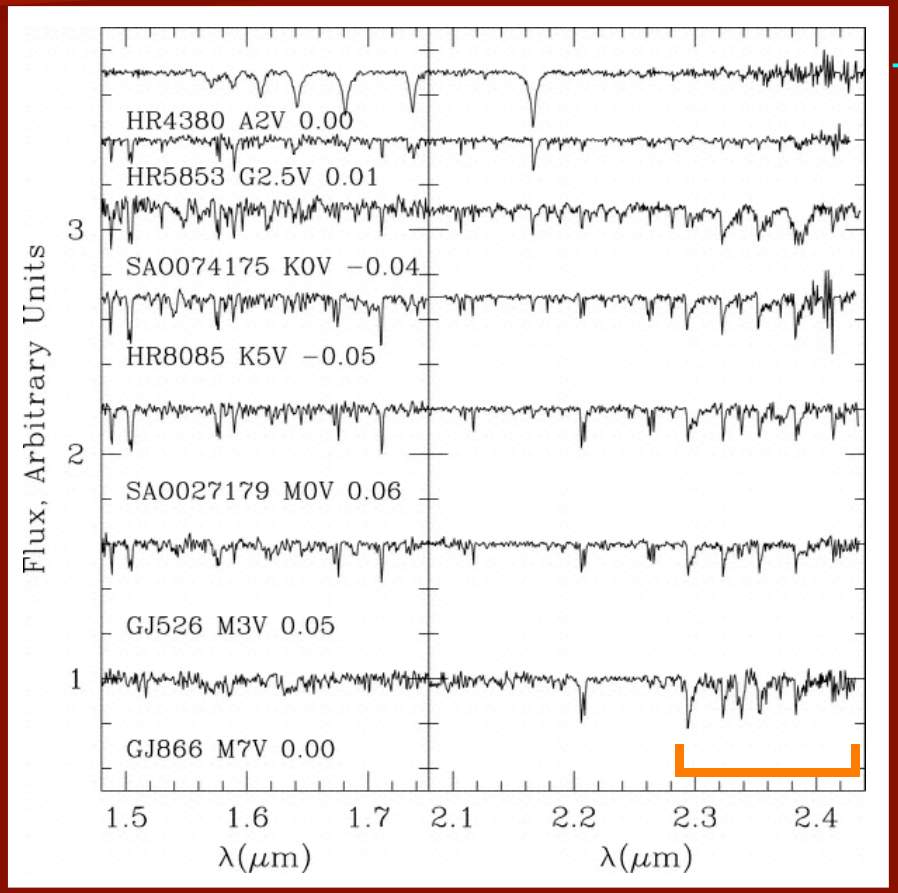
- CO can be used as a potential oxygen indicator
- CO can be used to detect intemediate age populations

Stellar libraries in the near-IR

Spectral Library Reference	λ (μm)	Spectral Type and Luminosity Class Range	Number of Stars	Spectral Resolution
Johnson & Mèndez 1970	1.2–2.5	A–M, I–V	32	550
Kleinmann & Hall 1986	2.0–2.5	F–M, I–V	26	2500–3100
Lançon & Rocca–Volmerange 1992	1.4–2.5	O–M, I–V	56	550
Origlia et al. 1993	1.5–1.7	G–M, I–V	40	1500
Ali et al. 1995	2.0–2.4	F–M, V	33	1380
Wallace & Hinkle 1996	2.02–2.41	G–M, I–V	12	45000
Dallier et al. 1996	1.57–1.64	O–M, I–V	37	1500–2000
Hanson et al. 1996	2.0–2.4	O–B, I–V	180	800–3000
Ramírez et al. 1997	2.19–2.34	K–M, III	43	1380, 4830
Wallace & Hinkle 1997	2.0–2.4	O–M, I–V	115	3000
Meyer et al. 1998	1.5–1.7	O–M, I–V	85	3000
Joyce 1998	1.0–2.5	K–M, III	29	500–1500
Förster-Schreiber 2000	1.90–2.45	G–M, I–III	31	830,3000
Wallace et al. 2000	1.05–1.34	O–M, I–V	88	3000
Lançon & Wood 2000	0.5–2.5	K–M, I–III	77	1100
Hicks et al. 2000	1.08–1.35	O–M, I–V	105	650
Ivanov et al. 2004	1.48-2.45	G-M, I-V	218	2000-3000

Ivanov's Library

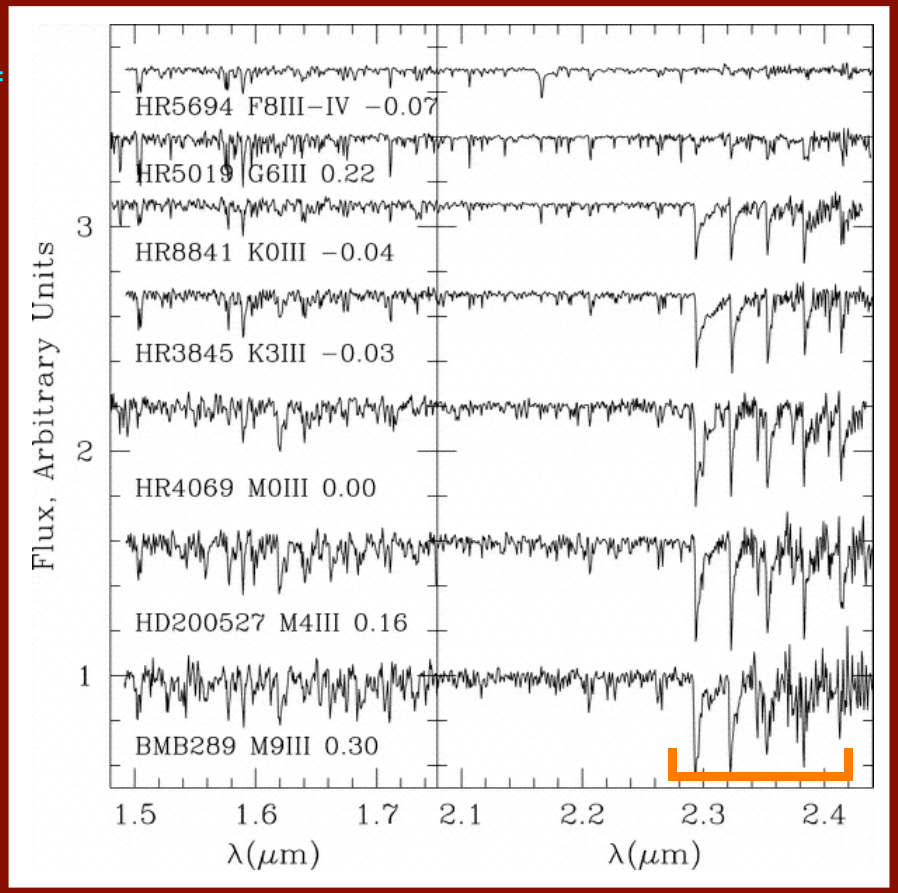
Dwarfs



H band K band

Teff

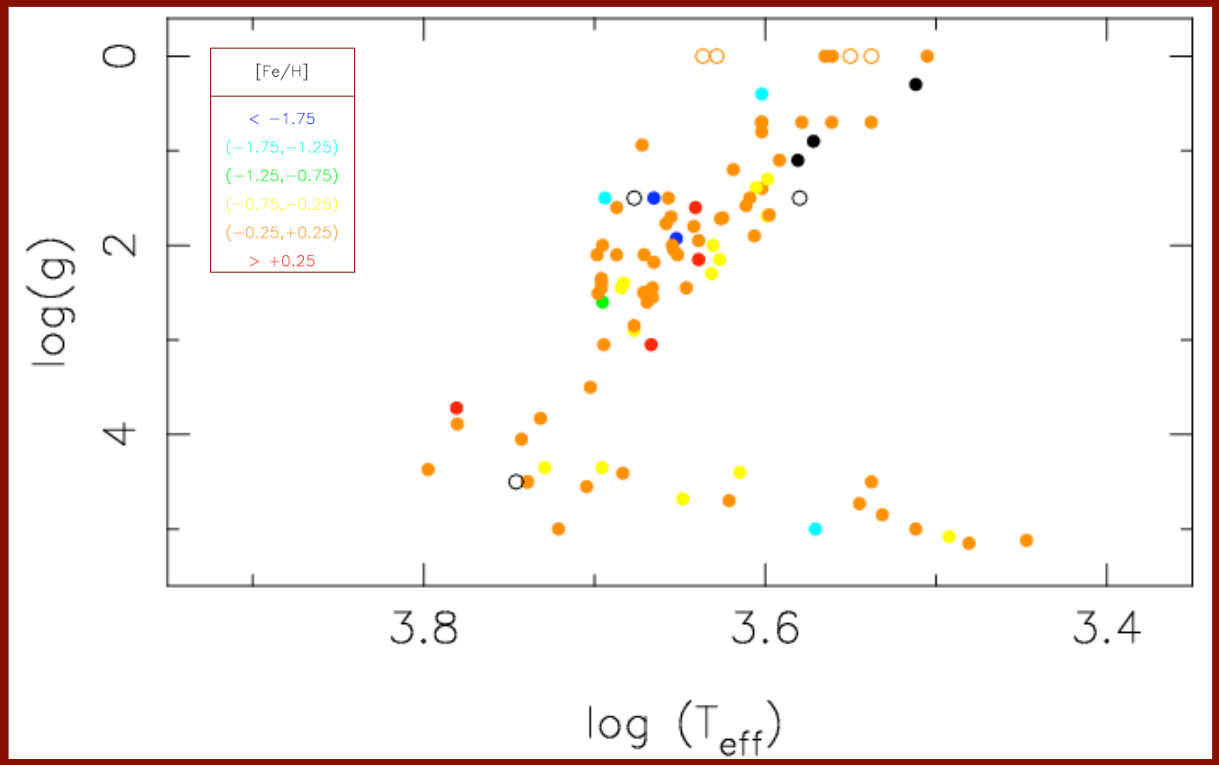
Giants



H band K band

Low resolution library: data

E. Mármol-Queraltó, R. Peletier, V. Ivanov, N. Cardiel, A.J. Cenarro, M. Mouhcine, K. Ganda, A. Vazdekis, M Pohlen, J. Gorgas



112 stars observed in visiting mode
(6 nights) with UIST at UKIRT (Mauna Kea, USA)

- Low resolution HK spectra for a subsample of Ivanov's library
- 0.86_120 arcsec slit
- R ~ 300 at 1.9 μm
- ABBA cycle
- Defocus of the telescope required
- Solar-type stars observed for flux calibration

Low resolution library: reduction (1)

Using REDUCME package (Cardiel 1999)

- Flatfielding
- Sky correction by subtracting AB images
- C-distortion correction
- Wavelength calibration: Argon arc spectra and OH emission lines (Oliva & Origlia 1992)
- Spectrum extraction
- Telluric correction and flux calibration
- Radial velocity correction

Low resolution library: reduction (2)

$$\frac{\text{problem spectrum}}{\text{solar standard spectrum}} \cdot \text{solar continuum model} = \text{flux-calibrated spectrum}$$

(Maiolino et al. 1996)

Solar continuum model:

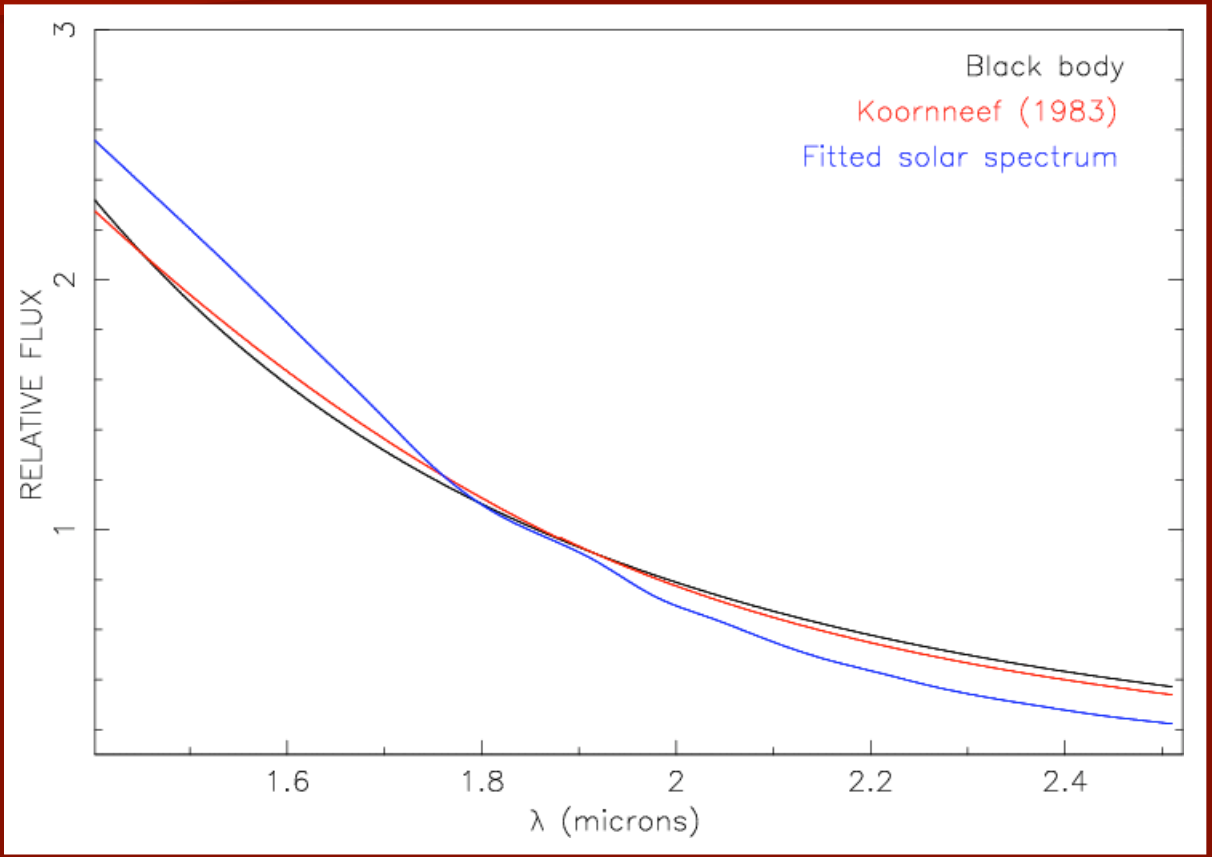
- Black body
- Koornneef's approximation used by Lançon & Rocca-Volmerange (1992) (Doyon et al. 1994)

$$\begin{cases} 1.40 - 1.86\ \mu\text{m}: F_\lambda = A\ 10^{-0.4K}\ (\lambda^2 + a\lambda + b) \\ 1.90 - 2.60\ \mu\text{m}: F_\lambda = B\ 10^{-0.4K}\ \lambda^{-3.63} \end{cases}$$

- Fitted solar spectrum (no features)

Livingston & Wallace (1991)

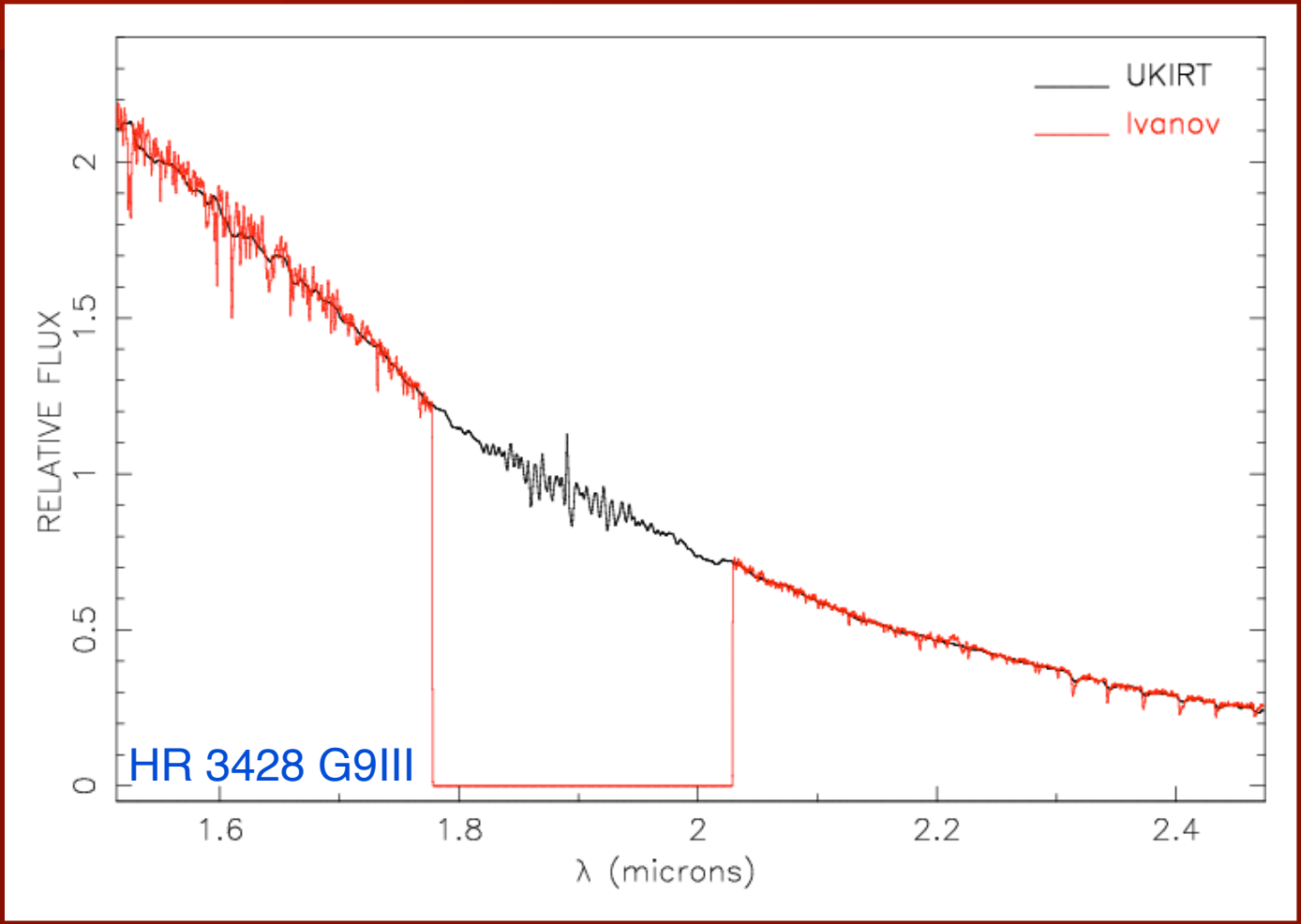
Low resolution library: reduction (3)



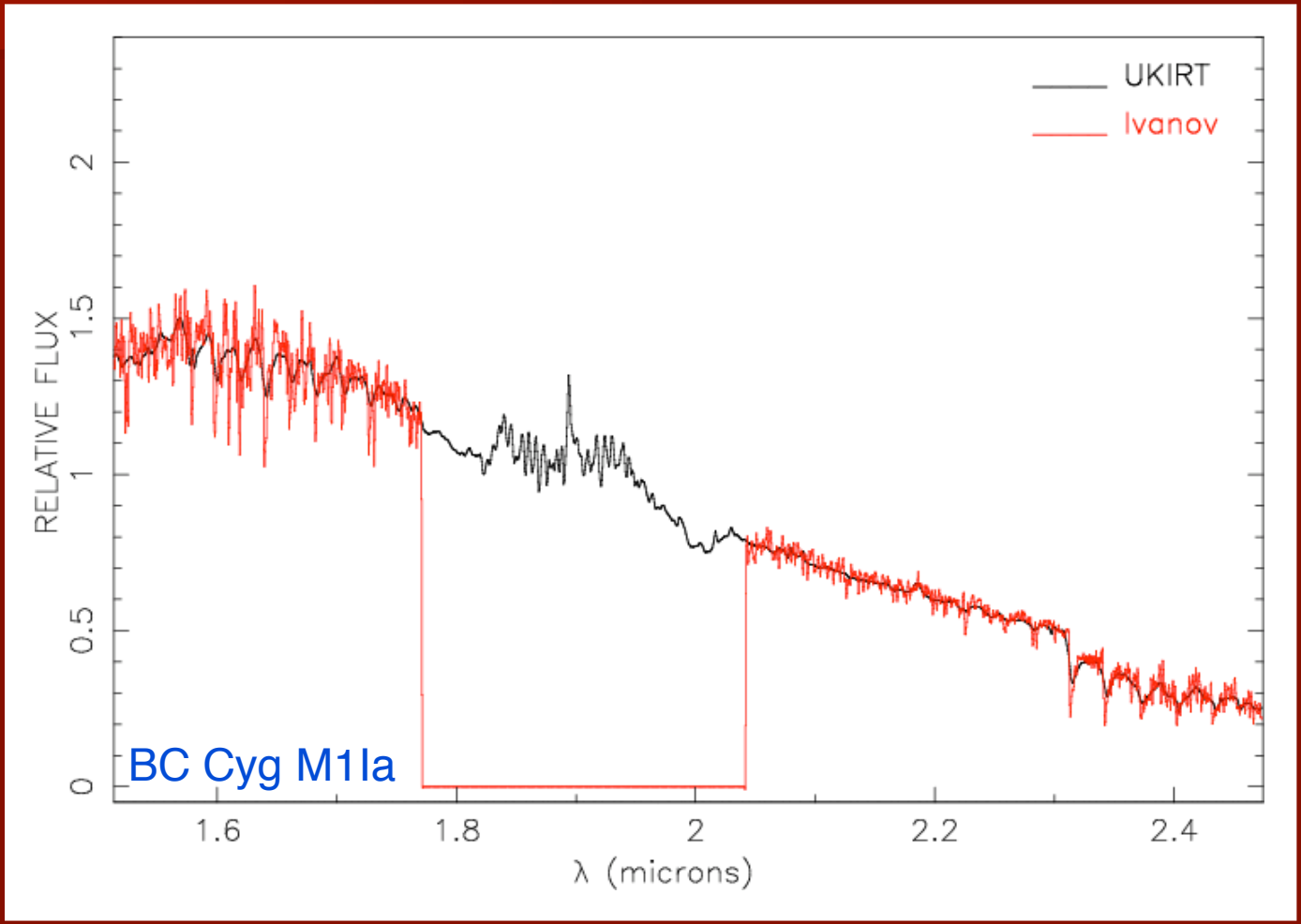
How to combine low and high resolution spectrum?

- Degrade Ivanov's spectra to our low resolution
- Fit polynomial (spline) to the ratio of the two spectra for each star
- Multiply this fit to the high resolution spectrum

We have a flux-calibrated library

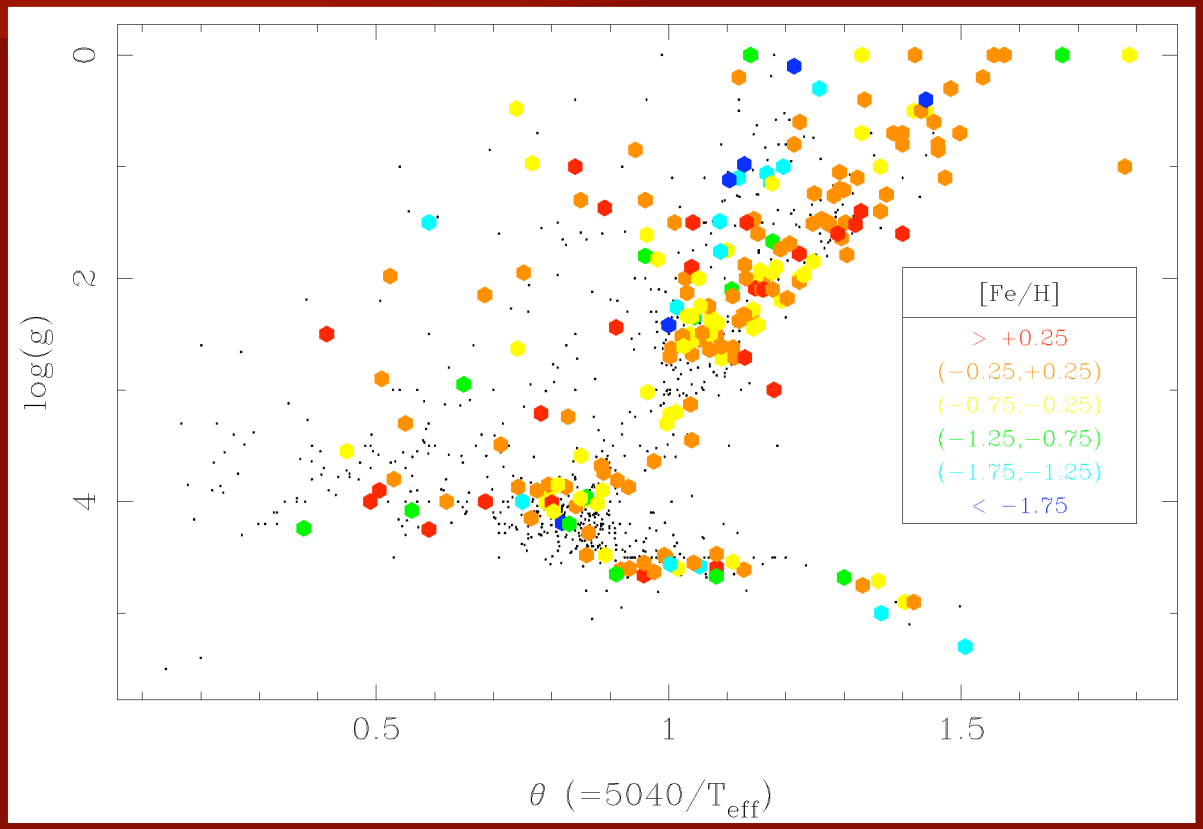


We have a flux-calibrated library



A new stellar library in the K band

E. Mármol-Queraltó, N. Cardiel, J. Gorgas, S. Pedraz,
A.J. Cenarro, P. Sánchez-Blázquez, A. Vazdekis, R. Peletier

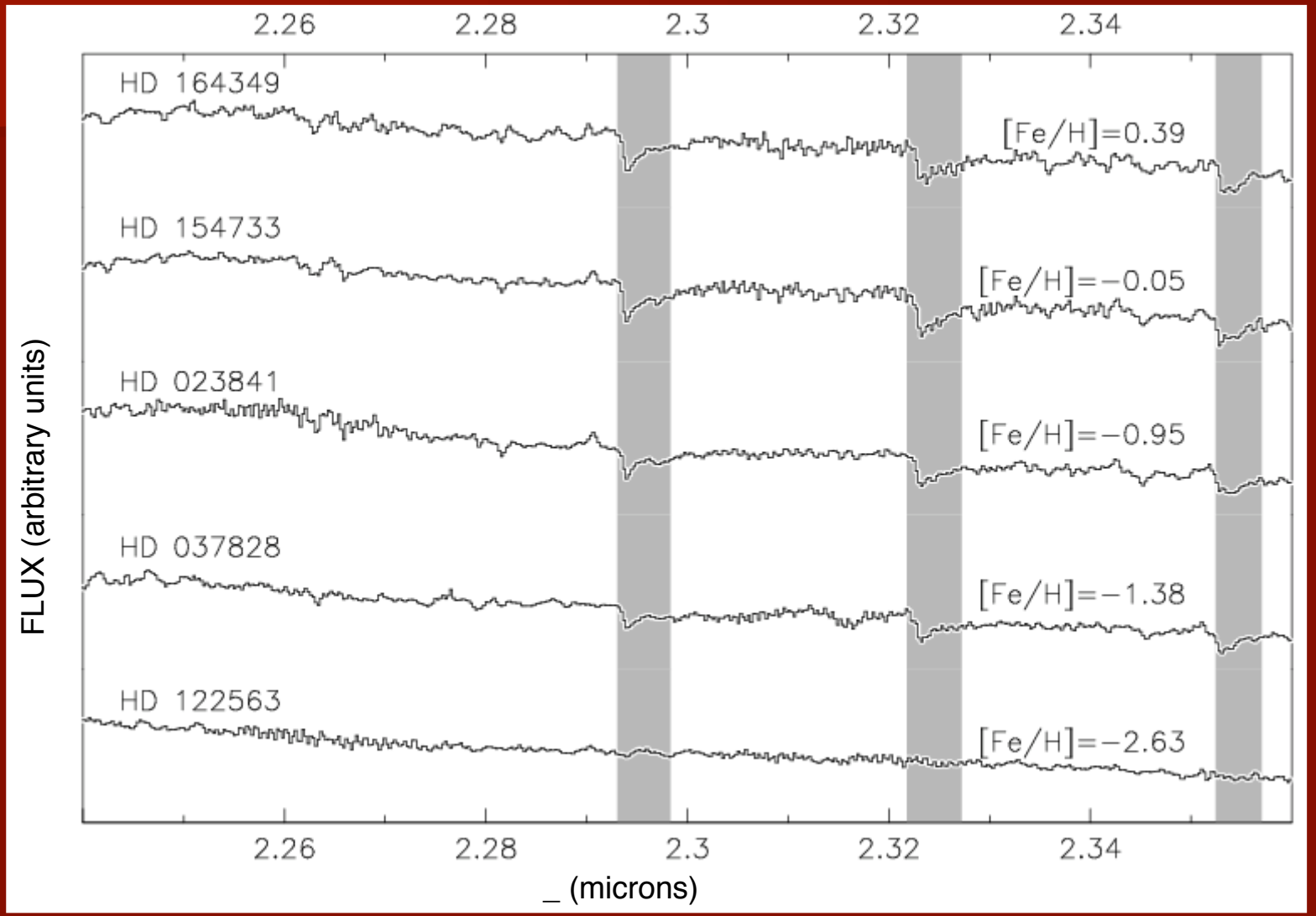


- K band, 2.11-2.37 μm
- 0.60_120 arcsec slit
- R ~ 2500 at 2.3 μm

2800 ≤ Teff ≤ 13400 K
0.0 ≤ < log g ≤ 5.3 dex
-2.63 ≤ [Fe/H] ≤ 1.33 dex

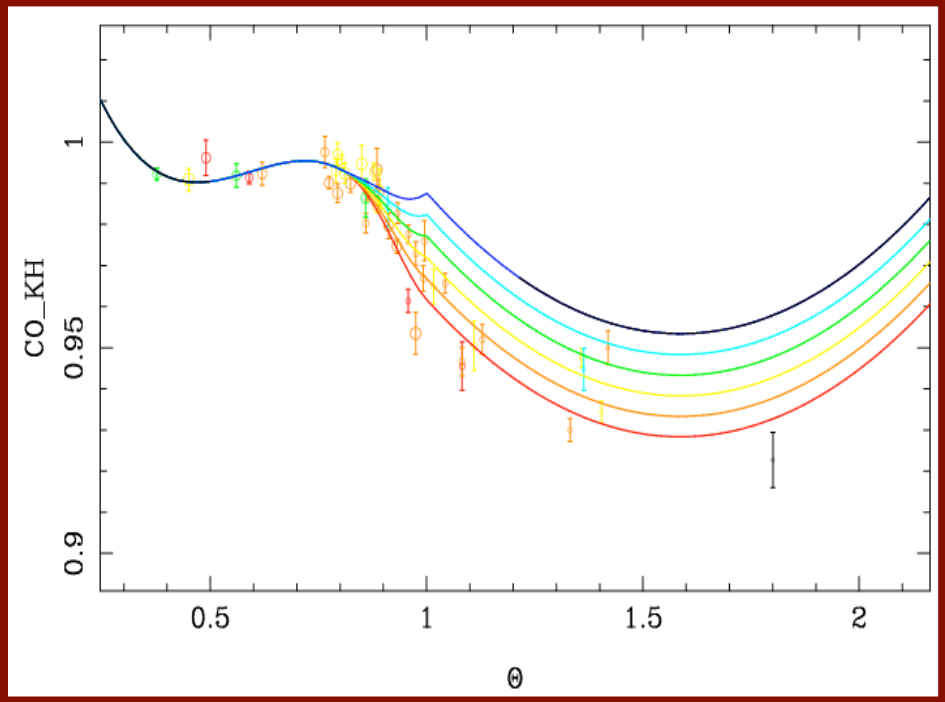
225 stars observed in 13 nights with _-CASS
at 3.5 m telescope in CAHA (Almeria, Spain)

Some examples…

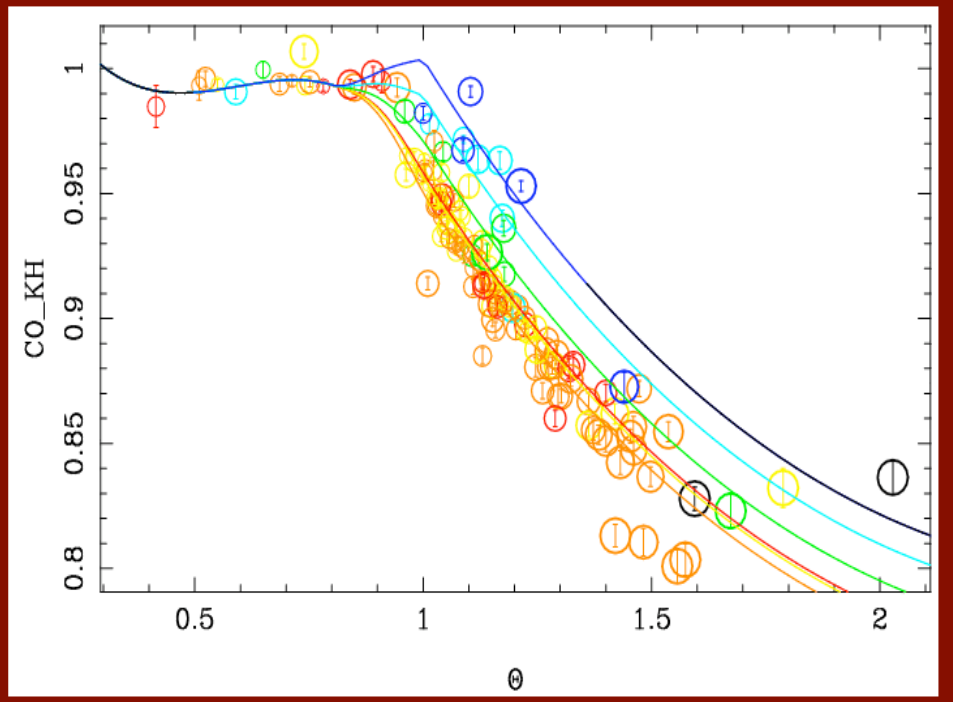


A new stellar library in the K band

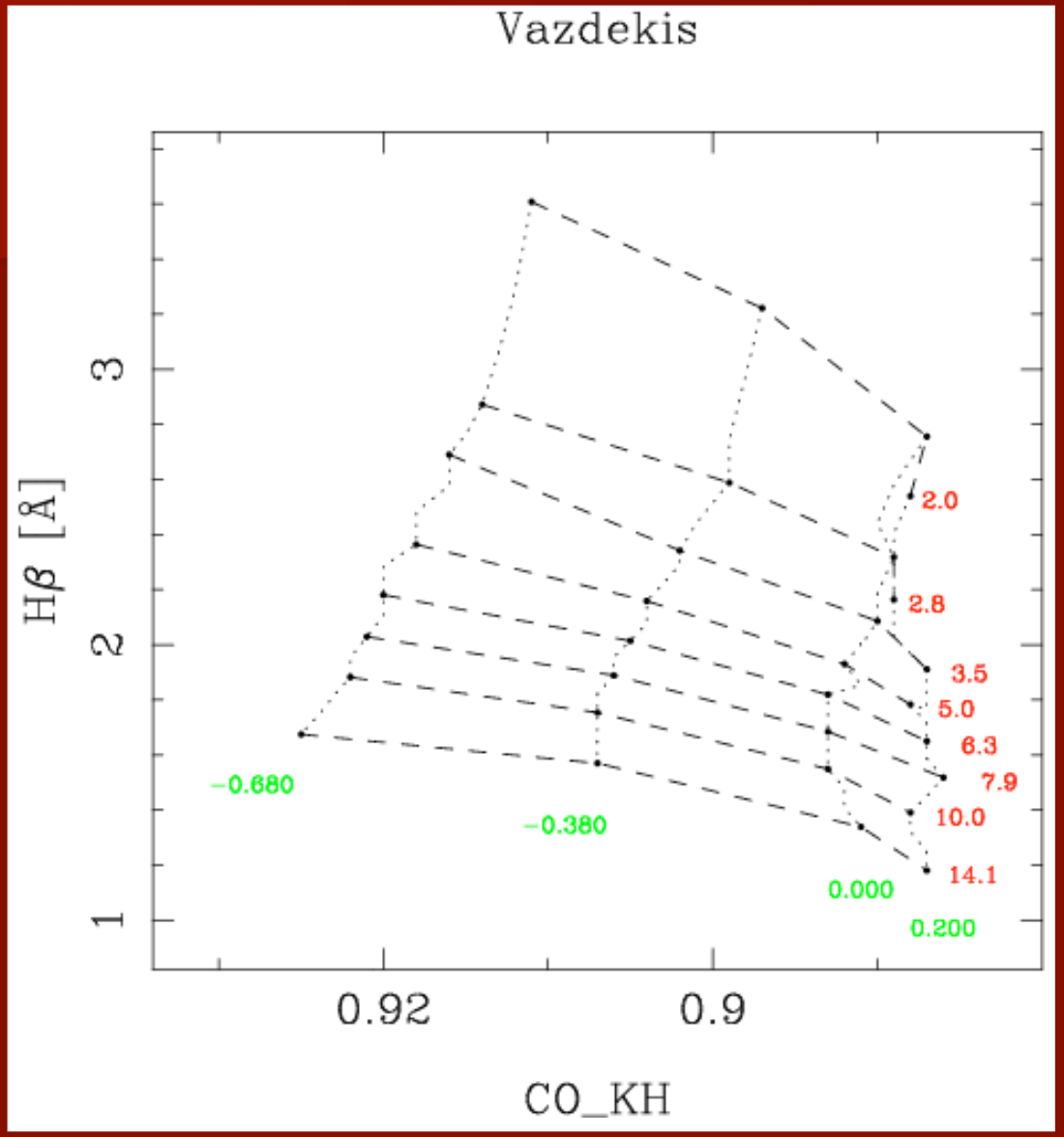
Dwarfs



Giants



$$CO\_KH = -2.5 \log F_{line} / F_{continuum}$$


Vazdekis
Hβ [Å]
3
2
1
0.92
0.9
CO_KH
2.0
2.8
3.5
5.0
6.3
7.9
10.0
14.1
−0.680
−0.380
0.000
0.200

Work in progress…

- Ivanov´s library (HK bands):
  - 112 flux-calibrated stars
  - Another observational run to complete the whole sample
- UCM library (K band):
  - 225 stars (including non-solar metallicity)
  - Preliminary fitting functions of the CO band
- Immediate applications:

  Observing run at the TNG-NICS: galactic globular clusters

  Observing run at the WHT-ISIS: M31 globular clusters

  Observing run at the VLT-ISAAC: field elliptical galaxies