Atmospheric parameters from lines with developed wings

- Hydrogen lines
- Metal lines

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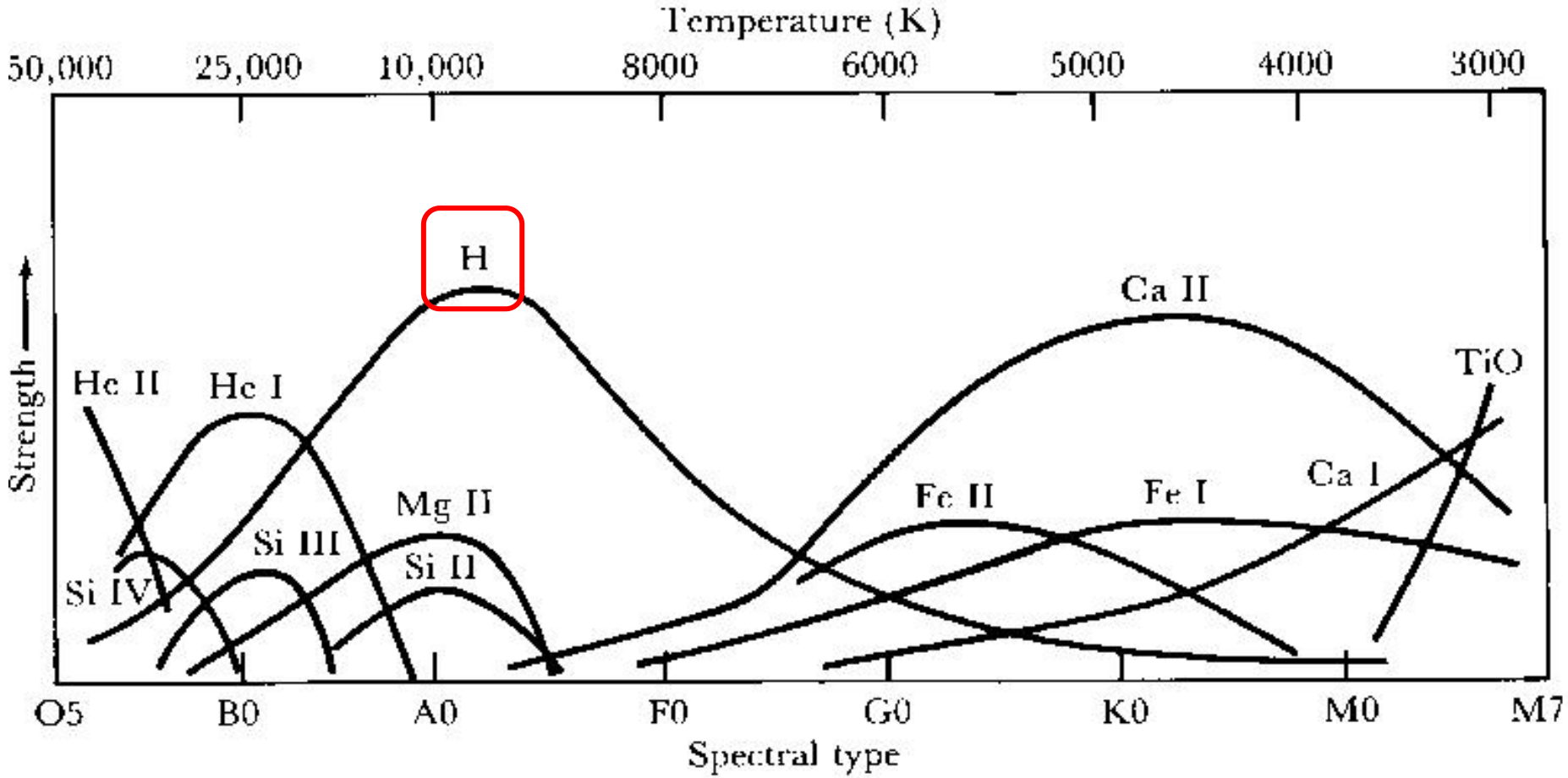
- Hydrogen lines

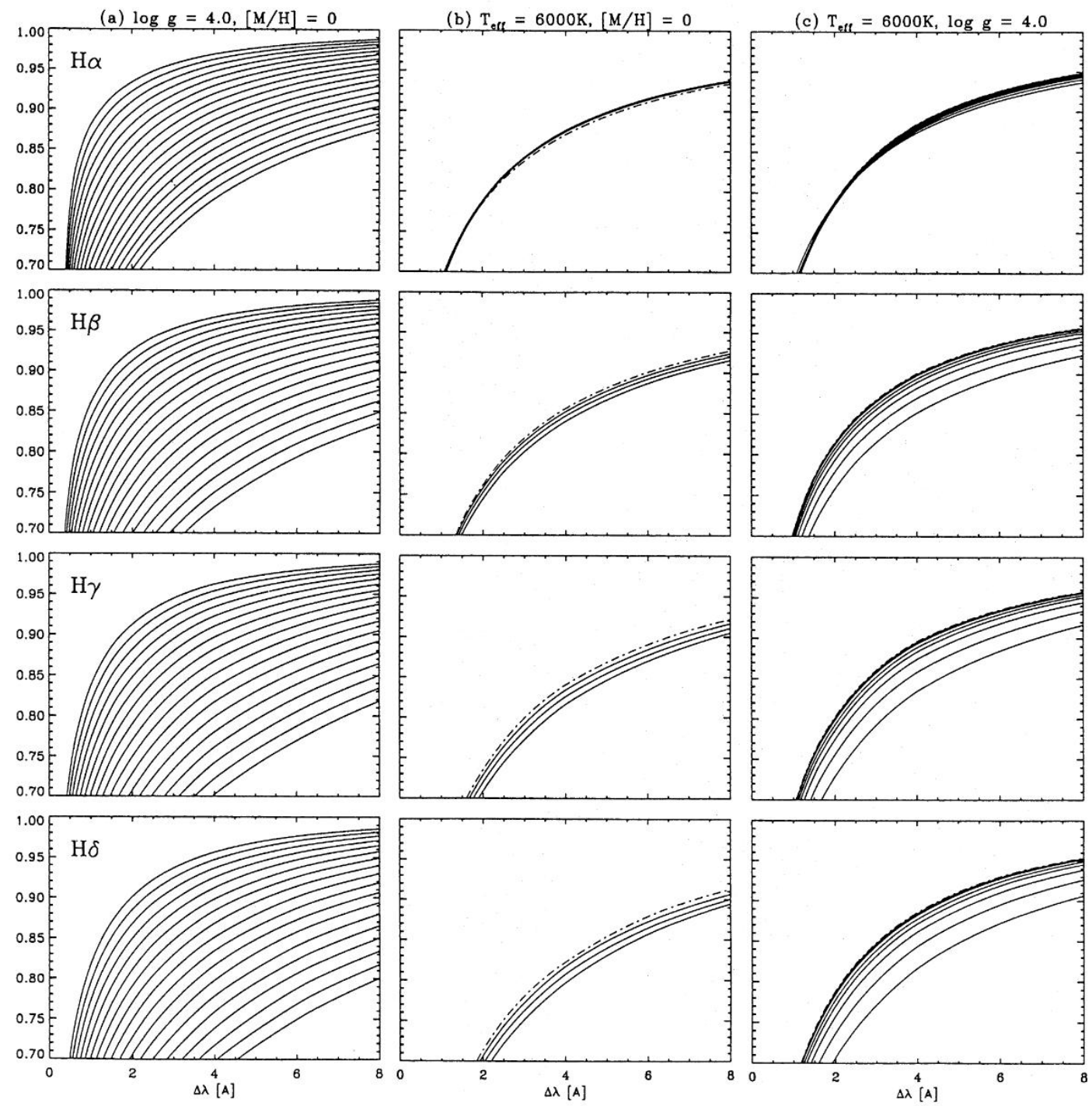
  We look at the line wings, because the line cores are in NLTE (they form in the uppermost low-density layers of the atmosphere)

- Metal lines

Atmospheric parameters from hydrogen line wings



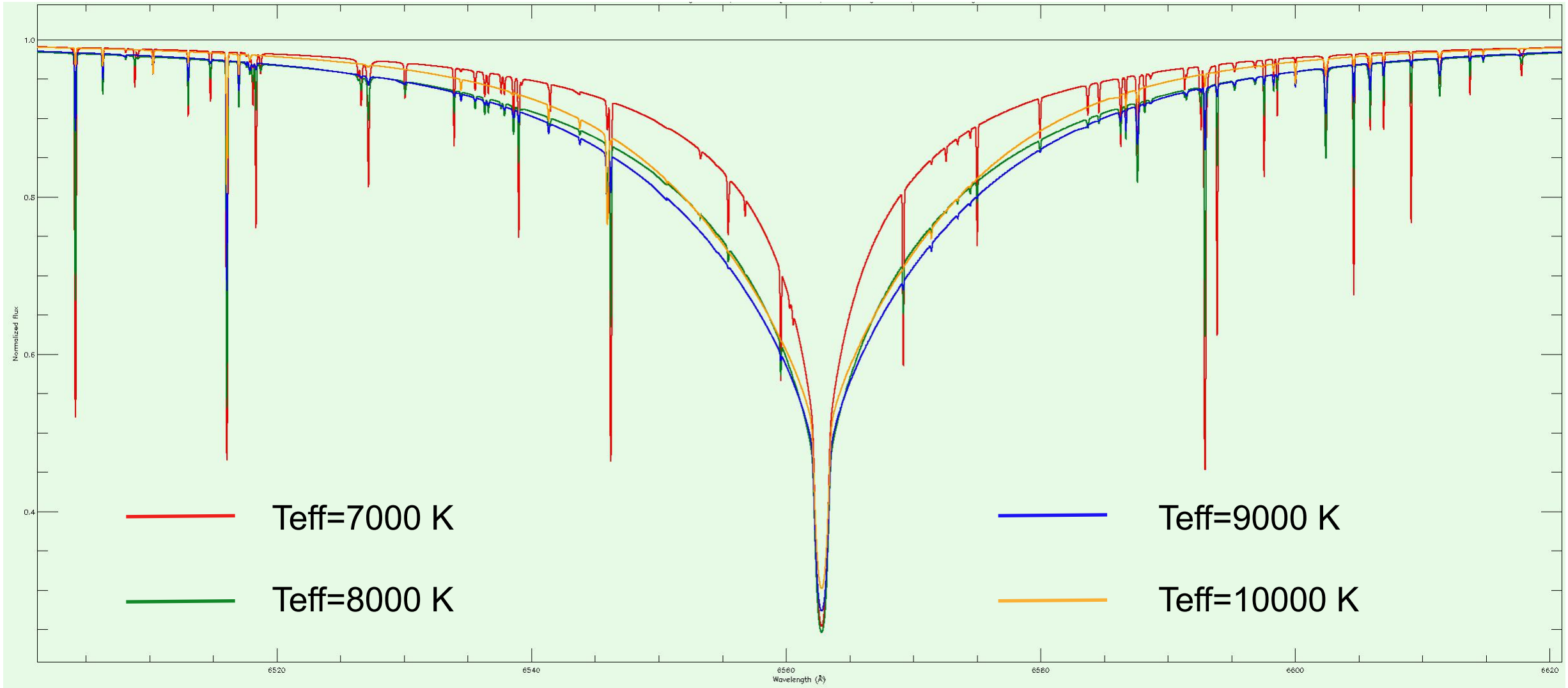
The strength of spectral lines, including that of the hydrogen Balmer lines, changes with effective temperature.

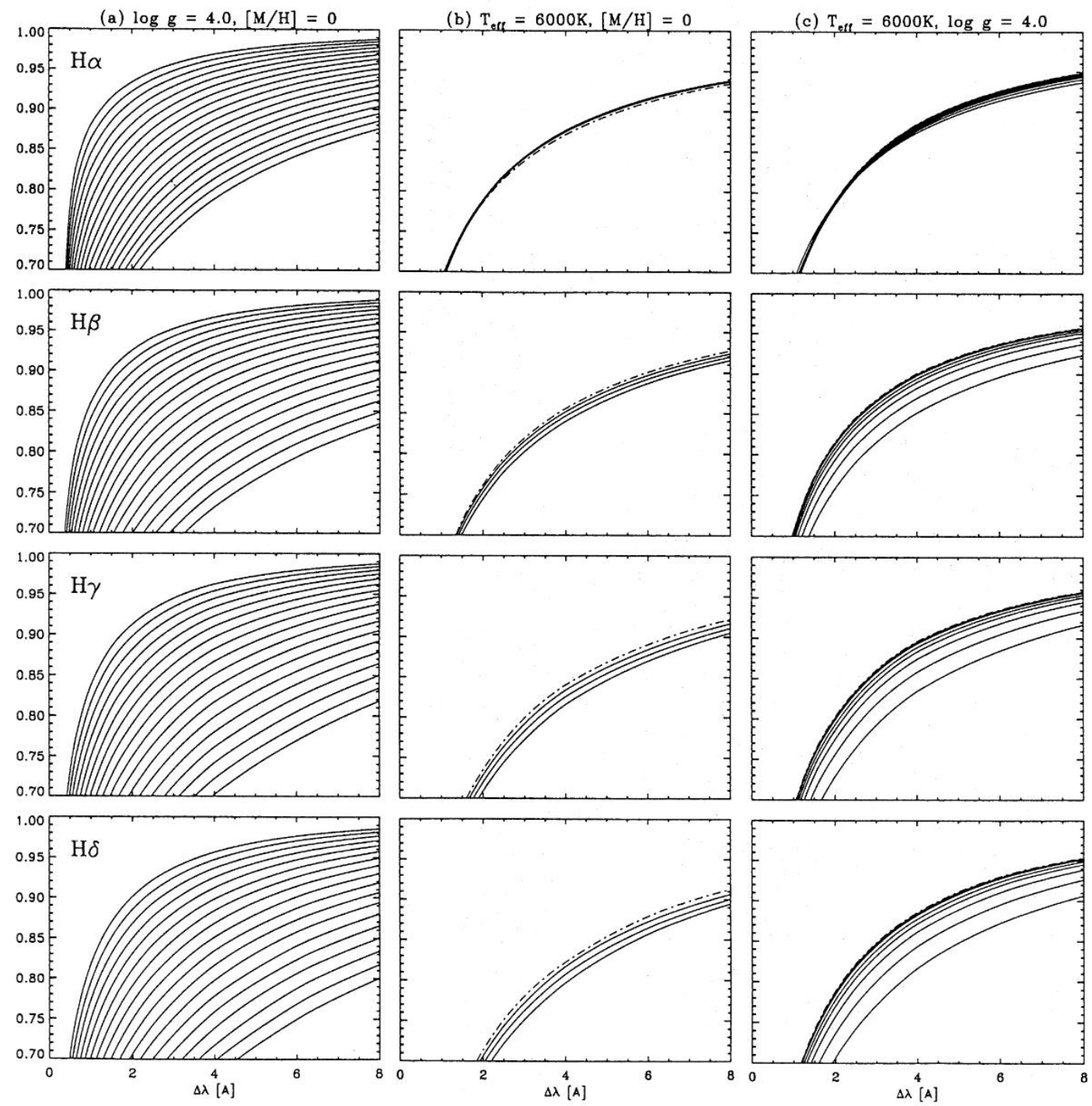


Teff: 5000 - 6700 K; ΔT=100 K
logg: 3.0 - 4.5: Δlogg=0.5
[M/H]: -3.5 - 0: Δ[M/H]=0.5

The wings of the Balmer lines get broader (i.e. stronger) with increasing temperature until about 9000 K and then the lines get narrower (i.e. weaker) again, but with a different shape.

Fuhrmann+1993


Teff=7000 K
Teff=8000 K
Teff=9000 K
Teff=10000 K
Normalized flux
1.0
0.8
0.6
0.4
6520
6540
6560
6580
6600
6620
Wavelength (Å)

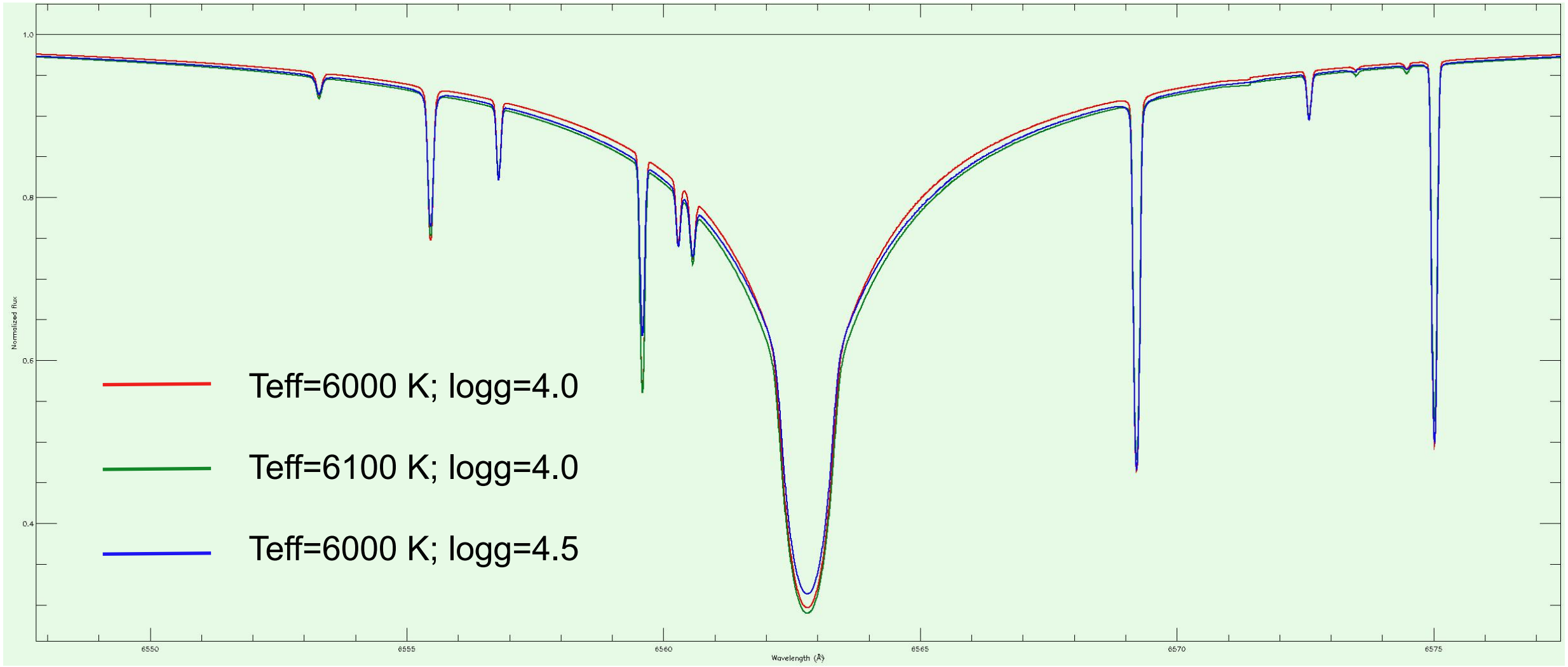


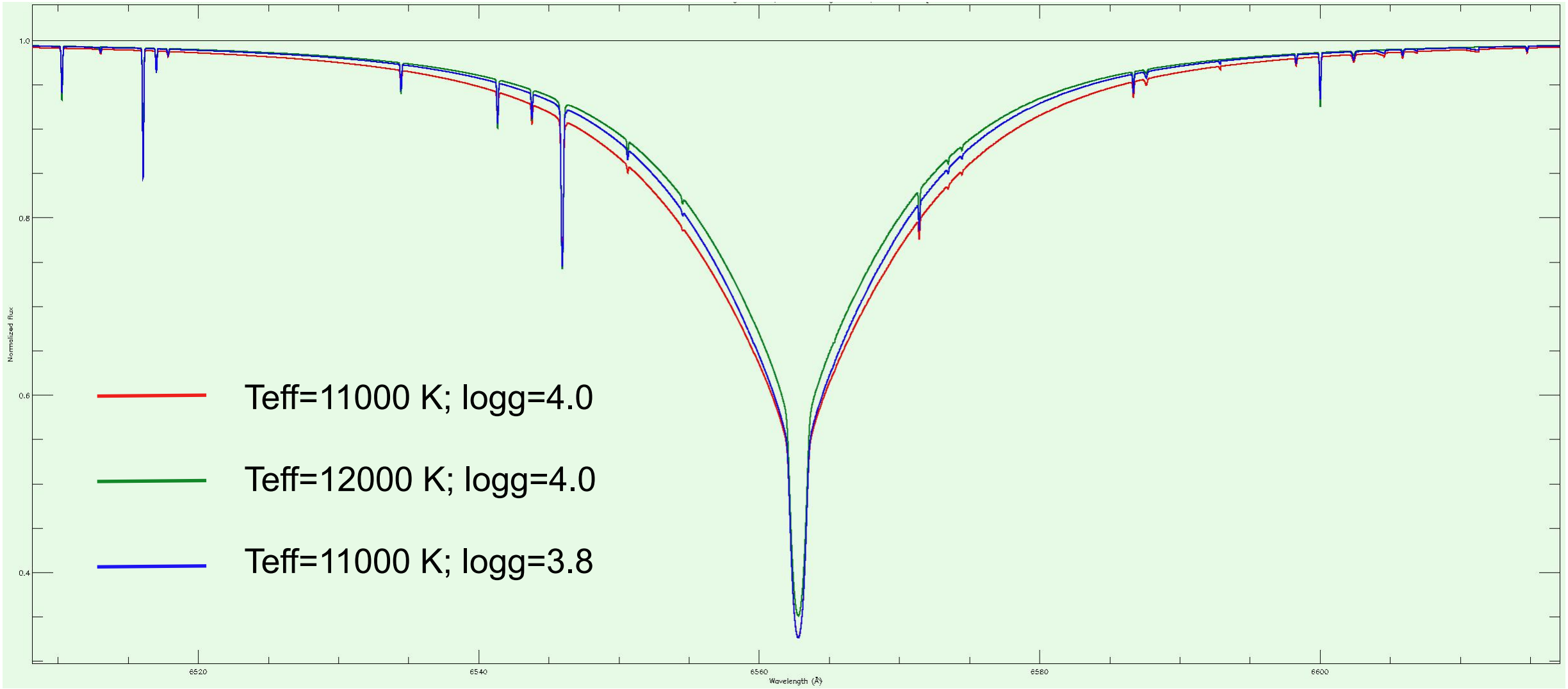
Teff: 5000 - 6700 K; ΔT=100 K
logg: 3.0 - 4.5: Δlogg=0.5
[M/H]: -3.5 - 0: Δ[M/H]=0.5

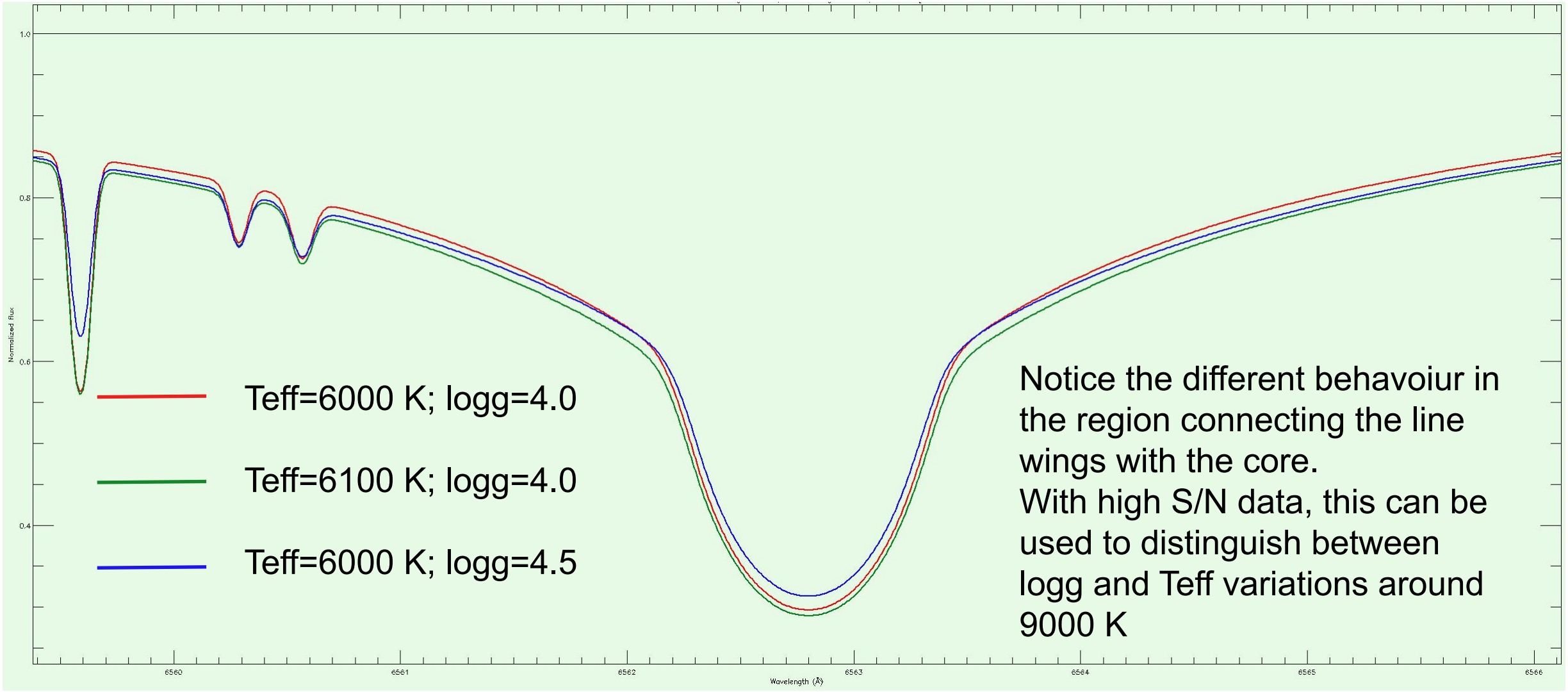
The wings of the Balmer lines get broader (i.e. stronger) with increasing temperature until about 9000 K and then the lines get narrower (i.e. weaker) again, but with a different shape.

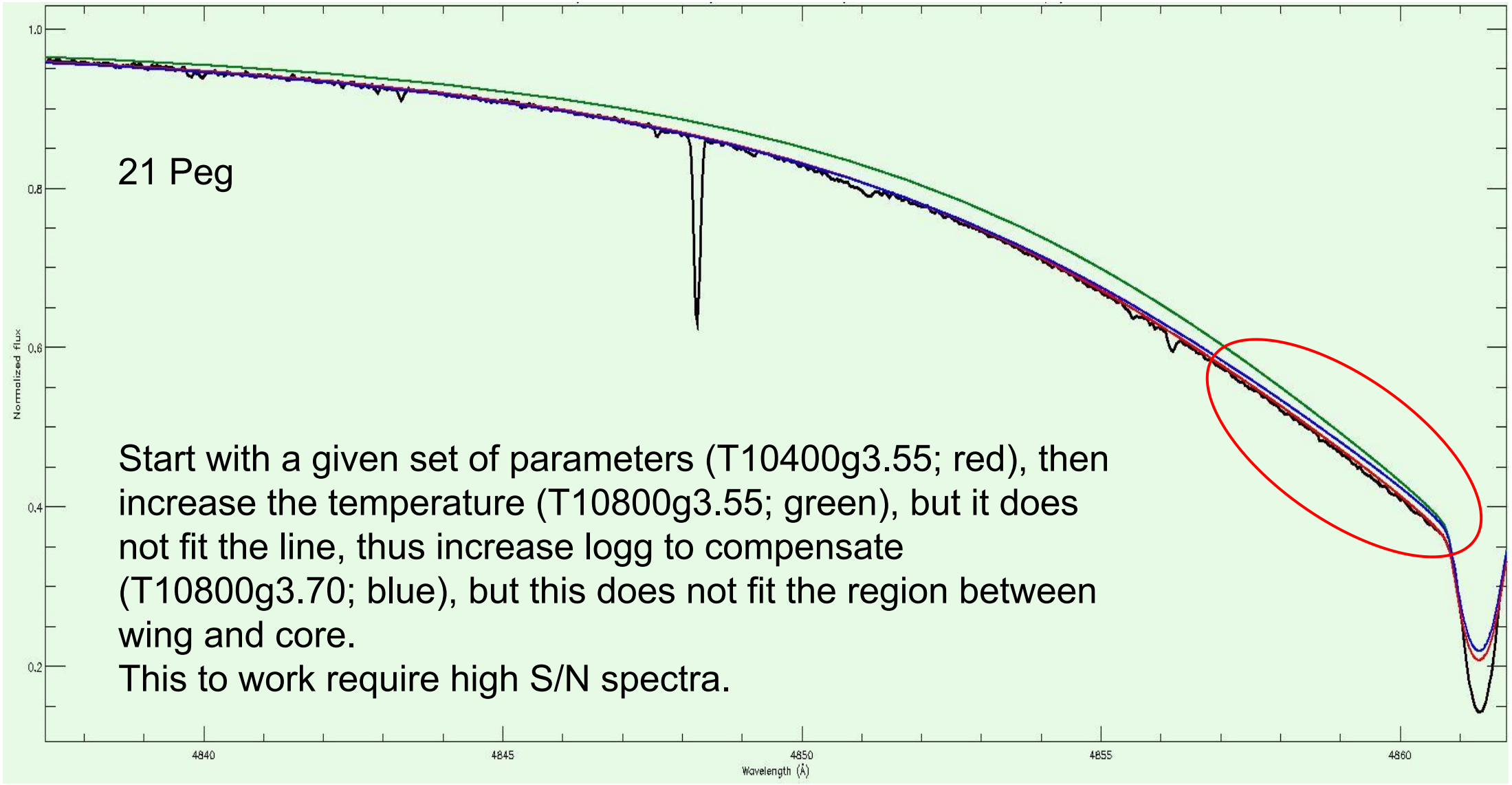
The wings of the Balmer lines are most sensitive to Teff variations at cooler temperatures (<~9000 K) and to logg variations at higher temperatures: for cooler stars the H lines are temperature indicators, while for hotter stars they are gravity indicators.

Fuhrmann+1993


Teff=6000 K; logg=4.0
Teff=6100 K; logg=4.0
Teff=6000 K; logg=4.5
Normalized flux
Wavelength (Å)
1.0
0.8
0.6
0.4
6550
6555
6560
6565
6570
6575


Teff=11000 K; logg=4.0
Teff=12000 K; logg=4.0
Teff=11000 K; logg=3.8
Normalized flux
1.0
0.8
0.6
0.4
6520
6540
6560
6580
6600
Wavelength (Å)


1.0
0.8
0.6
0.4
Normalized flux
6560
6561
6562
6563
6564
6565
6566
Wavelength (Å)
Teff=6000 K; logg=4.0
Teff=6100 K; logg=4.0
Teff=6000 K; logg=4.5
Notice the different behavoiur in the region connecting the line wings with the core.
With high S/N data, this can be used to distinguish between logg and Teff variations around 9000 K

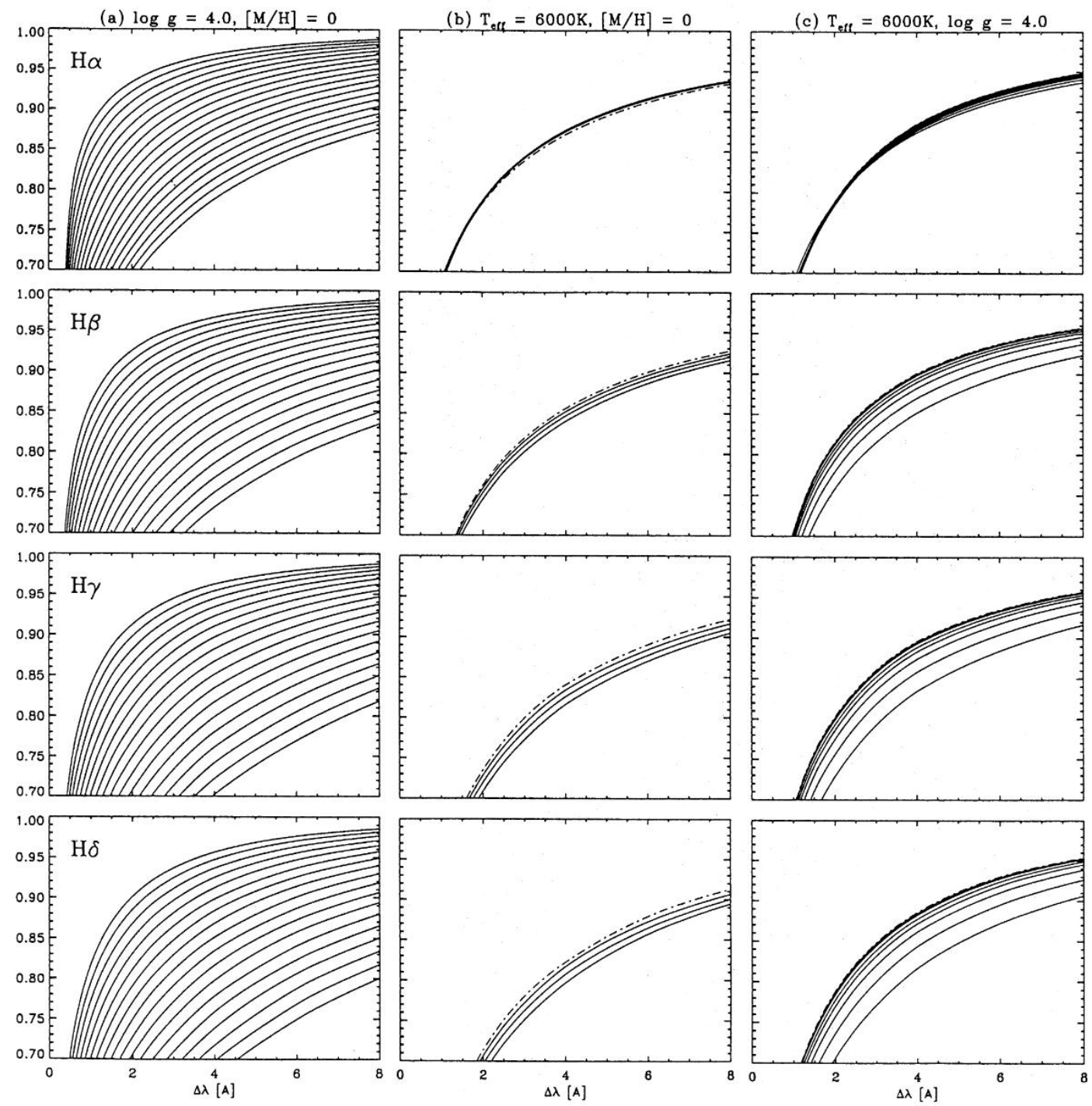


observation

T10800/g3.55

T10400/g3.55

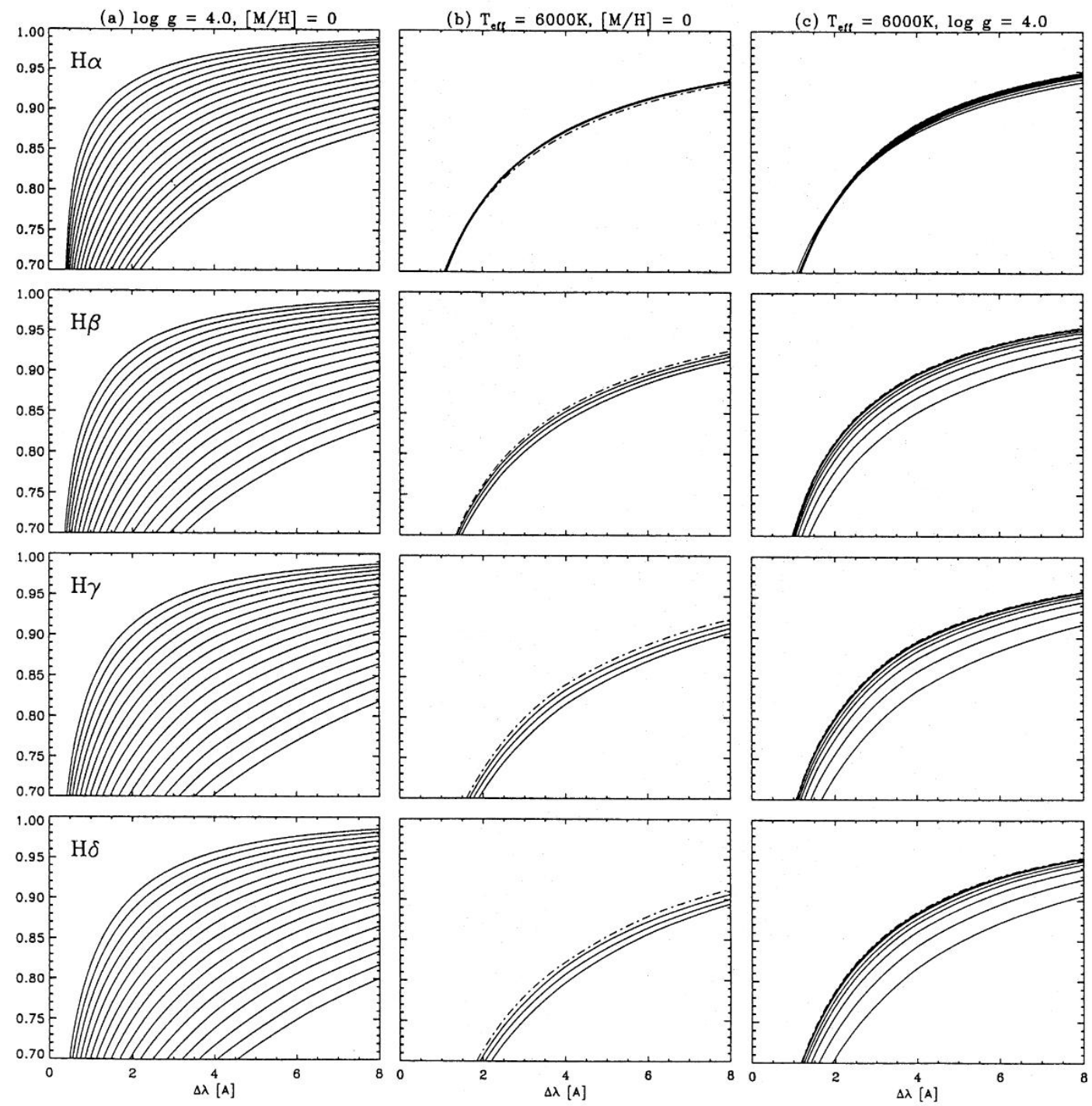
T10800/g3.70



Teff: 5000 - 6700 K; ΔT=100 K
logg: 3.0 - 4.5: Δlogg=0.5
[M/H]: -3.5 - 0: Δ[M/H]=0.5

Note the different sensitivity of the different lines to the different parameters.

Fuhrmann+1993

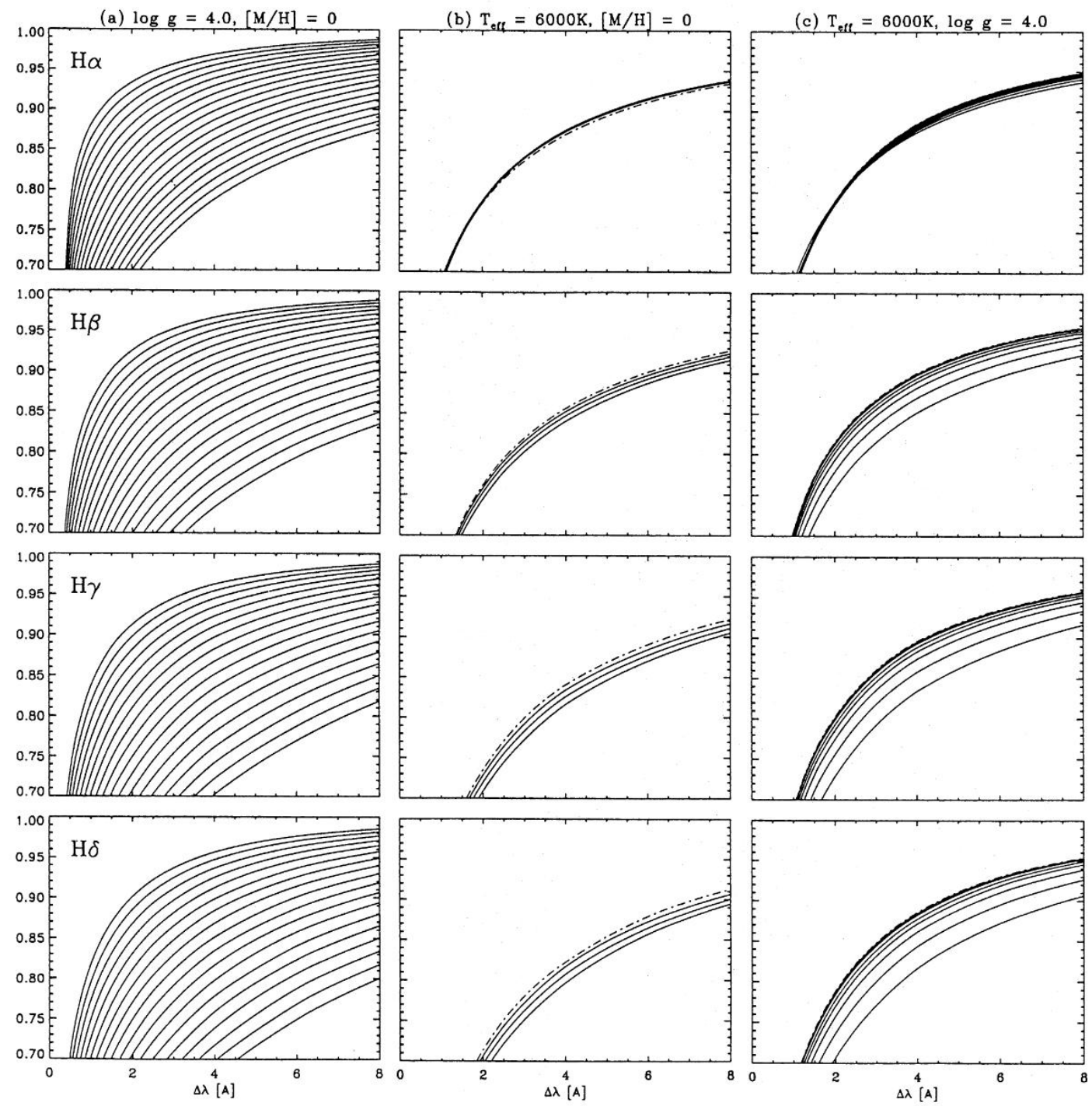


Teff: 5000 - 6700 K; ΔT=100 K
logg: 3.0 - 4.5: Δlogg=0.5
[M/H]: -3.5 - 0: Δ[M/H]=0.5

Note the different sensitivity of the different lines to the different parameters.

The right column tells that metallicity should be considered as a further parameter.
This is true in particular when changing the He abundance.
Therefore, measuring the atmospheric parameters is always an iterative process, even when using the hydrogen lines.

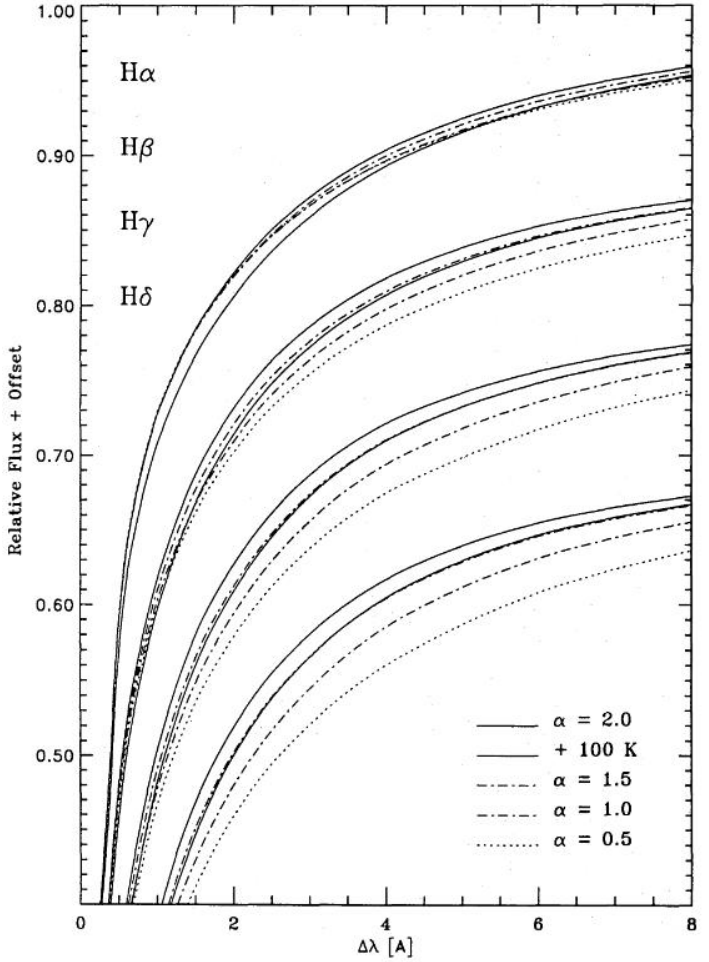
Fuhrmann+1993



Teff: 5000 - 6700 K; ΔT=100 K
logg: 3.0 - 4.5: Δlogg=0.5
[M/H]: -3.5 - 0: Δ[M/H]=0.5

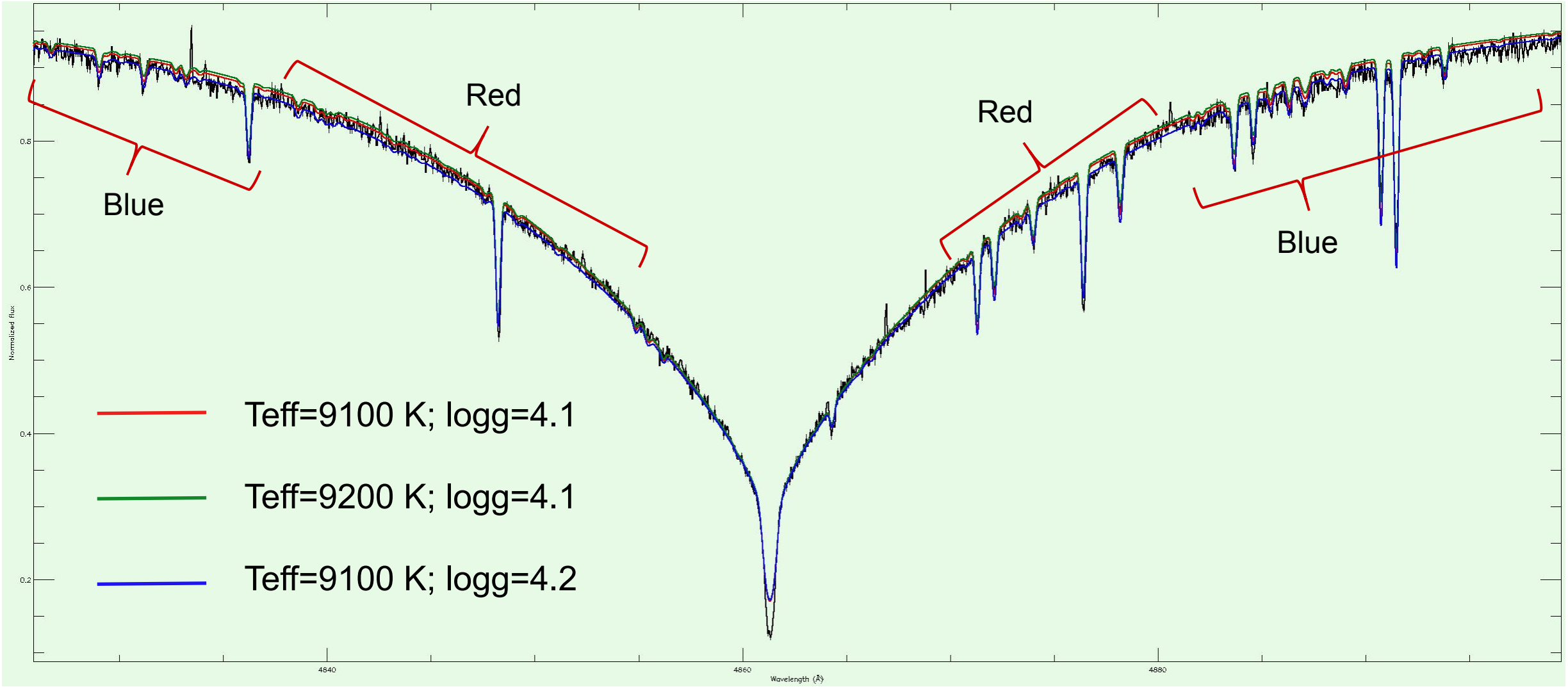
The strength of the Balmer line wings depends also on other parameters; e.g. MLT α.

The Hα line is the least sensitive to variations in the MLT α parameter.

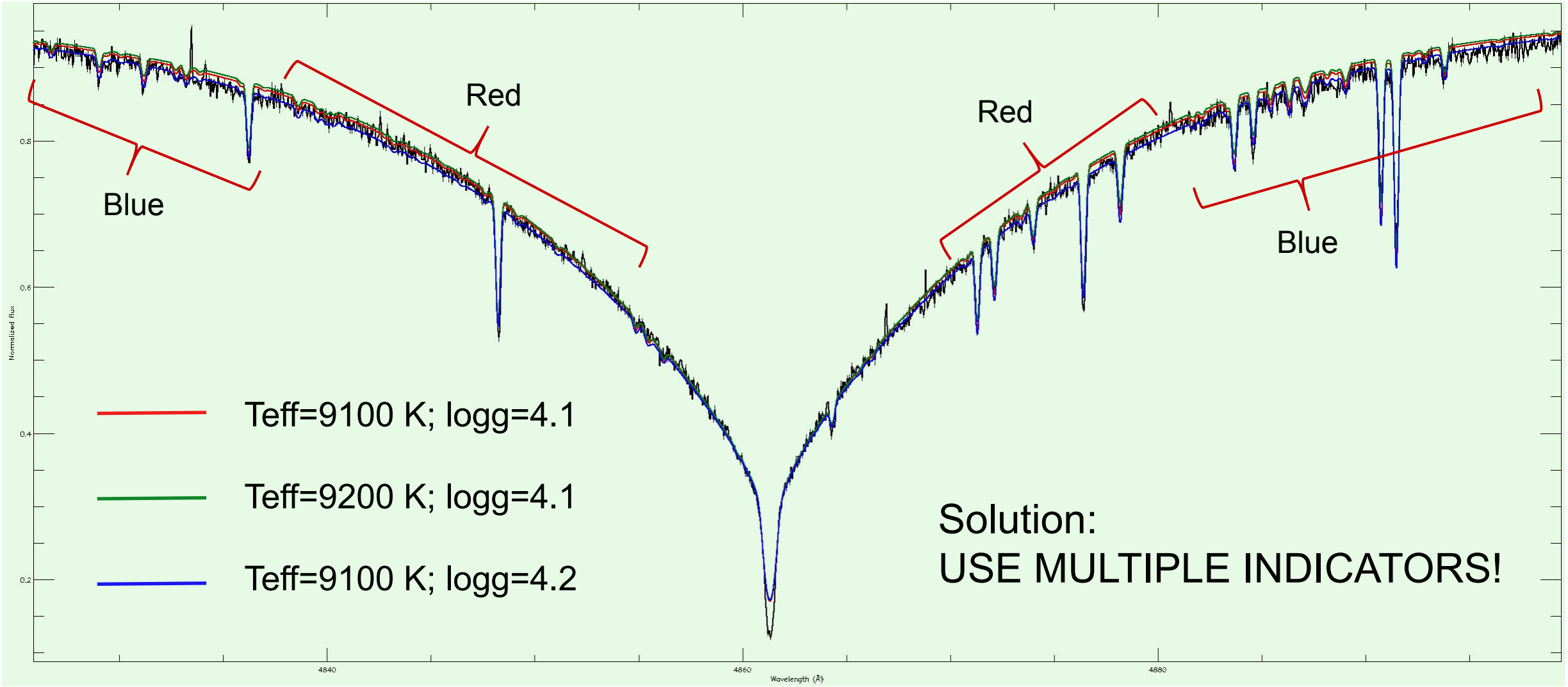


Fuhrmann+1993

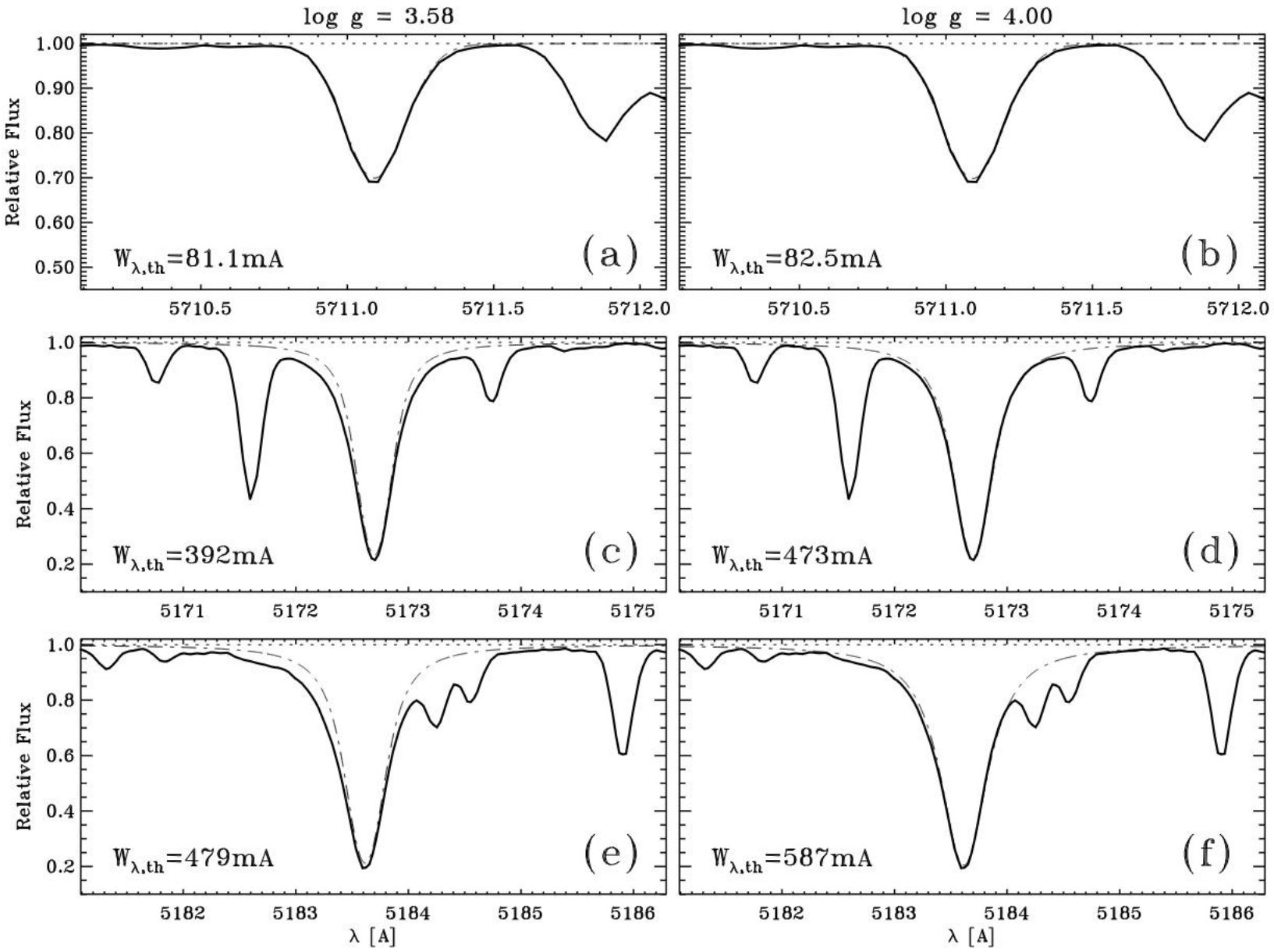
An “everyday” example:
High-resolution echelle spectrograph (R=60000), good quality data (S/N~180) and yet it is hard to get a reliable and unique estimate.



An “everyday” example:
High-resolution echelle spectrograph (R=60000), good quality data (S/N~180) and yet it is hard to get a reliable and unique estimate.



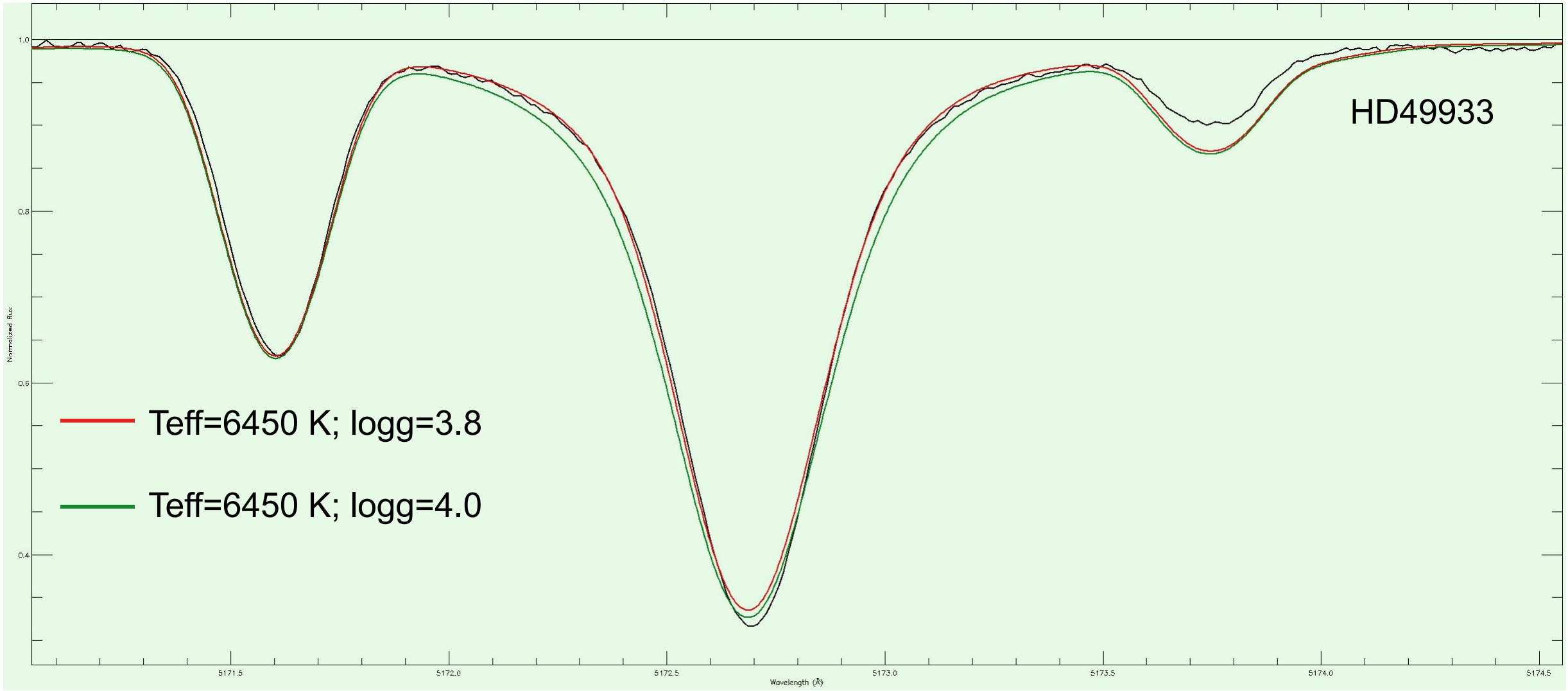
Atmospheric parameters from wings of metal lines



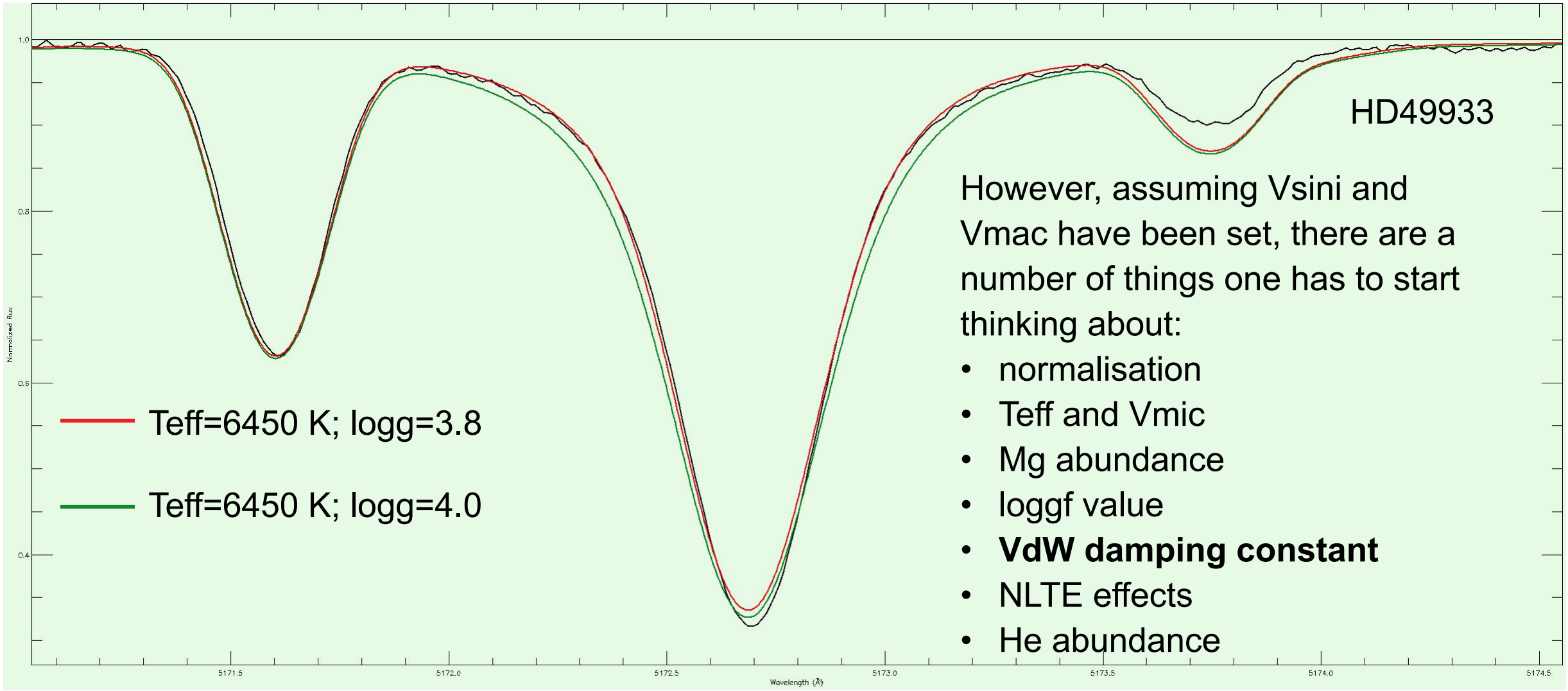
The wings of some metal lines, such as the MgIb lines (5167 Å [strongly blended with FeI line], **5172 Å**, **5183 Å**), NaID lines (5889 Å, 5895 Å; strongly affected by NLTE effects and telluric lines), CaI (6162Å, 6439Å; for the cooler stars, <7000 K).

Fuhrmann+1997

A simple (in theory) example



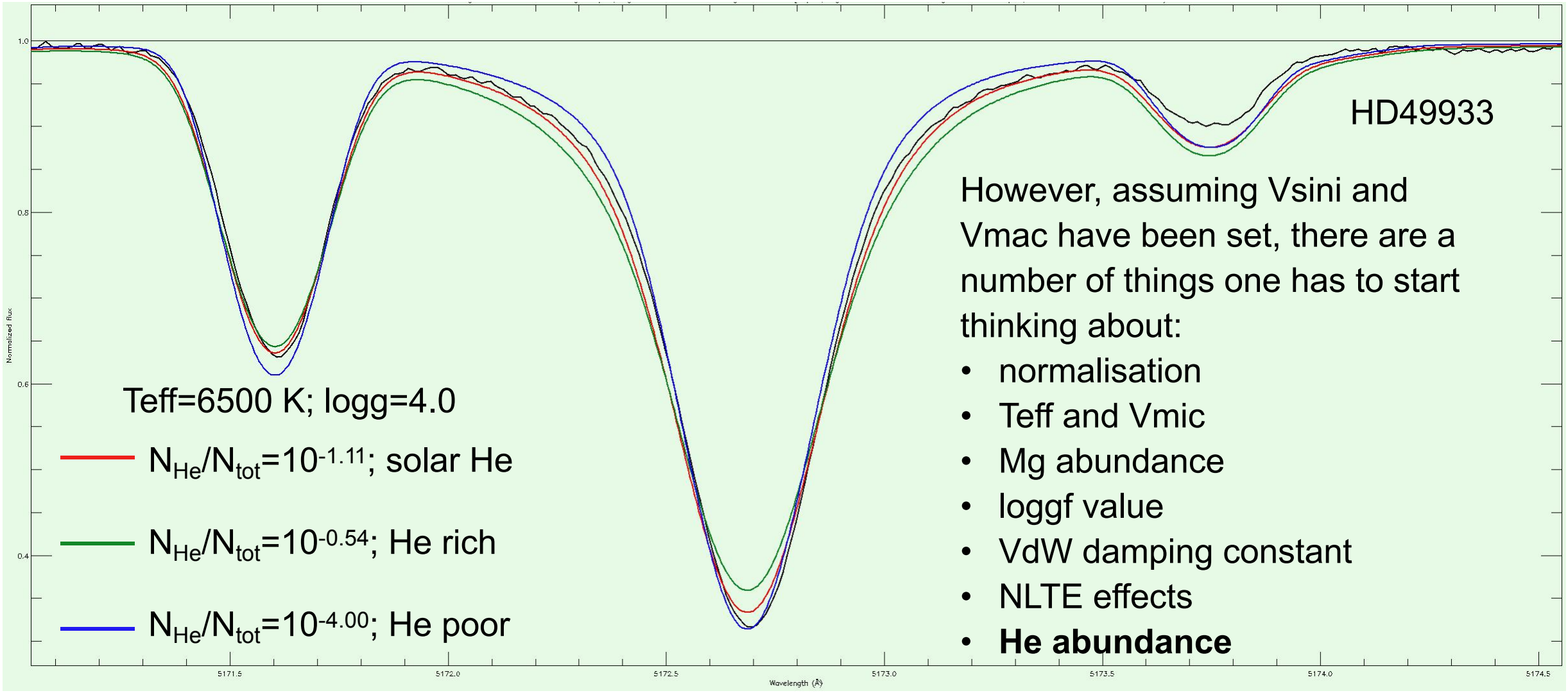
A simple (in theory) example



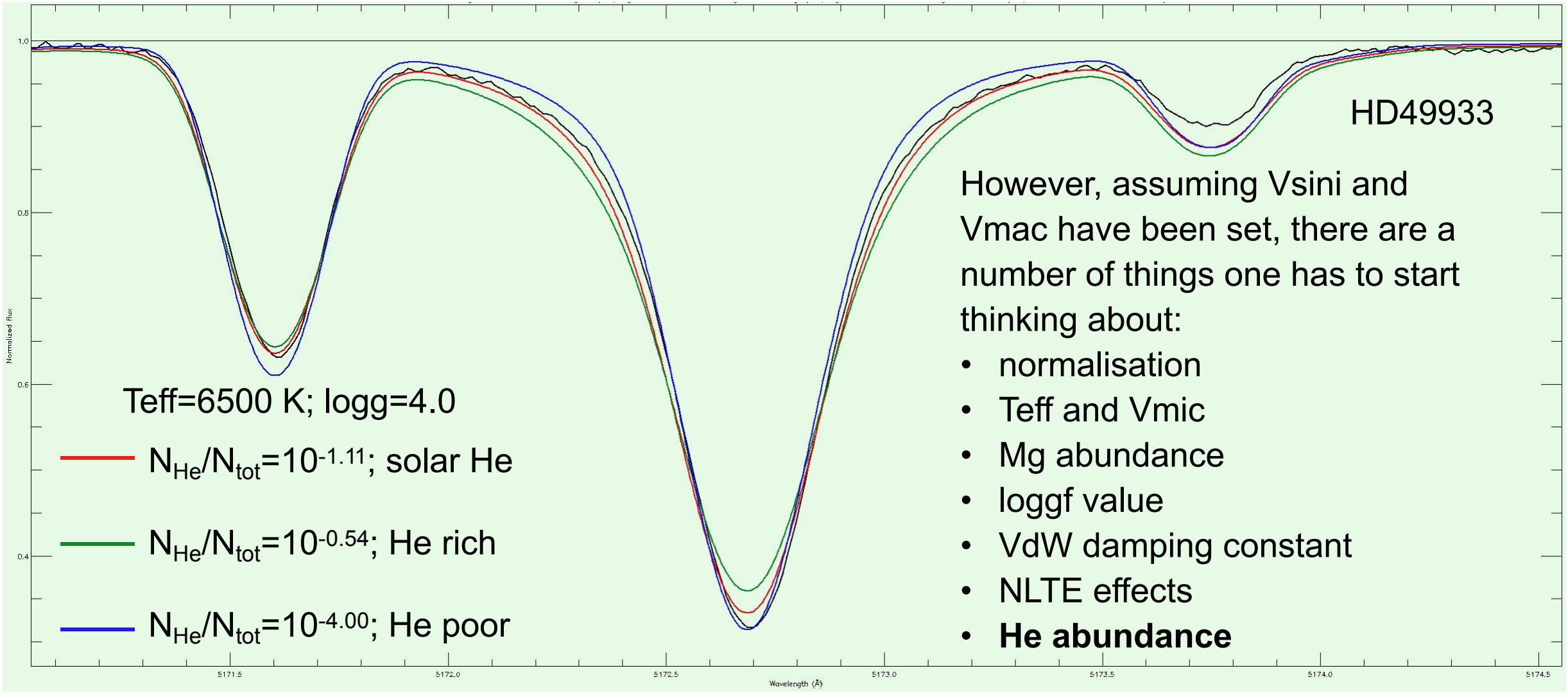
However, assuming Vsini and Vmac have been set, there are a number of things one has to start thinking about:

- normalisation
- Teff and Vmic
- Mg abundance
- loggf value
- **VdW damping constant**
- NLTE effects
- He abundance

A simple (in theory) example



A simple (in theory) example



Solution: **USE MULTIPLE INDICATORS!**