Atmospheric parameters from equivalent widths

- Microturbulence velocity (Vmic)

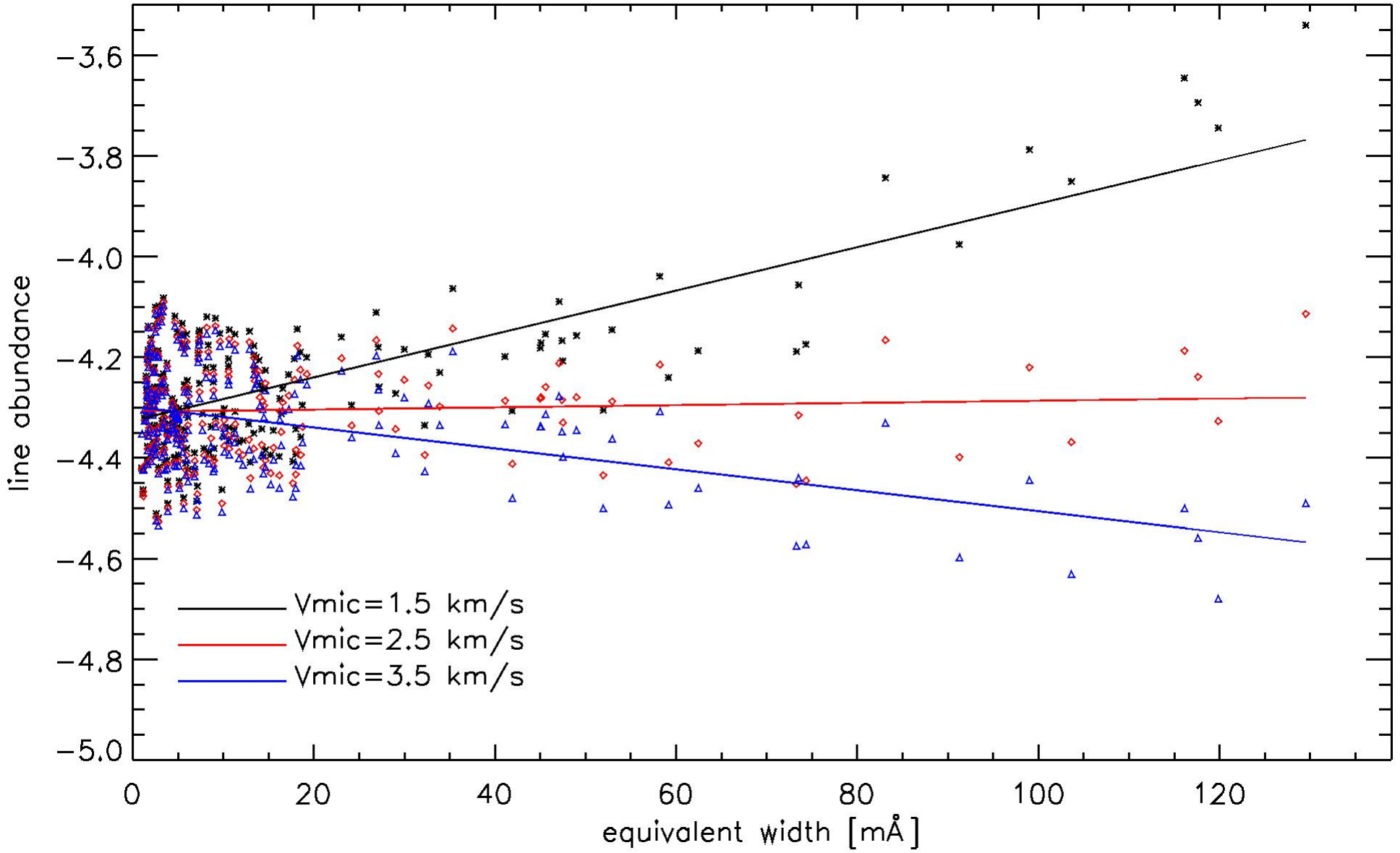
  Correlation between line abundance and equivalent width
- Effective temperature (Teff) - excitation balance

  Correlation between line abundance and line excitation energy (lower level)
- Surface gravity (logg) - ionisation balance

  Balance between abundances of different ions of the same element

This looks like old and superseded stuff, but it is how one understands what even the most sophisticated fitting machine actually does.

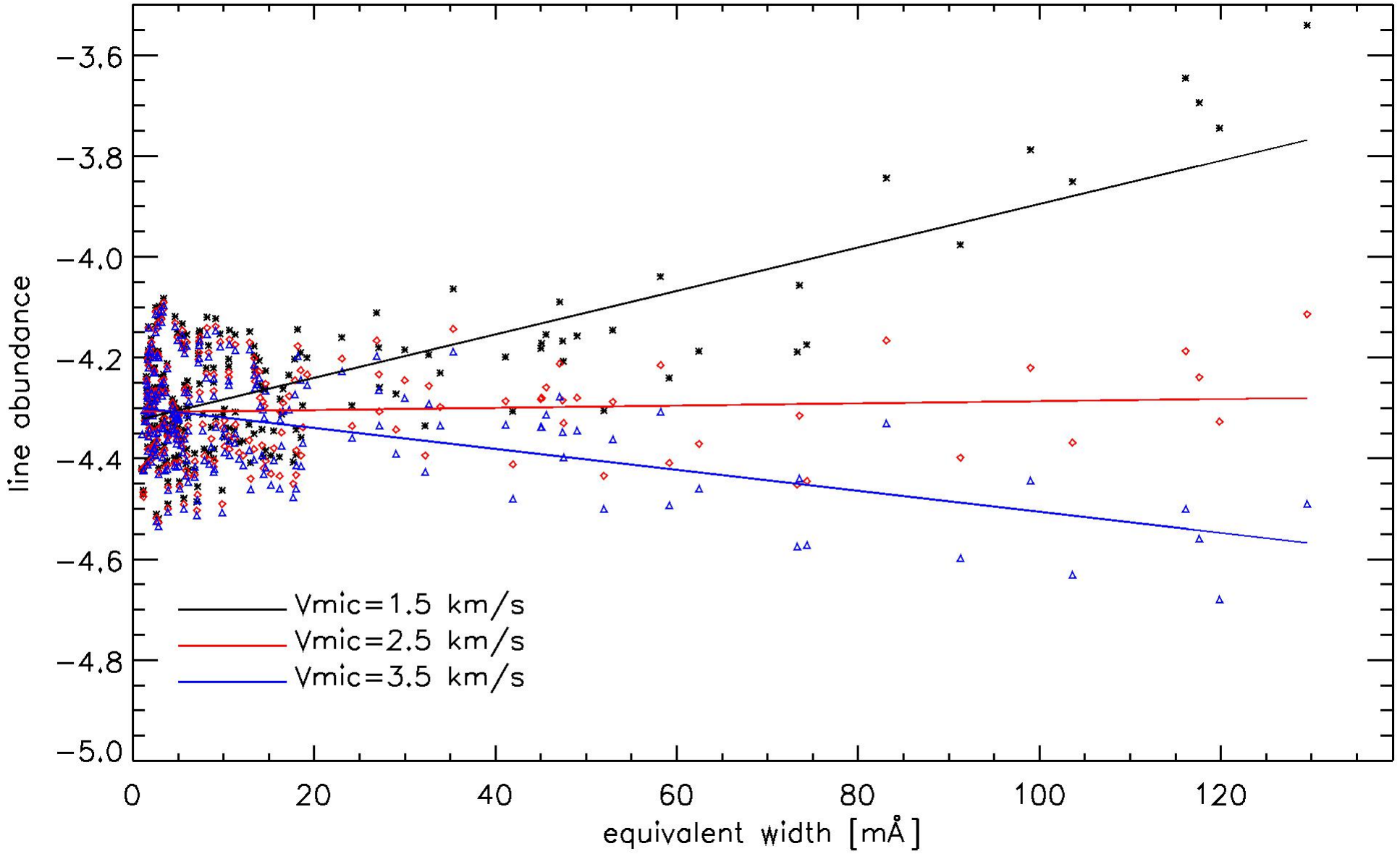
Microturbulence velocity



- The slope changes as a function of Vmic
- All lines belong to the same element/ion and thus need to give the same abundance
- Vmic is determined when the slope is 0

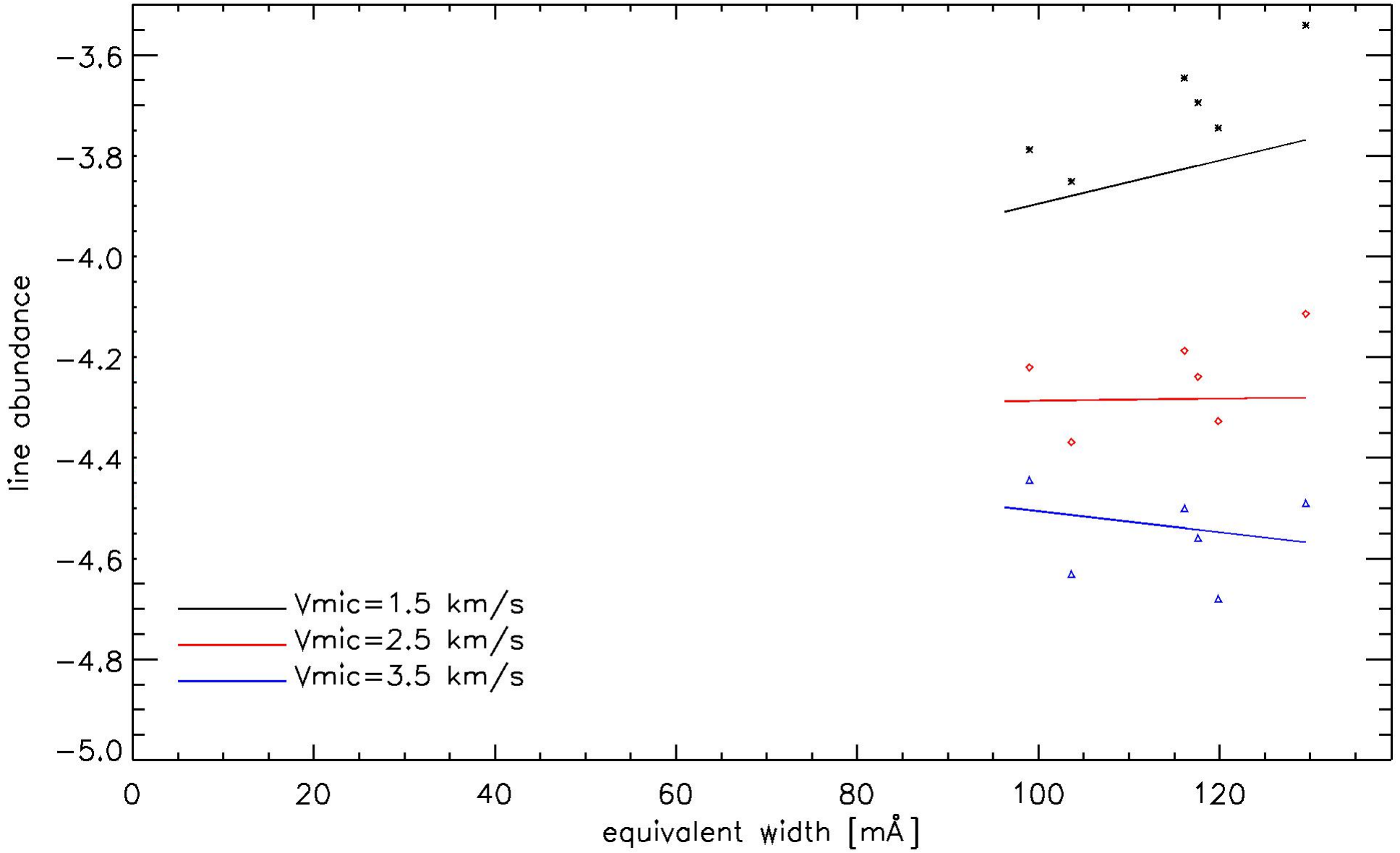
- At the end, whatever automatic fitting tool emplying synthetic spectra will determine Vmic in this way

Microturbulence velocity



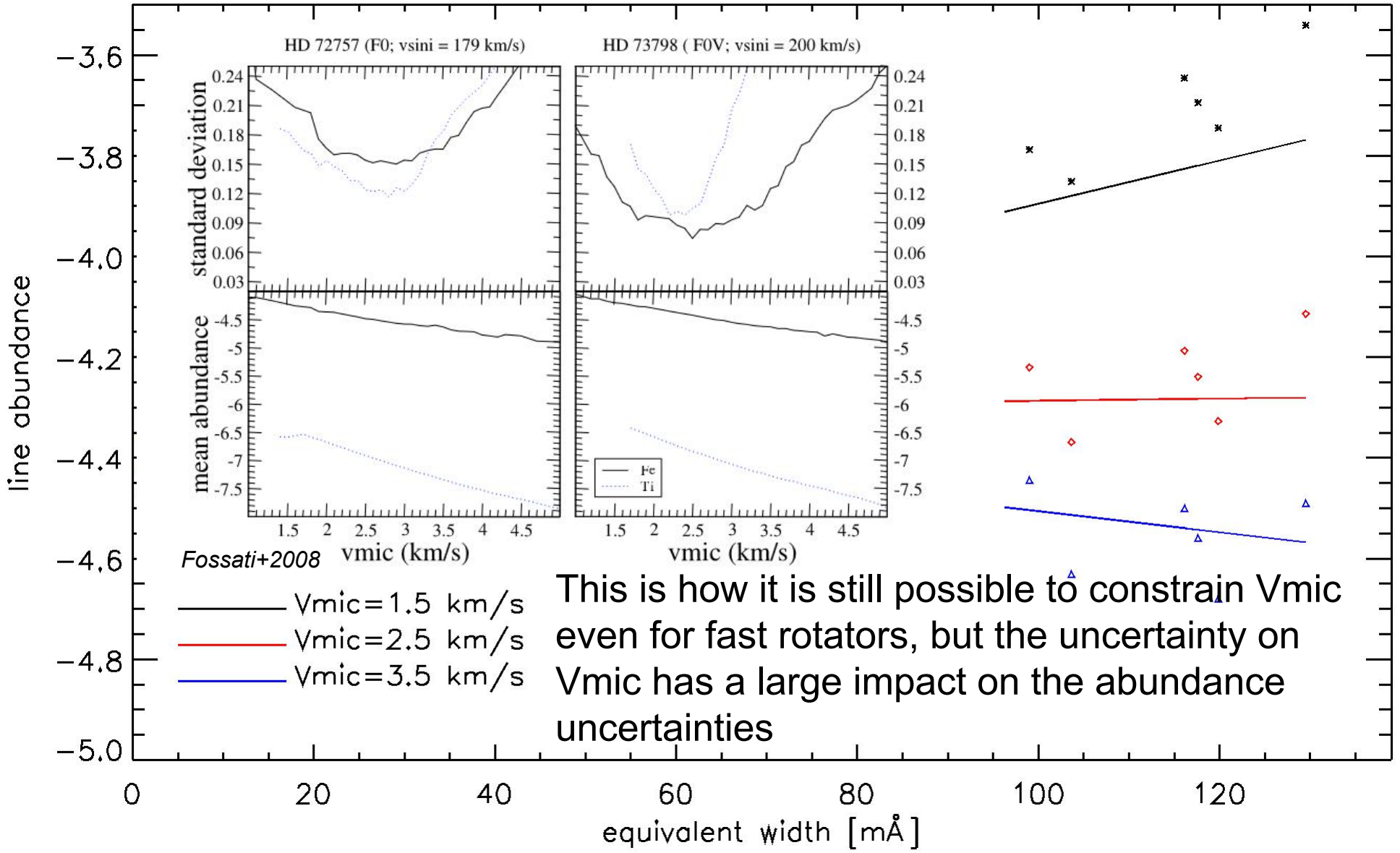
- Weak lines are insensitive to Vmic variations
- The sensitivity to Vmic increases with increasing line strength

Microturbulence velocity



- Weak lines are insensitive to Vmic variations
- The sensitivity to Vmic increases with increasing line strength
- This is a problem when determining Vmic for fast rotators, because the only measurable lines are the strong ones, leading to a strong dependance between Vmic and abundance

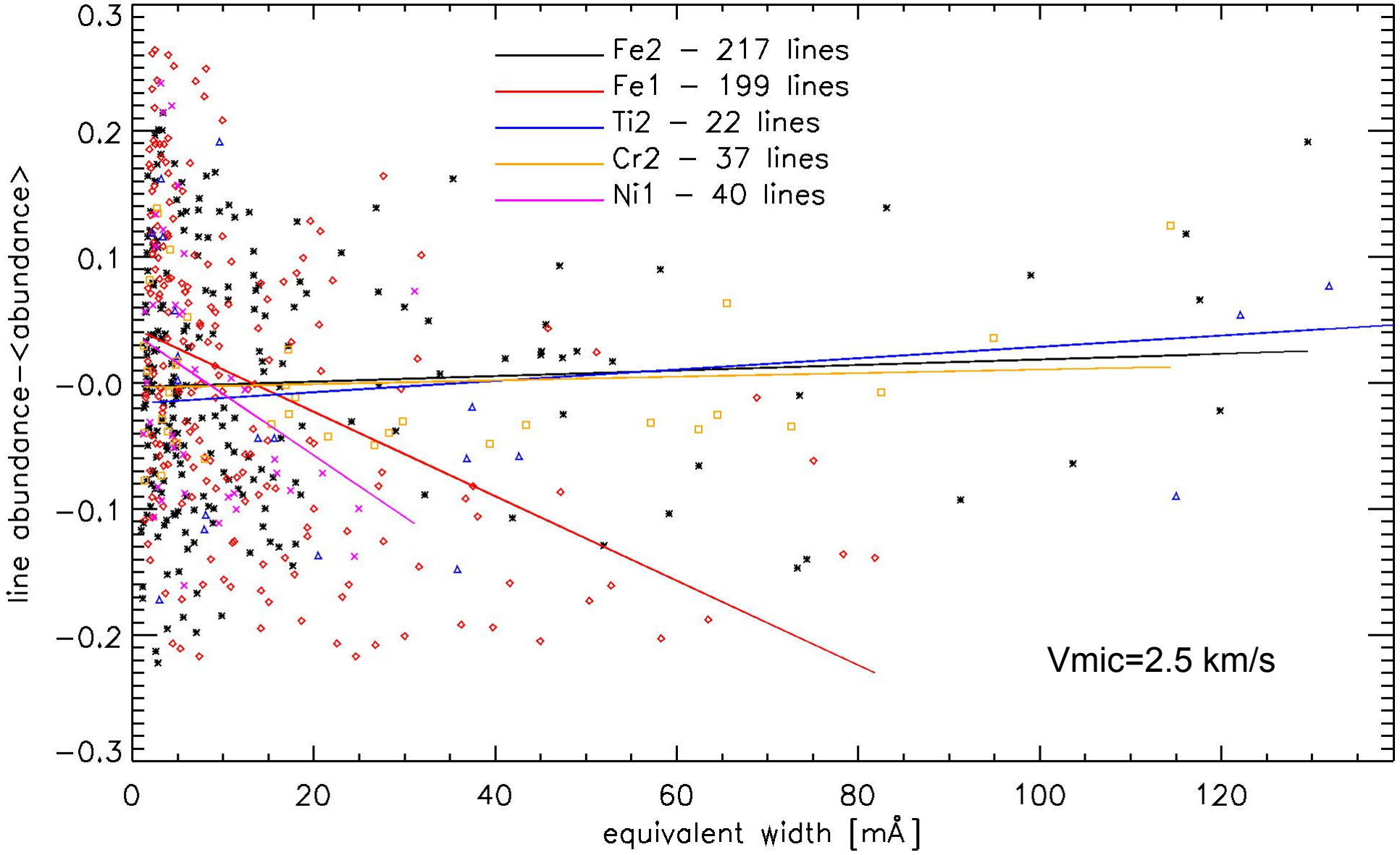
Microturbulence velocity



This is how it is still possible to constrain Vmic even for fast rotators, but the uncertainty on Vmic has a large impact on the abundance uncertainties

- Weak lines are insensitive to Vmic variations
- The sensitivity to Vmic increases with increasing line strength
- This is a problem when determining Vmic for fast rotators, because the only measurable lines are the strong ones, leading to a strong dependance between Vmic and abundance

Microturbulence velocity



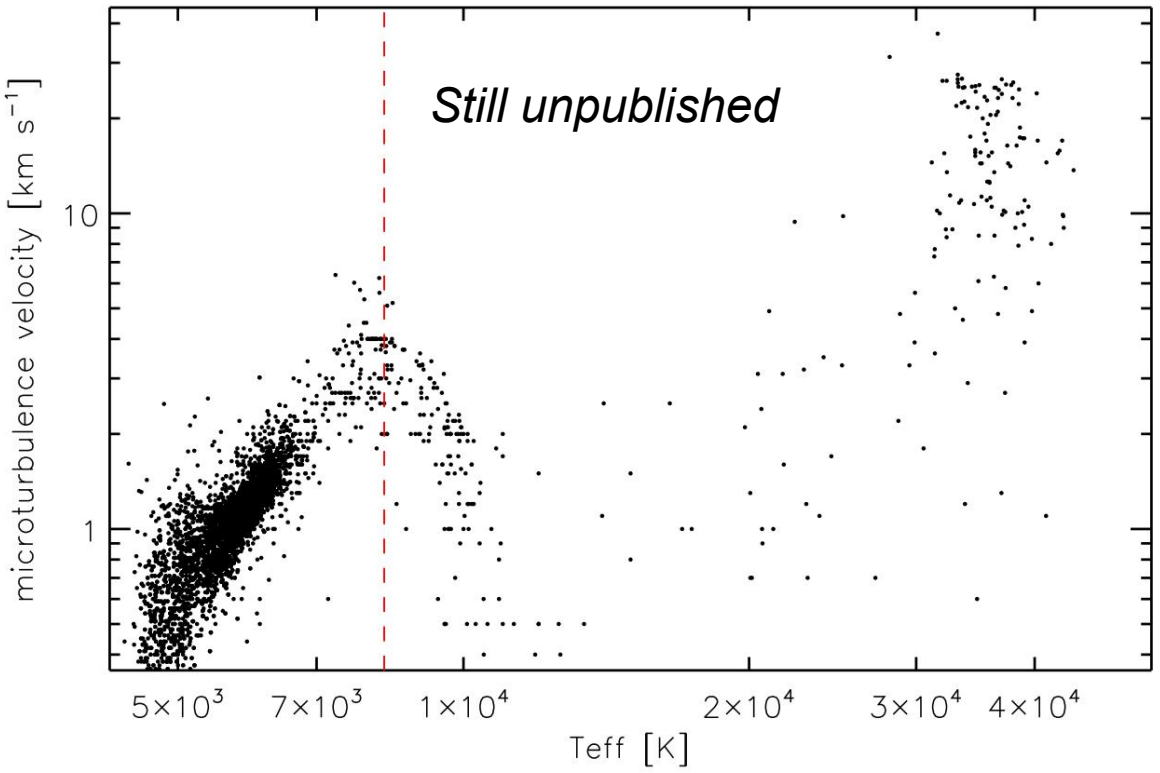
- Different ions give different answers

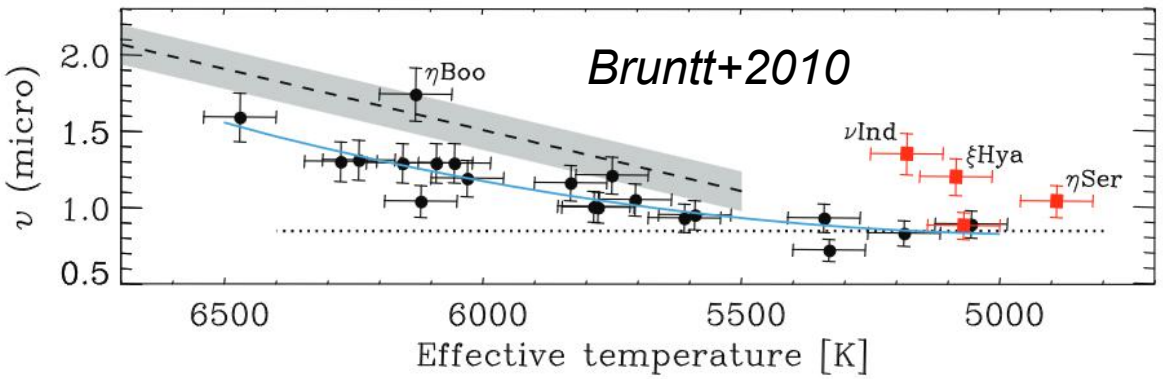
How to choose Vmic? Consider the ion(s) with

- the larger number of lines?
- the largest spread in equivalent width?
- use e.g. the number of lines as weight?

These are all viable solutions and whatever fitting algorithm will automatically follow some mix of them, depending on the spectral range.

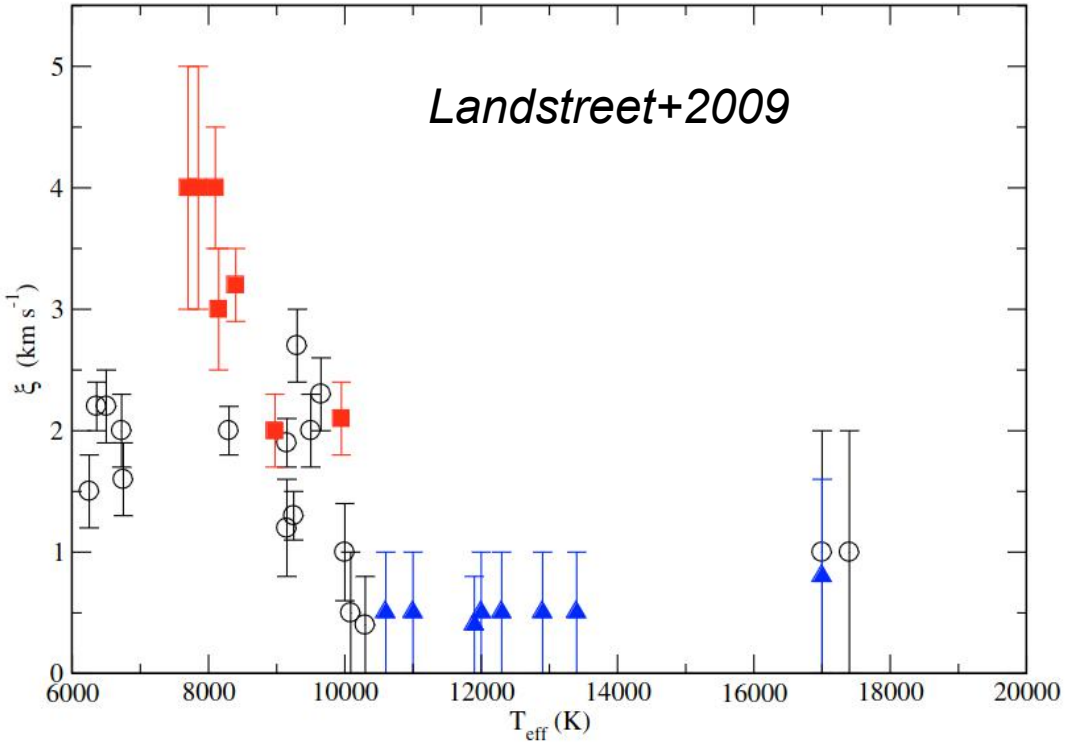
Microturbulence velocity



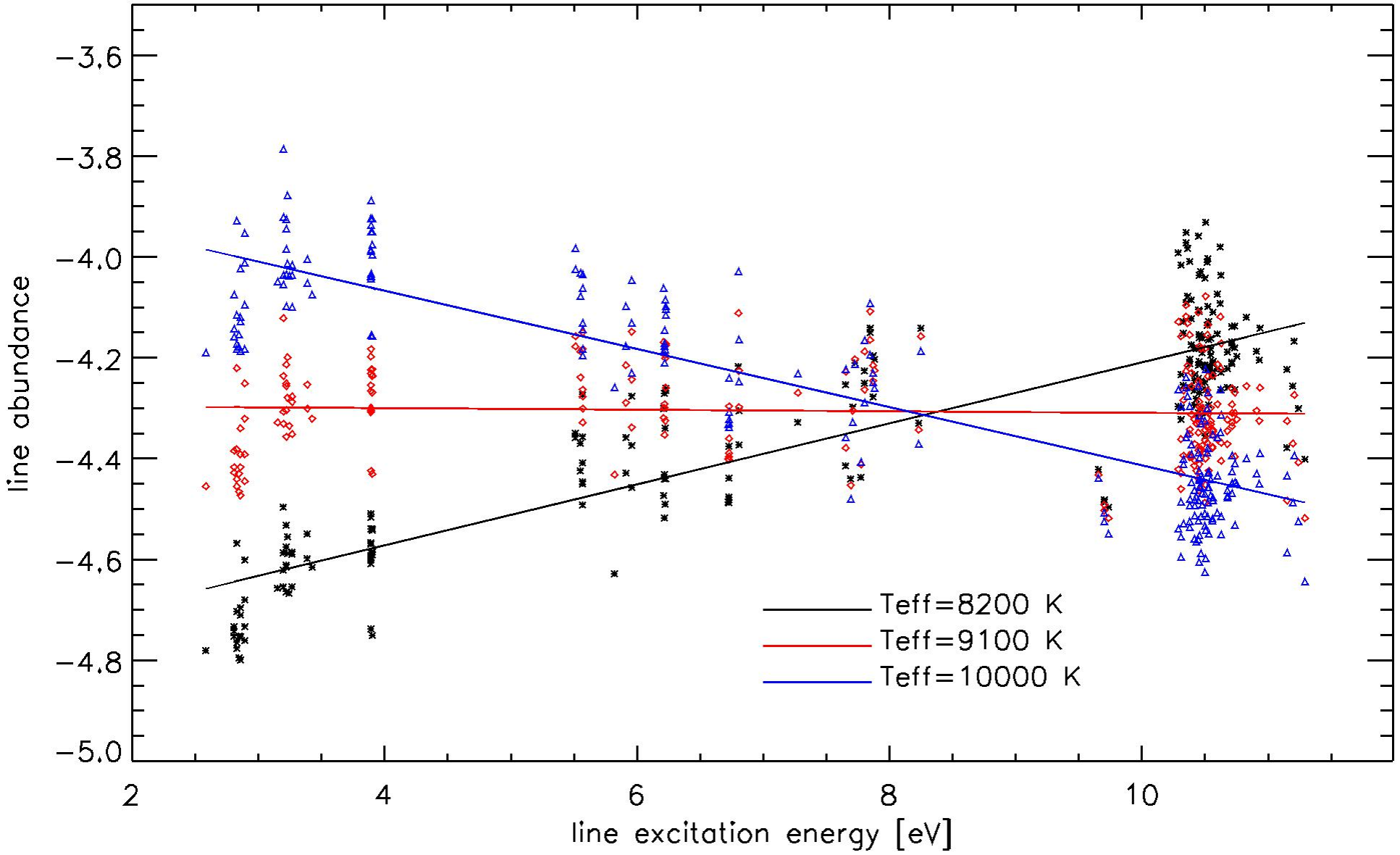


There are also calibrations with Teff and logg that one can use, particularly for stars below 7000 K. E.g.:

- Edvardsson+1993
- Valenti & Fisher 2005 - Vmic = 0.85 km/s
- Bruntt+2010



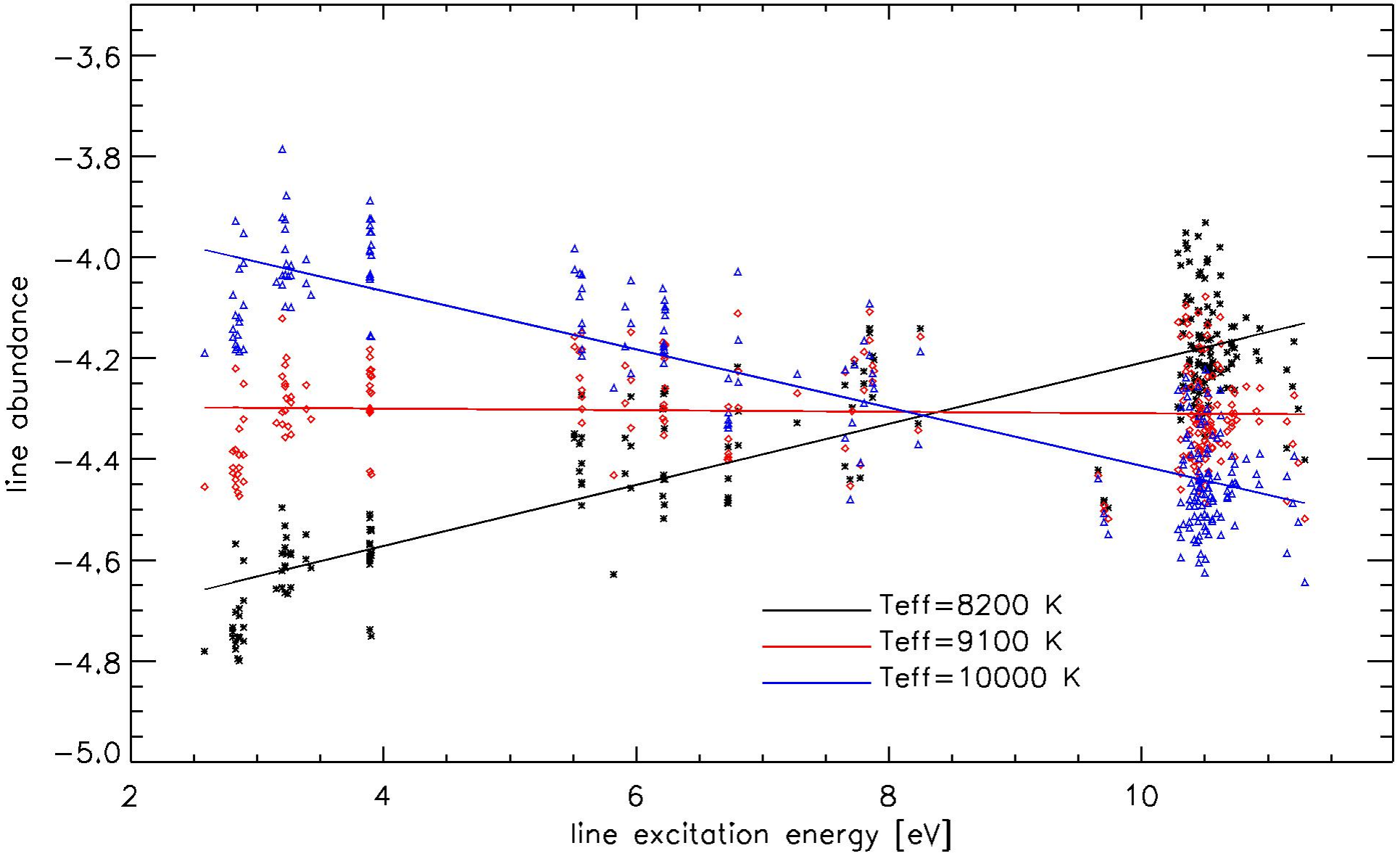
Effective temperature: excitation balance



- The slope changes as a function of Teff
- All lines belong to the same element/ion and thus need to give the same abundance
- Teff is determined when the slope is 0

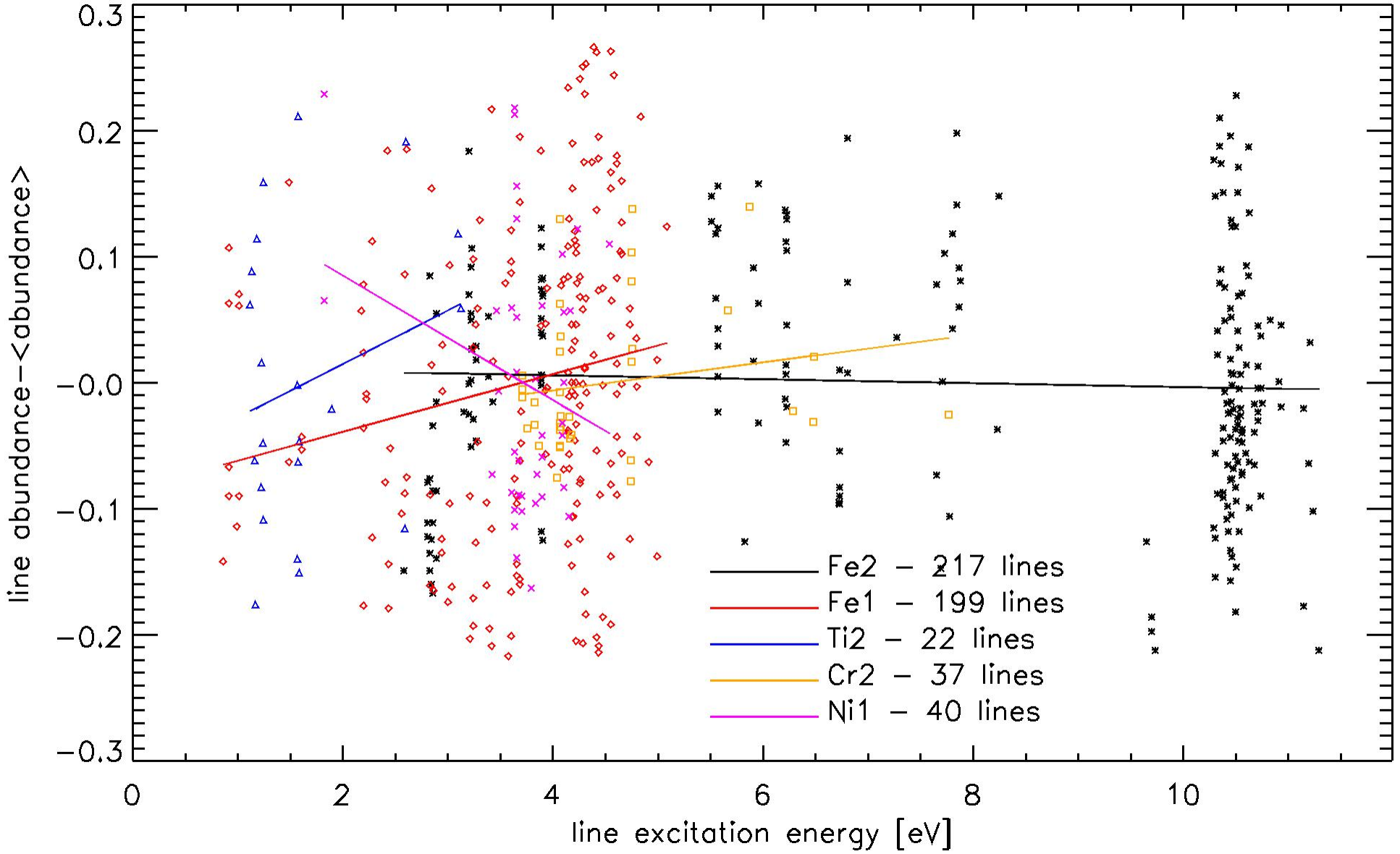
- At the end, whatever automatic fitting tool emplying synthetic spectra and metal lines will determine Teff in this way

Effective temperature: excitation balance



- It is important to consider lines of a given element with a large spread in excitation energy; Fe2 is a great for this
- When using an automatic fitting tool, one should make sure that the selected spectral range contains lines that enable one to constrain Teff

Effective temperature: excitation balance



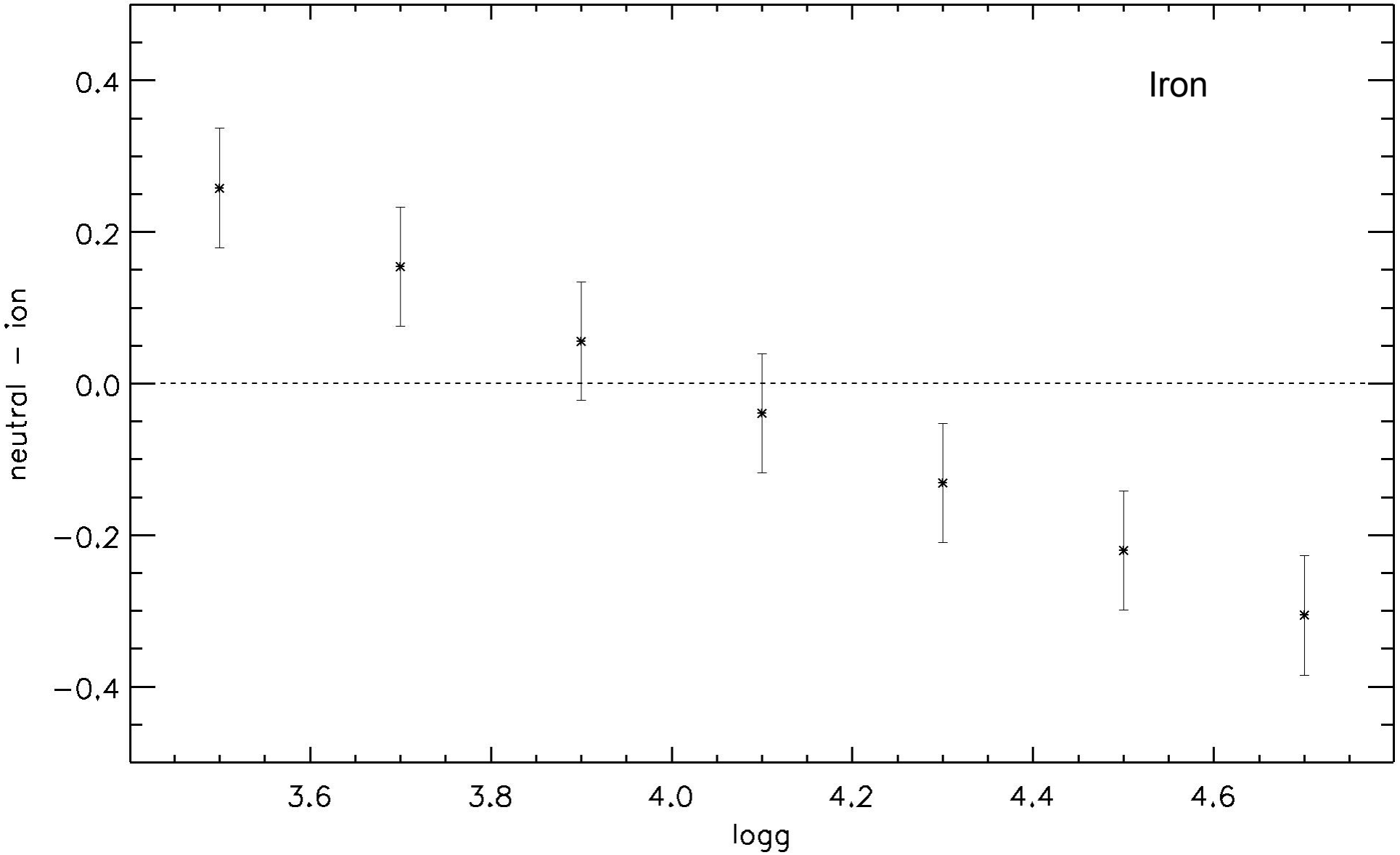
- Different ions give different answers

How to choose Teff? Consider the ion(s) with

- the larger number of lines?
- the largest spread in excitation energy?
- use e.g. the number of lines as weight?

These are all viable solutions and whatever fitting algorithm will automatically follow some mix of them, depending on the spectral range.

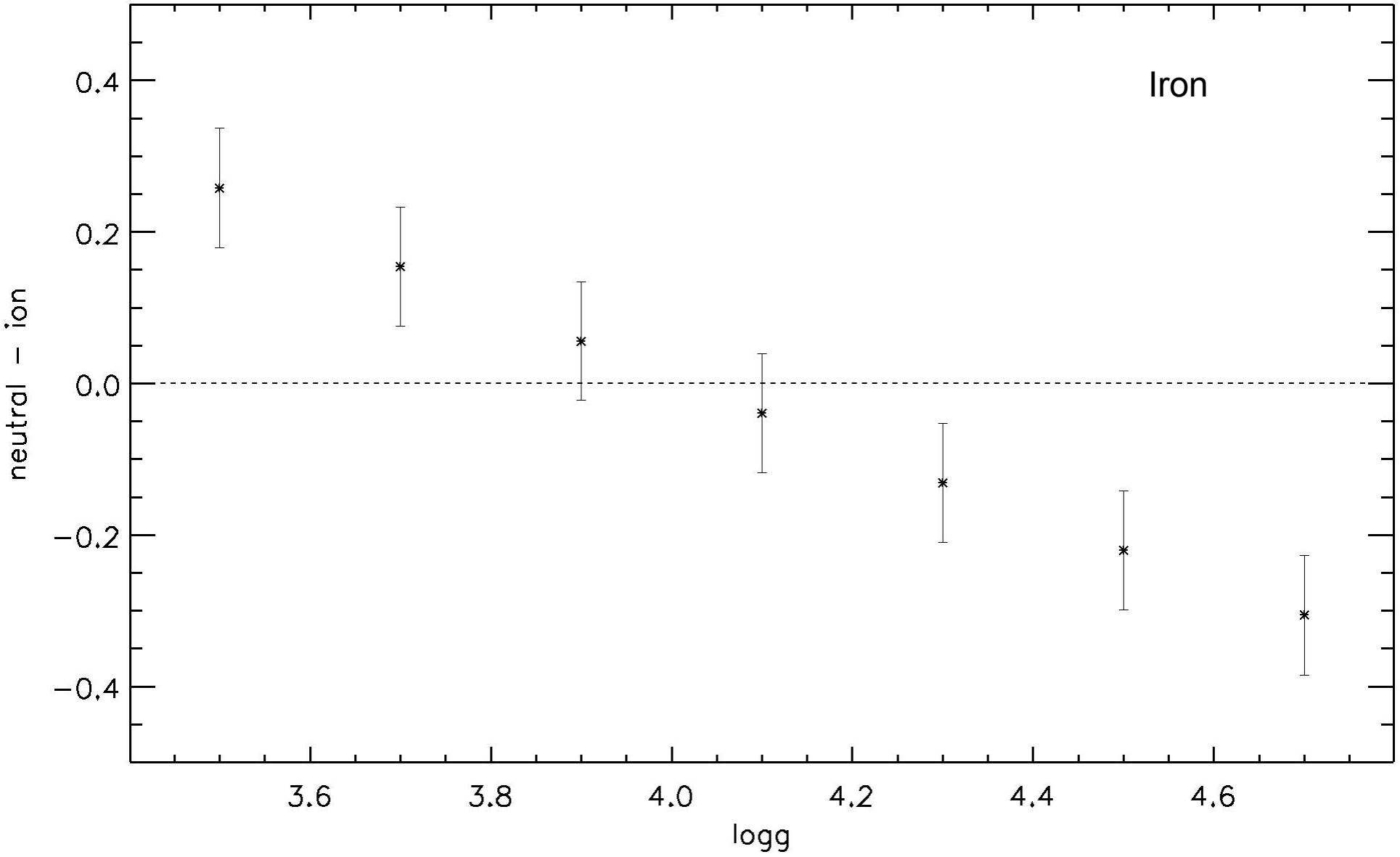
Surface gravity: ionisation balance



- The abundance difference between two ions of the same element changes as a function of logg
- All ions belonging to the same element need to give the same abundance
- logg is determined the difference is 0

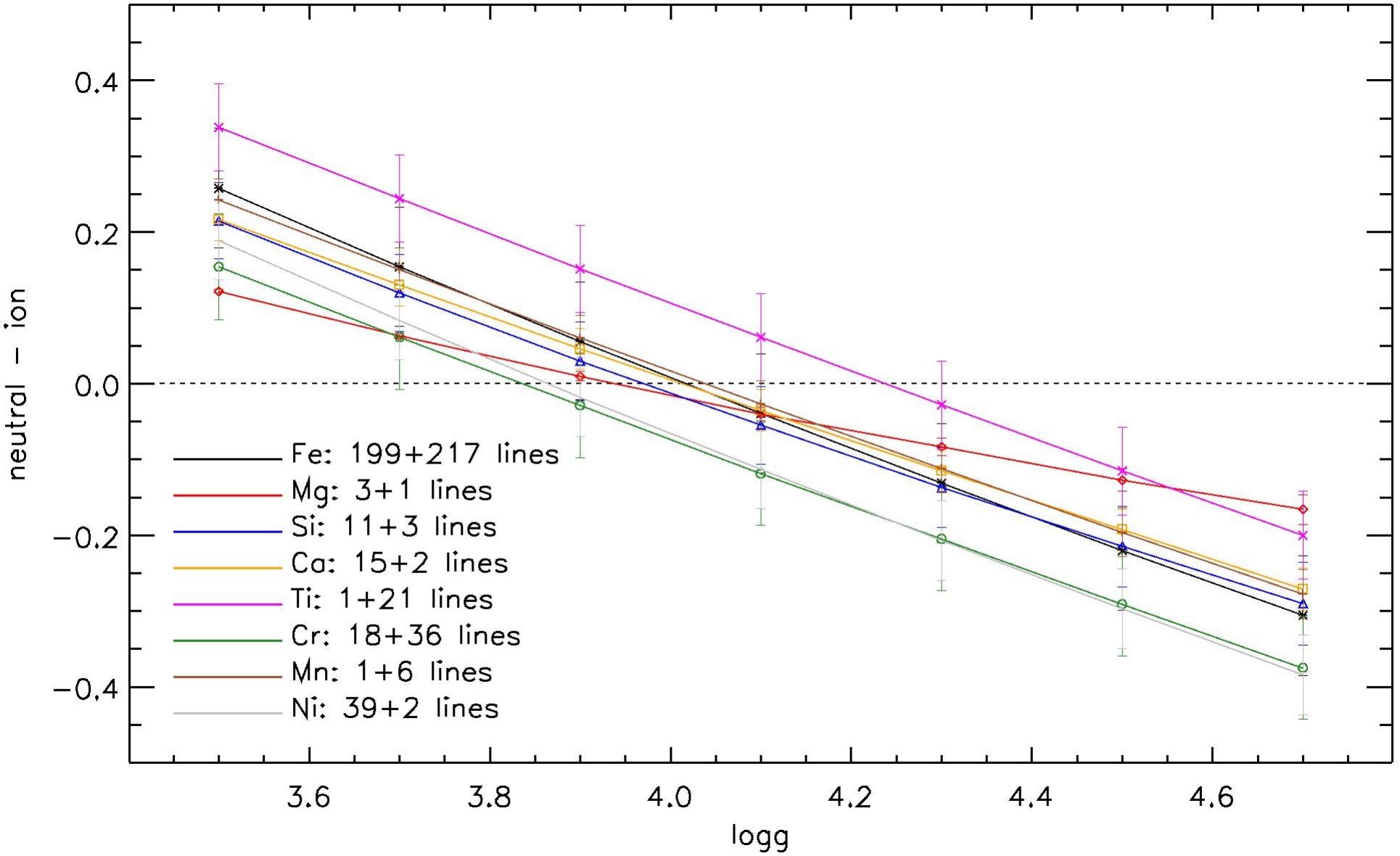
- At the end, whatever automatic fitting tool emplying synthetic spectra and metal lines will determine Teff in this way

Surface gravity: ionisation balance



- It is important to consider elements for which lines of multiple ionisation states appear in the spectrum
- When using an automatic fitting tool, one should make sure that the selected spectral range contains lines of different ions of the same element to be able to constrain logg

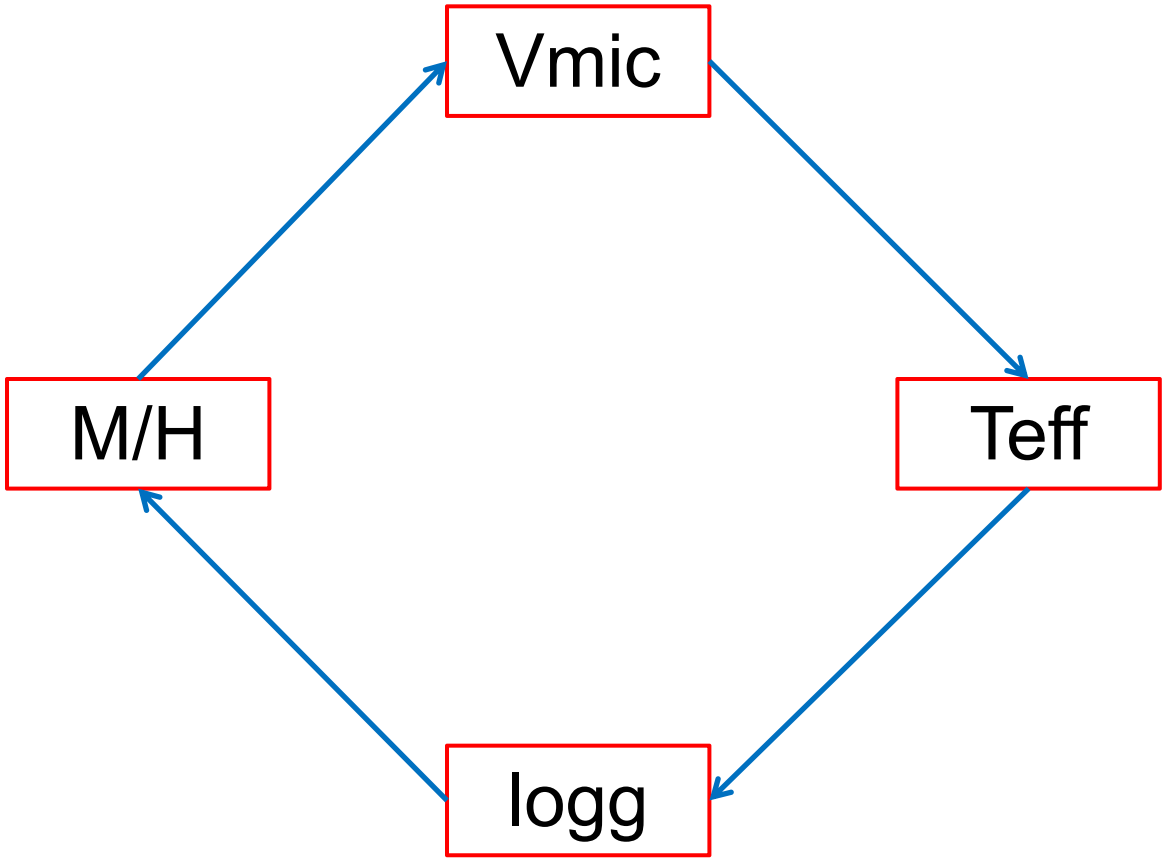
Surface gravity: ionisation balance



- Different elements give different logg values. How to choose it? Consider the element(s) with
- the larger number of lines?
- all elements equal?
- elements with the “best” loggf values?

These are all viable solutions and whatever fitting algorithm will automatically follow some mix of them, depending on the spectral range.

Determining the parameters is an iterative procedure



The entire procedure has to be iterated until convergence, that is the parameters do not vary significantly (within the typical uncertainties) any more.

From experience, for chemically normal stars, 2 iterations are typically enough, but for chemicall peculiar stars (including Am stars or high/low metallicity stars) more iterations are most likely necessary.