The Belgian Repository of fundamental Atomic Data and Stellar Spectra

BRASS

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Science motivation

- Compilation of high-quality optical spectral atlases of bright benchmark BAFGK stars with confirmed line identifications and quality-tested atomic line data.
- Modelling of high-resolution optical spectra of bright stars of every stellar spectral sub-class observed with SNR~1000 (HERMES & UVES)
- Perform detailed spectral synthesis calculations to test quality of atomic line input data from literature and online data providers (VAMDC, NIST, and more).
- Provide observed and theoretical spectra combined with quality-tested atomic data in public online database called BRASS.
- Institutional networking project of Belgian Federal Science Policy Office in the BRAIN.be program of 2015-, also involving ESO.

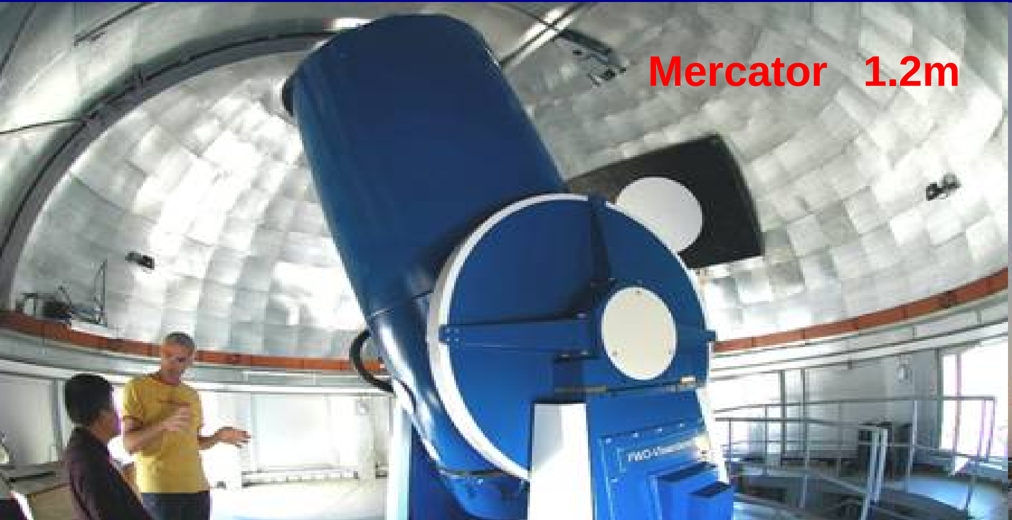
Mercator-HERMES and VLT-UVES spectrographs

- HERMES = High Efficiency and Resolution Mercator Echelle Spectrograph Collaboration project between the Univ. of Leuven, the Université Libre de Bruxelles and the Royal Observatory of Belgium, with contributions from the Observatoire de Genève (Switzerland) and the Thüringer Landessternwarte Tautenburg (Germany).

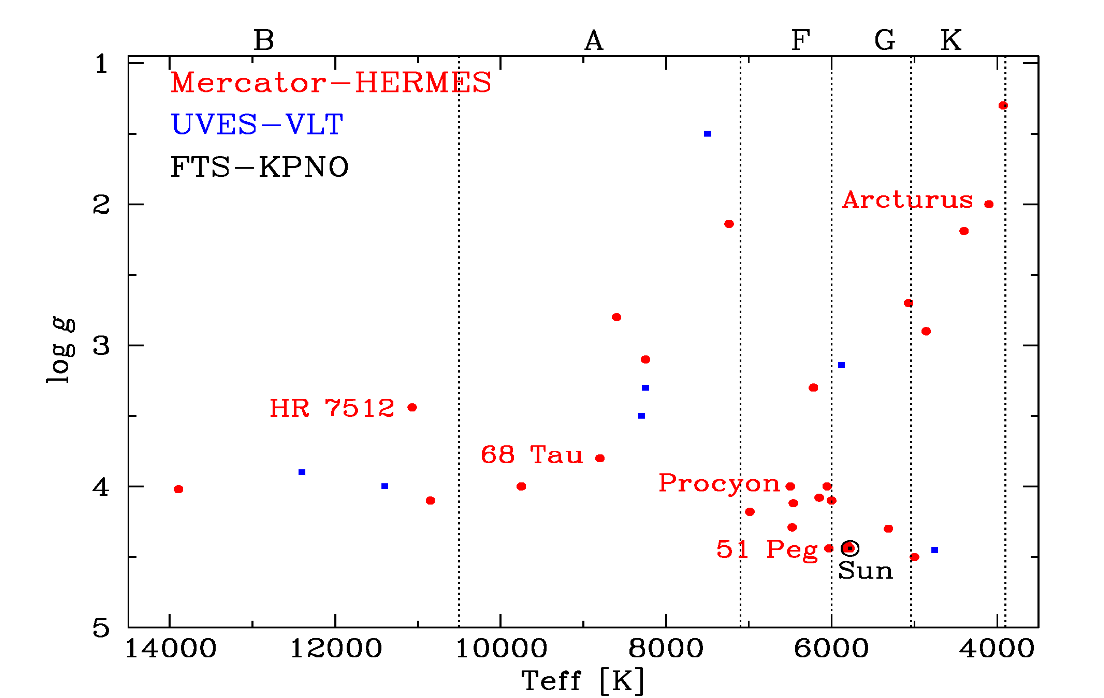
- UVES = Ultraviolet and Visual Echelle Spectrograph on ESO VLT UT2.

- HERMES spectral resolution R=85,000. Optimized for high efficiency in visual band.
  - λ=377 nm to 900 nm observed in a single exposure.

- UVES R=47,000. Built for maximum mechanical stability & accurate wavelength calibration.



BAFGK benchmark spectra for BRASS

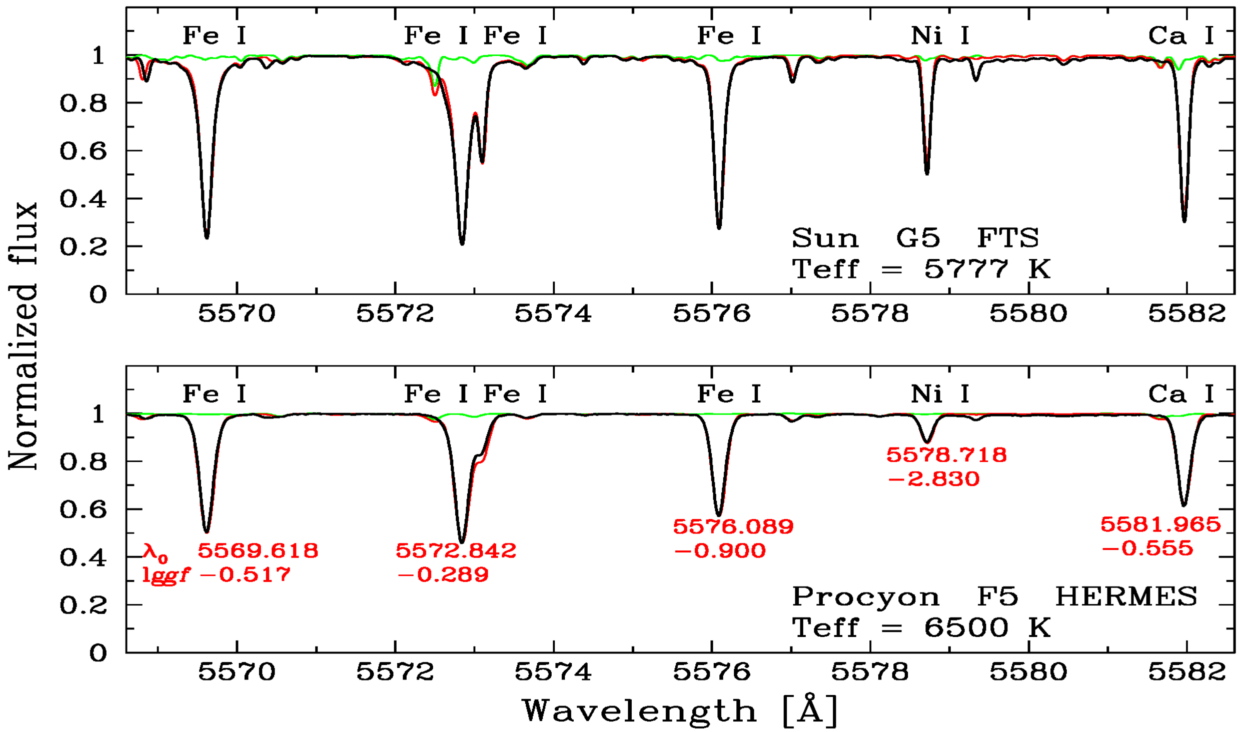


FGK – benchmarks:

Sun
51 Peg
70 Oph
70 Vir
10 Tau
Eps Eri
Bet Com

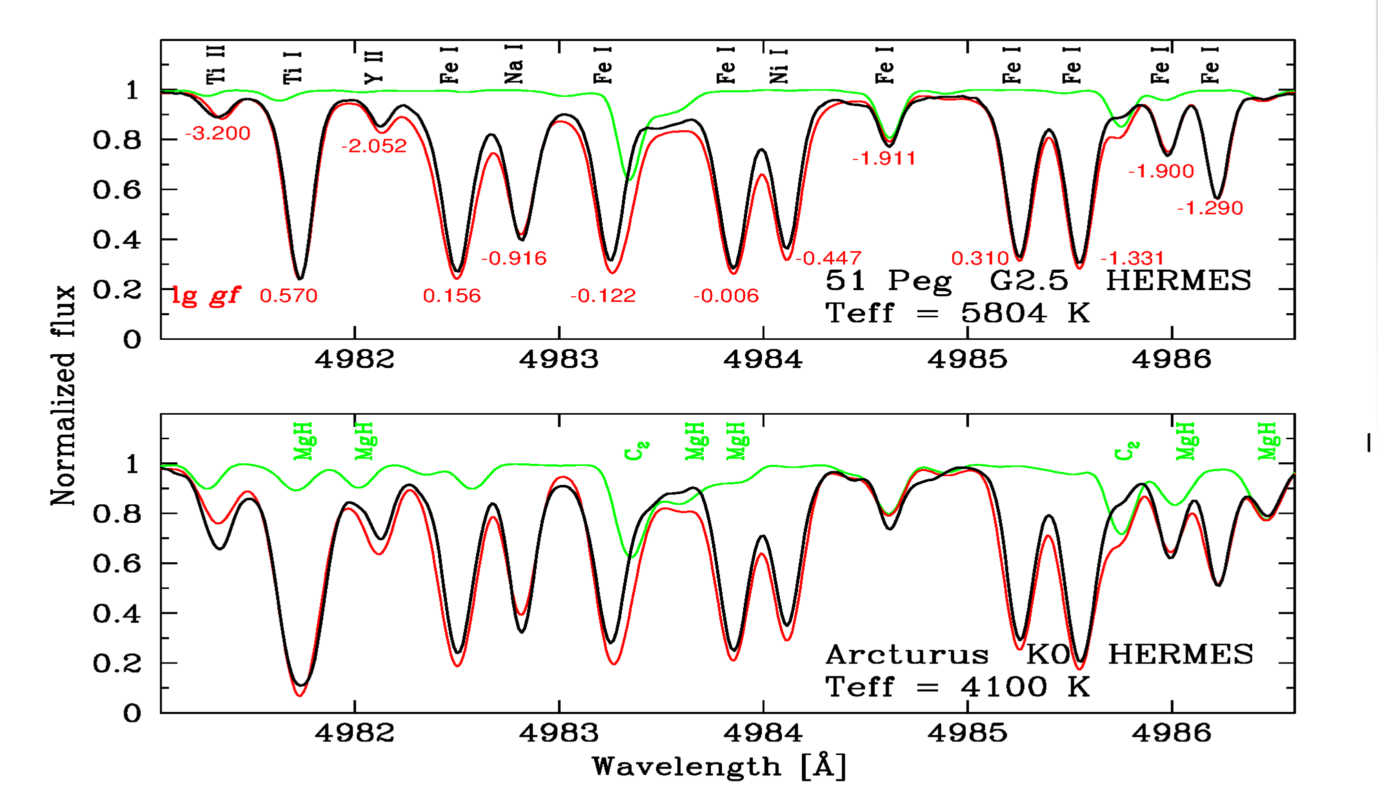
- Benchmark spectra of SNR~1000 are used for testing the quality of atomic input data.
- 5-7 bright stars per spectral type. Narrow-lined stars (Vrot < 20 km/s), single, invariable, not-peculiar stars are selected having metallicity close to solar (not metal-poor field/halo stars).
- We determine atmospheric parameters Teff, log*g*, [M/H], [α/H],Vmic, & [X/H] values using ~30 diagnostic lines and compare to literature parameters (Lobel et al. 2017, Can J. Phys., 95, 833).
- We develop ”synthetic template continuum normalization” procedure.

Detailed RT modeling of observed stellar spectra



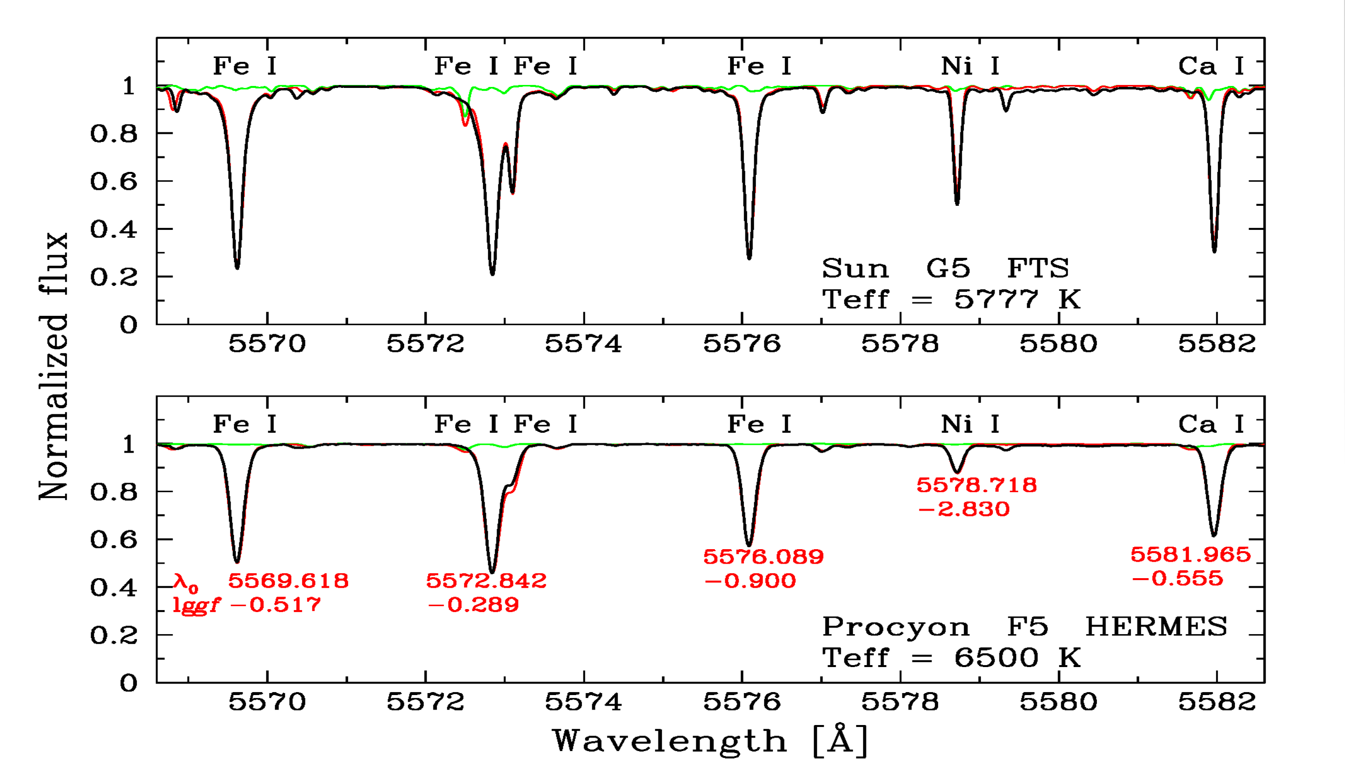
- Correctly fit detailed profiles of absorption lines simultaneously with atomic input line data:
  rest wavelength λ_0, oscillator strengths log(*gf*), line damping contants.
- Spectrum synthesis calculations with radiative transfer in LTE using 1-D hydrostatic atmosphere models of FGK-type dwarf stars of 5000 K < Teff < 6000 K.

Cool stars (F G K) benchmark spectra for BRASS



- Molecular line opacity included in the theoretical FGK spectrum calculations.
- Molecular lines in optical spectrum of the Sun (G-type) are weak, but stronger in K- and M-type stars.
- Atomic lines blending together with molecular lines are avoided for further analysis in BRASS.

Detailed RT modelling of observed stellar spectra



- Correctly fit detailed profiles of absorption lines simultaneously with atomic input line data: rest wavelength λ_0, oscillator strengths log(*gf*), line damping contants.
- Spectrum synthesis calculations with radiative transfer in LTE using 1-D hydrostatic atmosphere models of FGK-type dwarf stars of 5000 K < Teff < 6000 K.

Atomic and molecular data for BRASS

- BRASS atomic line data compiled from literature until 2012 (+2014) in 400 nm < λ < 680 nm.
- SpectroWeb compilation from literature before 2007 & older data in NIST V-4 & VALD-2.
- Retrieved CHIANTI, TIP/TOPbase, and Spectr-W^3 atomic line data from VAMDC database.

Repository	Origin	No. lines	Date	Ion	λ	A_{ki}	f_{ik}	$\log(gf)$	$E_{low/up}$	$J_{low/up}$
BRASS	-	82337	2012 [b]	✓	✓			✓	✓	✓
SpectroWeb	-	62181	2008 [b]	✓	✓			✓	✓ [f]	
VALD3	VALD	158861	26/05/2016	✓	✓			✓	✓	✓
NIST	NIST	36123	14/03/2016	✓	✓ [c]	✓	✓	✓	✓	✓
Spectr-W^3	VAMDC	5515	14/03/2016	✓	✓	✓	✓		✓	✓
TIPbase[a]	NORAD	33108	28/02/2017	✓	✓	✓	✓		✓ [g]	
TOPbase[a]	VAMDC	33462	24/05/2016	✓	✓			✓ [e]	✓ [g]	
CHIANTI	VAMDC	3587	18/03/2016	✓	✓ [d]	✓		✓ [e]	✓ [f]	✓

$\Rightarrow$ Total number of retrieved transitions: ~400,000 atomic lines

- Retrieved di-atomic molecular data from literature and ExoMol database for
  CN, C_2, CH, AlH, CaH, SiH, FeH, CrH, NH, OH, MgH, TiO, ZrO, VO:
  = several tens of millions of molecular lines added to spectrum synthesis line lists.

Cross-matching atomic line data for BRASS

- Atomic data sources carrying electronic configuration information are cross-matched based on electronic configuration information only (includes the terms and *J* of upper and lower states).

  ⇒ **First time this has been successfully accomplished for BRASS.**

  Resolve:
  - inhomogeneous configuration nomenclatures across sources
  - detection of many duplicated lines in data sources (VALD3)
  - book-keeping required for hyperfine and isotopic components

  Example:
  BRASS vs. NIST
  BRASS vs. VALD3
  BRASS vs. TOP/TIPBASE (spectral terms and seniority index)

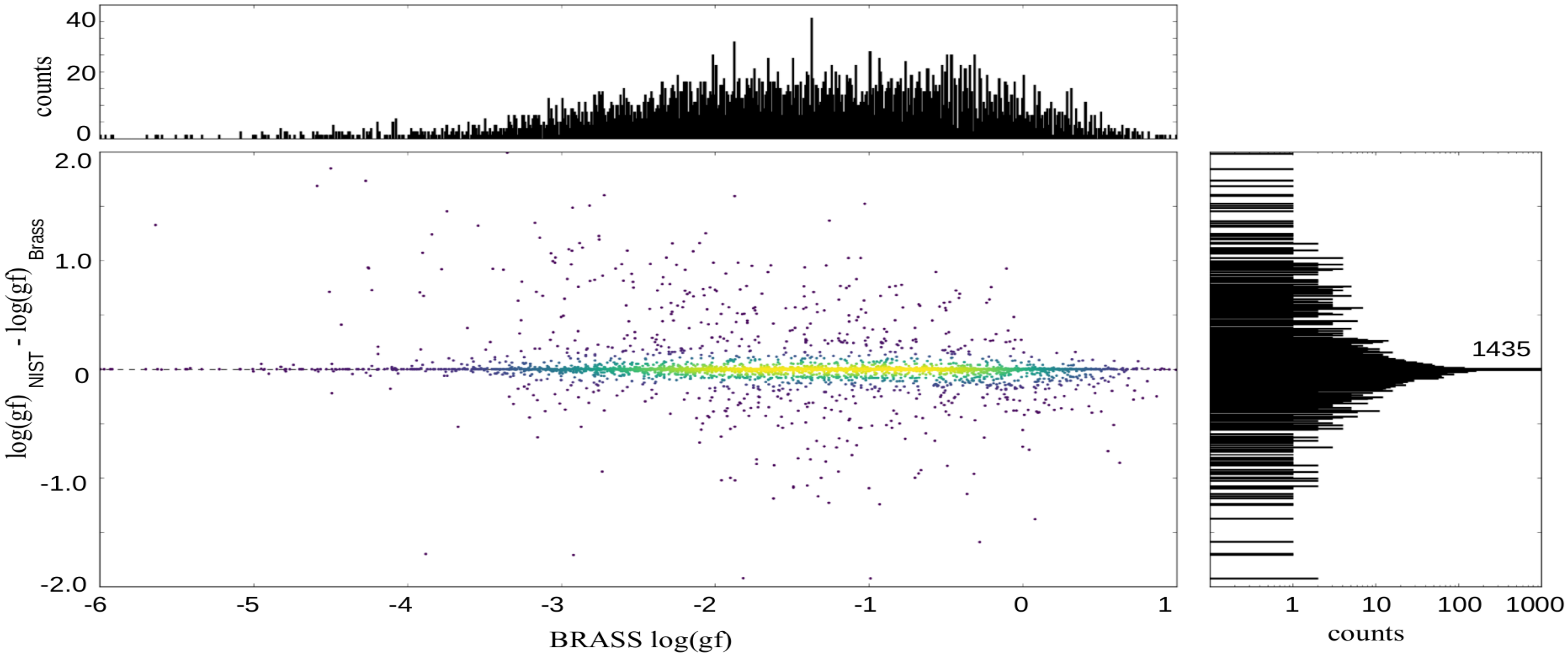
- Without electronic configuration info cross-matches consider thresholds for differences in λ_0 and energy levels. Traditional cross-matching method of atomic data source builders.

  Resolve:
  - cross-matches can be sensitive to choices of the threshold levels

  Example:
  BRASS vs. SpectroWeb
  BRASS vs. CHIANTI
  BRASS vs. Spectr-W^3

Cross-matching atomic line data for BRASS

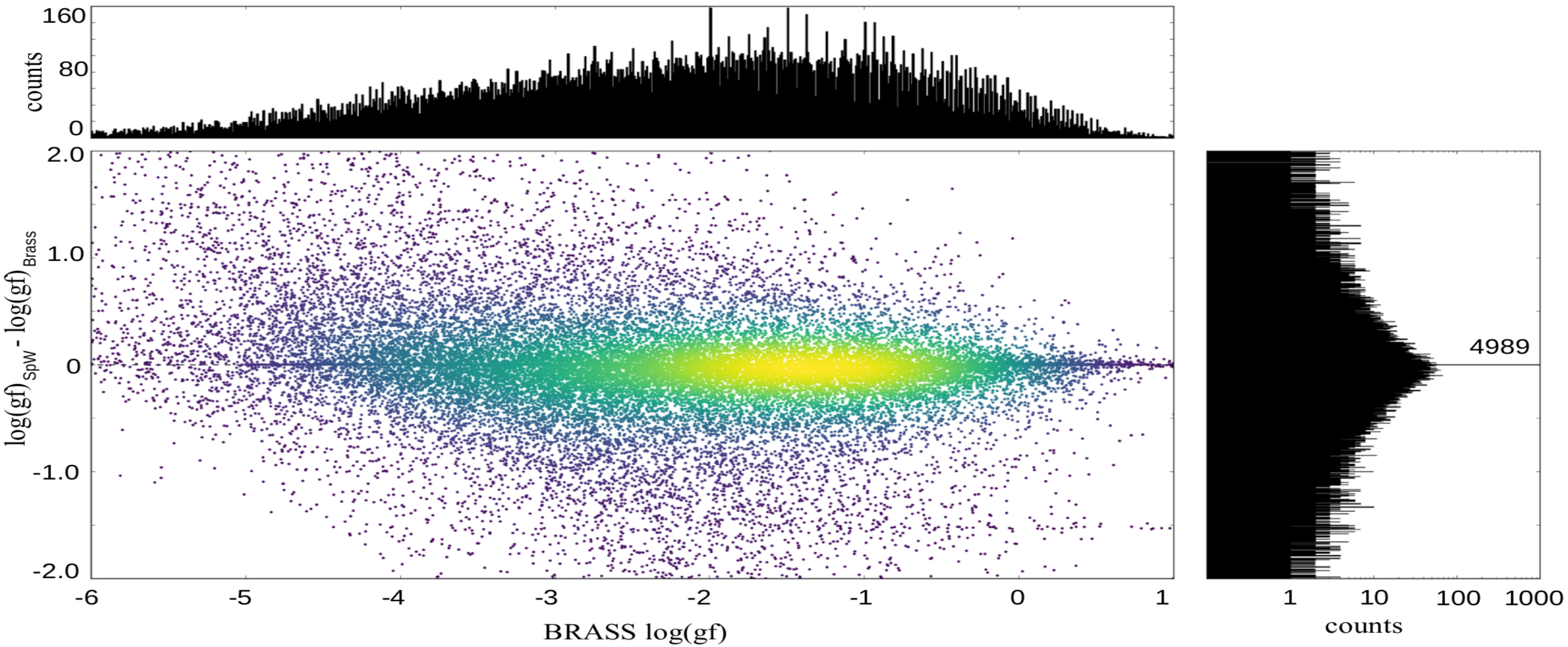
$\log(gf)_{BRASS(2012)}$ vs. $\log(gf)_{NIST(2016)} - \log(gf)_{BRASS(2012)}$



- NIST updates of atomic log(*gf*) values between 2012 and 2016
- log(*gf*) differences to ~2 dex.

Cross-matching atomic line data for BRASS

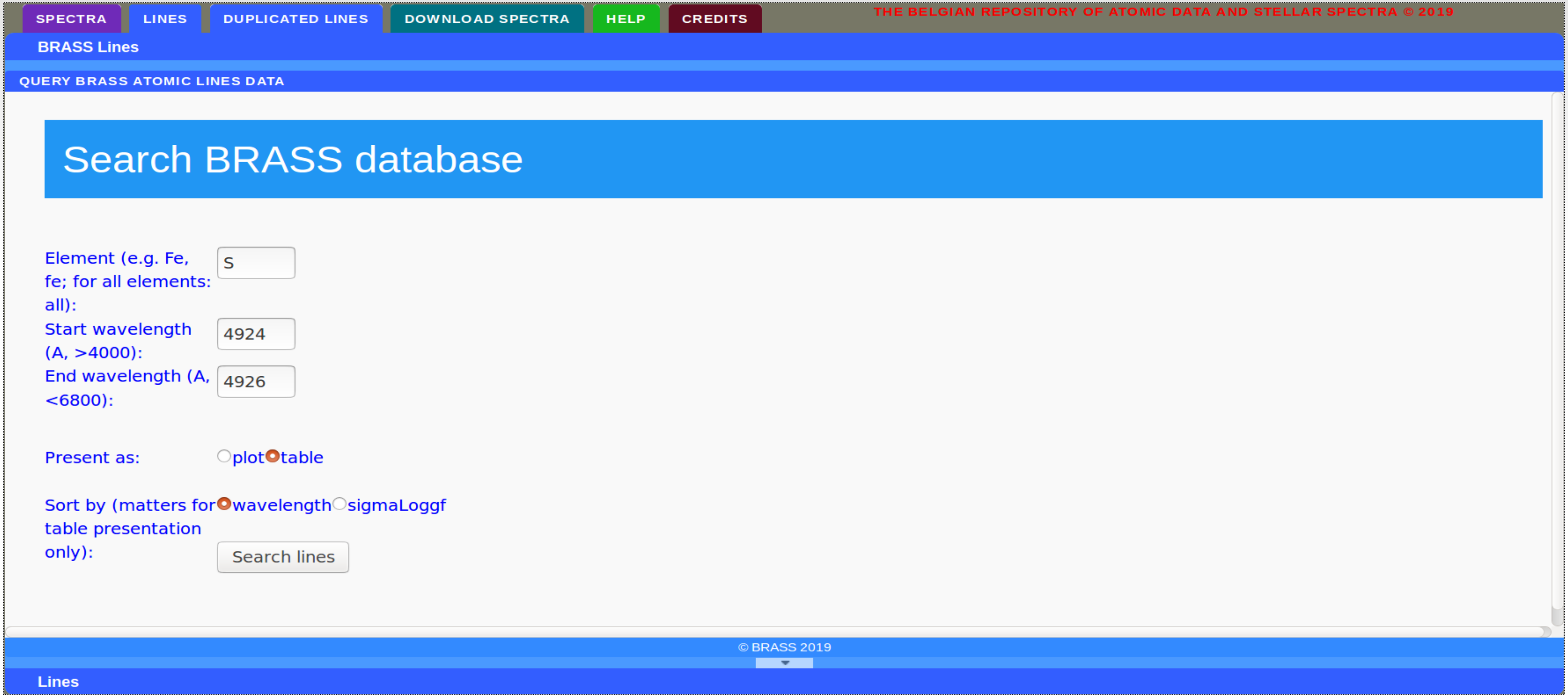
$\log(gf)_{BRASS(2012)}$ vs. $\log(gf)_{SpectroWeb(2007)} - \log(gf)_{BRASS(2012)}$



- Many updates of atomic log(*gf*)-values between 2007 and 2012
- log(*gf*) differences to >3 dex.

BRASS Data Interface – Atomic lines

http://brass.sdf.org



BRASS Data Interface – Atomic lines

BRASS Lines

QUERY BRASS ATOMIC LINES DATA

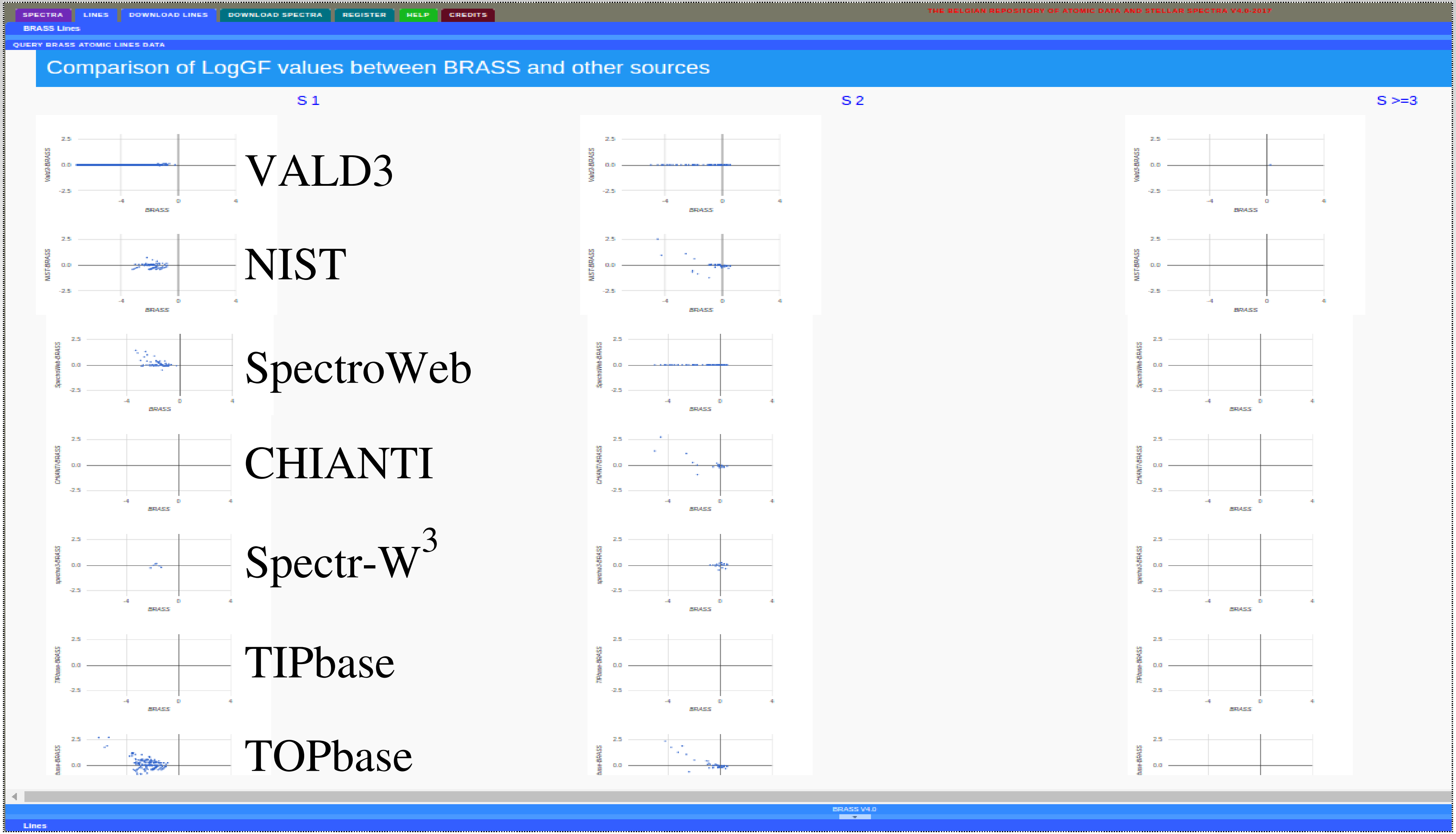
Lines of S

Save selected lines

ID BRASS	Source	Wavelength	E low	E up	Element	Ion	Log(gf)	Lower level	Upper level	Reference
							< > σ N			
☑ 18914	BRASS	4924.11	13.618	16.135	S	2	-0.059	LS 3s2.3p2.(3P).4s 4P	LS 3s2.3p2.(3P).4p 4P*	[Miller, M. H., Wilkerson, T. D., Roig, R. A., and Bengtson, R. D. 1974, Phys. Rev. A 9, 2312]
18914	VALD3	4924.11	13.6175	16.1347	S	2	-0.059	'LS 3s2.3p2.(3P).4s 4P'	'LS 3s2.3p2.(3P).4p 4P*'	[M. H. Miller, T. D. Wilkerson, R. A. Roig, and R. D. Bengtson. Absolute line strengths for carbon and sulfur. Phys. Rev. A, 9:2312--2323, Jun 1974. [DOI:10.1103/PhysRevA.9.2312]]
18914	NIST	4924.115	13.617382	16.134579	S	2	-0.341	'3s2.3p2.(3P).4s4P'	'3s2.3p2.(3P).4p4P*'	[Breit-Pauli oscillator strengths, lifetimes and Einstein A-coefficients in singly ionized sulphur, A. Irimia and C. Froese Fischer, Phys. Scr. 71, 172–184 (2005) DOI:10.1238/Physica.Regular.071a00172; G. Tachiev and C. Froese Fischer, The MCHF/MCDHF Collection (energy-adjusted MCHF calculations), downloaded on Decemner 21,2005]
18914	SpectroWeb	4924.11	13.6171	16.1341	S	2	-0.059	''	''	[M. H. Miller, T. D. Wilkerson, R. A. Roig, and R. D. Bengtson. Absolute line strengths for carbon and sulfur. Phys. Rev. A, 9:2312--2323, Jun 1974. [DOI:10.1103/PhysRevA.9.2312]]
18914	CHIANTI	4924.11	13.617	16.1342	S	2	-0.075514	'3s2 3p2 4s'	'3s2 3p2 4p'	v4
18914	spectrw3 TIPbase	4924.1	13.6163	16.1341	S	2	-0.142879			[Wiese W.L., Martin G.A., NSRDS-NBS, 1990, 68, Wavelengths and transition probabilities for atoms and atomic ions]
18914	TOPbase	5012.72123235	14.012134	16.494303	S	2	-0.210	'4s 4P'	'4p 4P*'	[Laverick M., Lobel A., Merle T., Royer P., Martayan C., David M., Hensberge H. and Thienpont E. 2018, Astron. Astrophys. 612, A60, dx.doi.org/10.1051/0004-6361/201731933]
							-0.135 0.099 7			
☑ 18936	BRASS	4925.343	13.584	16.101	S	2	-0.235	LS 3s2.3p2.(3P).4s 4P	LS 3s2.3p2.(3P).4p 4P*	[Miller, M. H., Wilkerson, T. D., Roig, R. A., and Bengtson, R. D. 1974, Phys. Rev. A 9, 2312]
18936	VALD3	4925.343	13.5839	16.1005	S	2	-0.235	'LS 3s2.3p2.(3P).4s 4P'	'LS 3s2.3p2.(3P).4p 4P*'	[M. H. Miller, T. D. Wilkerson, R. A. Roig, and R. D. Bengtson. Absolute line strengths for carbon and sulfur. Phys. Rev. A, 9:2312--2323, Jun 1974. [DOI:10.1103/PhysRevA.9.2312]]
18936	NIST	4925.347	13.583794	16.100362	S	2	-0.206	'3s2.3p2.(3P).4s4P'	'3s2.3p2.(3P).4p4P*'	[Breit-Pauli oscillator strengths, lifetimes and Einstein A-coefficients in singly ionized sulphur, A. Irimia and C. Froese Fischer, Phys. Scr. 71, 172–184 (2005) DOI:10.1238/Physica.Regular.071a00172; G. Tachiev and C. Froese Fischer, The MCHF/MCDHF Collection (energy-adjusted MCHF calculations), downloaded on Decemner 21,2005]
18936	SpectroWeb	4925.343	13.5835	16.0999	S	2	-0.235	''	''	[M. H. Miller, T. D. Wilkerson, R. A. Roig, and R. D. Bengtson. Absolute line strengths for carbon and sulfur. Phys. Rev. A, 9:2312--2323, Jun 1974. [DOI:10.1103/PhysRevA.9.2312]]
18936	CHIANTI	4925.35	13.5834	16.0999	S	2	-0.0601813	'3s2 3p2 4s'	'3s2 3p2 4p'	v4
18936	spectrw3 TIPbase	4925.3	13.5827	16.0999	S	2	-0.156032			[Wiese W.L., Martin G.A., NSRDS-NBS, 1990, 68, Wavelengths and transition probabilities for atoms and atomic ions]

Lines

- BRASS atomic lines data queries in 400 – 680 nm → centralization of all data sources.
- BRASS log(*gf*) references & provenance info provided; includes removal of duplicates.
- Users can request log(*gf*) difference plots per element, or for all elements.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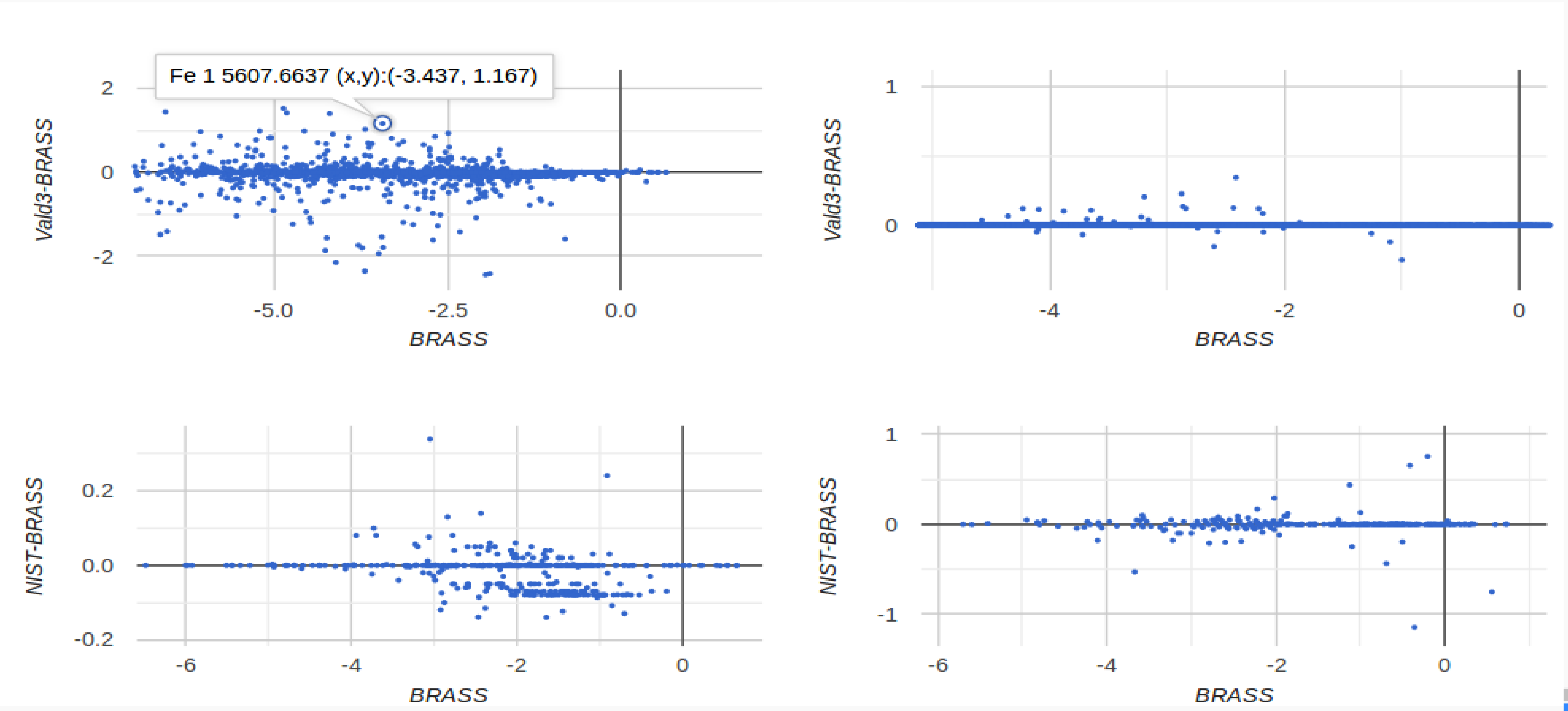
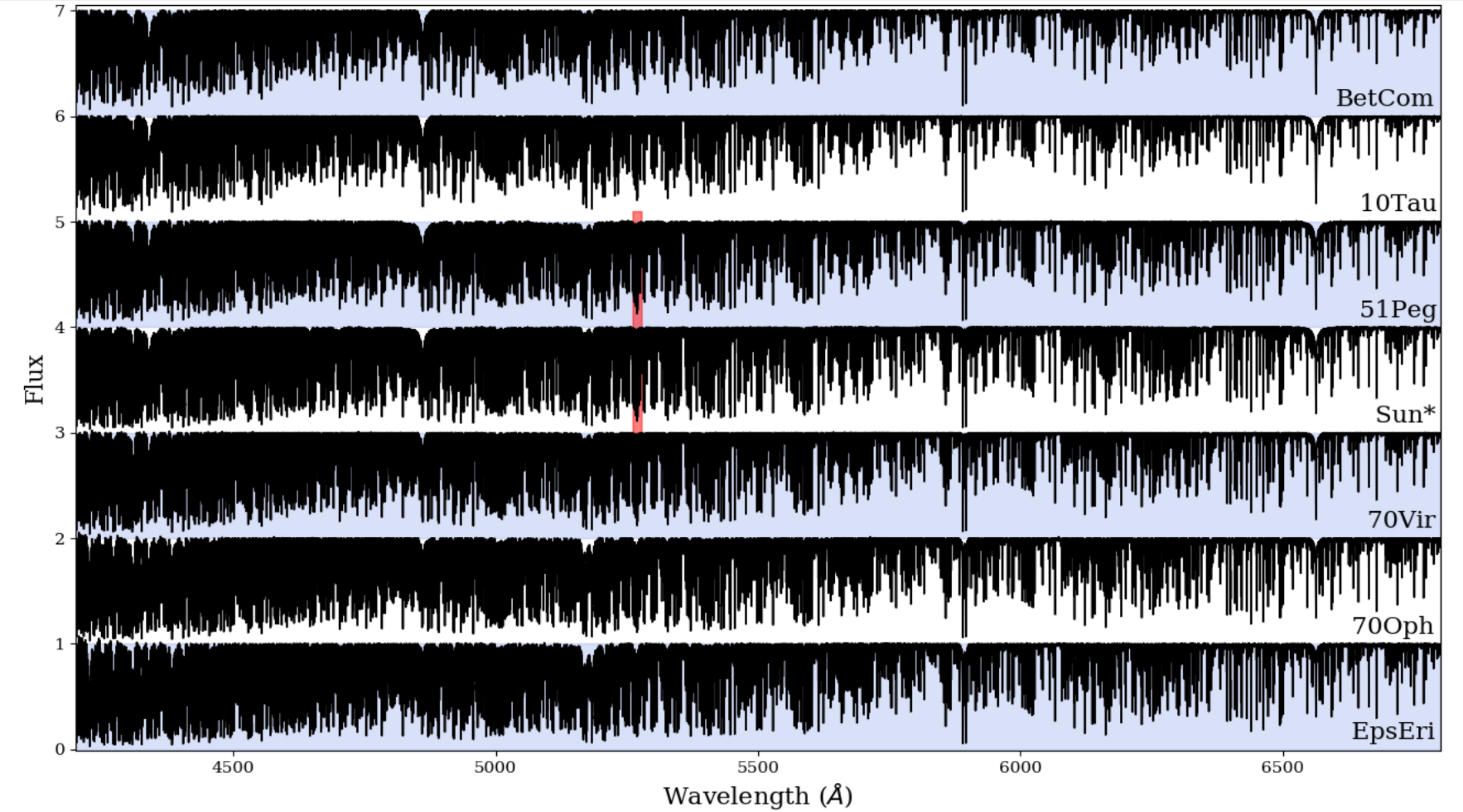
THE BELGIAN REPOSITORY OF ATOMIC DATA AND STELLAR SPECTRA V4.0-2017
BRASS Lines
QUERY BRASS ATOMIC LINES DATA
Comparison of LogGF values between BRASS and other sources
S 1
S 2
S >=3
VALD3
NIST
SpectroWeb
CHIANTI
Spectr-W3
TIPbase
TOPbase
BRASS V4.0
Lines

Comparison of LogGF values between BRASS and other sources

Fe 1 | Fe 2

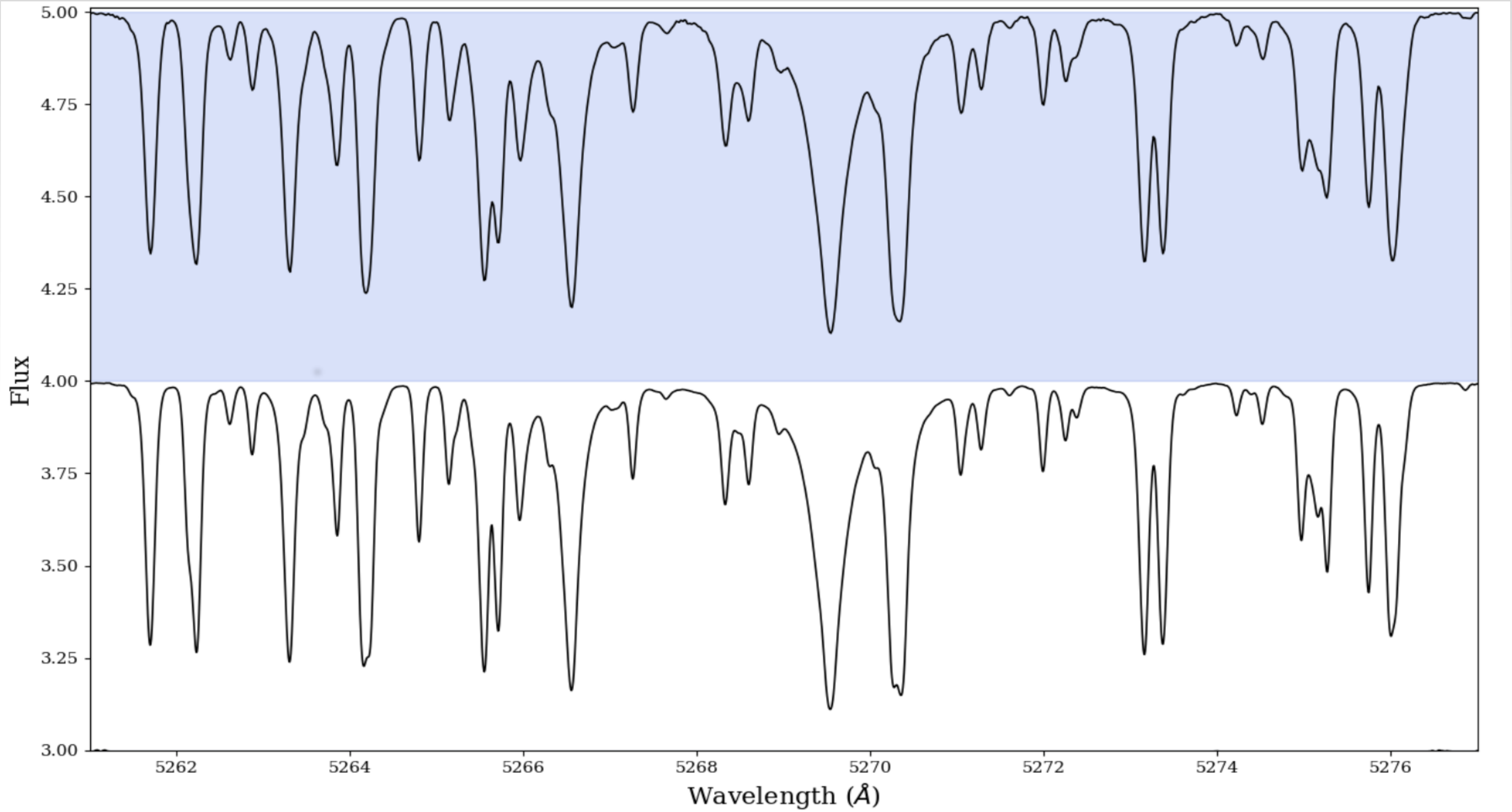


Continuum flux normalized FGK benchmark spectra



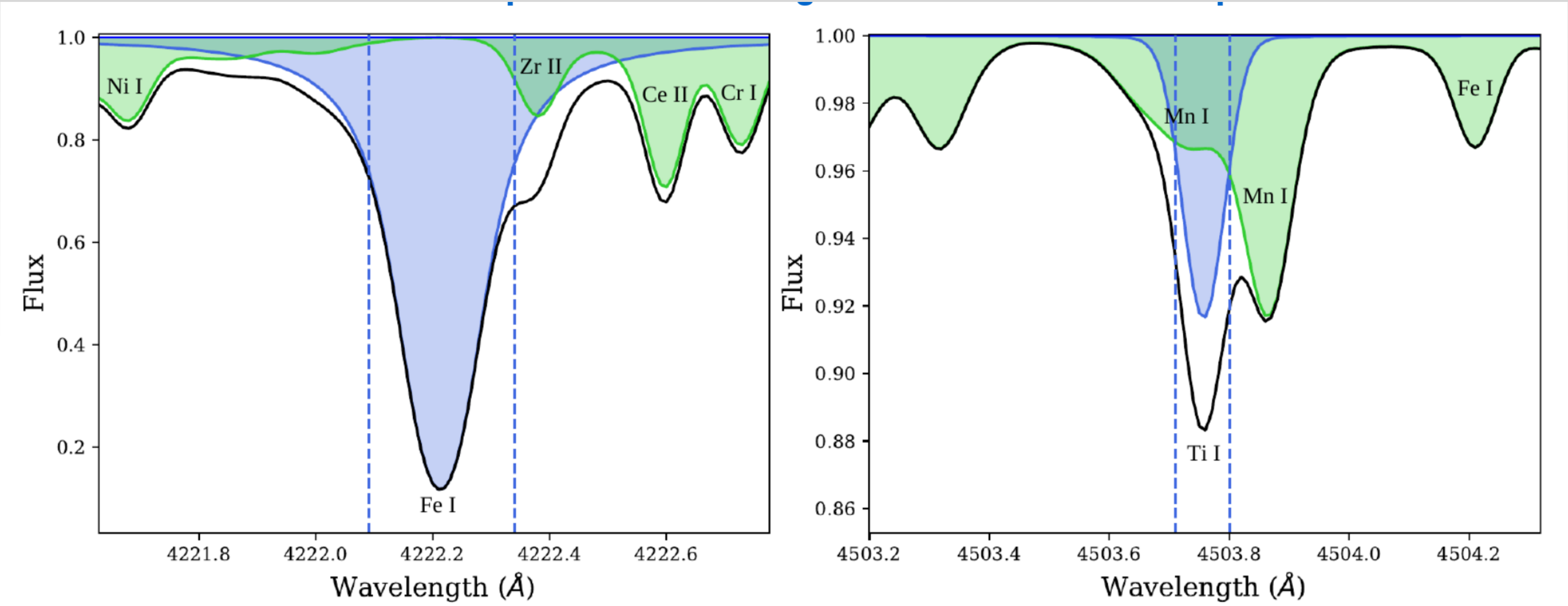
- Systematic search for sufficiently unblended atomic lines for atomic data quality assessment work.

Continuum flux normalized FGK benchmark spectra



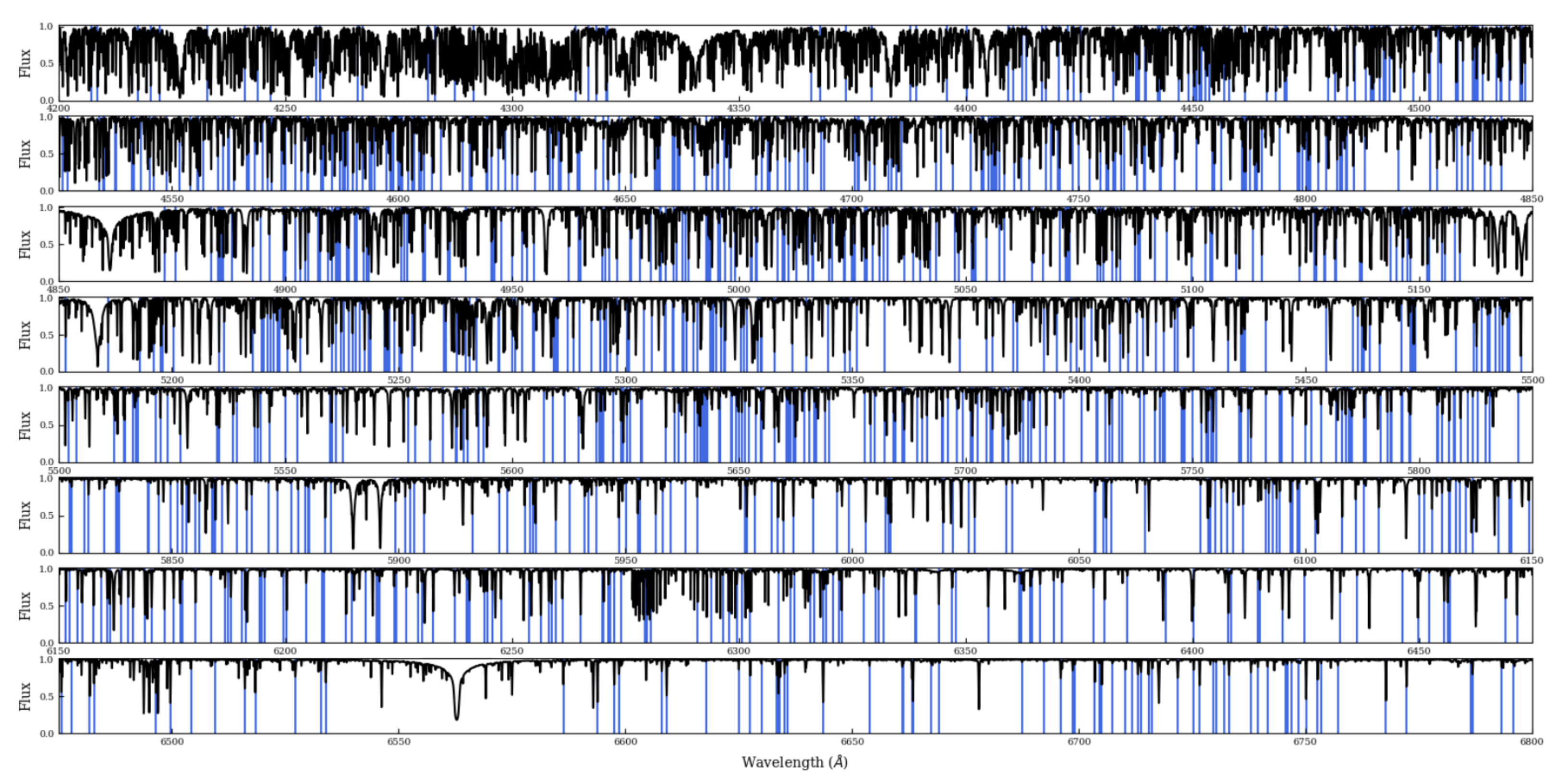
- Systematic search for sufficiently unblended atomic lines for atomic data quality assessment work.

1. Clean unblended lines selection procedure



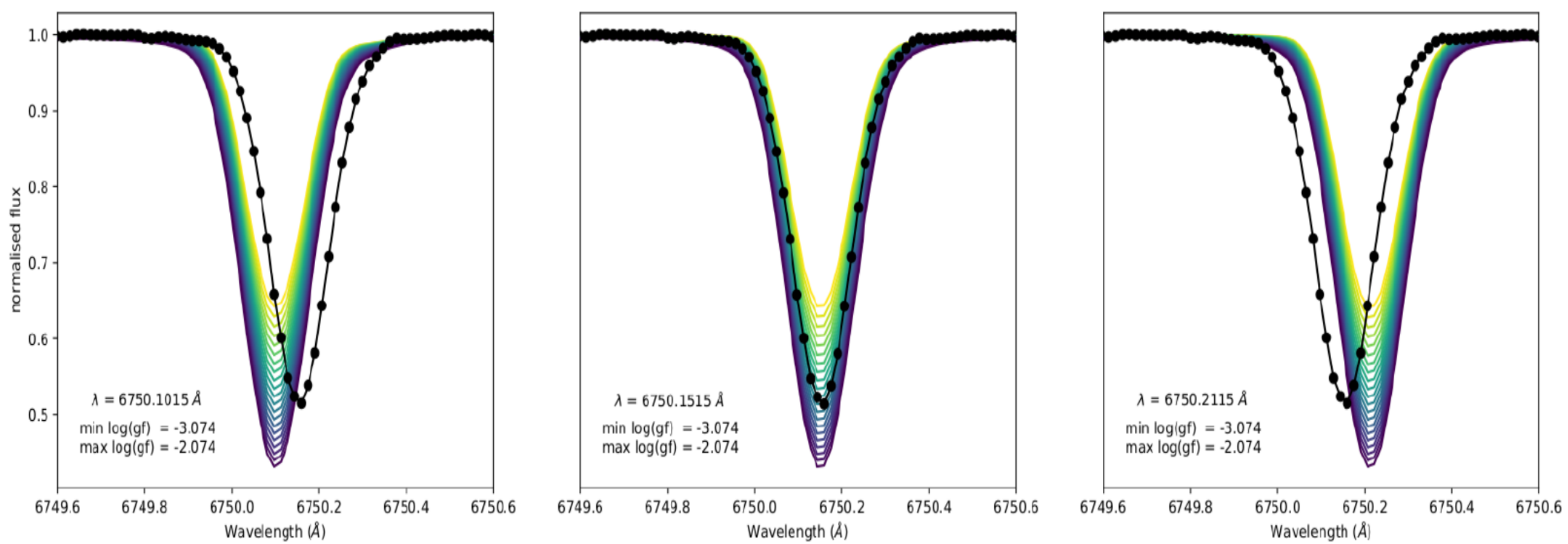
- Detailed line synthesis calculations to assess percentage of line blending by neighbouring lines.
- All 82337 atomic lines are calculated with and without neighbouring lines to quantify amount of overlap.
- 1091 lines are sufficiently unblended having clean core profiles required for detailed profile modelling.

Atomic lines selection for quality assessment



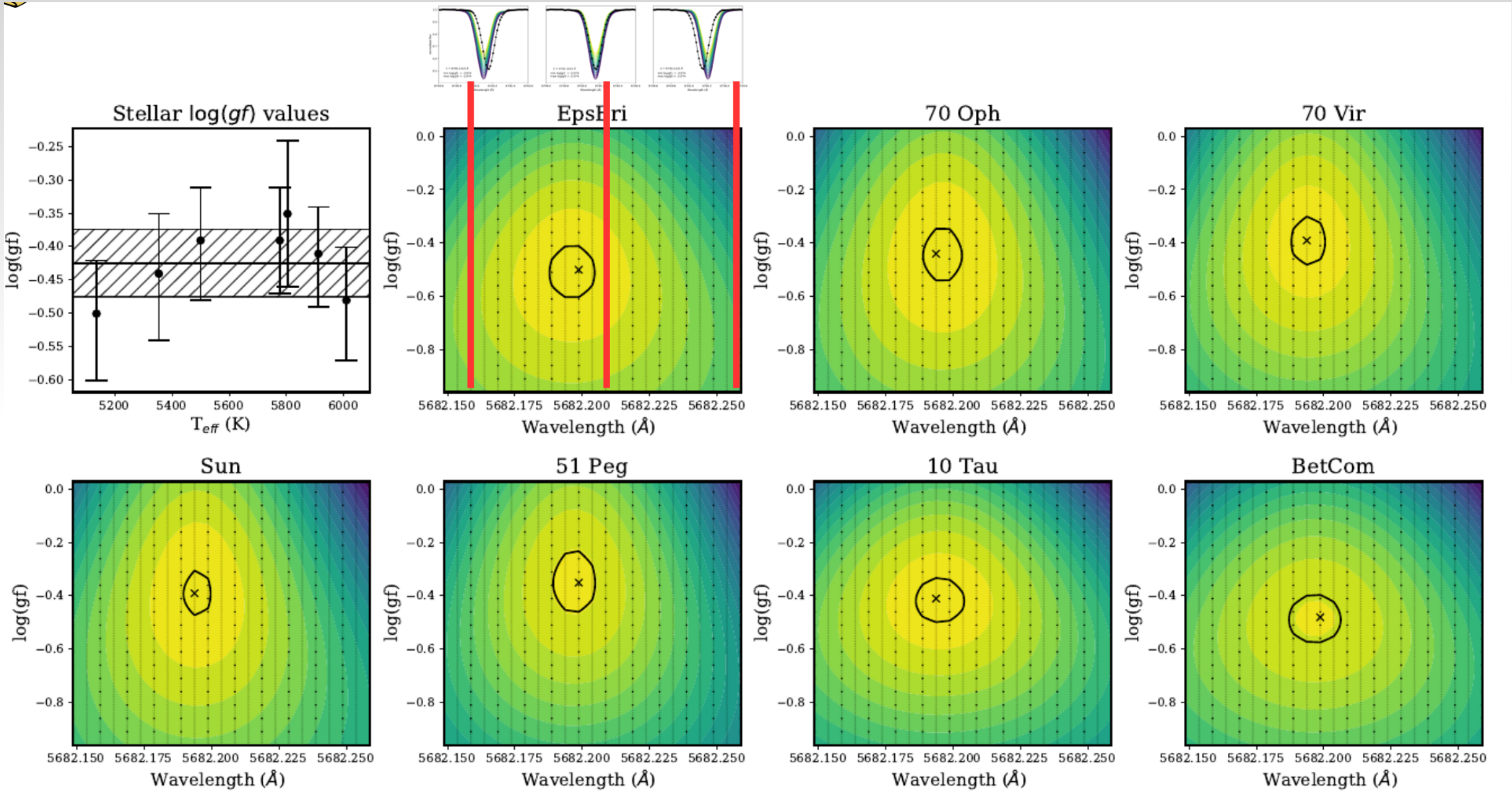
- 1091 photospheric lines are rather uniformly distributed across the 400 – 680 nm range.
- Lines inside very broad H Balmer wings are typically not selected.
- Optical and near-IR telluric H_2O and O_2 bands are avoided or lines de-selected during quality assessment.

2. Detailed line profile radiative transfer modelling



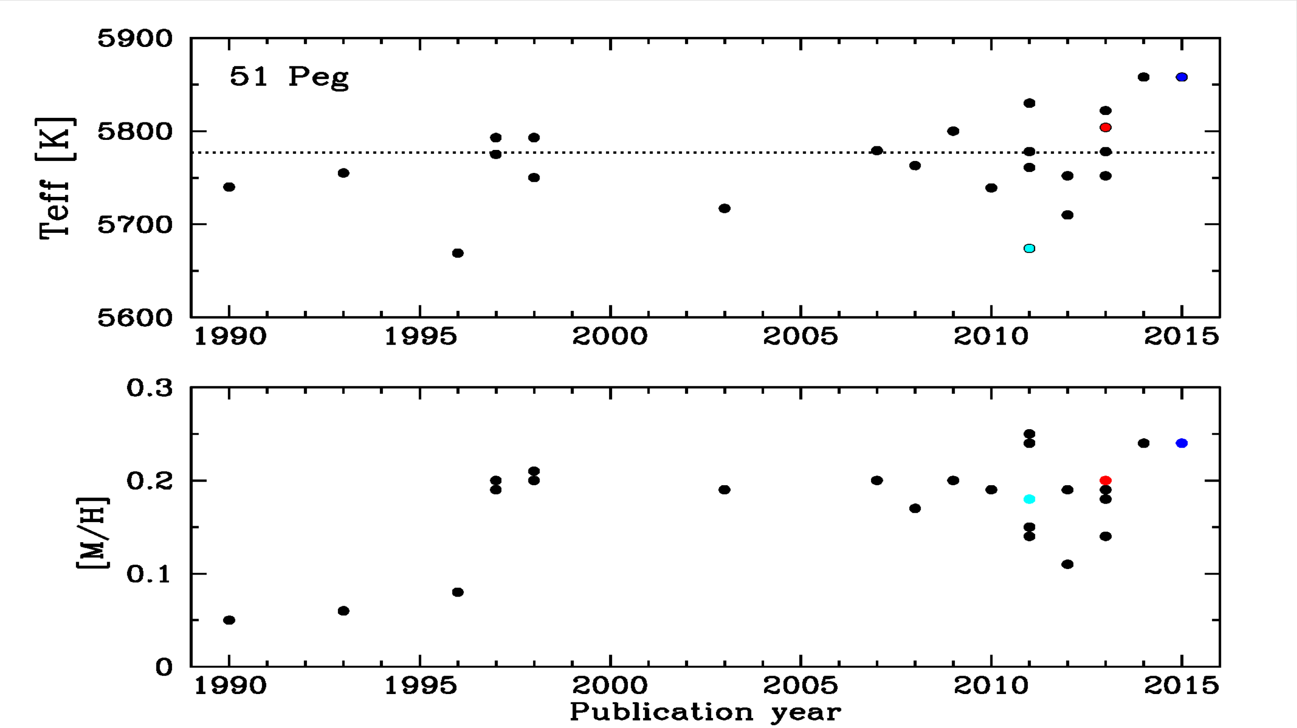
- Iteratively vary line rest-wavelength value in steps of 0.05 Å.
- Iteratively vary line log(*gf*)-value in steps of 0.005 dex.

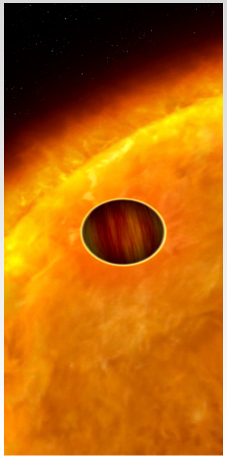
Best profile fit using B-splines in λ_0 and log(*gf*)



- B-splines minimization procedure finds best λ_0 and log(*gf*)-values per benchmark star.
- Calculate weighted mean and standard deviation per 1091 selected atomic lines.

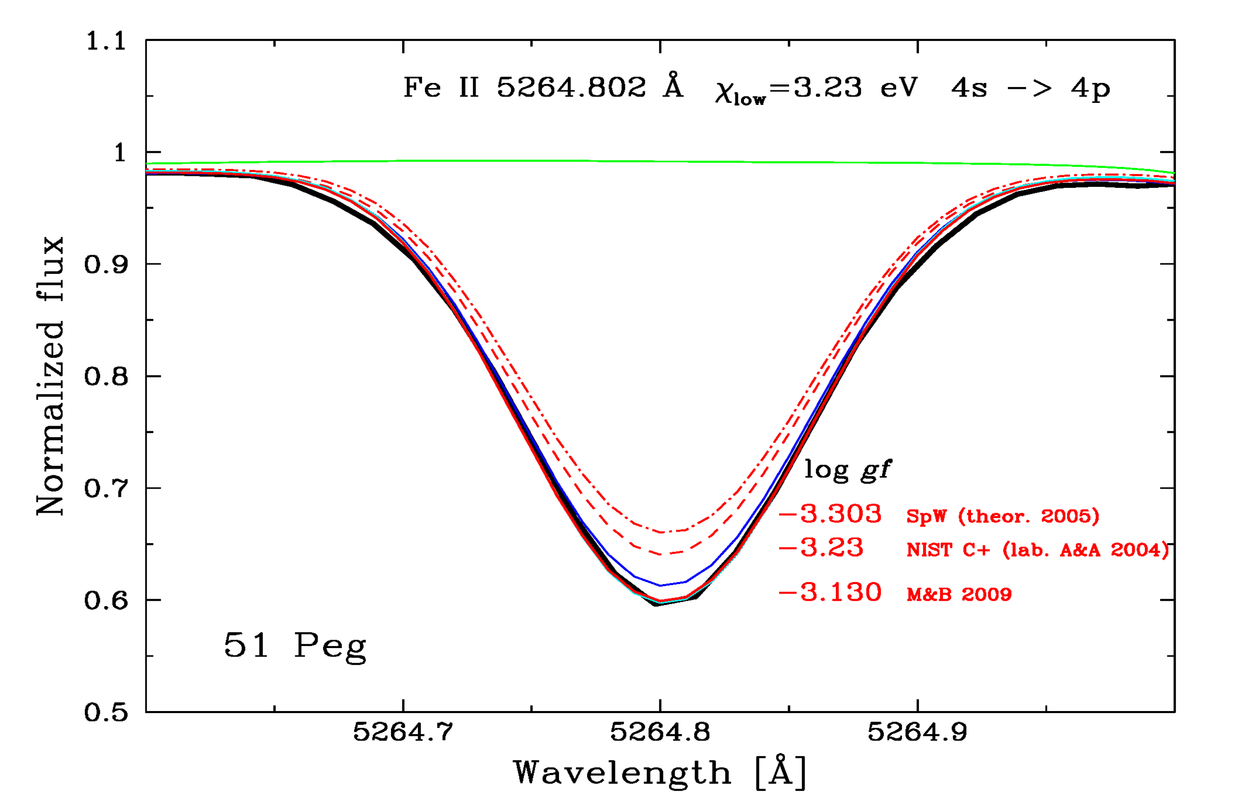
Modelling the spectrum of Sun-like star 51 Peg





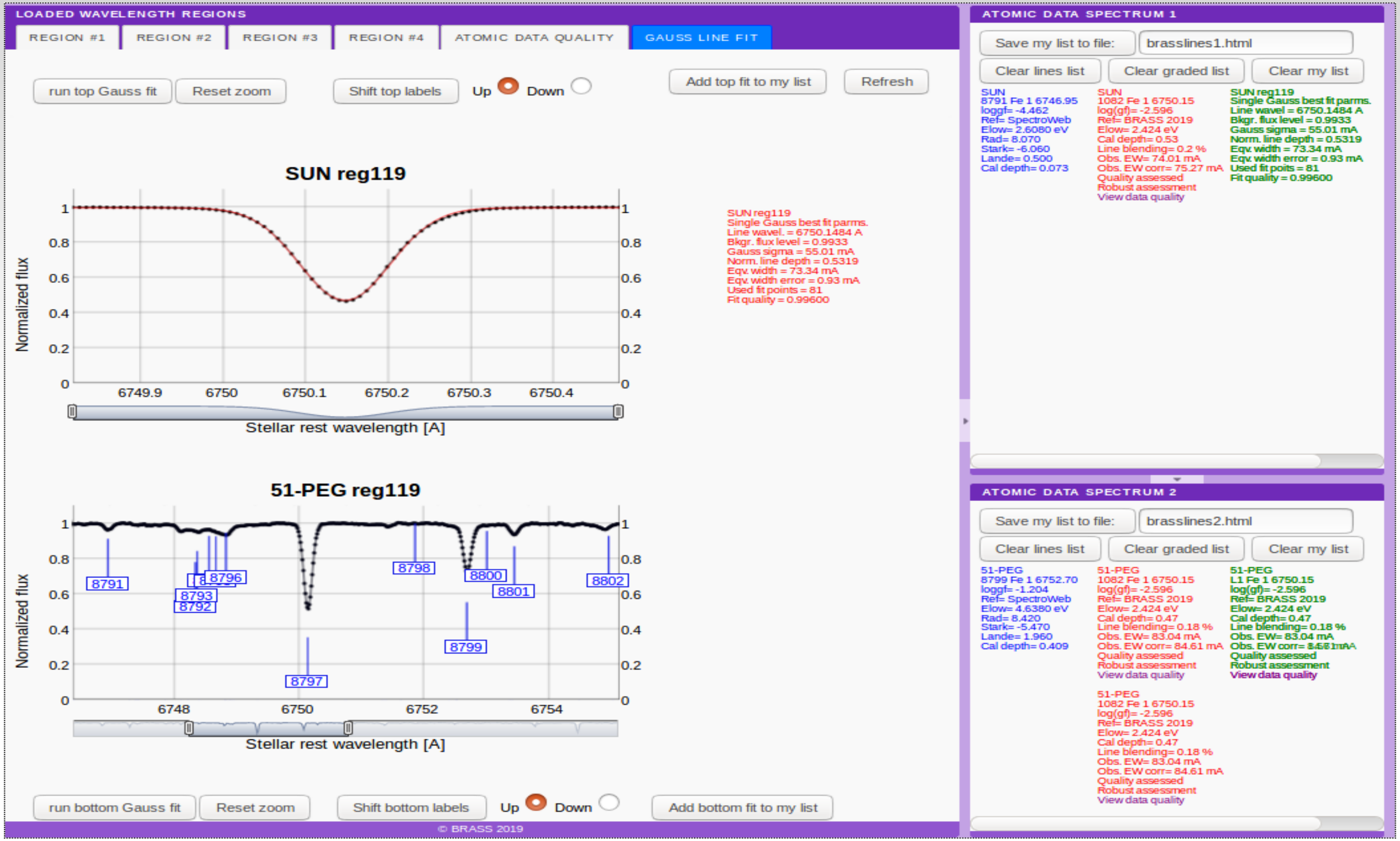
- First main-sequence star with Jupiter size exoplanet dicovered in 1995.
- Over 20 publications with atmospheric parameters of host star from spectra.
- Range of literature values: 5674 K ≤ Teff ≤ 5804 K and 0.18 ≤ [M/H] ≤ 0.24.

Example of detailed modelling in Sun-like star 51 Peg



- Range of log(*gf*) iterations typically spans differences in published log(*gf*)-values.
- Detailed best fit based on spectrum synthesis includes atomic&molecular background.

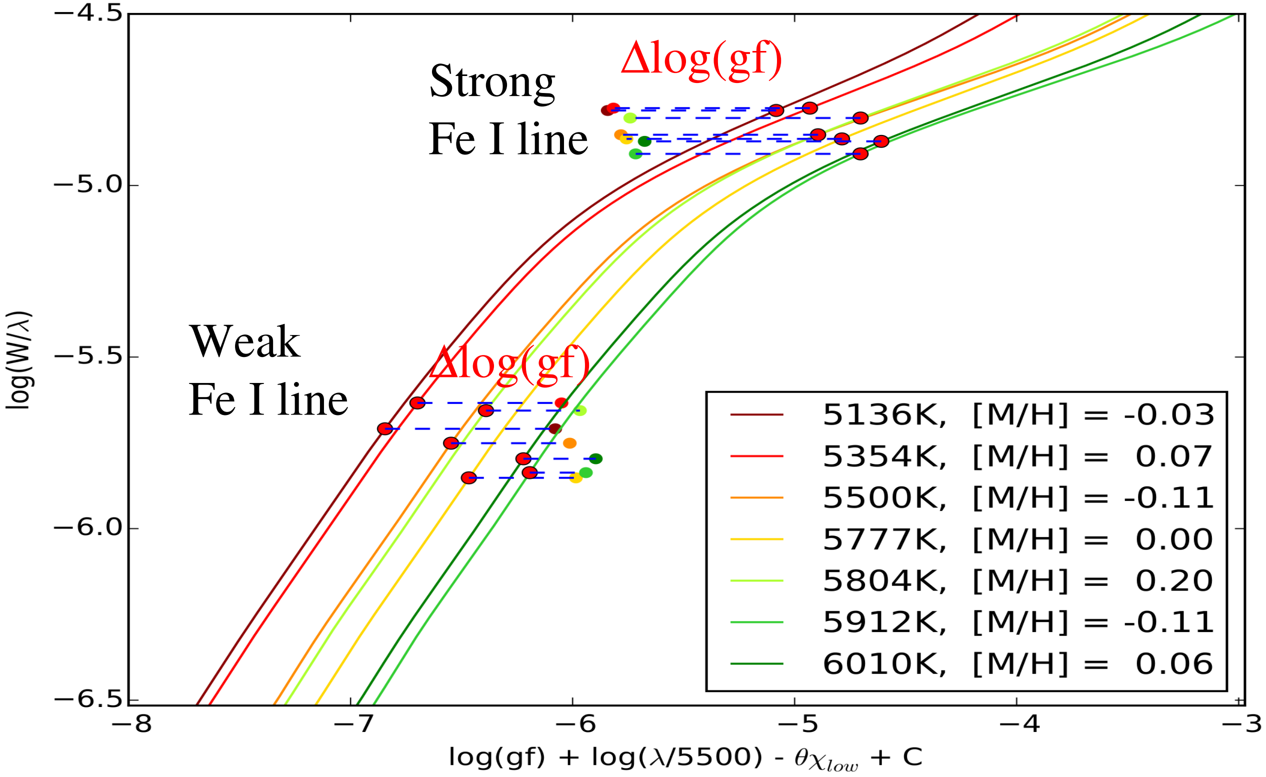
3. Accurate equivalent line width measurements



- Levenberg-Marquardt iteration using Gaussian fit function.
- Incorporate EW corrections in case of lines saturating on the curve-of-growth.

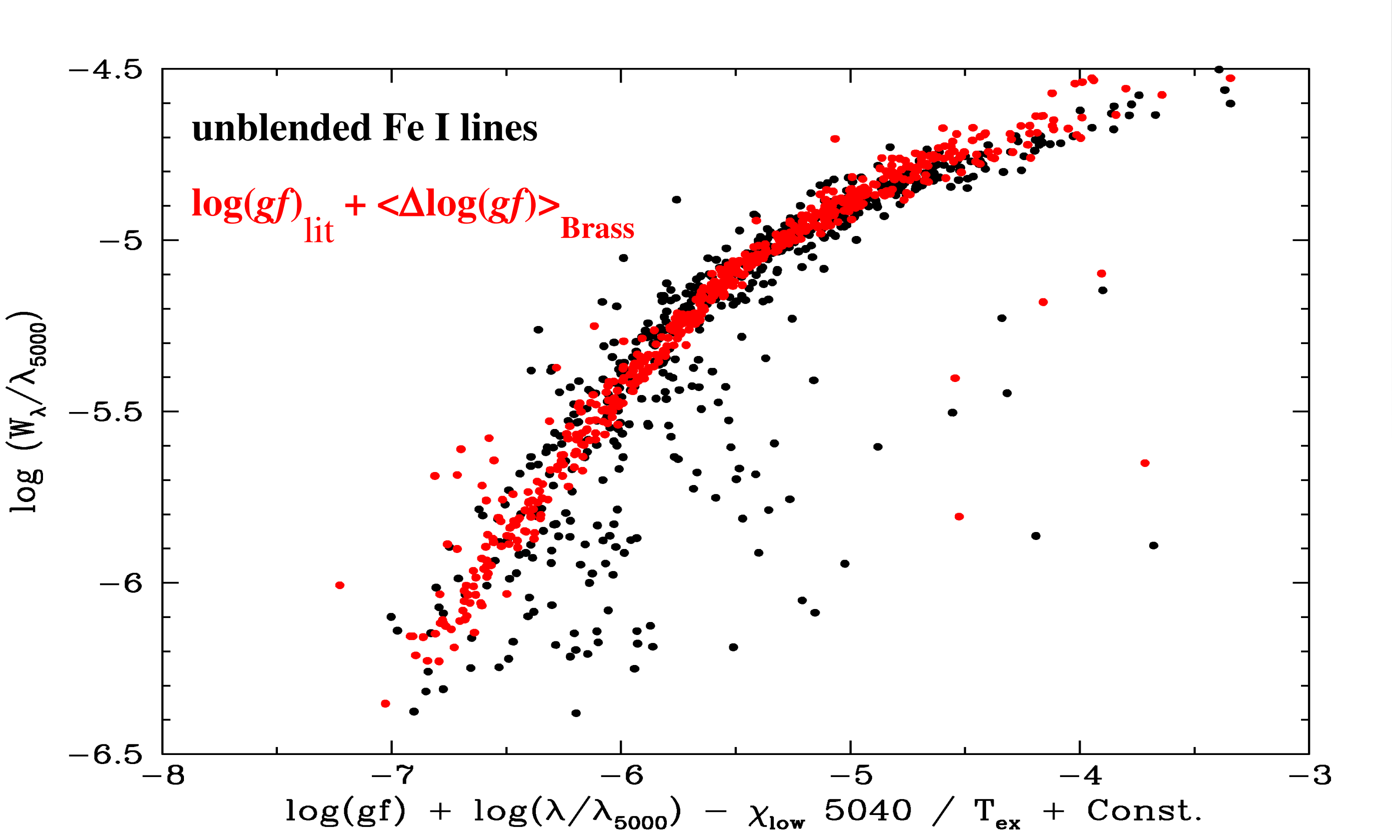
<Δlog(*gf*)> from RT model curves-of-growth

$$\log\left(\frac{W_\lambda}{\lambda}\right) = \log\left[const.\frac{\pi e^2}{mc^2}\frac{N_j/N_E}{u(T)}N_H\right] + \log A + \log gf\lambda - \theta_{ex}\chi - \log\kappa_\nu^{cont}$$



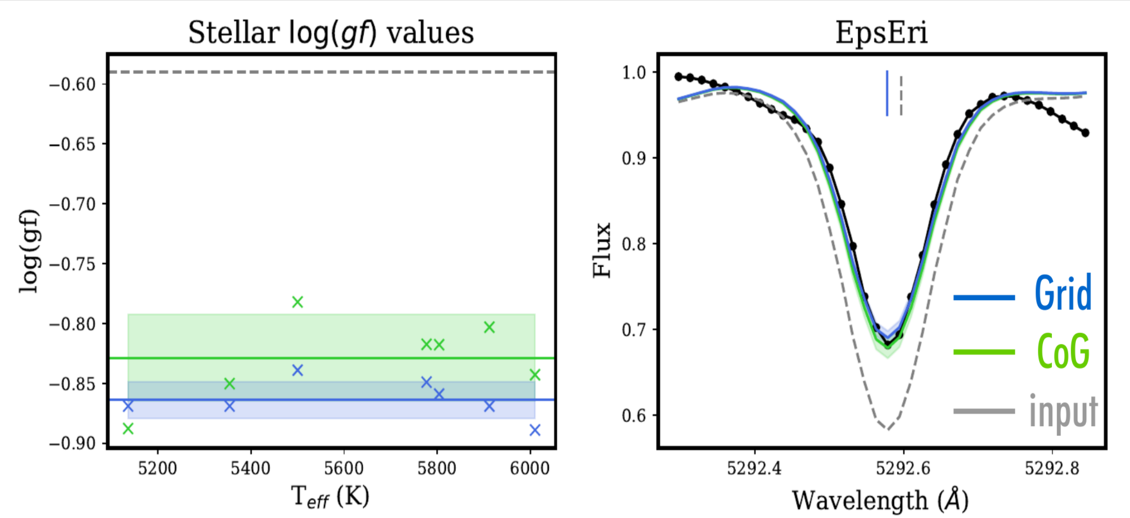
- Calculate mean <Δlog(*gf*)> to theoretical line c-o-gs of benchmark stars plus std. dev.

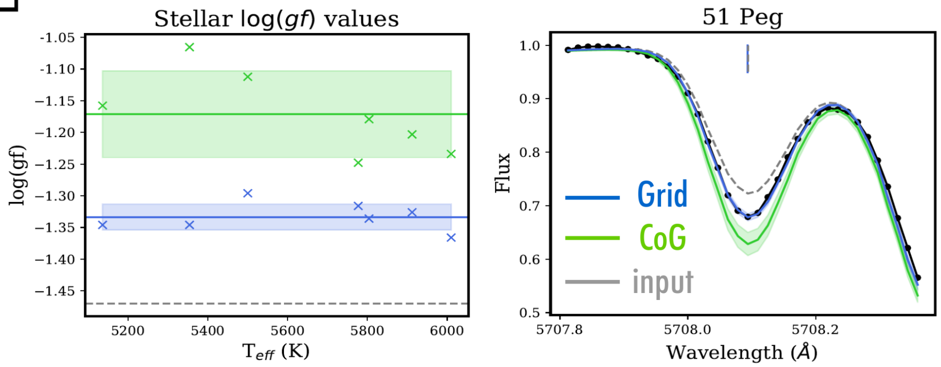
Observed Curve-of-Growth in the Sun



- Fe I curve-of-growth becomes less scattered when **mean <Δlog(*gf*)>** corrections are applied to literature log(*gf*)-values.

Selection of BRASS quality assessible lines





- If mean <Δlog(*gf*)> values from c-o-g and detailed profile fits agree within 0.04 dex the line is quality assessible (408 lines of 1091) and compared to all literature values.

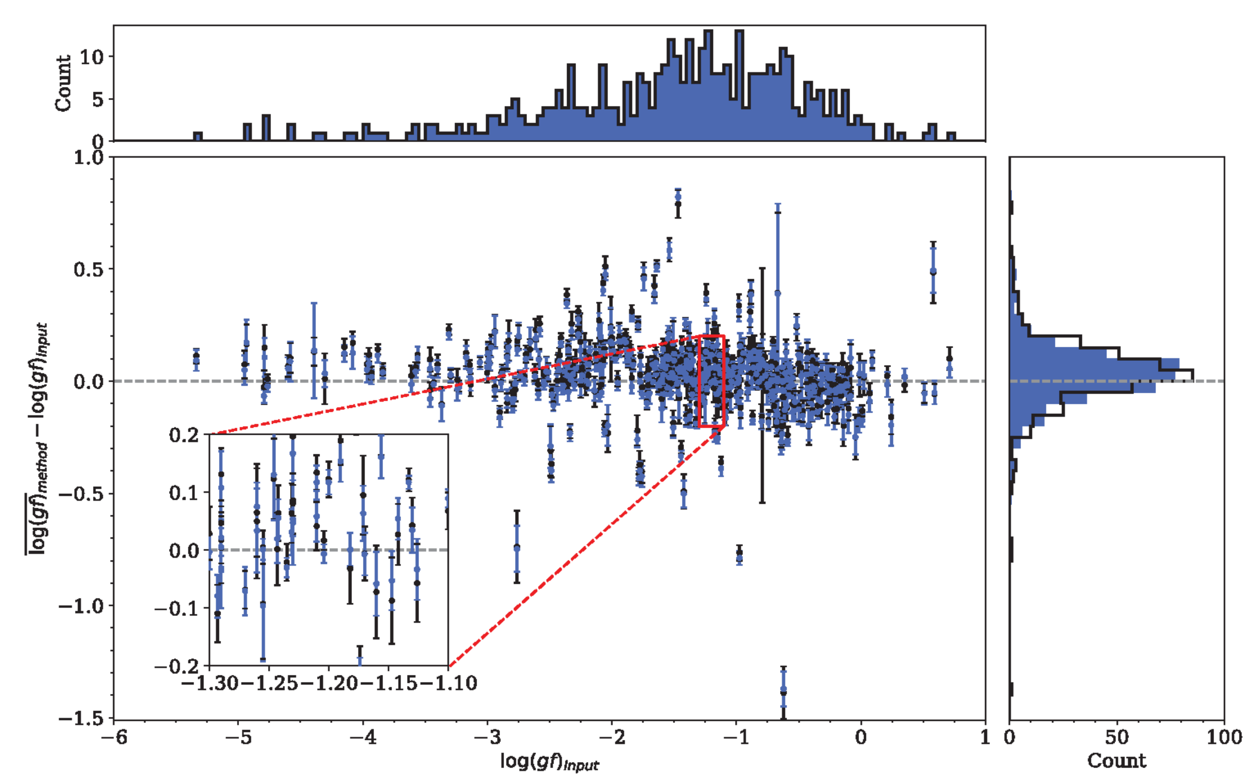
→ Error analysis discussed in M. Laverick, PhD Dissertation Sep 2019, KU Leuven.

BRASS log(*gf*) quality assessment results

Species	number of investigated lines	quality assessable	analysis independent
C I	1	1	
Na I	3	3	2
Mg I	5	5	2
Al I	2	2	1
Si I	56	42	14
Si II	2	2	
S I	1	1	
Ca I	21	21	10
Ca II	1		
Sc I	1	1	
Sc II	19	17	3
Ti I	90	80	47
Ti II	36	28	10
V I	15	14	6
V II	1	1	
Cr I	82	61	36
Cr II	12	7	3
Mn I	13	9	1
Fe I	543	401	231
Fe II	30	15	4
Co I	15	9	
Ni I	126	112	38
Zn I	2	2	
Sr I	1	1	
Y II	9	8	
Ba II	1		
La II	2	1	
Ce II	1	1	
Total:	1091	845	408

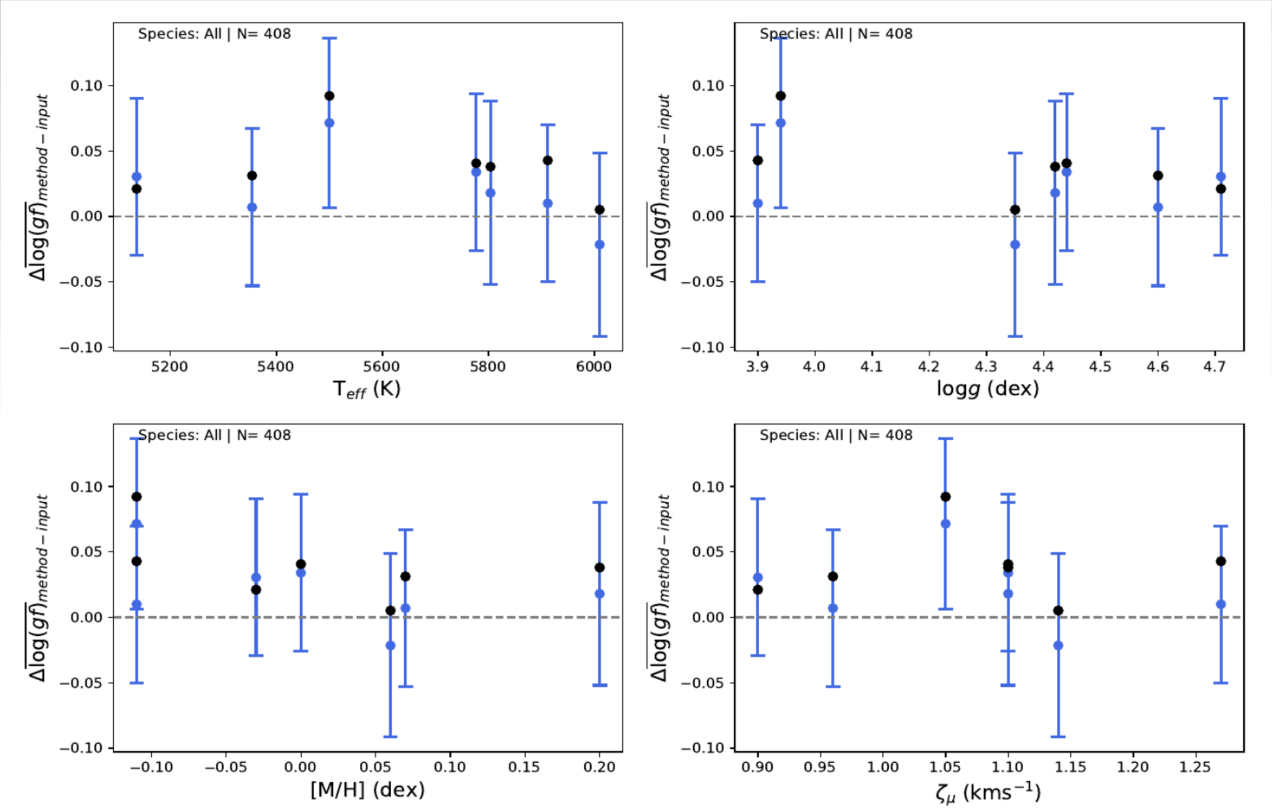
- 70% of Fe-group lines (incl. Fe II) have <u>at least one</u> literature log(*gf*) within errorbar of <log(*gf*)> from detailed fits.
- Only 38% of investigated Fe I lines have literature log(*gf*)-values in agreement with our analysis results.
- Dedicated pages available in BRASS interface with overview of quality assessment results for 1091 investigated atomic lines.

BRASS log(*gf*) quality assessment results



- 408 quality assessible lines reveal significant differences in medium-strong lines for BRASS input log(*gf*)-values between -3 and 0.
- Some transitions reveal log(*gf*) differences exceeding 0.5 dex for small std. dev. (→ Fe I lines).
- Towards weak lines with BRASS input log(*gf*) < -3 the differences substantially decrease.

Validation of BRASS quality assessible lines

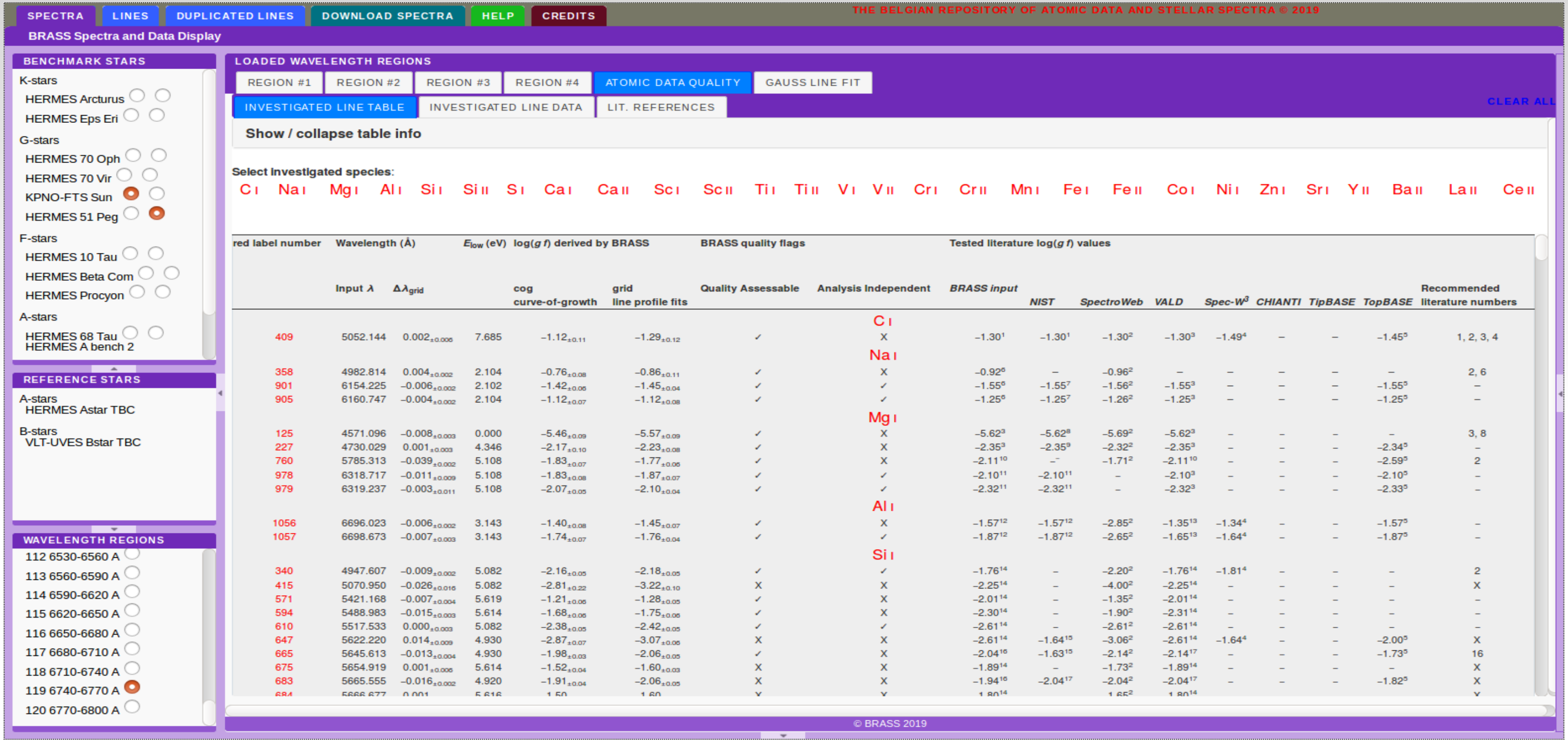


- Averages over 408 quality assessible lines show no systematic offsets between <log(*gf*)> and BRASS input log(*gf*) for model parameters of all benchmark stars.

BRASS Data Interface – Stellar spectra

- Interactive environment for the combined display of star spectra and atomic line data.
- Lines-of-interest can be saved to user disk with html links to atomic data and quality plots.
- Users can download observed & theoretical spectra and/or measure line properties online.

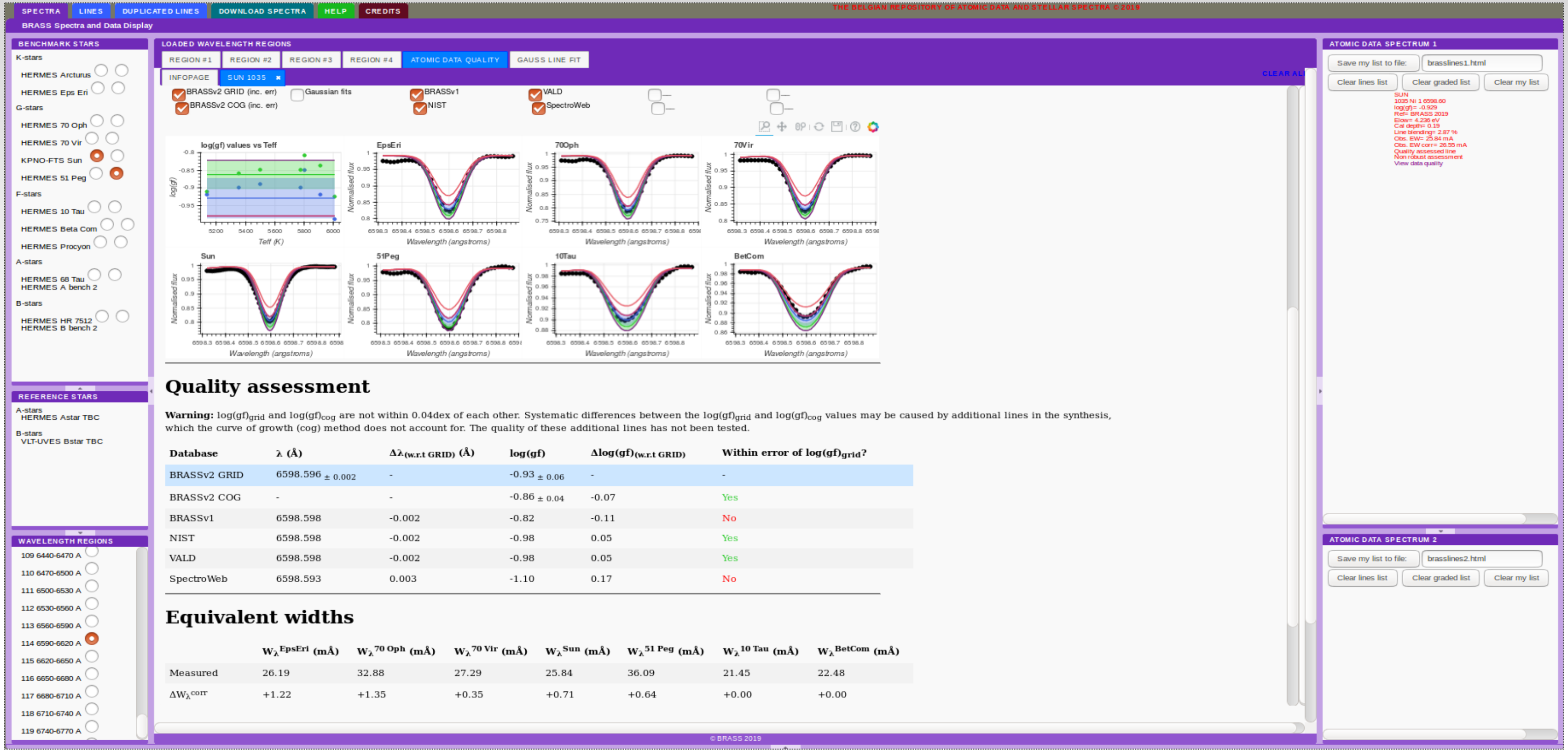
Atomic data quality assessment pages in BRASS



red label number	Wavelength (Å) Input λ	$\Delta\lambda_{grid}$	E_{low} (eV)	log(gf) derived by BRASS: cog curve-of-growth	grid line profile fits	BRASS quality flags: Quality Assessable	Analysis Independent	Tested literature log(gf) values: BRASS input	NIST	SpectroWeb	VALD	Spec-W3	CHIANTI	TipBASE	TopBASE	Recommended literature numbers
							C I									
409	5052.144	$0.002_{\pm0.006}$	7.685	$-1.12_{\pm0.11}$	$-1.29_{\pm0.12}$	✓	X	−1.30[1]	−1.30[1]	−1.30[2]	−1.30[3]	−1.49[4]	–	–	−1.45[5]	1, 2, 3, 4
							Na I									
358	4982.814	$0.004_{\pm0.002}$	2.104	$-0.76_{\pm0.08}$	$-0.86_{\pm0.11}$	✓	X	−0.92[6]	–	−0.96[2]	–	–	–	–	–	2, 6
901	6154.225	$-0.006_{\pm0.002}$	2.102	$-1.42_{\pm0.06}$	$-1.45_{\pm0.04}$	✓	✓	−1.55[6]	−1.55[7]	−1.56[2]	−1.55[3]	–	–	–	−1.55[5]	–
905	6160.747	$-0.004_{\pm0.002}$	2.104	$-1.12_{\pm0.07}$	$-1.12_{\pm0.08}$	✓	✓	−1.25[6]	−1.25[7]	−1.26[2]	−1.25[3]	–	–	–	−1.25[5]	–
							Mg I									
125	4571.096	$-0.008_{\pm0.003}$	0.000	$-5.46_{\pm0.09}$	$-5.57_{\pm0.09}$	✓	X	−5.62[3]	−5.62[8]	−5.69[2]	−5.62[3]	–	–	–	–	3, 8
227	4730.029	$0.001_{\pm0.003}$	4.346	$-2.17_{\pm0.10}$	$-2.23_{\pm0.08}$	✓	X	−2.35[3]	−2.35[9]	−2.32[2]	−2.35[3]	–	–	–	−2.34[5]	–
760	5785.313	$-0.039_{\pm0.002}$	5.108	$-1.83_{\pm0.07}$	$-1.77_{\pm0.06}$	✓	X	−2.11[10]	–	−1.71[2]	−2.11[10]	–	–	–	−2.59[5]	2
978	6318.717	$-0.011_{\pm0.009}$	5.108	$-1.83_{\pm0.08}$	$-1.87_{\pm0.07}$	✓	✓	−2.10[11]	−2.10[11]	–	−2.10[3]	–	–	–	−2.10[5]	–
979	6319.237	$-0.003_{\pm0.011}$	5.108	$-2.07_{\pm0.05}$	$-2.10_{\pm0.04}$	✓	✓	−2.32[11]	−2.32[11]	–	−2.32[3]	–	–	–	−2.33[5]	–
							Al I									
1056	6696.023	$-0.006_{\pm0.002}$	3.143	$-1.40_{\pm0.08}$	$-1.45_{\pm0.07}$	✓	X	−1.57[12]	−1.57[12]	−2.85[2]	−1.35[13]	−1.34[4]	–	–	−1.57[5]	–
1057	6698.673	$-0.007_{\pm0.003}$	3.143	$-1.74_{\pm0.07}$	$-1.76_{\pm0.04}$	✓	✓	−1.87[12]	−1.87[12]	−2.65[2]	−1.65[13]	−1.64[4]	–	–	−1.87[5]	–
							Si I									
340	4947.607	$-0.009_{\pm0.002}$	5.082	$-2.16_{\pm0.05}$	$-2.18_{\pm0.05}$	✓	✓	−1.76[14]	–	−2.20[2]	−1.76[14]	−1.81[4]	–	–	–	2
415	5070.950	$-0.026_{\pm0.016}$	5.082	$-2.81_{\pm0.22}$	$-3.22_{\pm0.10}$	X	X	−2.25[14]	–	−4.00[2]	−2.25[14]	–	–	–	–	X
571	5421.168	$-0.007_{\pm0.004}$	5.619	$-1.21_{\pm0.06}$	$-1.28_{\pm0.05}$	✓	X	−2.01[14]	–	−1.35[2]	−2.01[14]	–	–	–	–	–
594	5488.983	$-0.015_{\pm0.003}$	5.614	$-1.68_{\pm0.06}$	$-1.75_{\pm0.06}$	✓	X	−2.30[14]	–	−1.90[2]	−2.31[14]	–	–	–	–	–
610	5517.533	$0.000_{\pm0.003}$	5.082	$-2.38_{\pm0.05}$	$-2.42_{\pm0.05}$	✓	✓	−2.61[14]	–	−2.61[2]	−2.61[14]	–	–	–	–	–
647	5622.220	$0.014_{\pm0.009}$	4.930	$-2.87_{\pm0.07}$	$-3.07_{\pm0.06}$	X	X	−2.61[14]	−1.64[15]	−3.06[2]	−2.61[14]	−1.64[4]	–	–	−2.00[5]	X
665	5645.613	$-0.013_{\pm0.004}$	4.930	$-1.98_{\pm0.03}$	$-2.06_{\pm0.05}$	✓	X	−2.04[16]	−1.63[15]	−2.14[2]	−2.14[17]	–	–	–	−1.73[5]	16
675	5654.919	$0.001_{\pm0.006}$	5.614	$-1.52_{\pm0.04}$	$-1.60_{\pm0.03}$	X	X	−1.89[14]	–	−1.73[2]	−1.89[14]	–	–	–	–	X
683	5665.555	$-0.016_{\pm0.002}$	4.920	$-1.91_{\pm0.04}$	$-2.06_{\pm0.05}$	X	X	−1.94[16]	−2.04[17]	−2.04[2]	−2.04[17]	–	–	–	−1.82[5]	X

- Interactive environment for the combined display of star spectra and atomic line data.
- Lines-of-interest can be saved to user disk with html links to atomic data and quality plots.
- Users can download observed & theoretical spectra and/or measure line properties online.

Atomic data quality assessment pages in BRASS



- 1091 quality-assessed lines with interactive display in 7 FGK-type benchmark stars.
- Atomic data and line quality information λ_0, log(*gf*), % of line blending, obs. and model EWs.
- Full error budget analysis of literature log(*gf*)-values based on RT modelling and c-o-g analysis.

$\Rightarrow$ BRASS evaluates accuracy of log(*gf*)-values per atomic data source.

BRASS BDI - Spectrum download & Help pages

BRASS Data Download

DOWNLOAD PAGES REGISTER TO BRASS CONFIRM REGISTRATION LOGIN

Please first register via the menu above and next login

for accessing BRASS data files in these Tables

BRASS BENCHMARK STAR SPECTRA

Spectral Type	Instrument	Star name	Spectrum	Spectrum	Spectrum	Spectrum
			OBSERVED	OBSERVED	MODEL	MODEL
			NORMALIZED	NOT NORMALIZED	UNBROADENED	BROADENED
K	Hermes	Arcturus	Arcturus_OBN.ascii Arcturus_OBN.fits	Arcturus_OBU.ascii Arcturus_OBU.fits	Arcturus_MUB.ascii Arcturus_MUB.fits	Arcturus_MBR.ascii Arcturus_MBR.fits
K	Hermes	Eps Eri	Eps_Eri_OBN.ascii Eps_Eri_OBN.fits	Eps_Eri_OBU.ascii Eps_Eri_OBN.fits	Eps_Eri_MUB.ascii Eps_Eri_OBN.fits	Eps_Eri_MBR.ascii Eps_Eri_OBN.fits
G	Hermes	70 Oph	70-Oph_OBN.ascii 70-Oph_OBN.fits	70-Oph_OBU.ascii 70-Oph_OBN.fits	70-Oph_MUB.ascii 70-Oph_OBN.fits	70-Oph_MBR.ascii 70-Oph_OBN.fits
G	Hermes	70 Vir	70-Vir_OBN.ascii 70-Vir_OBN.fits	70-Vir_OBU.ascii 70-Vir_OBN.fits	70-Vir_MUB.ascii 70-Vir_OBN.fits	70-Vir_MBR.ascii 70-Vir_OBN.fits
G	Hermes	51 Peg	51-Peg_OBN.ascii 51-Peg_OBN.fits	51-Peg_OBU.ascii 51-Peg_OBN.fits	51-Peg_MUB.ascii 51-Peg_OBN.fits	51-Peg_MBR.ascii 51-Peg_OBN.fits
F	Hermes	10 Tau	10-Tau_OBN.ascii 10-Tau_OBN.fits	10-Tau_OBU.ascii 10-Tau_OBN.fits	10-Tau_MUB.ascii 10-Tau_OBN.fits	10-Tau_MBR.ascii 10-Tau_OBN.fits
F	Hermes	Beta Com	Bet_Com_OBN.ascii Bet_Com_OBN.fits	Bet_Com_OBU.ascii Bet_Com_OBN.fits	Bet_Com_MUB.ascii Bet_Com_OBN.fits	Bet_Com_MBR.ascii Bet_Com_OBN.fits
F	Hermes	Procyon	Procyon_OBN.ascii Procyon_OBN.fits	Procyon_OBU.ascii Procyon_OBN.fits	Procyon_MUB.ascii Procyon_OBN.fits	Procyon_MBR.ascii Procyon_OBN.fits
A	Hermes	68 Tau	68-Tau_OBN.ascii 68-Tau_OBN.fits	68-Tau_OBU.ascii 68-Tau_OBN.fits	68-Tau_MUB.ascii 68-Tau_OBN.fits	68-Tau_MBR.ascii 68-Tau_OBN.fits
B	Hermes	HR 7512	HR_7512_OBN.ascii HR_7512_OBN.fits	HR_7512_OBU.ascii HR_7512_OBN.fits	HR_7512_MUB.ascii HR_7512_OBN.fits	HR_7512_MBR.ascii HR_7512_OBN.fits
More to come	Other	Other	Other	Other	Other	Other

BRASS REFERENCE STAR SPECTRA

Spectral Type	Instrument	Star name	Spectrum	Spectrum
			OBSERVED	OBSERVED
			NORMALIZED	NOT NORMALIZED
Under construction	Other	Other	Other	Other

BRASS Help

HELP PAGES LINES BDI SPECTRA BDI SAVE DATA CONTACT

LINES BDI

How do I query BRASS for atomic line data?

Play video tutorial

How do I make a plot of BRASS cross-matched log(gf)-values?

Play video tutorial

SPECTRA BDI

How do I interactively display BRASS stellar spectra?

Play video tutorial

How do I make a plot of graded BRASS lines?

SAVE DATA

How do I save a list of graded BRASS lines?

How do I measure equivalent line widths?

- Offers un/normalized benchmark spectra.
- Offers un/broadened theoretical spectra calculated with BRASS quality assessed atomic data values.

Summary

- **BRASS centralizes atomic data needed in quantitave stellar spectroscopy.**
- **Atomic data are retrieved from literature of the past half century, and from 7 main atomic databases with ~ half million lines for synthetic spectrum modelling.**
- **BRASS provides semi-empiric assessments of the quality of log(*gf*)-values and rest-wavelengths of ~1100 unblended atomic absorption lines observed in stellar benchmark spectra, fully covering 400 – 680 nm.**
- **11 benchmark spectra currently incorporated in BRASS repository for combined interactive display of line identifications, atomic data quality assessments, and observed line properties (% blending, EWs, depths).**
- **Currently based on FGK benchmark stars. Will be further expanded to hot (lateB & A) benchmarks with focus on more and higher ionic lines (requiring non-LTE RT).**