MOPED for Stellar Atmosphere Parameters from Spectra

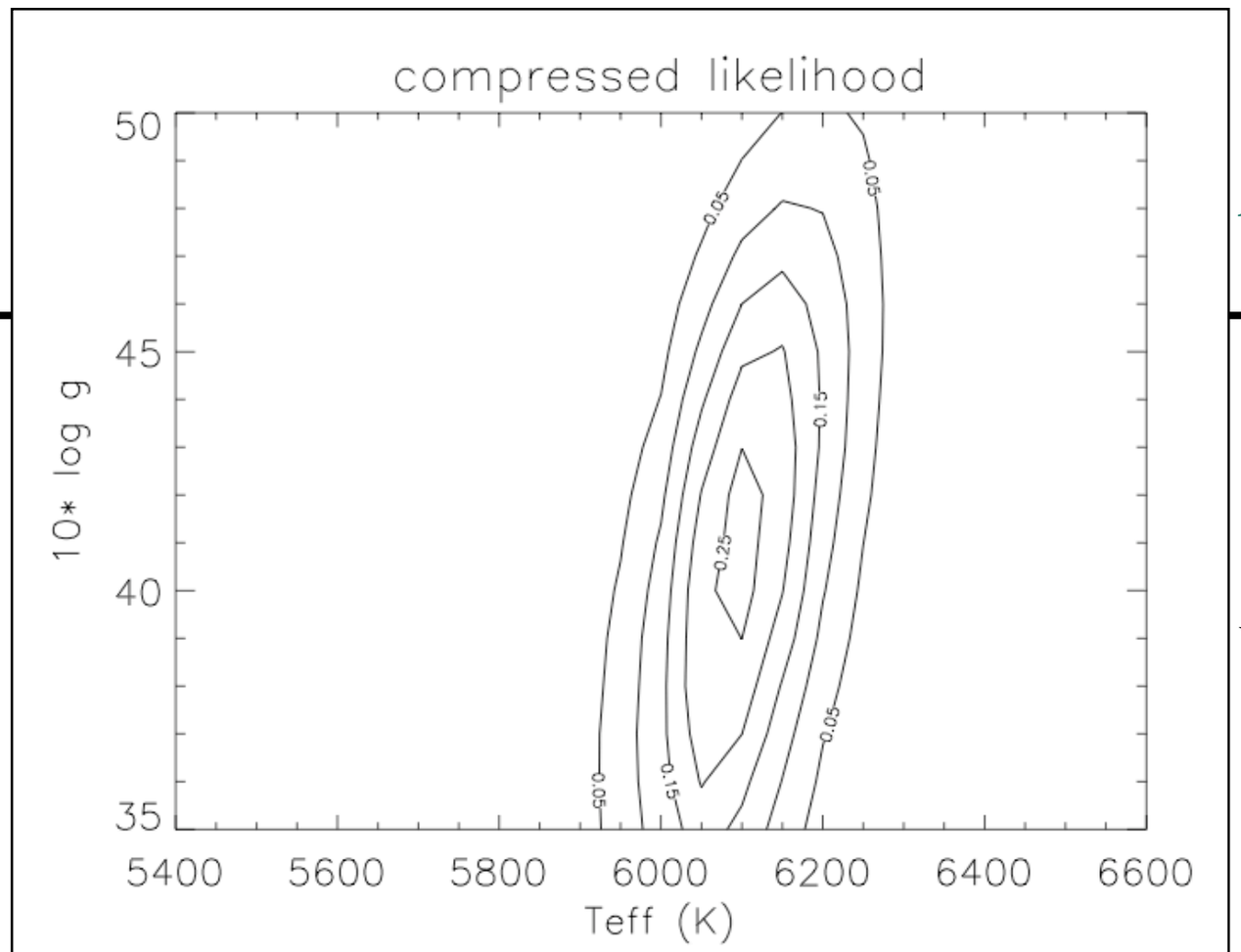
Paula Jofre Pfeil (Max Planck Institute for Astrophysics)
Achim Weiss (MPA)
Ben Panter (Royal Observatory Edinburgh)

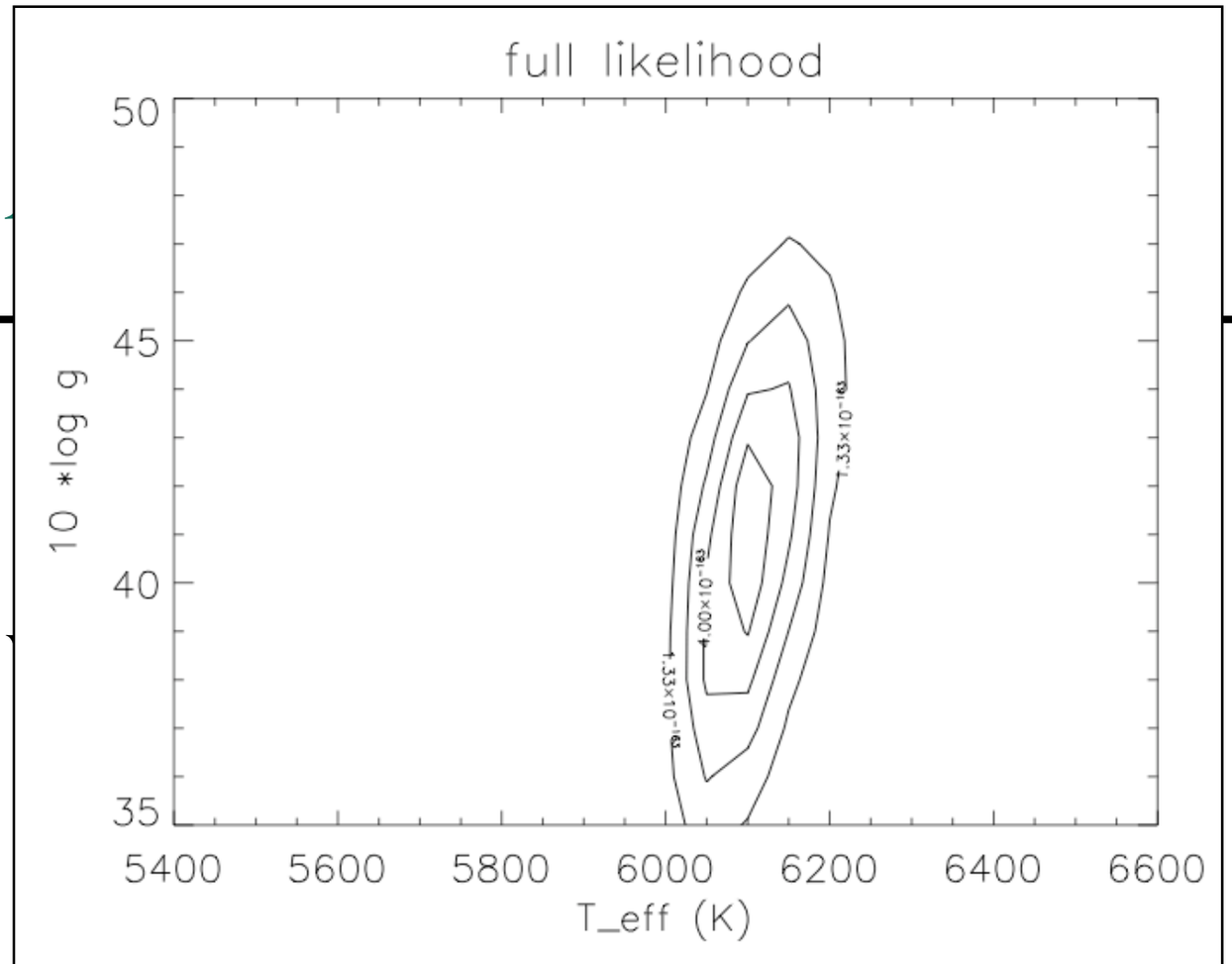
Motivation for MOPED

- For PhD: metallicities of the halo stars from the Milky Way
- One standard method: finding in a grid of synthetic spectra the model that fits the best to a given observed spectrum by looking χ^2 likelihoods.
  - Disadvantage: If grid of models or data sample are too large, the method becomes slow
  - MOPED: lossless information compression algorithm that enables extremely rapid parameter estimation from a large data set.
    - It works for analysis of galaxy spectra (Ben Panter) and therefore should work also for analysis of stellar spectra.

MOPED Algorithm

- Compression scheme that looks at areas where are particularly sensitive to a given parameter:
  - Definition: $b_\alpha = \frac{\partial F}{\partial \theta_\alpha}$
  - Compression: $y_\alpha = b_\alpha * X$
  - Goodness of fit: $\chi^2_{compressed} \sim \frac{1}{mean(\sigma^2)} \sum_{\alpha}^{N_{par}} (y_{\alpha,d} - y_{\alpha,m})^2$
  - Classical: $\chi^2_{reduced} \sim \frac{1}{DoF} \sum_{i}^{N_{bits}} \frac{(X_{i,m} - X_{i,d})^2}{\sigma^2}$





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Our Analysis

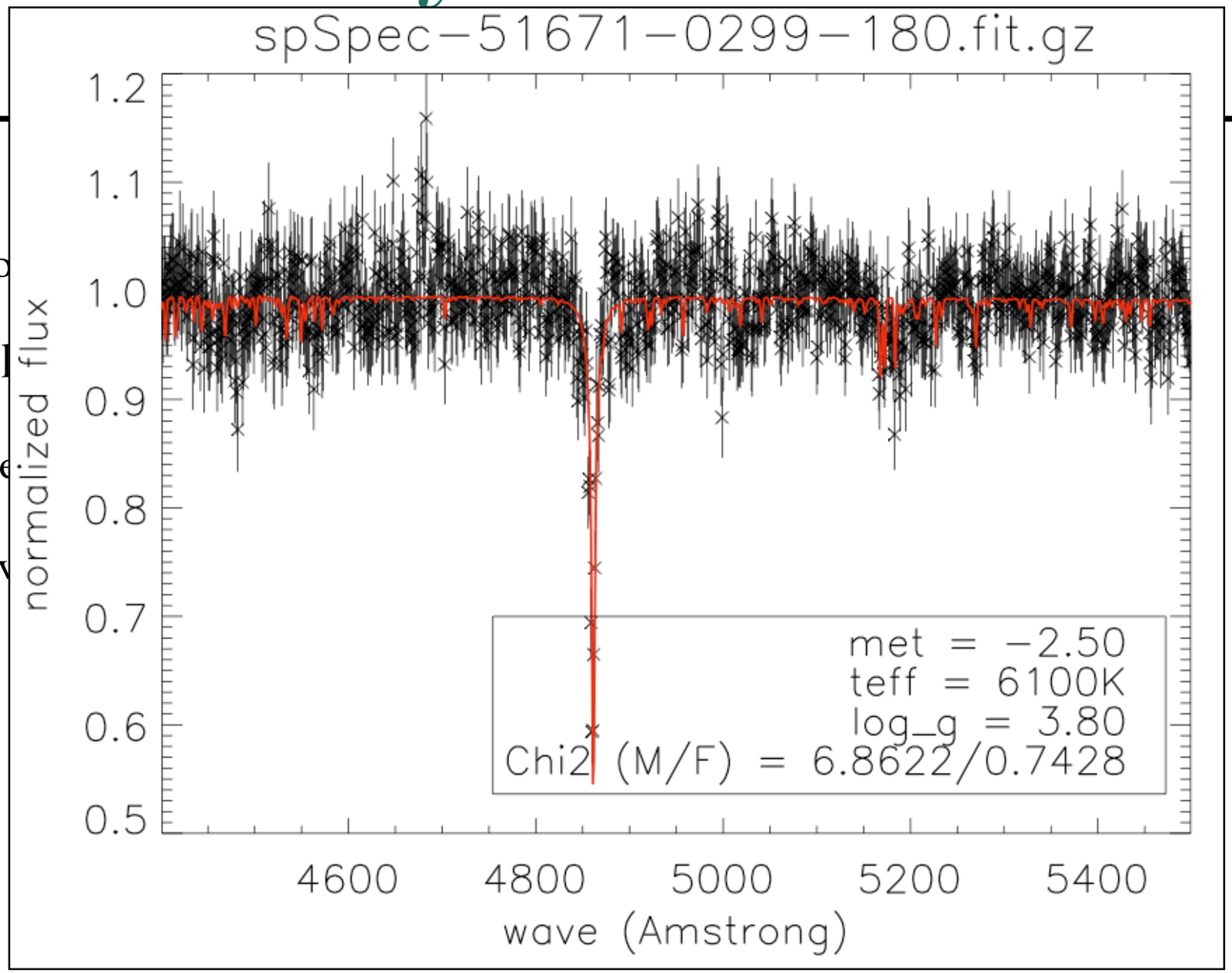
- Use MOPED for estimate metallicity, effective temperature and gravity (log g) of stellar spectra from SDSS (R ~ 2000)
- Grid of models using:
  - stellar atmosphere models from Castelli and Kurucz
  - synthetic spectra code SPECTRUM from Gray
- 123648 elements with:
  - [Fe/H] from -0.5 to -2.5 in steps of 0.1 dex
  - T eff from 5500 to 6500 K in steps of 50 K
  - Log g from 3.5 to 5 in steps of 0.1 dex

Our Analysis

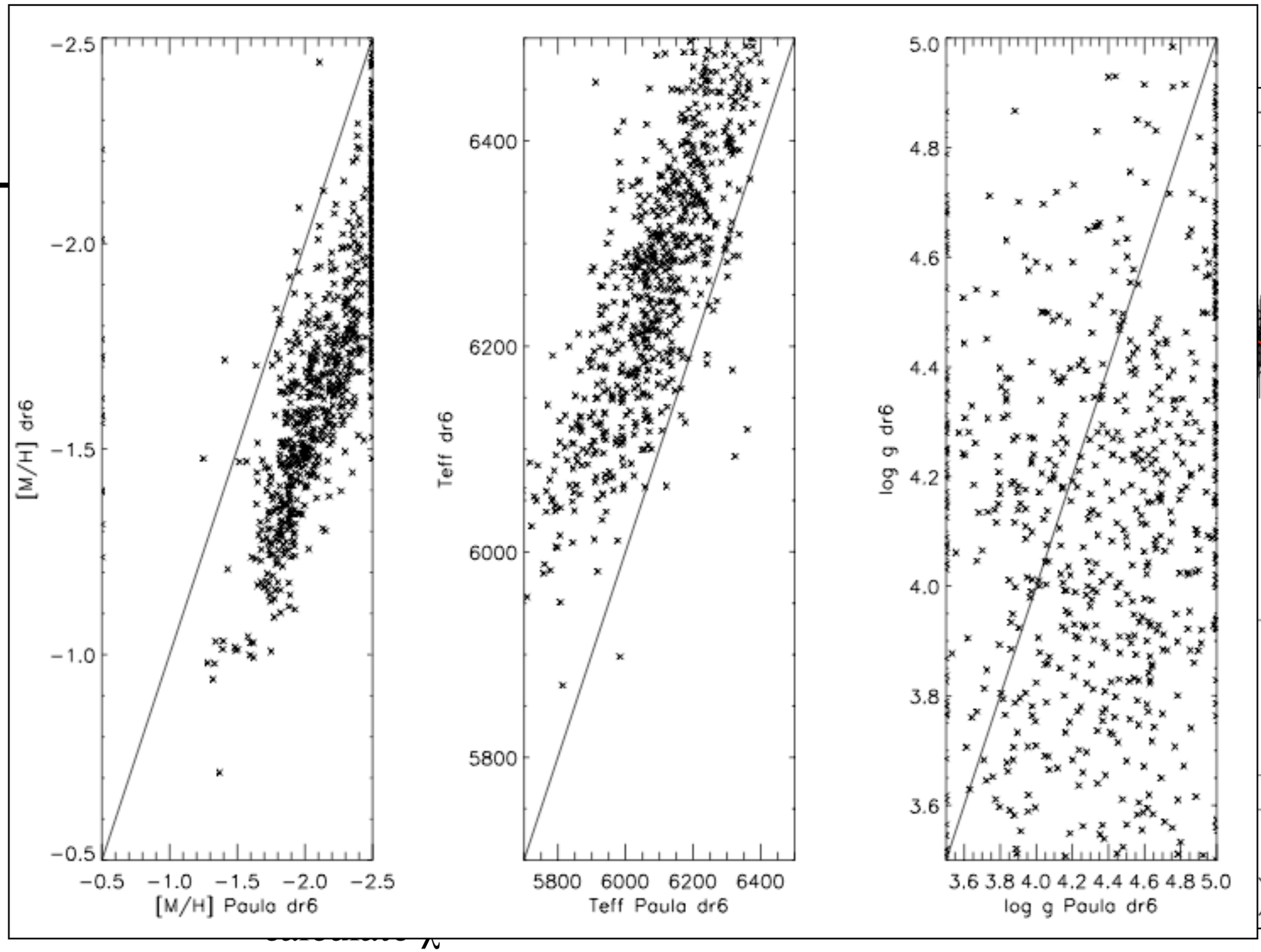
- Corrections:
  - smooth model to SDSS resolution
  - normalize model and data to 1.0
  - interpolate model and data to the same wavelength
  - correct data by velocity
  - select for model and data range of analysis
- Steps:
  - calculate b vectors and y grid
  - calculate y numbers for data and χ^2
  - search minimum

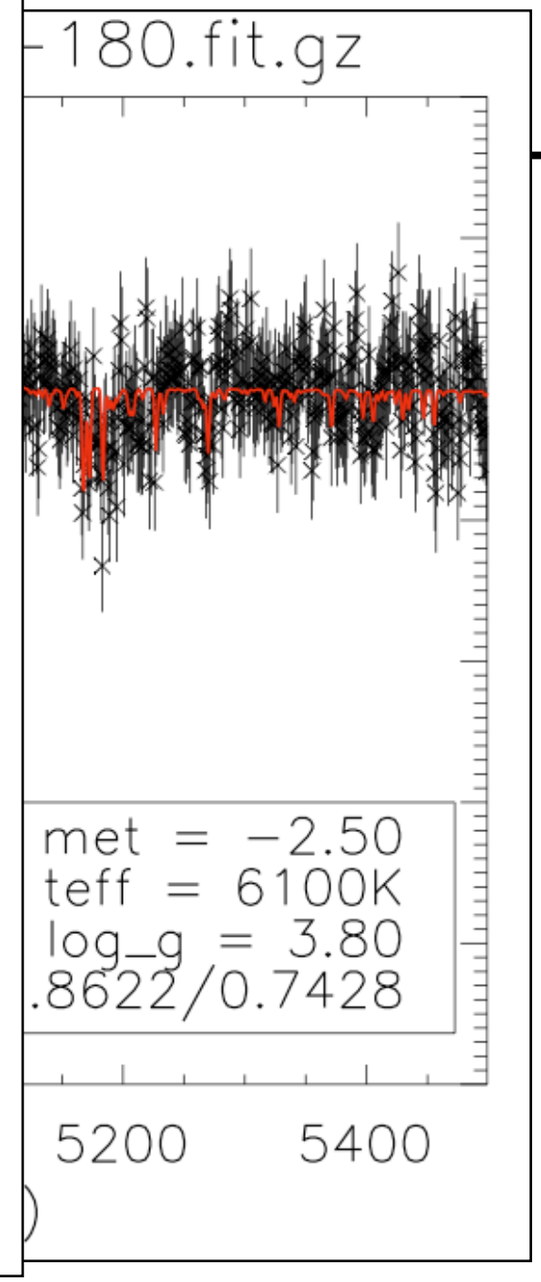
Our Analysis

- Corrections:
  - smooth model to
  - normalize model
  - interpolate mode
  - correct data by v
  - select for model
- Steps:
  - calculate y grid
  - calculate χ^2
  - search minimum



→ ~ 0,4 seconds





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Future Work

- calculate errors (in prep)
- create definitive grid (broader in metallicity, include α-enhanced elements as parameter)
- test MOPED with high resolution spectra and run it in SDSS/SEGUE (in prep)
- re-write moped independent of: model, data, wavelength range, parameter

MOPED for Stars in VO?

- a VO user could know one parameter of a given star
- a VO user could know many parameters of a sample of stars
- a VO user could use our grid of models/data sample to make his own analysis and then compare with our results
- a VO user could use the MOPED tool in order to analyze his own data sample with his own grid of models.
- would it be possible to add this tool into VO?