



STELLAR
POPULATIONS
SYNTHESIS MODELS

WITH VARYING IMF AND
ABUNDANCE RATIOS

A. Vazdekis (Tenerife, Spain): **Models**

J. Falcón-Barroso (Tenerife, Spain): miles.iac.es

P. Coelho (Sao Paulo, Brasil): **Stellar atmospheres**

S. Cassisi (Teramo, Italy): **Stellar evolution models**

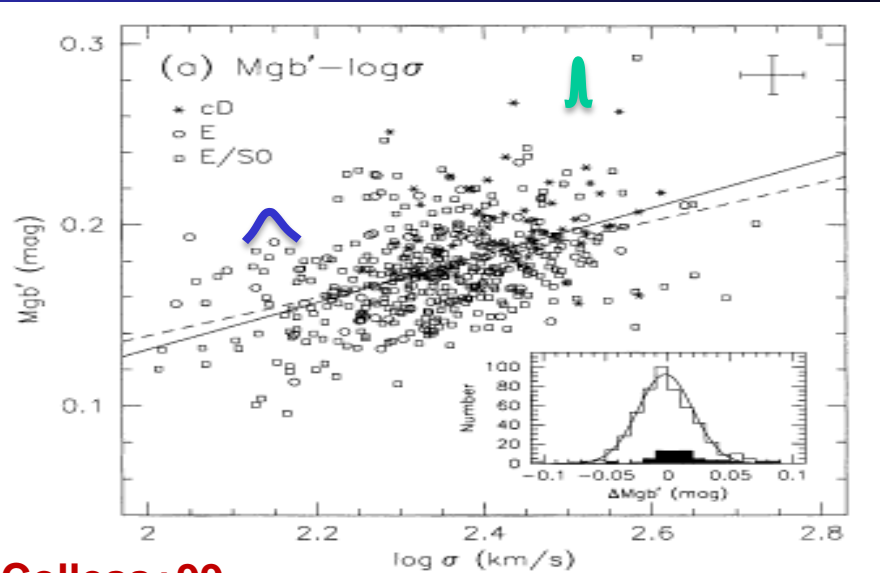
E. Ricciardelli (Valencia, Spain): **SFHs**

Sp12: A fresh look at the stellar Initial Mass Function
EWASS 2013, Turku, Finland, 11-12 July 2013

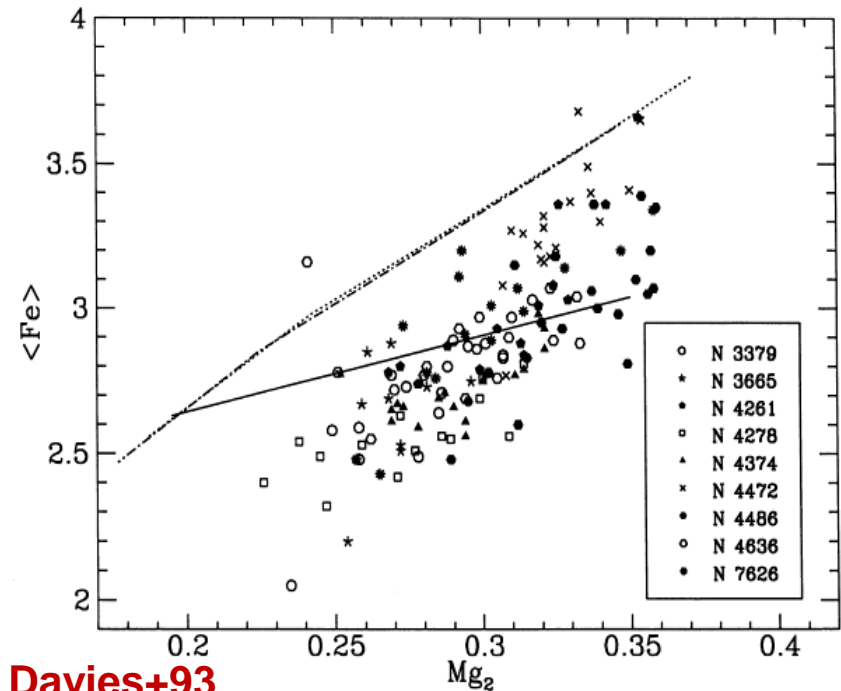
Motivation

Massive ETGs:

- [Mg/Fe]-enhanced:
well established result
...requires further
model developments
(e.g., full SEDs).



Colless+99

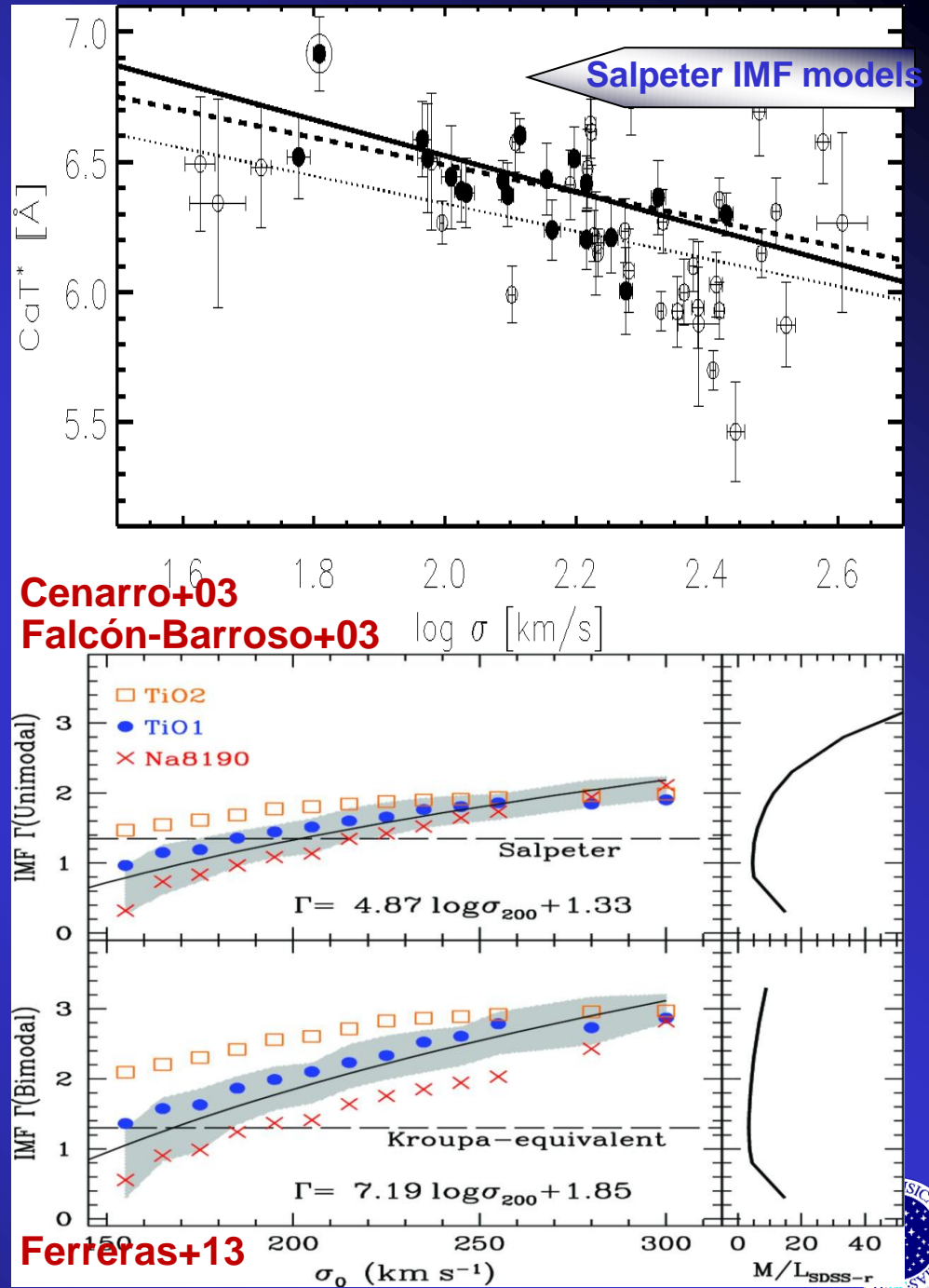


Davies+93

Motivation

Massive ETGs:

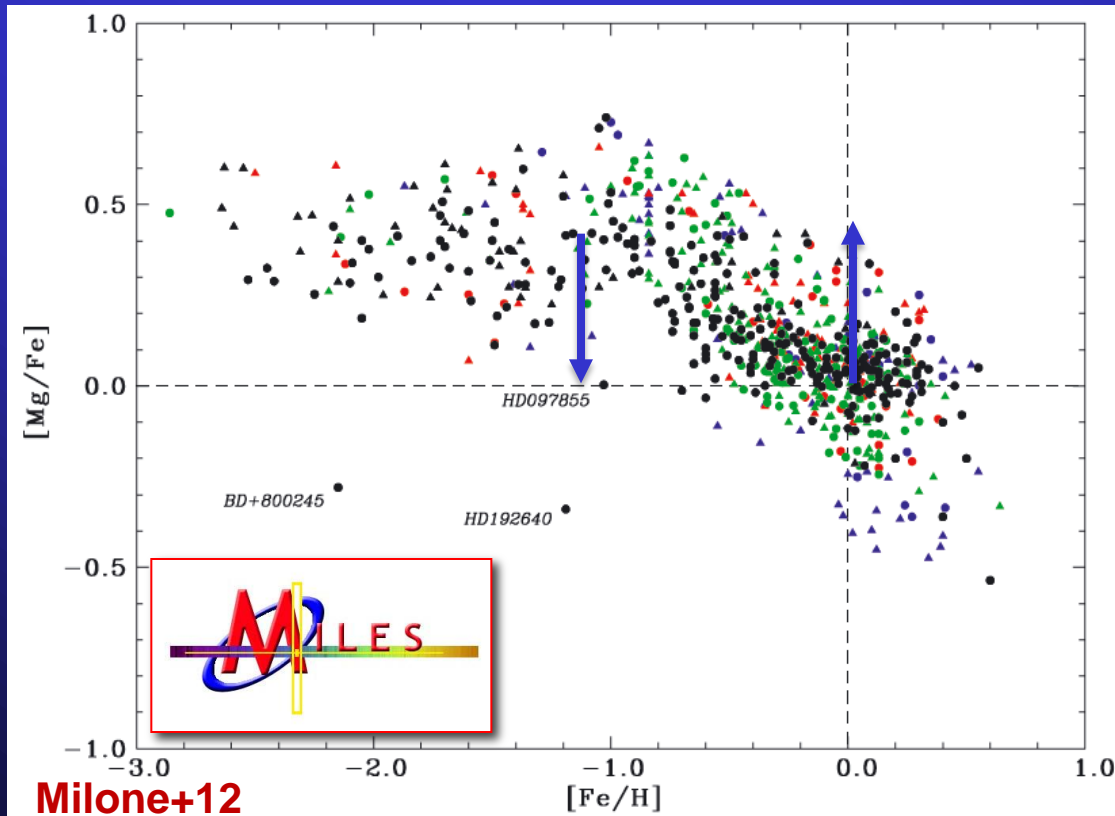
- Bottom-heavy IMF ?
This is why we are meeting today at EWASS 2013 (Sp12) ... requires better means to constrain it (e.g., new IMF-sensitive indicators).



α -enhanced and scaled-solar models

Base models:

Scaled-solar isochrones + MILES spectra
(s-s @ solar metallicity; α @ low metallicity)



Scaled-solar models:

Scaled-solar Isochrones
+
Scaled-solar spectra

α -enhanced models:

α -enhanced isochrones
+
 α -enhanced spectra

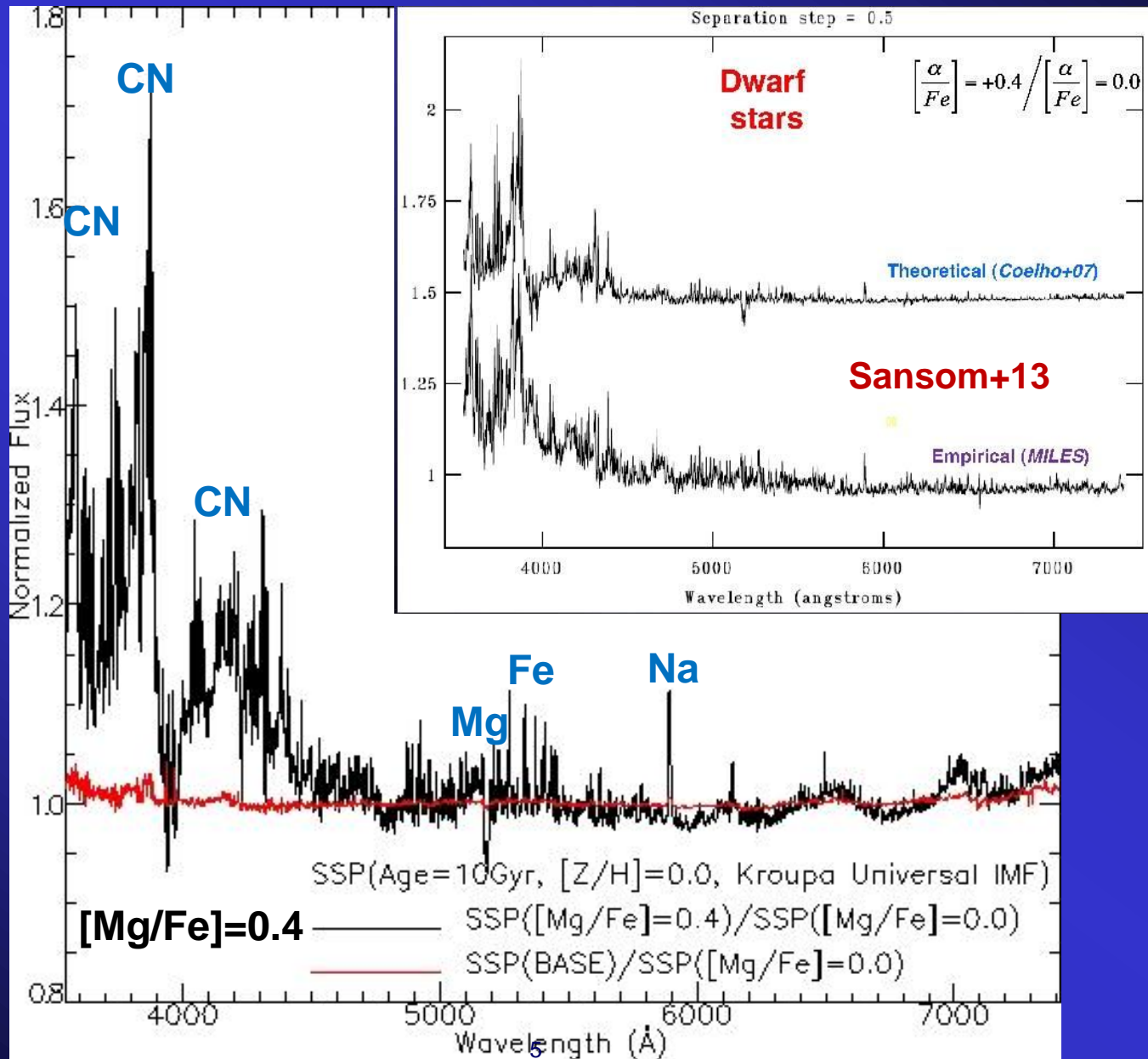
Ingredients:

Isochrones:
Pietrinferni+04,+06

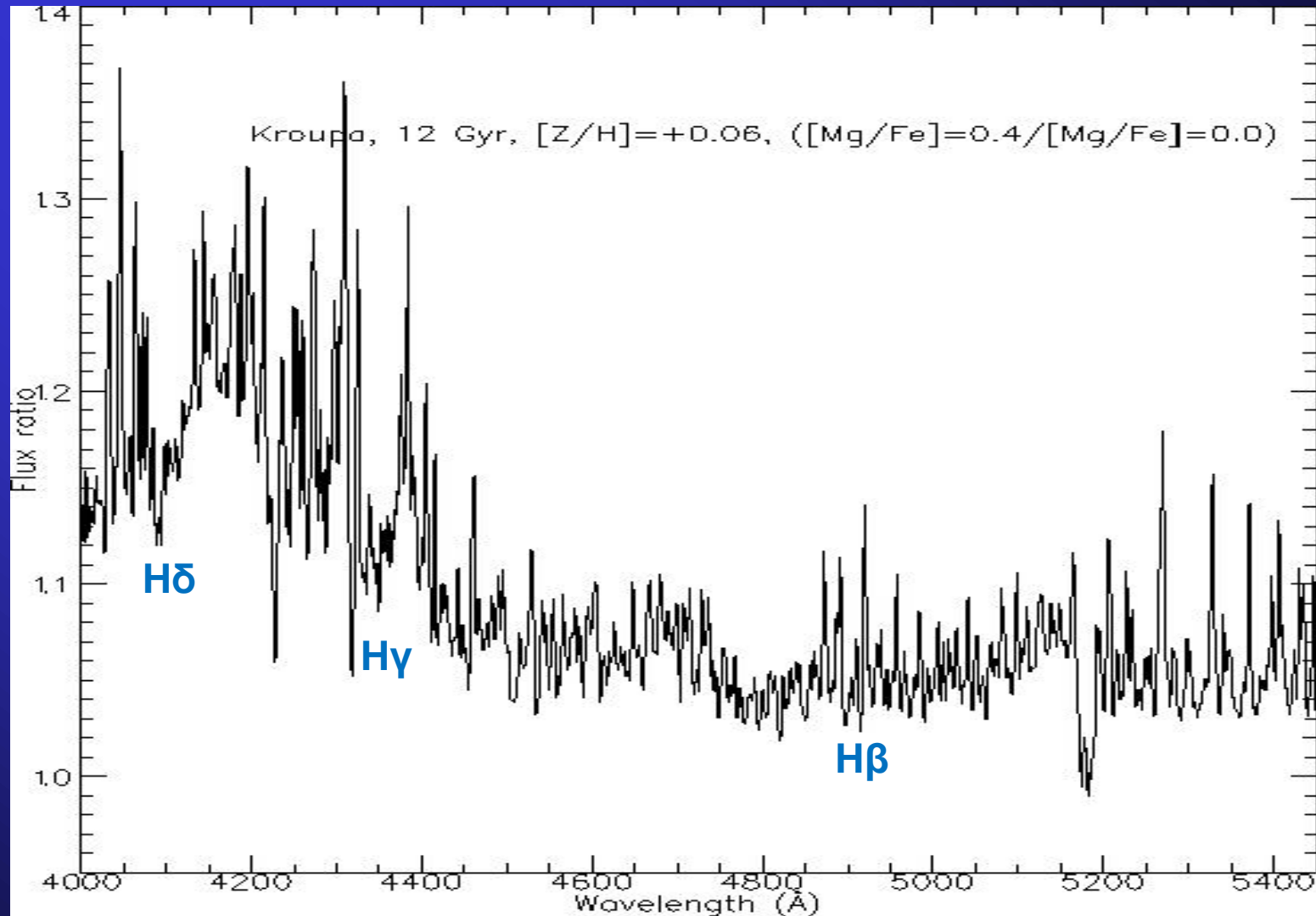
+
Stellar spectra:
MILES, Coelho+05



Enhanced vs. scaled-solar SSP SEDs:

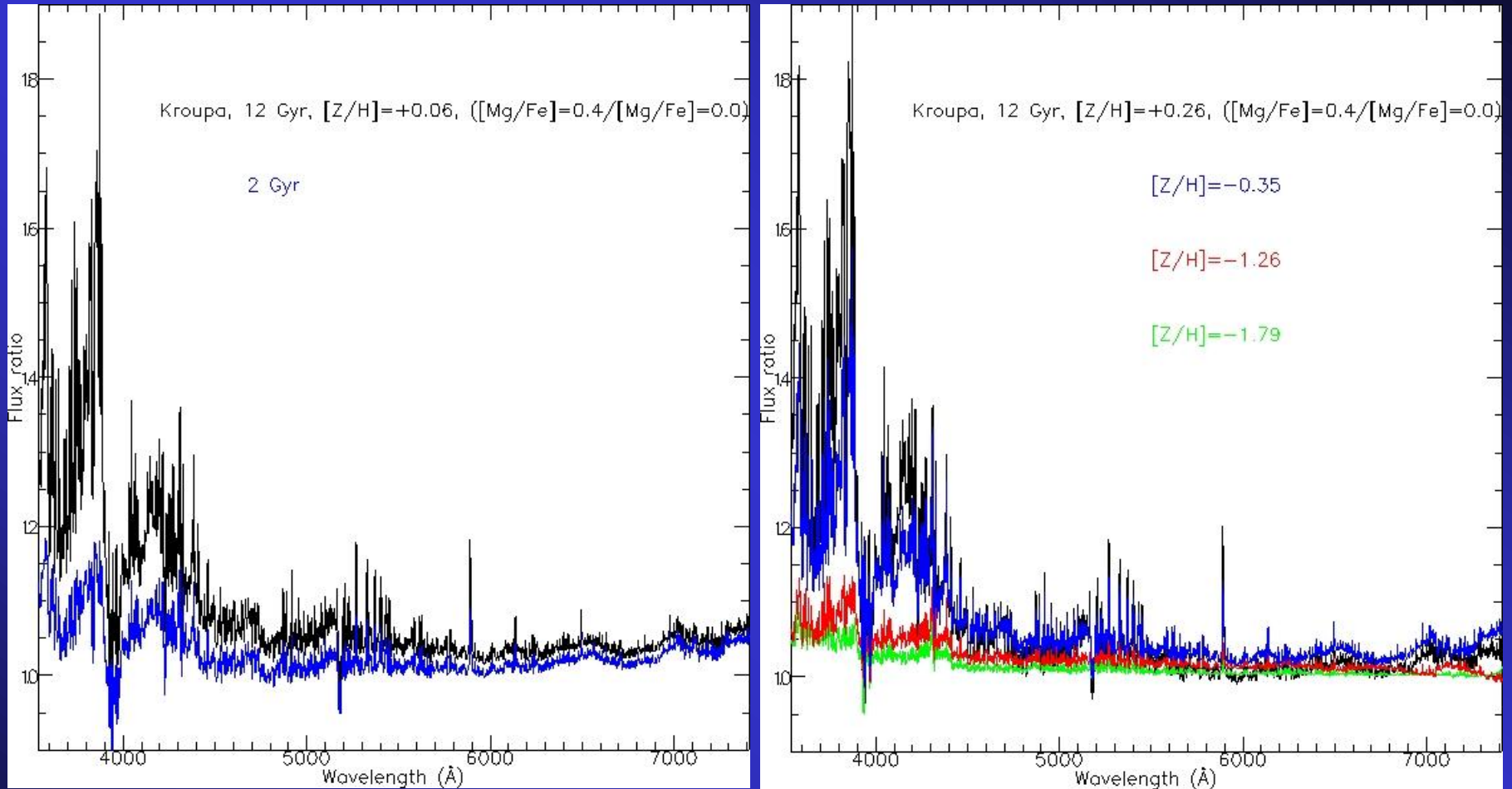


Balmer features:



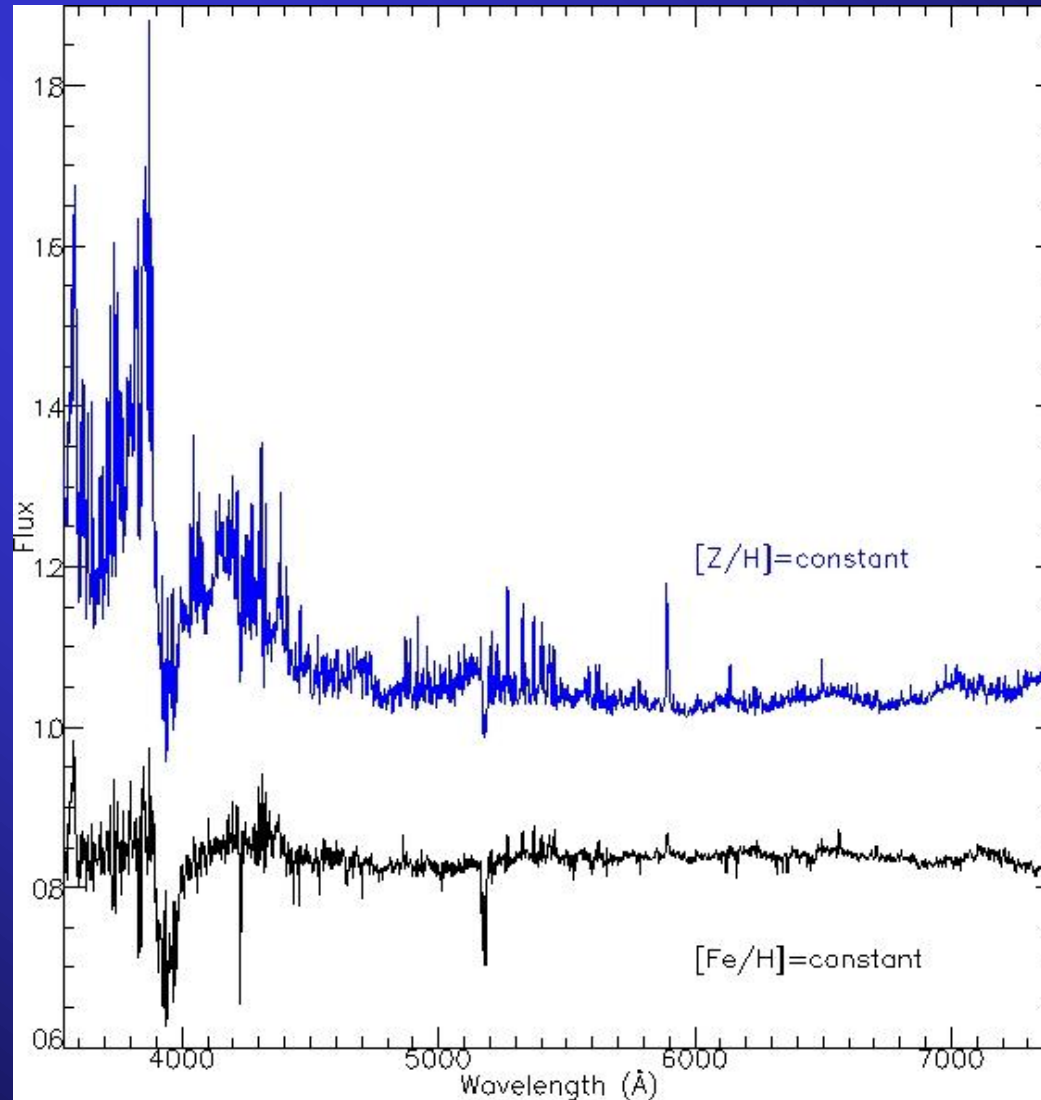
Higher order Balmer lines sensitivity rely on the blueness of the continuum and depend on the resolution.

Age and total metallicity effects:

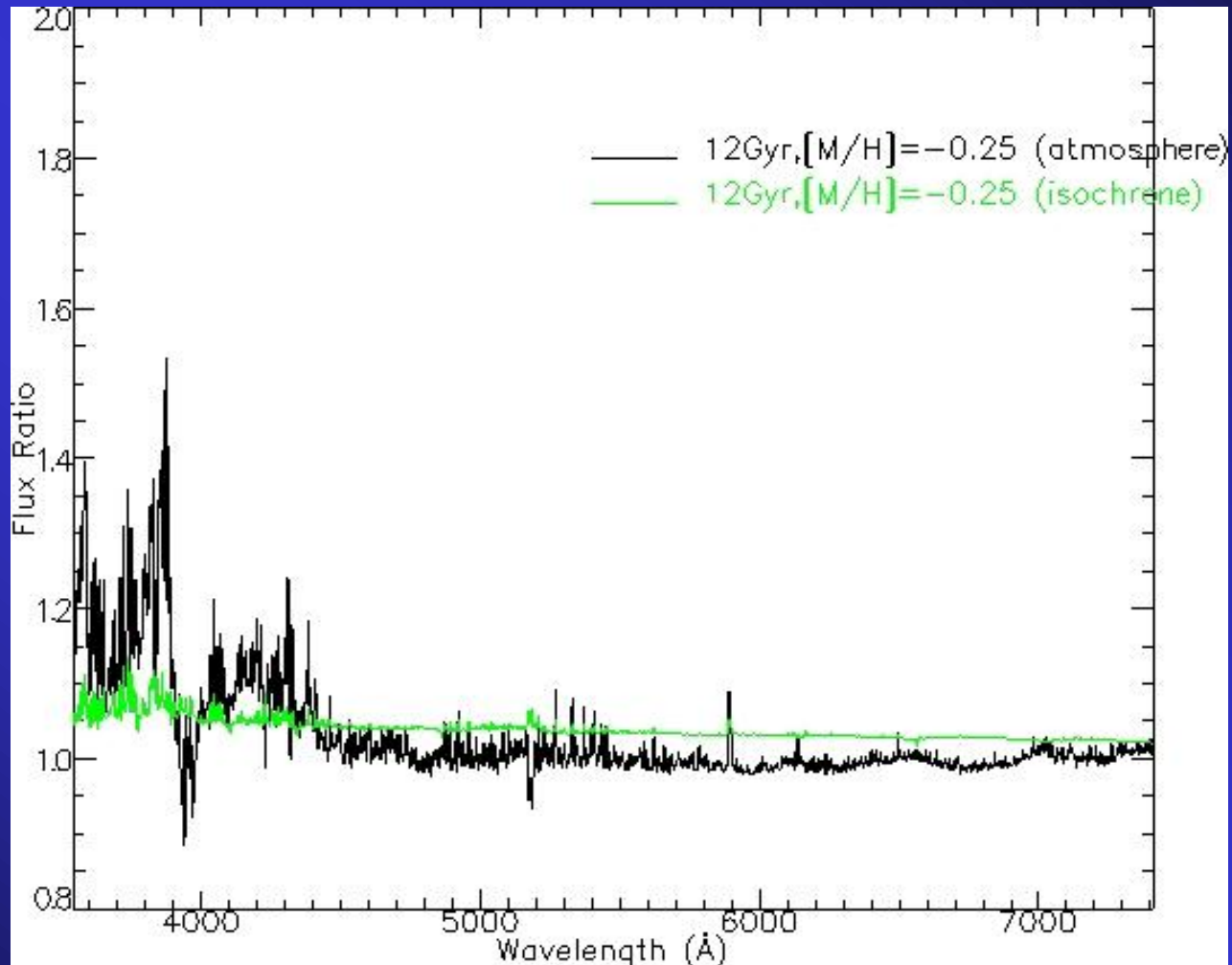


Decreasing effect with decreasing age and decreasing total metallicity

The main contributor to the bluening:

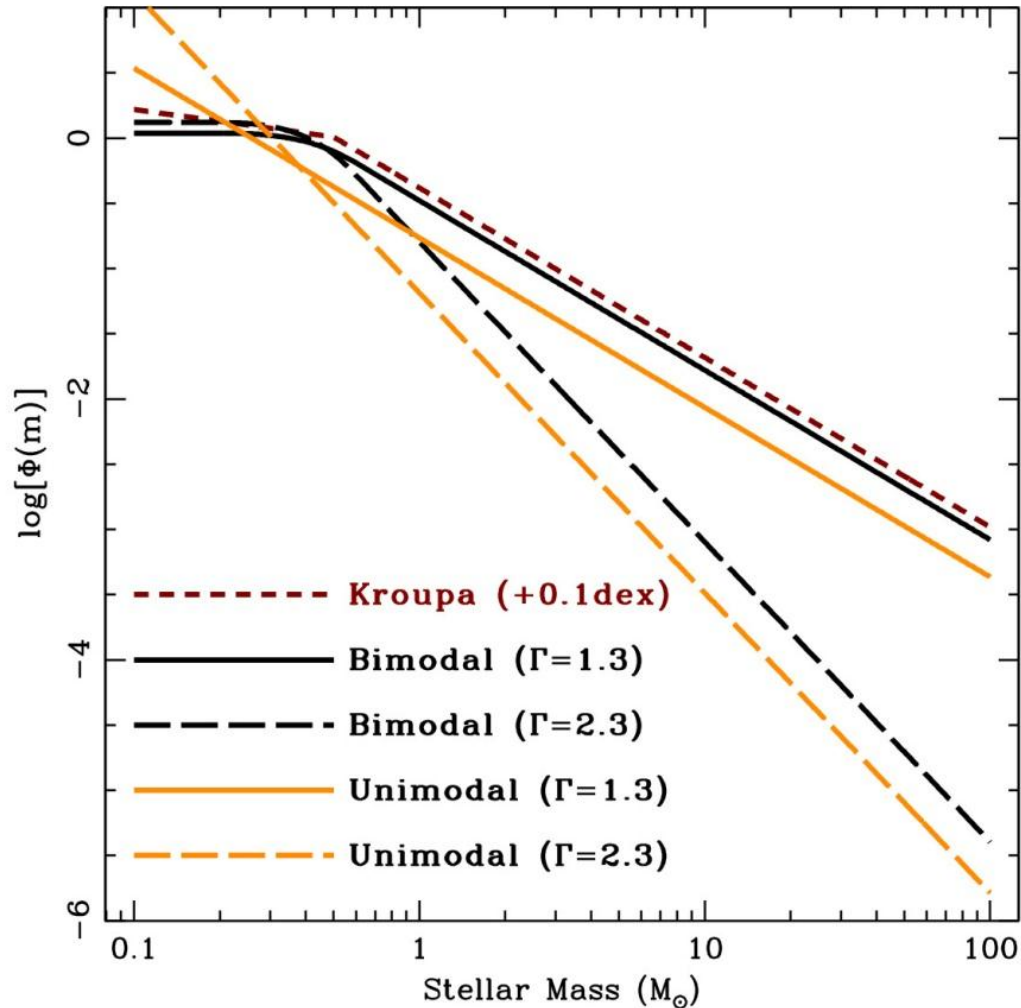


Isochrone vs. stellar atmospheres

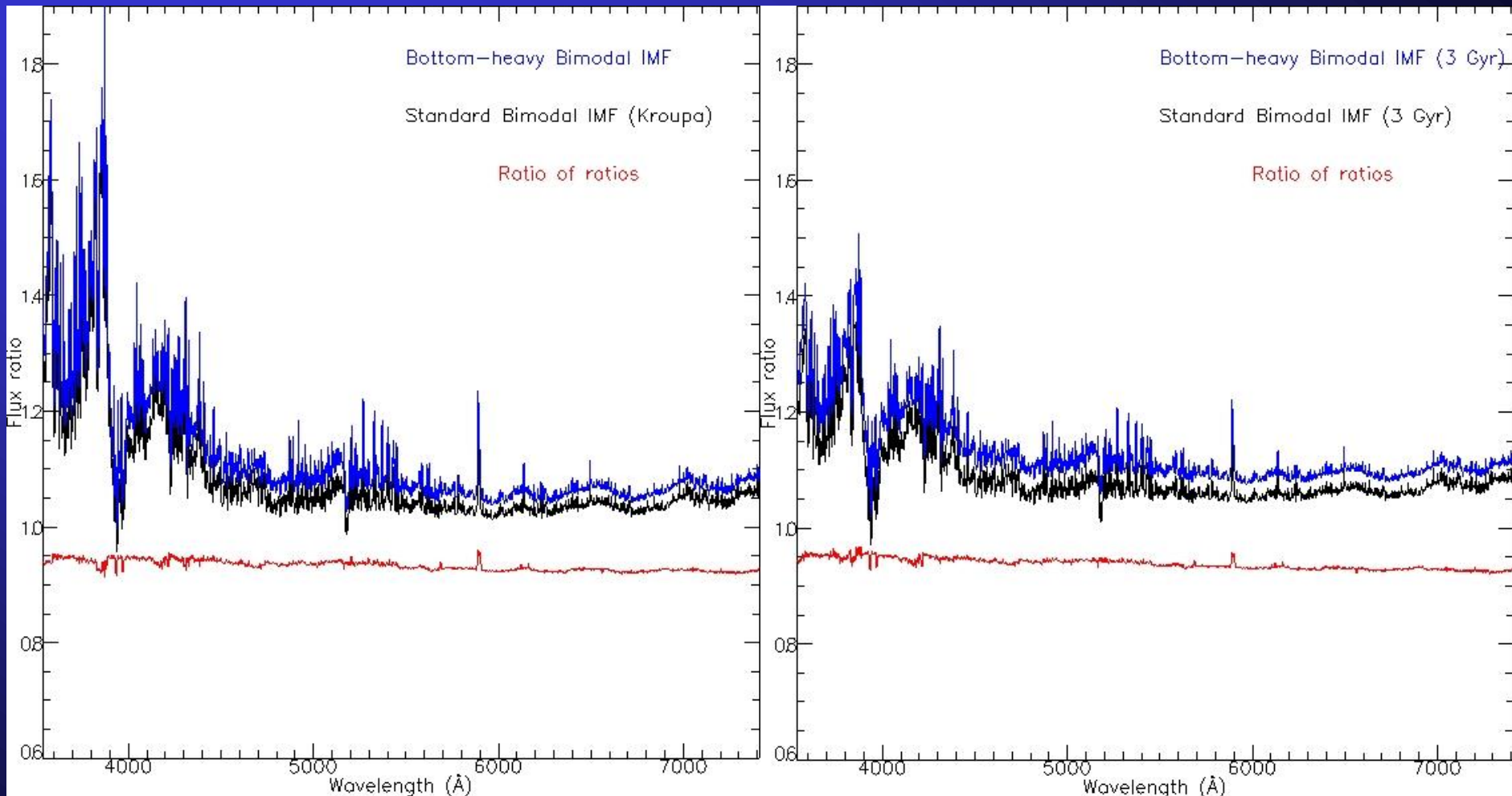


Isochrone effect significantly milder and it mainly varies the total flux.

Adopted IMF shapes:



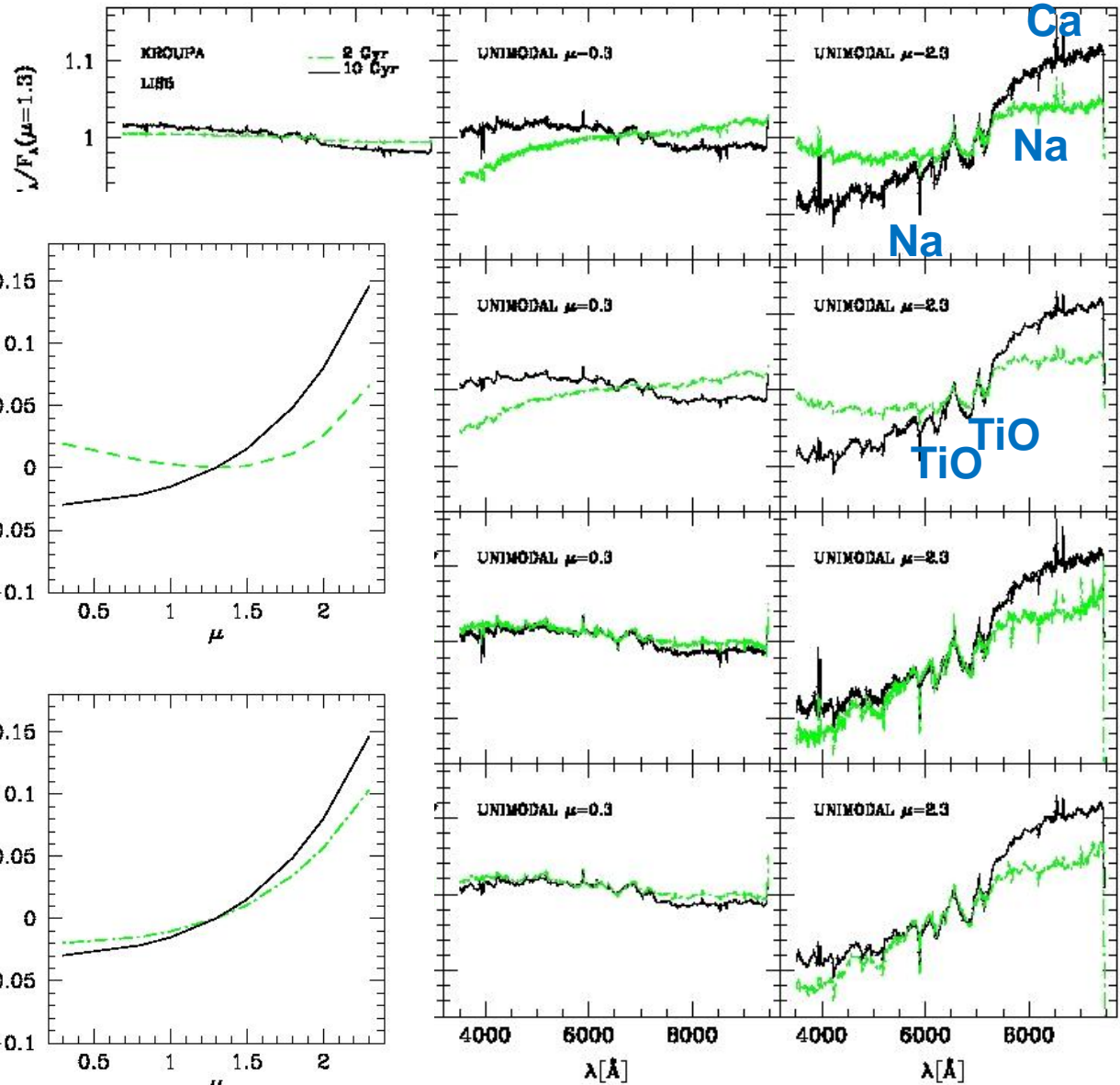
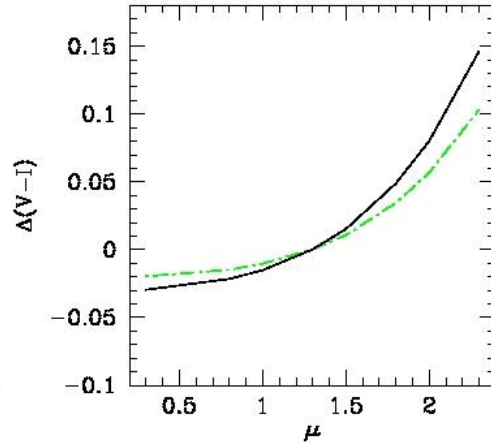
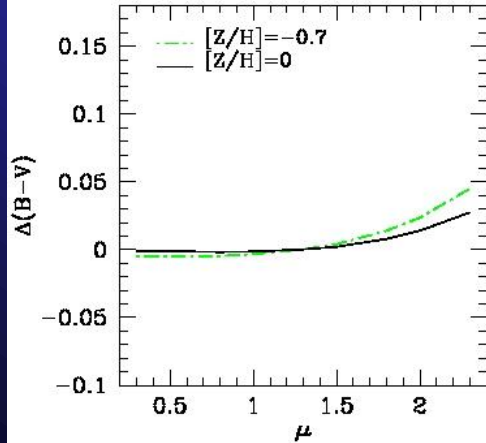
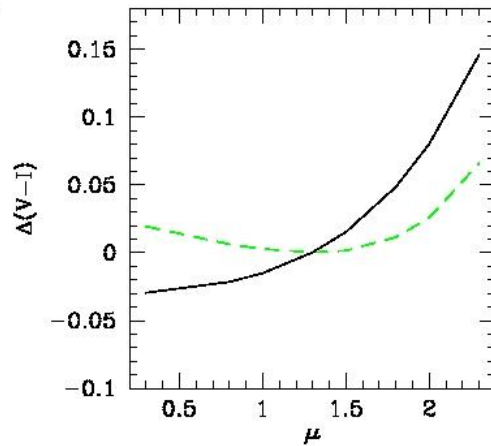
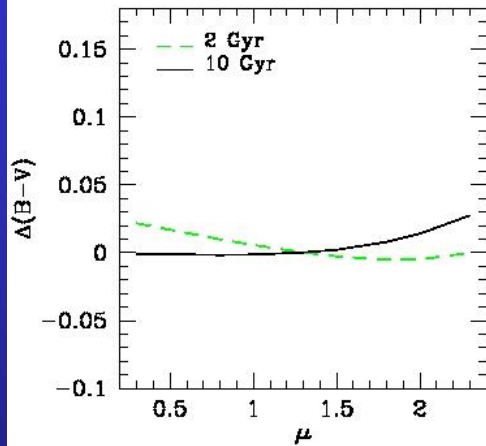
IMF varying α -enhanced vs. scaled-solar SEDs:



The α -enhancement effect dependence on the IMF is $< 5\%$ level.

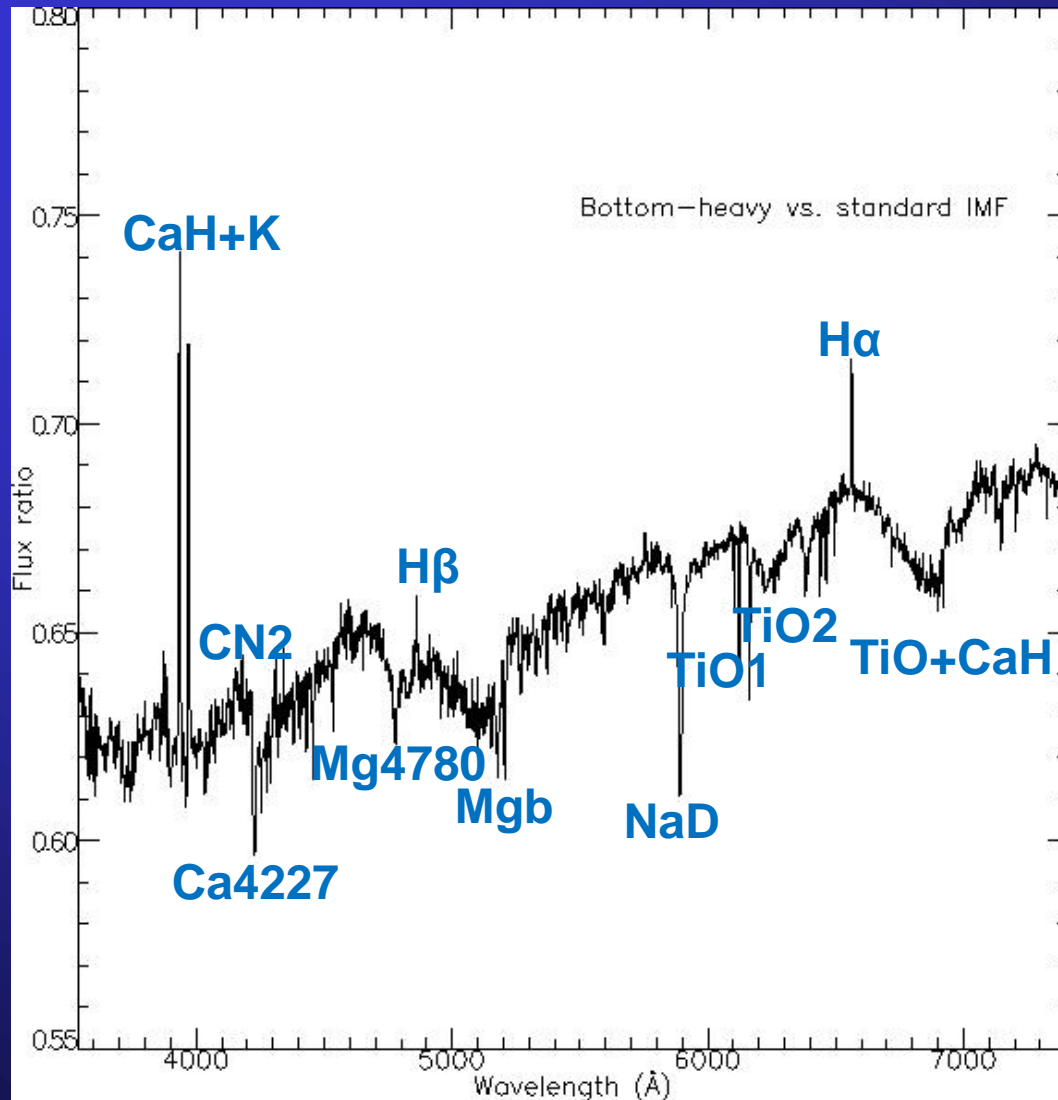
IMF effects

IMF sensitive atomic & molecular bands and redder colours



V+12

Optical IMF-sensitive features:

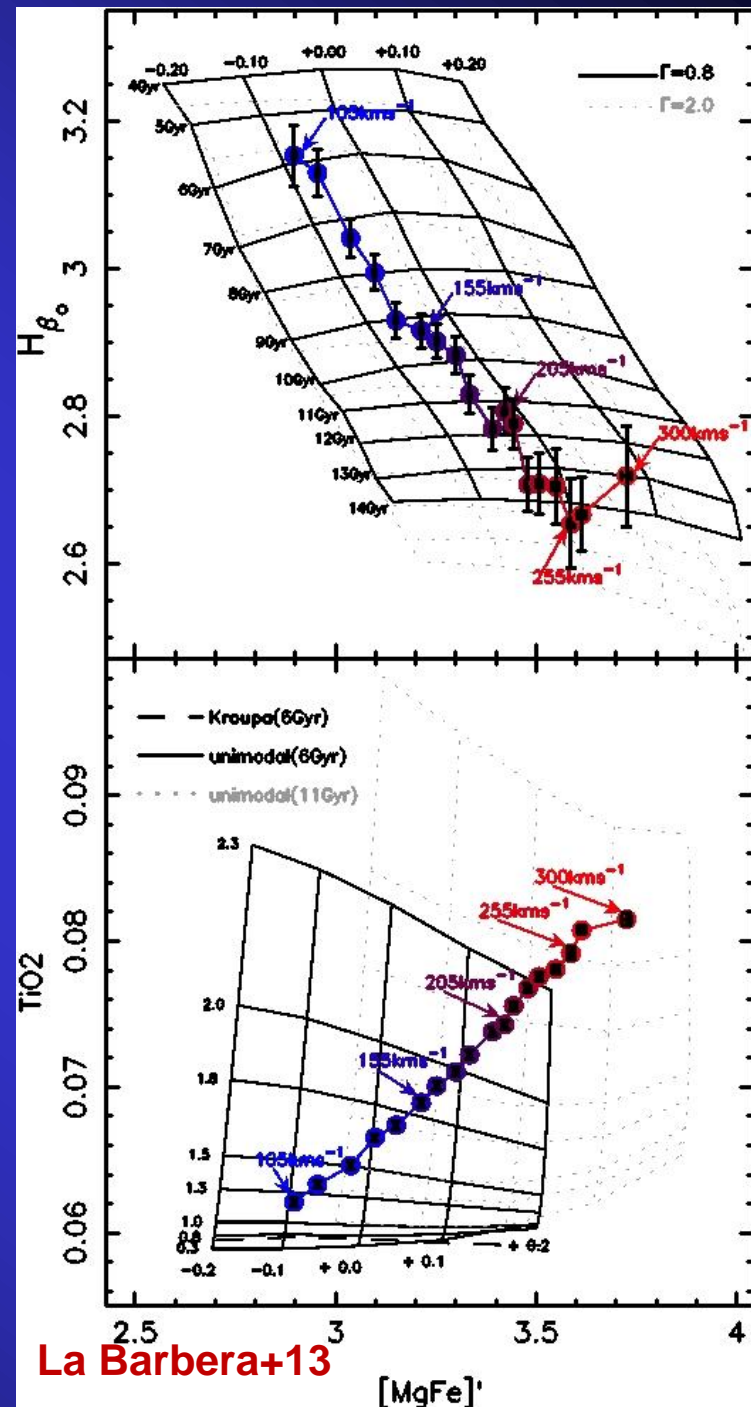


IMF-sensitive indices:

Balmer lines do show a mild IMF sensitivity but the extremely old outliers seen in the standard model grids are now in!

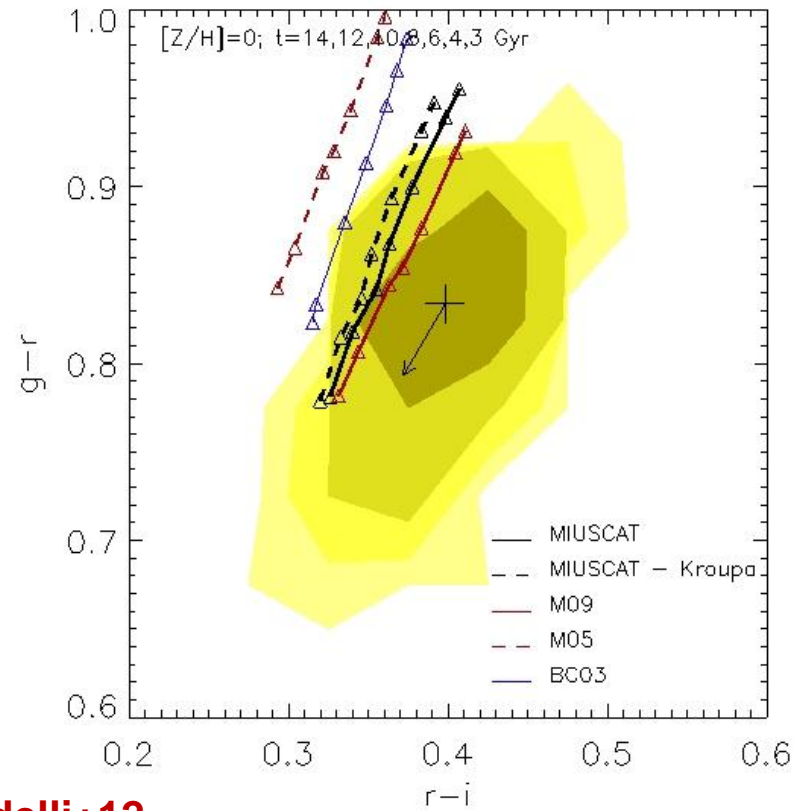
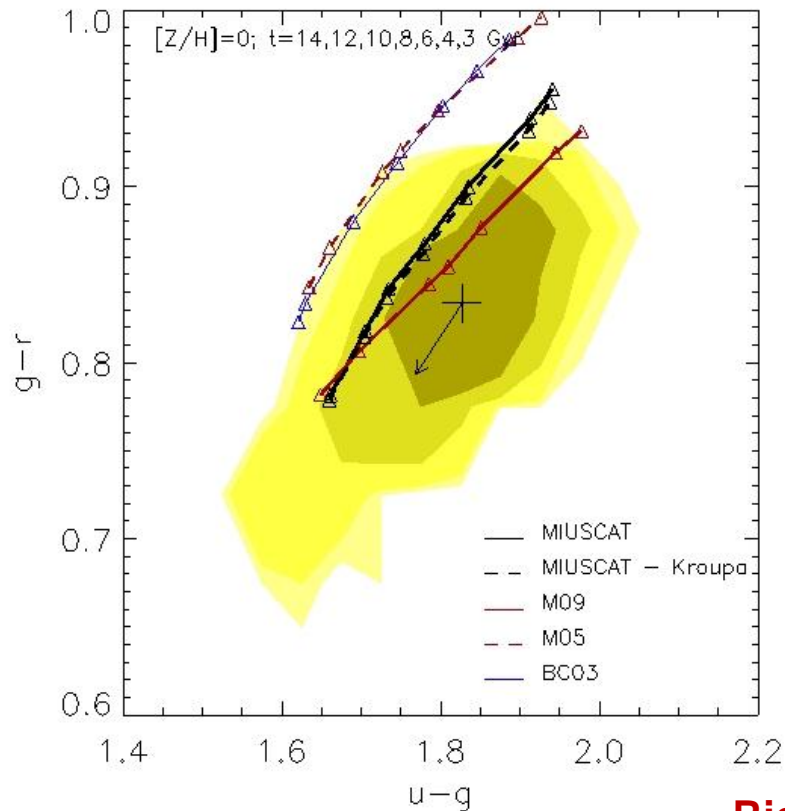
Other indices such as the TiO2 show a much stronger IMF sensitivity. They clearly disentangle it!

It is much harder to disentangle the effects for low IMF slopes. In fact it can be mimic by other effects: e.g. abundances, Temp. scale...



Modelling LRG colours:

SSPs do not fit the two colour-colour diagrams simultaneously:

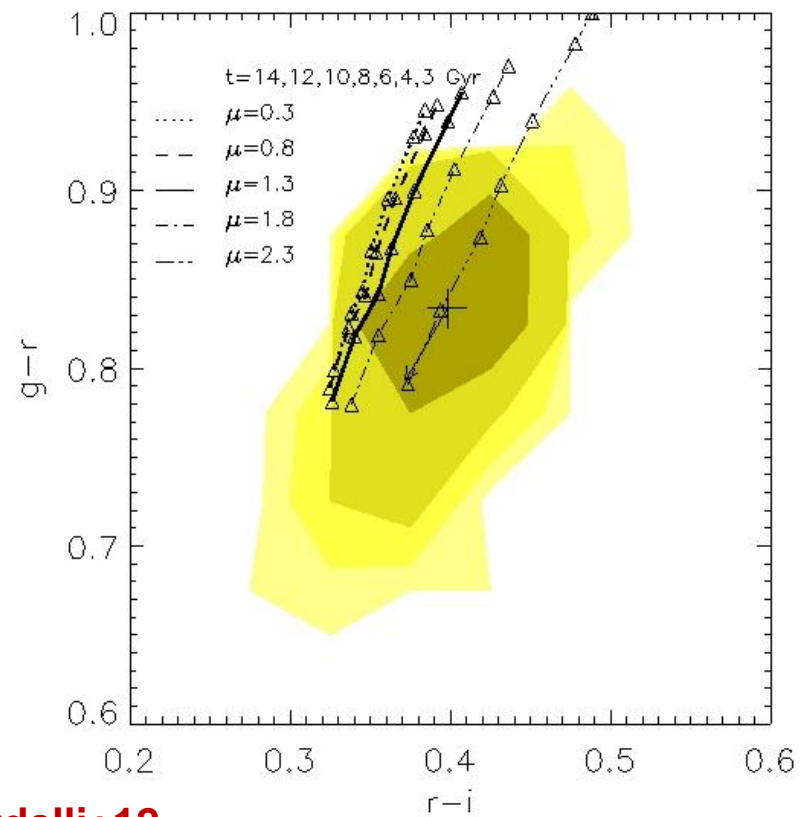
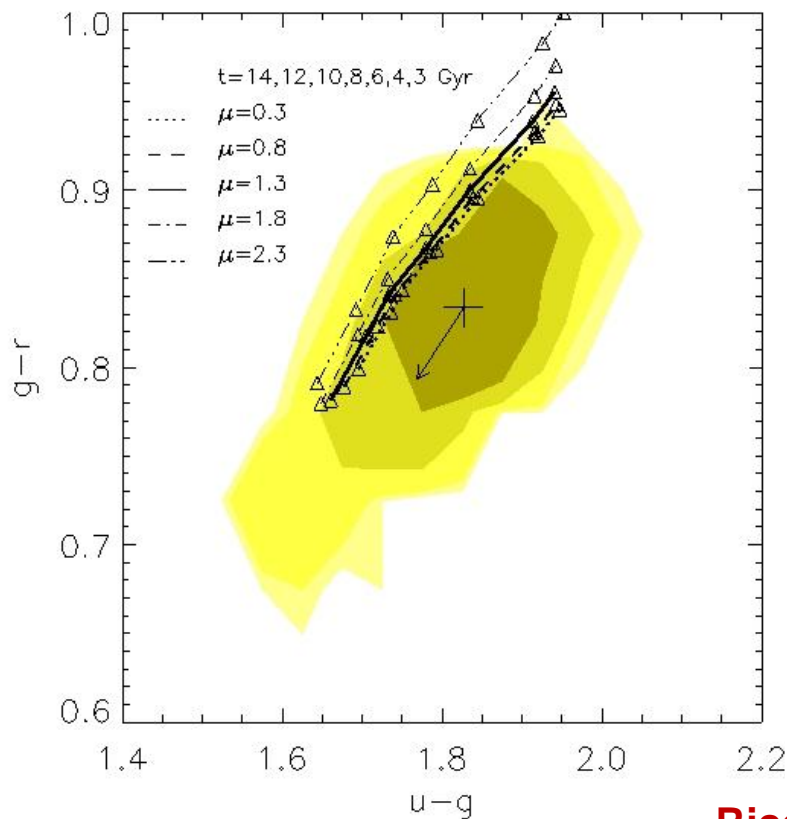


Ricciardelli+12

Other models do not fit either.

Modelling LRG colours with MIUSCAT

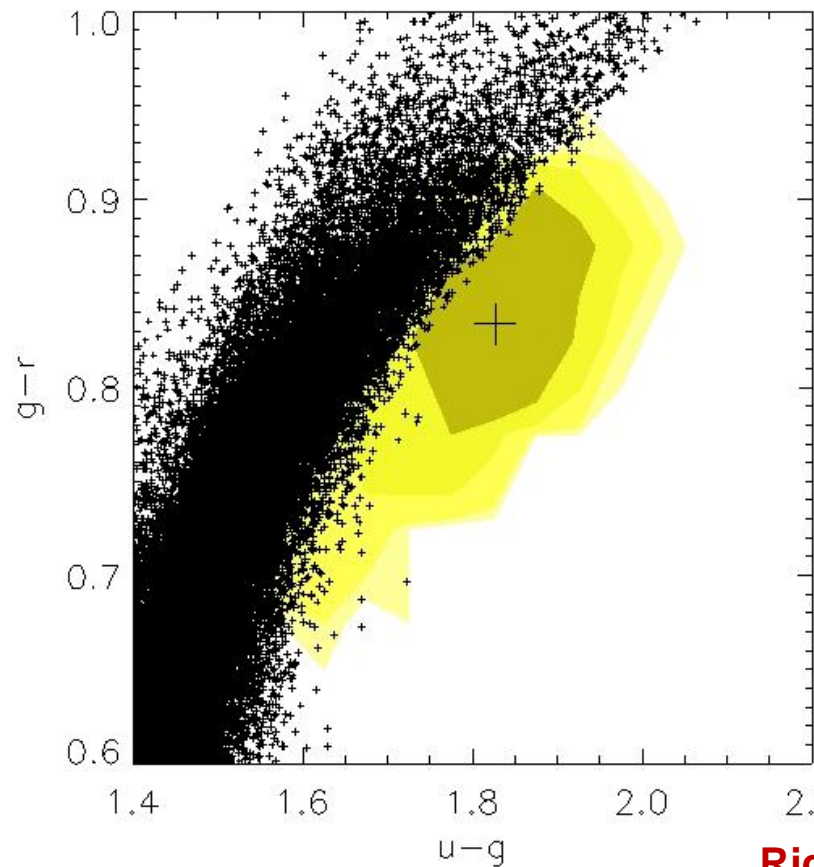
SSPs with steeper IMF slopes:
improve $g-r$ vs. $r-i$
worsen $g-r$ vs. $u-g$:



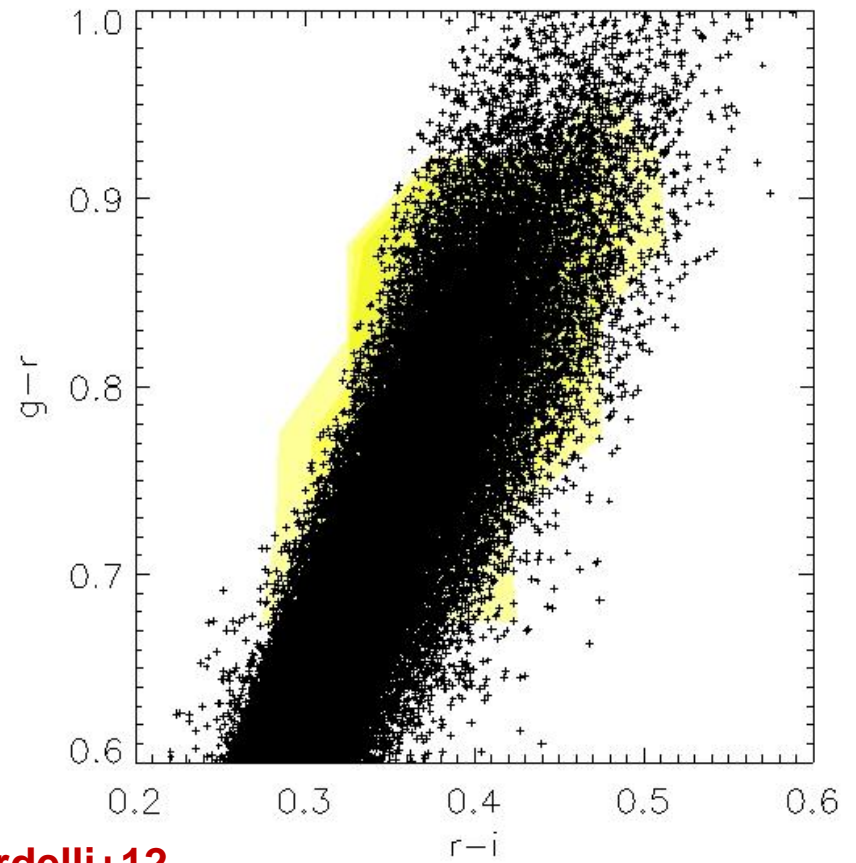
Ricciardelli+12

Modelling LRG colours:

Monte Carlo simulations varying age, metallicity and IMF slope:

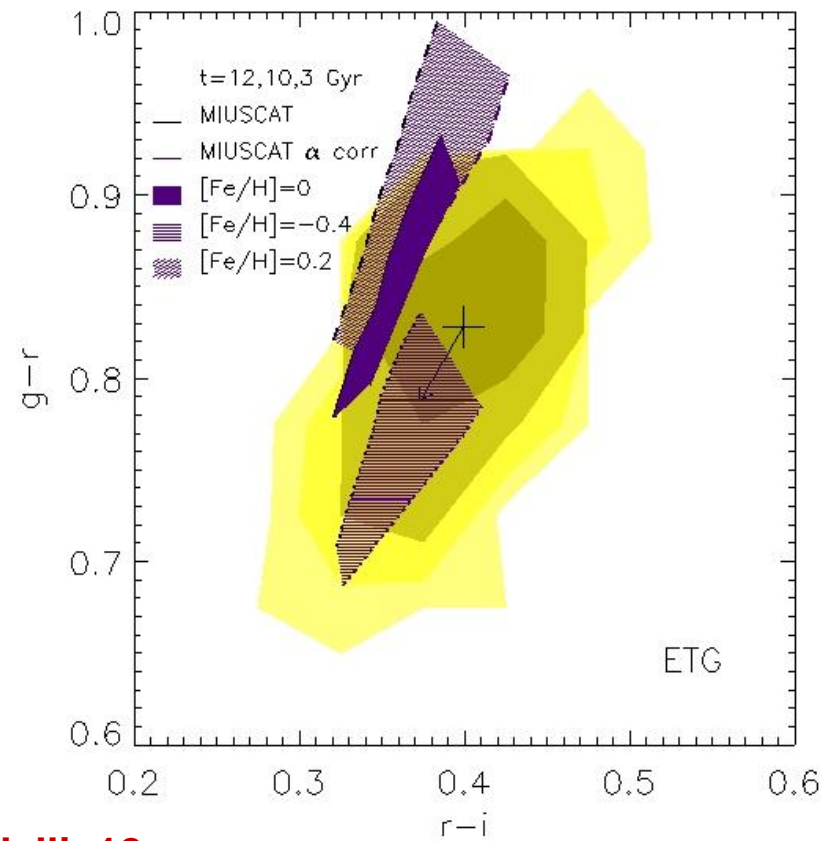
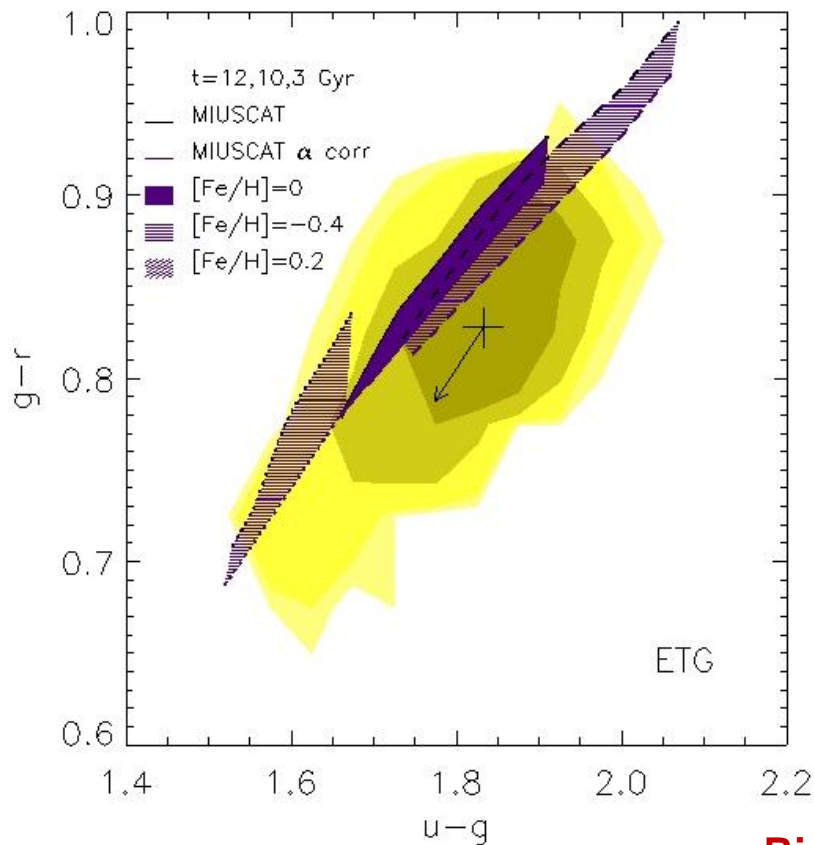


Ricciardelli+12



Modelling LRG colours:

Enhancement + bottom-heavy IMF seems to provide better fits!!!



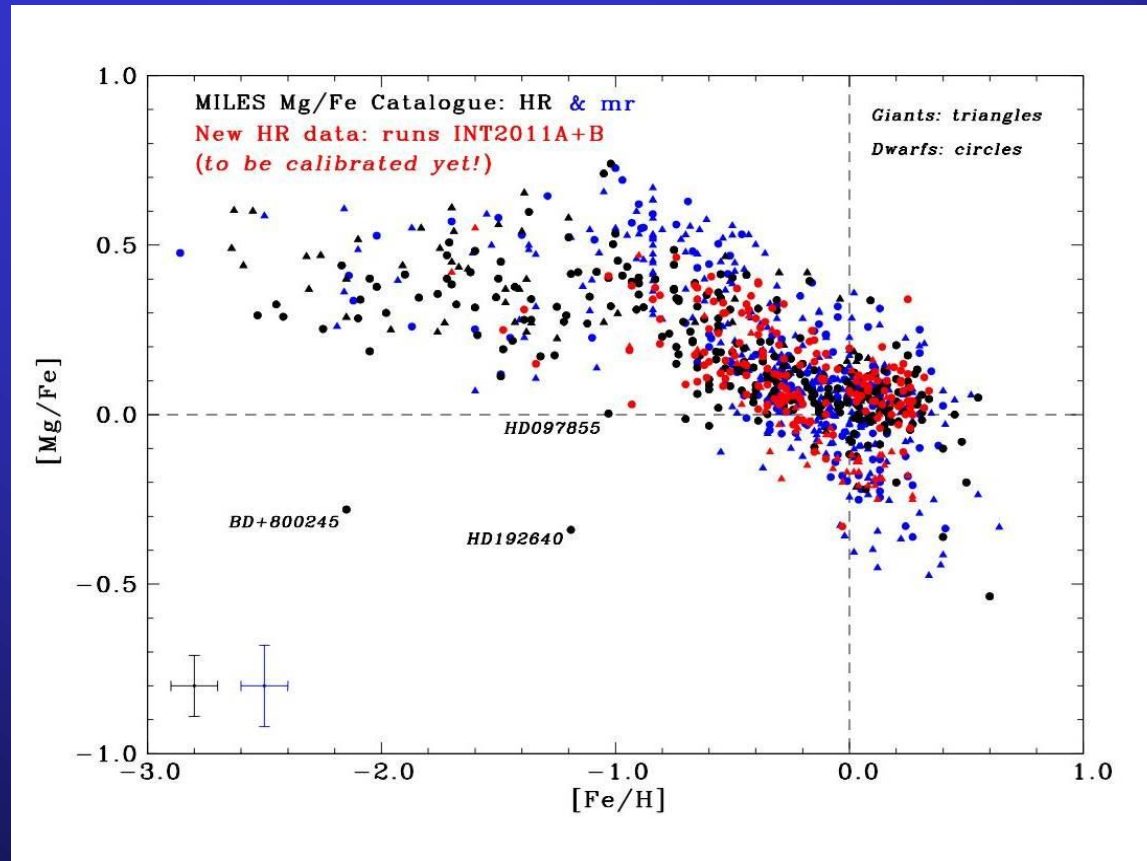
Ricciardelli+12

Expanding the [Mg/Fe] coverage of MILES

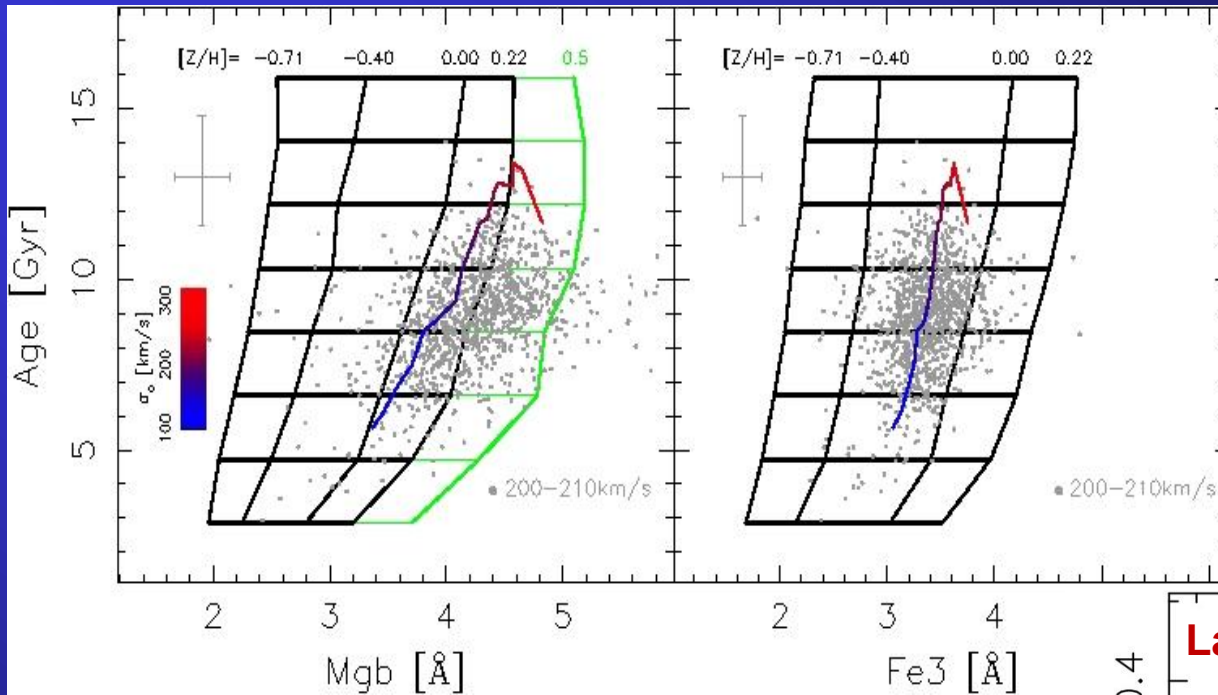
New observing programme to improve the Mg/Fe coverage of MILES, mainly around solar metallicity (already observed around 250 stars!).

Same instrumental configuration and data treatment.

Measuring the abundance ratio of the stellar spectra of both the original MILES sample (Milone+12), and the new stars.



...after all



Alpha-enhanced models are not required to derive the $[Mg/Fe]$!!!

...but they are useful to understand what is going on.

