# Abundance Analyses of Post-AGB Stars With Disks

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Within the framework of the HERMES Binary Survey:

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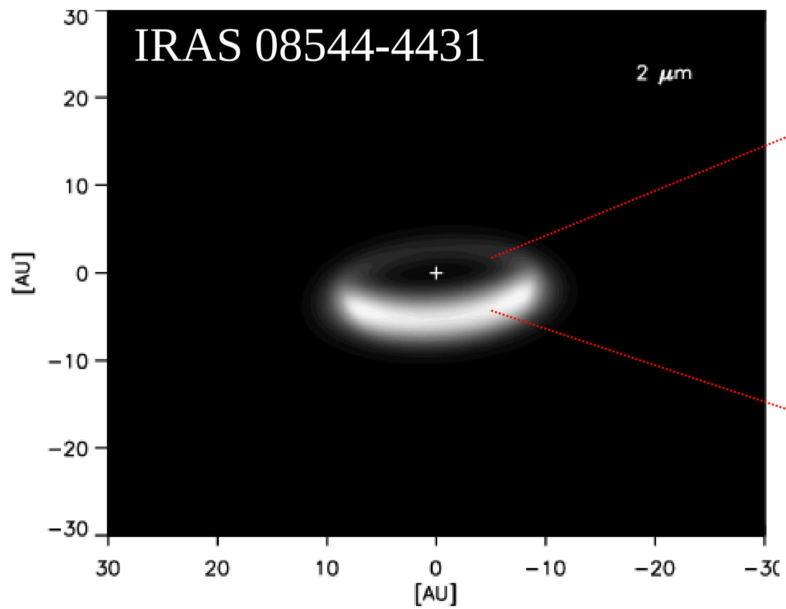
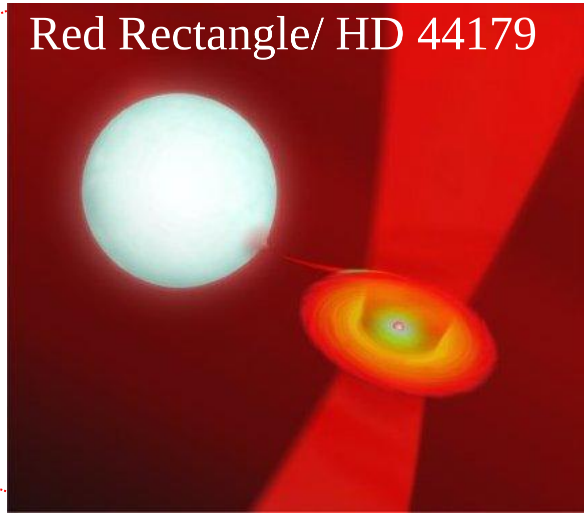
*G. Van de Steene (Royal Observatory of Belgium)*

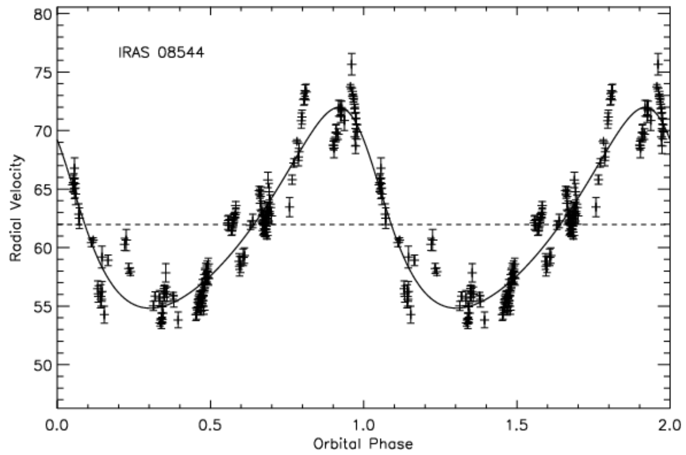
# The Sample: post-AGB Giants with Dusty Disks



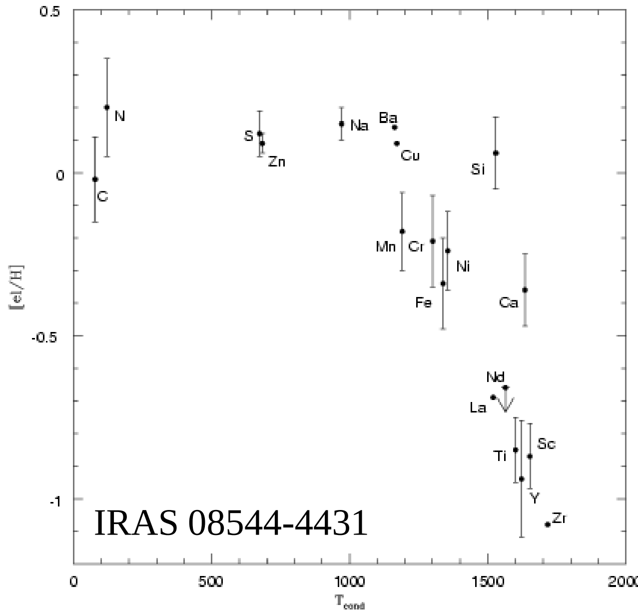

*De Roo et al. 2007, A&A, 474, L45*




*Witt et al. 2009, ApJ, 693*




*Van Winckel et al., 2009, A&A, 505,1221*




*Maas et al. 2003 A&A 405, 271*

*Van Aarle et al. 2011, A&A, submitted:*

50% of LMC pAGBs!

# Our Data and Goals

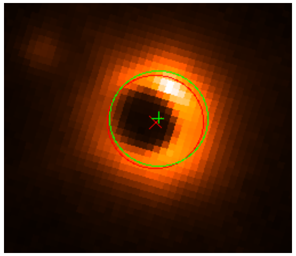
## Spectra:

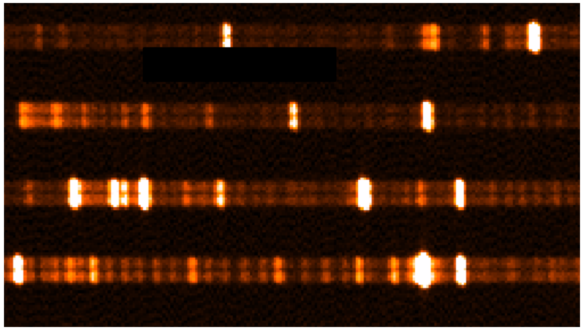
HERMES fiber echelle spectrograph with an image slicer on Mercator 1.2m telescope (La Palma)

R~85,000, Δλ=3800 - 9000A

*Raskin et al. 2010, A&A, 526, 69*

http://www.mercator.iac.es/instruments/hermes/





## Goals:

RV monitoring for binarity

Physical parameters ($T_{eff}$, logg, $V_{micro\text{-}tur}$)

Chemical composition

# Plan of the Talk

Solar abund: phot. from Grevesse et al. 1996 ASPC 99,117

Example case: BD +46 442 F2-5 III V=9.5$^{m}$ S/N~130

1. Teff

Analyses Tools:

2. logg, Vtur, [Fe/H]
3. [X/H]

EW analyses with MOOG by C. Sneden
*http://www.as.utexas.edu/~chris/moog.html*
&
ATLAS9(2003) by R. Kurucz & F. Castelli
*http://wwwuser.oat.ts.astro.it/castelli/grids.html*

4. Comparing with WIDTH9 and Atlas9(1992)

*http://wwwuser.oat.ts.astro.it/castelli/sources/width9.html*

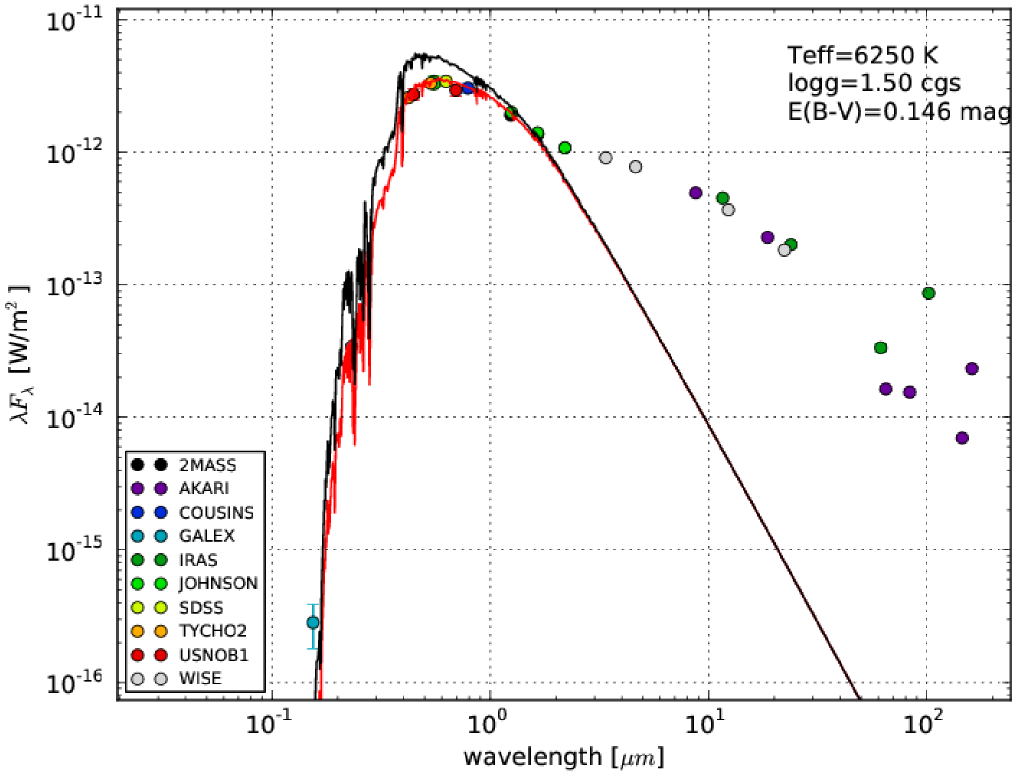
5. Solar oscillator strengths (loggf)

Extended list of
V. Kovtyukh & S. Andrievsky
*1999 A&A 351, 597* (KA99),
based on solar phot. Abs.
of Grevesse et al. 1996 *ASPC 99,117*

# Methods of Teff determination that Did Not Work for Our Star

~~Spectral energy distribution:~~ Near-IR and possibly a UV excess

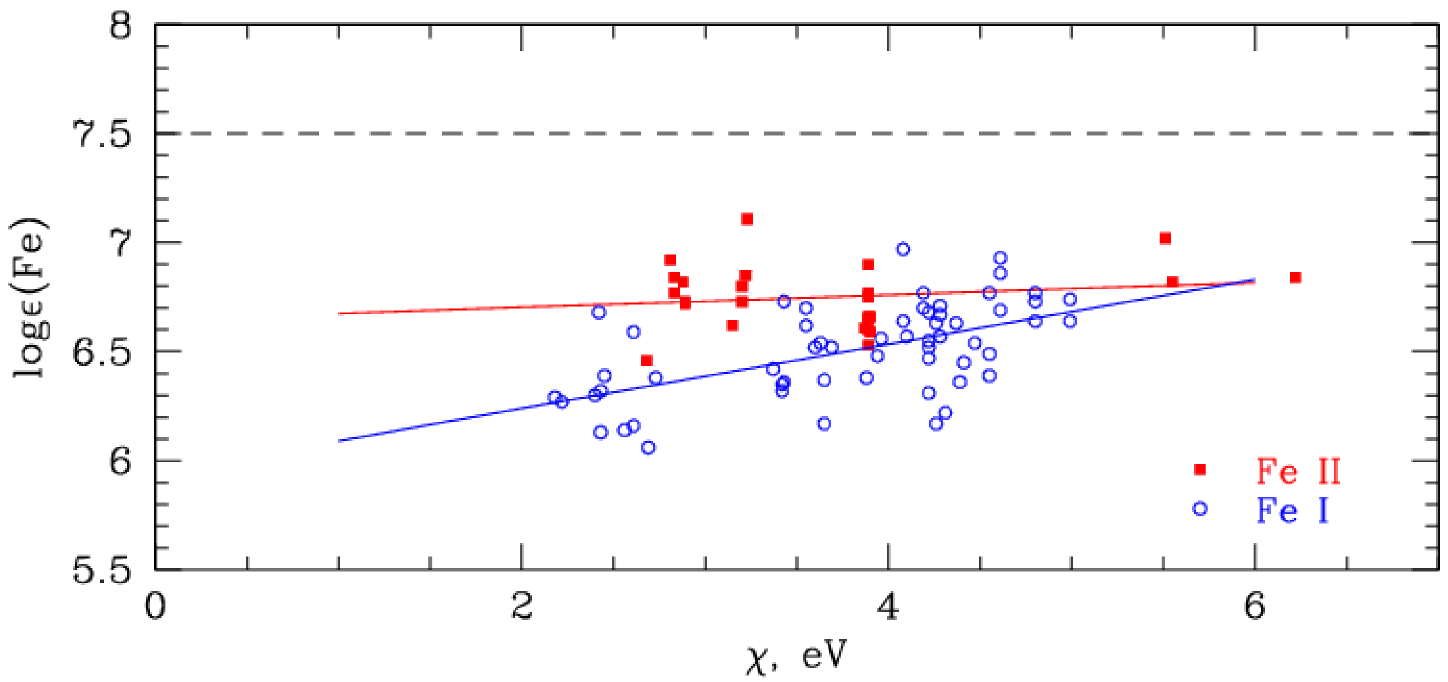
IS+CS reddening is expected ⟶ Av vs Teff degeneracy



# Methods of Teff determination that Did Not Work for Our Star

~~Removing trend of abundance vs the lower excitation level for FeI lines:~~

Teff too high for the SpT: >7500 K ⟶ NLTE effects at low logg?



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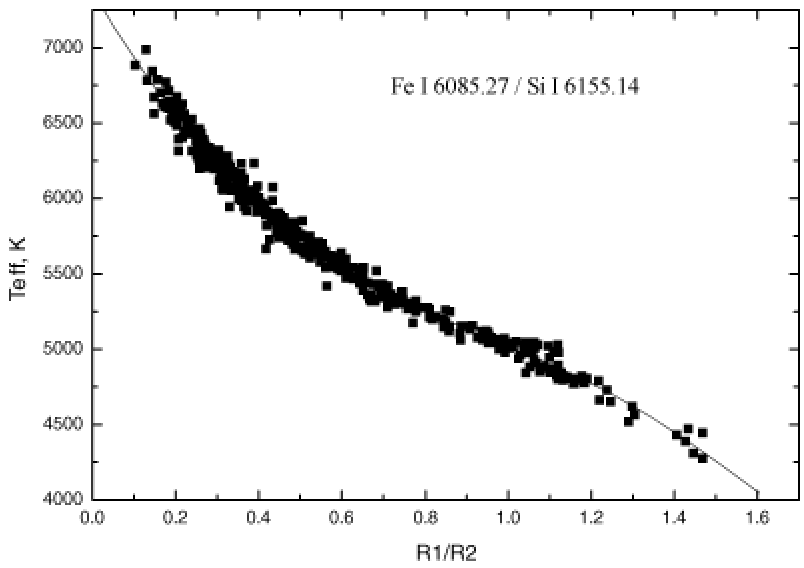



~~Line depth ratio:~~

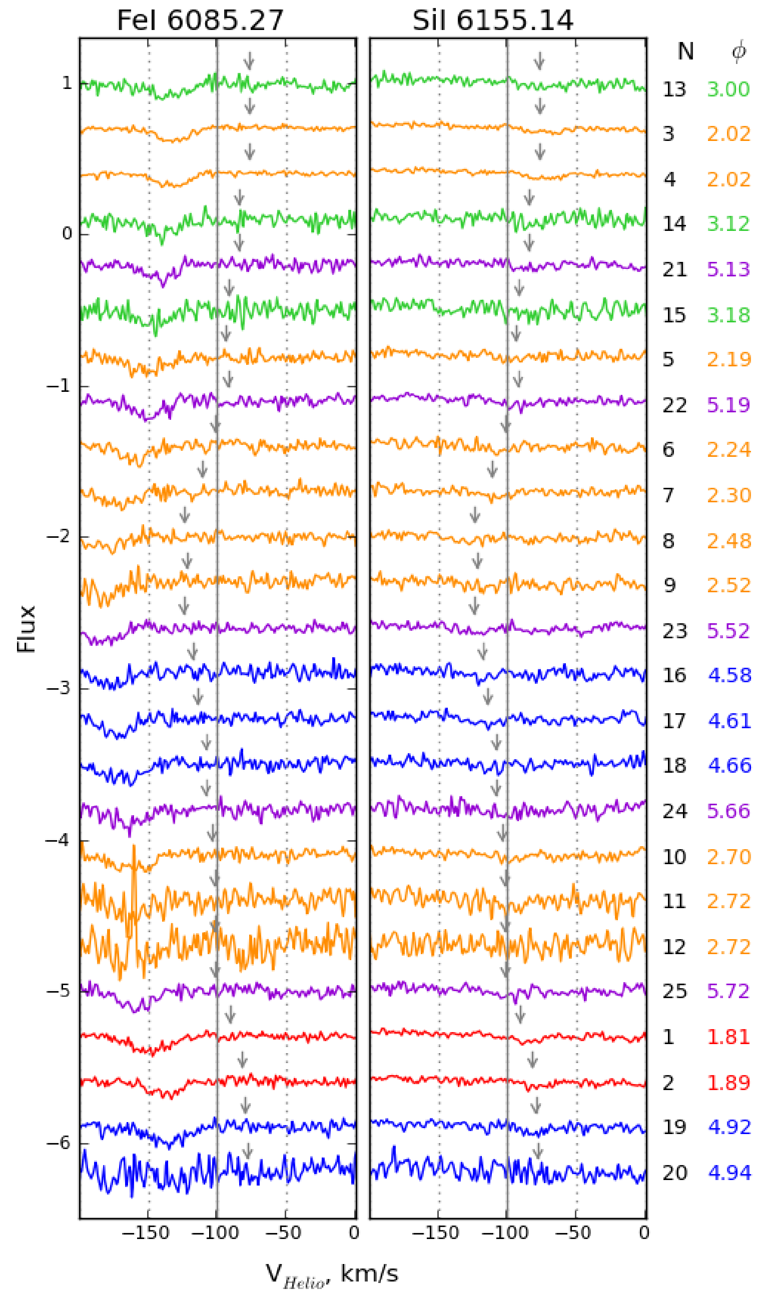
*Kovtyukh et al.*

*2007 MNRAS 378, 617 F-K* – supergiants

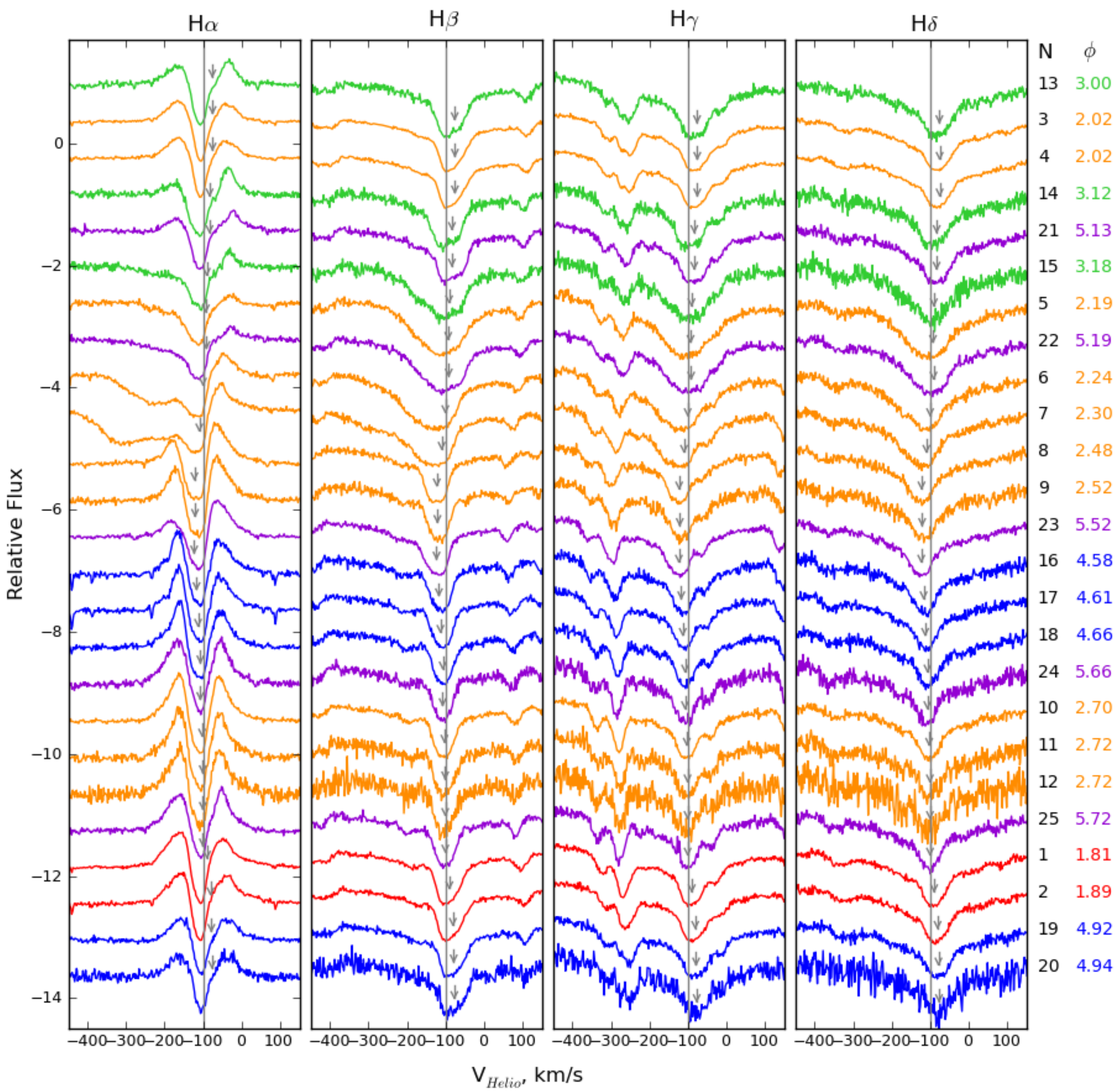
*2006 MNRAS 371, 879 F-K* – giants

*2003 A&A 411, 559 F-K* – dwarfs

→ Lines too weak, low metallicity?

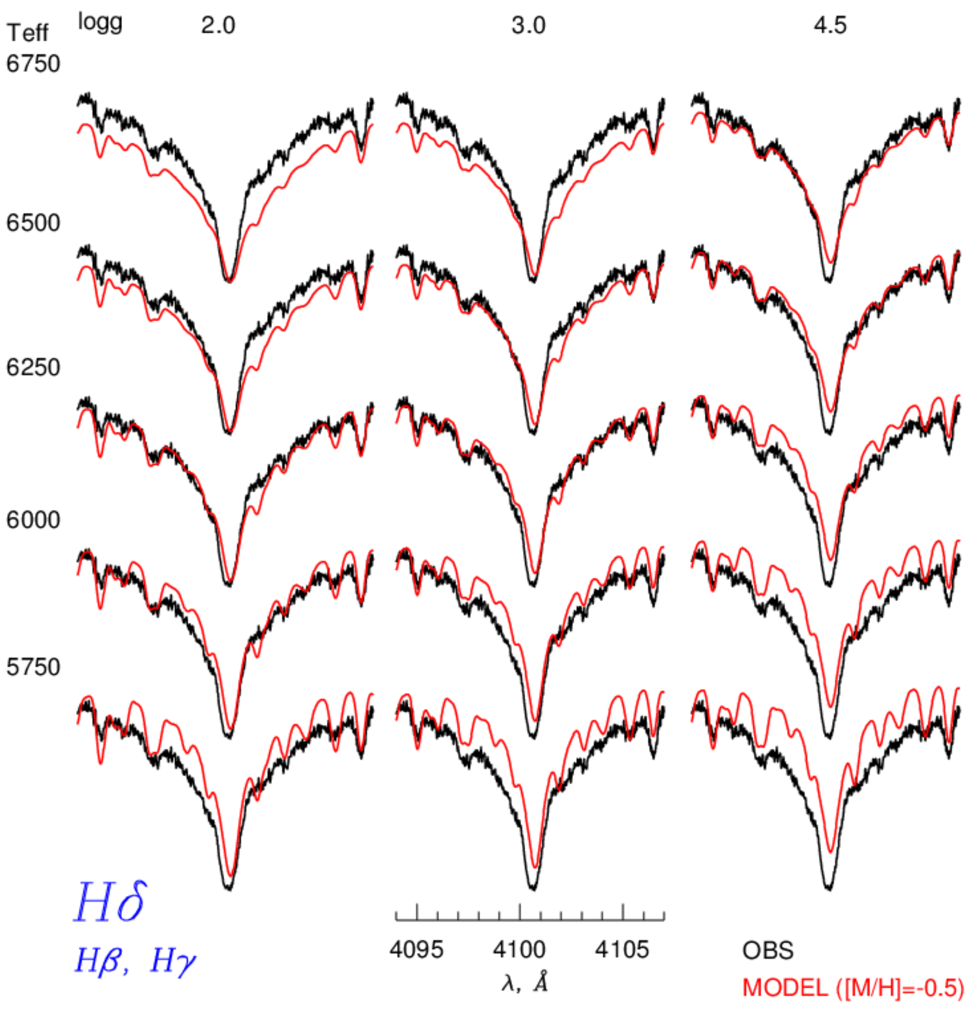


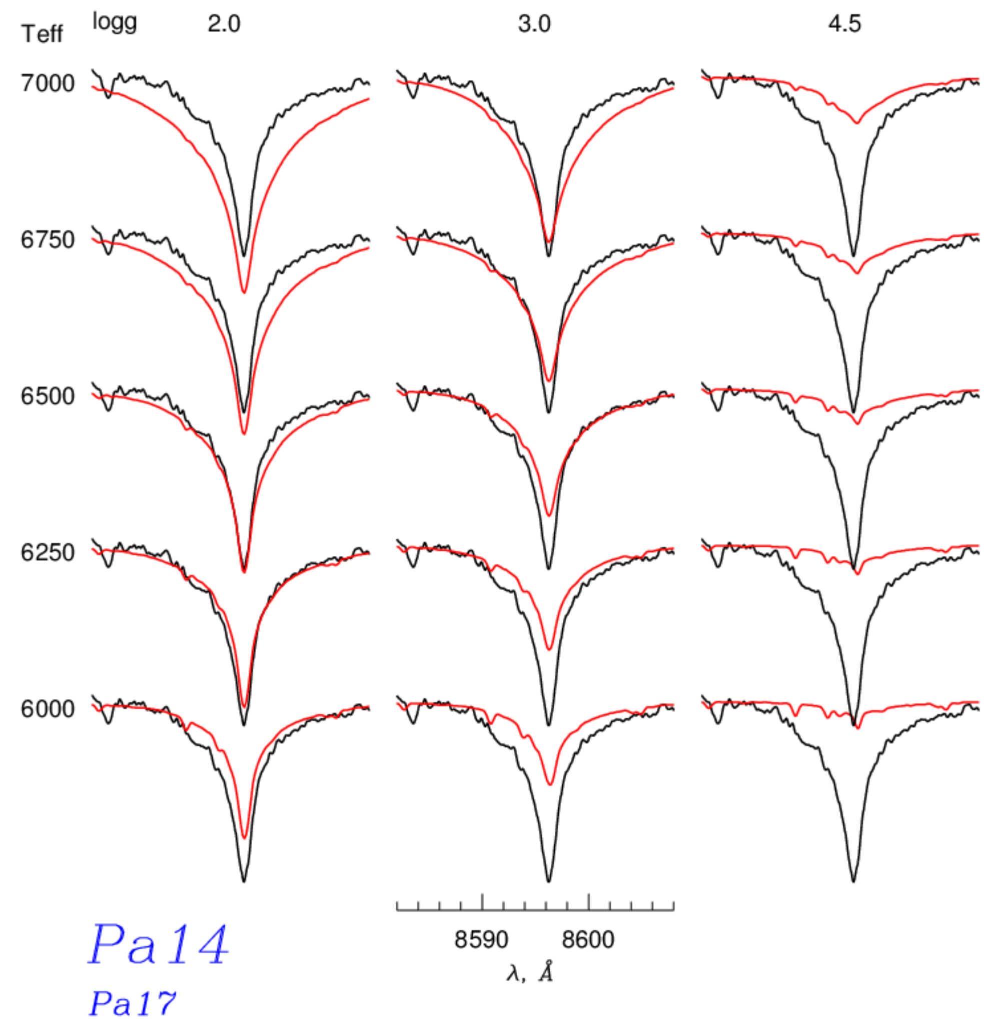
# Teff from Hydrogen Lines




Hα in emission,
other lines- ok in most phases

# Teff from Hydrogen Lines: Comparison With Synthetic Profiles



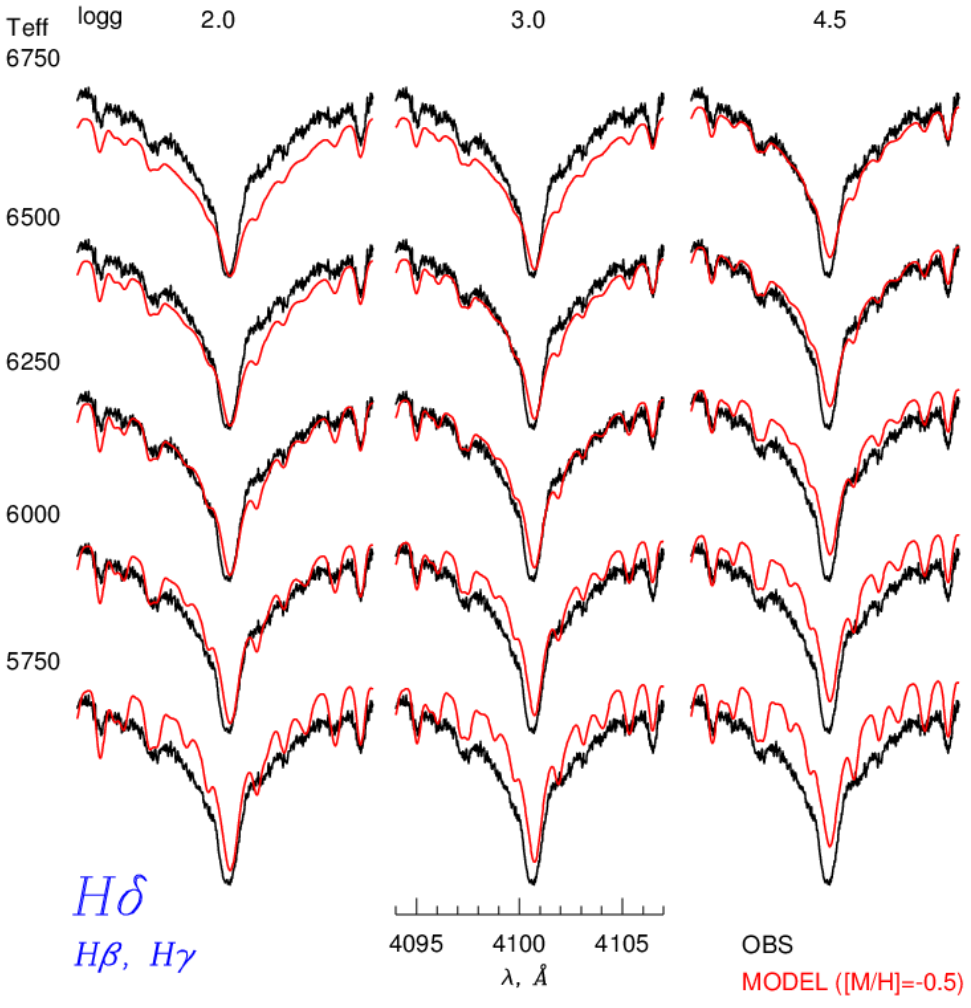



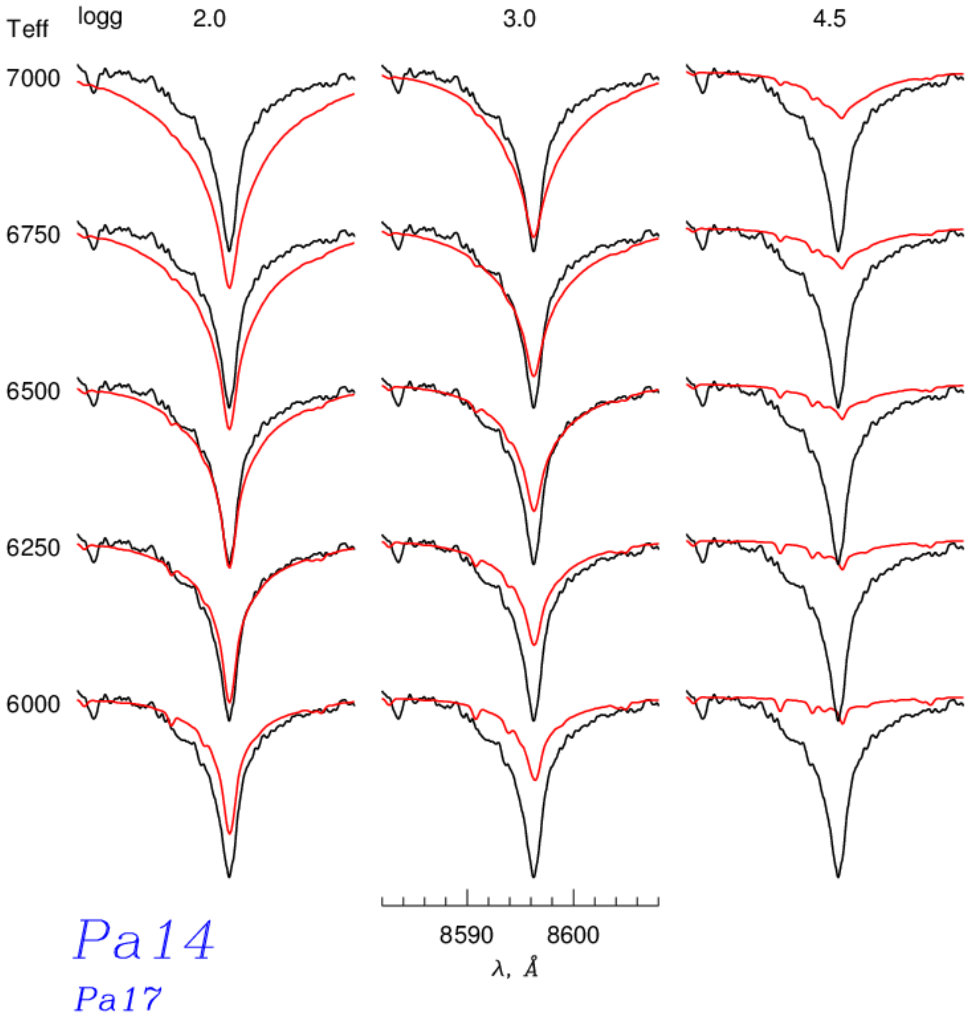

Coelho et al. 2005 *A&A, 443, 735* R=85,000 Munari et al. 2000 *A&A 141, 141* R=20,000

*http://www.mpa-garching.mpg.de/PUBLICATIONS/DATA/SYNTHSTELLIB/synthetic_stellar_spectra.html*
*http://vizier.u-strasbg.fr/viz-bin/VizieR-4?-source=III/238*

# Teff from Hydrogen Lines: Comparison With Synthetic Profiles

*Teff = 6250 ± 250K, logg < 3*

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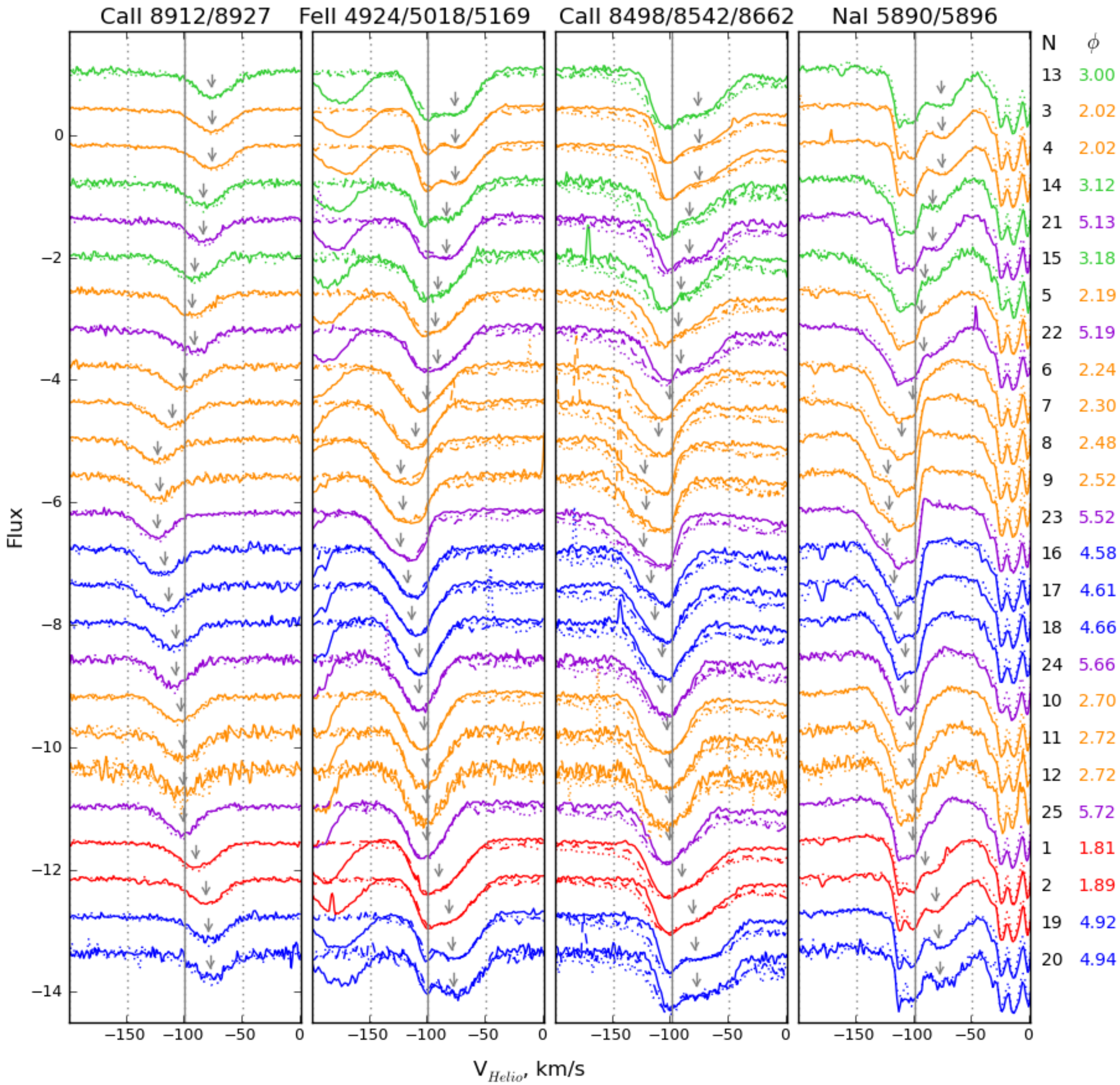
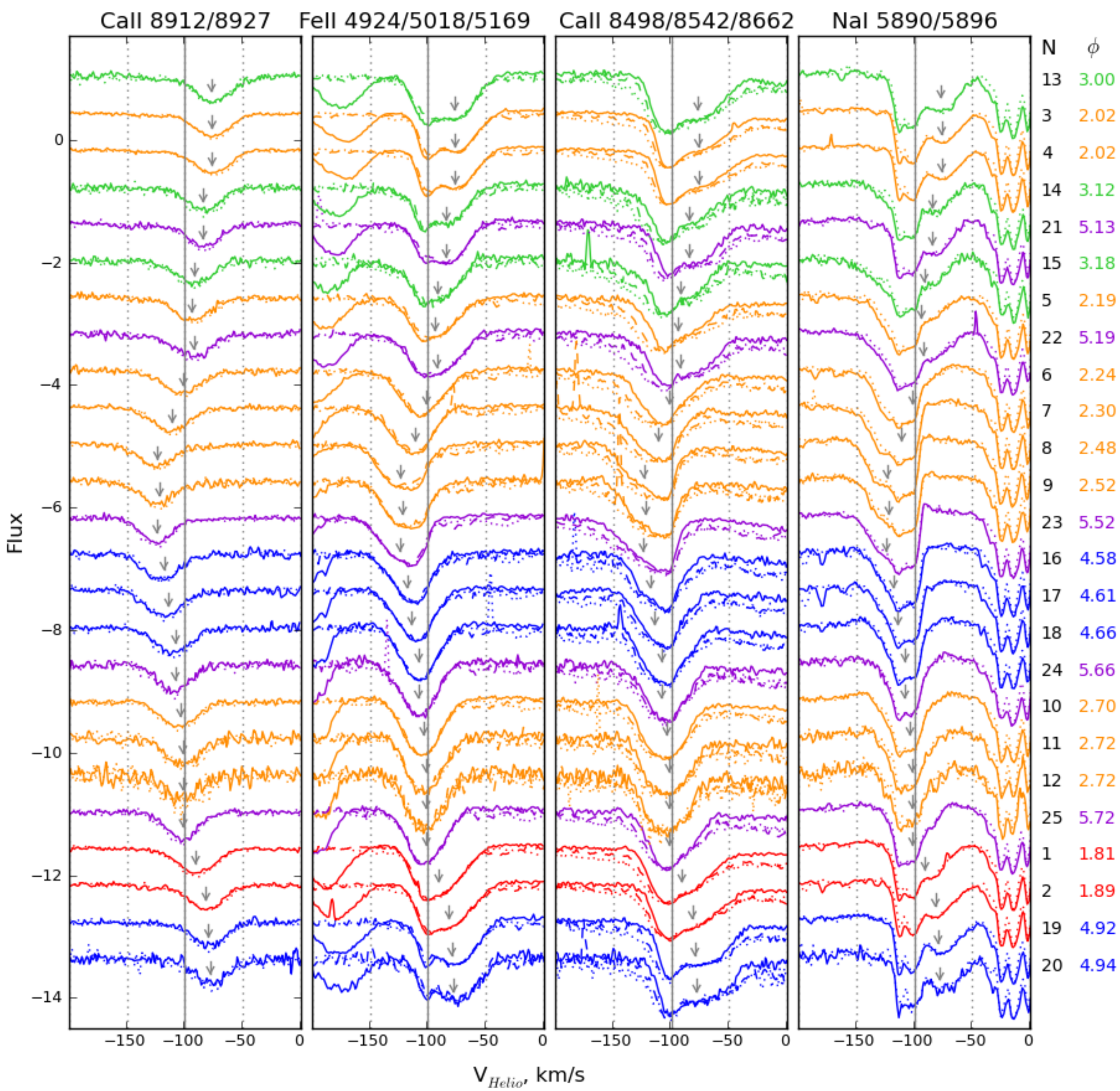
*http://www.mpa-garching.mpg.de/PUBLICATIONS/DATA/SYNTHSTELLIB/synthetic_stellar_spectra.html*

*http://vizier.u-strasbg.fr/viz-bin/VizieR-4?-source=III/238*

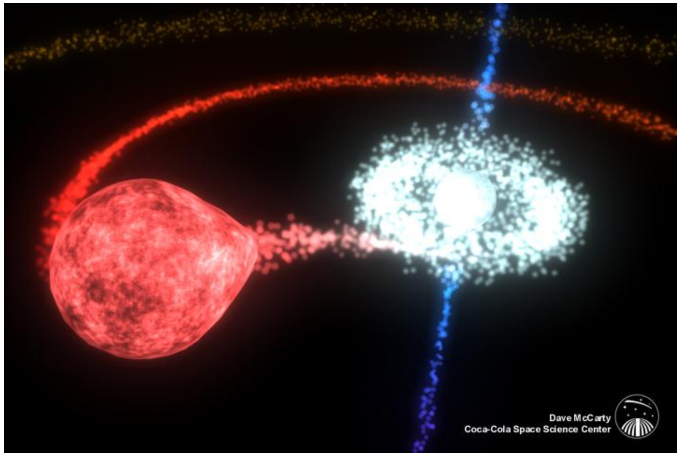
# Circumstellar components in strong lines



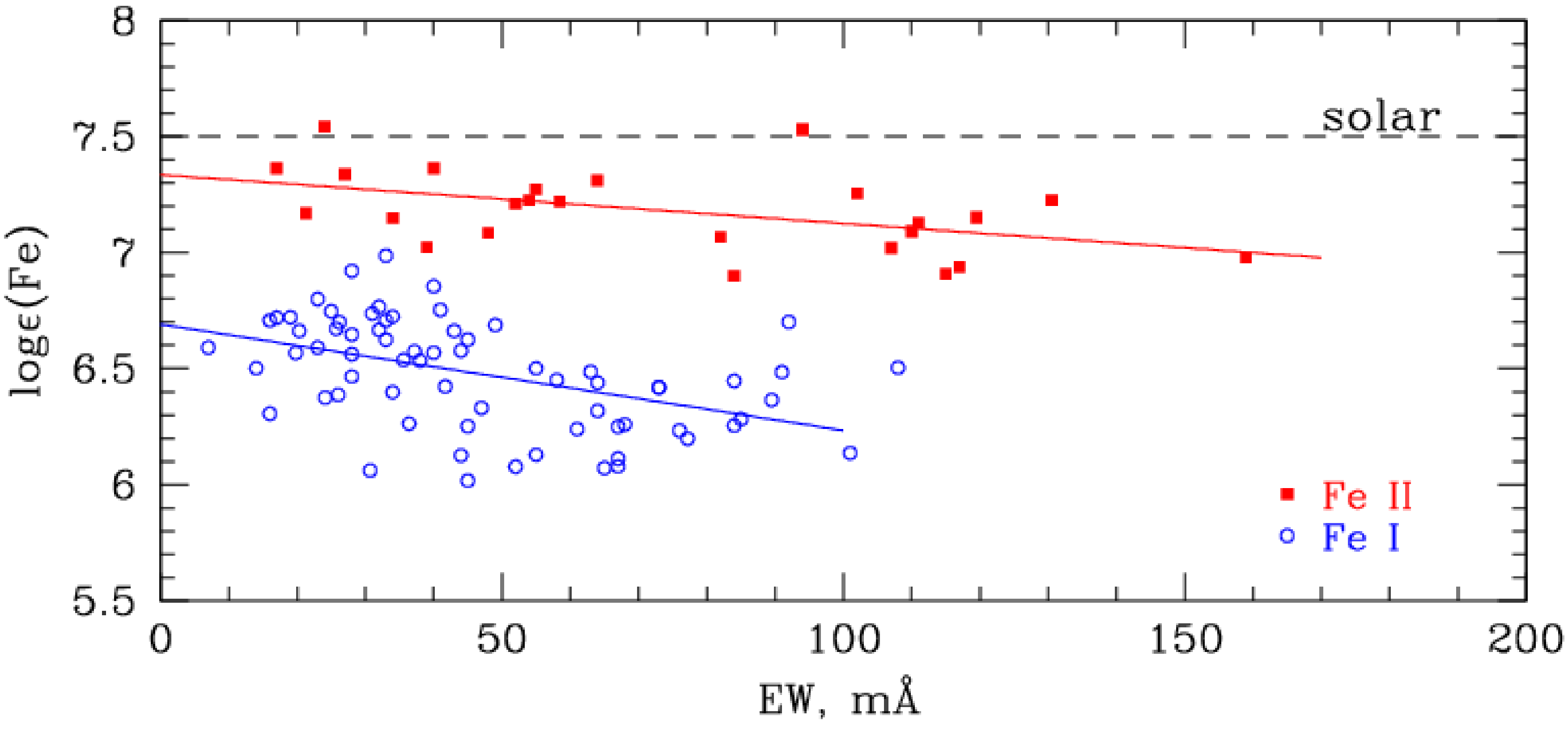
# Circumstellar components in strong lines




Lines with EW<300mA
are free from the CS features;
we use EW<170 mA



# Using FeI, FeII lines for Teff, logg, Vmicro-tur, [Fe/H]




*Teff=6200K, logg=3.0, vtur=8.0 km/s*

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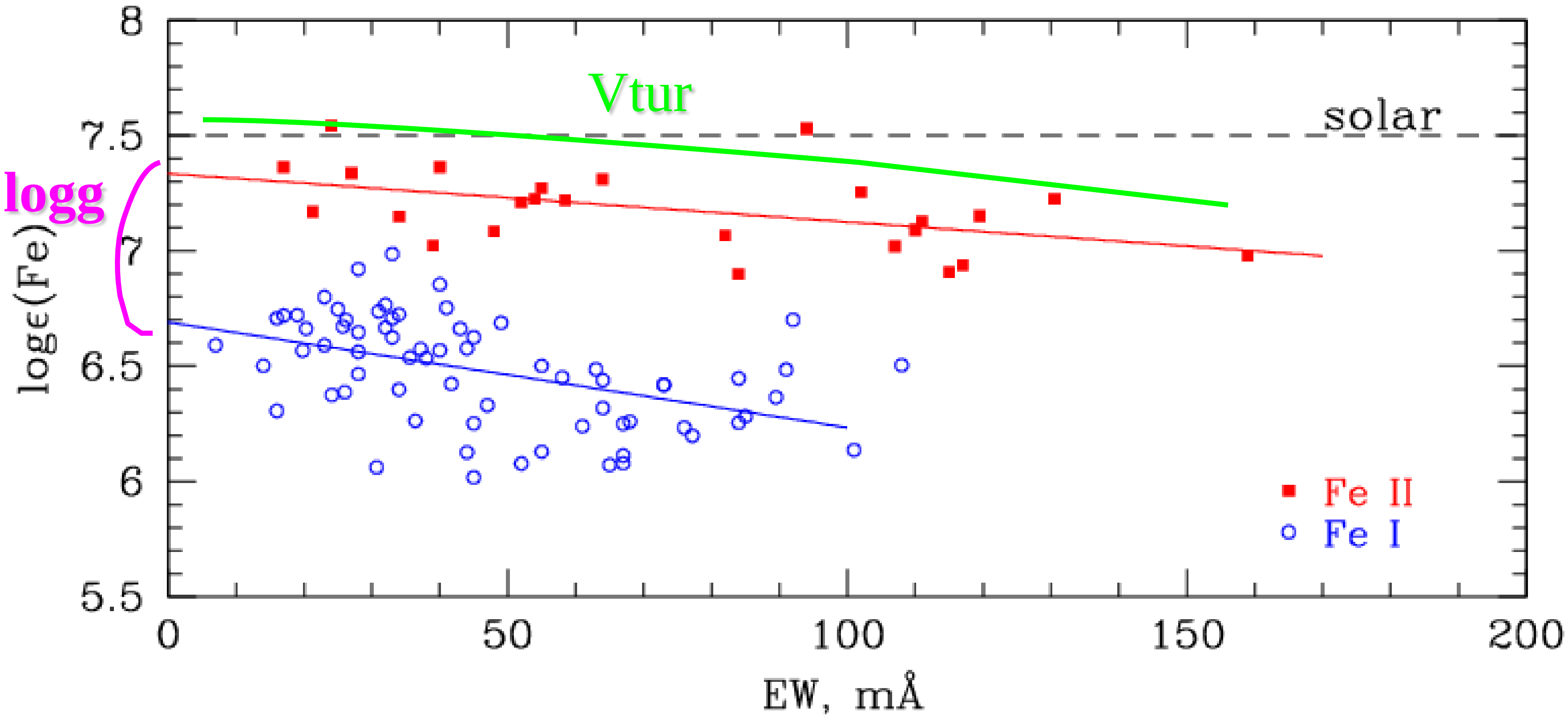
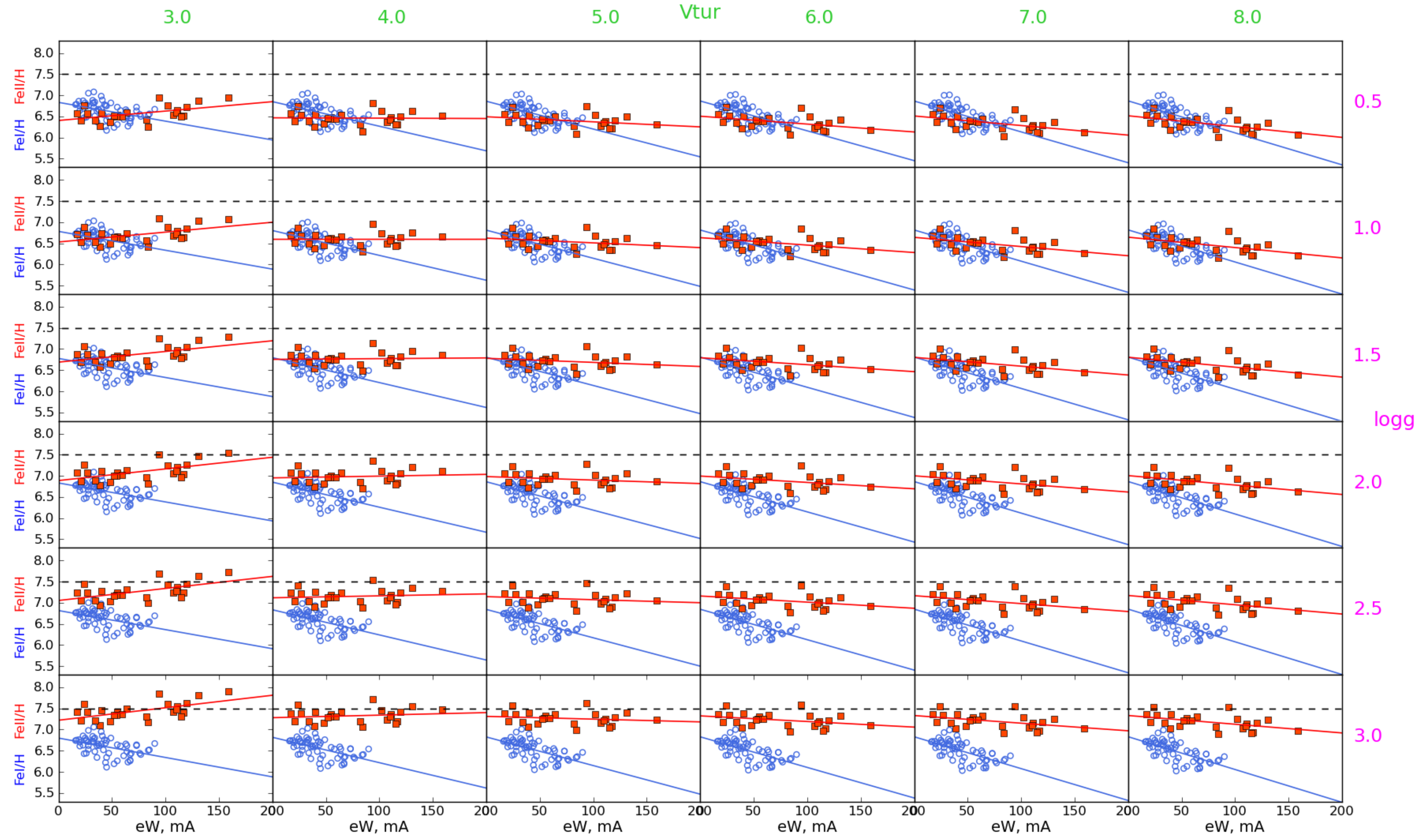
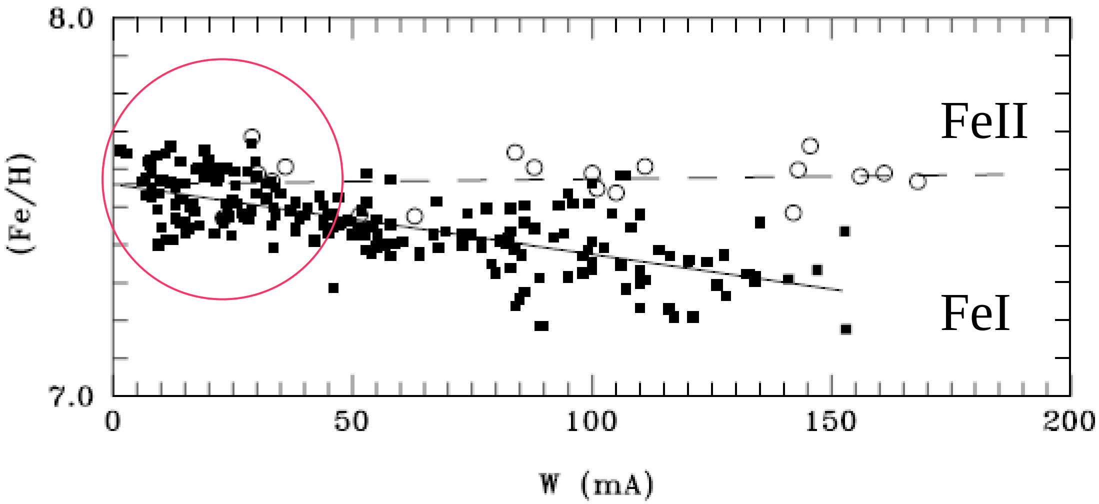



*Teff=6200K, logg=3.0, vtur=8.0 km/s*

# Using FeI, FeII lines for Teff, logg, Vmicro-tur, [Fe/H]

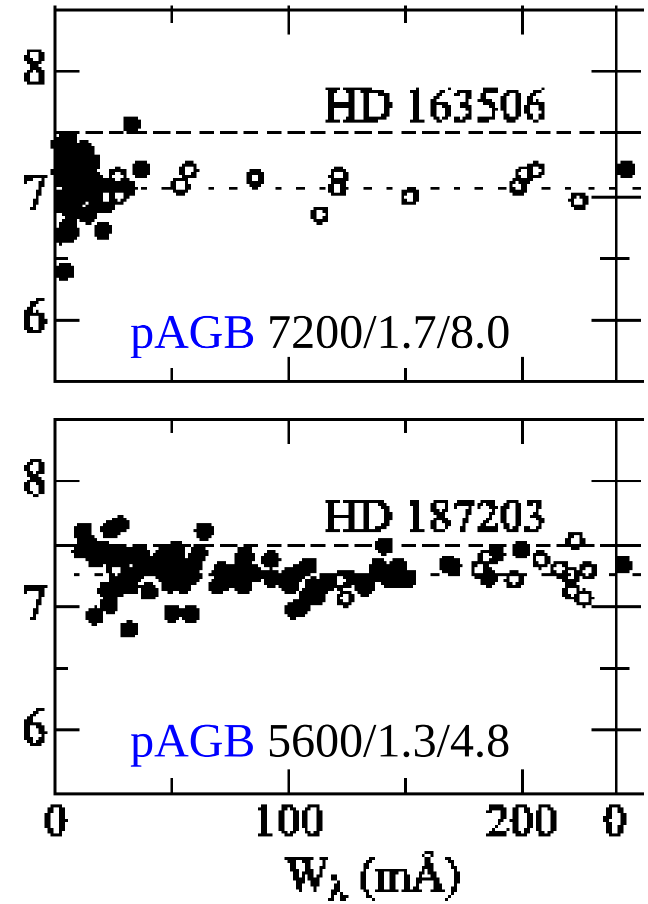
*Teff = 6250 K*






*Kovtyukh & Andrievsky 1999, A&A, 351, 597*

δ Cep 5760/2.1/3.5



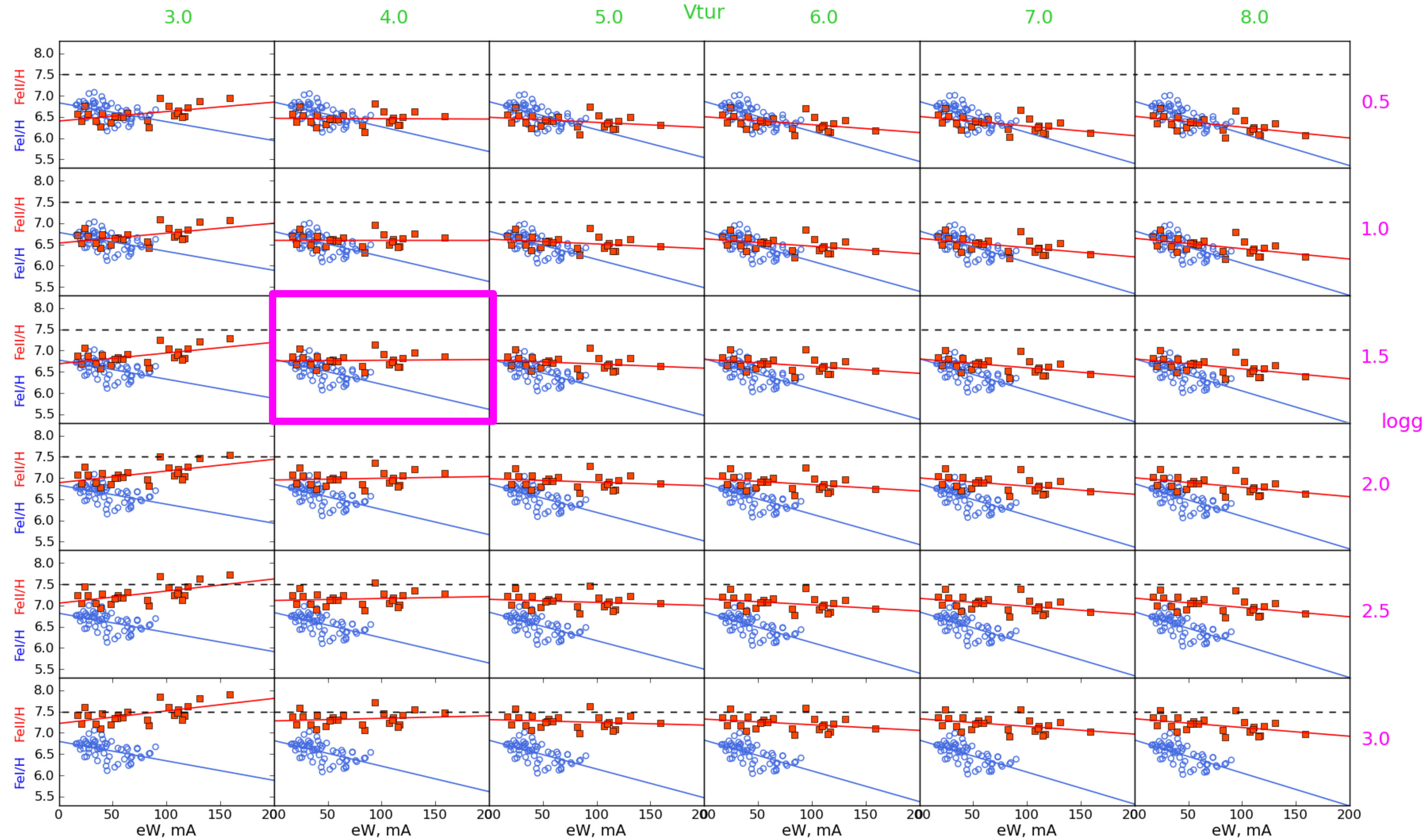

*Takeda et al. 2007 PASJ 59, 1127*

Vmicro-tur Discrepancy between FeI and FeII in supergaints:

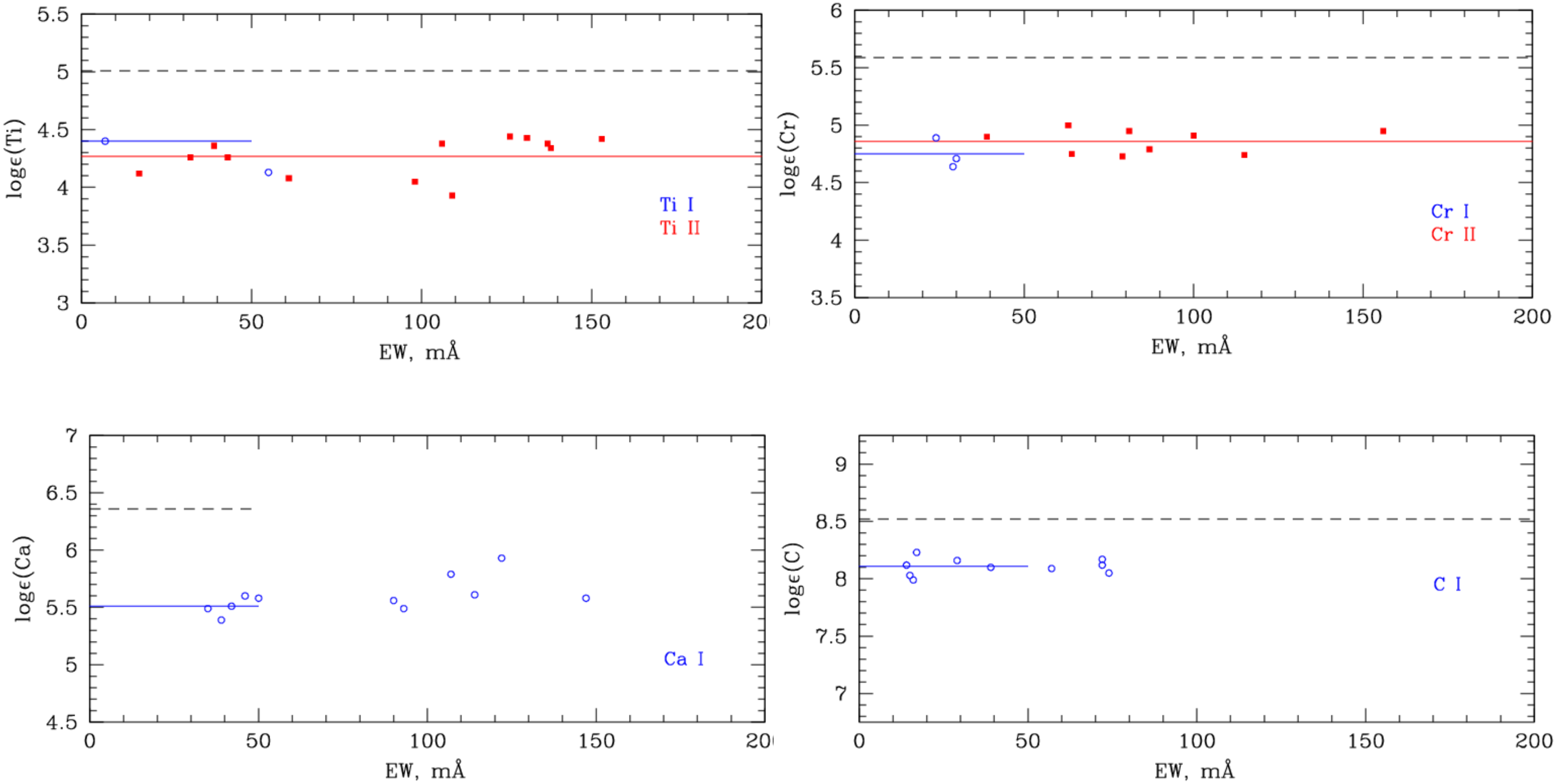
Use all FeII lines and FeI lines <50mA !

# Using FeI, FeII lines for Teff, logg, Vmicro-tur, [Fe/H]

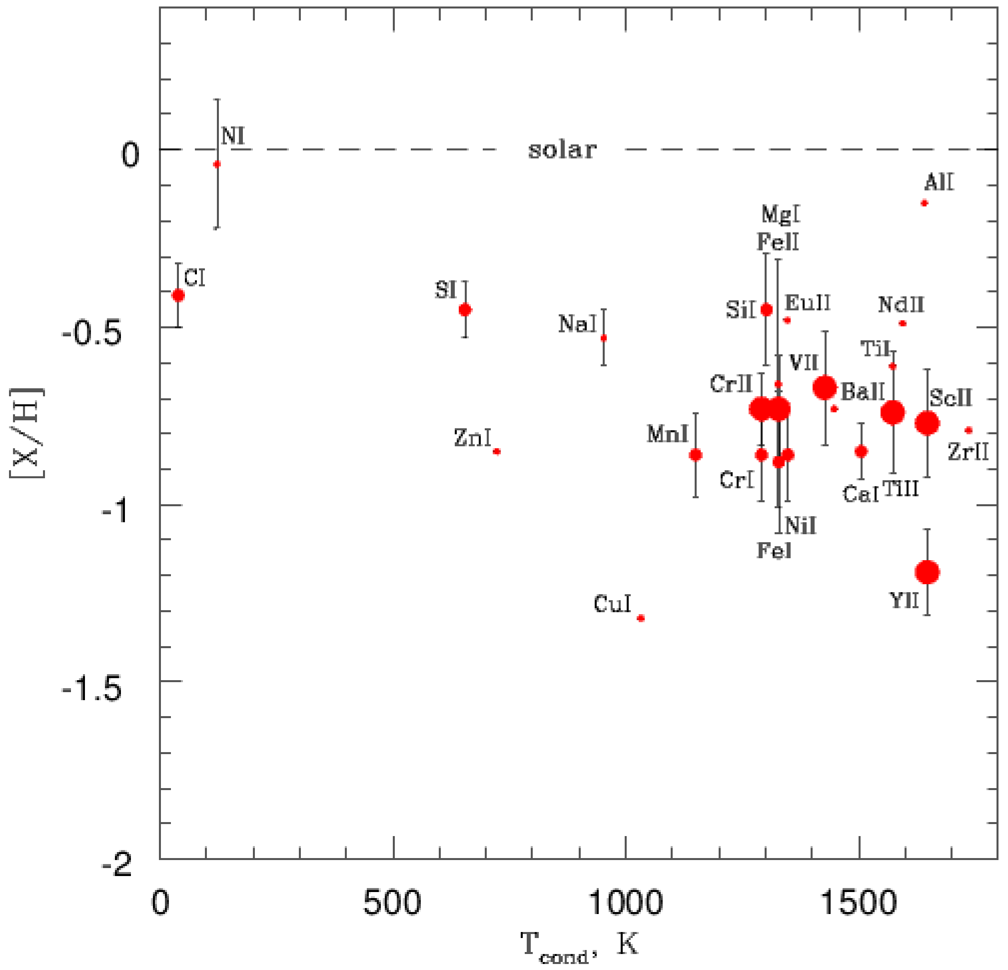
*Teff = 6250 ± 250, logg = 1.5 ± 0.5, Vtur=4 ± 0.5, [Fe/H]=6.65 ± 0.1*



# Run with EW for other elements: whenever trend, use EW<50mA

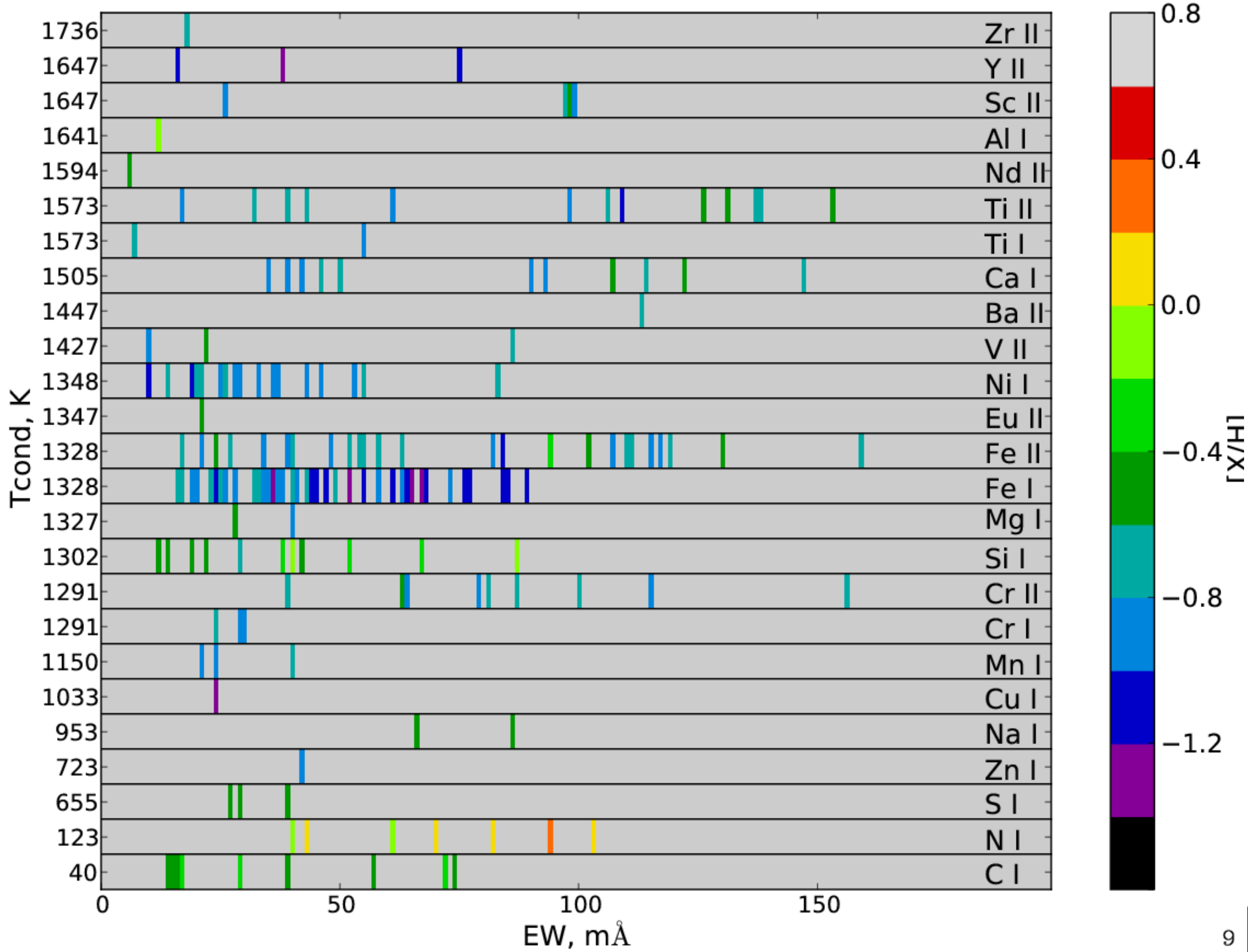


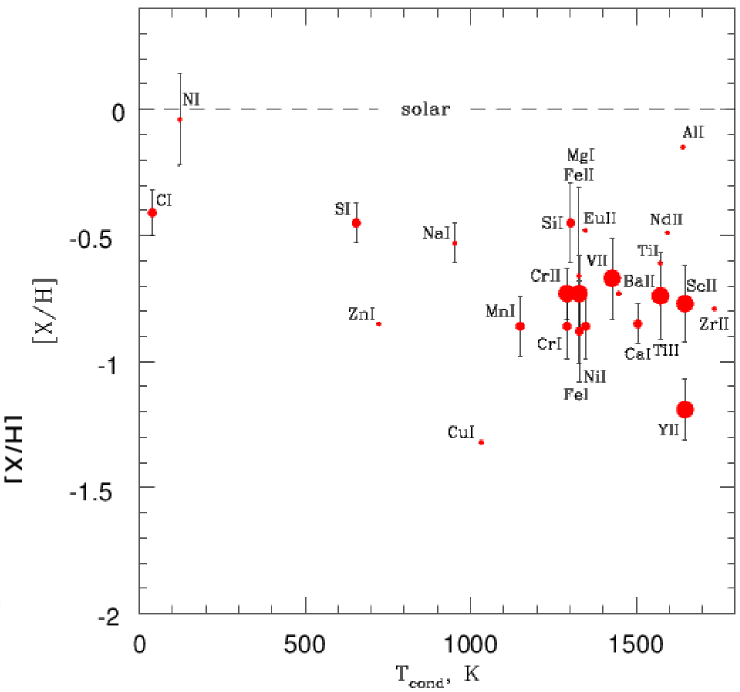
# Derived Abundances of BD+46 442 as a Function of the Condensation Temperature



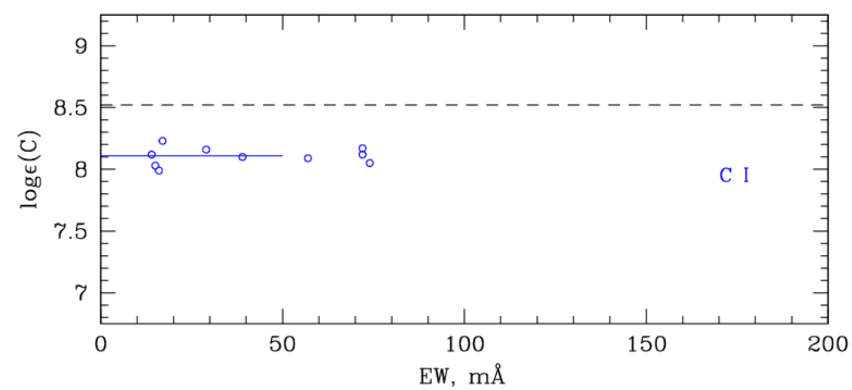

A weak depletion or a moderately metal-poor star with [M/H]= -0.8 ?

# "Abundogram"- a 2d Represenation of the Chem. Composition




Allows to spot trends more easily- real or with EW

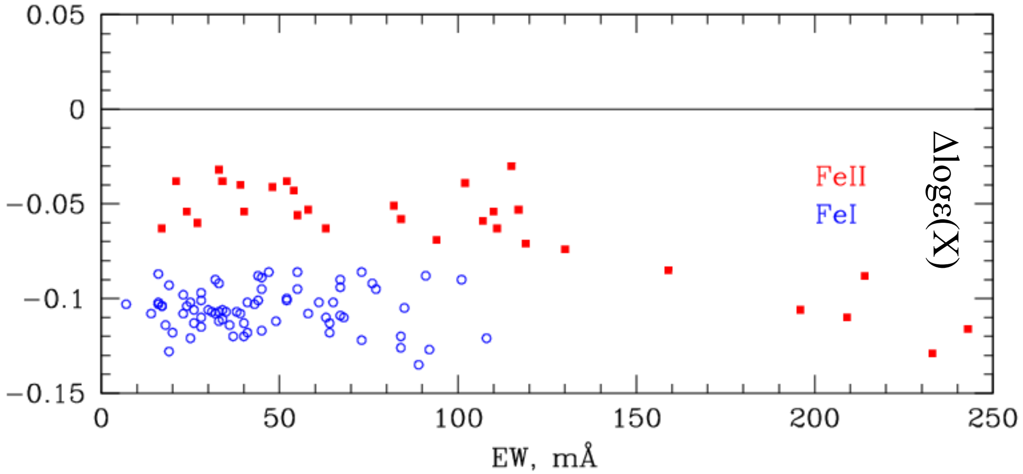


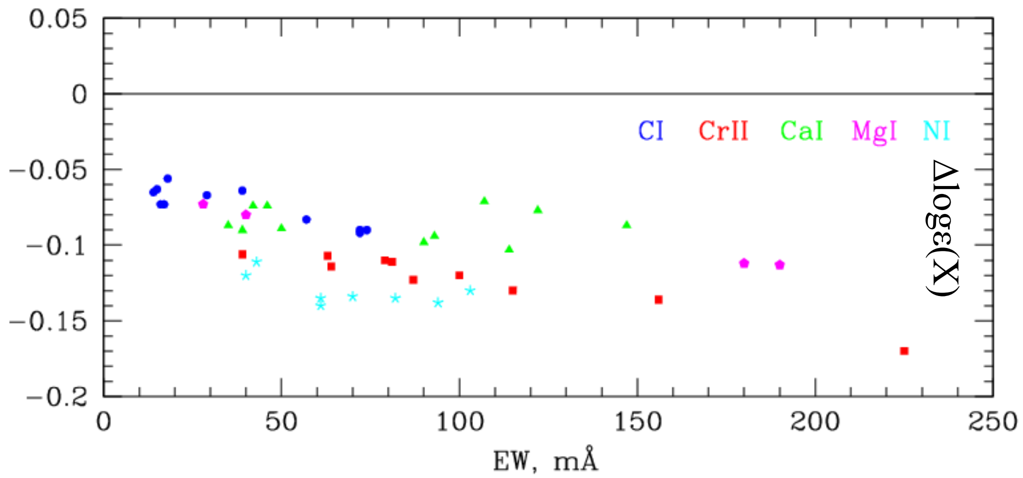
# Comparing Codes and Atmospheric Models:

## MOOG vs. WIDTH9 Atlas9(1992) vs. Atlas9-Castelli(2003)

*Teff / logg / vtur / M/H=6250 / 2.0 / 5.0 / 0.0*

MOOG+Castelli vs WIDTH9+Atlas9



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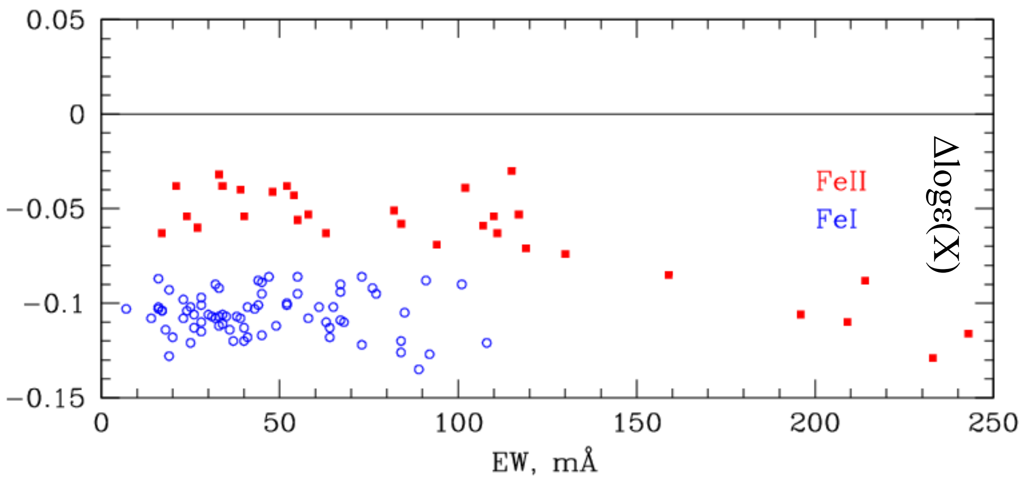
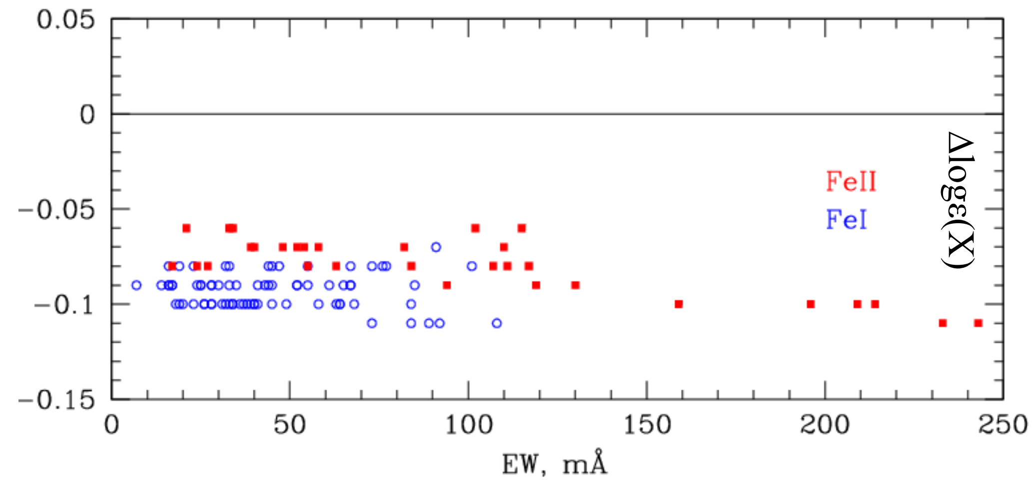
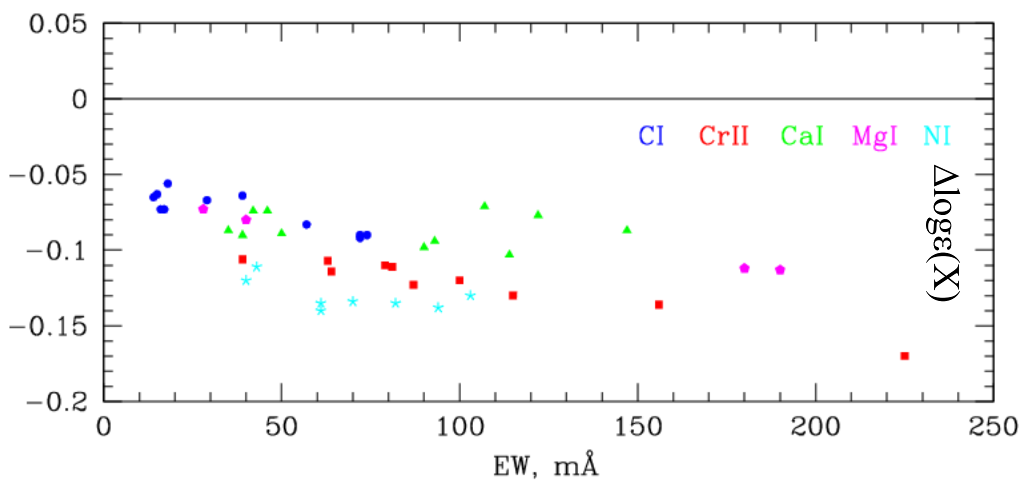
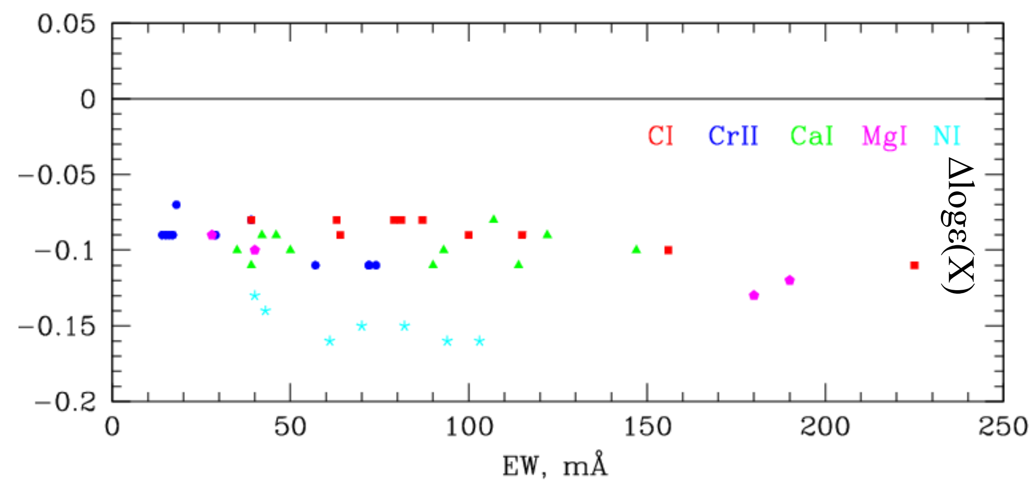
MOOG+Castelli vs WIDTH9+Atlas9

MOOG+ Atlas9 vs Castelli



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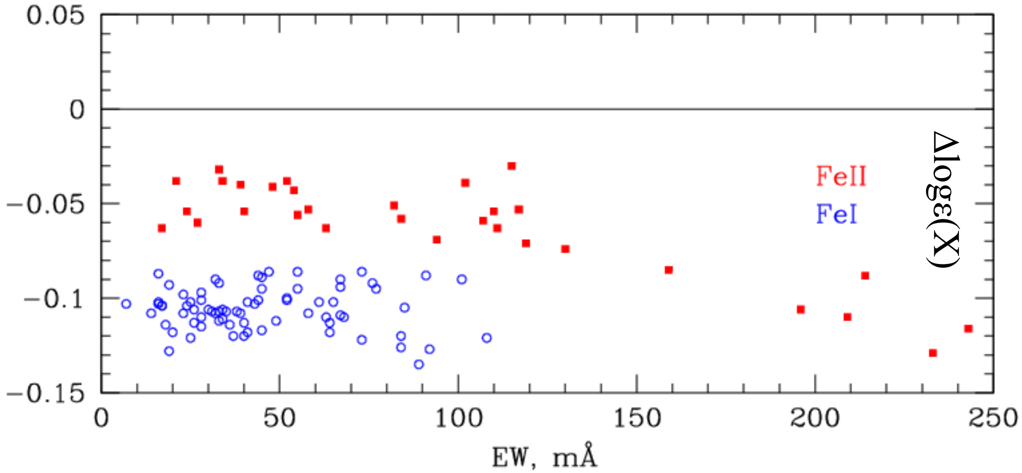
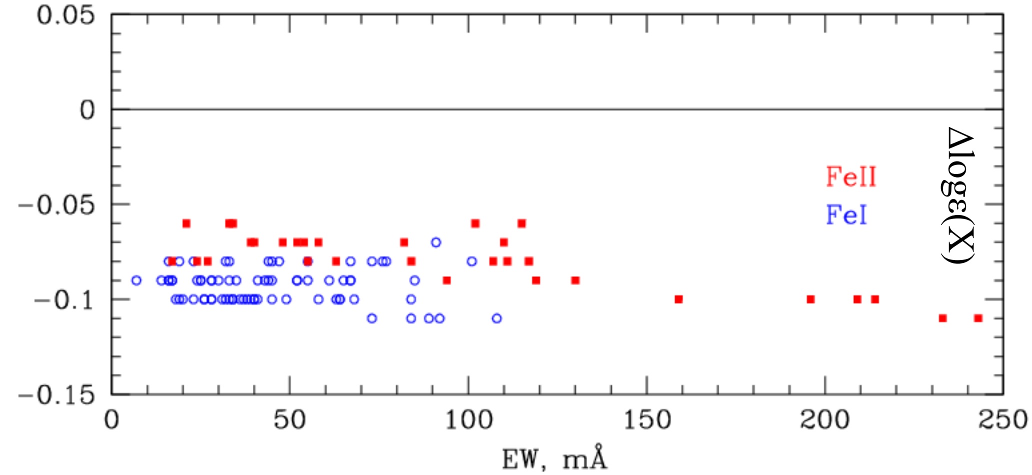
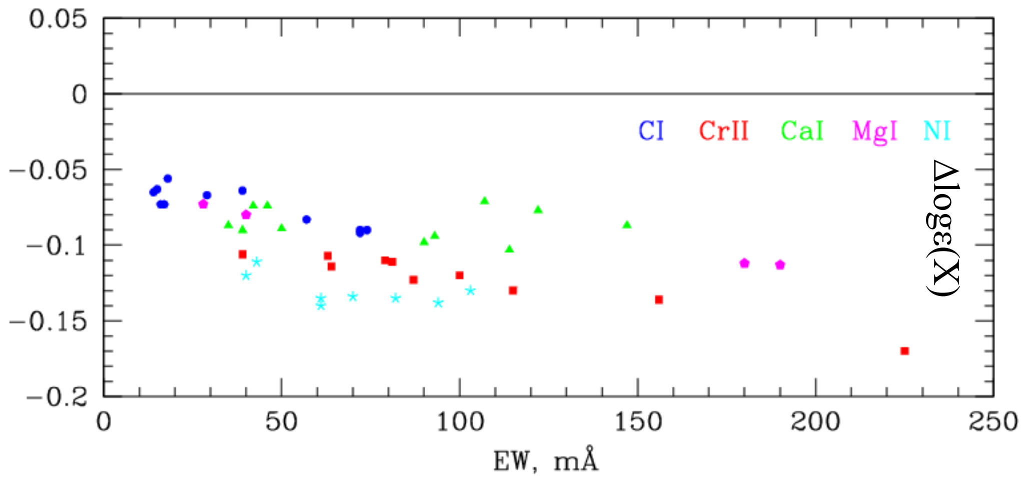
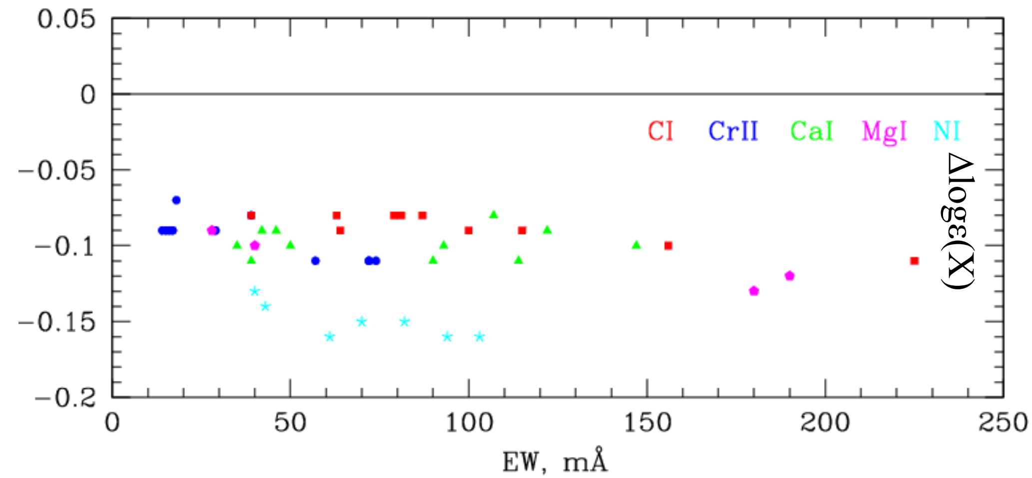
MOOG+Castelli vs WIDTH9+Atlas9

MOOG+ Atlas9 vs Castelli




Castelli - Atlas : up to -0.15 dex, MOOG - WIDTH9 : up to ± 0.05 dex

# Abundance Analyses relative to the Sun

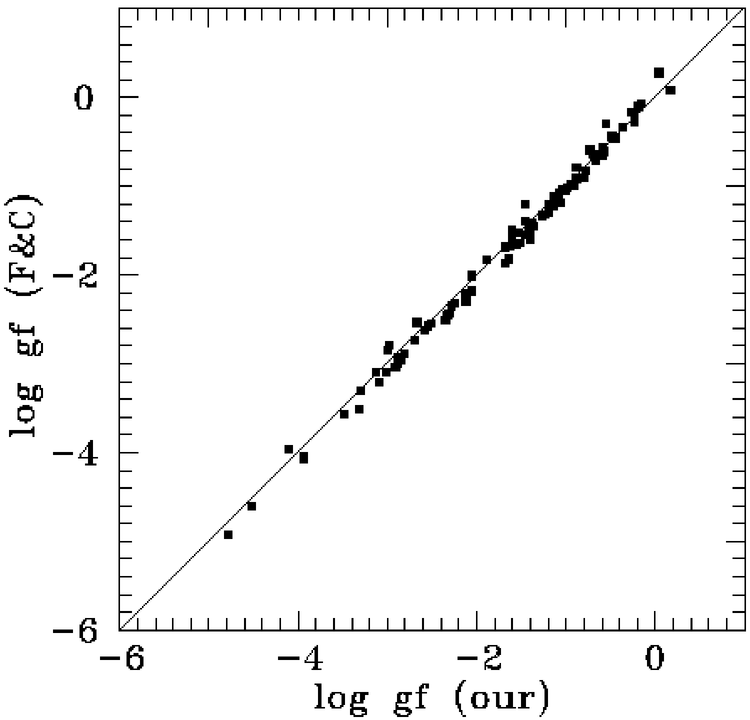
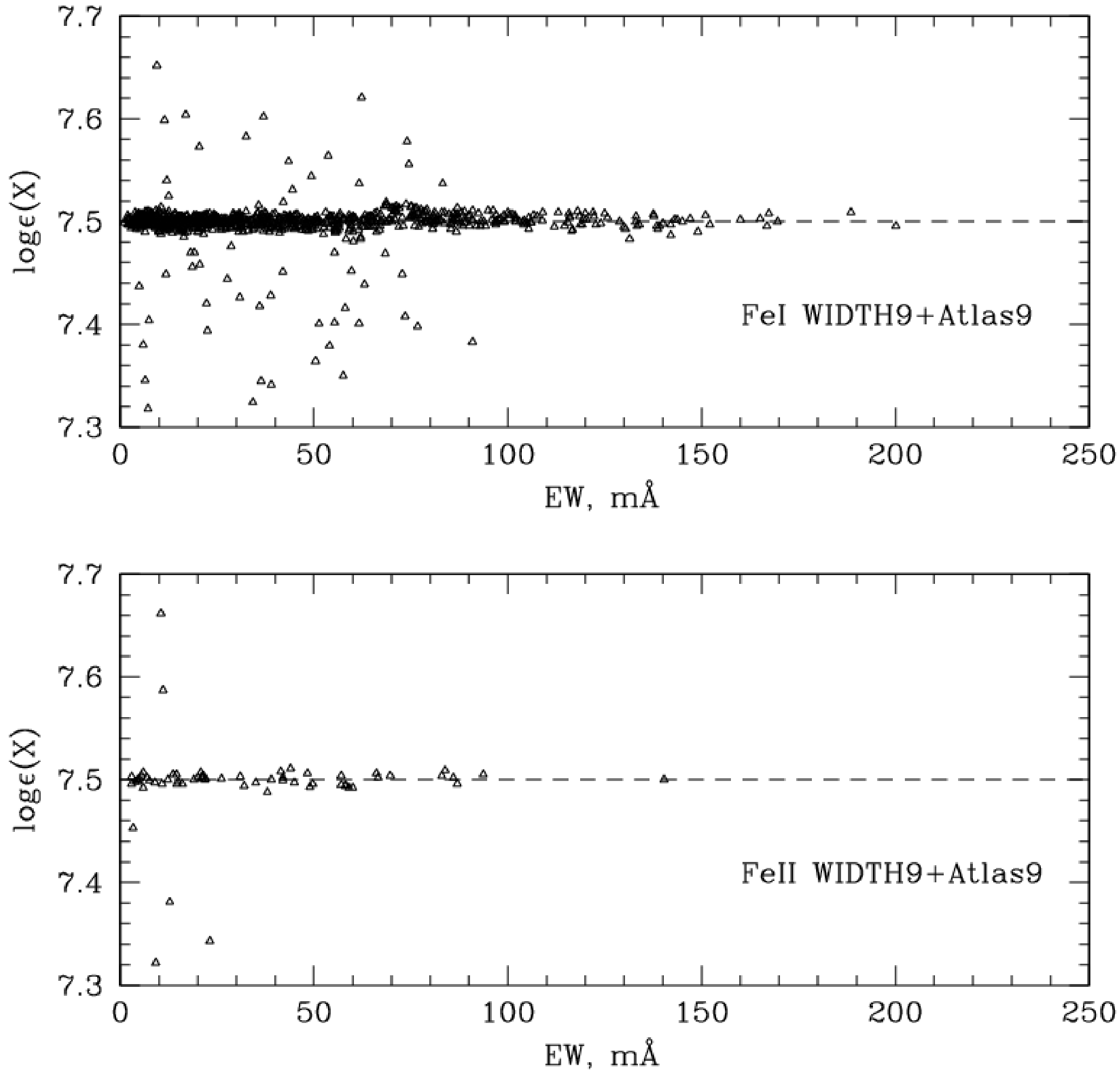



**Fig. 2.** Comparison of our oscillator strengths with those of Fry & Carney (1997).




1. Take solar loggfs from
*Kovtyukh & Andrievsky 1999 A&A 351, 597*

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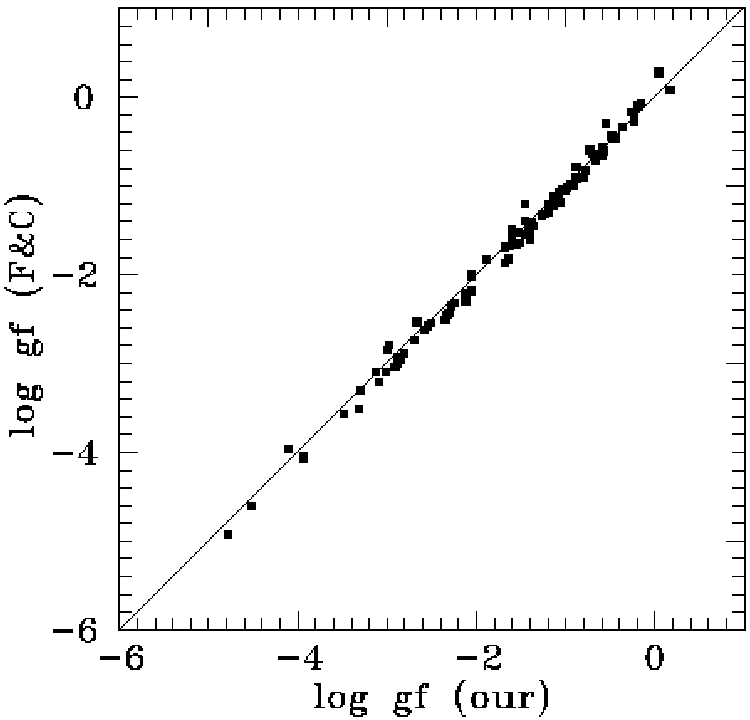


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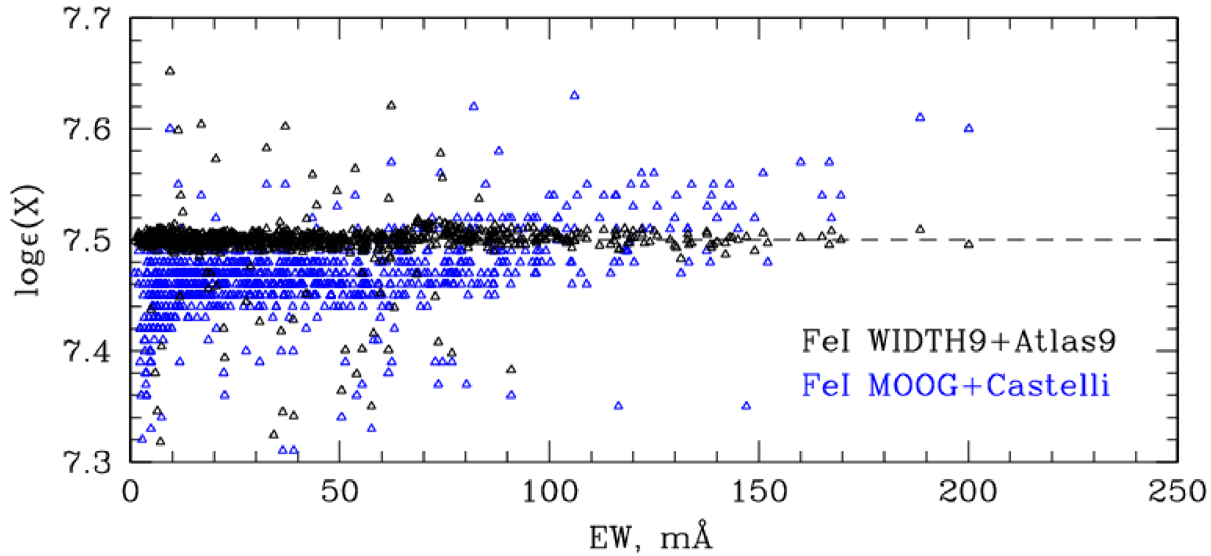


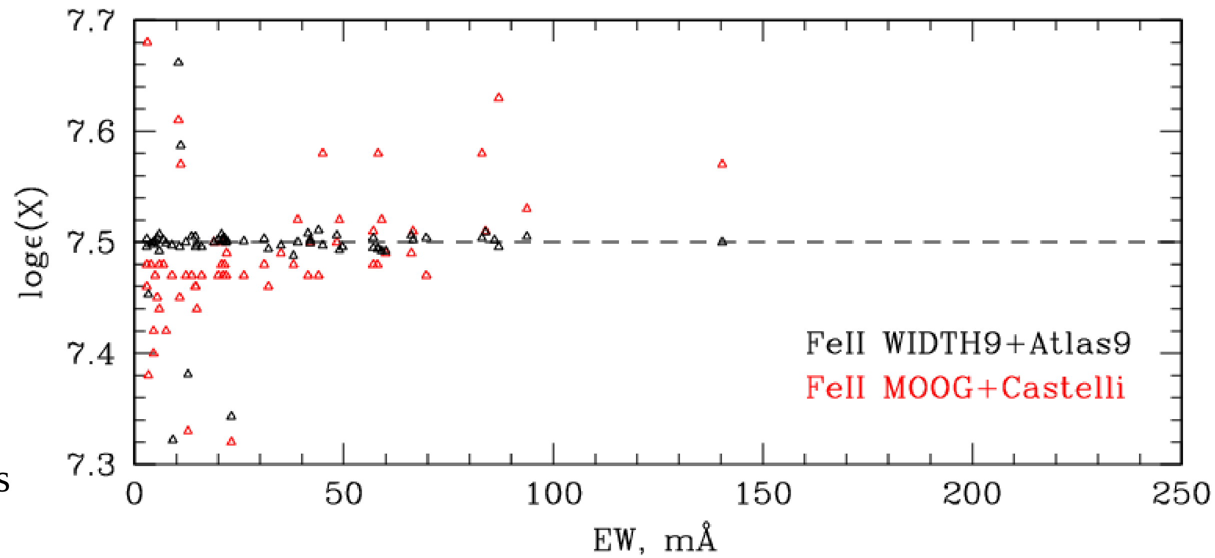


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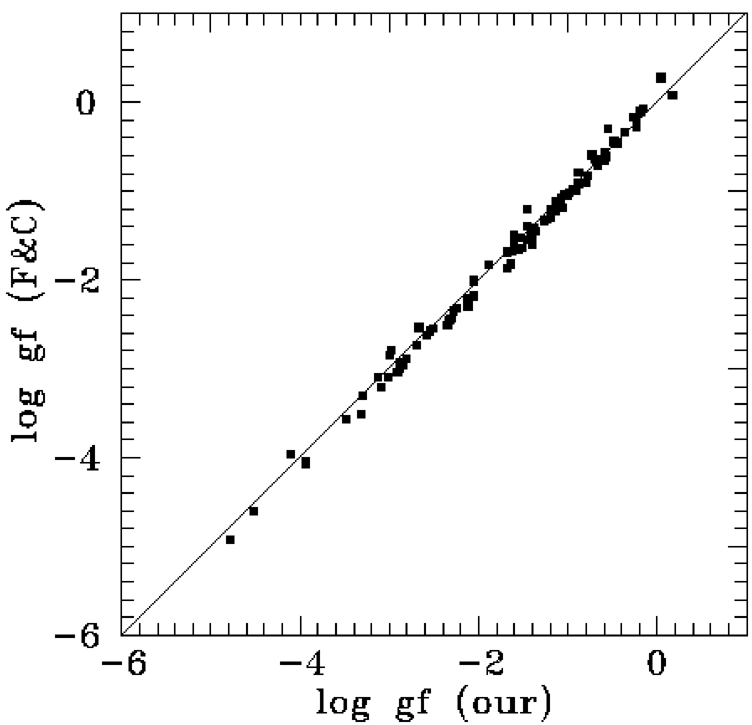
2. Compute abundances for the Sun with their EWs using MOOG+Castelli

# Abundance Analyses relative to the Sun

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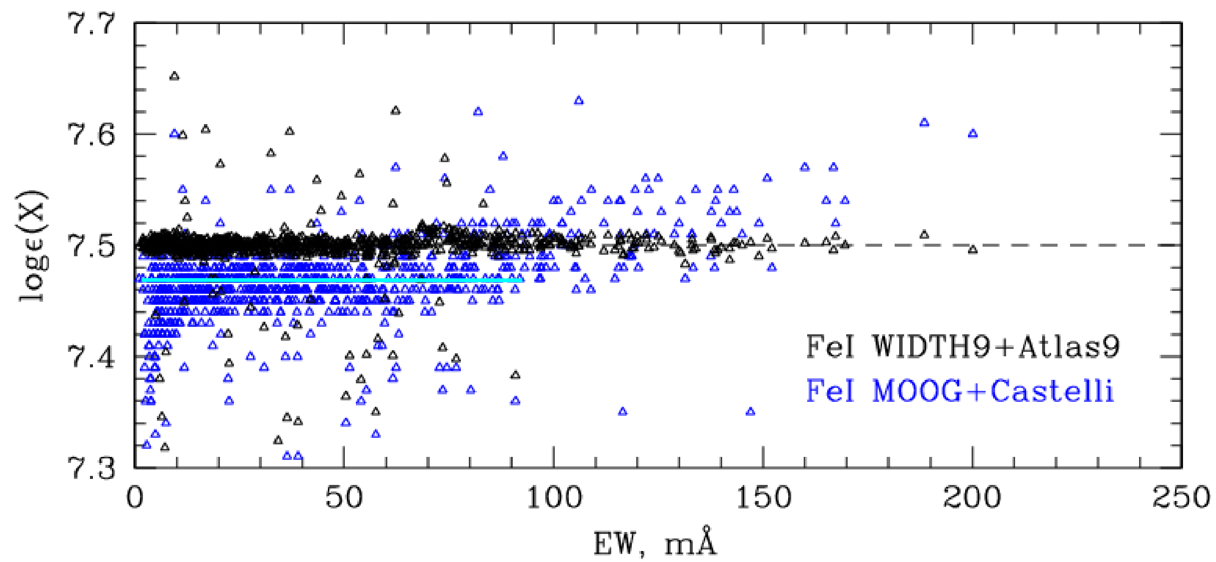


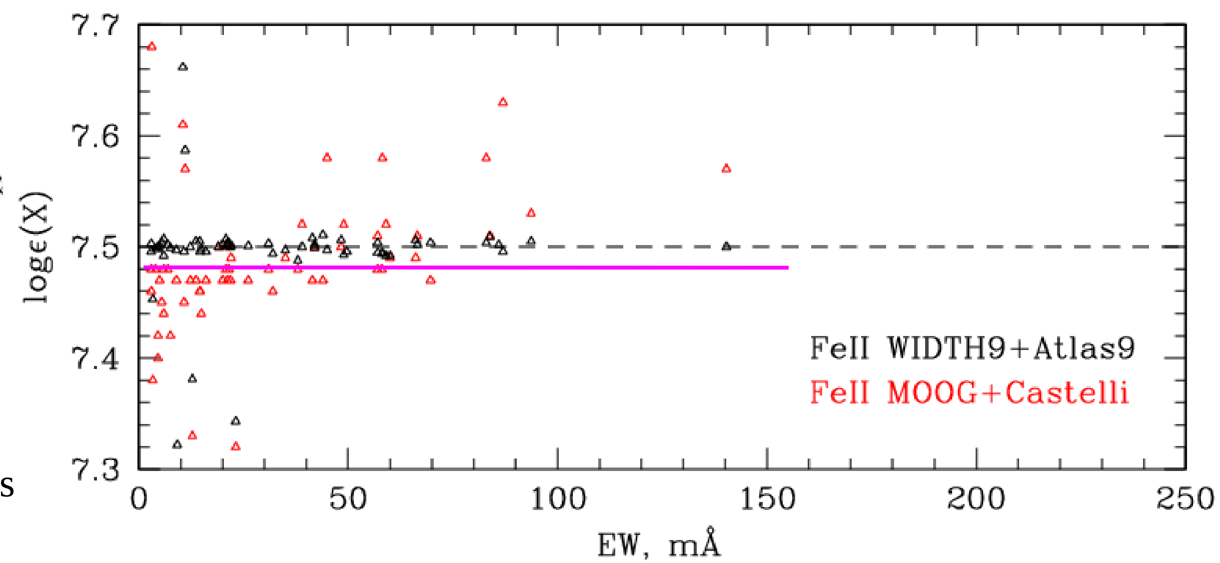


1. Take solar loggfs from *Kovtyukh & Andrievsky 1999 A&A 351, 597*

2. Compute abundances for the Sun with their EWs using MOOG+Castelli

3. Adjust solar abundances of KA99 / Grevesse et al. 1996 when calculating [X/H] for our stars

corr-s: from -0.08 for CrII to +0.07 for SiII ; most uncertain: C,N,O,S (most loggfs non-solar)

# Summary

## Used:

HERMES spectrum S/N~130, R=85,000 of a SB1, F2III, IRAS source BD+46 442
MOOG + Atlas9-Castelli (EW mode)
Solar loggfs of KA99

## Obtained:

| | |
|---|---|
| Teff = 6250 ± 250 K | $H_\beta$, $H_\gamma$, $H_\delta$, $Pa_{14}$, $Pa_{17}$ *(Coelho et al, Munari et al.)* |
| logg = 1.5 ± 0.5 | <FeII> = FeI (EW→0 ) |
| Vmicro-tur = 4.0 ± 0.5 | no trend FeII vs. EW |
| [Fe/H] = -0.80 ± 0.08 | <FeII> = FeI (EW→0 ) |
| [X/H] for 21 other elements, | <X/H> or <X/H (EW<50mA)> |
| weak trend with Tcond | |

## Compared:

Castelli vs Atlas9 : up to -0.15 dex for logg=1.5, ±0.1 dex for the Sun (logg=4.4)

MOOG vs WIDTH9: differences smaller

The above justifies the solar loggf approach at least for EW<100 mA, except for C,N,O loggf-s: may be uncertain up to 0.6 dex