Useful information

on stellar parameter estimation

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Bugs are all around our life

- When encounter any error/bug using pysme/pymoog/etc:
  - Ask bing/google/chatgpt about it.
  - Find out whether it is a bug in your code or the package.
    - Your code: fix it yourself
  - Bug in the package
    - Is there any way to bypass it?
    - Is there any replacement?
  - Ask me in Wechat / raise an issue in Github / send me an email / call me
    - Some problems about pymoog in read the docs · Issue #75 · MingjieJian/pymoog (github.com)
  - Problem description + minimum code block + full error message

pymoog doc update

- In “Guide for each driver” page:
  - weedout, abfind, blends, cog pages are updates (with workable example)
  - other pages: under construction.

Stellar parameters and abundances measurement
-- never a simple task

The take-home-message

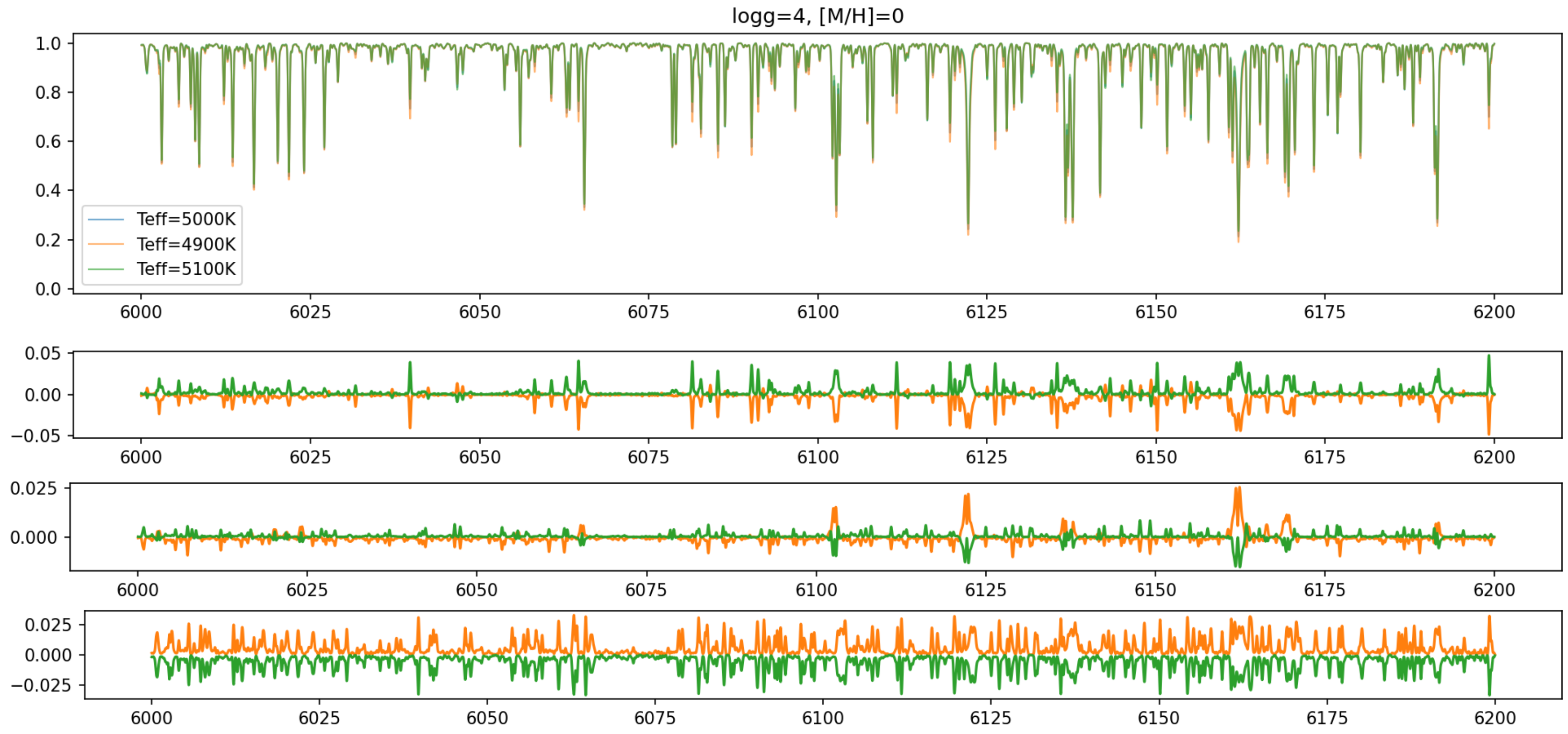
Spectral sensitivity to paras

- The top three parameters which affect the spectra the most:

$$T_{\rm eff} = 5000 \pm 100{\rm K}$$

$$\log g = 4.0 \pm 0.1$$

$$[{\rm Fe/H}] = 0.0 \pm 0.1$$

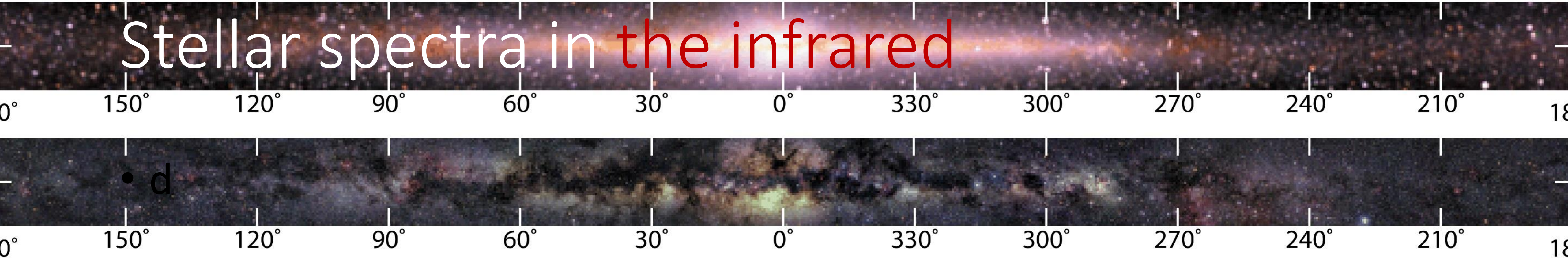


Using pymoog.

To make this task more complex

Let’s go to infrared.

Stellar spectra in the infrared



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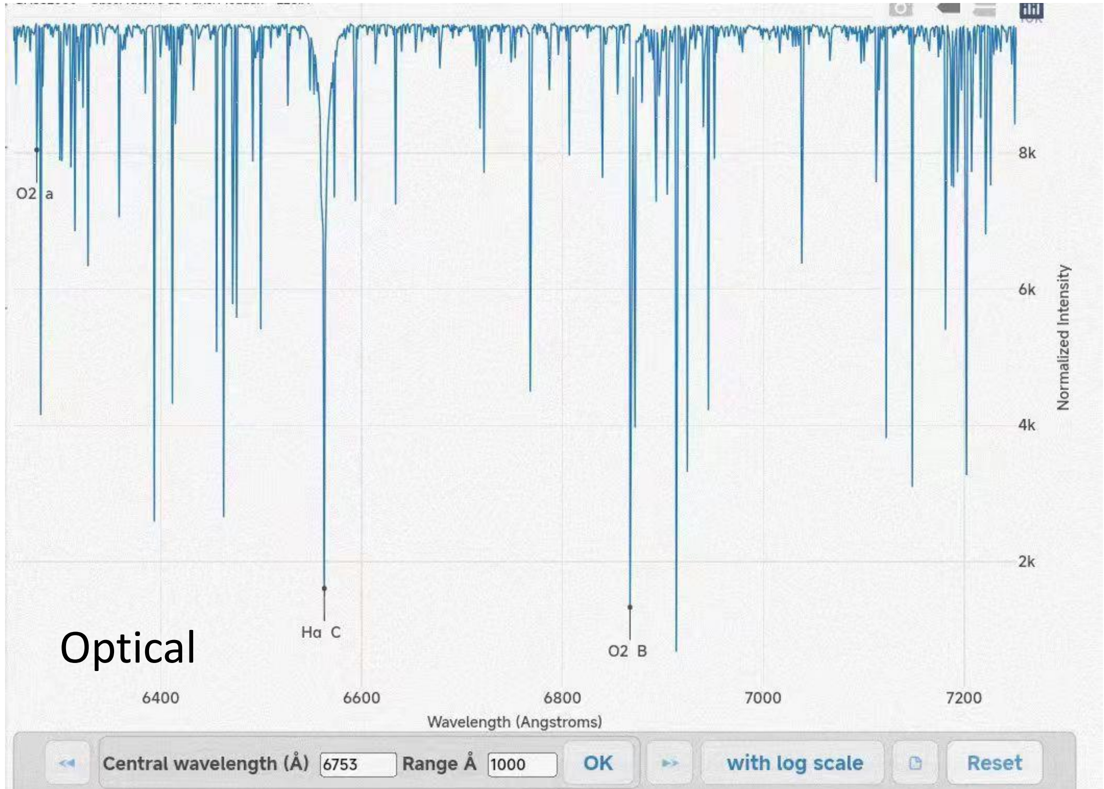
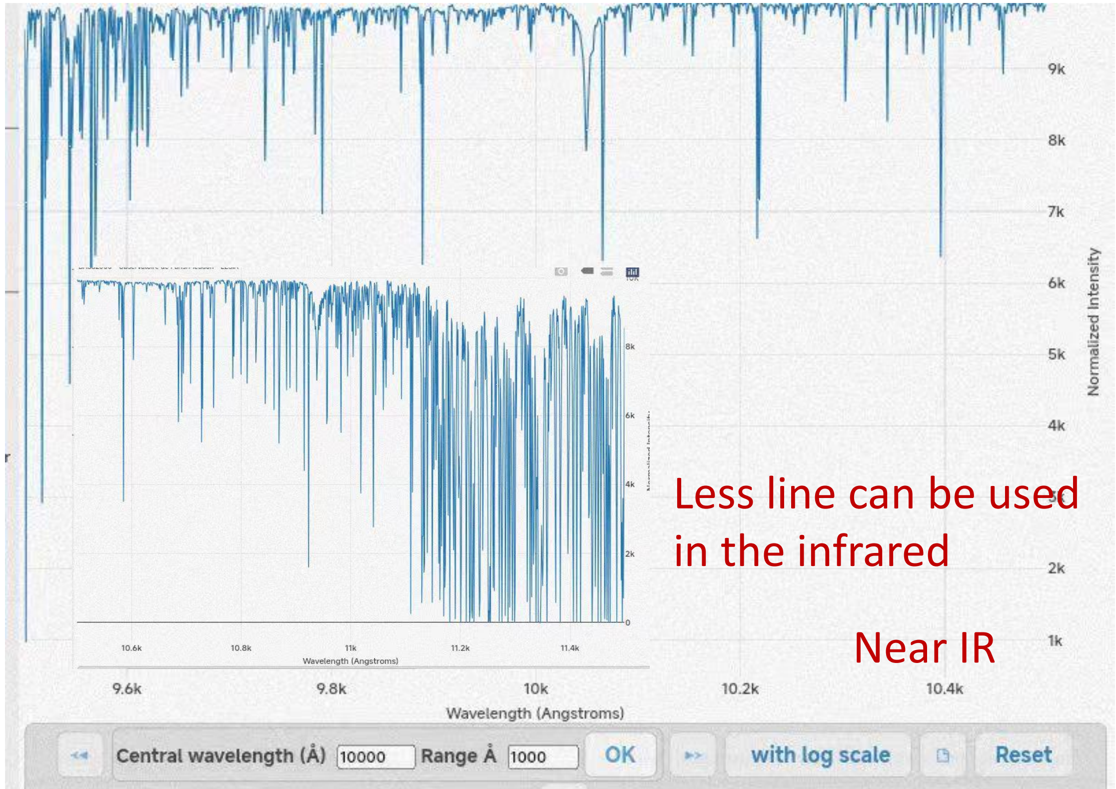


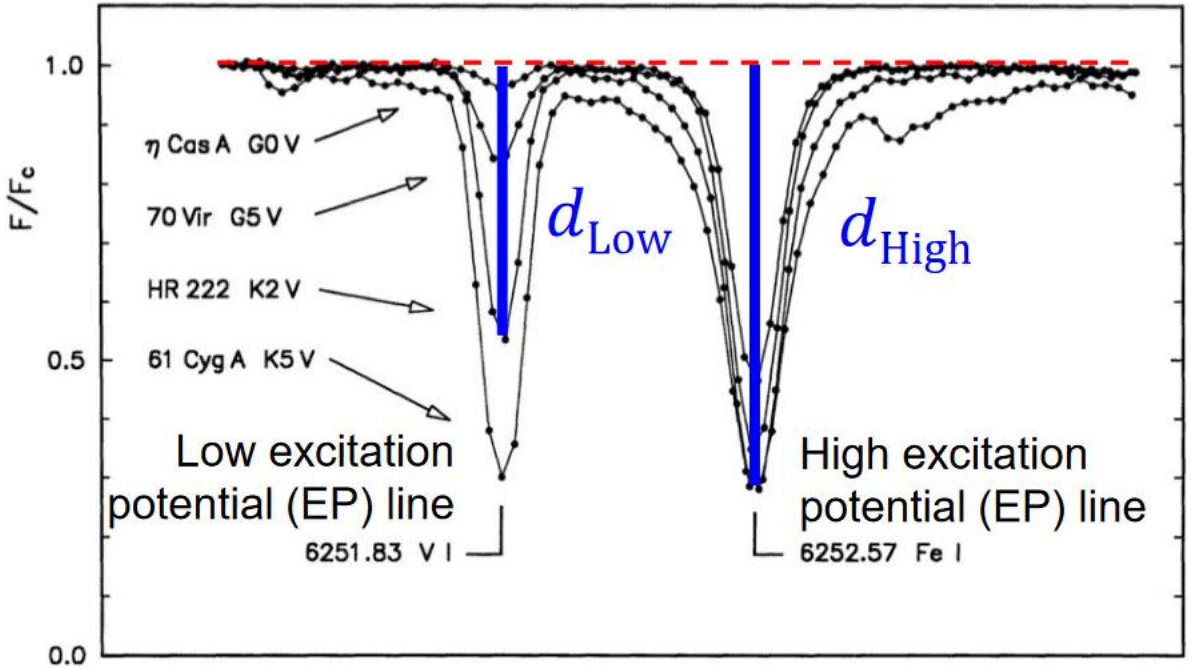


Credit: BASS2000

Line-depth ratio (LDR) method

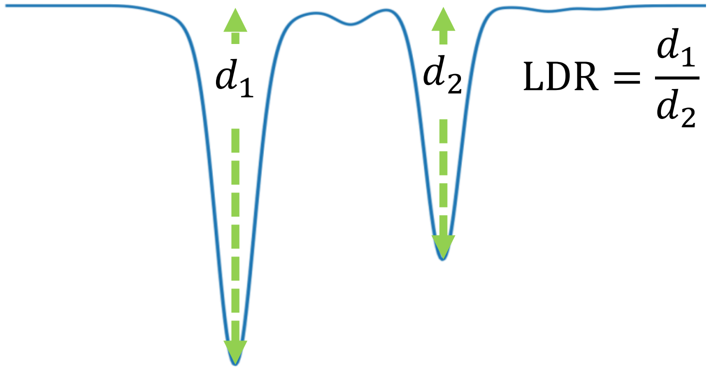
- Spectral lines have different reaction to T_{eff} change.
- Low EP line is sensitive to T_{eff} while high EP line is not.
- $\text{LDR} = \frac{d_{\text{low}}}{d_{\text{high}}}$ -> T_{eff} indicator

- Empirical, easy to calibrate/use;
- Can achieve high precision (~10K).

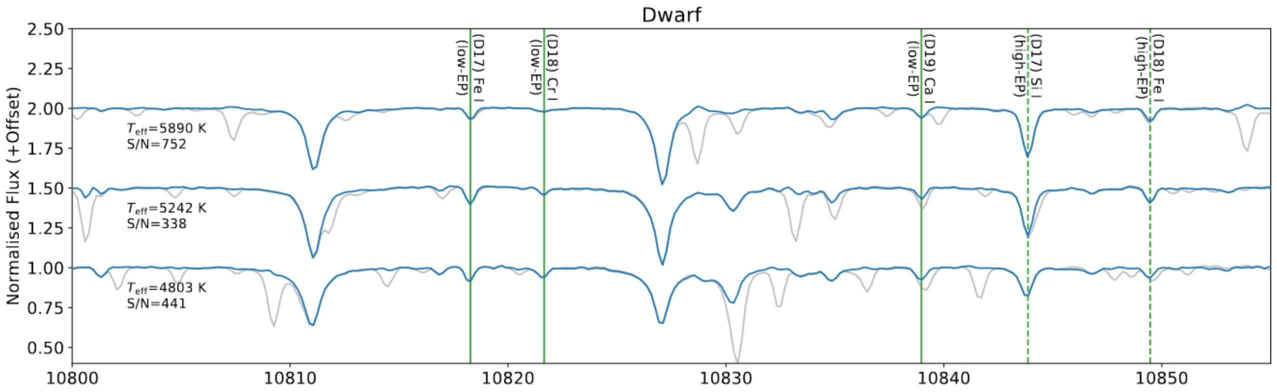


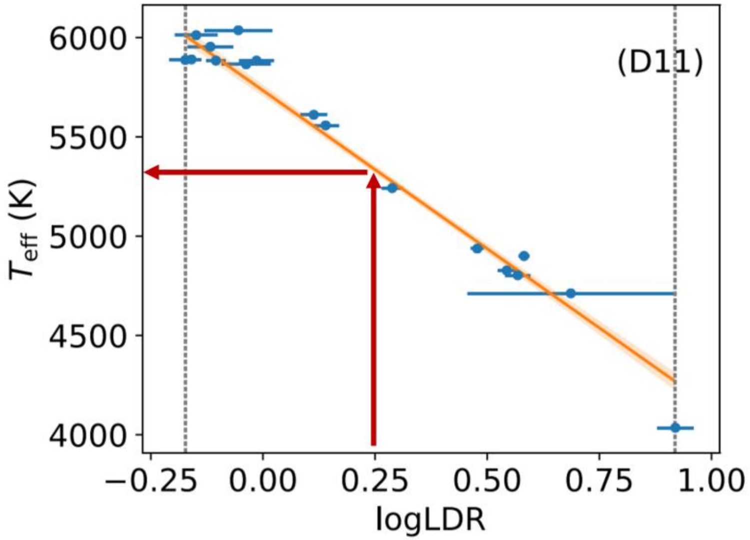
(Gray 1994)

Line-depth ratio (LDR) method



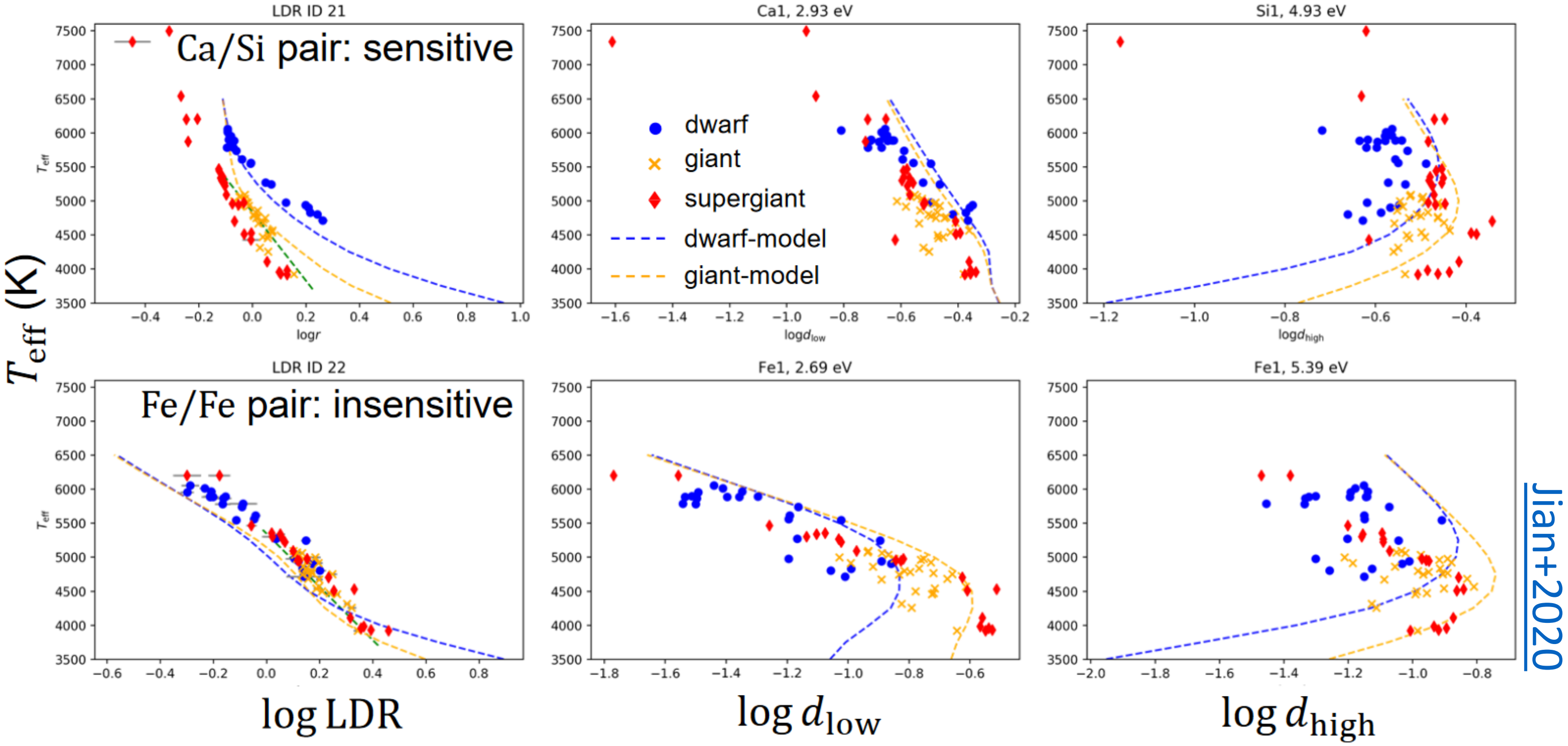
- Well developed in the optical but not in the NIR.
- Line depths are also altered by other parameters
  - $\log g$, [Fe/H]





LDR: gravity effect

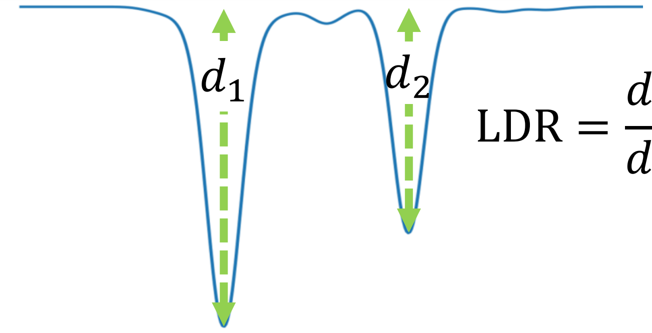
- Whether most of the atoms are in neutral or ionized states determines the line $\log g$ sensitivity.



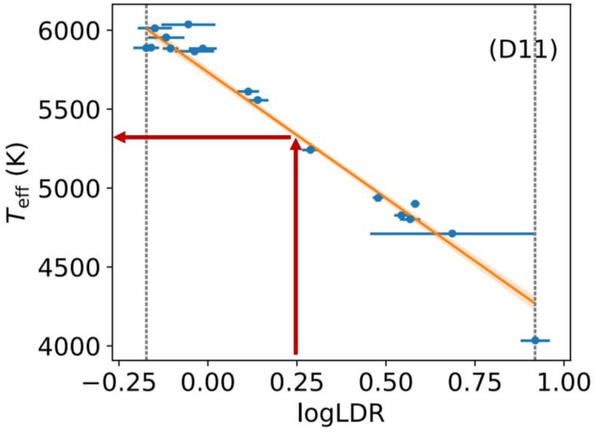
- Use line pairs with similar ionization energy, or calibrate the relations for dwarfs, giants and supergiants separately.

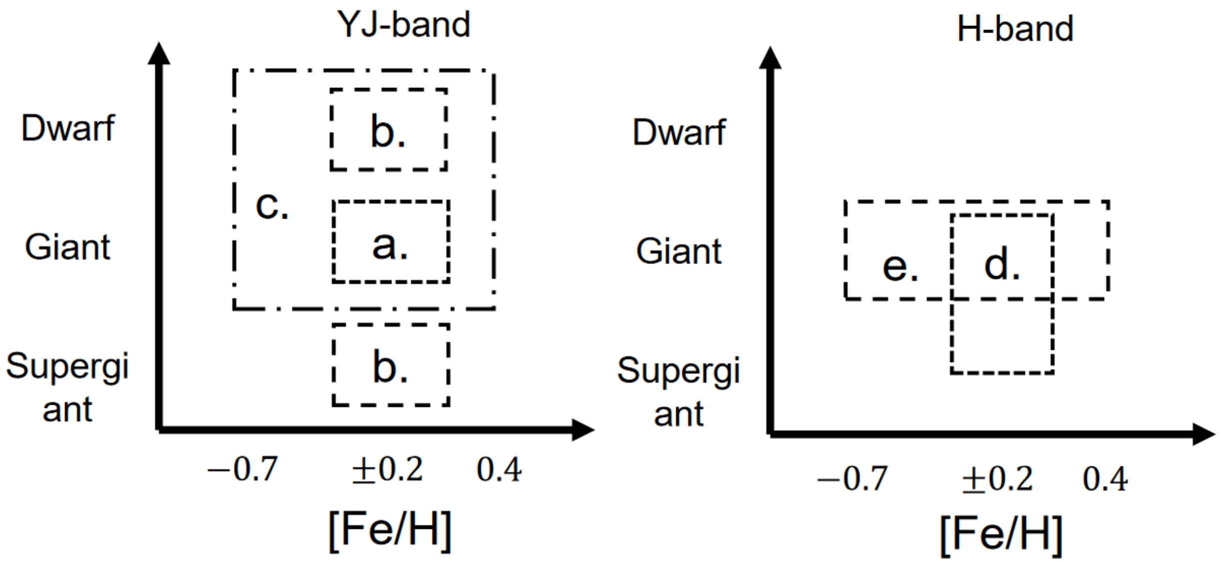
$T_{\mathrm{eff}} \rightarrow \log g \rightarrow V_{\mathrm{micro}}, [\mathrm{M/H}] \rightarrow [\mathrm{X/Fe}]$

The LDR-Teff relations in the NIR



$$\mathrm{LDR} = \frac{d_1}{d_2}$$

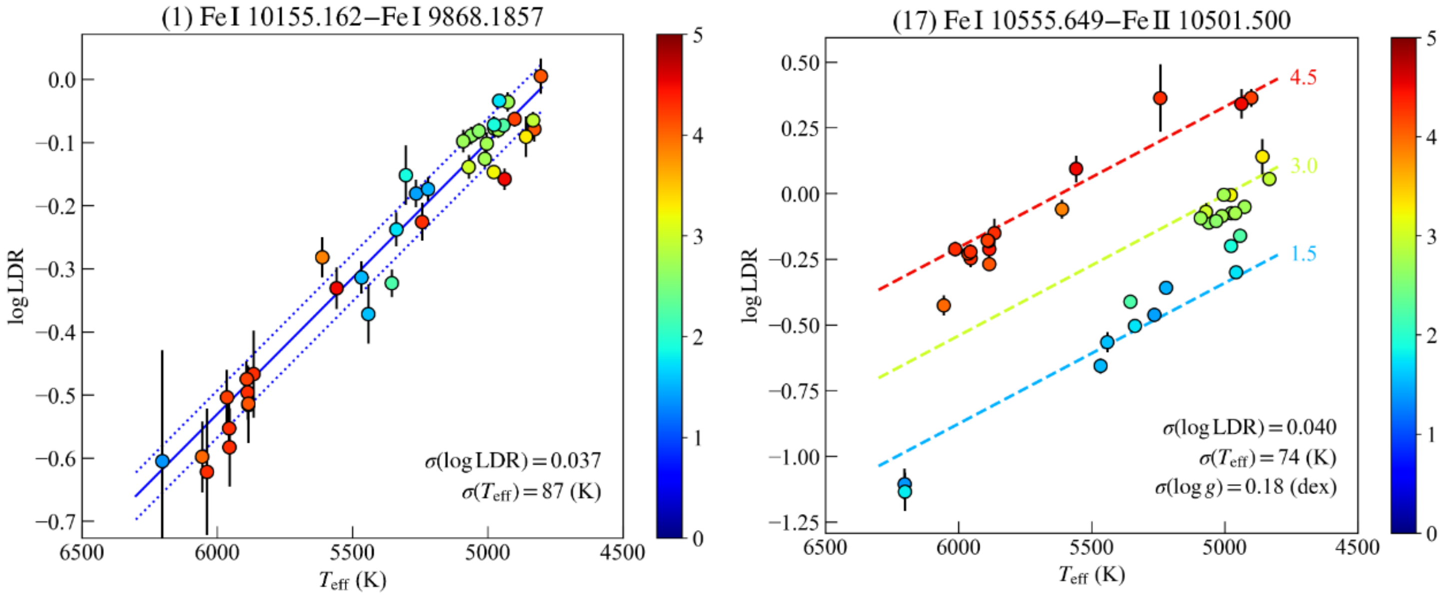




a. Taniguchi+2018, 10-30K, solar-metal stars only;
b. Jian+2020, 10-30K, solar-metal stars only;
c. Jian+in prep, ~20K;
d. Fukue+2015, ~60K, solar-metal stars only;
e. Jian+2019, 30-90K;

Measuring $\log g$

- Ionization balance
  - Ionized lines are sensitive to $\log g$
  - X I and X II should gives consistent [X/Fe] in a $\log g$.
- LDR
  - Use X I and X II line pairs
  - Precision: 50 K and 0.2 dex

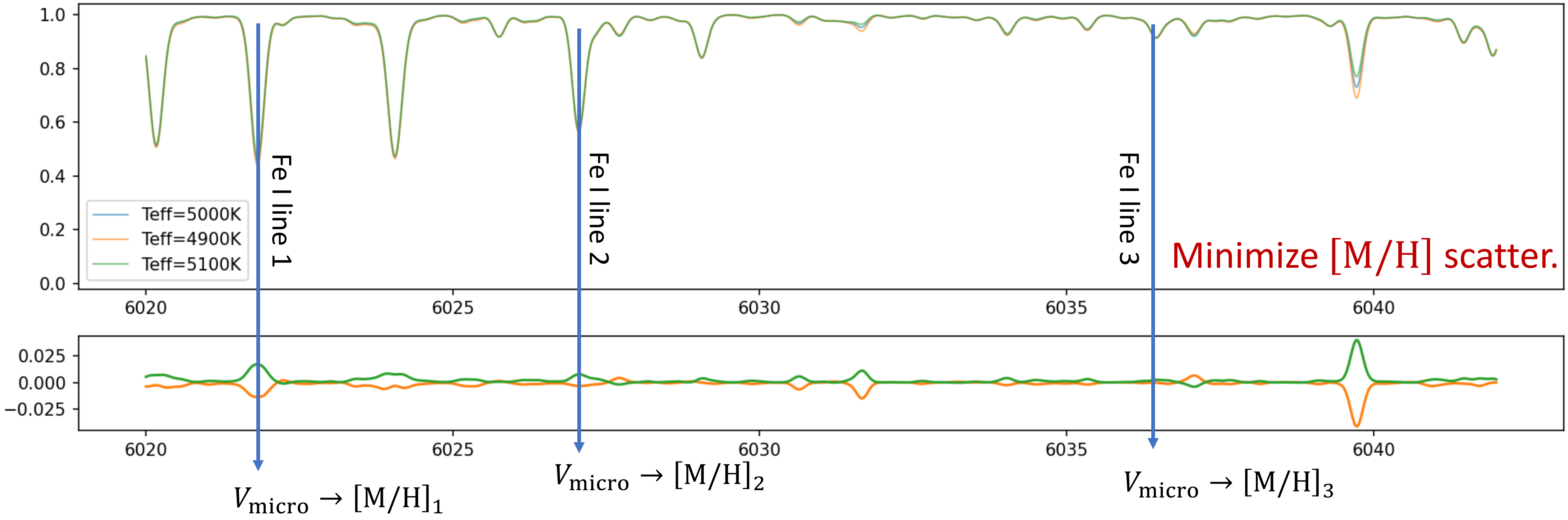


Matsunaga+2021

Measuring V_{micro} and [M/H]: MPFIT

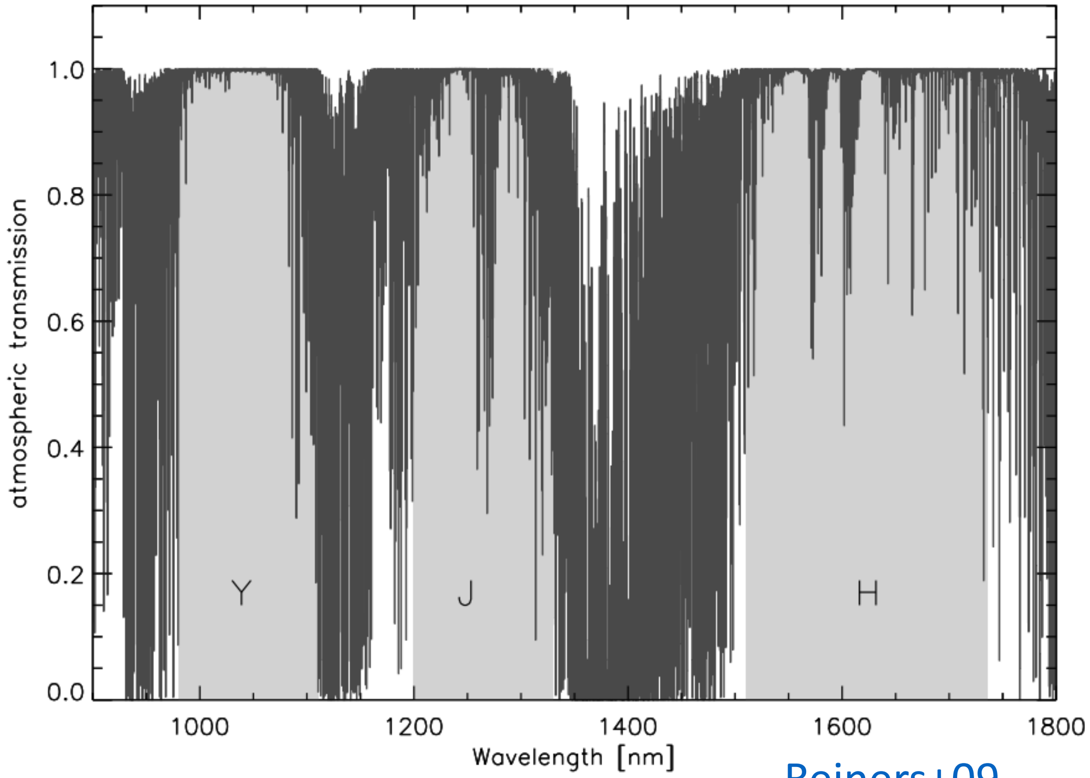
Takeda (1995), inside pymoog

- V_{micro} is degenerated with [Fe/H]



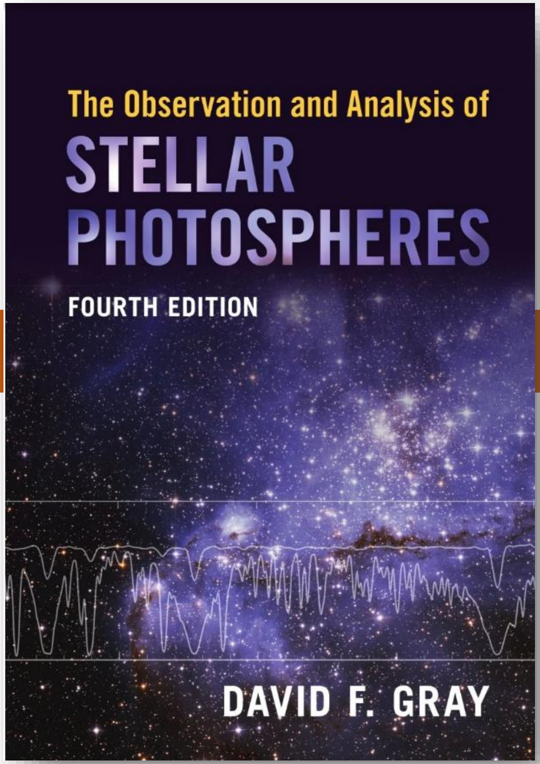
Useful resources

- Telluric line correction
  - [Welcome to TelFit's documentation! — TelFit 1.3.0 documentation]
- Continuum normalization
  - AFS ([Xu+2019])



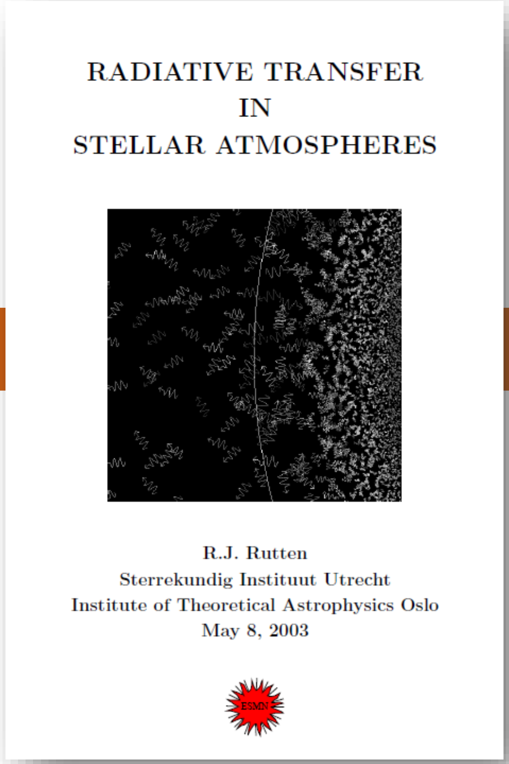
Reiners+09

Further reading



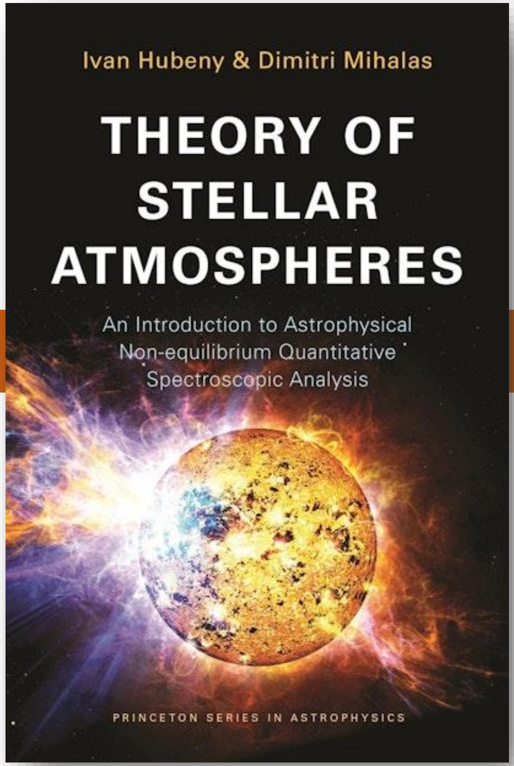
Easy
Practical
No NLTE
[(Note)]

[Link to the book]



Normal
Theory
NLTE
(also other books)

[Link to the book]



Dictionary
Wikipedia
Bible

[Link to the book]