SpectroWeb Database Development

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SpectroWeb

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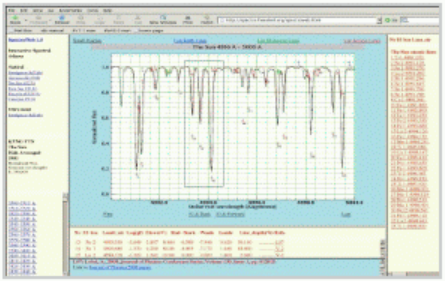
The Interactive Database of Spectral Standard Star Atlases



Enter SpectroWeb

SPECTROWEB STATUS: SEPTEMBER 2010 (UNDER CONSTRUCTION SINCE 2005)

SpectroWeb Rationale

SpectroWeb was developed to provide the astronomical community with publicly available interactive digital spectral atlases of bright stars for the identification of spectral features used in a wide range of scientific and instrumental applications. The demand for publicly available standard spectral atlases is steadily increasing with the fast improvements in spectral wavelength resolution and the quality by which bright stars of nearly all spectral types are being observed with modern spectrographs. Printed atlases of stellar spectra often only provide a small list of identified features without an assessment of the reliability of the spectral line identifications. Users often have no means of telling whether or not the spectral line identifications are valid, or if they have been revised since publication. On the other hand, many public databases with spectral line information (that can be text queried on-line), are based on theoretical calculations that have not been tested, or are difficult to test against observed stellar spectra. Users often cannot verify if the provided line lists apply to their spectroscopic observations. The spectral line information can contain identifications that do not apply to an observed stellar spectrum because of unknown atmospheric formation conditions or elemental abundance differences with the solar values. Conversely, observed spectral features can often not be identified because the quality of the provided atomic and molecular line data is limited and requires further improvements.

SpectroWeb has been developed to provide users with a means to directly assess the quality of spectral line identifications by comparing high-quality observed spectra of bright stars with state-of-the-art computed spectra through an interactive on-line application. The program currently allows users to select 10 and 25 Angstroms spectral regions of interest from an interactive list of observed wavelengths. The continuum normalized observed and computed spectra are overplotted and marked with spectral line identifications when the central flux of the lines differs by more than two percent from the flux level of the stellar continuum. The user can further enlarge (zoom in) the displayed spectral regions by selecting smaller regions of interest by pressing and releasing the left mouse button. Atomic, molecular, and Earth spectral line identifications in the region of interest can be selected and listed in an interactive table to the right of the displayed spectrum. Each identified line can then be selected from the table to list corresponding detailed atomic and molecular information. View a SpectroWeb screenshot.

SpectroWeb Software and Releases

SpectroWeb 1.0 is based in part on graphical software packages written nearly a decade ago by Leigh Brookshaw of the Univ. of Southern Queensland, Australia [1]. The Java software packages are written to allow dynamic linking across the Web through an "applet" that loads in any Internet browser for which the Java interpreter has been activated. Java is an object-oriented programming language that has much in common with the C++ programming language.

SpectroWeb Development and Science Goals

- On-line graphical database of bright spectral reference stars for reliable identification of optical atomic, molecular and telluric absorption features based on state-of-the-art detailed spectral synthesis calculations.

- Interactively provides line rest wavelengths, log(gf)-values, damping constants, and central core depths. Also lists computed equivalent width values of evaluated lines.

- Currently includes HERMES spectra of Procyon (F5 V), Eps Eri (K2 V), and Arcturus (K1 III) between 4000 and 6800 Å observed with S/N~2,000 for program No. 20. Also includes spectra of the Sun (G2 V) from KPNO-FTS, and Betelgeuse (M2 Iab) & Canopus (F0 II) from VLT-UVES.

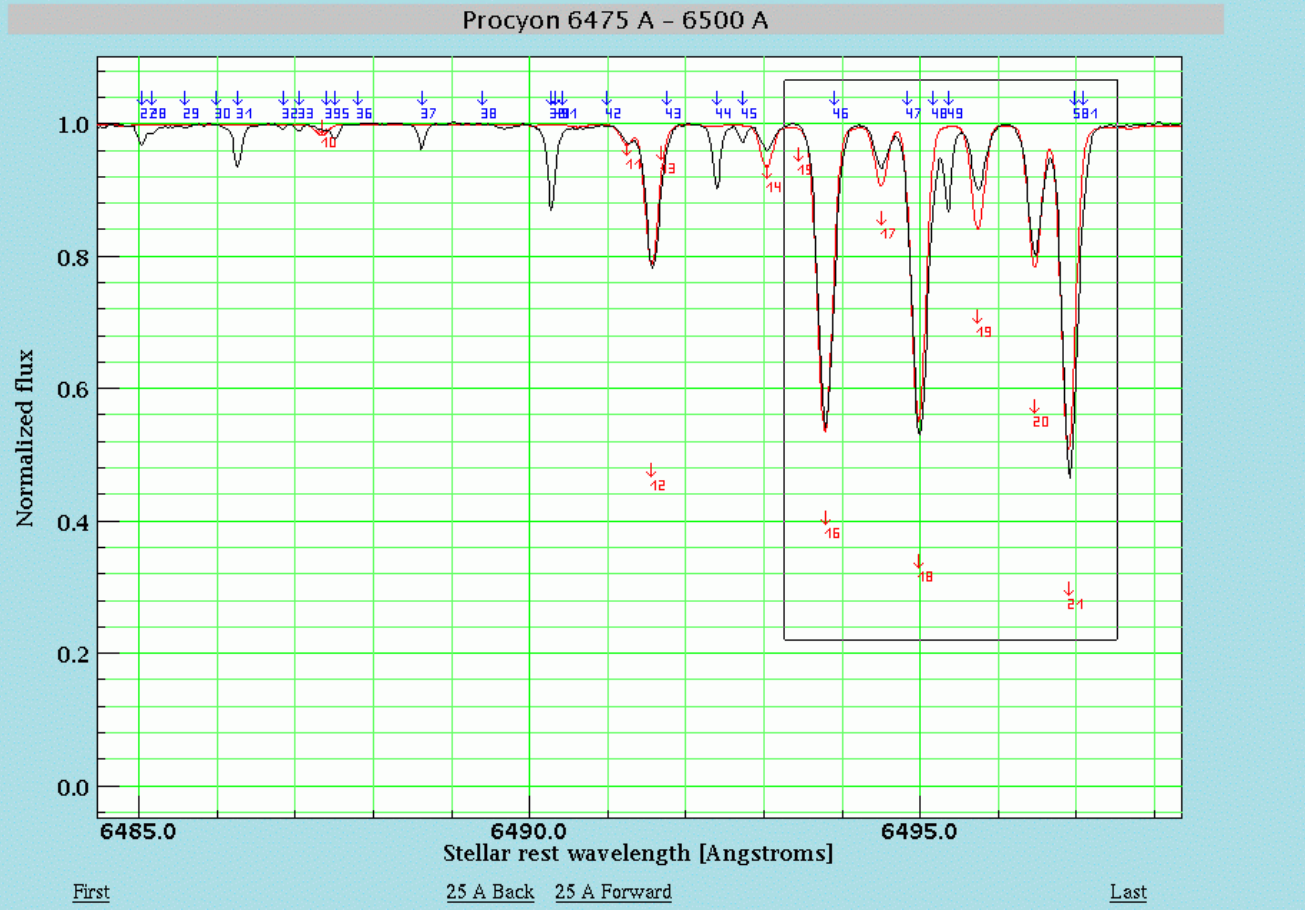
- Involve students in hands-on stellar spectroscopy for its development.

- Perform detailed spectral synthesis calculations to check quality of atomic line input data from atomic databases and the literature. Evaluate, and if required, adjust the literature log(gf)-values. Measure log(gf) and investigate systematic trends in the adjustments.

Mercator Hermes
Alpha CMi
6 Apr 2010
Normalized flux
Stellar rest wavelengths
R~80,000
S/N~2,000

3300-3325 A
3325-3350 A
3350-3375 A
3375-3400 A
3400-3425 A
3425-3450 A
3450-3475 A
3475-3500 A
3500-3525 A
3525-3550 A
3550-3575 A
3575-3600 A
3600-3625 A
3625-3650 A
3650-3675 A
3675-3700 A
3700-3725 A
3725-3750 A
3750-3775 A

Small Display | List Earth Lines | List Molecular Lines | List Atomic Lines



First | 25 A Back | 25 A Forward | Last

Nr El Ion Lam_air

Procyon atomic lines
1 Ca 1 6475.236
2 Fe 1 6475.624
3 Co 1 6477.853
4 Si 1 6478.936
5 Si 1 6479.881
6 Fe 1 6481.869
7 Fe 2 6482.204
8 Ni 1 6482.796
9 Fe 1 6483.944
10 Fe 2 6487.339
11 Fe 2 6491.246
12 Ti 2 6491.561
13 Mn 1 6491.687
14 Fe 2 6493.035
15 Si 1 6493.446
16 Ca 1 6493.781
17 Fe 1 6494.498
18 Fe 1 6494.980
19 Fe 1 6495.737
20 Fe 1 6496.466
21 Ba 2 6496.897
22 Fe 1 6498.937
23 Si 1 6499.021
24 Si 1 6499.230
25 Ca 1 6499.650

Nr	El	Ion	Lam0_air	Log(gf)	Elow(eV)	Rad	Stark	Waals	Lande	Line_depth(%)	Weq(mA)	Refs.
15	Si	1	6493.446	-1.831	6.125	9.060	-3.650	-7.000	0.770	6.5	----------	V-2
16	Ca	1	6493.781	-0.109	2.521	7.640	-6.071	-7.704	0.880	61.4	----------	V-2
17	Fe	1	6494.498	-1.456	4.733	8.410	-4.570	-7.510	1.250	16.1	----------	V-2
18	Fe	1	6494.980	-1.273	2.404	8.010	-6.080	-7.629	1.030	67.9	----------	V-2
19	Fe	1	6495.737	-0.940	4.835	8.400	-5.880	-7.154	0.630	31.1	----------	V-2
20	Fe	1	6496.466	-0.780	4.795	8.400	-4.730	-7.175	1.080	44.5	44	L07
21	Ba	2	6496.897	-0.377	0.604	0.000	0.000	-7.578	99.000	72.2	----------	V-2

SpectroWeb - Mozilla

File Edit View Go Bookmarks Tools Window Help

http://spectra.freeshell.org

Go Search

SpectroWeb 1.0

Interactive Spectral Atlases

Optical

Betelgeuse (M2Iab)
Arcturus (K1.2 III)
Eps Eri (K2 V)
The Sun (G2 V)
Beta Aqr (G0 Ib)
Procyon (F5 IV-V)
Canopus (F0 II)

Ultraviolet

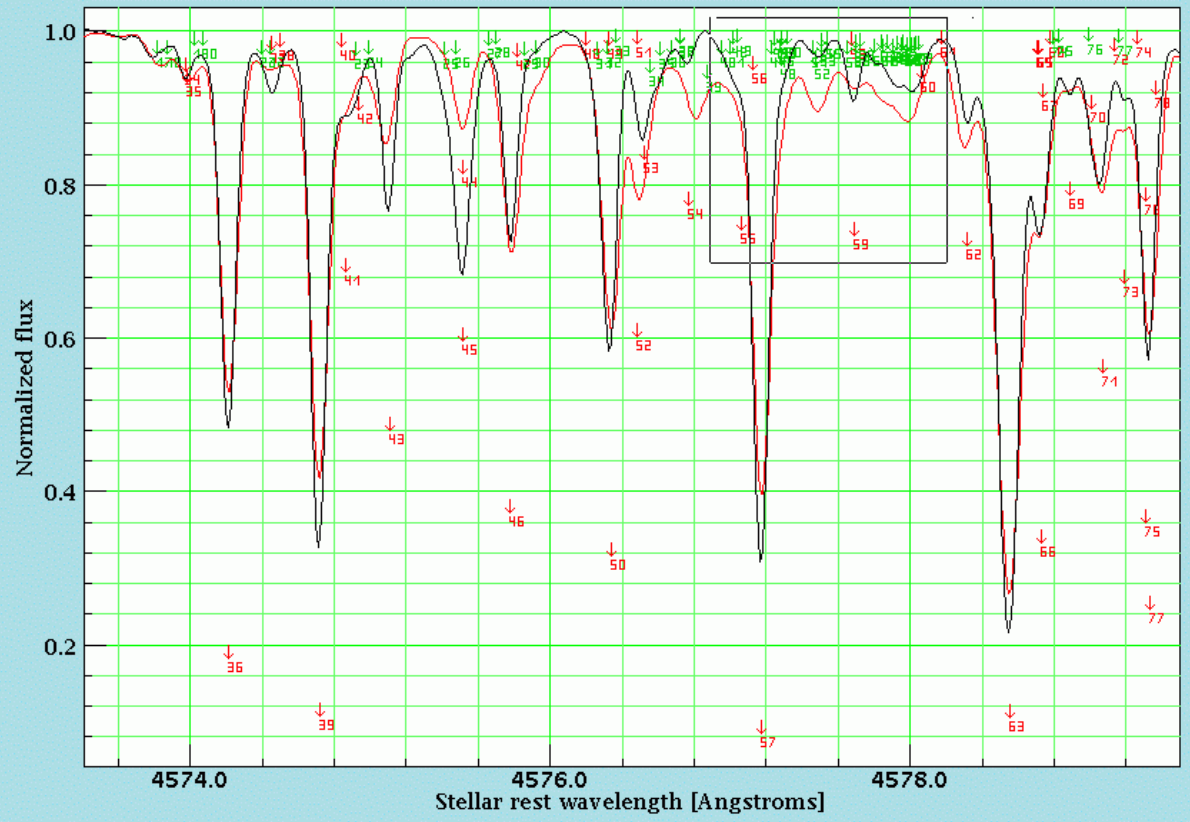
Betelgeuse (M2Iab)
Beta Aqr (G0 Ib)

Mercator Hermes
Epsilon Eri
12 Sep 2009
Normalized flux
Stellar rest wavelengths
R~80,000
S/N~2,000

4000-4010 A
4010-4020 A
4020-4030 A
4030-4040 A
4040-4050 A
4050-4060 A
4060-4070 A
4070-4080 A
4080-4090 A
4090-4100 A
4100-4110 A
4110-4120 A
4120-4130 A
4130-4140 A
4140-4150 A
4150-4160 A
4160-4170 A
4170-4180 A
4180-4190 A

Small Display | List Earth Lines | List Molecular Lines | List Atomic Lines

Eps Eri 4570 A – 4580 A



First | 10 A Back | 10 A Forward | Last

_Nr	Molec	Branch	Lam0_air	Log(gf)	E_low(eV)	Line_depth(%)
71	CN	BX	4578.024	-1.890	0.013	3.257
72	CN	BX	4578.029	-1.938	0.013	3.055
73	CN	BX	4578.047	-1.913	0.013	3.163
74	CN	BX	4578.790	-2.335	0.000	2.395
75	CN	BX	4578.827	-2.361	0.000	2.258
76	CH	R11ff	4578.988	-1.659	0.050	2.037
77	CH	oP12ff	4579.155	-1.641	0.050	2.120

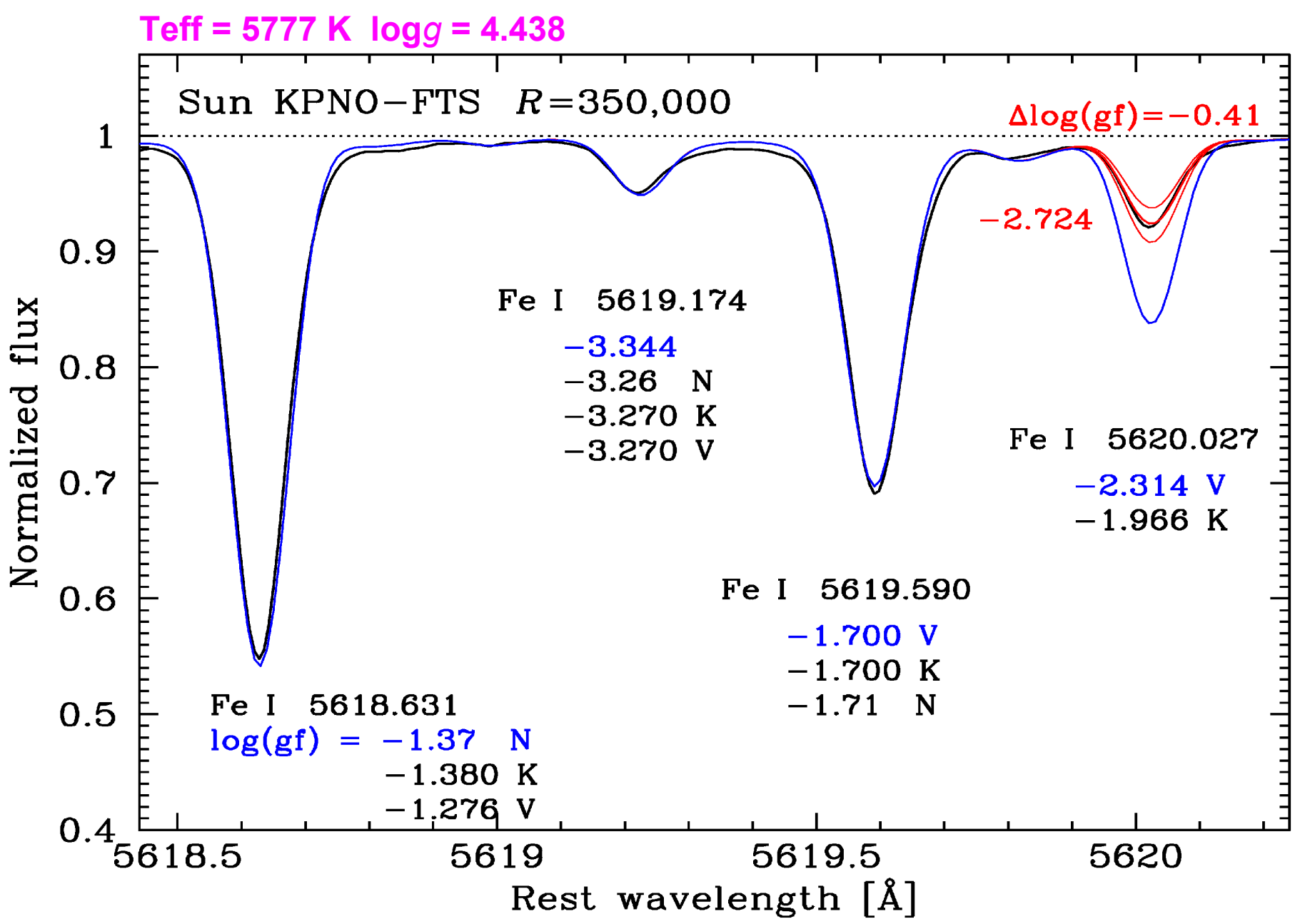
Nr Molec Lam_air

22 CN 4574.442
23 CN 4574.919
24 CN 4574.991
25 CN 4575.412
26 CN 4575.476
27 CN 4575.655
28 CN 4575.694
29 CN 4575.852
30 CN 4575.916
31 CN 4576.263
32 CN 4576.312
33 CN 4576.365
34 CH 4576.556
35 CN 4576.612
36 CN 4576.675
37 CN 4576.723
38 CN 4576.723
39 CH 4576.872
40 CN 4576.953
41 CN 4576.998
42 CN 4577.017
43 CN 4577.042
44 CN 4577.229
45 CN 4577.242
46 CN 4577.280
47 CN 4577.282
48 CH 4577.285
49 CN 4577.286
50 CN 4577.313
51 CN 4577.461
52 CH 4577.472
53 CN 4577.509
54 CN 4577.510
55 CN 4577.542
56 CN 4577.648
57 CN 4577.694
58 CN 4577.698
59 CN 4577.722
60 CN 4577.797
61 CN 4577.837
62 CN 4577.846
63 CN 4577.869
64 CN 4577.901
65 CN 4577.929
66 CN 4577.952
67 CN 4577.962
68 CN 4577.980
69 CN 4577.986
70 CN 4578.006
71 CN 4578.024
72 CN 4578.029
73 CN 4578.047
74 CN 4578.790
75 CN 4578.827
76 CH 4578.988
77 CH 4579.155

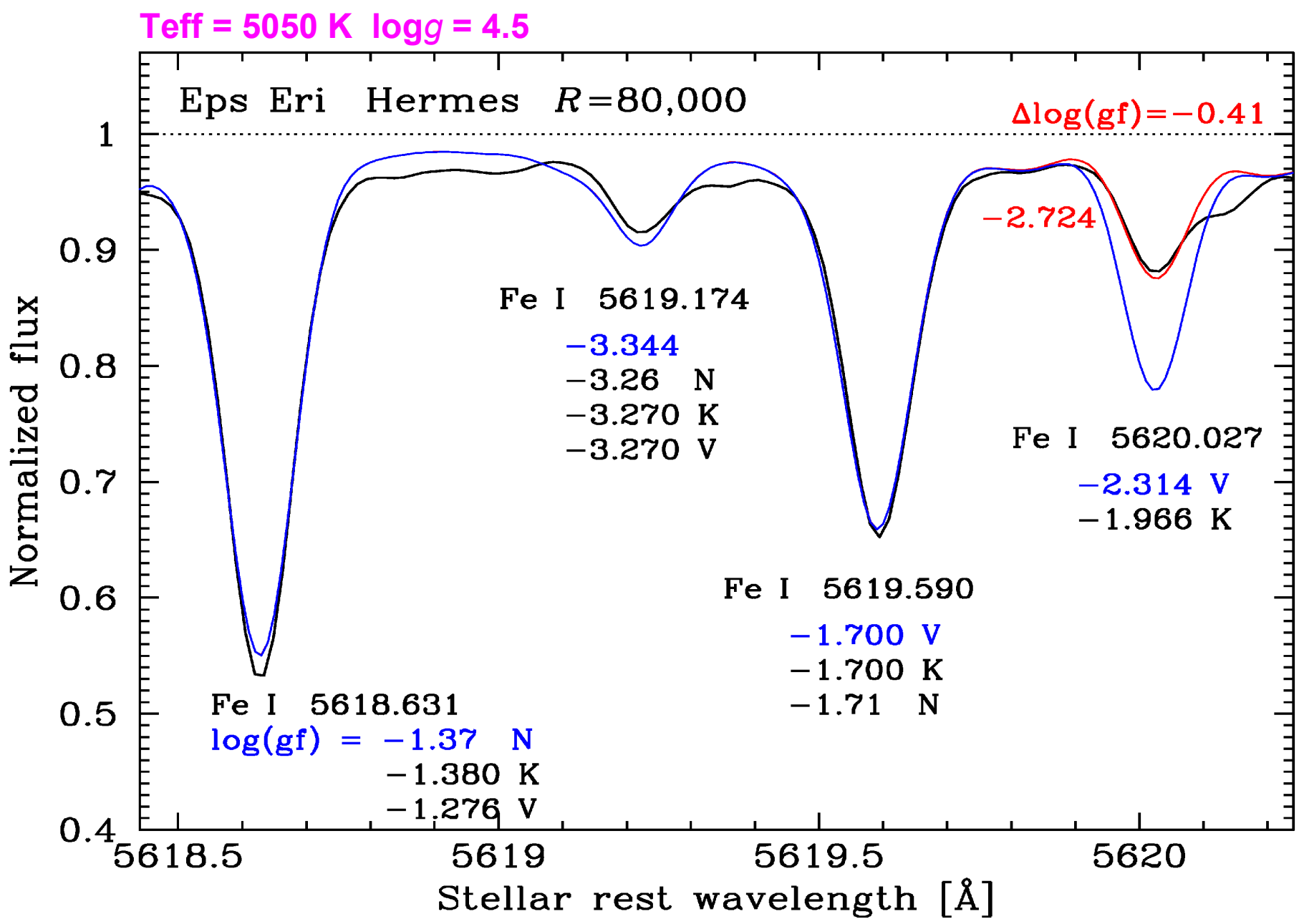
Spectral synthesis modeling method

- Radiative transfer in LTE approximation for dwarf star atmospheres.
- Comparative absorption line spectrum calculations with SCANSPEC code of:
  - Sun (G2) Teff = 5777 K, log*g* = 4.438
    FTS/KPNO disk integrated spectrum, R=350,000 & SNR~2,500.
  - Procyon (F5) Teff = 6550 K, log*g* = 4.0, [Fe/H]=-0.05±0.03
    HERMES 50 x 20 s ($V=0^m.34$), R=80,000 & SNR~2,200.
  - Epsilon Eridani (K2) Teff = 5050 K, log*g* = 4.5, [Fe/H]=-0.01±0.08
    HERMES 20 x 160 s ($V=3^m.73$), R=80,000 & SNR~2,000.
- 1-D model atmosphere structures (Tgas, density, …) without chromosphere.
- MLT theory approximation, constant micro-turbulence velocity with depth.
- Elemental abundance values of Anders & Grevesse (1989), [M/H]=0.
- Equation of state includes important hydrides, C_2, CN, CO, TiO, SiO, ...
- Atomic input data from NIST (N), VALD-2 (V), Kurucz website (K), Topbase, CHIANTI, … online databases.

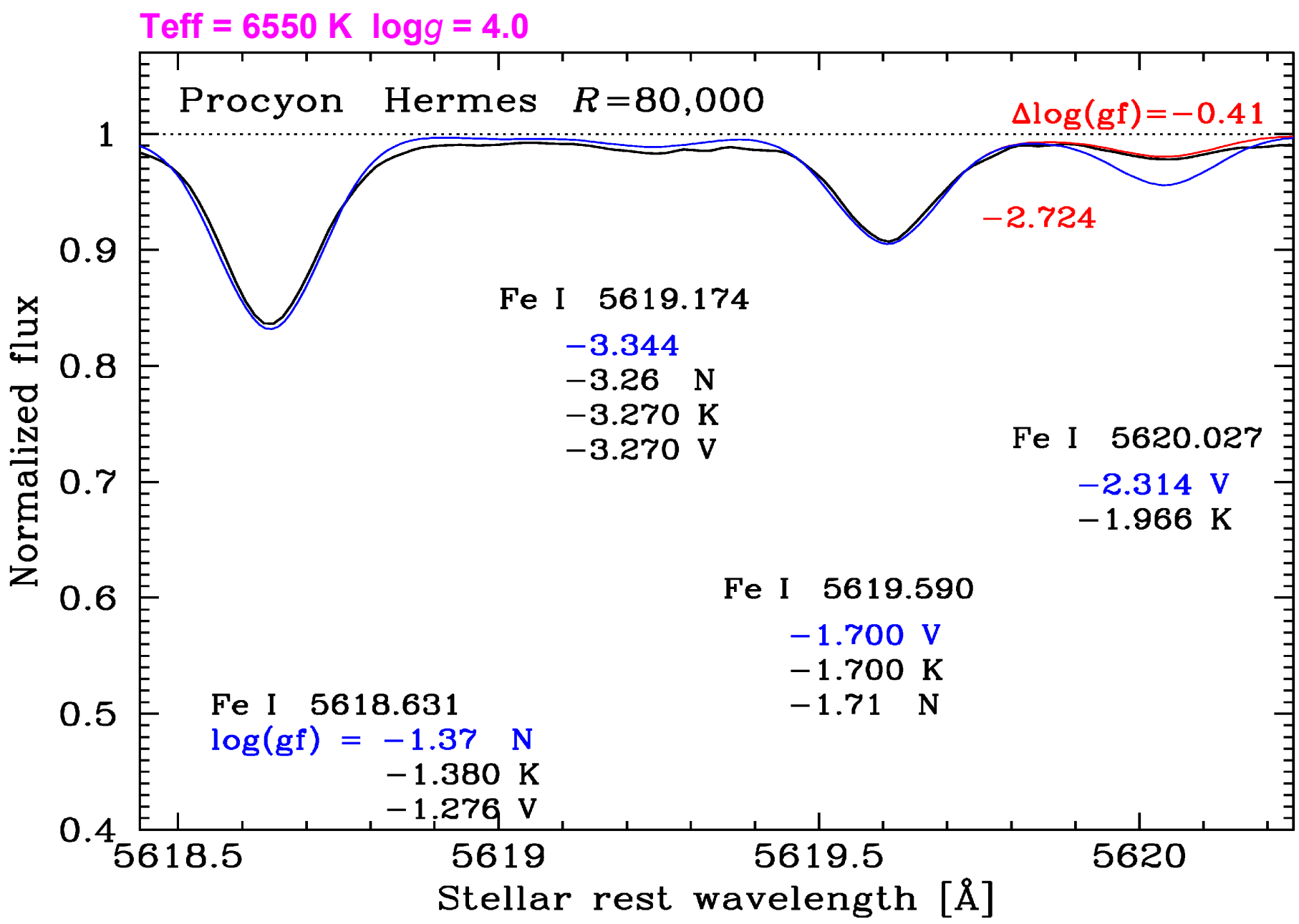
Spectral synthesis log(gf) measurement method



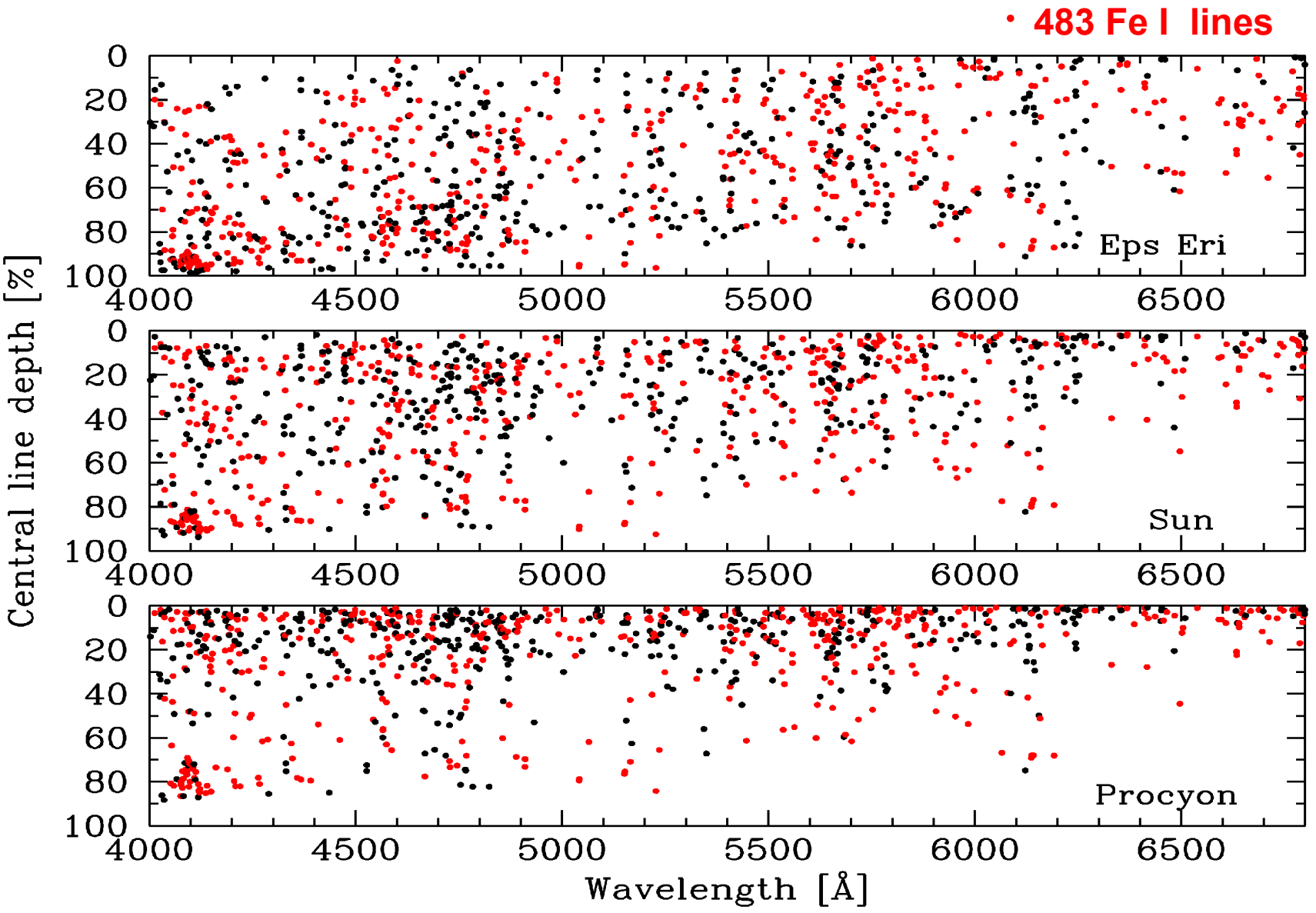
Spectral synthesis log(gf) measurement method



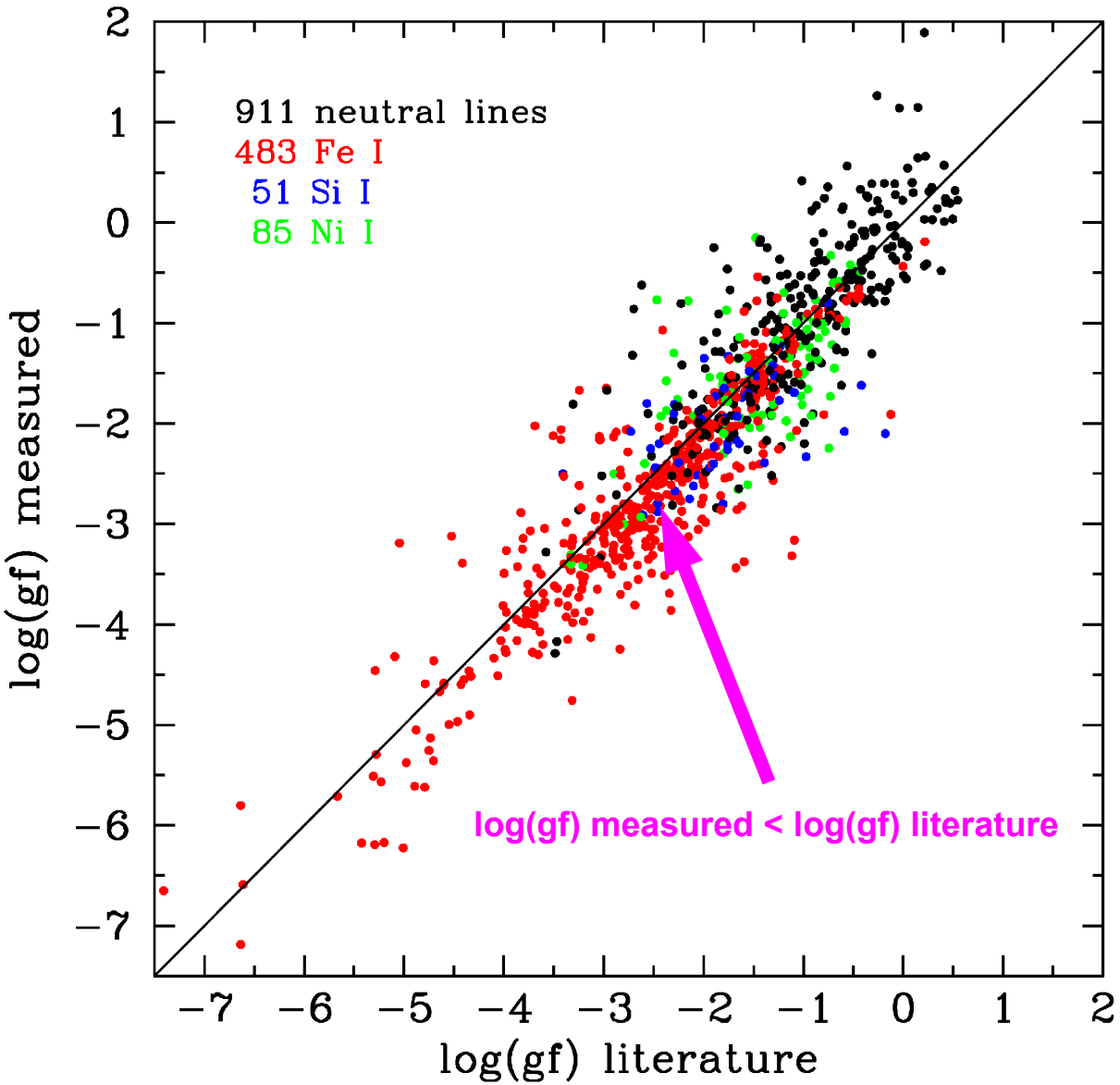
Spectral synthesis log(gf) measurement method



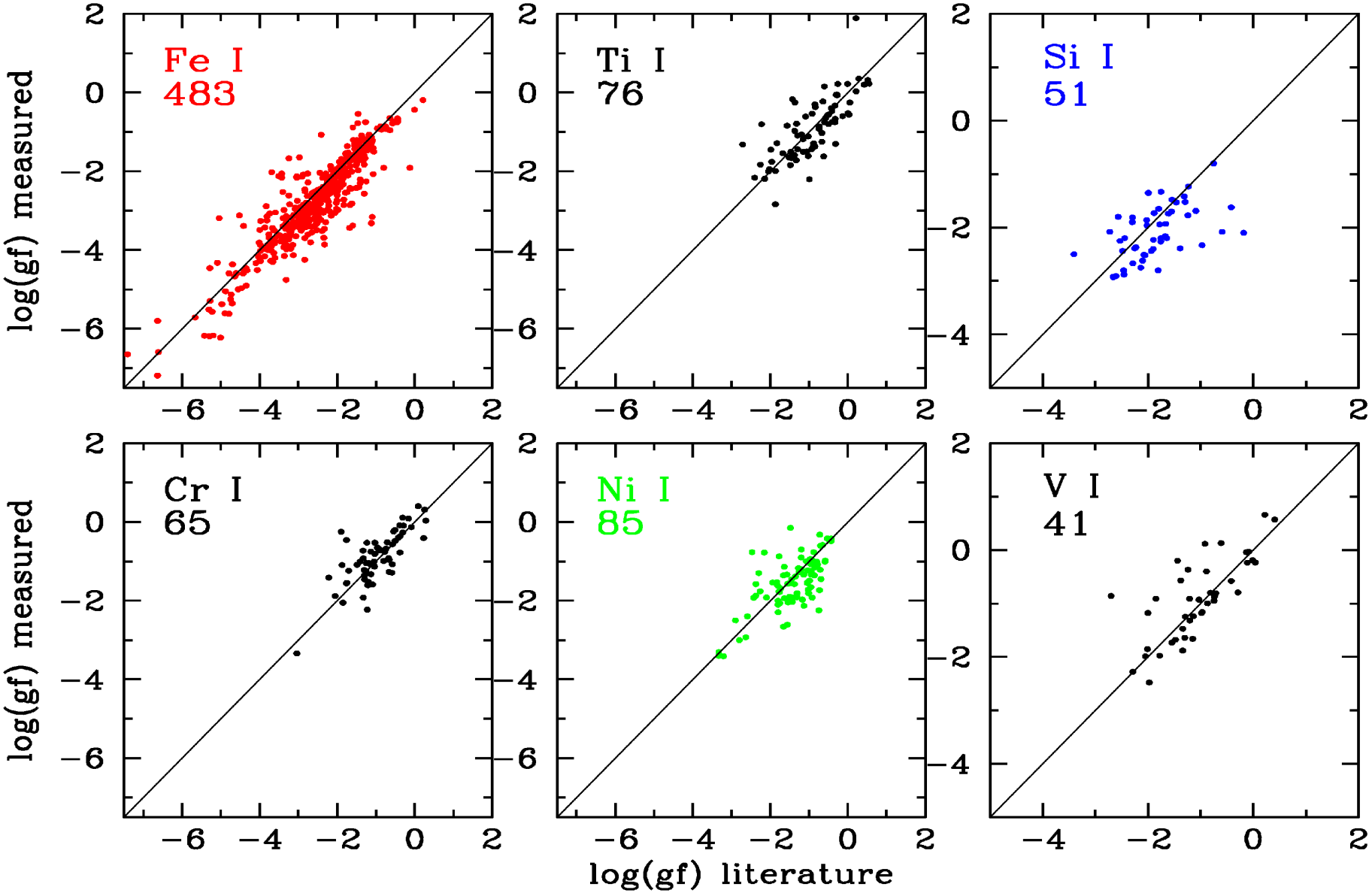
Iterative log(gf) measurement of 911 neutral lines



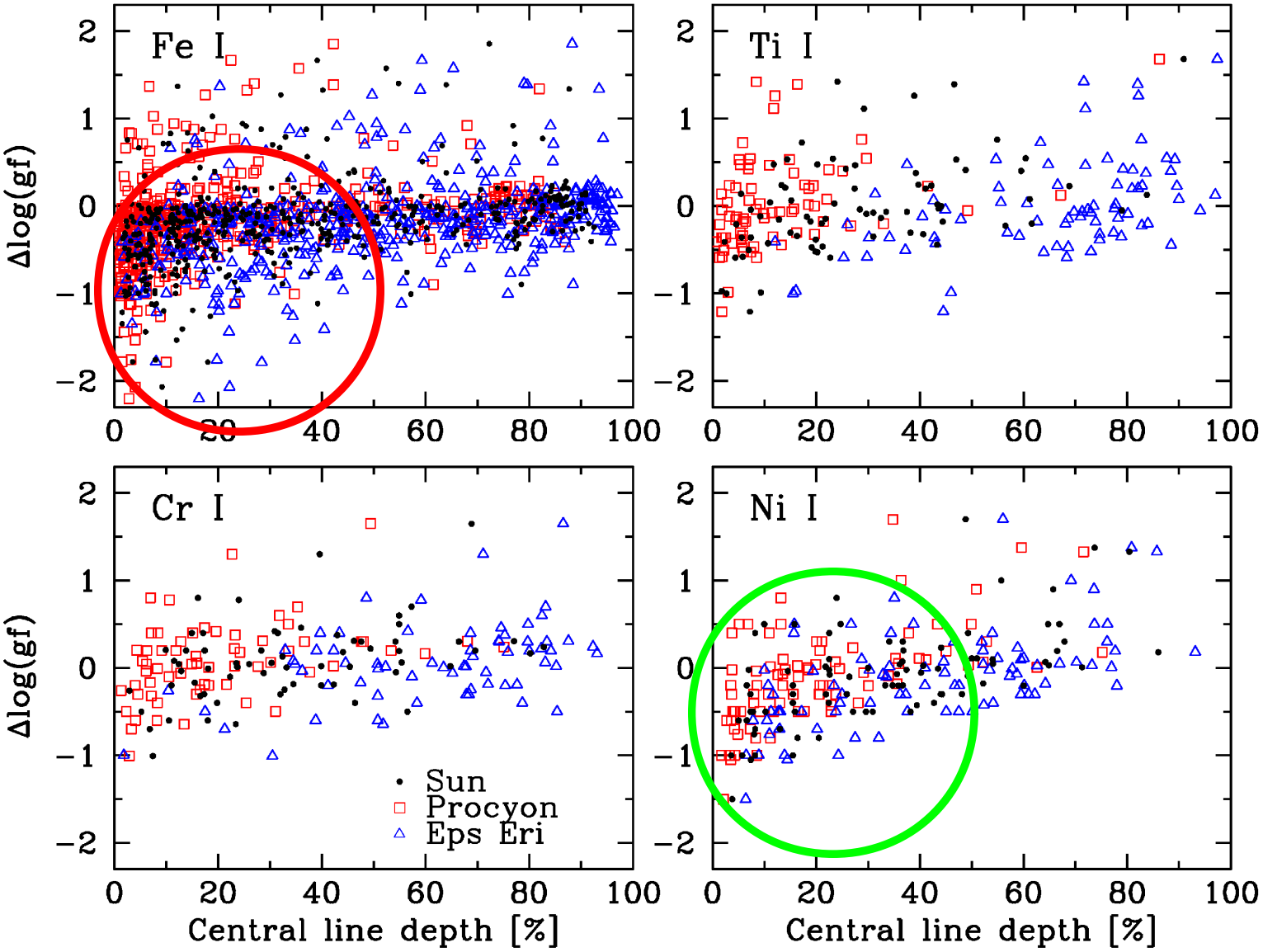
Measured vs. literature log(gf)-values



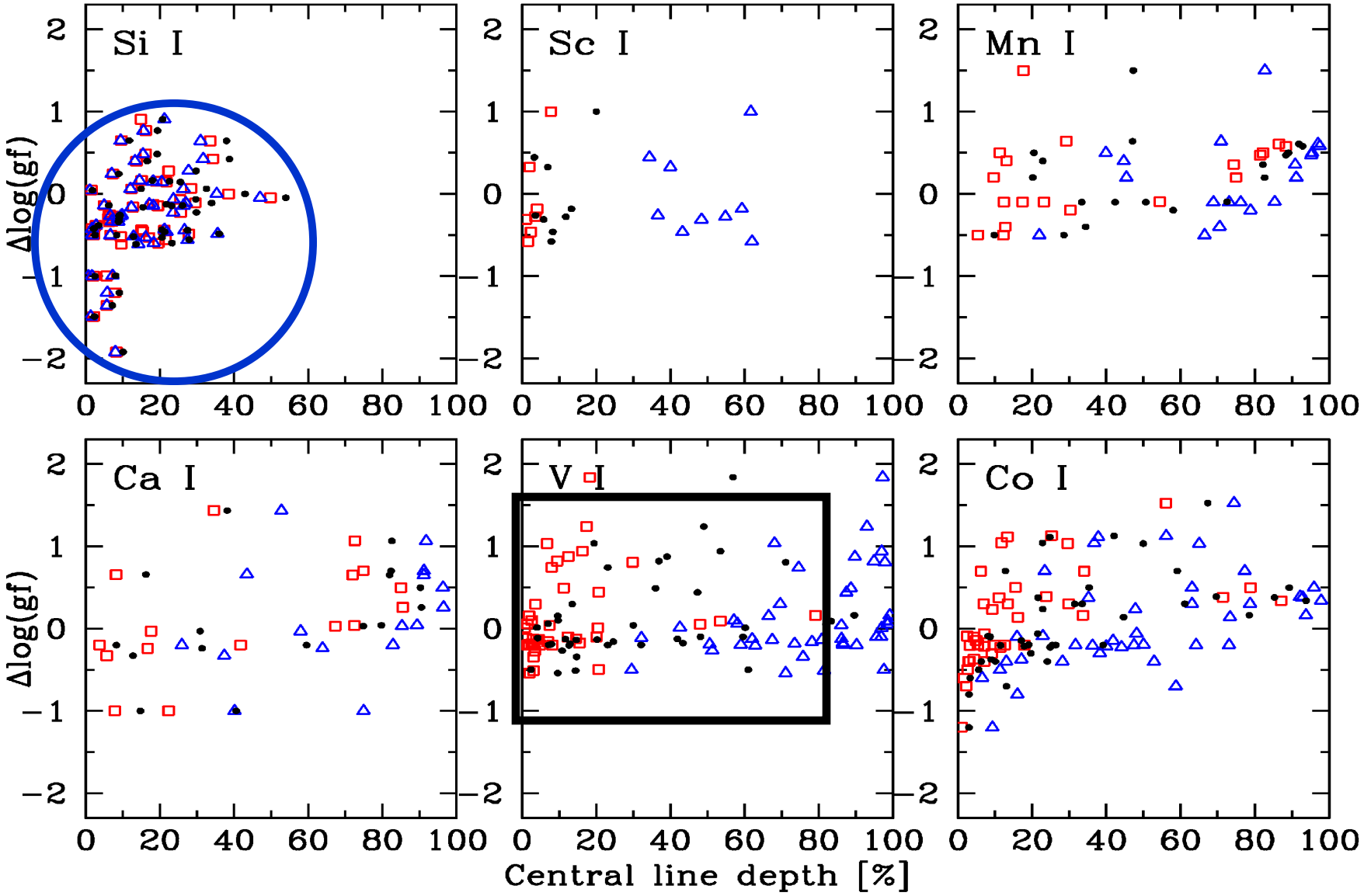
Measured vs. literature log(gf)-values



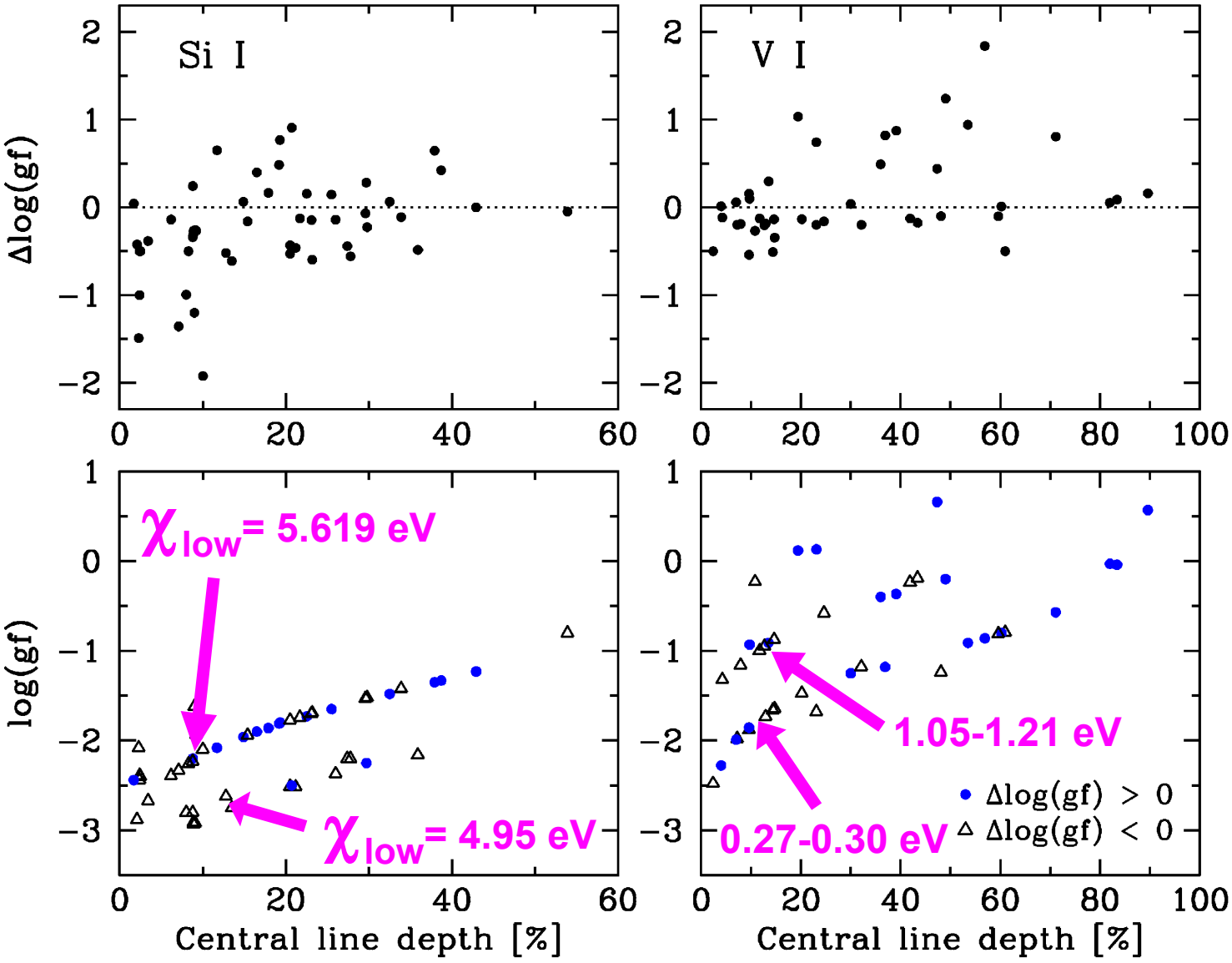
log(gf)-corrections vs. computed line depths



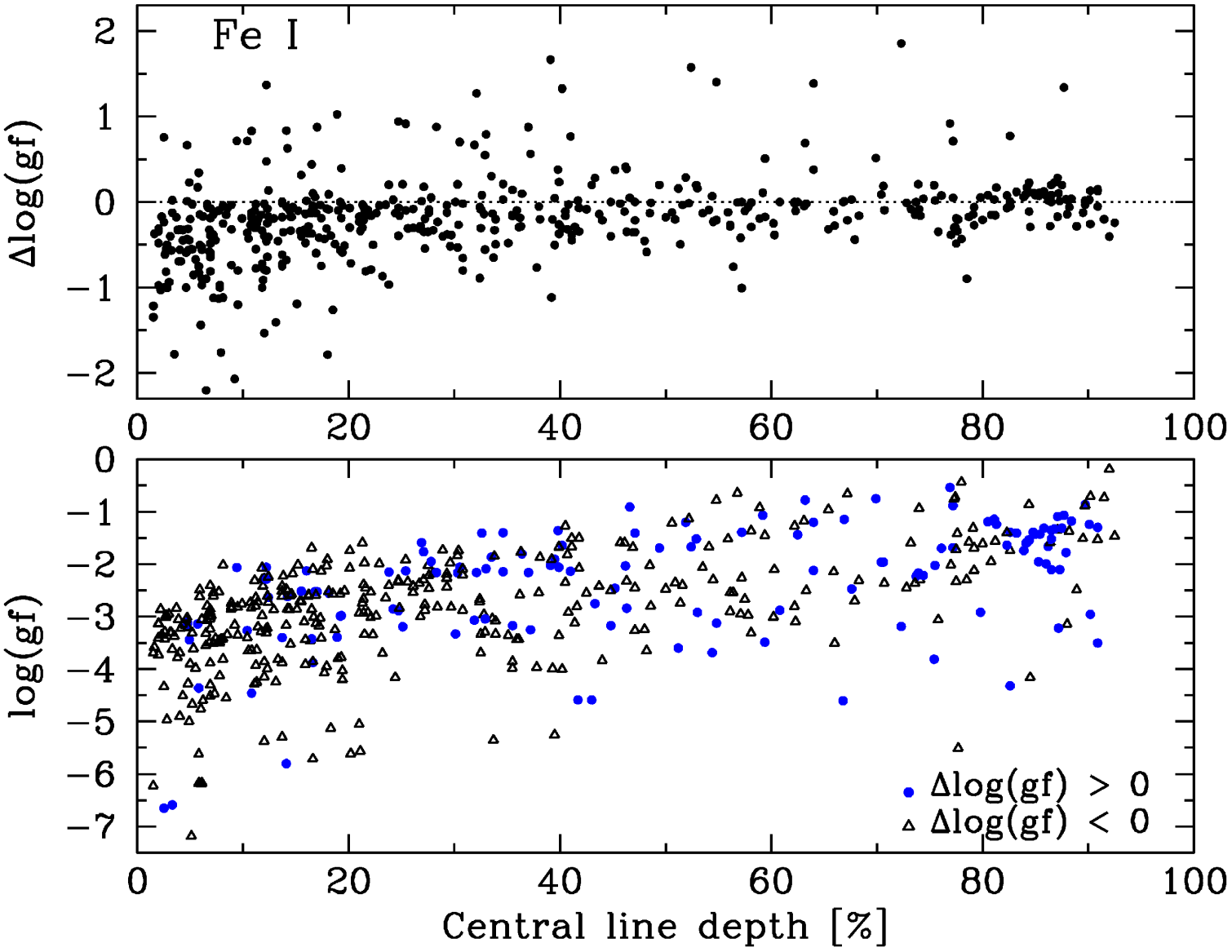
log(gf)-corrections vs. computed line depths



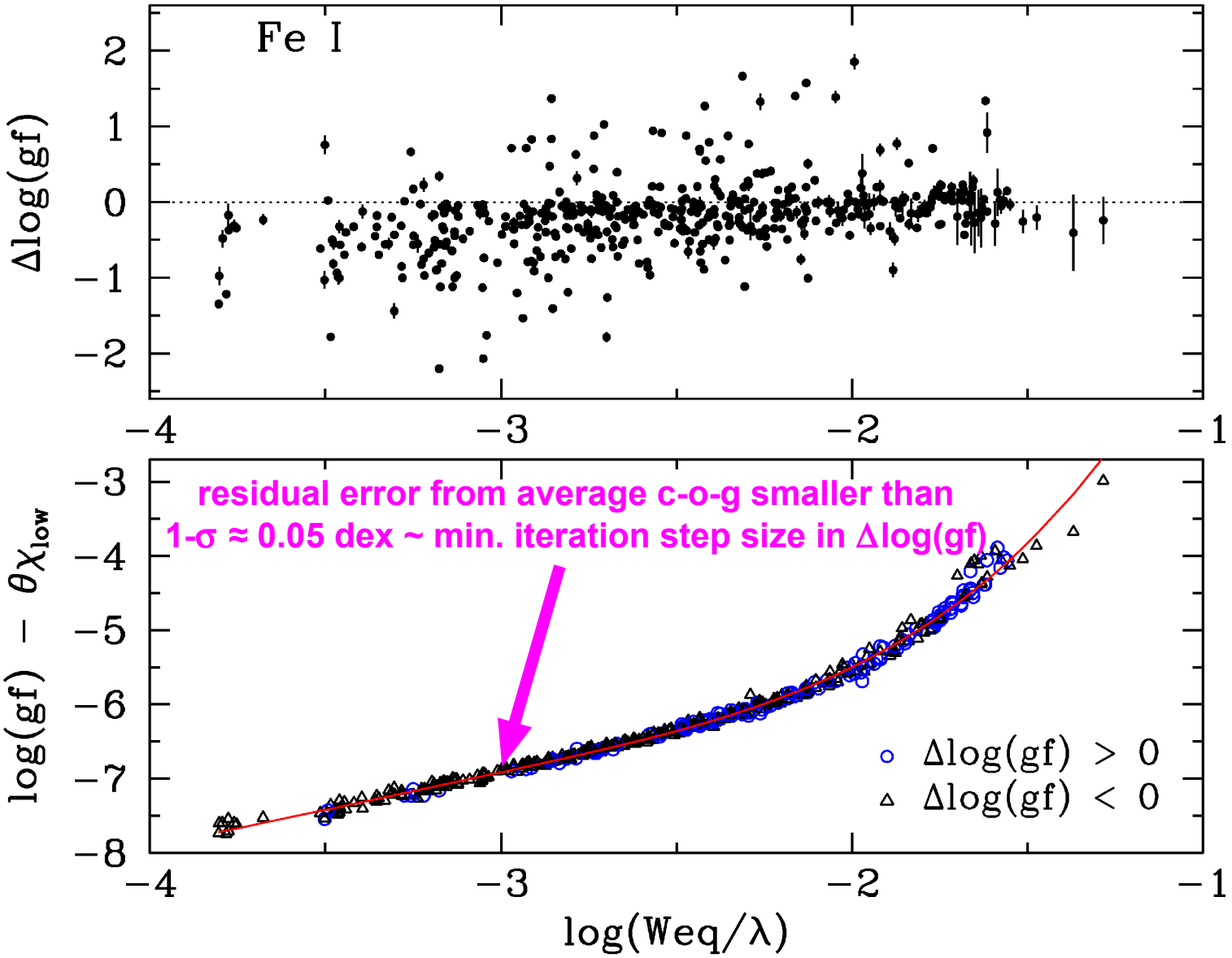
Curve of growth analysis



Curve of growth analysis



Curve of growth analysis



Summary

- Detailed spectrum synthesis of optical HERMES spectra of Procyon and Eps Eri with S/N~2,000 and the Sun used for measurements of accurate log(gf)-values of 911 weak and medium-strong absorption lines (483 Fe I).

- We measure remarkable systematic over-estimations of literature log(gf)-values for weak lines (< 15 %) of iron-peak elements Fe I, Ni I, and also Si I. Average curve-of-growth error budget of the log(gf) measurements yields mean accuracies of 0.05 – 0.1 dex.

- The Δlog(gf) trends are due to the limited accuracy of log(gf)-values for weak lines offered in atomic databases and literature. Many of the measured lines have only predicted log(gf)-values.

$\forall \Rightarrow$ *A. Lobel, Oscillator Strength Measurements of Atomic Absorption Lines from Stellar Spectra, Can. J. Phys.* 2010, submitted.

- **Future research:** HERMES observations with S/N~2,000 of spectral standard stars with Teff > 7000 K.

  Analyses of literature log(gf)-values and accurate log(gf) measurements of ionic species. Evaluation of many more log(gf)-values for line identification in optical spectra.