



The X-Shooter Spectral Library

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outline

Why do we need a stellar library?

Previous stellar libraries

X-Shooter spectral library

Why and what?

- What do galaxies consist of?

(How galaxies formed, evolve? And why?)

- Galaxies are made up of stars

understanding of the spectra of stars is the key process of understanding the spectra of galaxies.



Previous libraries

Empirical:

- Optical: Lick/IDS, MILES, ELODIE, Stelib, Pickles, etc
- NUV: MILES, NGSL
- NIR: IRTF-Spex, Lançon & Wood, Mármol-Queraltó et al.

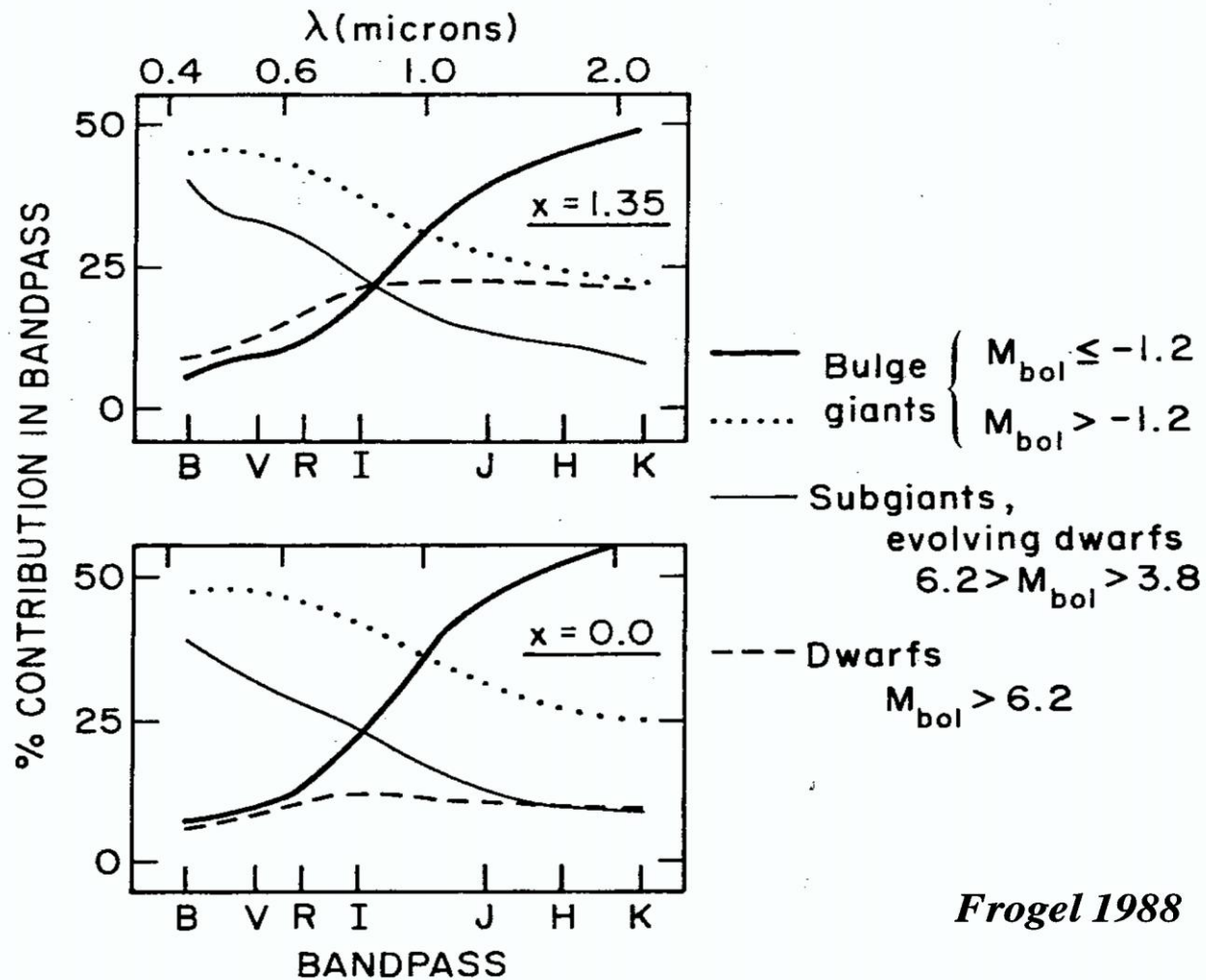
Theoretical: (synthetic stellar spectra)

- Coelho et al. (2005, 2007)
- Munari et al. (2005)
- Gustafsson et al. (2008)

Some examples of previous libraries

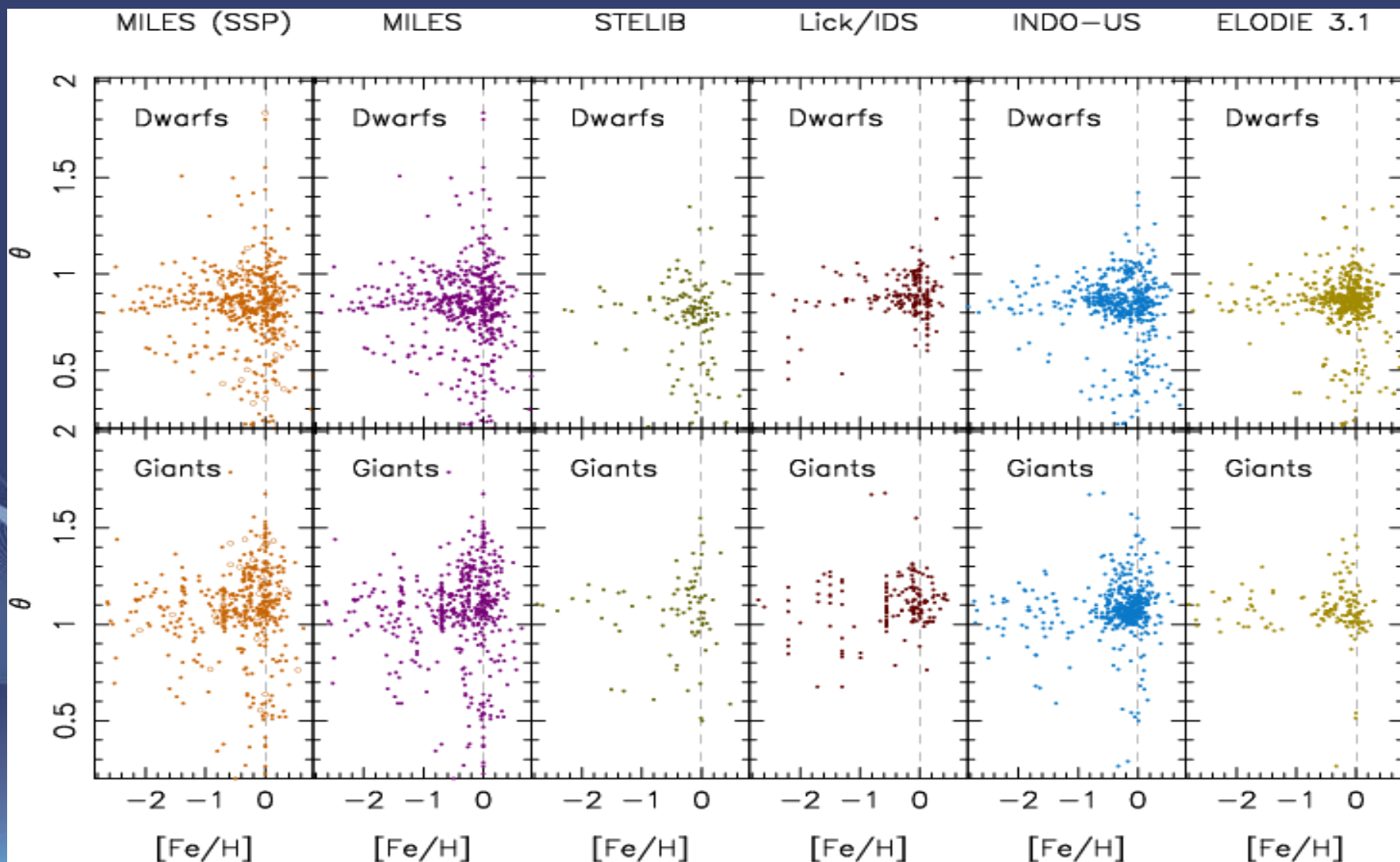
| Library | Resolution $R = \lambda/\Delta\lambda$ | Spectral range(nm) | Number of stars | References |
|-----------|---|-----------------------|--------------------|-----------------------------------|
| STELIB | 2000 | 320-930 | 249 | Le Borgne et. al., 2003 |
| ELODIE | 10000 | 410-680 | 709 | Prugniel & Subiran, 2001, 2004 |
| INDO-US | 5000 | 346-946 | 1273 | Valdes et. al., 2004 |
| MILES | 2000 | 352-750 | 985 | Sánchez-Blázquez et al. 2006 |
| IRTF-SpeX | 2000 | 800-2500 | 210 | Rayner, Cushing & Vacca (2009) |
| NGSL | 1000 | 167-1025 | 374 | Gregg et. al., 2004 |
| UVES-POP | 80000 | 307-1030 | 300 | Bagnulo et al., 2003 |
| LW2000 | 1100 | 500-2500 | 100 | Lançon & Wood, 2000 |

Importance of a large wavelength coverage



Frogel 1988

Importance of a good coverage of stellar parameters



Atmospheric parameters coverage of different libraries compared with the parameter coverage of MILES

The need for a higher resolution library

- Dwarf galaxies with a velocity dispersion of 10 km/s need stellar population models with $R=10000$ to be able to analyse the full spectrum, without having to degrade the spectra.
- High resolution also needed for:
 - Late type spiral galaxies
 - Globular clusters in external galaxies
- Study of faint absorption lines needed for abundance determinations of several different elements.

XSL: The X-Shooter Spectral Library

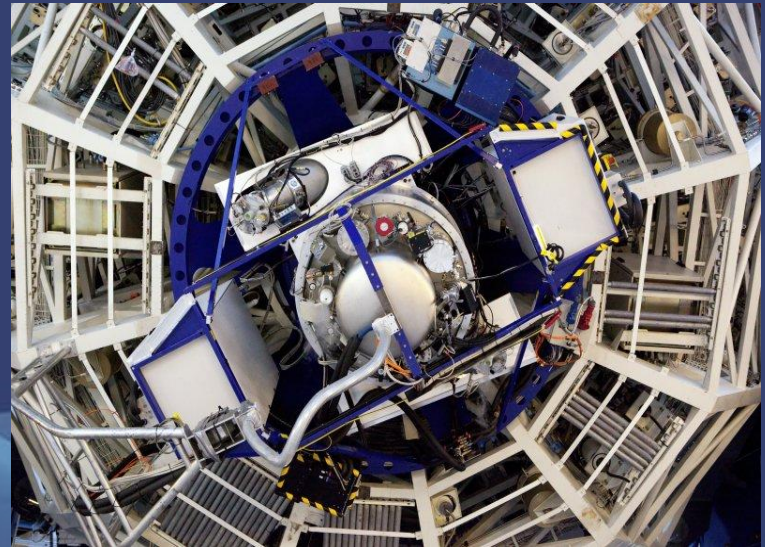
Instrument & capability

- Wavelength coverage:
300-2500nm split in 3 arms
- Spectral resolution

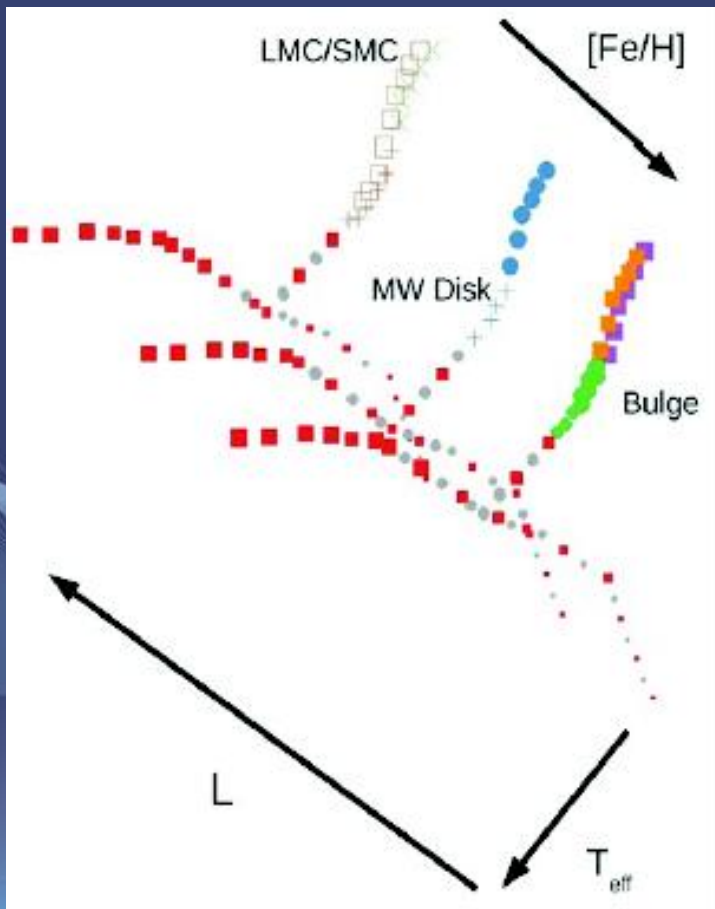
UVB : 300-550nm, R~ 9100

VIS : 550-1000nm, R~11000

NIR : 1000-2500nm, R~ 8100



XSL Stellar parameter coverage



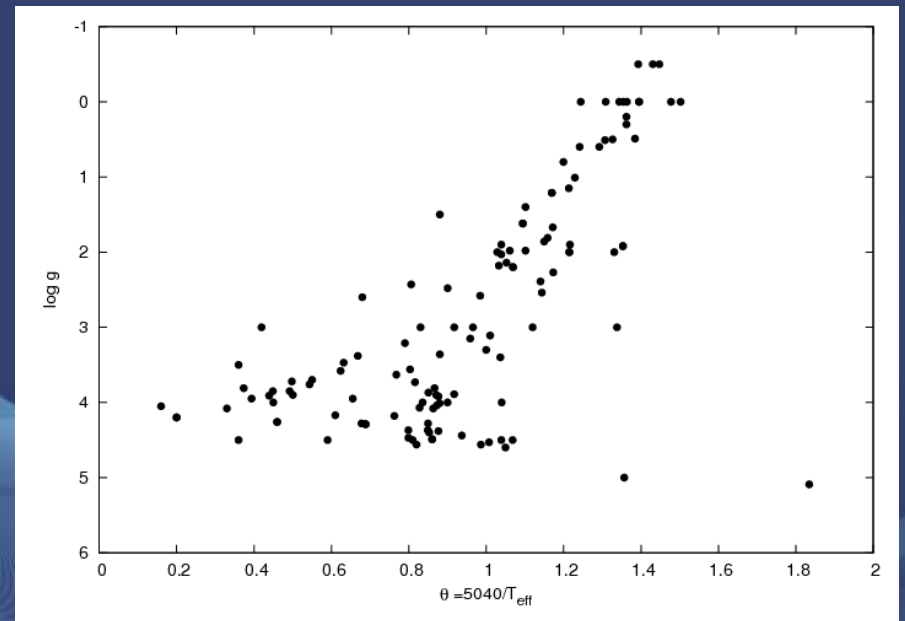
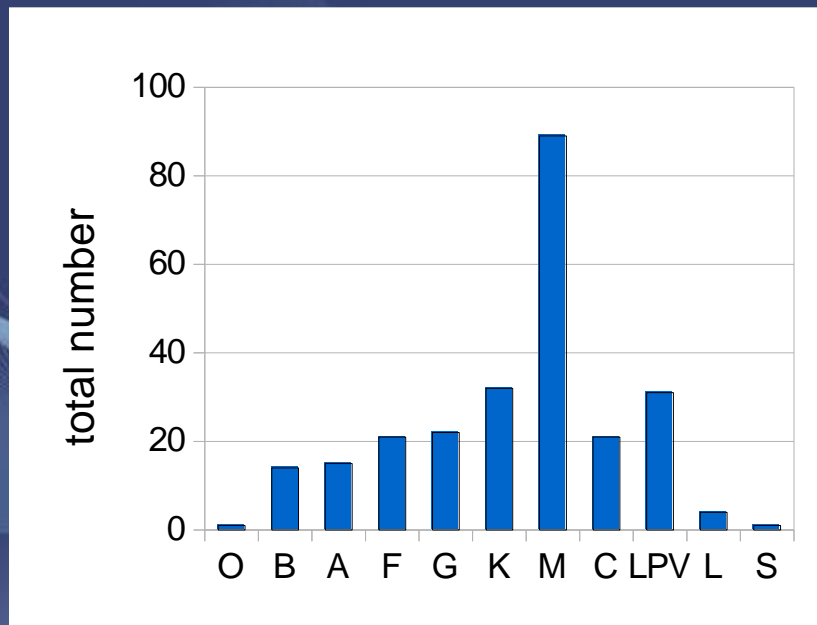
Wide coverage of T_{eff} , $\log g$, metallicity Z , metallicity spread from LMC/SMC, MW Disk and the Bulge.

Same stars at every wavelength, so more reliable st. pop. Models e.g. variable stars.

About 600 stars will be included.

Data and reduction

234 stars are available from P84/85

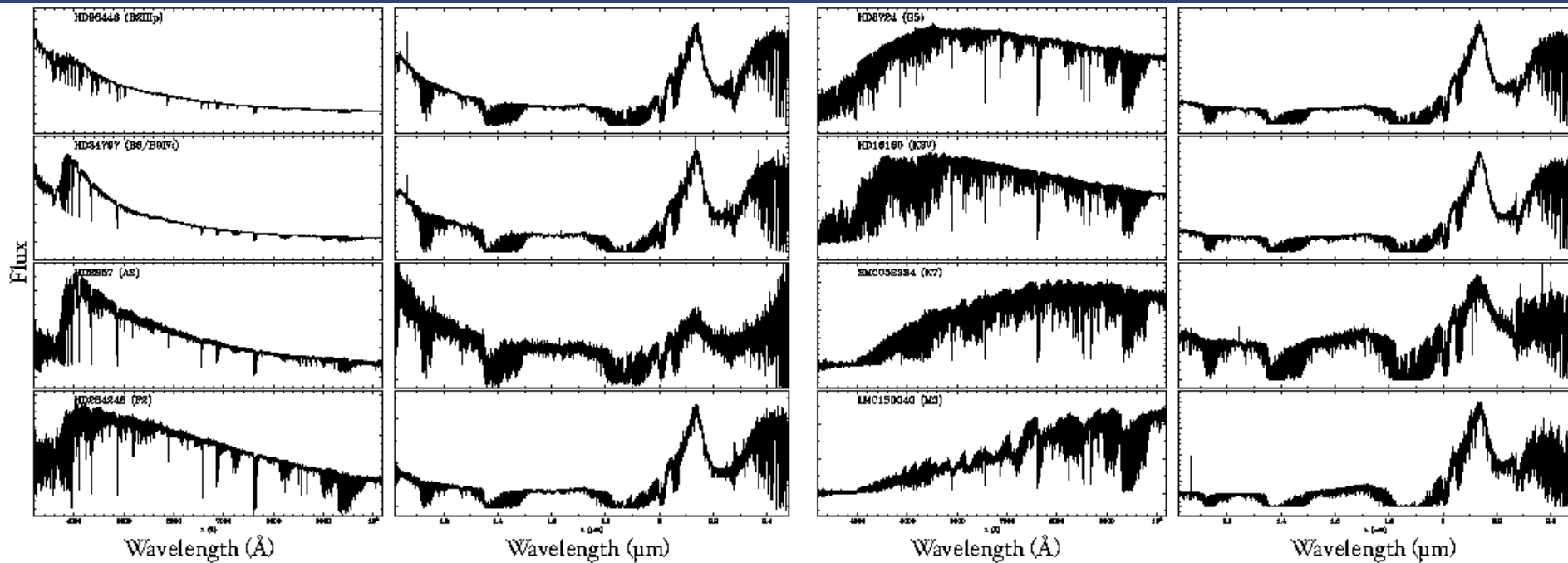


Statistics of different stellar types

H-R diagram, distribution of observations

Software: XSH pipelines + Iraf

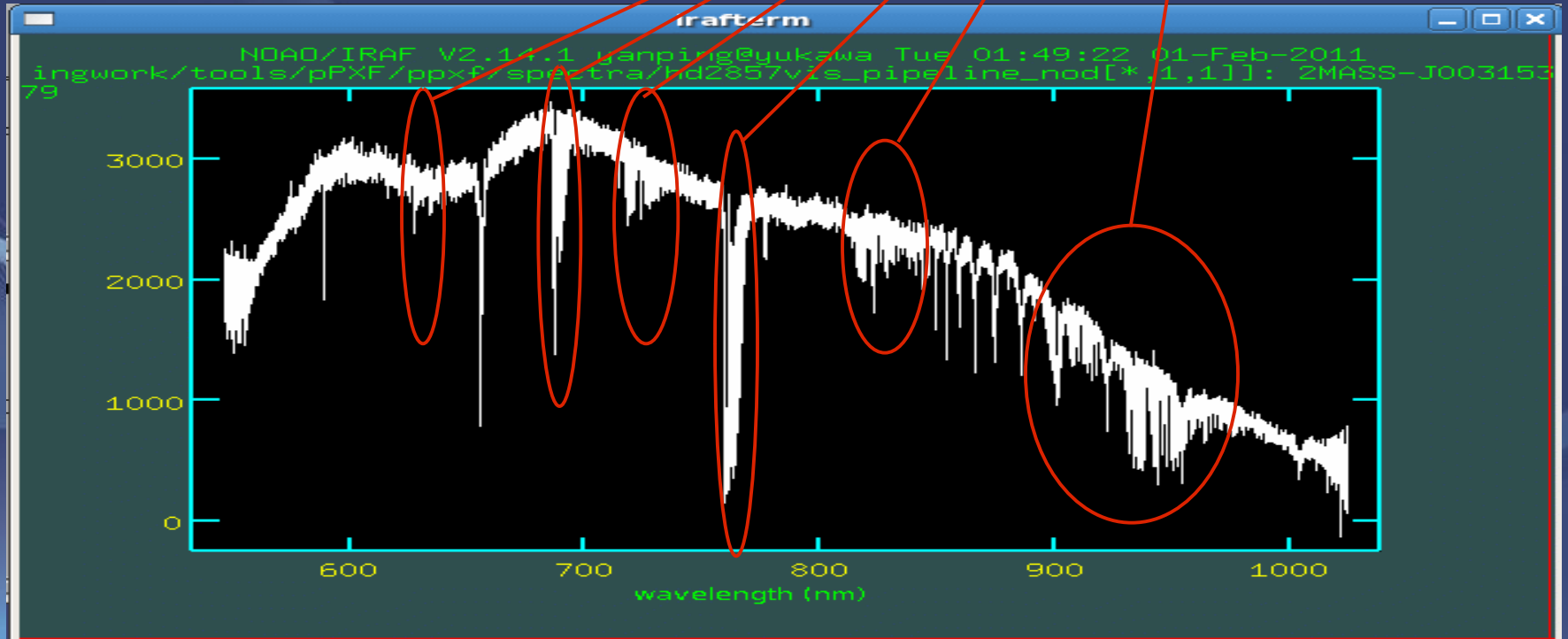
First result



The quality of XSL stars without telluric correction, where the UVB and VIS arm are roughly flux calibrated, while the NIR arm are not flux calibrated.

Telluric correction

Telluric absorption!



still in progress...

Ideal telluric spectrum:

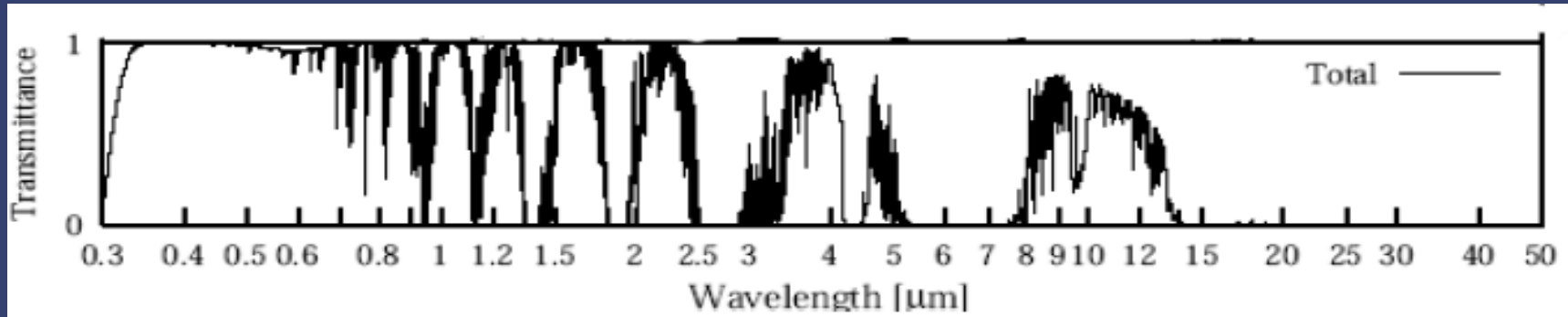
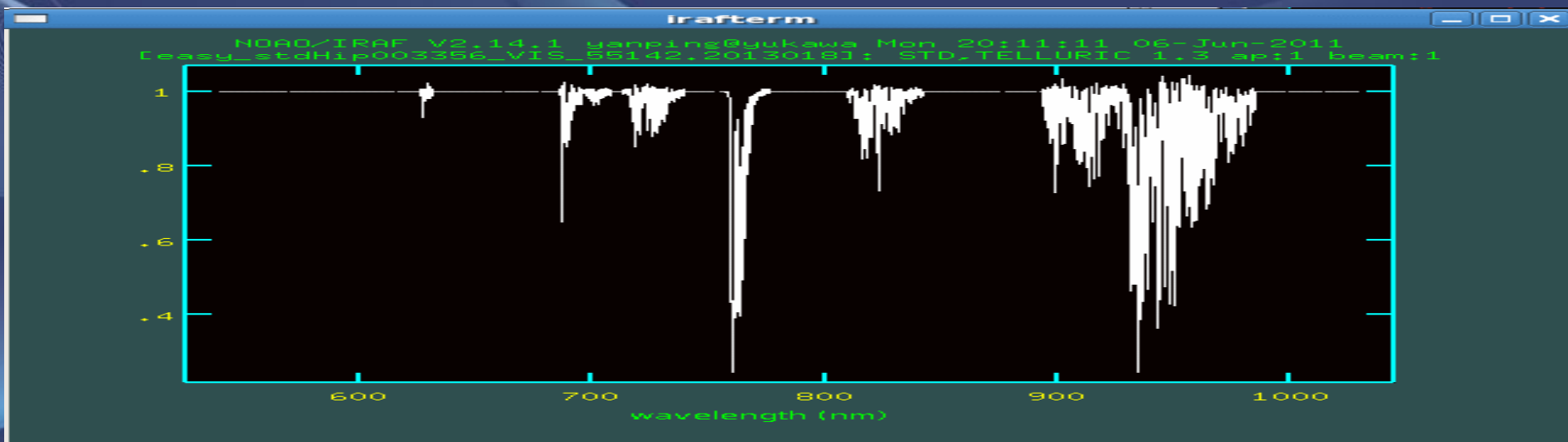
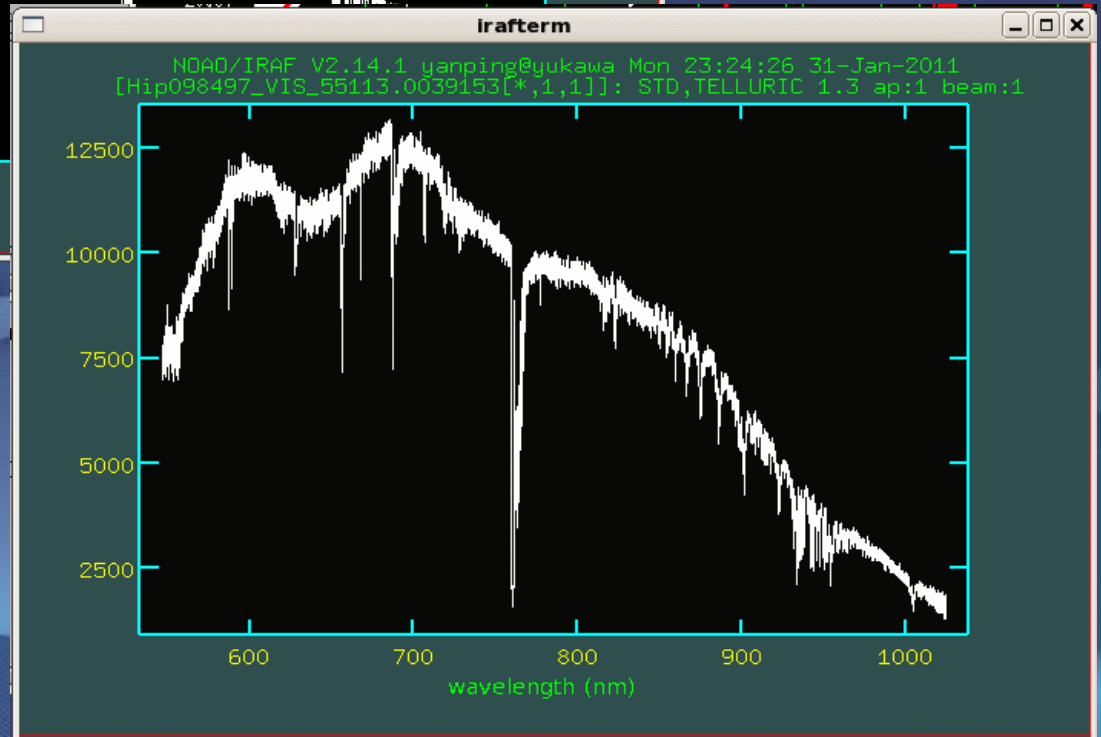
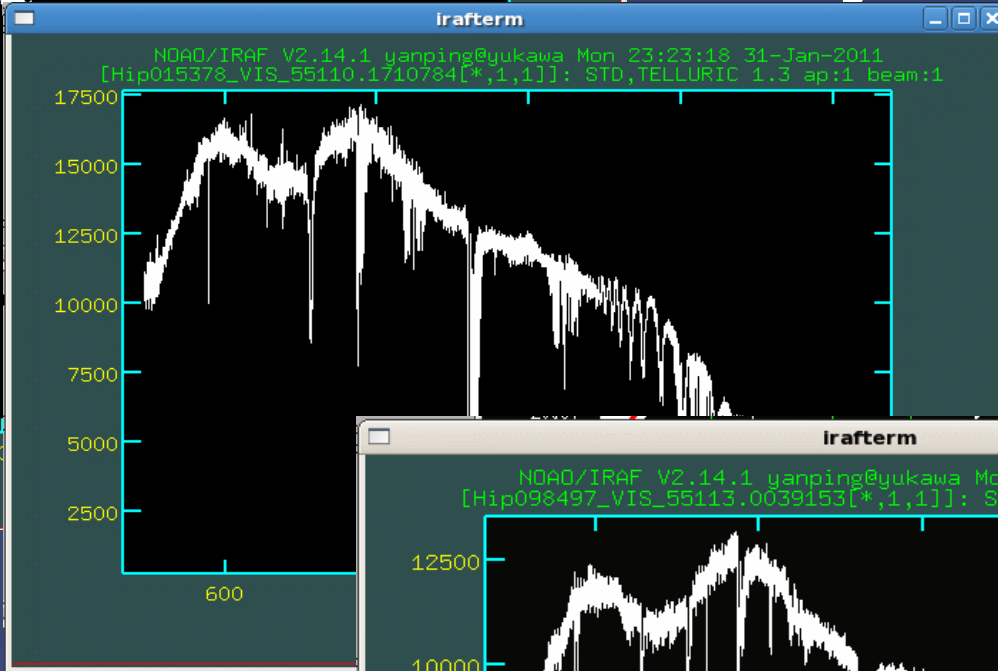
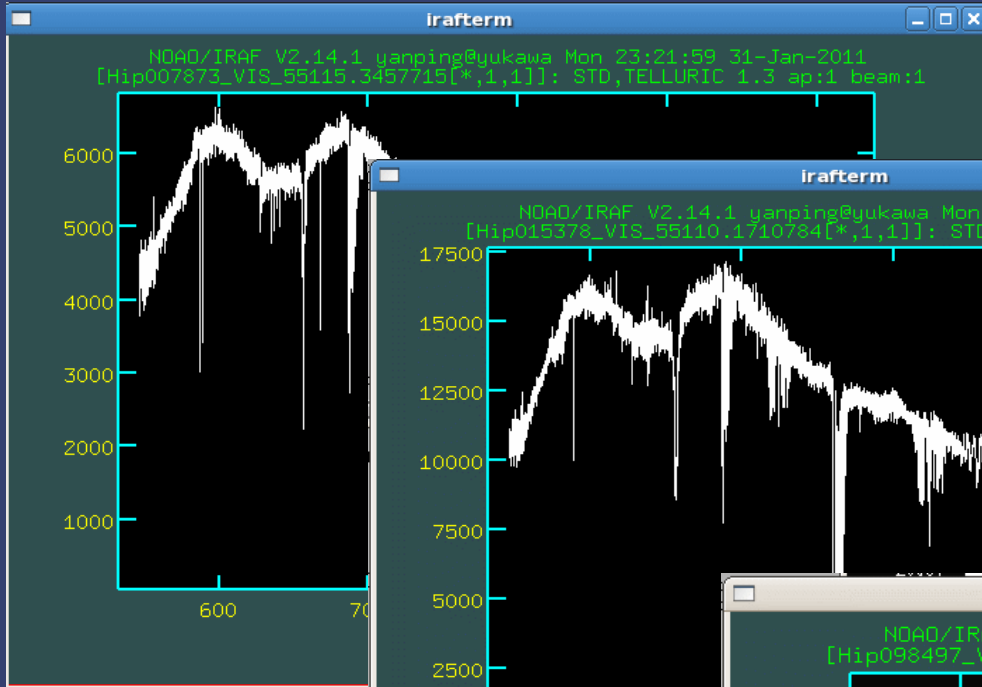


Figure 6.3 Transmission spectra of the major atmospheric gases.

What we can do:



brary



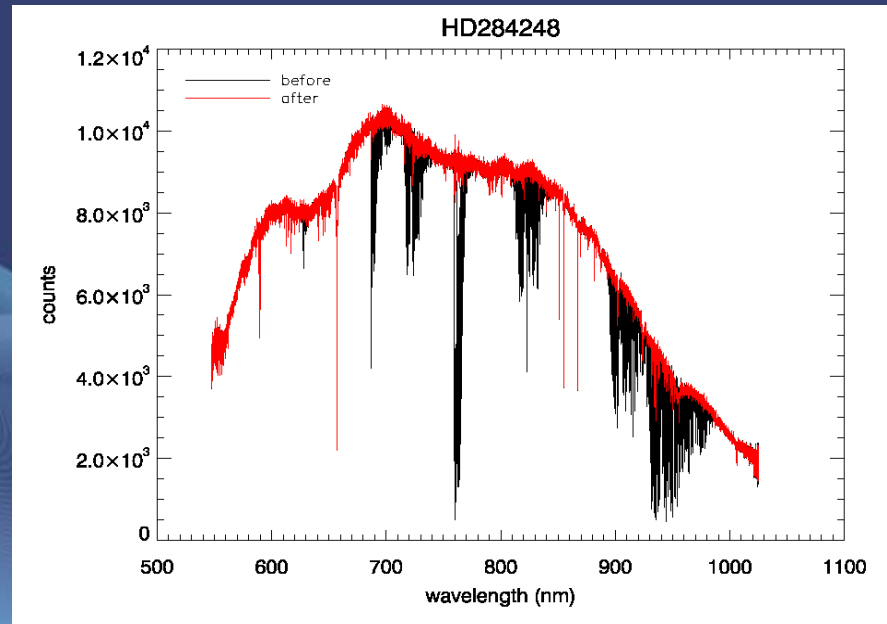
Our method:

1) Define the Hydrogen lines in the telluric library sample, and mask them out from the telluric region

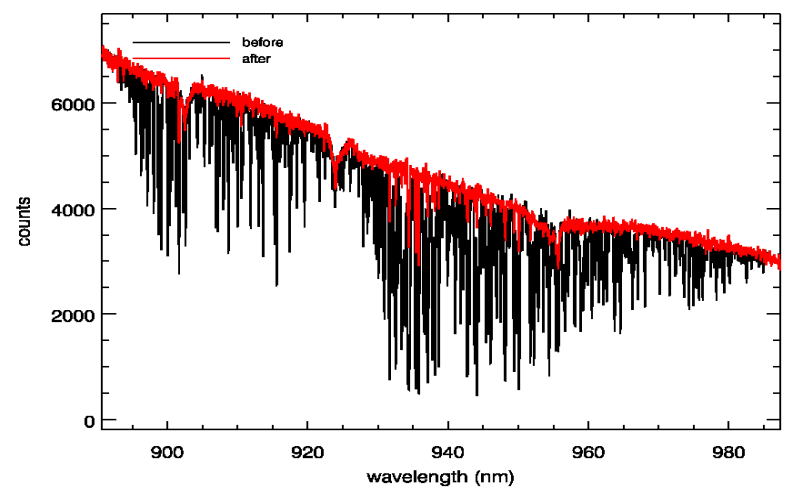
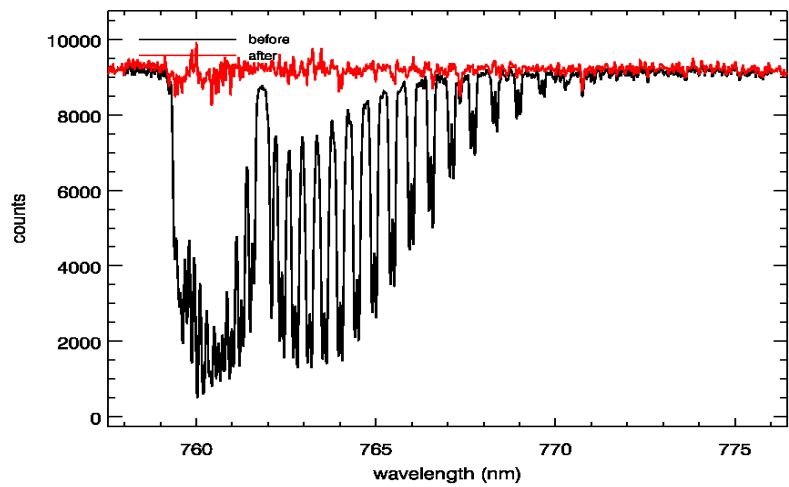
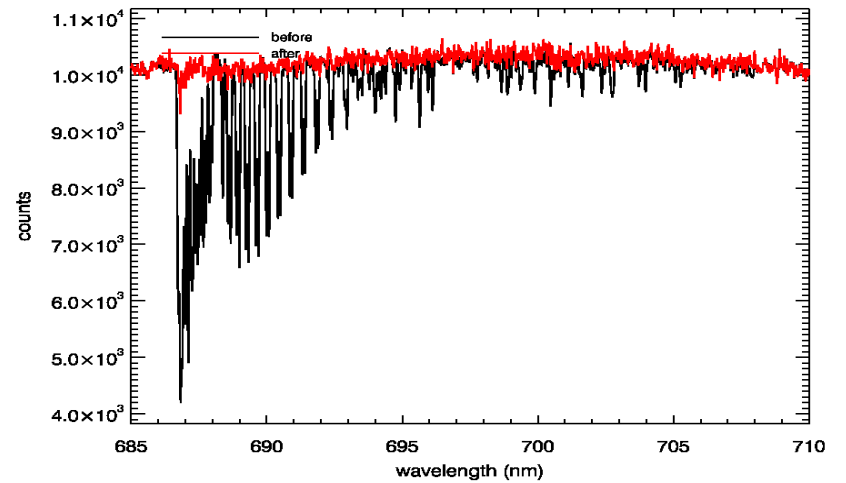
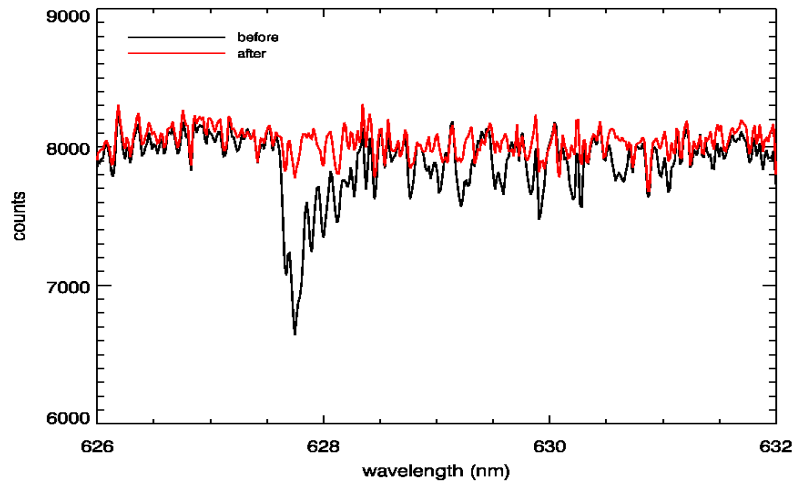
Generate the Hydrogen corrected telluric library.

2) Define the telluric absorption regions in the science object, fit those features by the corrected telluric library.

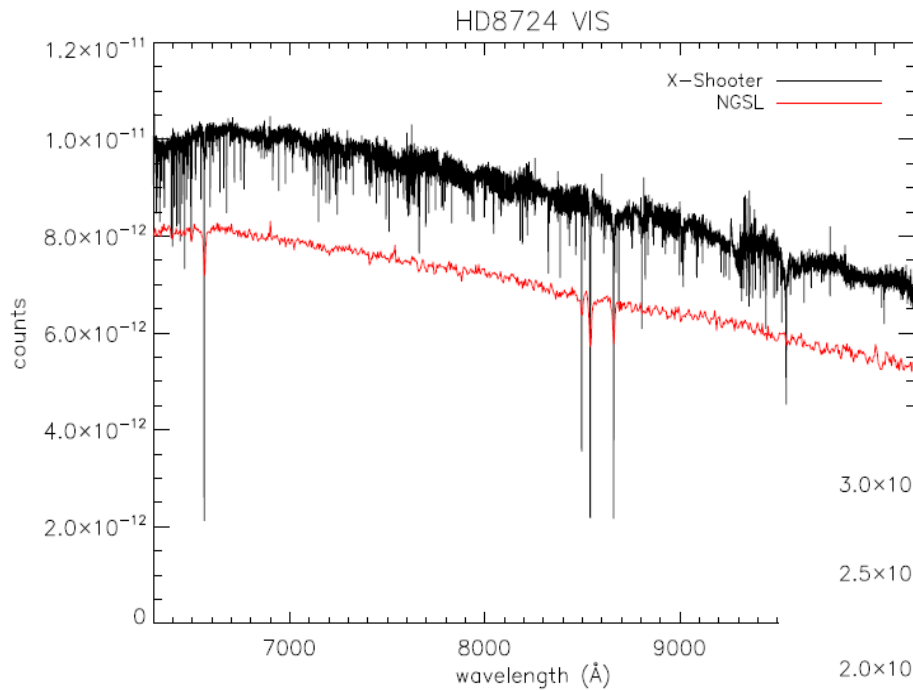
Telluric template (for certain science object)
= "bestfit" / continuum of the "bestfit"



the "bestfit" of HD284248 by pPXF (Cappellari & Emsellem ,2004, PASP, 116, 138)

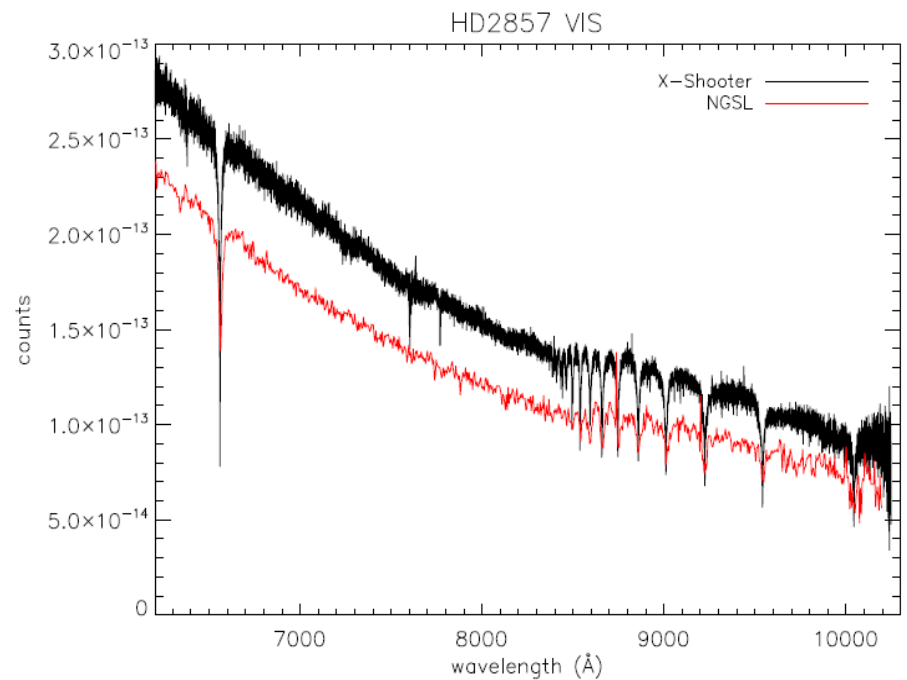


Flux calibrated data



HD 8724 (G5) observed with X-Shooter vs. NGSL

HD 2857 (A2) observed with X-Shooter vs. NGSL



Summary of The X-Shooter Library (XSL):

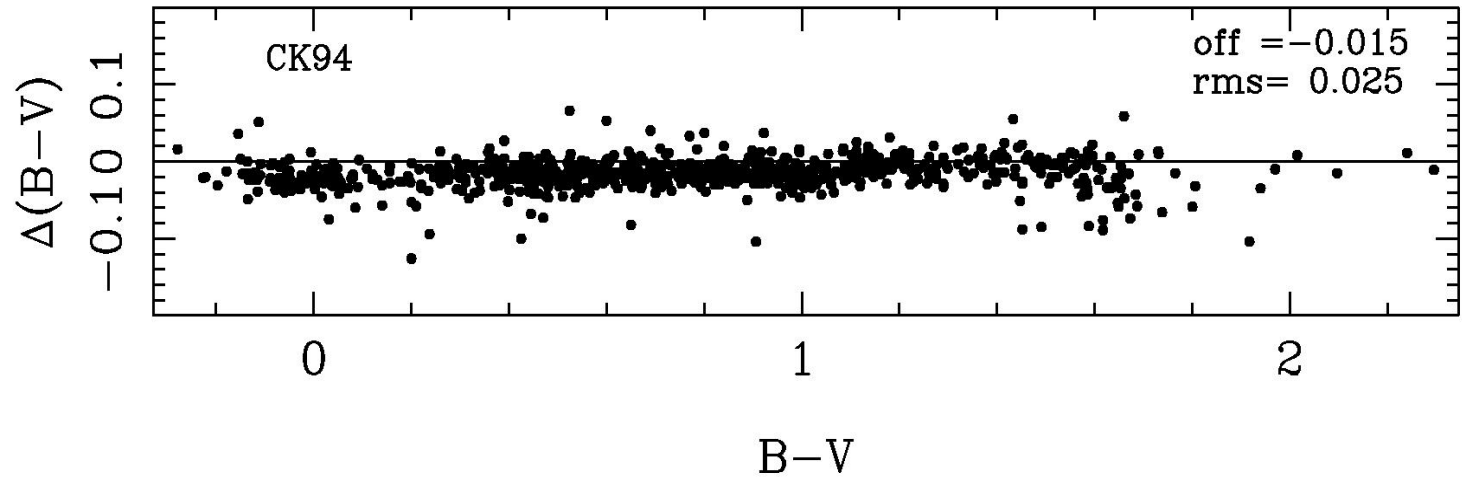
- Wavelength coverage: 3000Å – 2.5 micron
- Spectral Resolution: $R = \lambda/\Delta\lambda \sim 10000$
- Wide Coverage of T_{eff} , $\log g$, metallicity Z
- About 600 stars, flux calibrated
- Same stars at every wavelength, so more reliable st. pop. models

A first version of XSL, with spectra of ~240 stars and rough Stellar Population Models will be available soon.

Features based on our models, including in the NIR arm, will be used as stellar population diagnostics.

Thanks!

Good flux calibration is important for wide range applications



Comparison of B-V colour measured on the MILES spectra with the Lausanne photometric database (Mermilliod et al. 1997).

If we perform a good flux calibration, the some of the XSL stars can serve as secondary standards across the whole Southern sky.