Contact day meeting
19th September 2017
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BRASS

The Belgian Repository of fundamental Atomic data and Stellar Spectra

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European Southern Observatory, Chile
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Science motivation

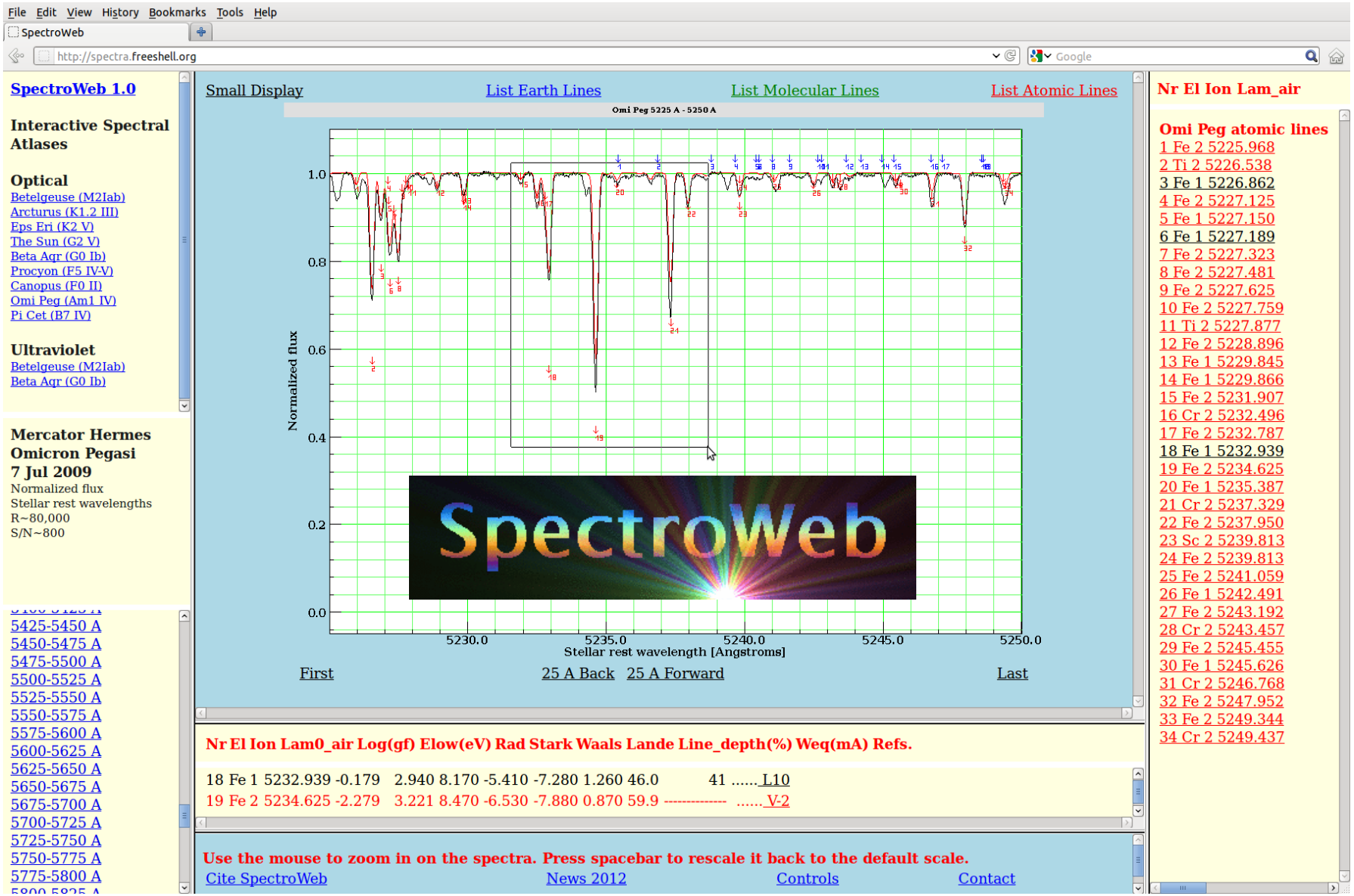
- First steps towards removing systematic errors from input atomic data in stellar spectroscopy

- Compilation of high-quality optical spectral atlases of bright benchmark BAFGK stars with confirmed line identifications and quality-tested atomic data.

- Perform detailed spectral synthesis calculations to test quality of atomic line input data from literature and online data providers (VALD/NIST/etc) by modeling bright benchmark stars.

- Provide observed and theoretical spectra combined with quality-tested atomic data in a new public online database called BRASS

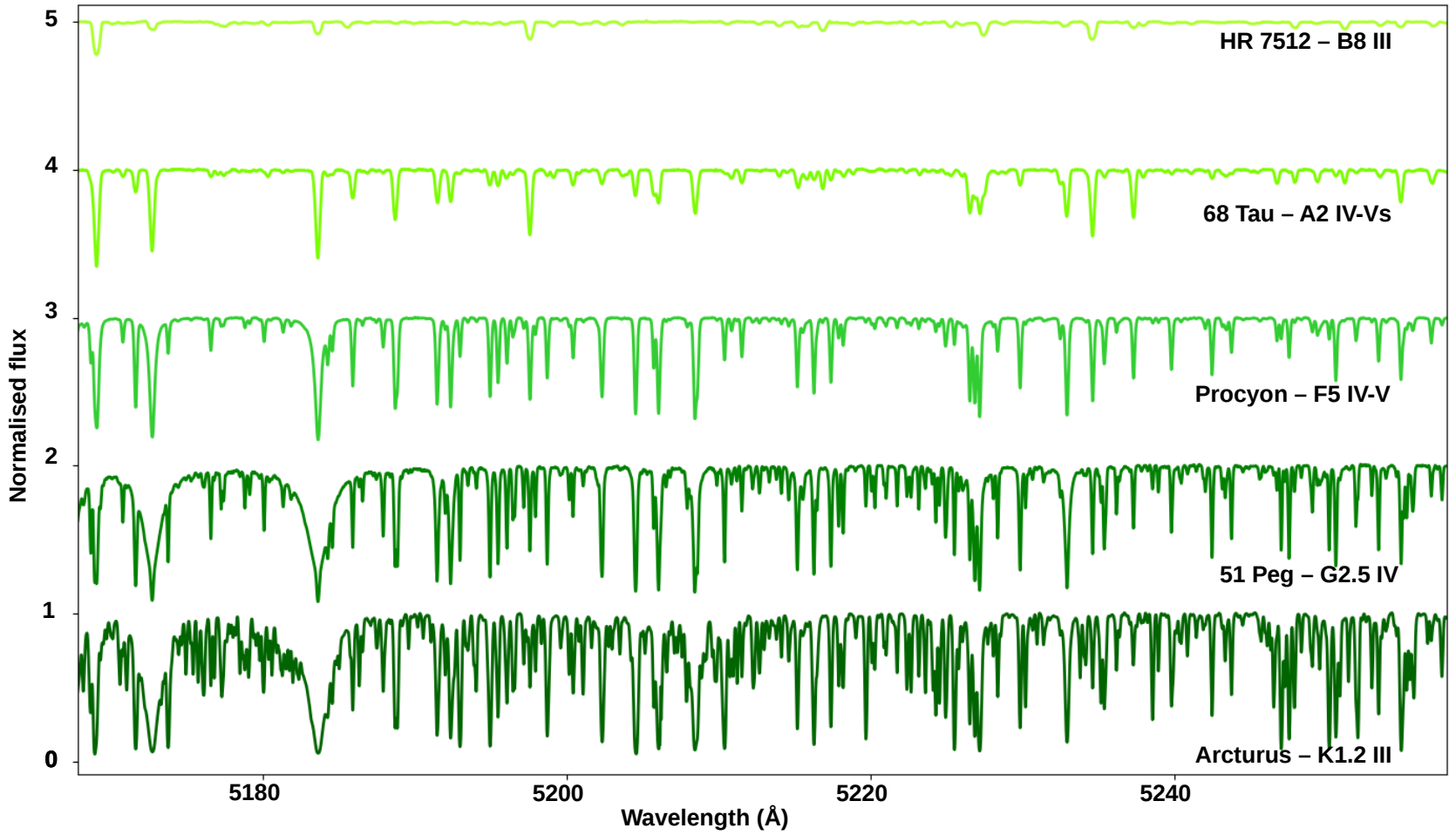
Science motivation : previous literature work



Spectroweb – A. Lobel 2008

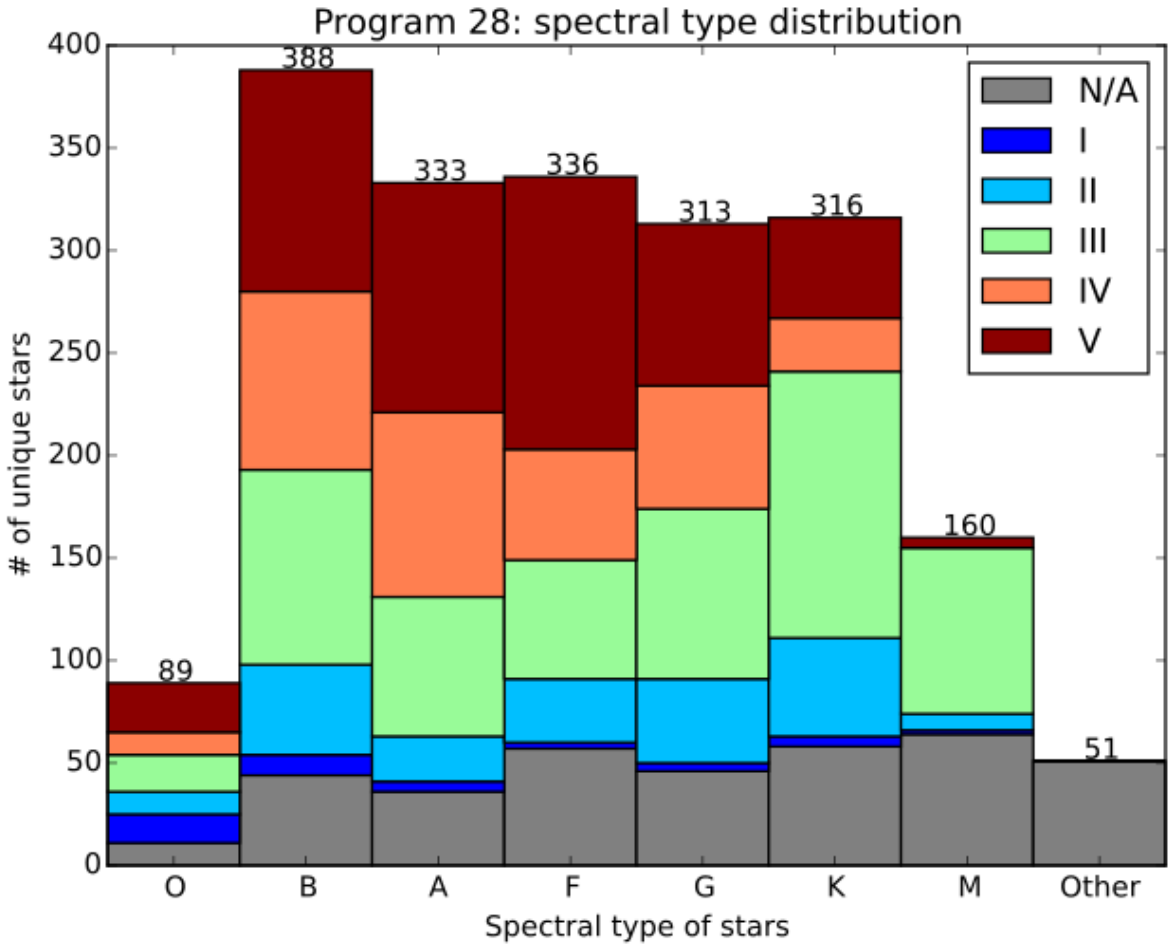
Science motivation : benchmark spectra

- ~30 spectra of bright BAFGK stars with S/N ratio ~1000, taken using the Mercator-HERMES and VLT-UVES high-resolution spectrographs



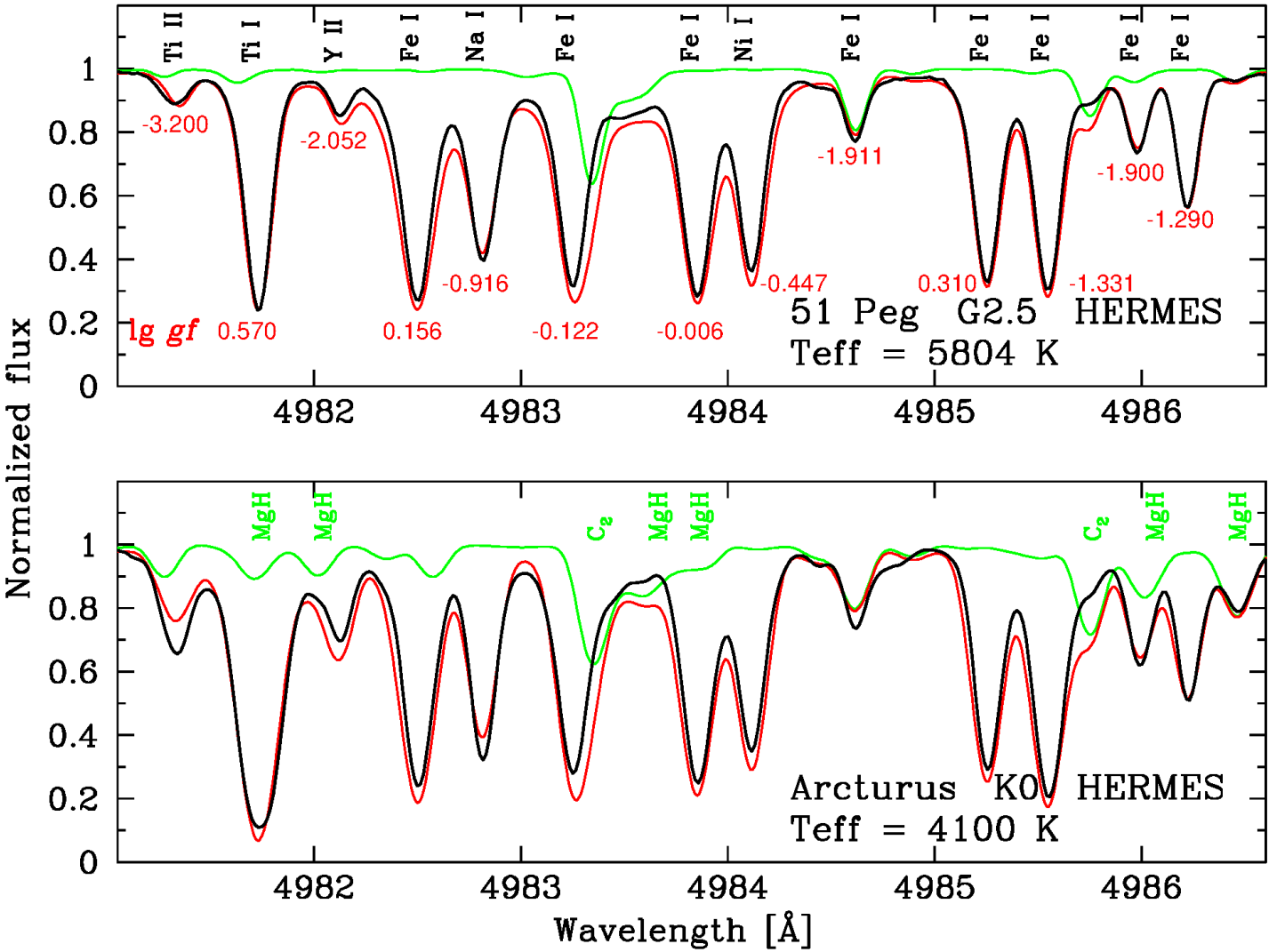
Science motivation : high-quality spectra

- Over 1000 spectra of BAFGK stars with good stellar parameter-space coverage. S/N ratios of ~100-300+ and taken with Mercator-HERMES .



Science motivation : synthesis & line identification

- Detailed spectral calculations of entire benchmark spectra (inc. molecules)

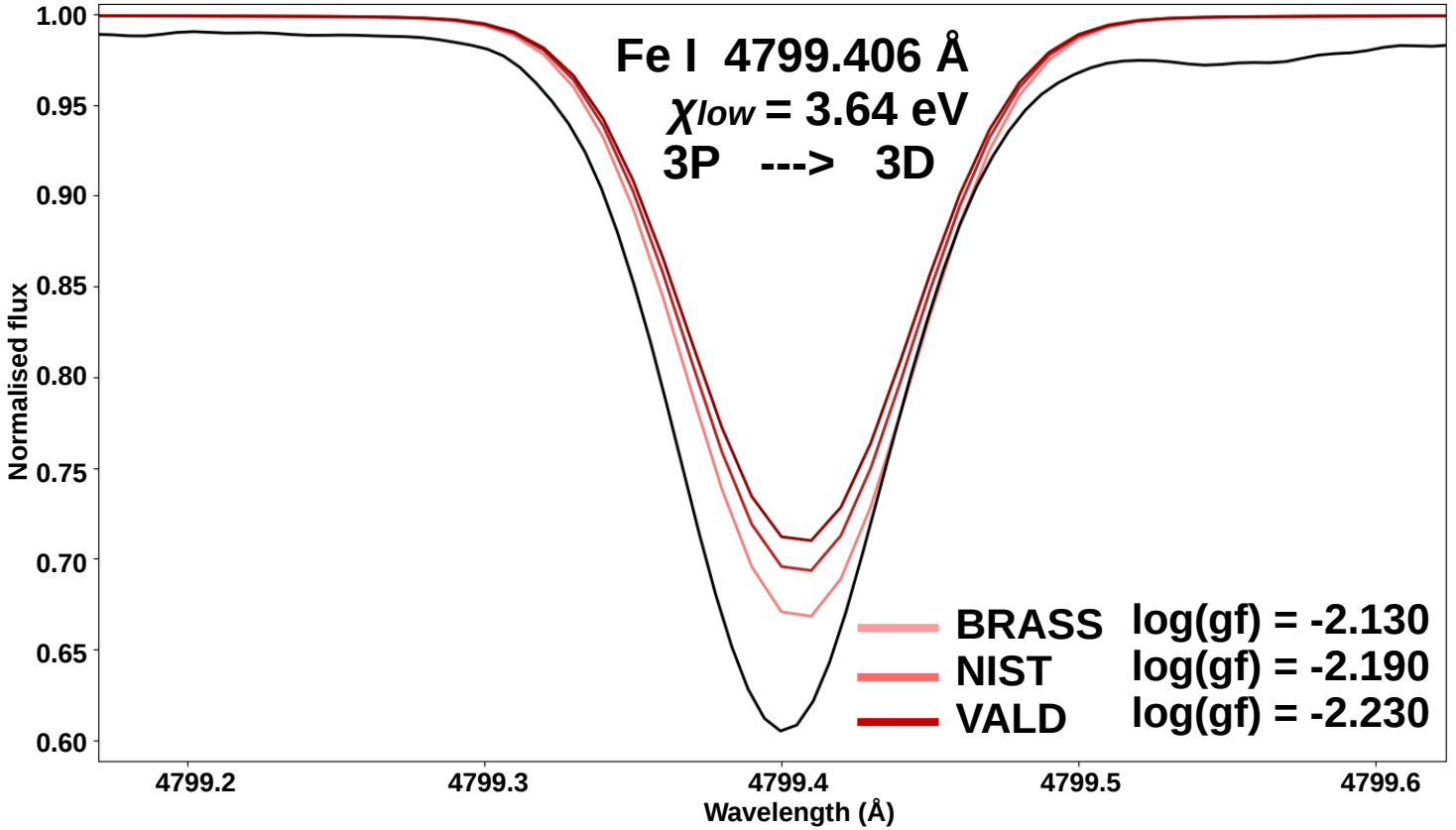


Lobel et al 2017

Science motivation : quality-assessed atomic data

- Benchmark spectra quality high enough to compare and assess literature atomic data on the largest scale to date (λ , spectral type, quantity)

- Scatter in atomic data can have significant impact on stellar parameters



Science motivation : BRASS database (brass.sdf.org)

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Where do I fit in to BRASS?

- Compilation of high-quality optical spectral atlases of bright benchmark BAFGK stars with confirmed line identifications and quality-tested atomic data.

- Perform detailed spectral synthesis calculations to test quality of atomic line input data from literature and online data providers (VALD/NIST/etc) by modeling bright benchmark stars.

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Where do I fit in to BRASS? - Atomic lines!

- ~~Compilation of high-quality optical spectral atlases of bright benchmark BAFGK stars with confirmed line identifications and quality-tested atomic data.~~

- Perform detailed spectral synthesis calculations to test quality of atomic line input data from literature and online data providers (VALD/NIST/etc) by modeling bright benchmark stars.

- ~~Provide observed and theoretical spectra combined with quality-tested atomic data in a new public online database called BRASS~~

Atomic lines

Laverick et al: BRASS I. Cross-matching atomic databases of astrophysical interest

Table 4. (a) - (c) show three sets of cross-matched lines. (a) the Mn II pair have been correctly cross-matched by both the parametric and non-parametric methods. (b) the Cr I pair have been incorrectly cross-matched using the parametric method and not the non-parametric method. (c) the Fe II pair have been incorrectly cross-matched using the parametric method and not the non-parametric method.

	Ion	λ (Å)	E_{low} (eV)	E_{up} (eV)	J_{low}	J_{up}	Configuration: lower - upper	references
(a)	Mn II	4639.152	10.774	13.446	3	2	$3d^4(^5D)4s4p(^3P^\circ)$ w^5P° - $3d^5(^6S)7s$ ^5S	K09 [a]
	Mn II	4639.160	10.774	13.446	3	2	$3d^4(^5D)4s4p(^3P^\circ)$ w^5P° - $3d^5(^6S)7s$ ^5S	L562 [b]
(b)*	Cr I	4244.770	3.890	6.810	4	5	$3d^5(^4F)4s$ a^5F - $3d^5(^4G)5p$ v^3H°	K10 [a]
	Cr I	4244.340	3.857	6.777	4	5	$3d^4(^5D)4s4p(^3P^\circ)$ z^5F° - e^5F	L808 [c]
(c)**	Fe II	6207.273	11.051	13.048	7/2	5/2	$3d^6(^5D)5p$ $6P^\circ$ - $3d^6(^5D)5d$ $6S$	K13 [a]
	Fe II	6207.342	11.051	13.048	7/2	5/2	$3d^5(^4P)4s4p(^3P)$ $6P^\circ$ - $3d^6(^5D)5d$ $6G$	RU [d]

Notes. *Cross-matched using $\Delta E = \pm 0.1$ eV **Cross-matched using $\Delta E = \pm 0.0005$ eV [a]Kurucz 1999-2014 [b]Kramida & Sansonetti 2013 [c]Saloman 2012 [d]Raassen & Uylings 1998

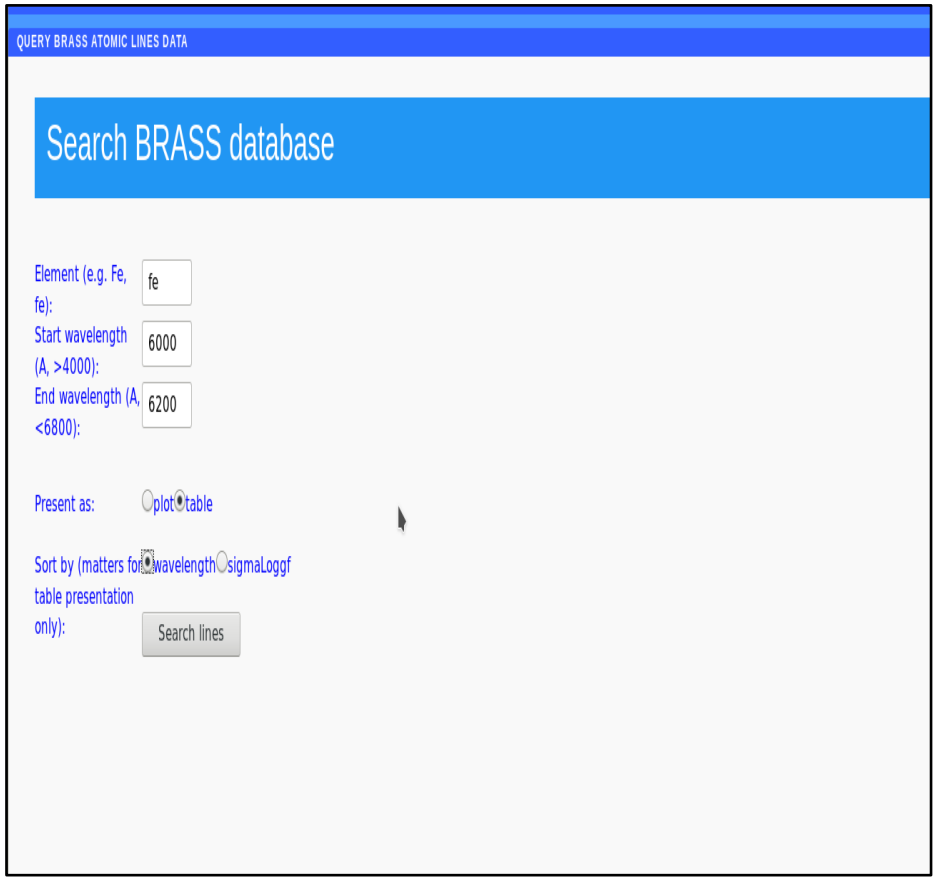
Laverick et al 2017 (Submitted)

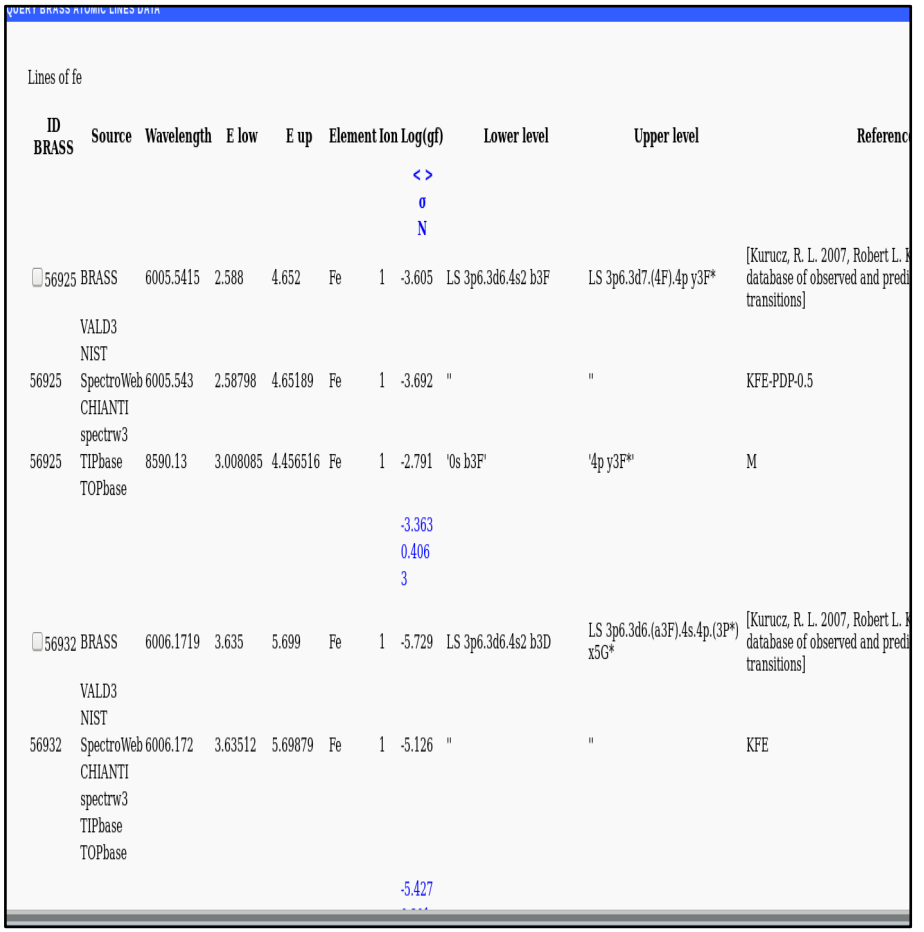
- Several line lists and repositories cross-matched against our BRASS atomic line list (including VALD3, NIST, SpectroWeb, Chianti, TIP/TOPbase)

- ~130,000 transitions cross-matched with our BRASS list of 80,000 lines

Atomic lines : (available at brass.sdf.org)

- Cross-matched atomic data available via the brass.sdf.org → “lines” Tab (currently under development)

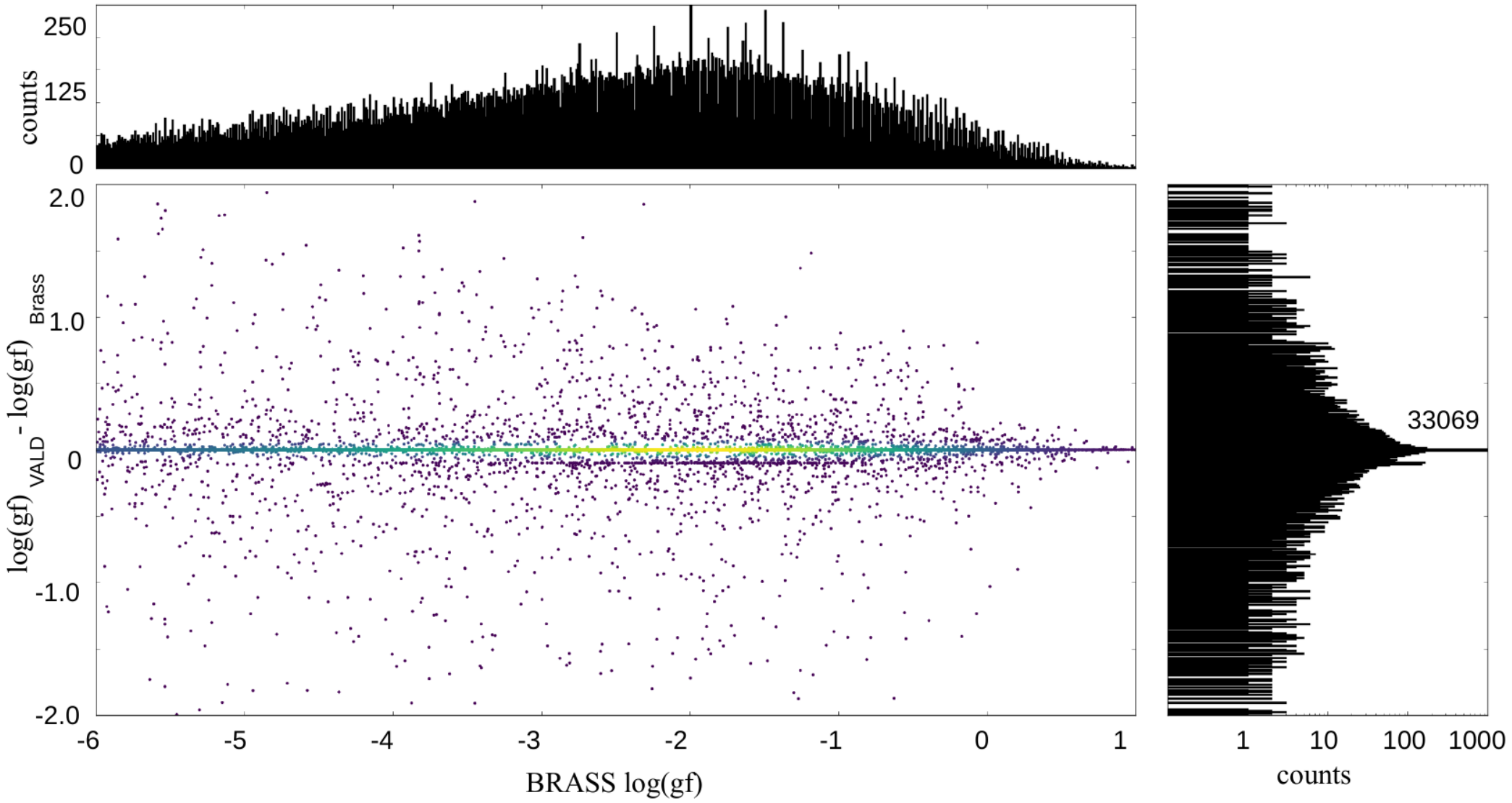




Laverick et al 2017 (Submitted)

Atomic lines : BRASS vs VALD3 (2012 vs 2016)

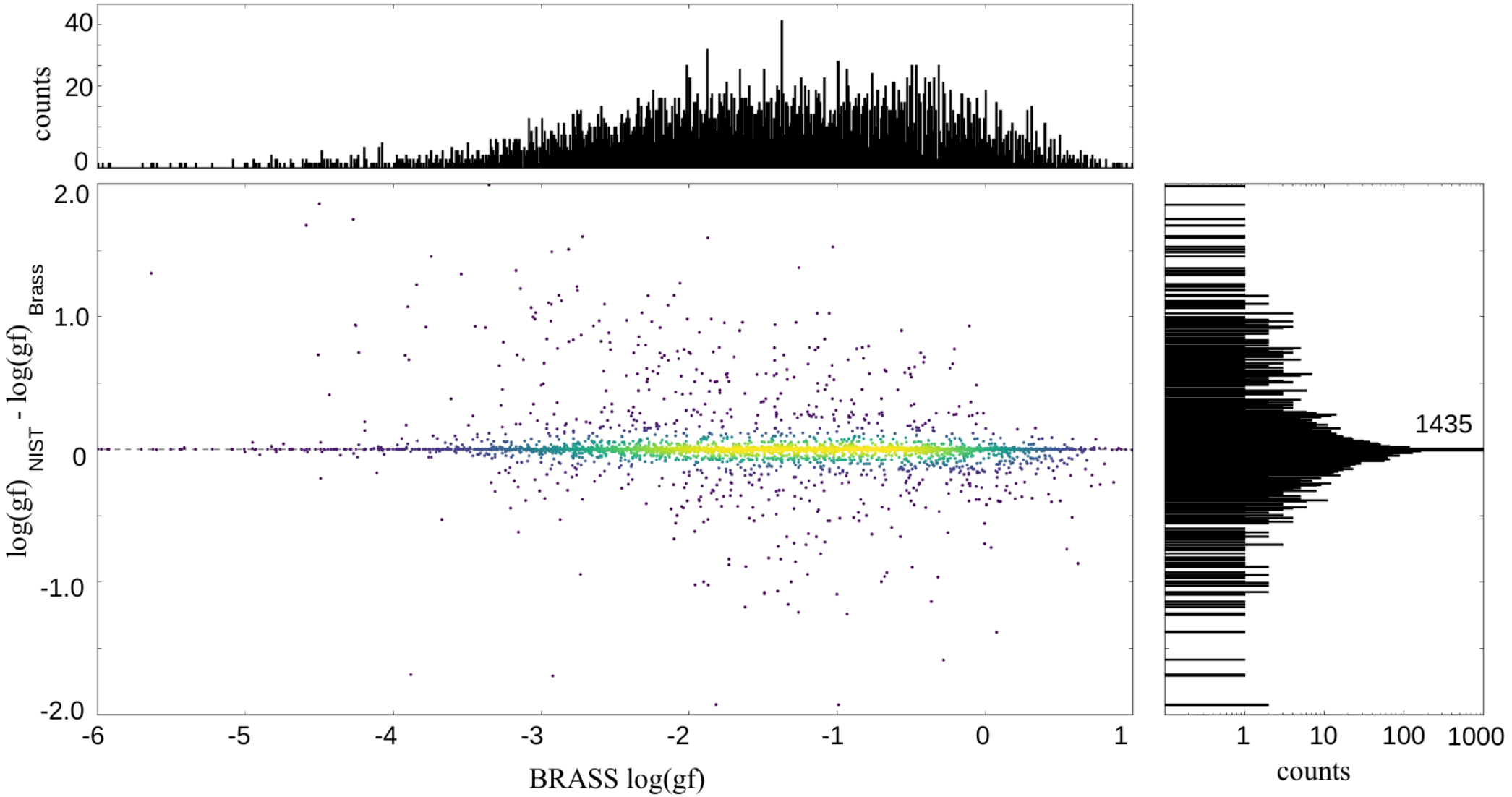
- Updates to literature log(gf) values over time. Scatter up to 2 dex!



Laverick et al 2017 (Submitted)

Atomic lines : BRASS vs NIST (2012 vs 2016)

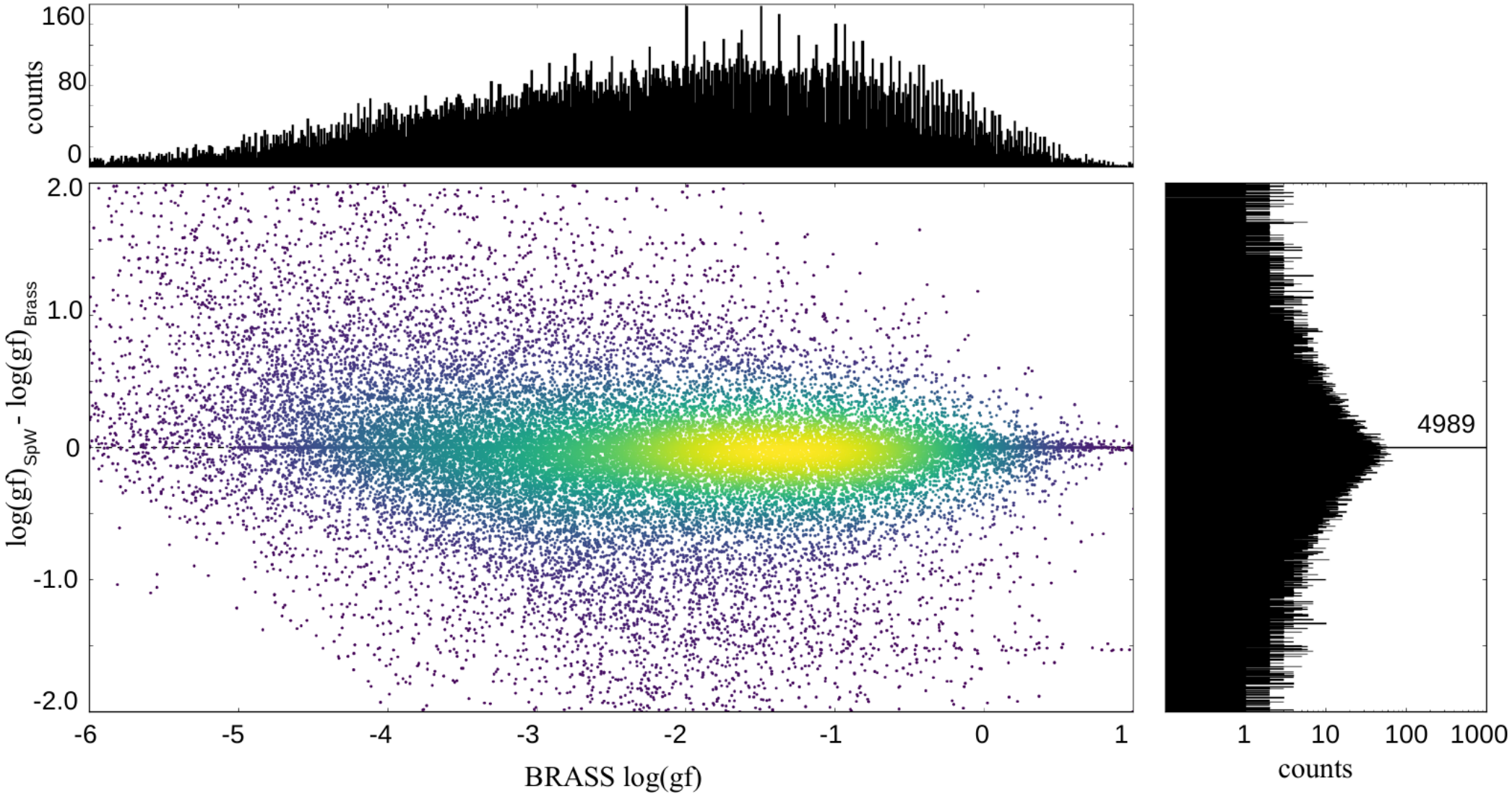
- Scatter still up to 2 dex!



Laverick et al 2017 (Submitted)

Atomic lines : BRASS vs SpectroWeb (2012 vs 2008)

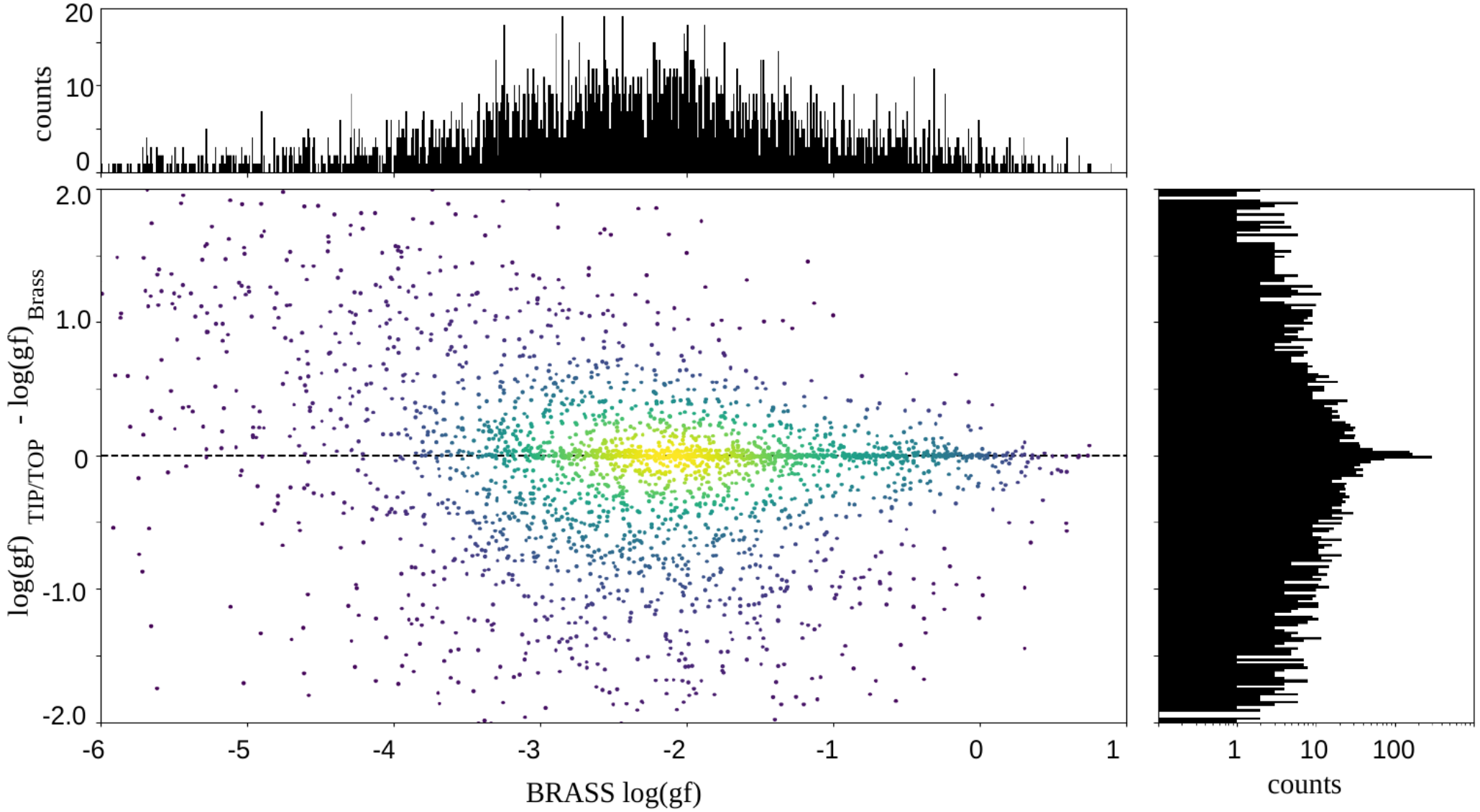
- Scatter up to 4 dex for older transitions!



Laverick et al 2017 (Submitted)

Atomic lines : BRASS vs TOPbase (2012 vs 1993)

- Changes in log(gf) values lead to similar changes in line abundances !!!

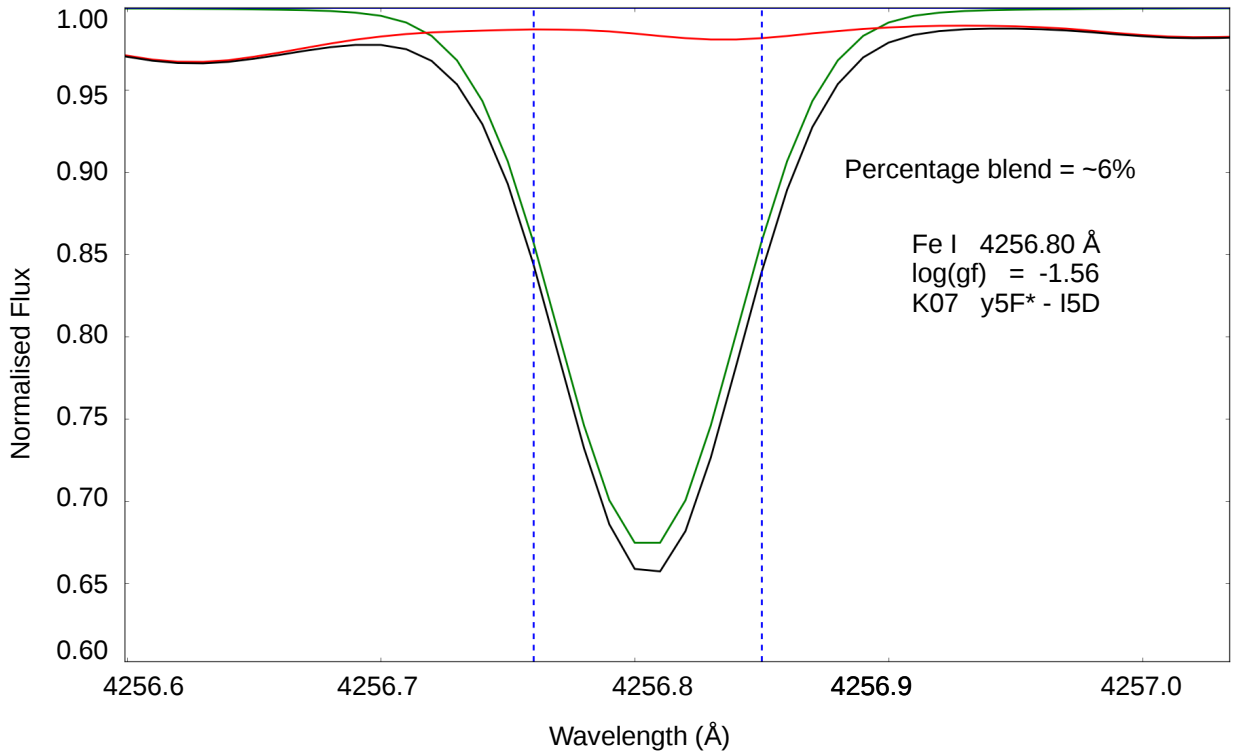


Laverick et al 2017 (Submitted)

Atomic lines : line selection

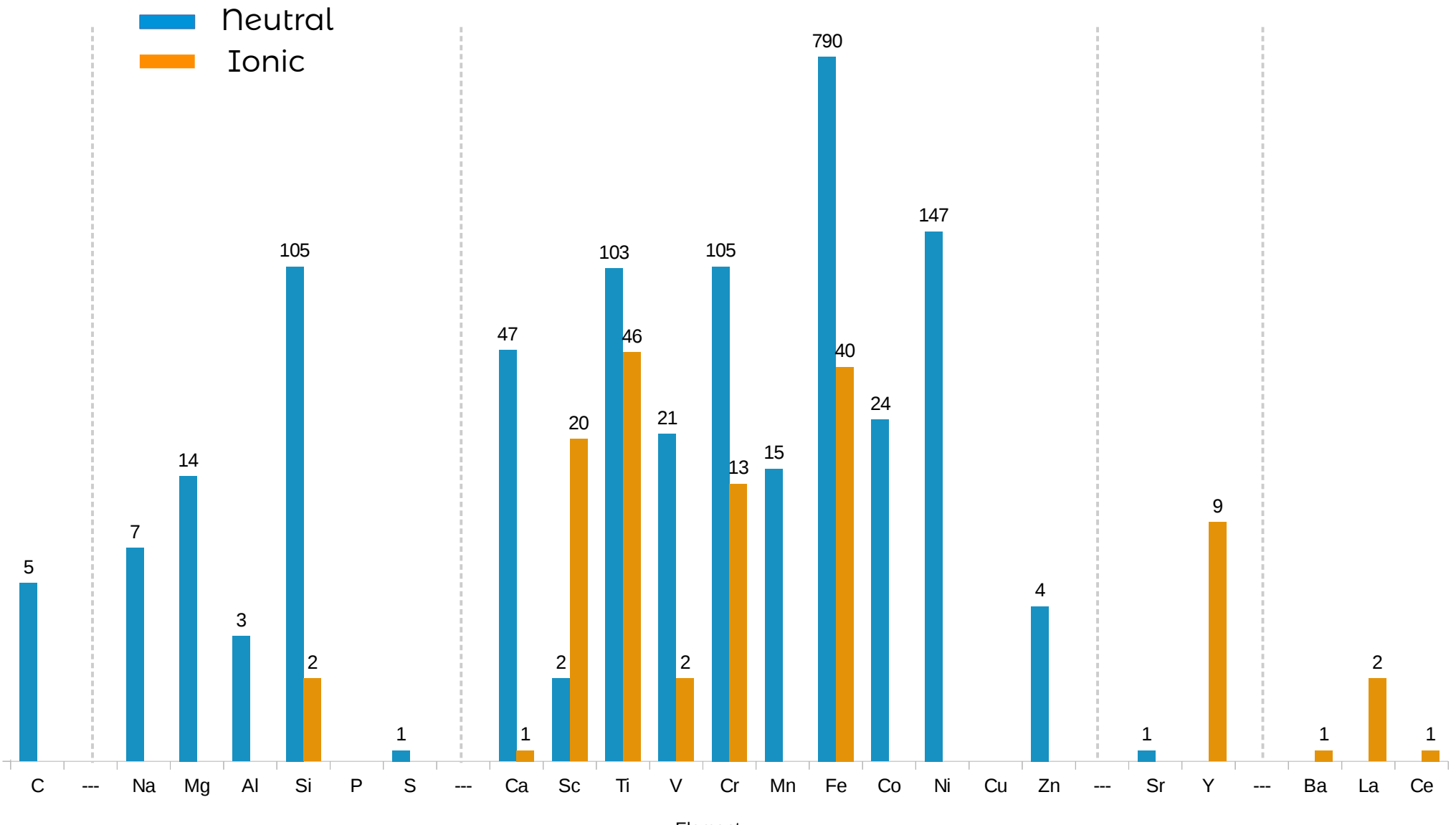
- Systematic selection of deep + unblended lines using our 80,000 lines, performed for each BAFGK spectral type

- Synthesise each line individually - line considered “unblended” if it reproduces at least 90% of the total synthetic line profile



Atomic lines : line selection

- G type stars : ~1500 theoretically deep and unblended lines to assess



Atomic lines : quality assessment

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1) Measure the equivalent width of the observed line profile in one star

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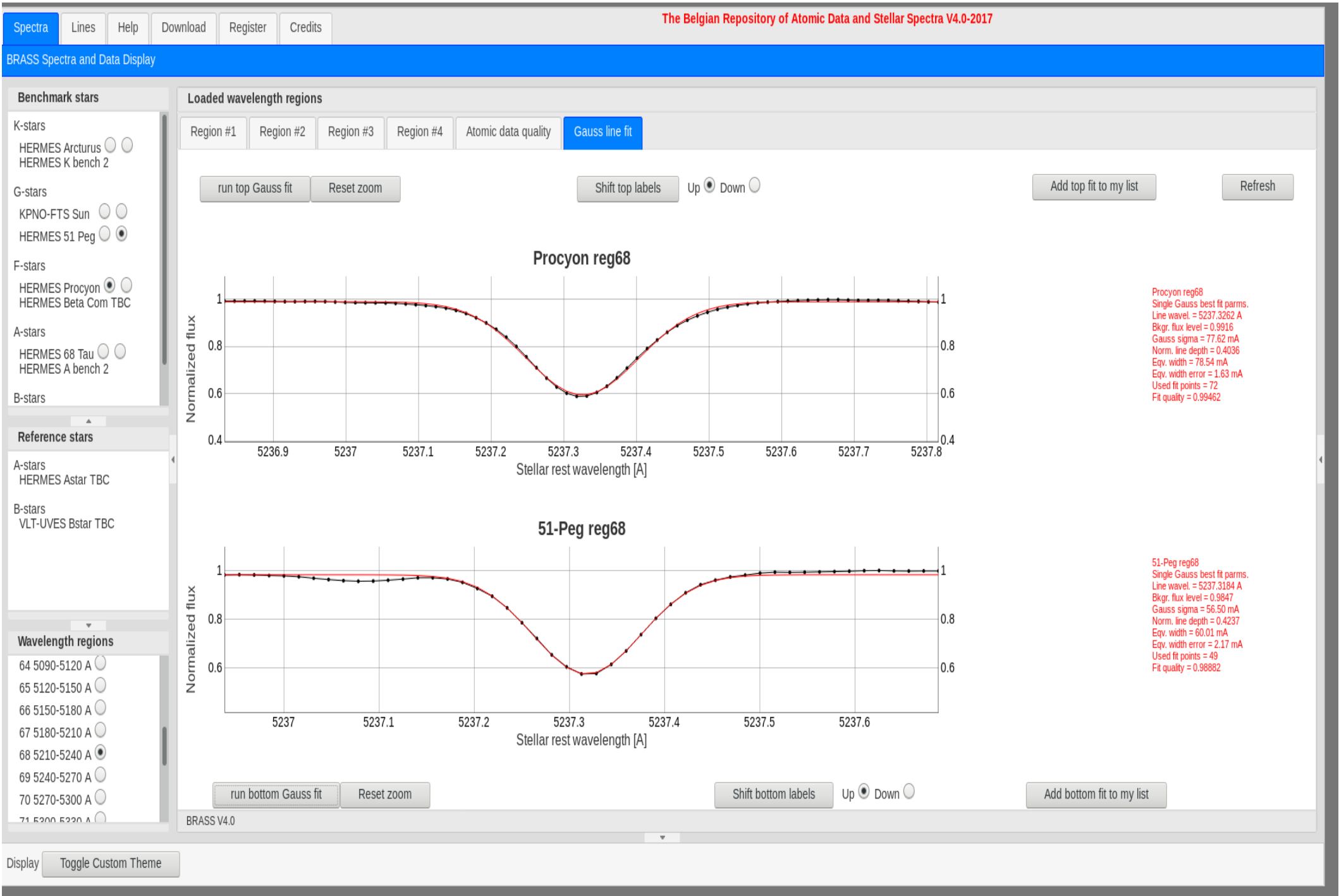

Atomic lines : quality assessment

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1) Measure the equivalent width of the observed line profile in one star

2) Use the theoretical Curve of Growth and measured EW to “adjust” the BRASS log(gf) value

Atomic lines : quality assessment

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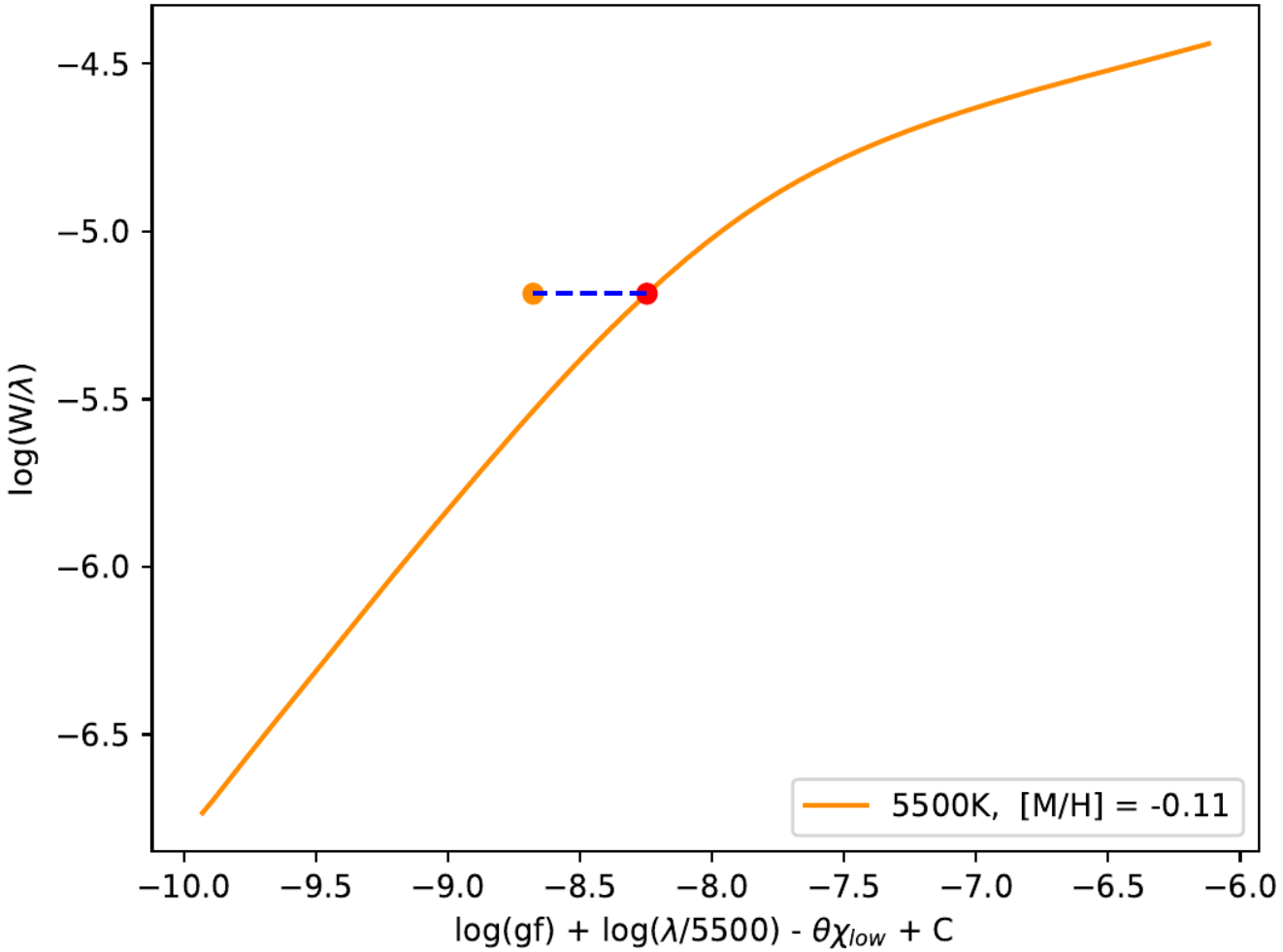
1) Measu : in one star

2) Use the “adjust” the BRASS



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3) Repeat for all G-type benchmarks. Calculate mean “adjustment”

Atomic lines : quality assessment

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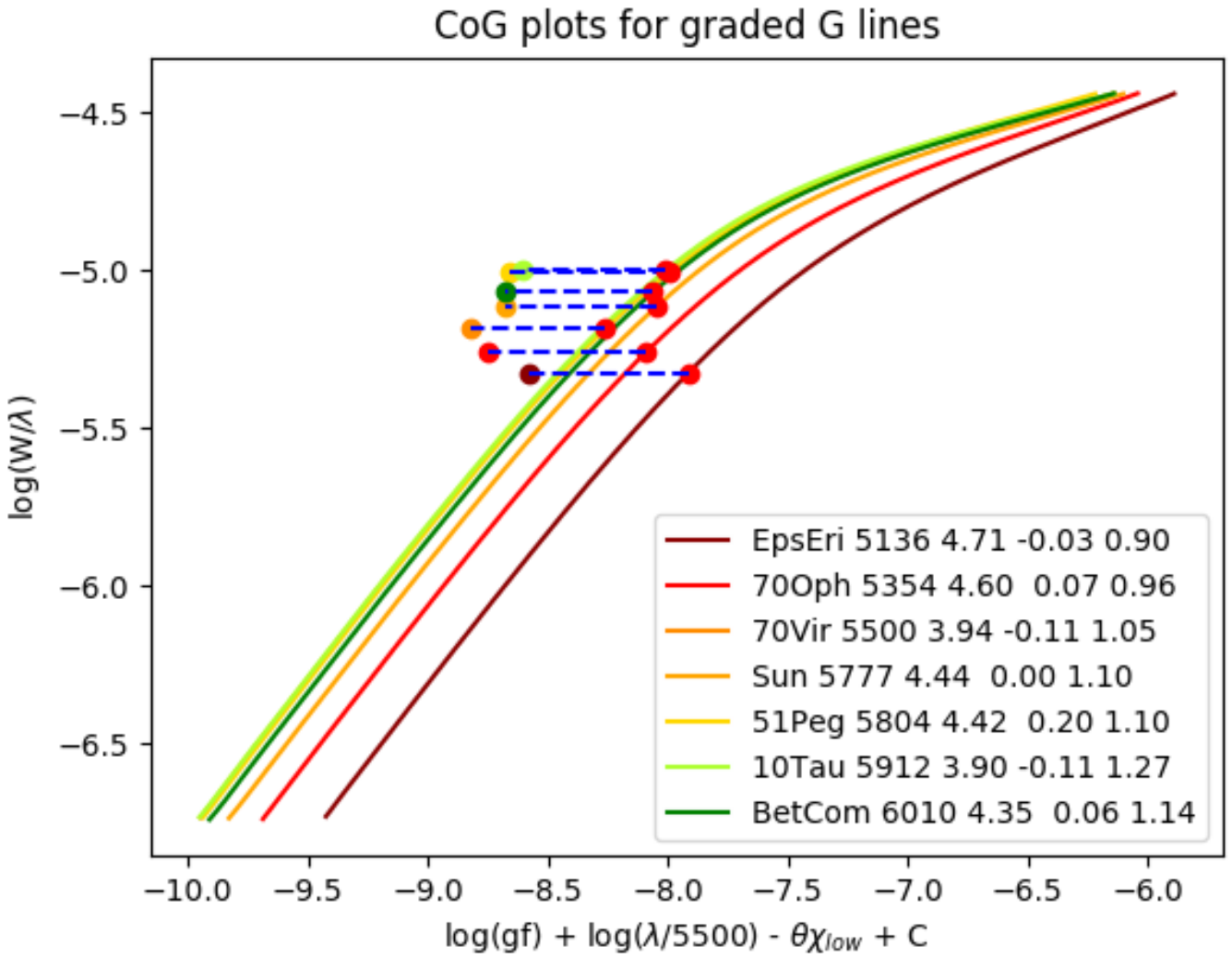

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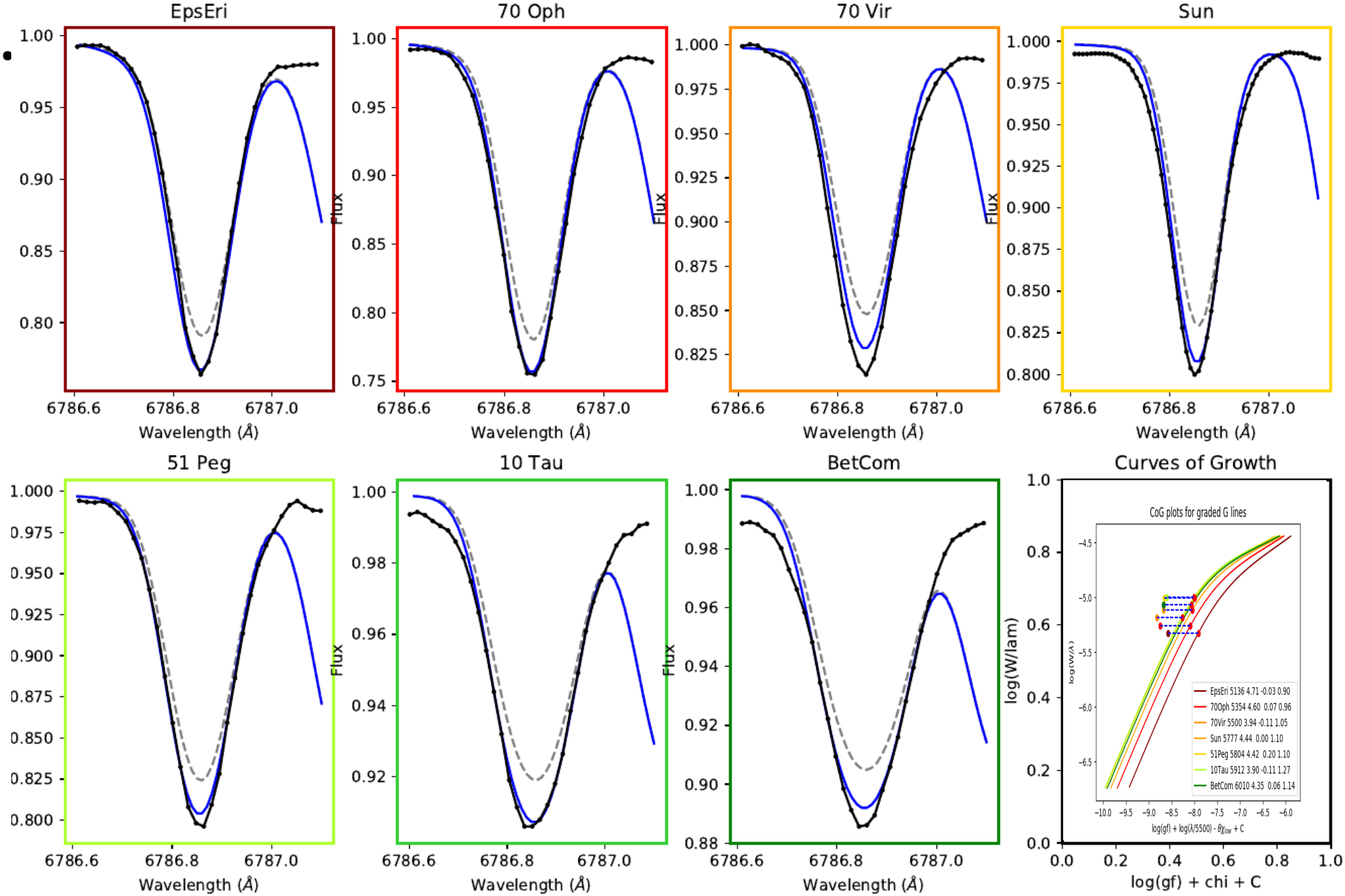

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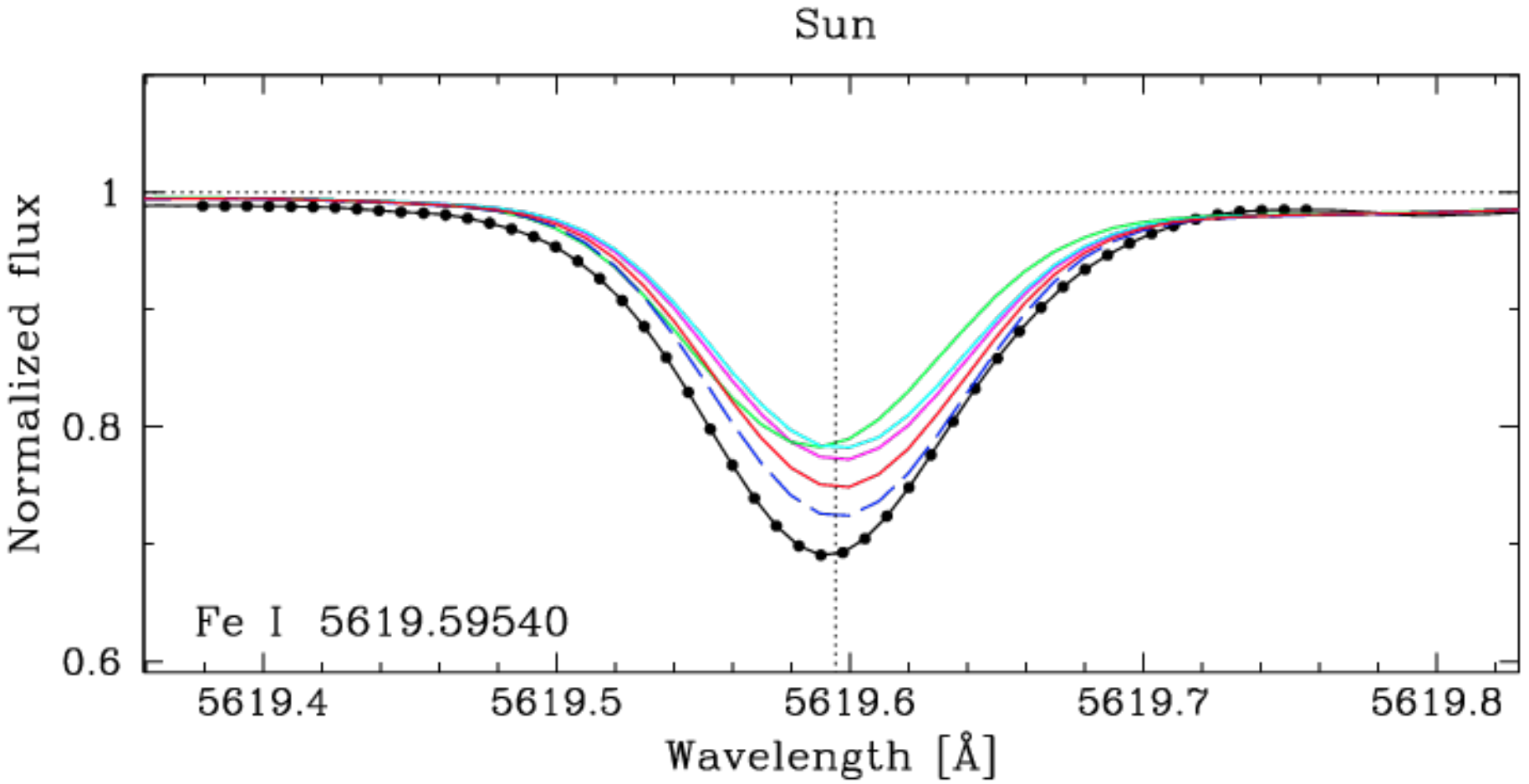
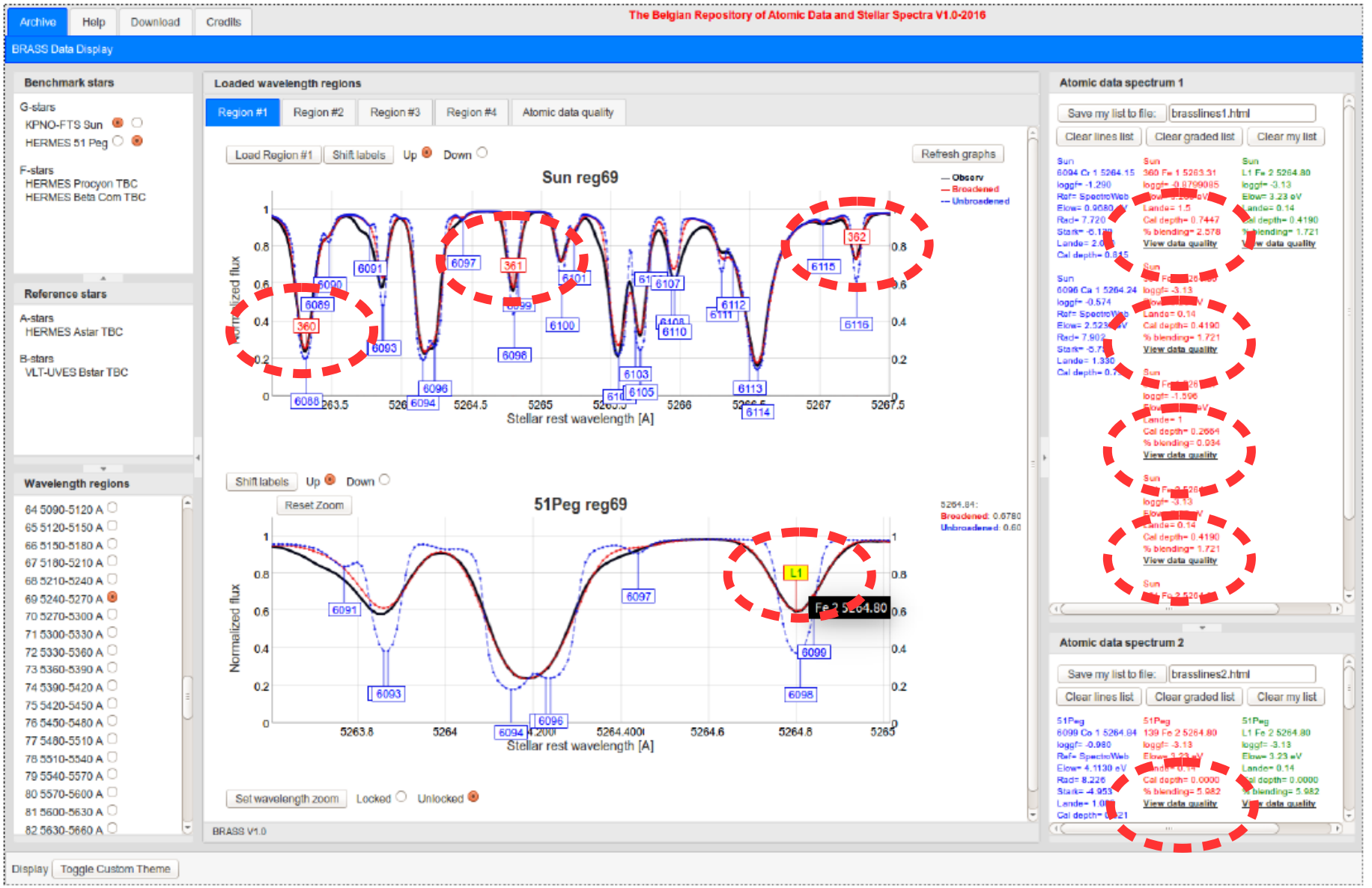
5) Good fits means line can be assessed. Bad fits are likely hidden blends

Atomic lines : quality assessment results



Source	λ [Å]	log(gf)	Δlog(gf)	χ^2(λcorr)	W_{eq} [mÅ]	Nor. depth
Observed	5619.5938				35.6	0.30463
G-benchmarks	*5619.59712*	*−1.531*		0.0166	31.2	0.27674
BRASS	5619.59540	−1.6	0.069	0.0279	28.3	0.25212
NIST	5619.5951	−1.67	0.139	0.0386	25.7	0.22838
SpectroWeb	5619.587	−1.7	0.169	0.0434	24.6	0.21722
VALD	5619.595	−1.7	0.169	0.0431	24.6	0.21849

BRASS : Results and future work



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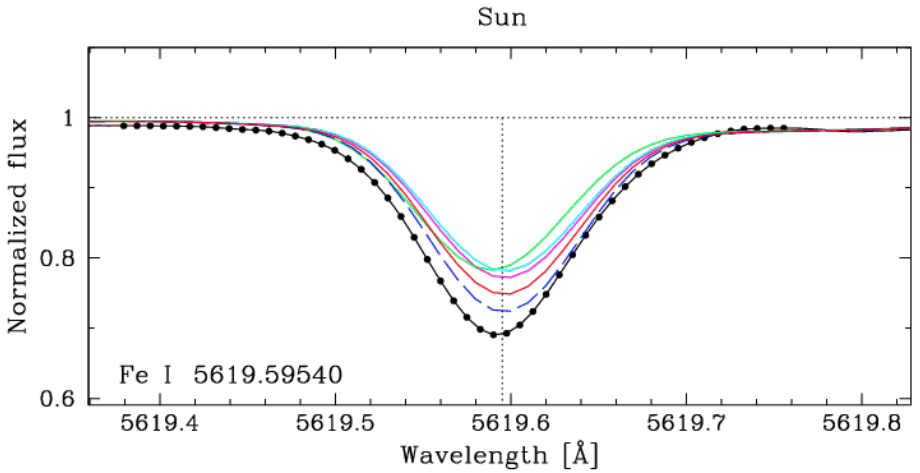
BRASS : Results and future work

- Preliminary results available online at brass.sdf.org
- Quality assessment for ~700 G-type atomic lines
- Publication of complete g-type results by the end of the year



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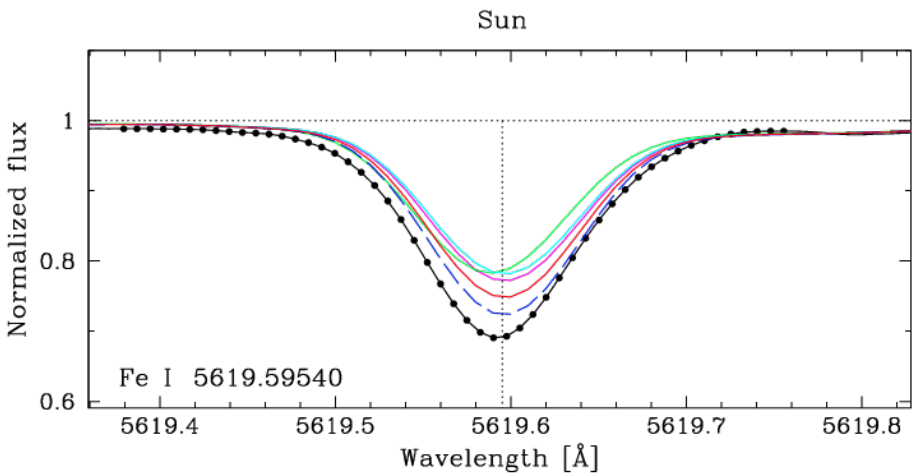

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- Expand quality assessment work to B,A,F,K spectral types
- Complete spectral processing work of over 1000 different targets
- Fully release the BRASS database including all data products

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Thank you for listening!

Questions?

Belgian Science Policy Office
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