

SPADES: A STELLAR PARAMETER DETERMINATION SOFTWARE

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Observatoire de Paris Meudon

Summary:

- Introduction:
  - Scientific context
  - Motivation
- Introducing SPADES:
  - General concept
  - Implemented parts and perfomances
  - Upcoming work
- Conclusion

Introduction

- Scientific Context:
  - Chemical caracterisation:
    - Metallicity and individual abundances
    - Metallicity Distribution Function and Abundance Distribution Function as a function of z
    - Correlation and kinematics
  - Study of the Thick Disk of the Milky Way
  - Study of any galaxy with resolved stars

- Motivation:
  - GCDS: about 160'000 stars
  - Gaia: 5'000'000 stars for chemical abundances
  - RAVE: 452'398 so far and about 1'100'000 expected
  - GREAT: about 1'000'000 stars
  - Gyes : 500'000
  - HERMES: about 1'000'000 stars
  - Etc…

Introduction

- Software needs:
  - Automatic
  - Fast
  - Robust
  - Applicable to different types of stars

- Existing softwares:
  - TGMET (ETOILE)
  - MATISSE
  - MyGIsFOS
  - Neural Network
  - SEGUE pipeline

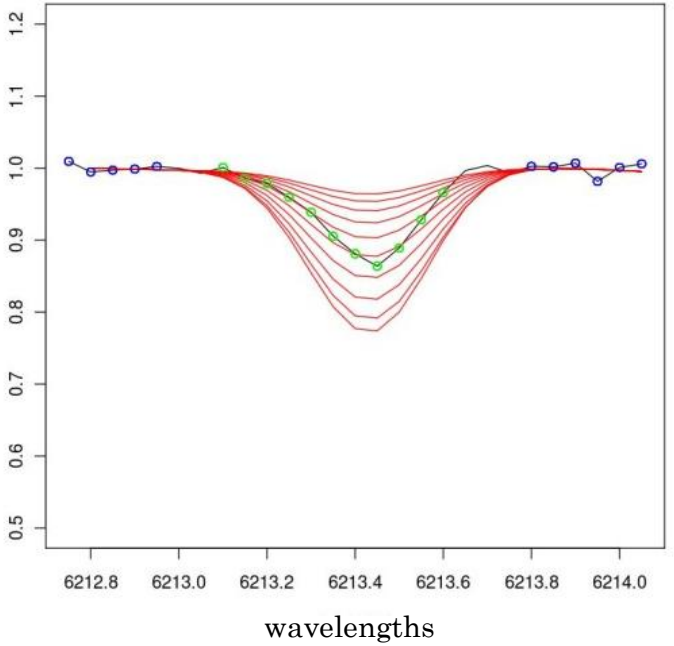
General review: “Automated stellar classification for large surveys: a review of methods and results” . Coryn A.L. Bailer-Jones (2001)

Introduction

- Actual constraints:
  - By hand analysis:
    - Too long
  - Global methods :
    - Do not allow individual abundances determinations
  - Automatic measures of equivalent widths
    - Hard to determine the continuum
      - Cold stars or/and high metallicities
    - Hard to « deblend » lines

Introducing SPADES

- Line by line analysis
- Modeled lines

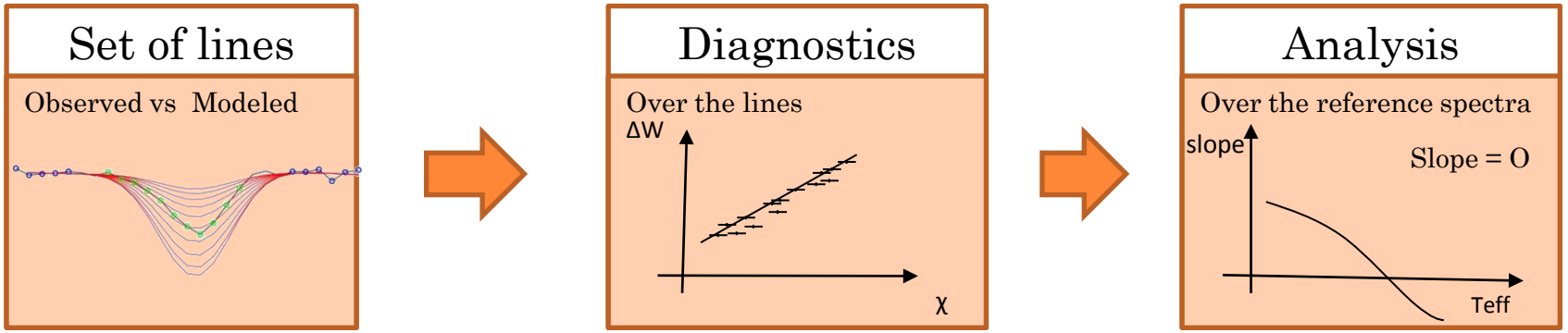


- No equivalent width measurements
- No growth curve use
- Local continuum
- If blended lines:
  - Should be in the reference spectrum too

  => Effect partially canceled out by taking the difference

Introducing SPADES

- General concept:

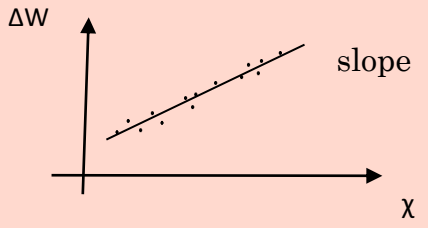
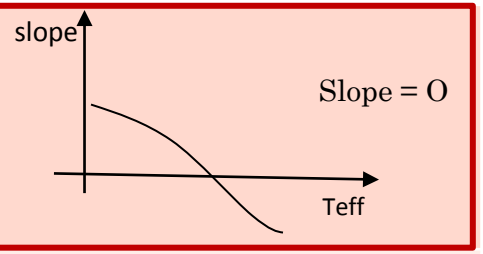
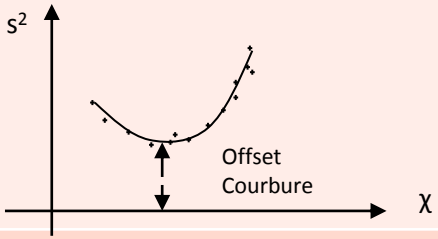
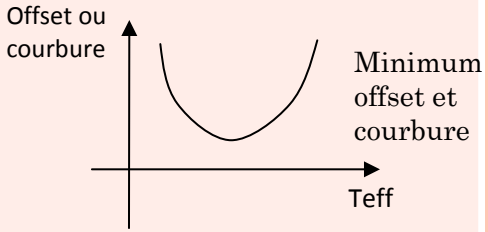
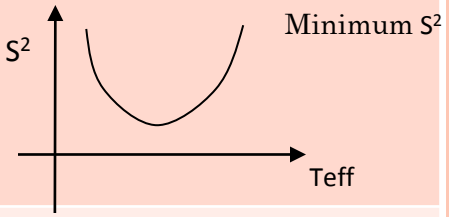
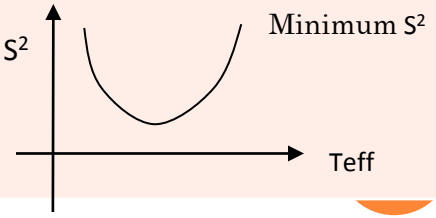


PARAMETER:
-Teff
-logg
-[Fe/H]
-[Xn/H] (tbd)
-microTurbulence (tbd)

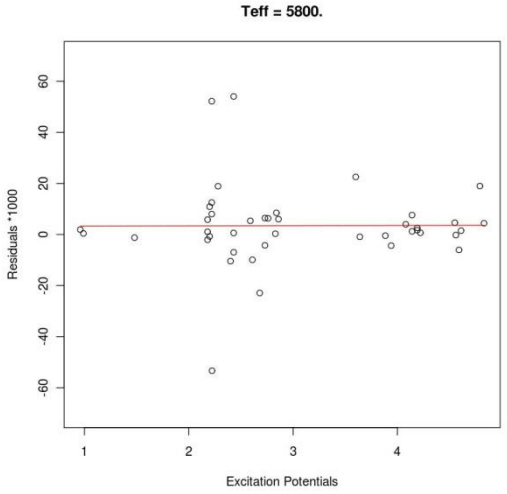
Convergence methods

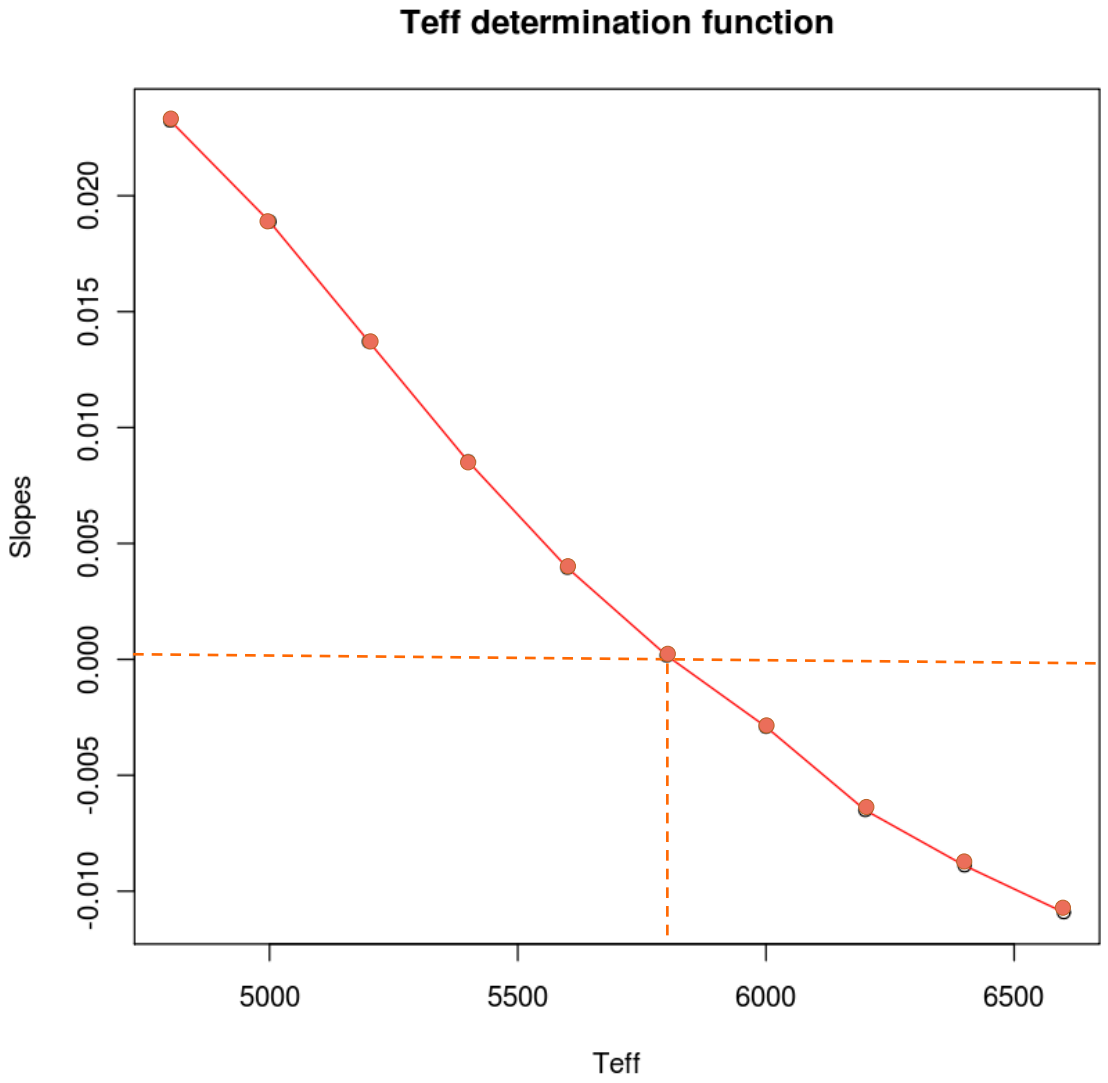
Possible approches:
-Iterative approch
-Direct approch

Teff determination

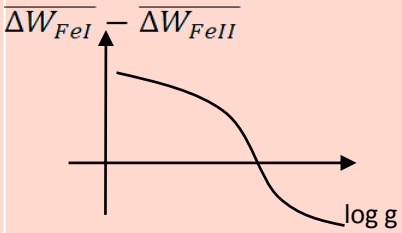
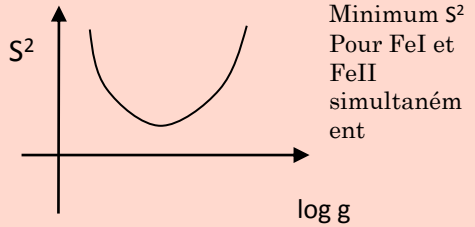
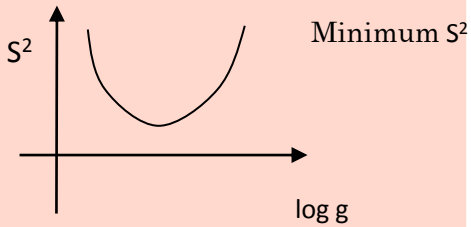
Method	Measure (by line)	Diagnostic (by spectrum)	Analysis (by grid)
Excitation equilibrium	$\Delta W = \sum_{pixels} -(x_{obs} - \tilde{x}_{ref})$		
	$s^2 = \sum_{pixels} \frac{(x_i - \tilde{x}_i)^2}{{\sigma_i}^2}$		
	$s^2 = \sum_{pixels} \frac{(x_i - \tilde{x}_i)^2}{{\sigma_i}^2}$	$S^2 = \sum_{raies} \sum_{pixels} \frac{(x_i - \tilde{x}_i)^2}{{\sigma_i}^2}$	
Hα and/or Hβ	$s^2 = \sum_{pixels} \frac{(x_i - \tilde{x}_i)^2}{{\sigma_i}^2}$	$S^2 = \sum_{raies} \sum_{pixels} \frac{(x_i - \tilde{x}_i)^2}{{\sigma_i}^2}$ $s^2 = S^2$ si 1 raie	

Teff determination example:

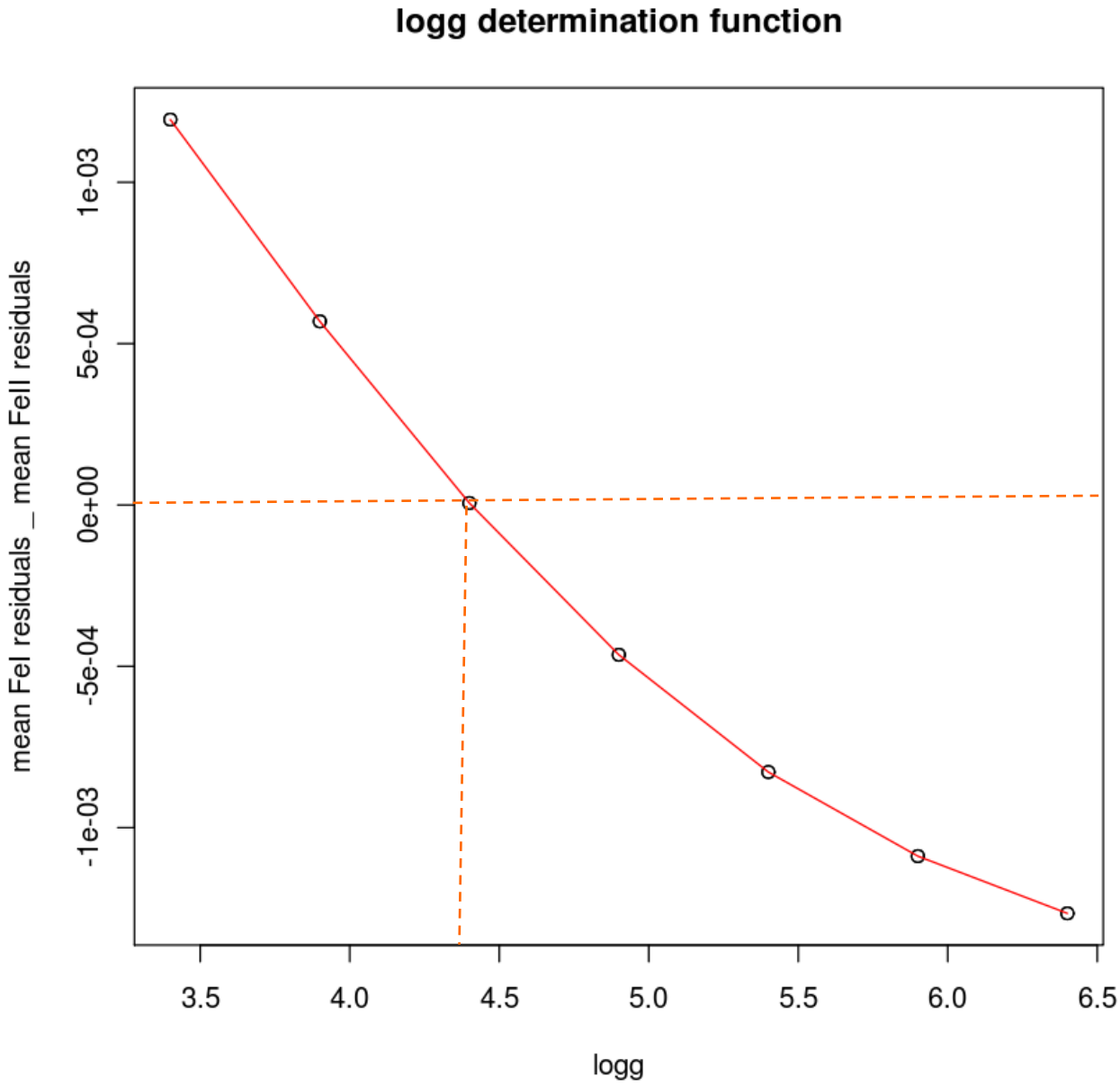




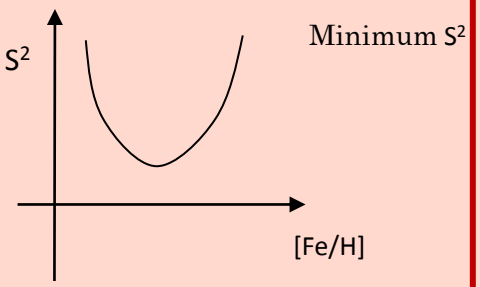
log g determination:

Method	Measure (by line)	Diagnostic (by spectrum)	Analysis (by grid)
Ionisation equilibrium	$\Delta W_{FeI} = \sum_{pixels} -(x_{obs} - \tilde{x}_{ref})$ $\Delta W_{FeII} = \sum_{pixels} -(x_{obs} - \tilde{x}_{ref})$	$\overline{\Delta W_{FeI}} - \overline{\Delta W_{FeII}}$	
	$s^2{}_{FeI} = \sum_{pixels} \frac{(x_i - \tilde{x}_i)^2}{\sigma_i{}^2}$	$S^2{}_{FeI} = \sum_{raies} \sum_{pixels} \frac{(x_i - \tilde{x}_i)^2}{\sigma_i{}^2}$	
	$s^2{}_{FeII} = \sum_{pixels} \frac{(x_i - \tilde{x}_i)^2}{\sigma_i{}^2}$	$S^2{}_{FeII} = \sum_{raies} \sum_{pixels} \frac{(x_i - \tilde{x}_i)^2}{\sigma_i{}^2}$	
Strong lines	$s^2 = \sum_{pixels} \frac{(x_i - \tilde{x}_i)^2}{\sigma_i{}^2}$	$S^2 = \sum_{raies} \sum_{pixels} \frac{(x_i - \tilde{x}_i)^2}{\sigma_i{}^2}$ Strong lines	

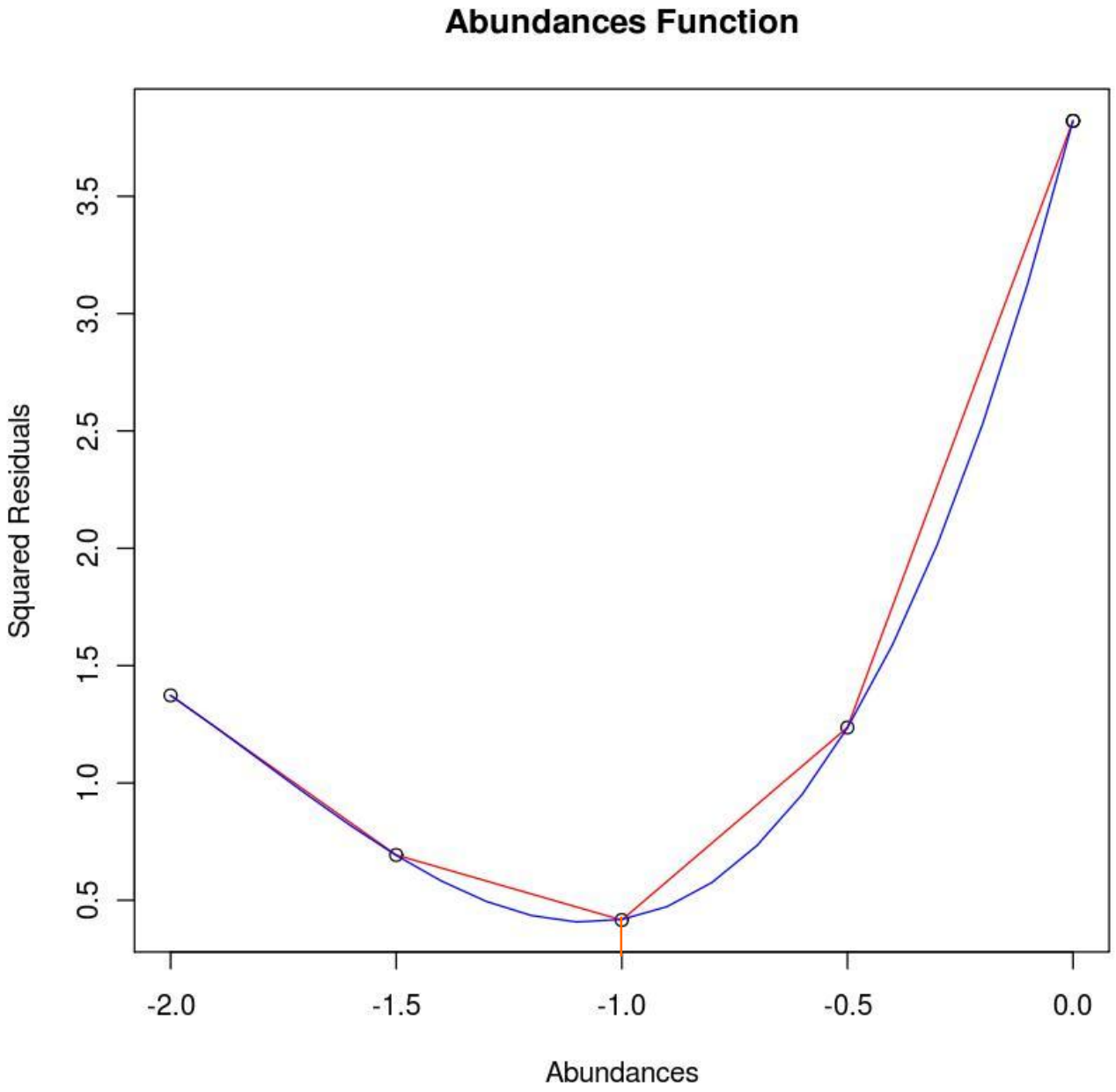
logg determination example:



[Fe/H] determination (same for [Xn/H])

Method	Measure (by line)	Diagnostic (by spectrum)	Analysis (by grid)
Profil adjustment	$s^2 = \sum_{pixels} \frac{(x_i - \tilde{x}_i)^2}{{\sigma_i}^2}$	$S^2 = \sum_{raies} \sum_{pixels} \frac{(x_i - \tilde{x}_i)^2}{{\sigma_i}^2}$ Fe lines	

[Fe/H] determination example:



Smaller step needed

Introducing SPADES

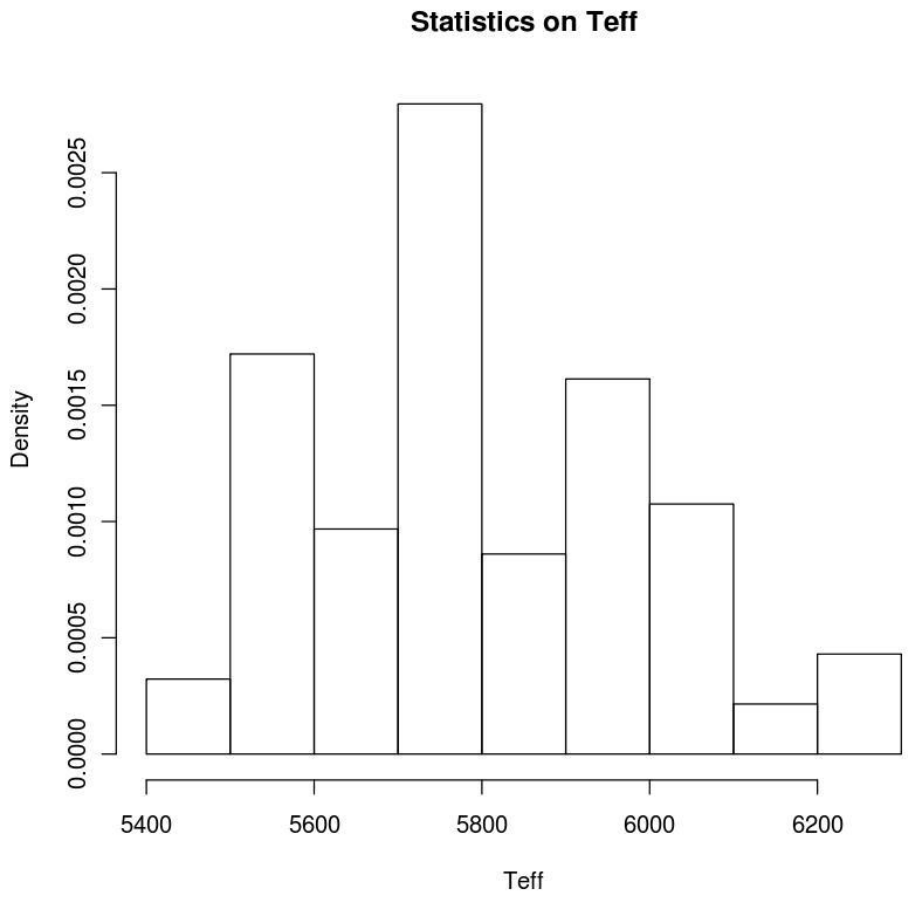
- Test perfomances:

Analysed spectrum	Reference spectra grid
-Kurucz -R = 20 000 -spectral domain: [6000 ,6789.9] A -SNR = 100 / pixel -Teff = 5800 K -logg = 4.4 -[Fe/H] = -1.0 dex -χ = 1 km/s (fixed)	-Kurucz (Atlas 9) -R = 600 000 -spectral domain: [6000 ,6789.9] A -Teff = [4200, 6600], step = 200; -logg = [3.4 , 6.4] , step = 0.5; -[Fe/H] = [-2.0 , 0.0] , step = 0.5; -χ = 1 km/s (fixed)

Bensby FeI and FeII line list

Introducing SPADES

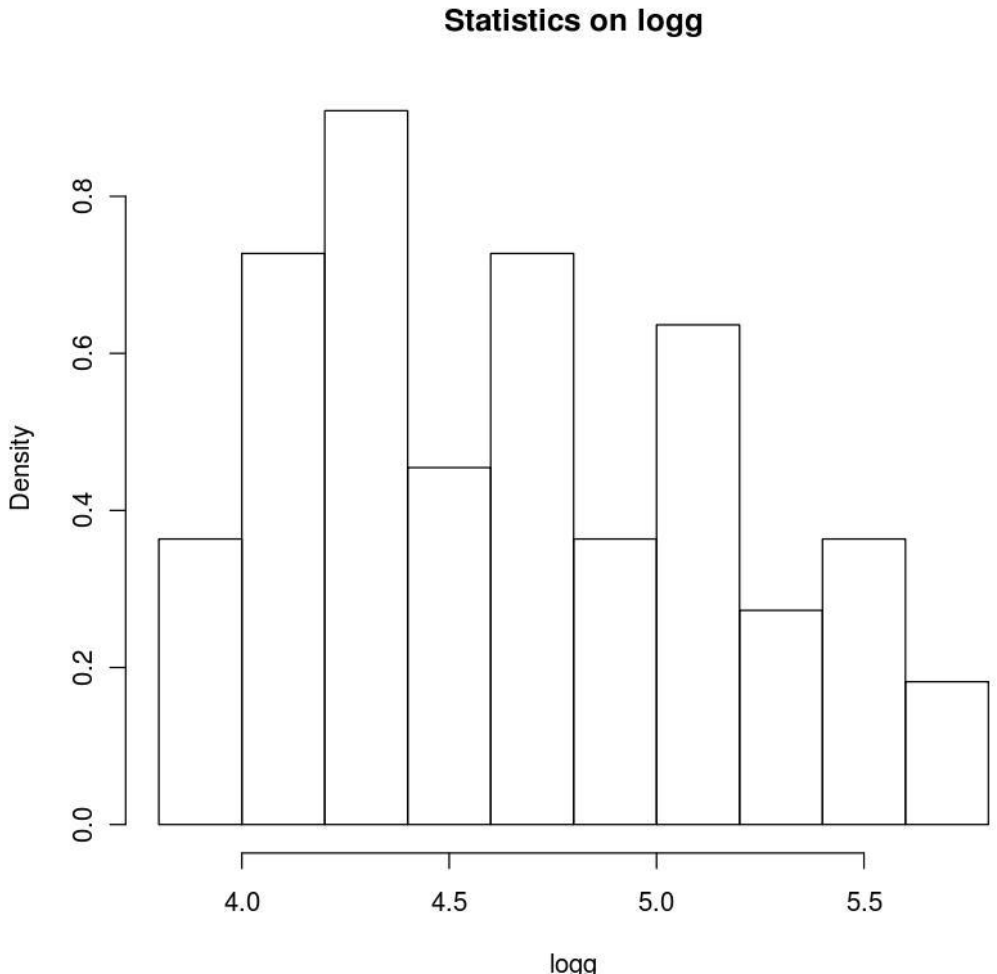
- Test perfomances:
  - Teff:



Expected Value = 5800 K
Mean = 5797.453
Median = 5772.165
Stdv = 198.58.

Introducing SPADES

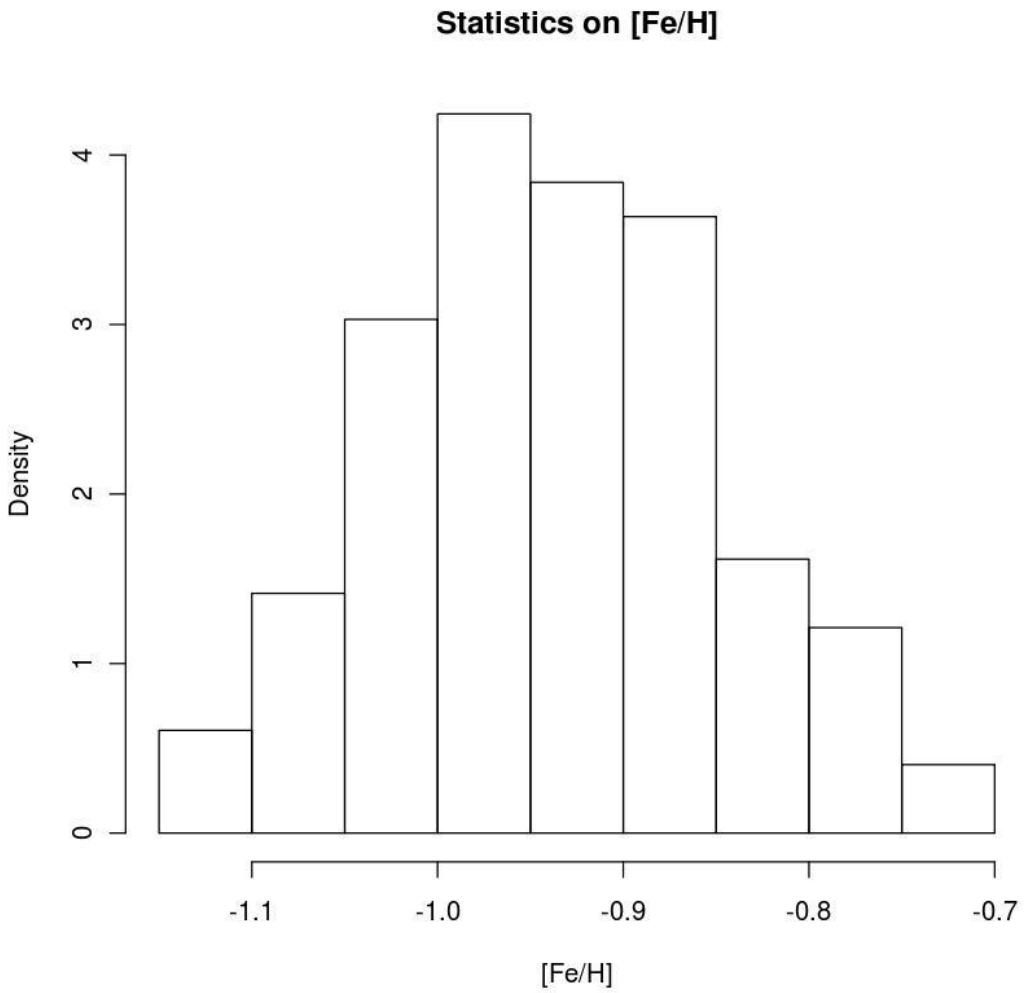
- Test perfomances:
  - Logg:



Expected Value = 4.40
mean = 4.6502
median = 4.618
stdv = 0.508

Introducing SPADES

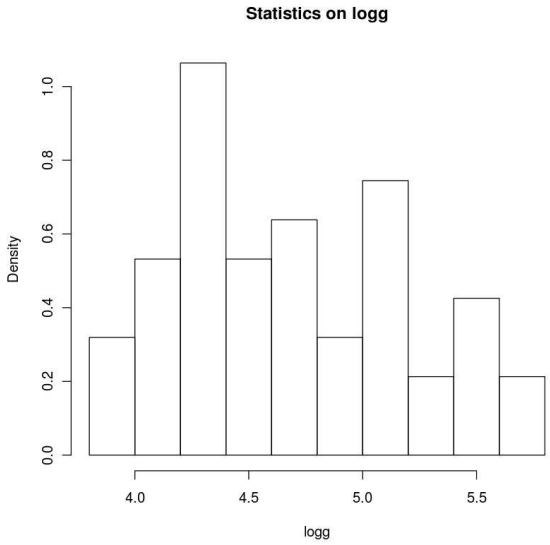
- Test perfomances:
  - [Fe/H]:

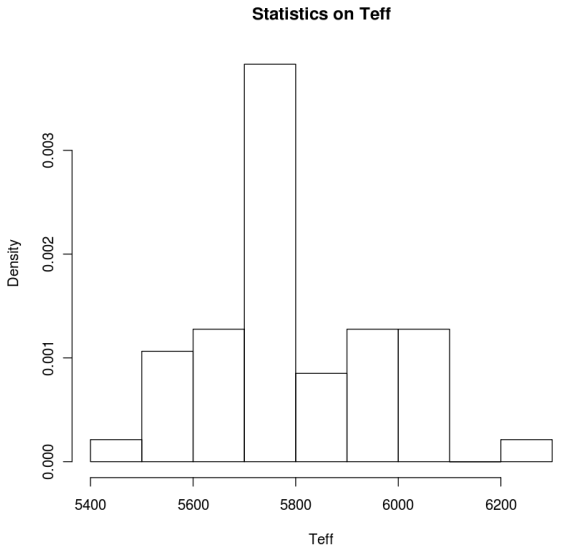


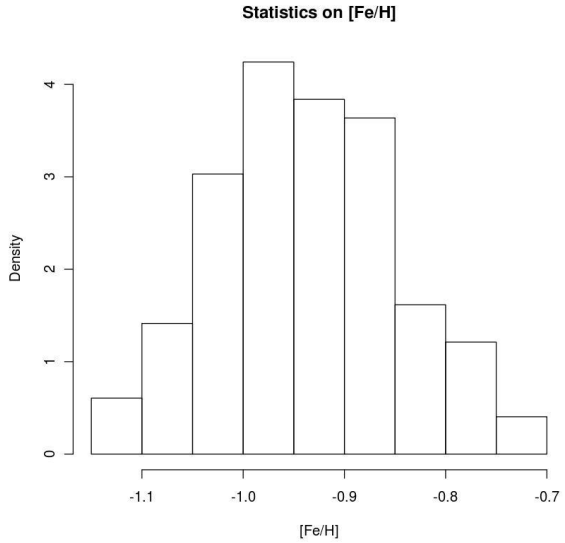
Expected Value = -1.0 dex
Mean = -0.931
Median = -0.932
Stdv = 0.1004

Introducing SPADES

- Test perfomances:
  - Test convergence (iterative):







Teff : 5789.981 ± 170.1857
Logg : 4.678155 ± 0.5168516
Fe/H : -0.921311 ± 0.1200866

Upcoming work

- First tests 5 days old
- Ameliorations
  - Larger grid with smaller « steps »
  - Line list / diagnostics
  - Continuum determination
- Convergence methods
  - Direct
  - Iterative
- Formal error calculations
- On the fly synthetic spectra calculation
  - Crucial for the individual abundances determinations
- Implementing new diagnostics

Conclusion

- Large spectra surveys
- Need for automatic stellar parameter determination softwares
- SPADES:
  - Automatic
  - Line to line analysis
  - Modeled reference grids
  - Robust
  - Adaptable
    - Can add diagnostics when needed
    - To different start types
- Still work to be done
- To be used on Giraffe spectra for chemical characterisation of the Thick Disk of the MW.

THANK YOU