



Systematic Uncertainties in Stellar Spectroscopy

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Line-list group
Lumba node

Systematic uncertainties

Developments within GES

- **Atomic data : transition probabilities**
- NLTE and 3D : H, Na, Mg, Ca, Fe

Line-list version 5

- Access via <http://ges.roe.ac.uk>
- Fits-format same as v4, except e.g.:
 - NAME → NAME1, NAME2, NAME3
 - LOG_GF_REF → LOGGFREF
- Plots available on the line-list wiki:
<http://great.ast.cam.ac.uk/GESwiki/GesWg/GesWg11/Linelists>
- Extended to cover the full range 4200-9200Å, to allow UVES RED520 analysis **for cool stars** (<8000K).
- Updated VALD3 extraction as basis for atomic lines and some updates of molecular data
- New isotopologues : 25MgH, 26MgH, 12C15N
- Updated transition probabilities for Ca, Ni, Fe and Y.



Atomic data: Fe

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Fe I Oscillator Strengths for the Gaia-ESO Survey

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Fe I OSCILLATOR STRENGTHS FOR TRANSITIONS FROM HIGH-LYING EVEN-PARITY LEVELS

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G. Nave⁴

New experimental data
for 228 Fe I lines

SECURITY LEVELS

Fe I OSCILLATOR STRENGTHS

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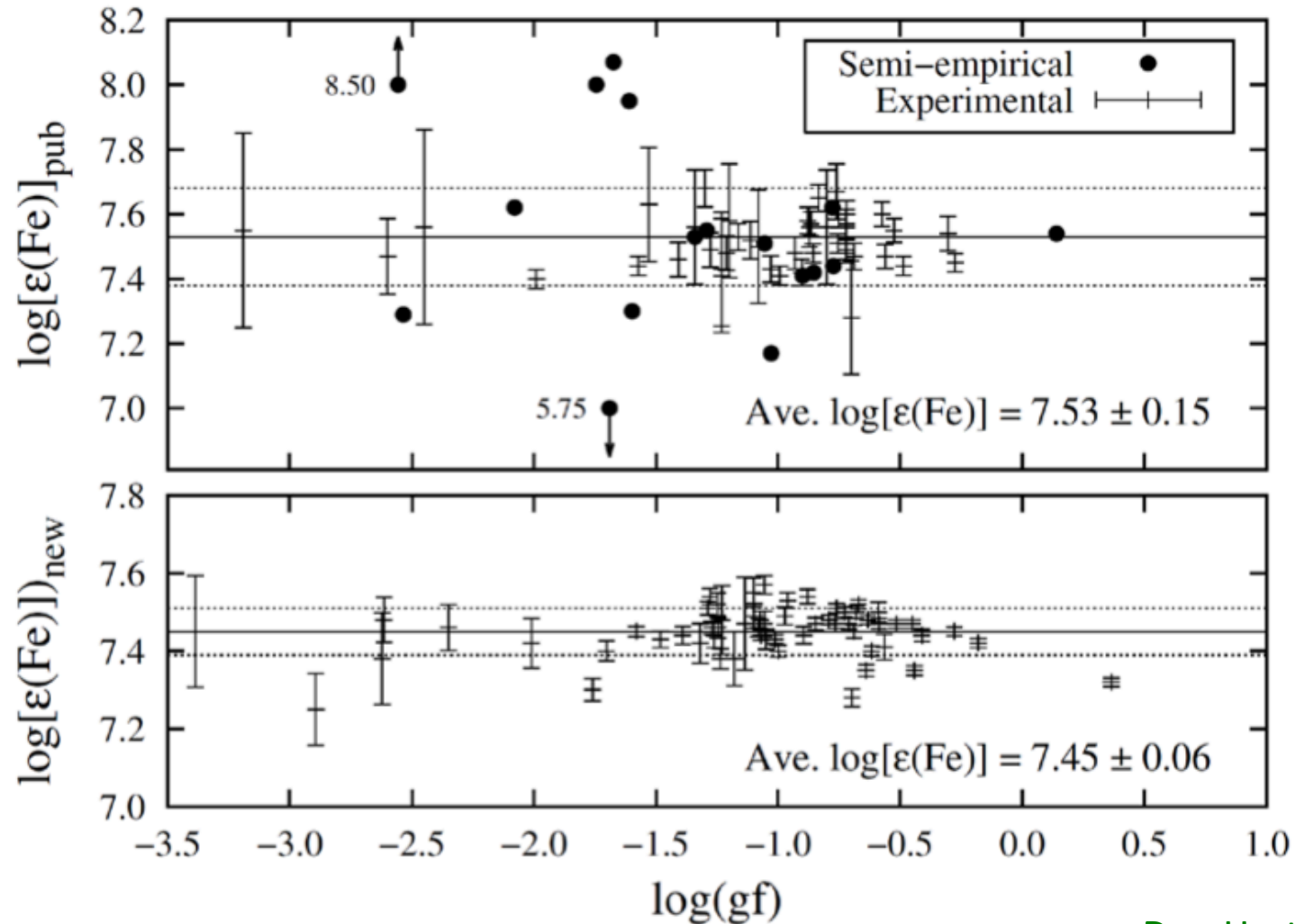
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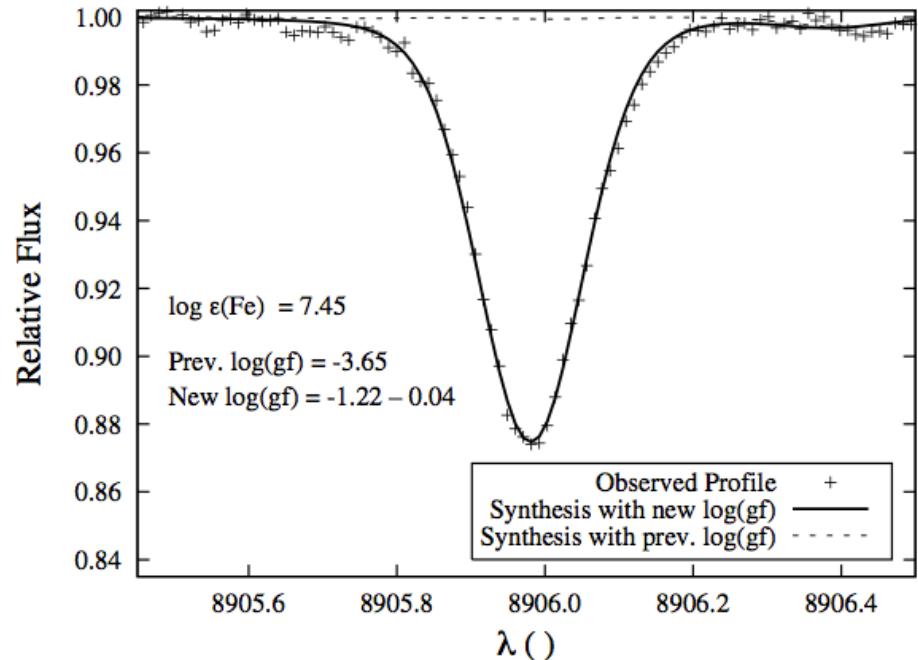
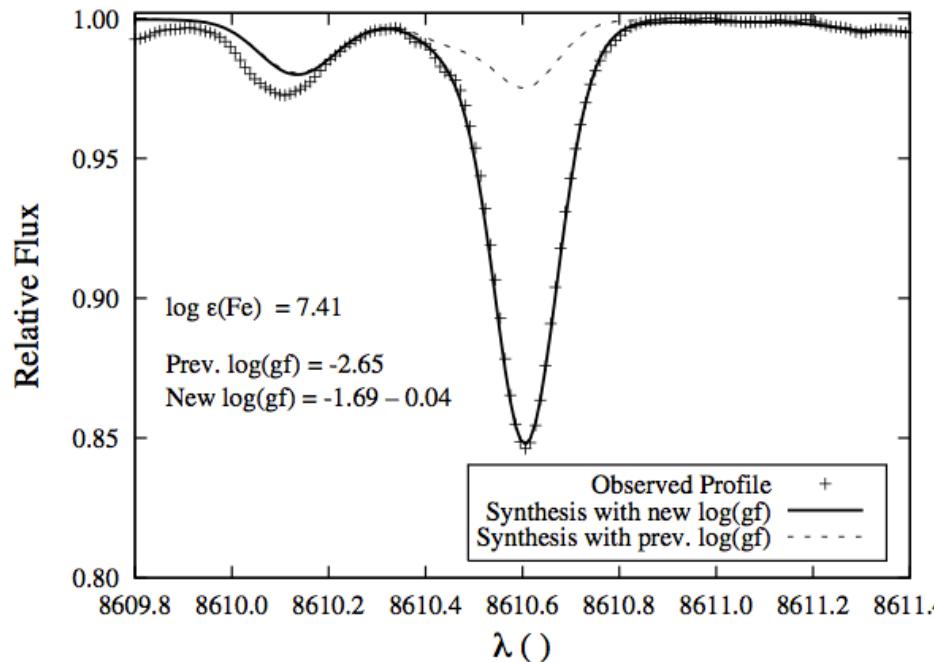
e-mail: eadenhar@wisc.edu

Atomic data : Fe



Atomic data: Fe

Solar synthesis



Note that the atomic line-list is still full with semi-empirical $\log(gf)$ values for Fe and other species. Be cautious with these lines !

Systematic uncertainties

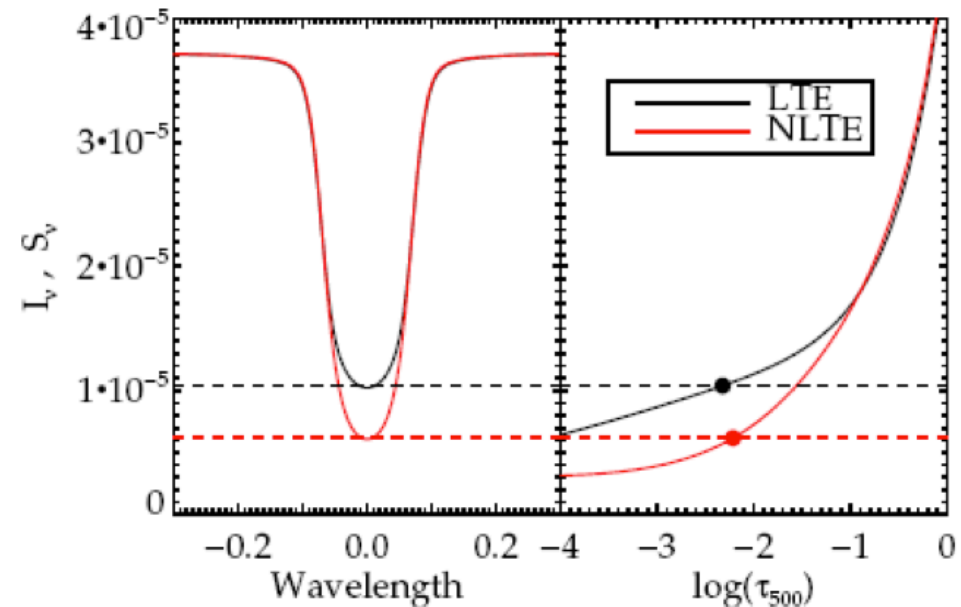
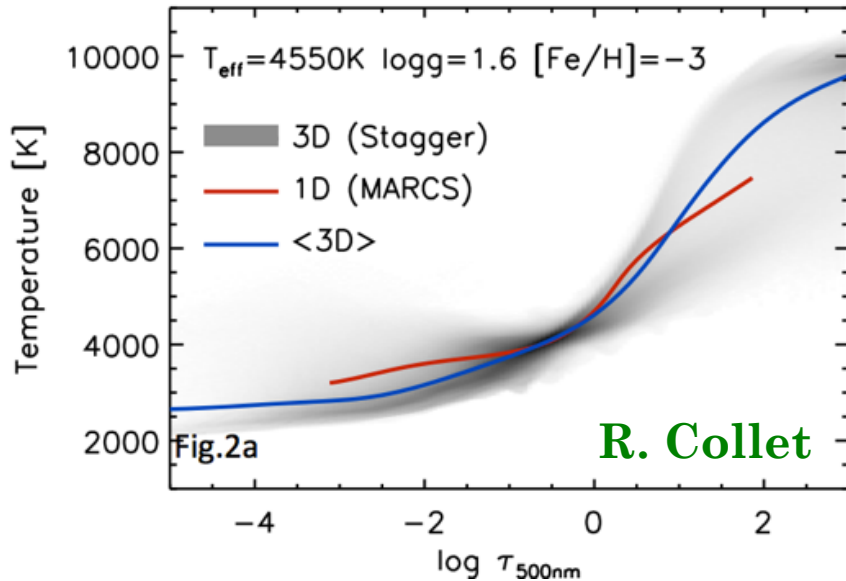
Developments within GES

- Atomic data : transition probabilities
- **NLTE and 3D : H, Na, Mg, Ca, Fe**

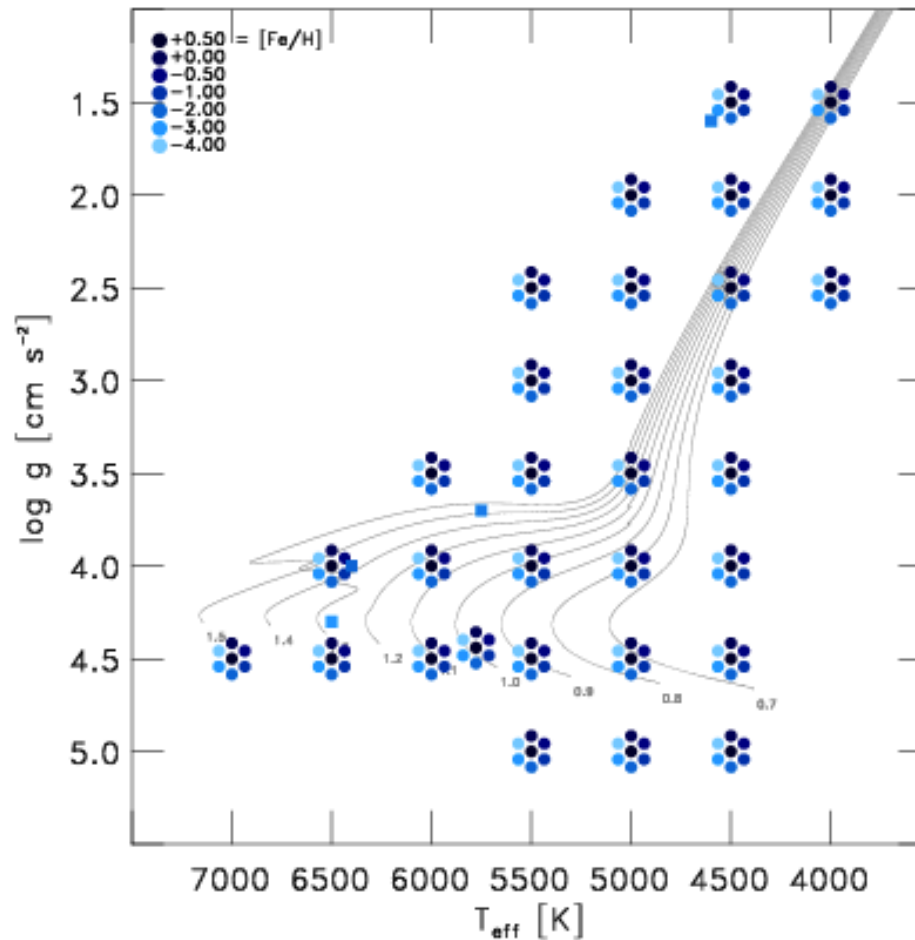
Methods

Model atmosphere
1D/<3D>/3D LTE

Detailed rad. transfer
1D/3D LTE/NLTE



Stagger 3D grid

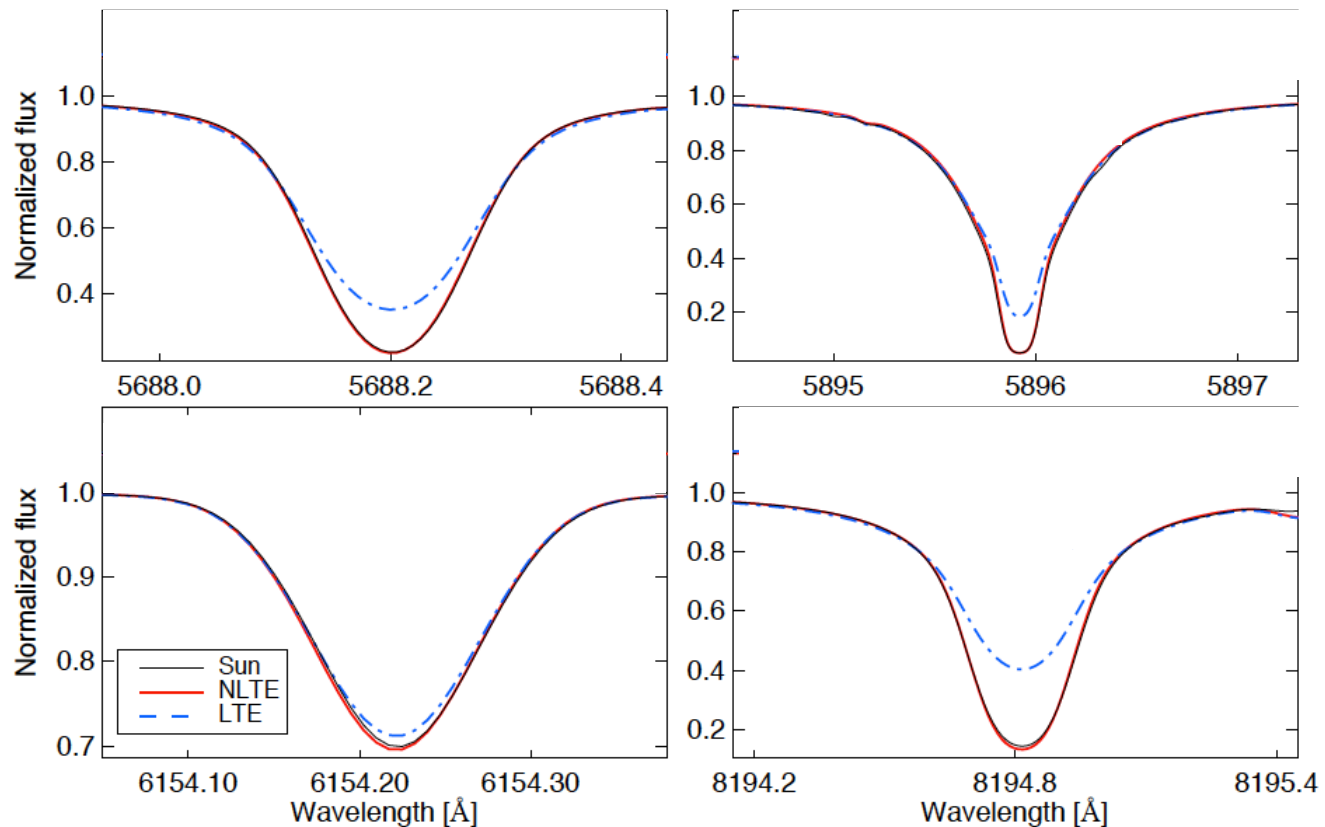


<3D> model grid
can be found on CDS

NLTE for large samples

Pre-computed departure coefficients \rightarrow NLTE synthesis

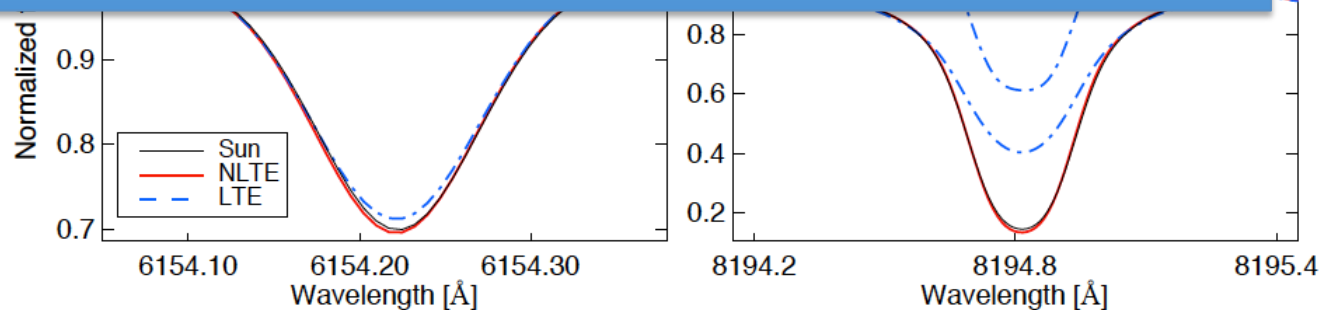
Na I lines
in the Sun



NLTE for large samples

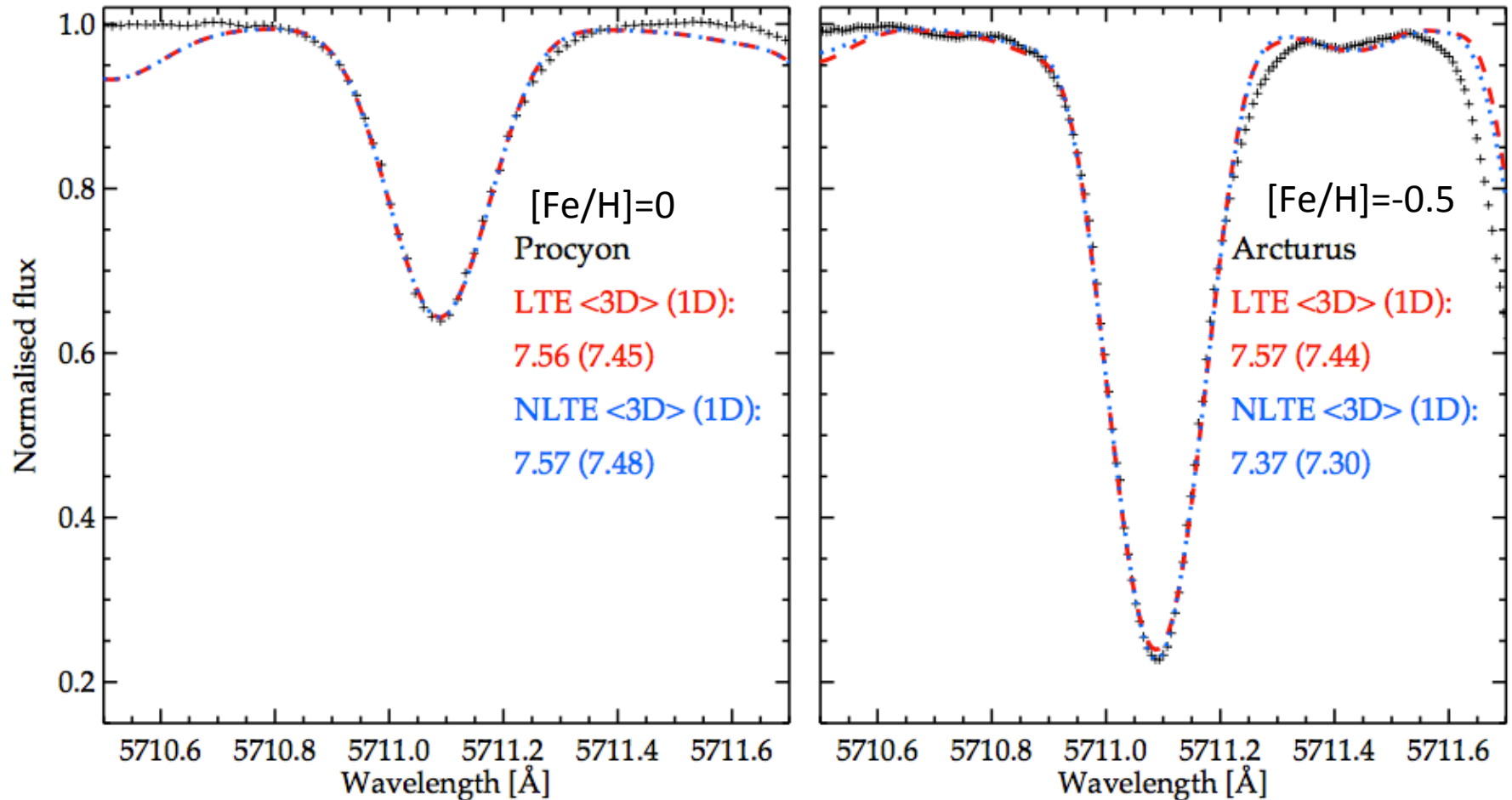
Pre-computed departure coefficients \rightarrow NLTE synthesis

**Automated 1D and <3D>
NLTE synthesis with SME**

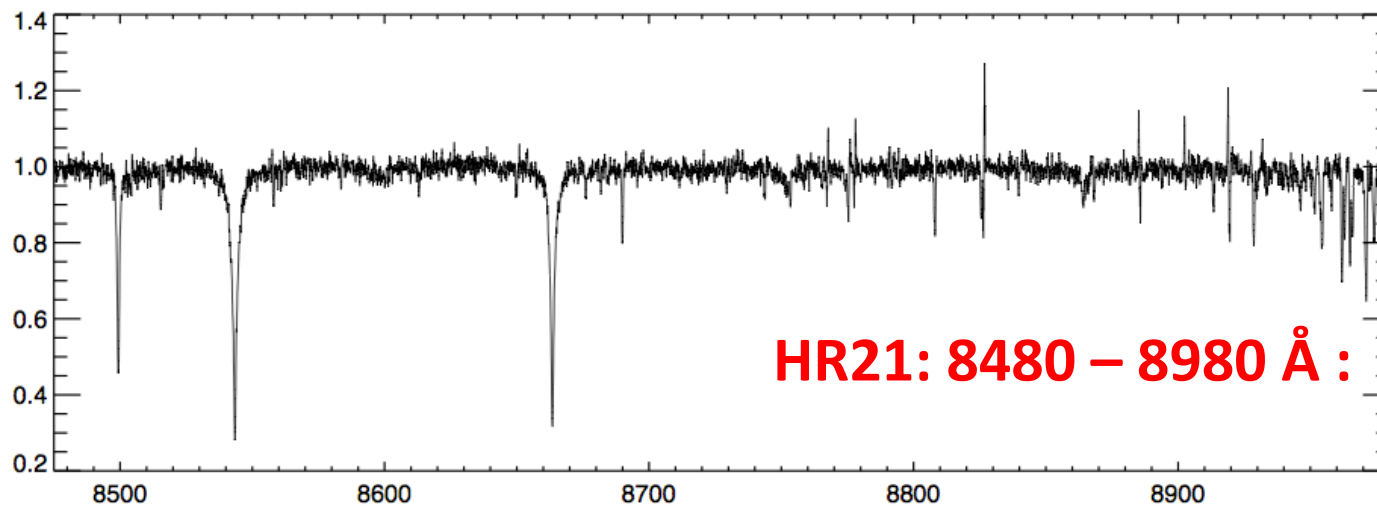
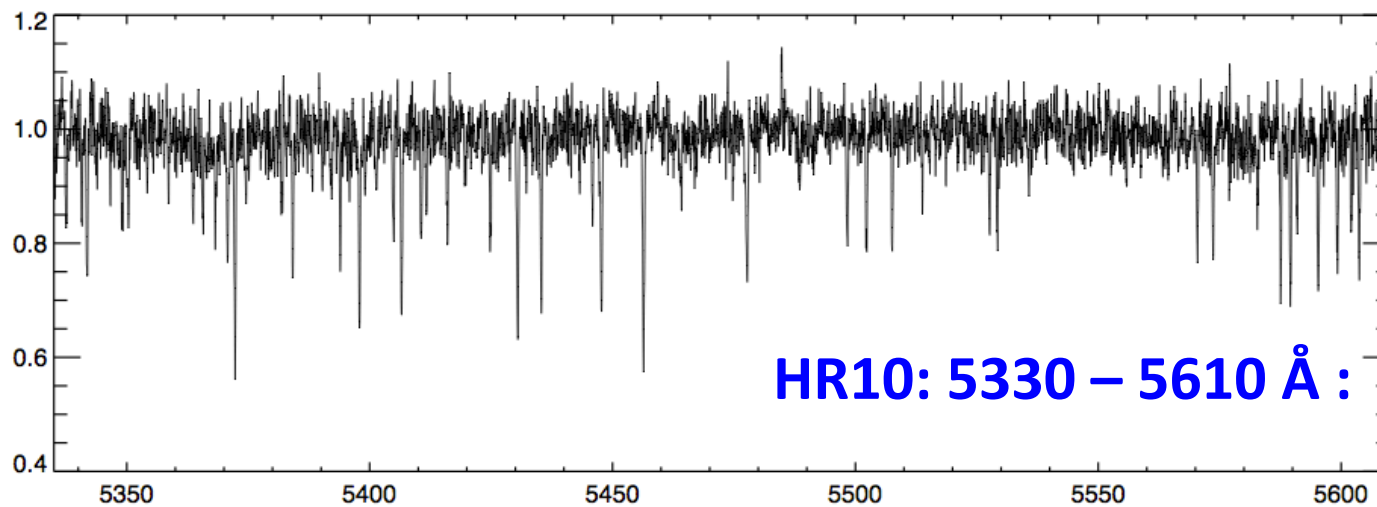


Mg

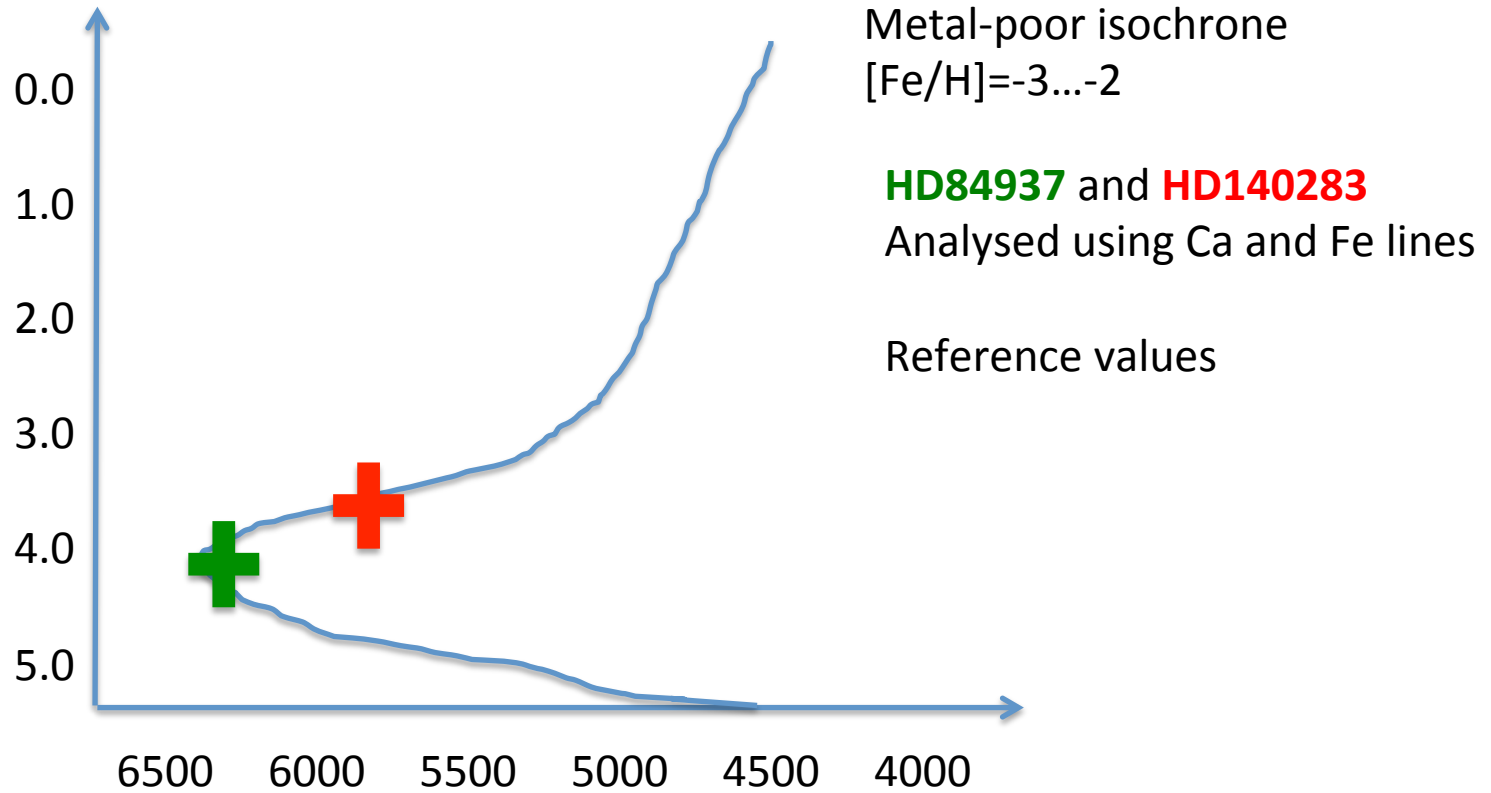
“Chemical tagging” of a turn-off star and a red giant



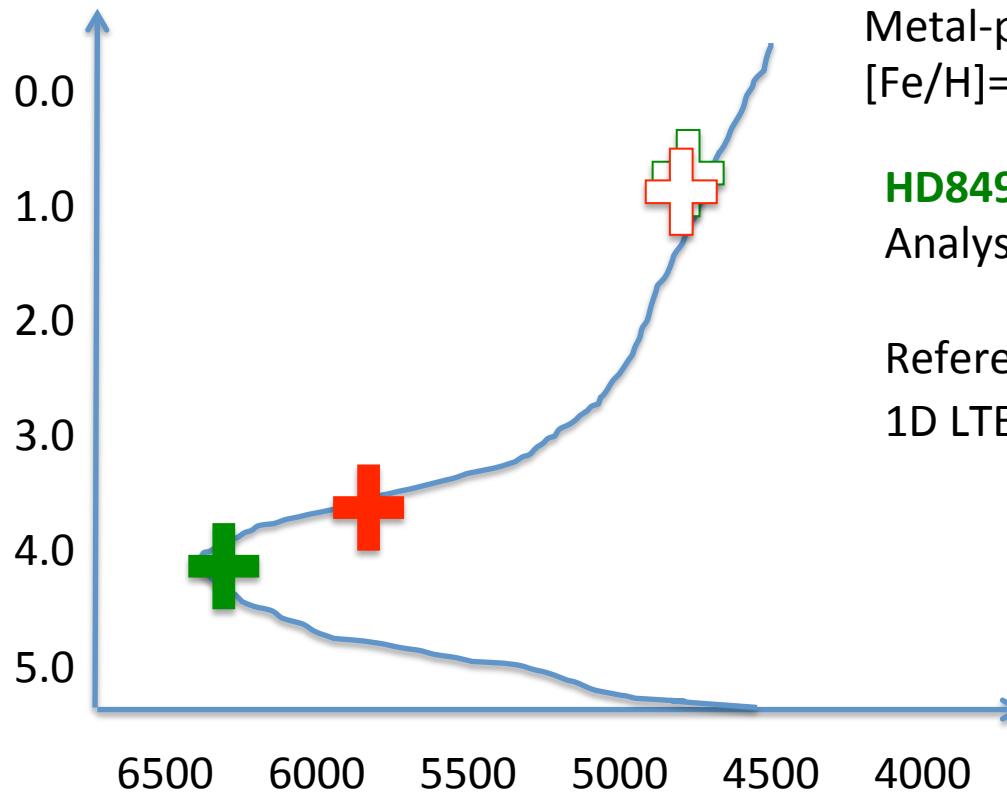
HR10 and HR21



Ca NIR triplet



Ca NIR triplet

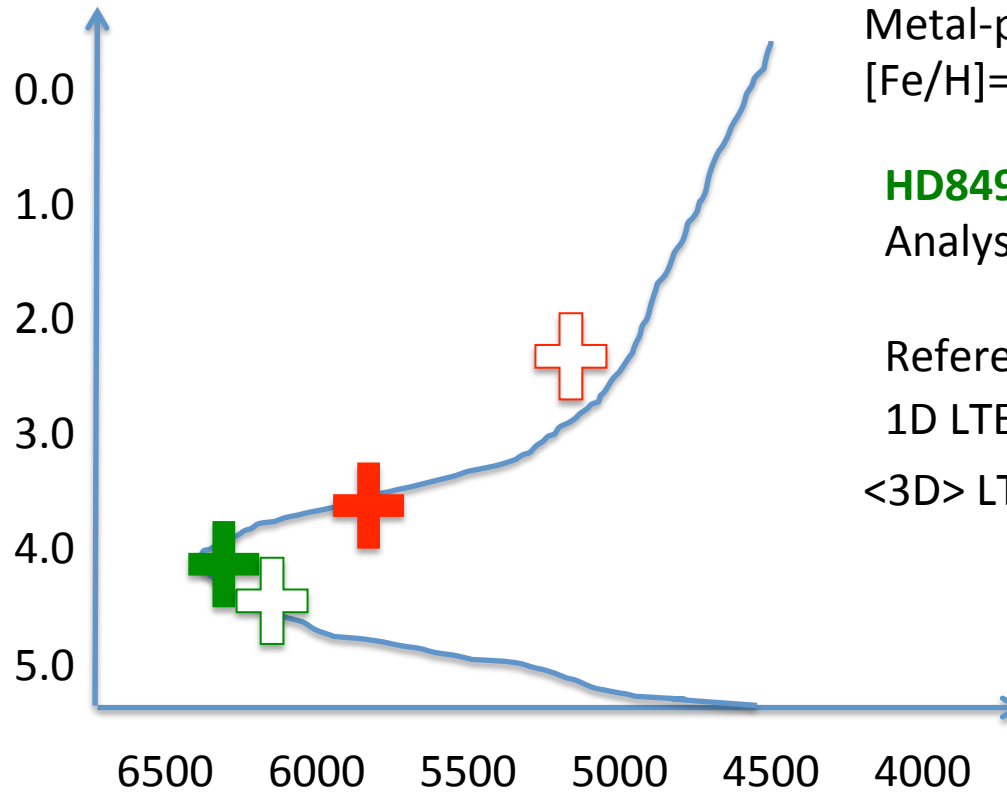


Metal-poor isochrone
[Fe/H]=-3...-2

HD84937 and **HD140283**
Analysed using Ca and Fe lines

Reference values
1D LTE, including Ca II line cores

Ca NIR triplet

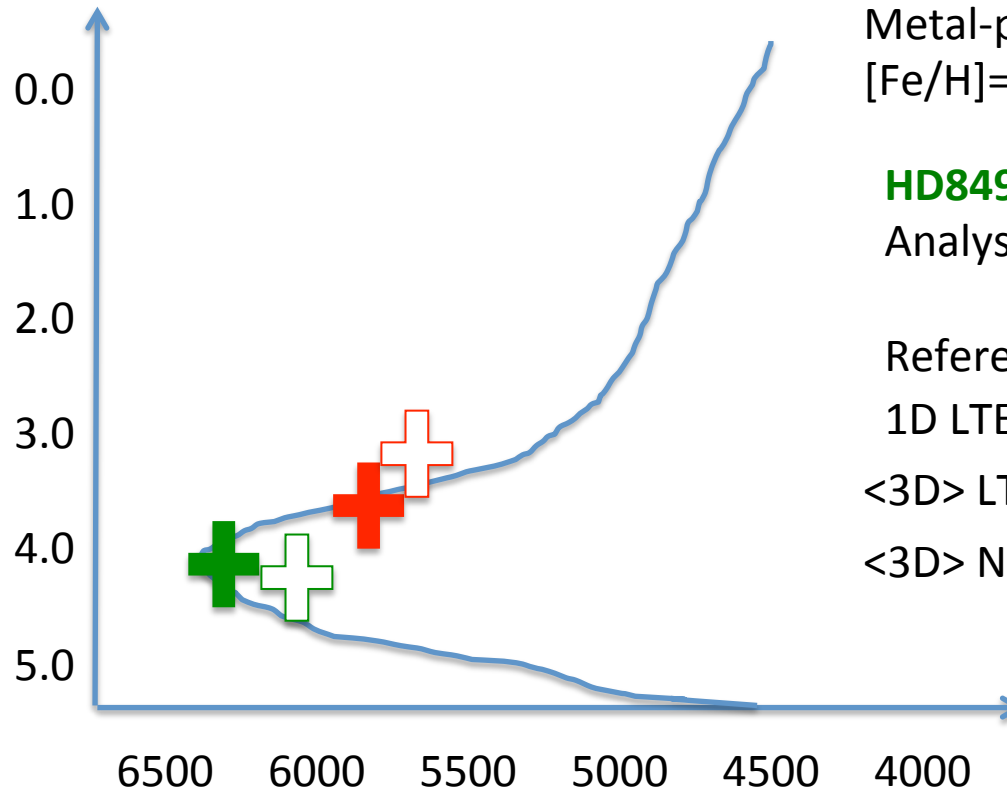


Metal-poor isochrone
[Fe/H]=-3...-2

HD84937 and **HD140283**
Analysed using Ca and Fe lines

Reference values
1D LTE, including CaII line cores
<3D> LTE, including CaII line cores

Ca NIR triplet



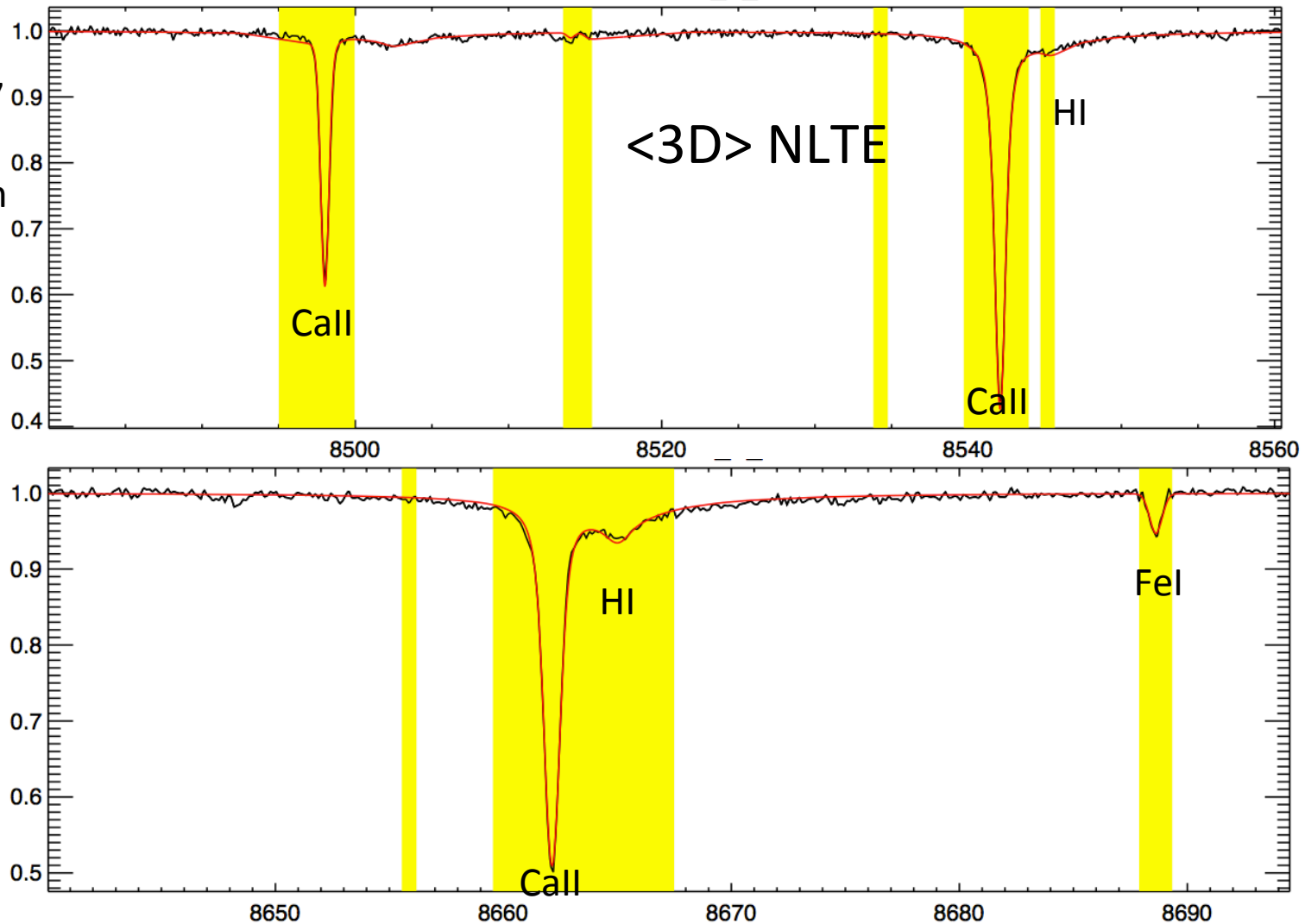
Metal-poor isochrone
 $[Fe/H] = -3 \dots -2$

HD84937 and **HD140283**
 Analysed using Ca and Fe lines

Reference values
 1D LTE, including Call line cores
 <3D> LTE, including Call line cores
 <3D> NLTE, including Call line cores

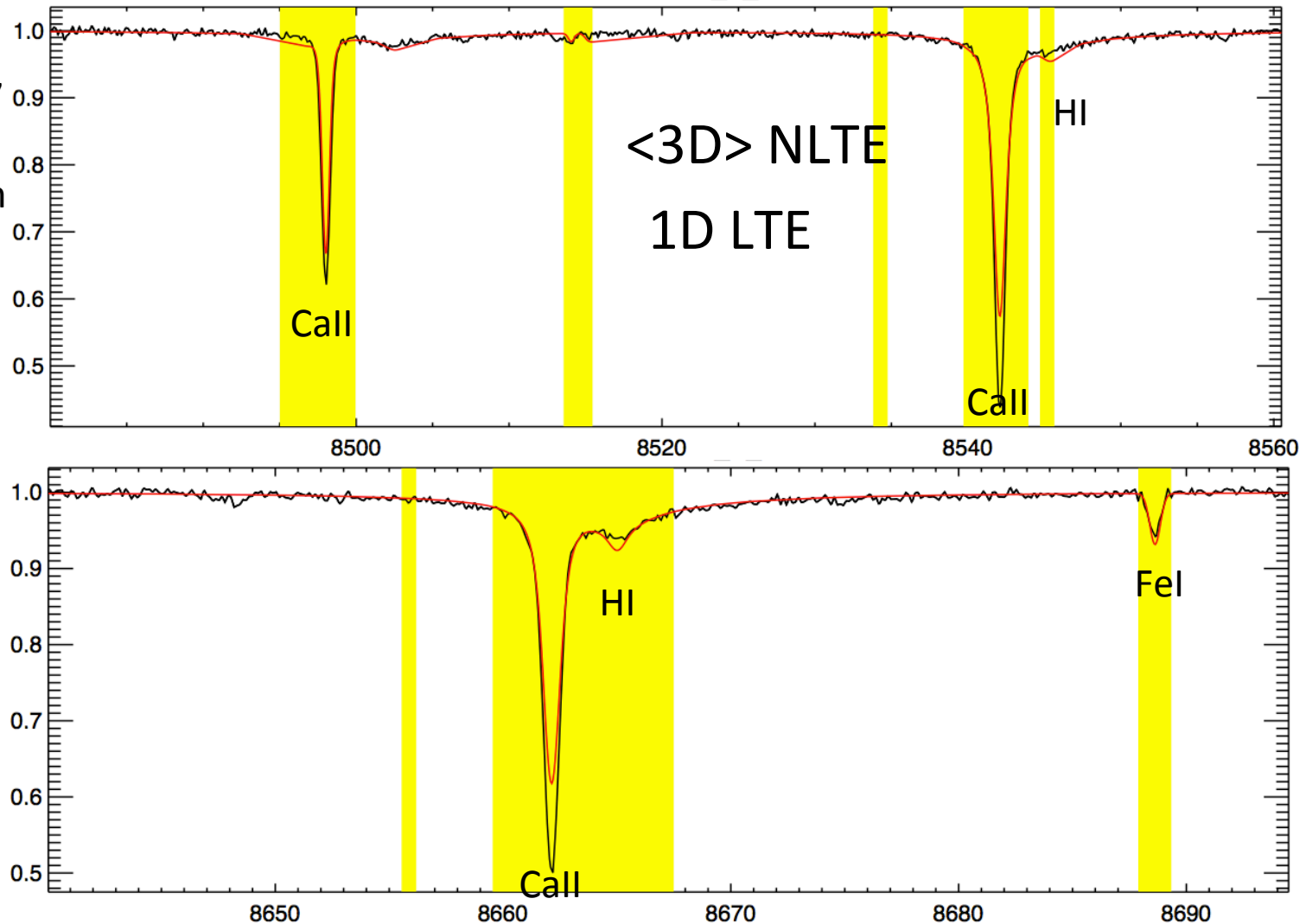
Ca NIR triplet

HD84937
GES
spectrum
HR21



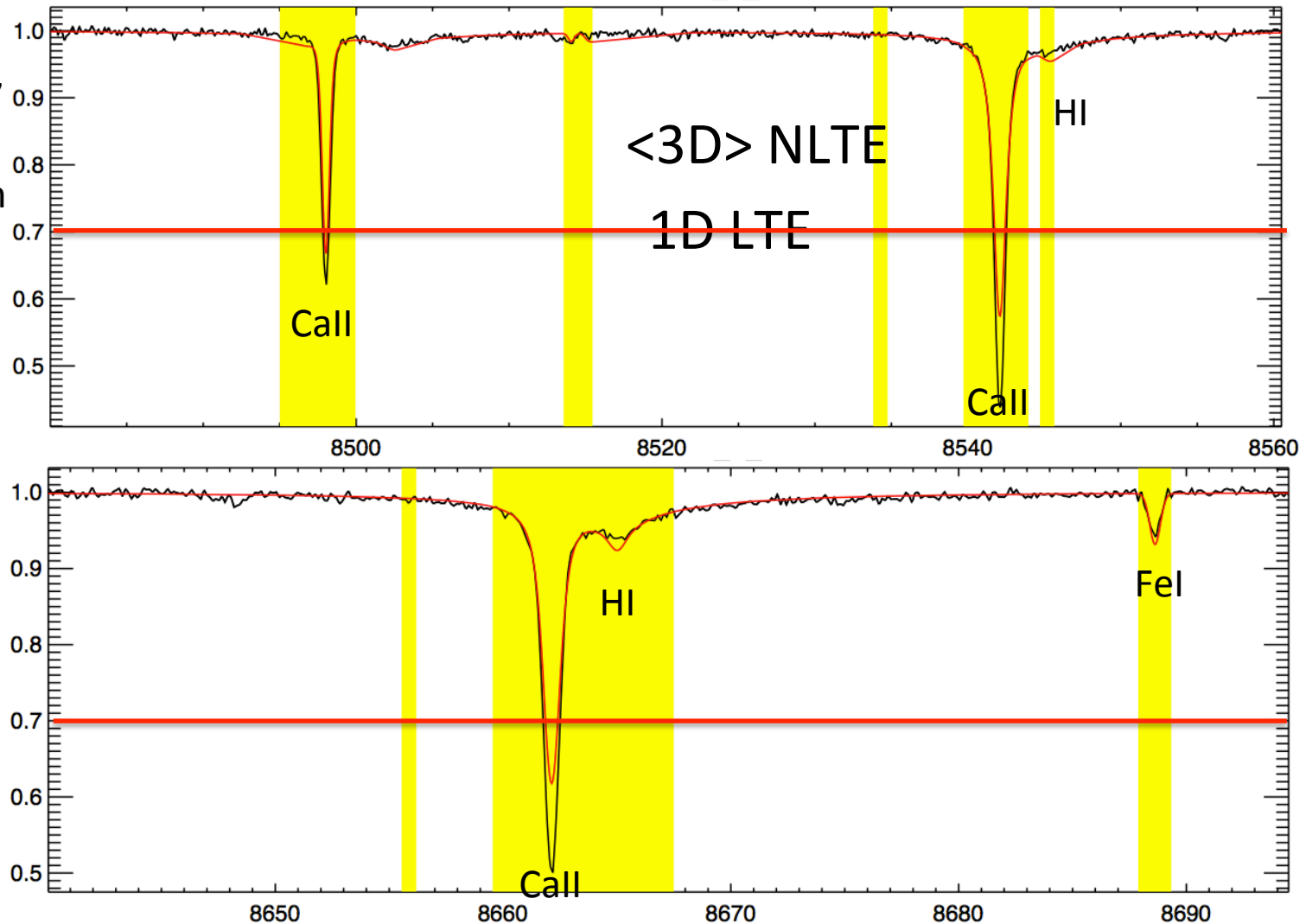
Ca NIR triplet

HD84937
GES
spectrum
HR21

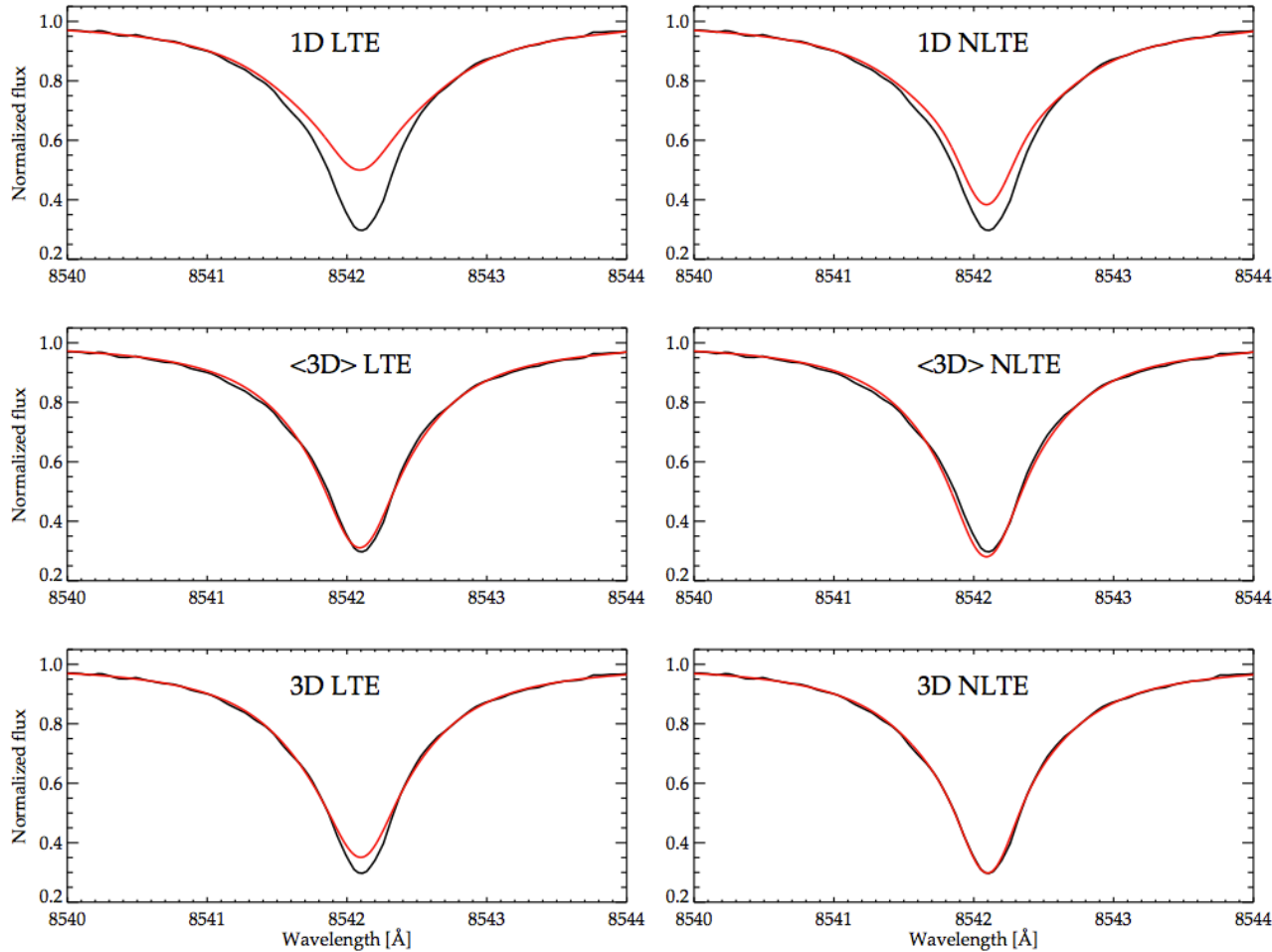


Ca NIR triplet

HD84937
GES
spectrum
HR21



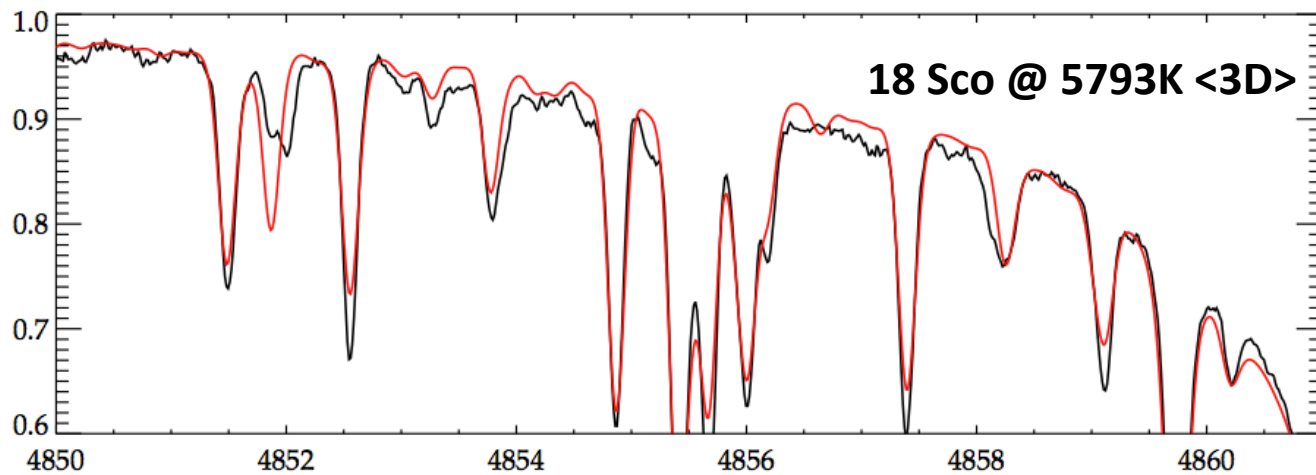
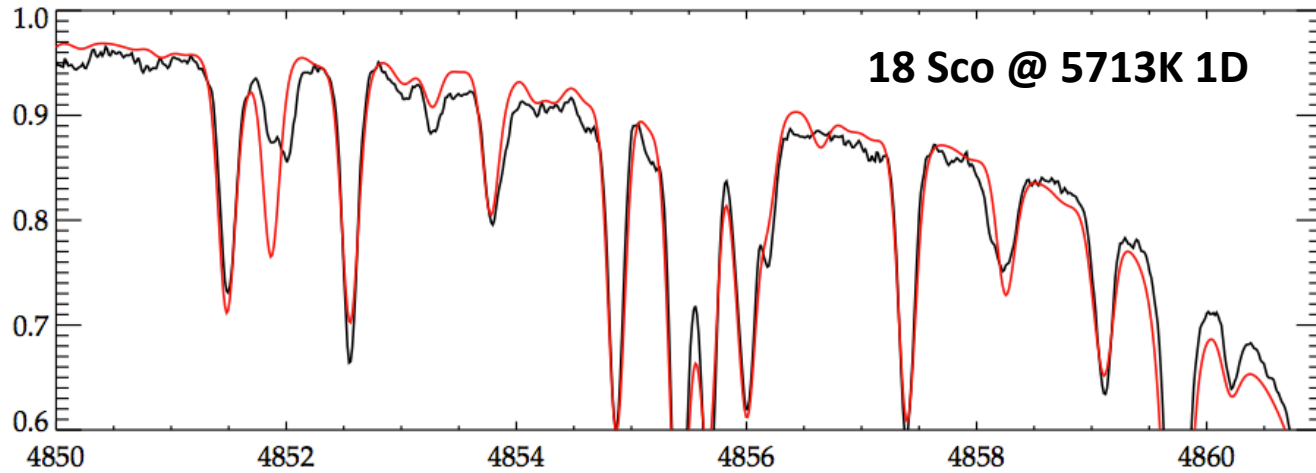
Ca NIR triplet



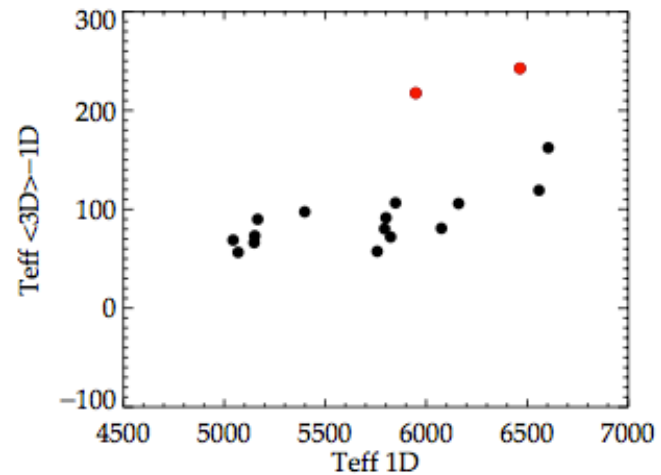
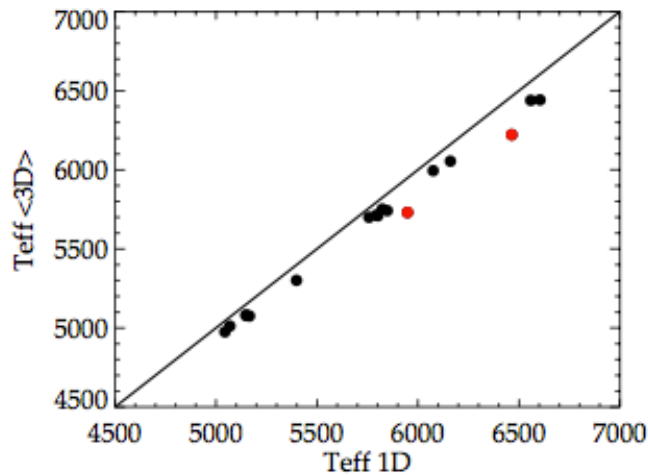
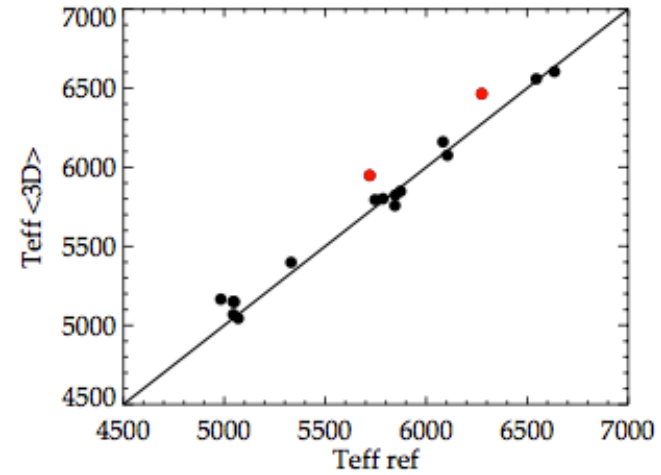
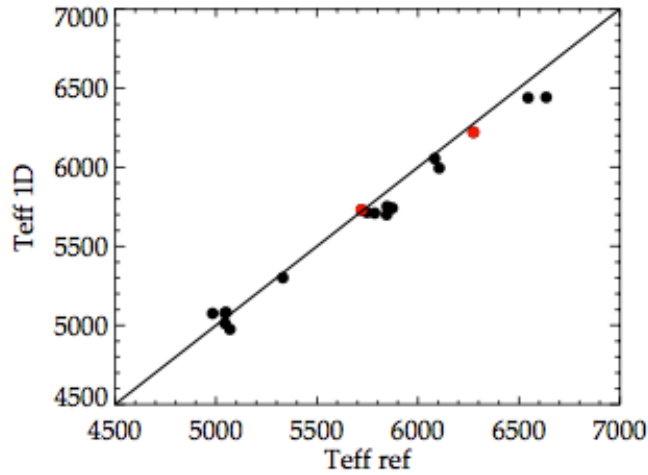
Metal-poor dwarf

Same parameters
Same Ca abundance

Balmer lines



Balmer lines



Conclusions

- The line-list group is continuously improving the common GES line-list. Version 5 is now available through WFAU and spectral atlases can be found on the line-list wiki.
- A large grid of <3D> Stagger models was published earlier this year by Magic, Collet, Asplund et al. They prove superior to 1D models in the synthesis of e.g. Balmer lines and CaII NIR triplet.
- Automated NLTE analysis is possible for several astrophysically crucial elements
- **How should non-standard analysis methods be treated in GES?**