



Observatoire astronomique
de Strasbourg



The Xshooter Spectral Library “XSL”

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The Xshooter Spectral Library

Why another empirical spectral library for population synthesis?

Population synthesis: the tool used to interpret spectra of galaxies.

Requirements :

Resolution : $\sim 10\,000$ is sufficient (velocity dispersion)

Reasonable sampling of the HR diagram at various metallicities

Broad wavelength coverage and good spectrophotometry:

Predict the relative contributions of various stars at various wavelengths
[ex: relative number of giants and dwarfs \rightarrow IMF]

Good spectral features

[evolution of selected spectral indices; performance of
“full spectrum fitting” algorithms \rightarrow star formation histories, LOSVD]

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Why another empirical spectral library for population synthesis?

Existing empirical/semi-empirical libraries :

BaSeL, Pickles

Broad wavelength coverage \leftrightarrow low spectral resolution
+ patchwork, not the same stars at all wavelengths

Good resolution and sampling of the HR diagram \rightarrow optical only

MILES, Indo_US, ELODIE, Gaia/ESO, Hermes/Galah,
LAMOST/LÉGUE, WHT/WEAVES, VISTA/4most, ...

Existing theoretical libraries :

Good coverage of parameter space ($\log[g]$, T_{eff} , Z , $[M/Fe]$)

But not tested well over the full UV+VIS+near IR (lack of adequate empirical data)

Tests for cool stars: not yet satisfactory

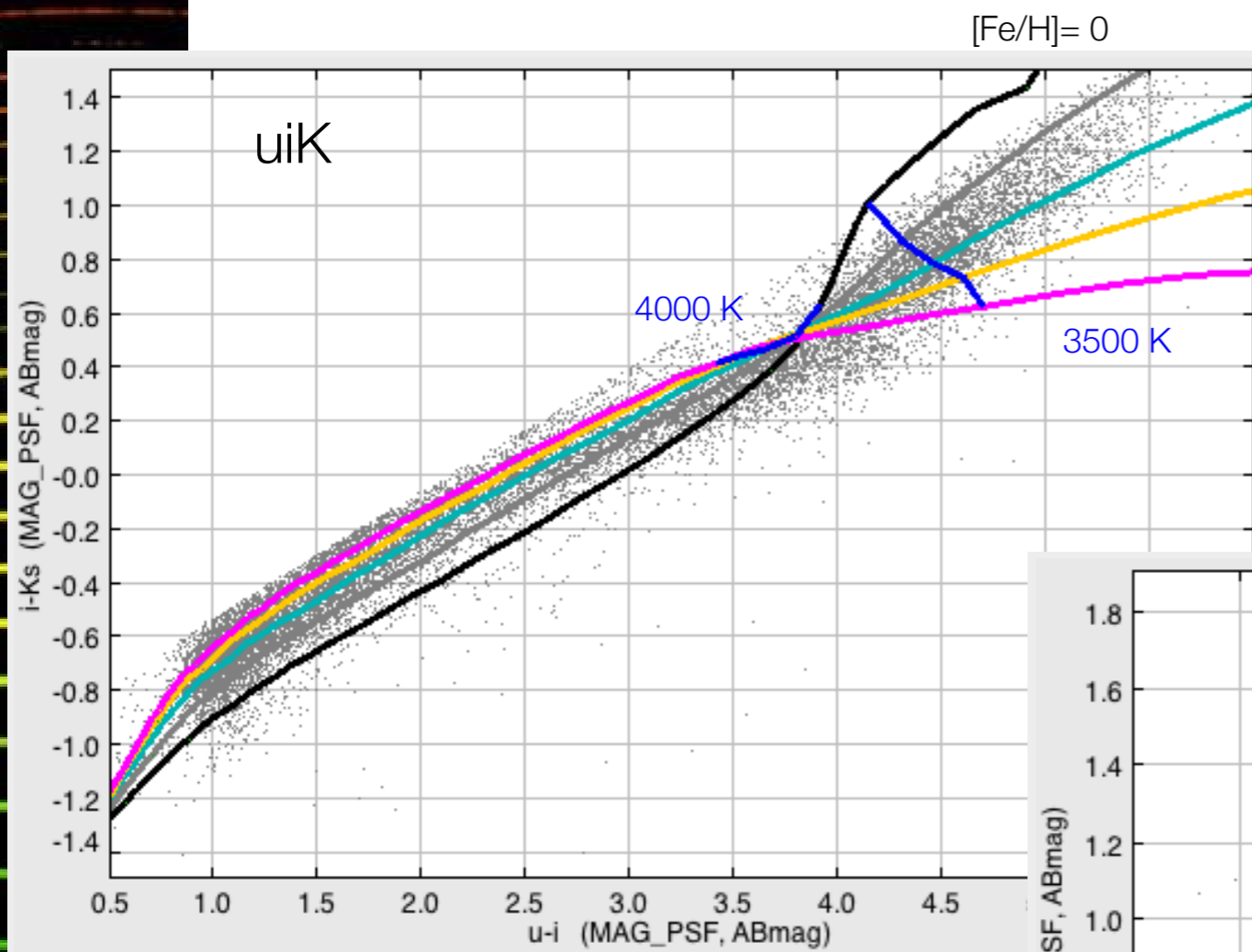
- conclusions from SEDs and from spectral features differ
- molecular line lists approximate

Consequences for population synthesis: ... to be improved before JWST and other NIR instruments

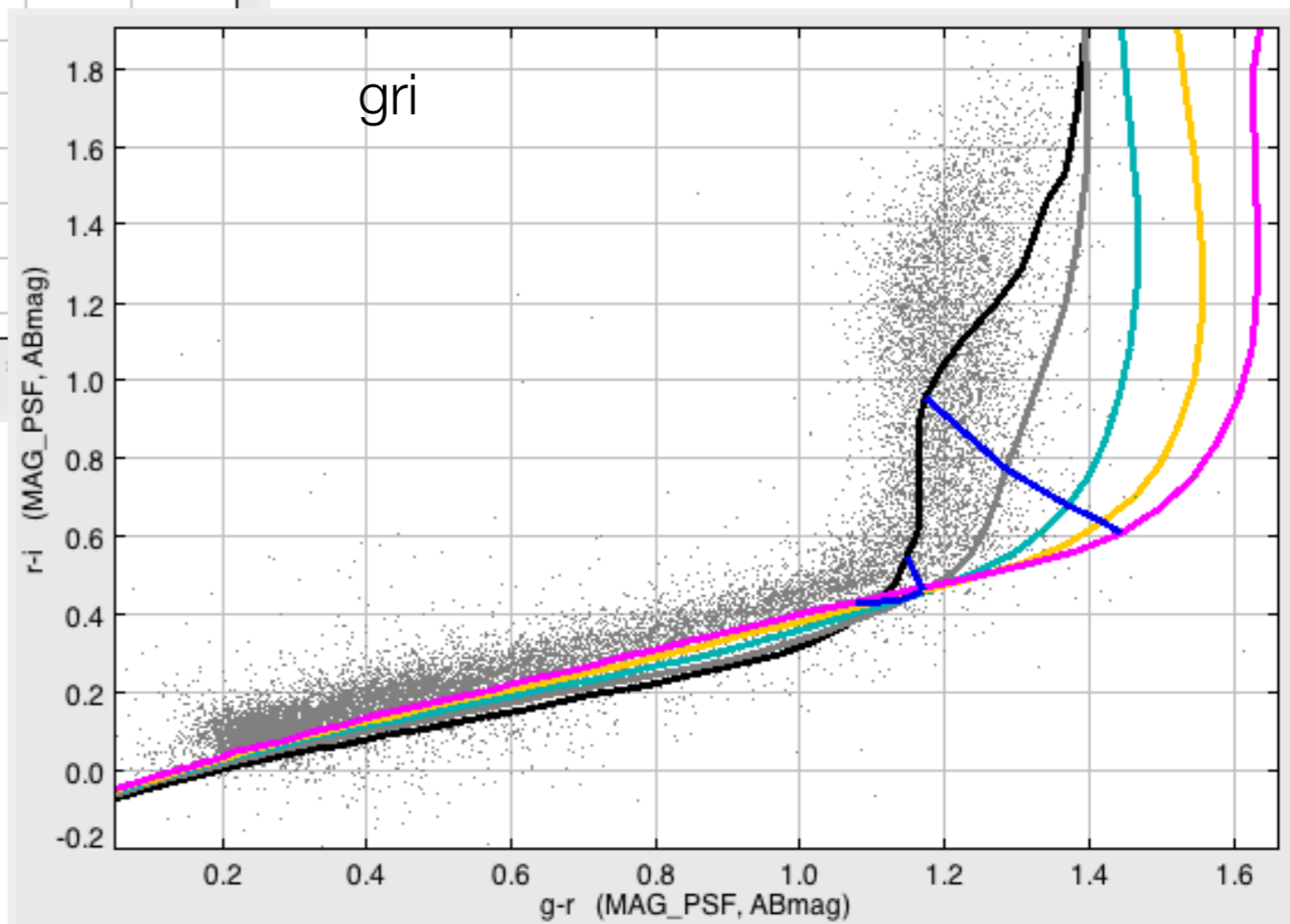
- Lack of confidence in near-IR analyses (stellar mass of galaxies at $z \sim 0 \rightarrow z \sim 1$, IMF variations, etc.)
- Poor predictions of near-IR line indices (contamination by poorly modeled molecular lines)

Some illustrations of the issues : photometry of cool dwarfs

Important for IMF estimates
in galaxies



[Fe/H]= - 1
[Fe/H]= - 1.5
[Fe/H]= - 2

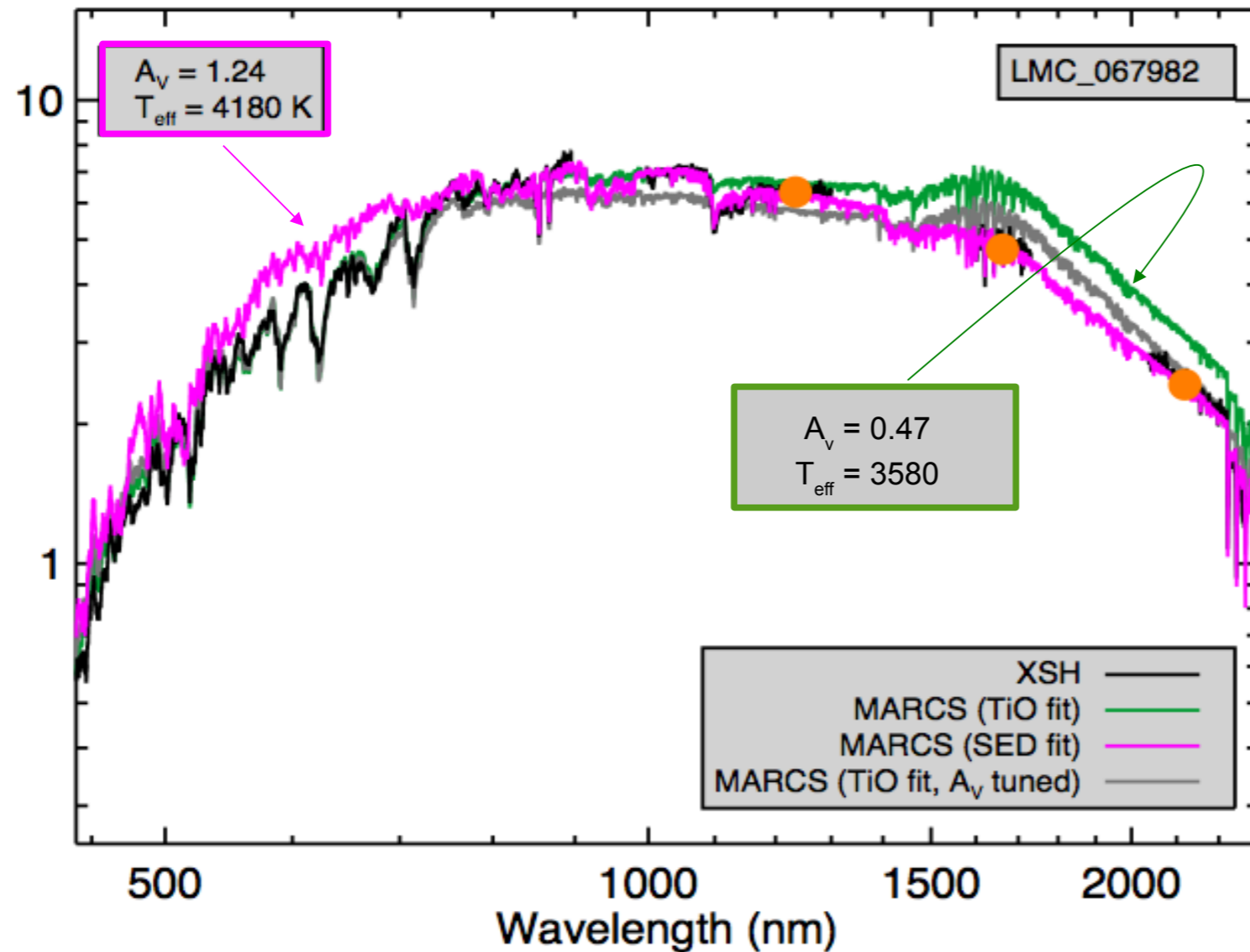


NextGen dwarf models.
Much improved recently.

Still, derived parameters
depend on color.

Some illustrations of the issues : SEDs and TiO features in Red Supergiants

Important for starburst galaxies and young star clusters



Standard models cannot match optical and near-IR spectra simultaneously.

Davies et al. 2012 → revised T_{eff}

Interpretation: large convective cells with a range of surface T (3D models needed)

(see also Lançon et al. 2007 for models that explore effects of dredge-up)

The Xshooter Spectral Library

Scott Trager (PI), Reynier Peletier (co-PI), Ariane Lançon (co-PI)

In France : Anaïs Gonneau (PhD Strasbourg), Philippe Prugniel (Lyon) - new collaborators welcome

Elsewhere : Yanping Chen (PhD completed), Sofia Meneses-Goytia (PhD), Mariya Lyubenova, Alexandre Vazdekis, Mina Koleva, Javier Cenarro, Jesus Falcón-Barroso, Esther Mármol-Queraltó, Patricia Sánchez-Blázquez, Jakob Walcher, Peter Hauschildt, David Silva

The aim : UV+VIS+NIR spectroscopic library designed primarily for population synthesis purposes.

Numerous comparisons with stellar models in order to :

- estimate fundamental parameters
- progress towards agreement between theory & observations across UV...NIR.

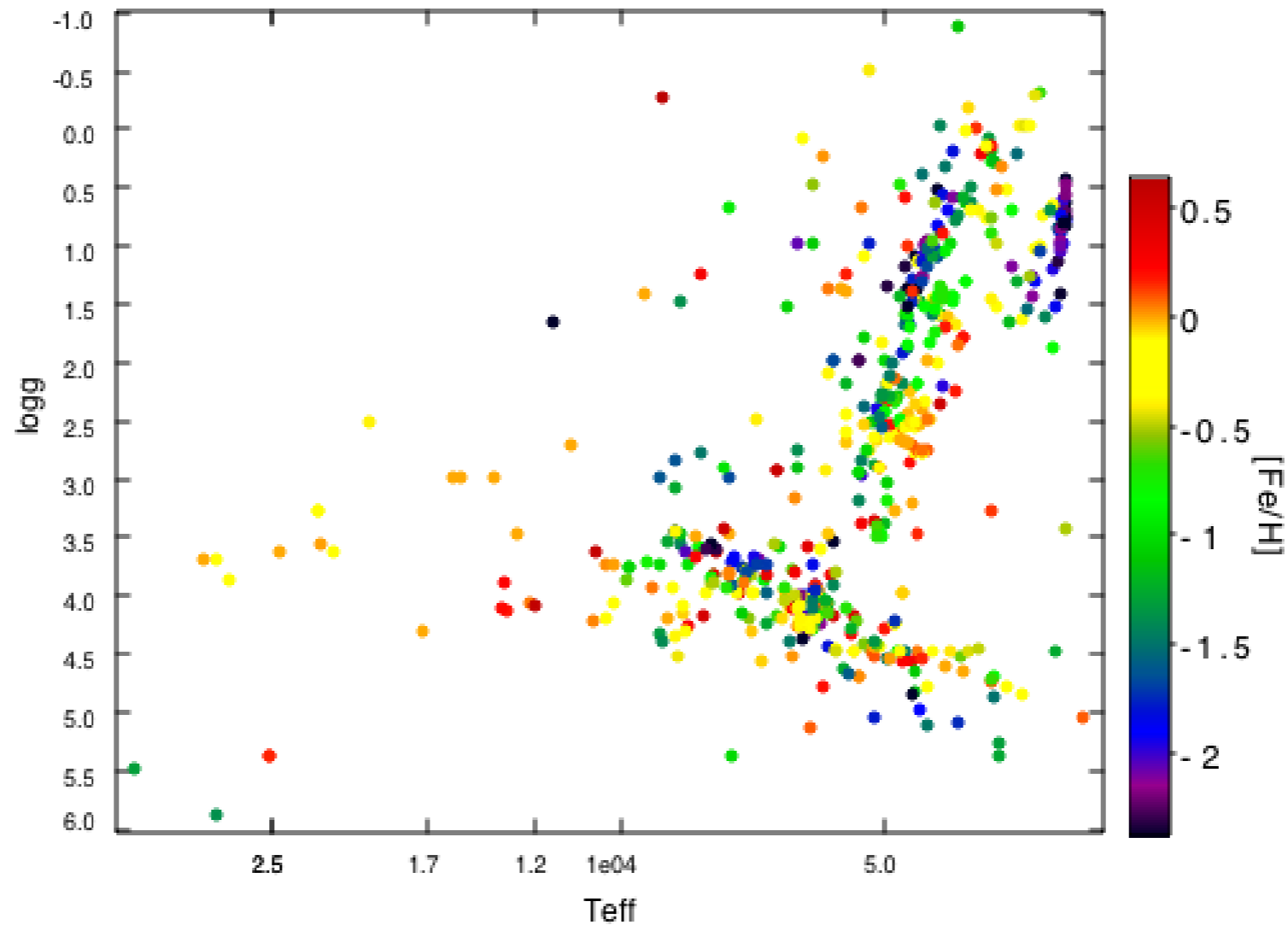
The project : 800+ stars across the HR-diagram at various metallicities
Xshooter observations : $R \sim 10000$ [not much need for higher R when studying galaxies]
 $\lambda \lambda$ 320 – 2400 nm [in one shot]

Data reduction specifics : (Relative) flux calibration
Correction for telluric absorption

Post-processing : fundamental parameters of the observed stars

DR1 : 230 stars from the “pilot program”, UVB+VIS (Yan-Ping Chen et al. 2014 – submitted)
DR1 database + web site (ready – A. Gonneau)

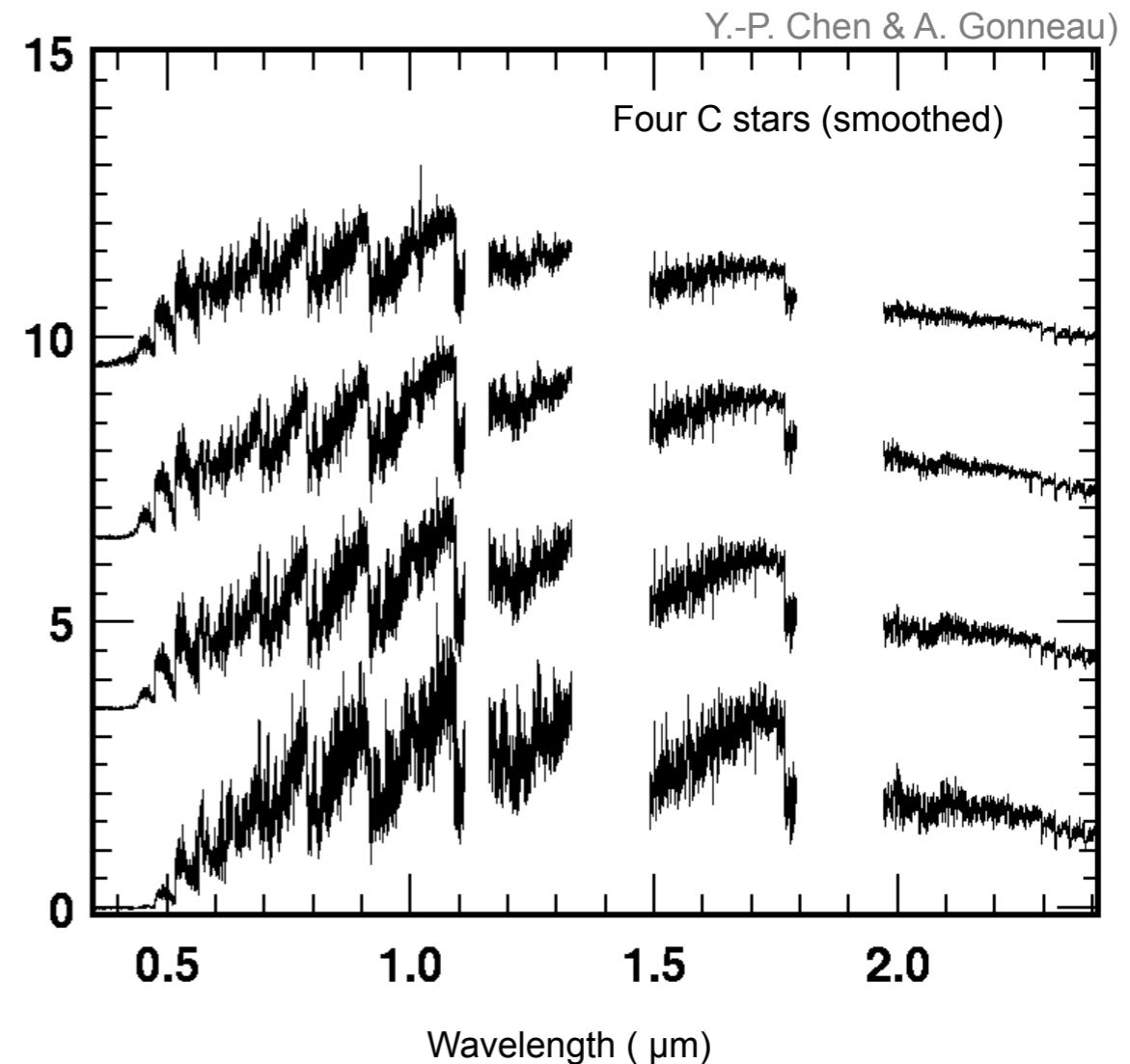
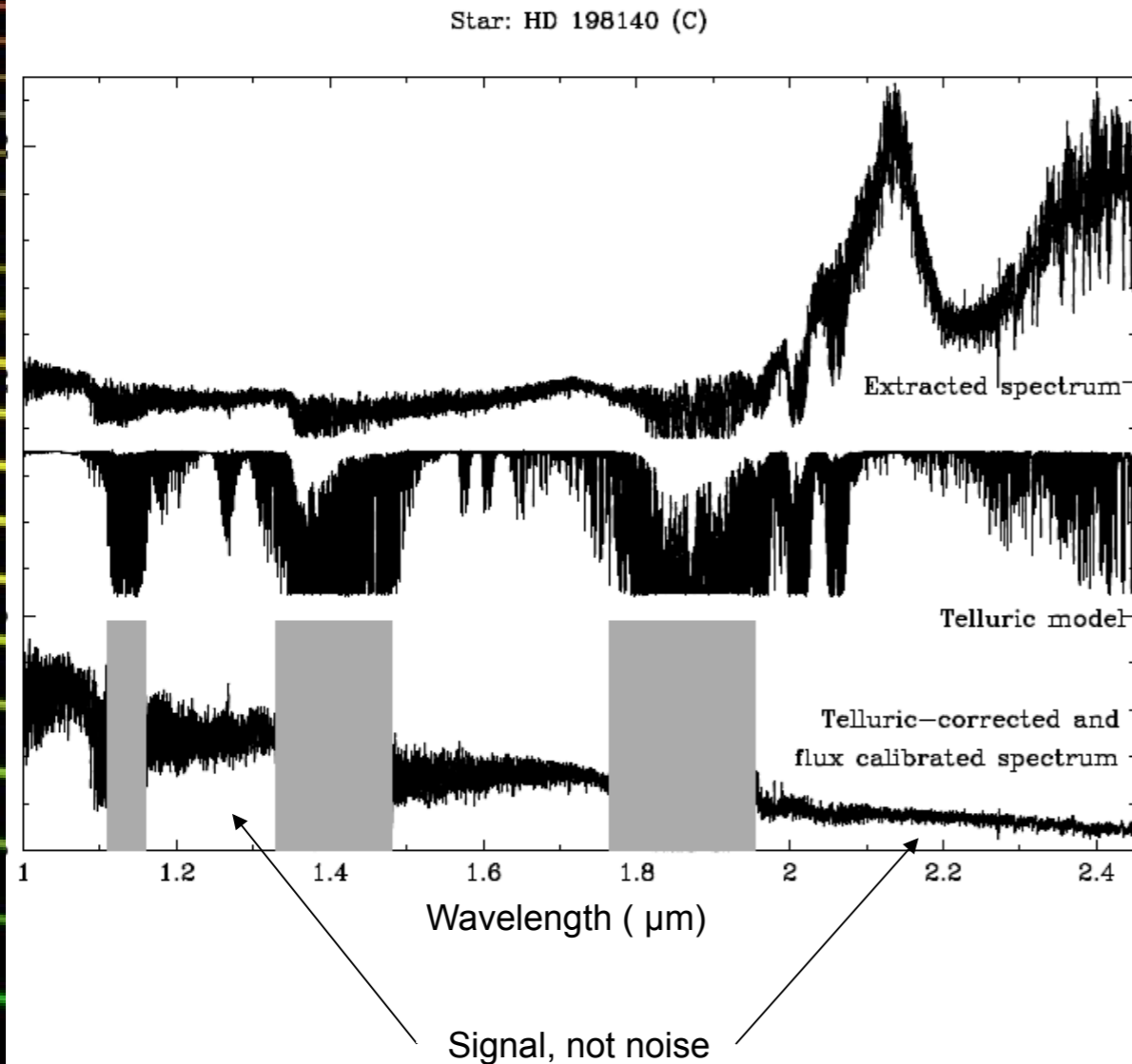
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Almost complete survey, with parameters mostly from the input catalogs (to be improved)

(NB: TP-AGB stars are placed and colored arbitrarily; many more B and A stars available)

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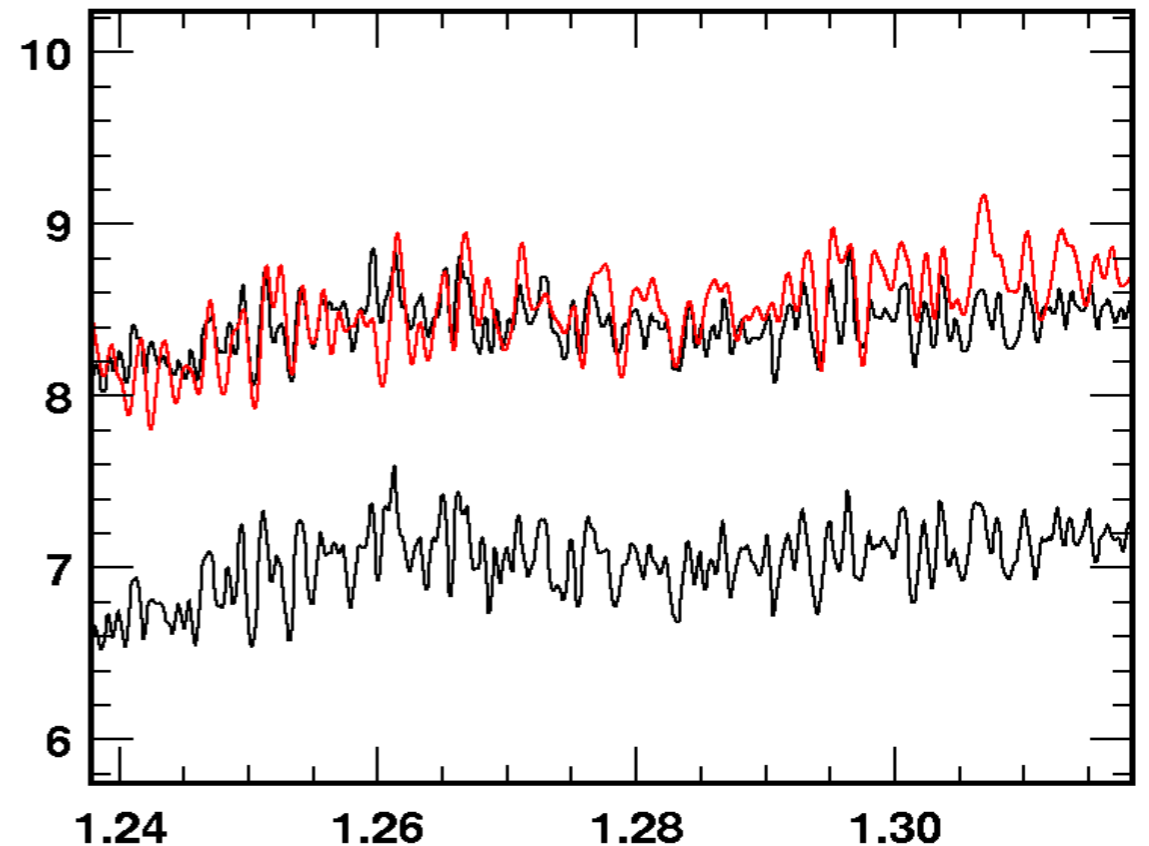
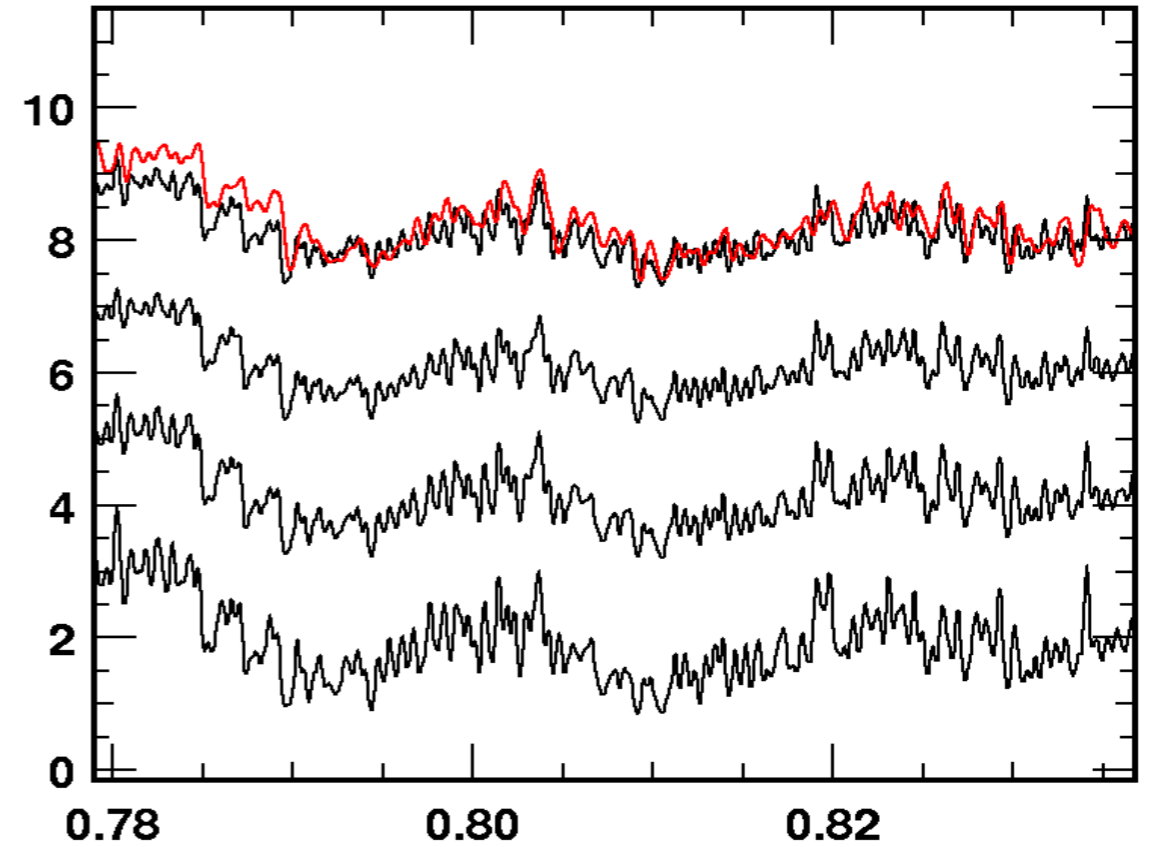
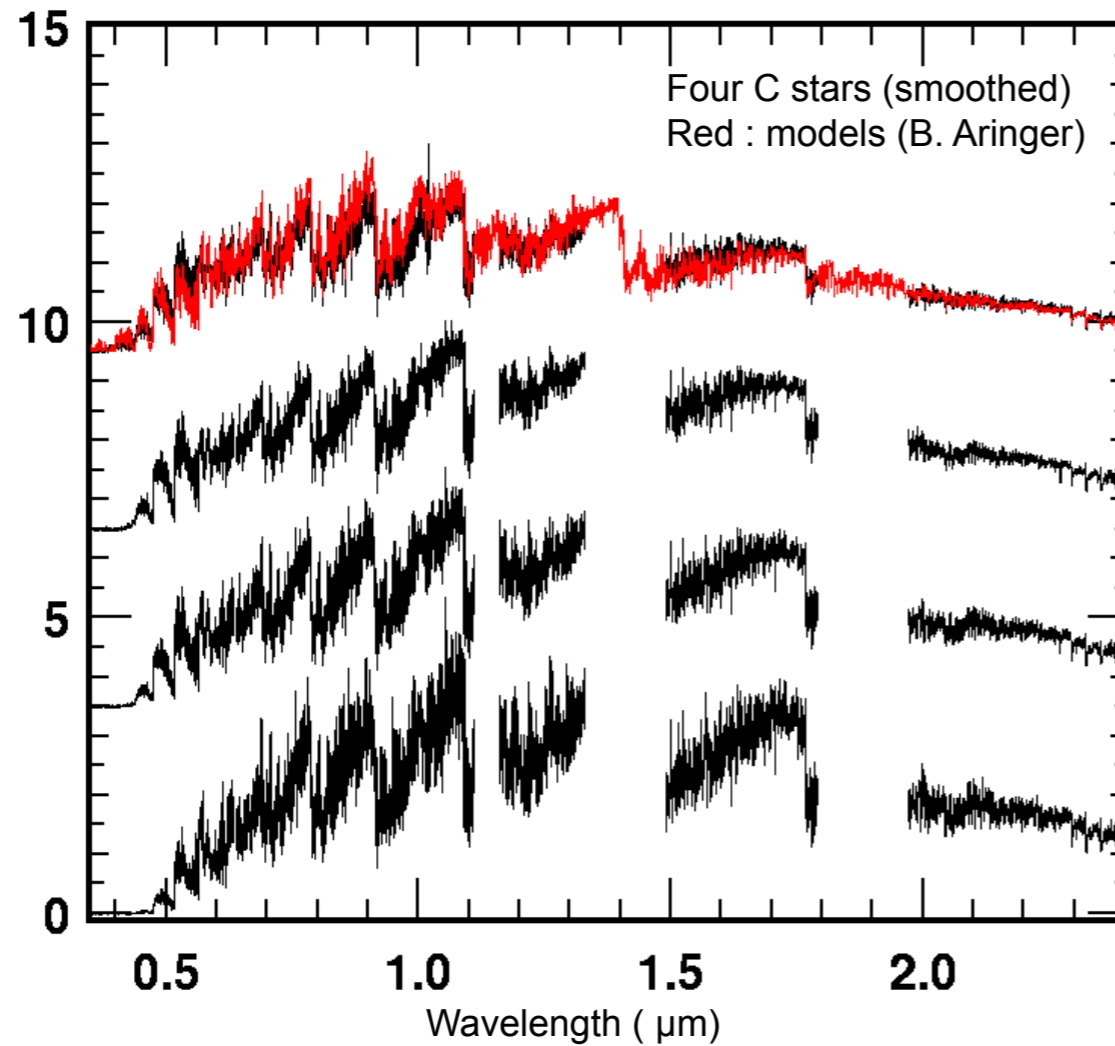
Responsibilities in France :

Reduction of the observations in the NIR arm (Strasbourg– Anaïs Gonneau)

Analysis of the luminous cool stars : RGB, AGB, RSG (Strasbourg – Anaïs Gonneau)

Interpolation, contribution to fundamental parameter estimations for all stars (Lyon +)

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Questions reg. C stars :

Fundamental parameters? Evolutionary status ?

Circumstellar extinction (related to pulsation and mass loss for $J-K > 1.4$ – Nowotny et al.2012).

Extinction law? Relation to evolutionary status?

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The next few years

Data reduction / validation to be completed. Database (DR1 is ready).

Comparison with theoretical spectra : only some spectral types currently under scrutiny
→ [collaborators welcome](#)

Fundamental parameters, abundance estimates, interpolation methods...

... but what is really sought is convergence between observations and theory,
so that future population synthesis tool can rely on model spectra.

[And of course applications to existing/new VIS+NIR observations of clusters and galaxies]

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