Faint Spectrophotometric Standards from the SDSS

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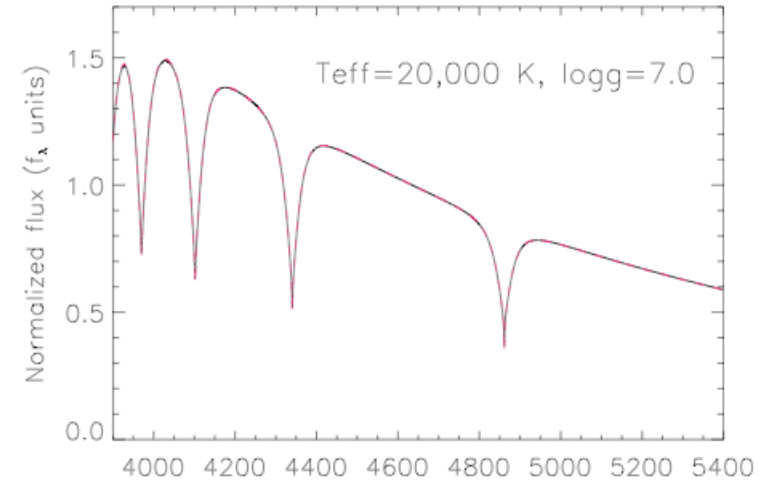
The Need for New Standards

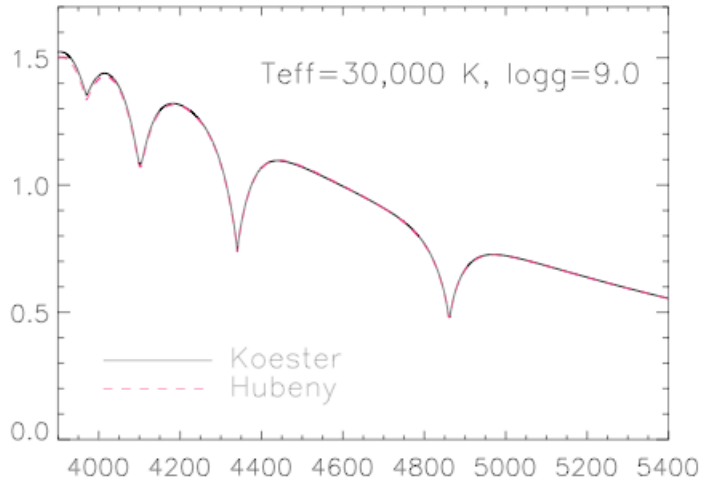
- Can’t have enough of them! Increased coverage over the sky
- HST primary standards considered the best. These are only three stars. Secondary stars imply a 2-step calibration
- New instrumentation demands fainter standards

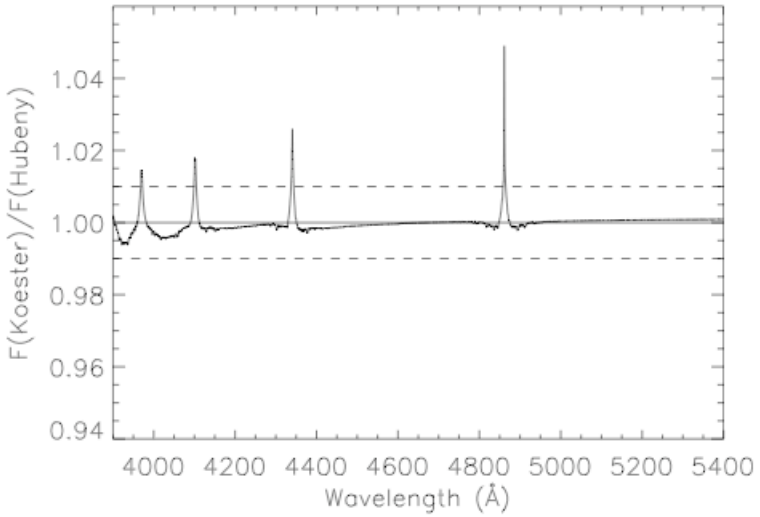
Why DA

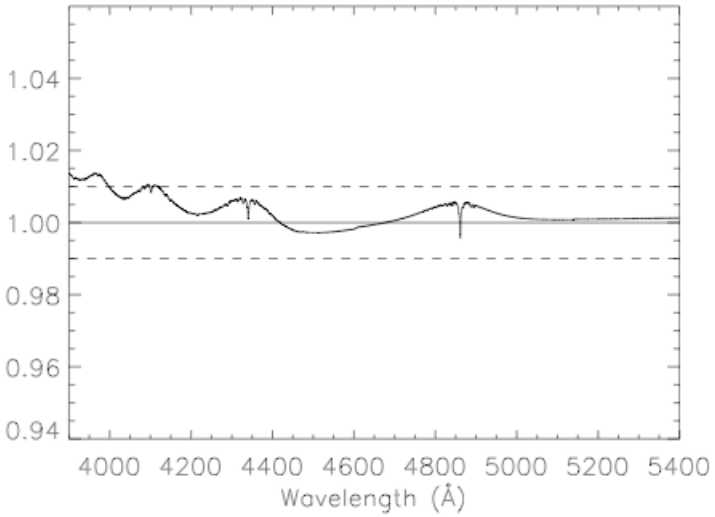
- Simple
- Near
- Proven
- But relatively scarce …

DA modeling


Teff=20,000 K, logg=7.0
Normalized flux (f$_\lambda$ units)
1.5
1.0
0.5
0.0
4000 4200 4400 4600 4800 5000 5200 5400


Teff=30,000 K, logg=9.0
Koester
Hubeny
1.5
1.0
0.5
0.0
4000 4200 4400 4600 4800 5000 5200 5400


F(Koester)/F(Hubeny)
1.04
1.02
1.00
0.98
0.96
0.94
4000 4200 4400 4600 4800 5000 5200 5400
Wavelength (Å)


1.04
1.02
1.00
0.98
0.96
0.94
4000 4200 4400 4600 4800 5000 5200 5400
Wavelength (Å)

DA model grid

- Unpublished grid computed by I. Hubeny with the TLUSTY code: NLTE, Lemke (1997) Stark line absorption coefficients, level dissolution and pseudo-cont. opacity Hubeny, Hummer & Lanz (1994)
- Covered approx. $20{,}000 < T_{eff} < 100{,}000$ K , $7.0 < \log g < 9.5$ with spectra computed for the band 300-700 nm
- Added reddening effects as in the Fitzpatrick (1999) prescription (see below)
- Smoothed with a Gaussian kernel to R=2000 (as appropriate for SDSS spectra)

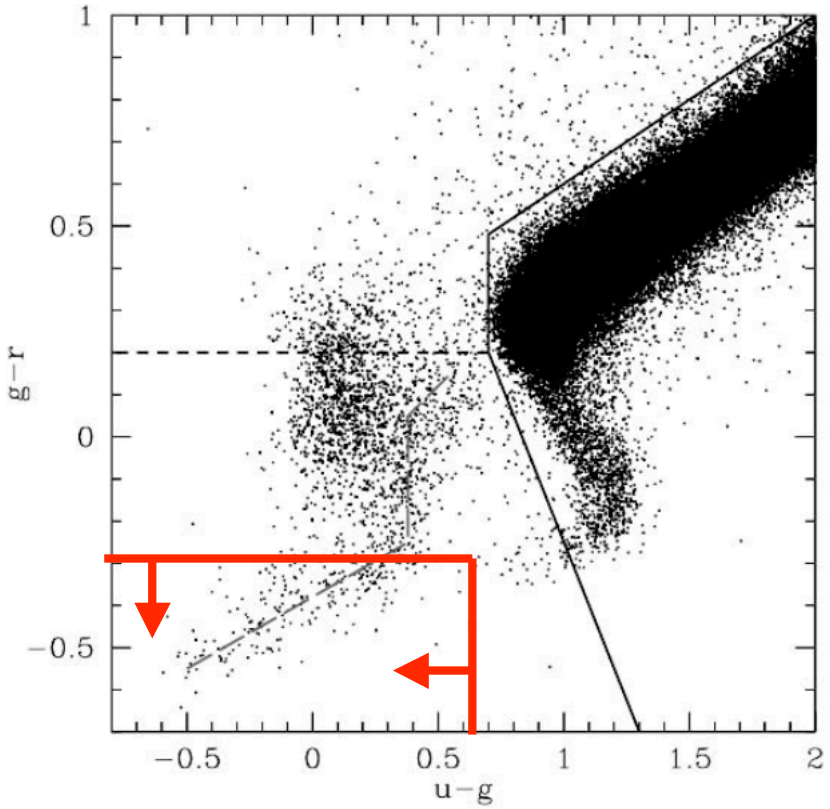
Looking for hot DAs in the SDSS

- u-g<0.6
- g-r < -0.2
- E(B-V)<0.27
- 14<g<17

598 objects

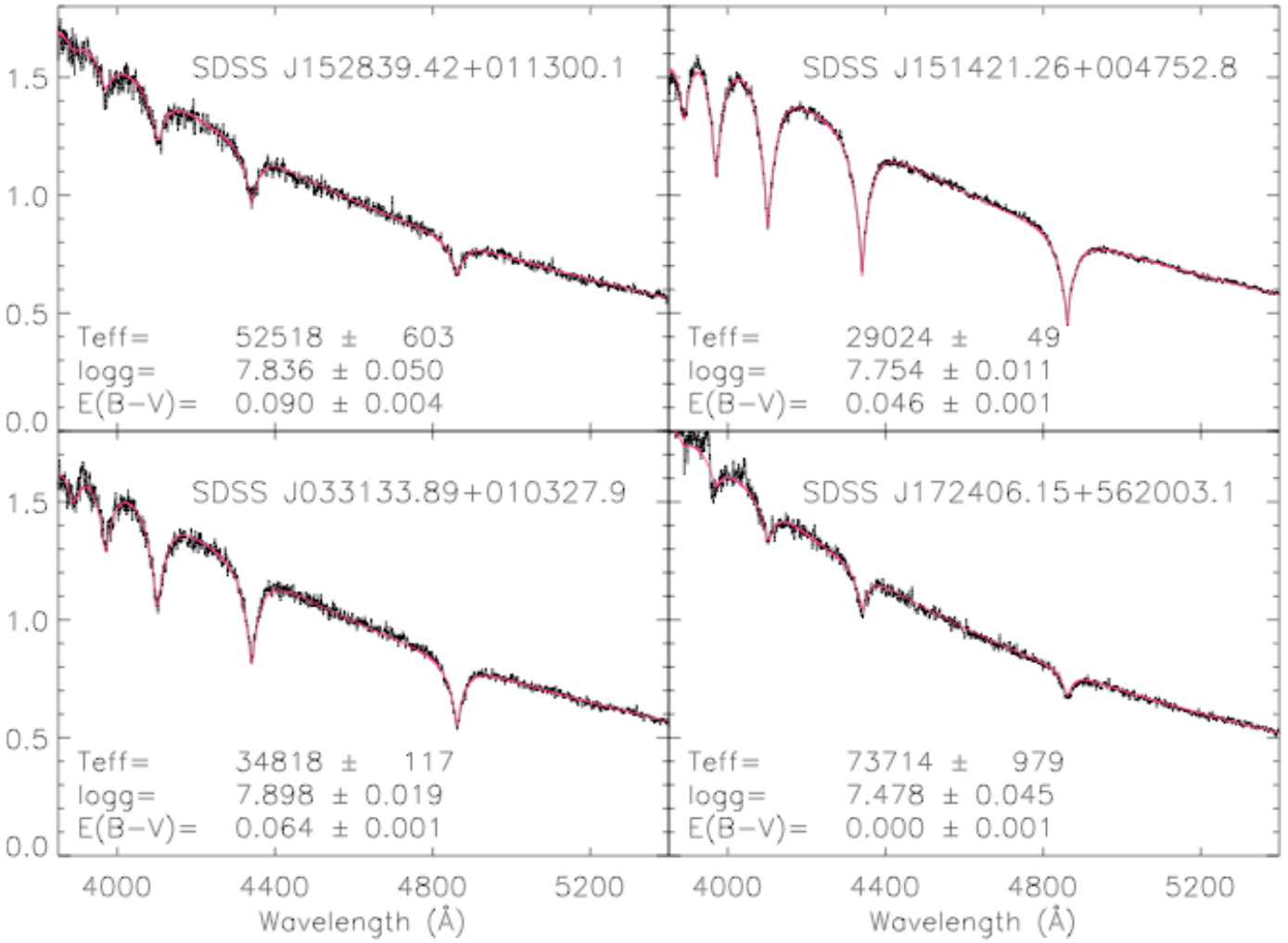
- χ^2<0.63
- 21,000<T_{eff}<85,000 K
- 7.1<logg<9.4
- E(B-V)<0.1

57 objects

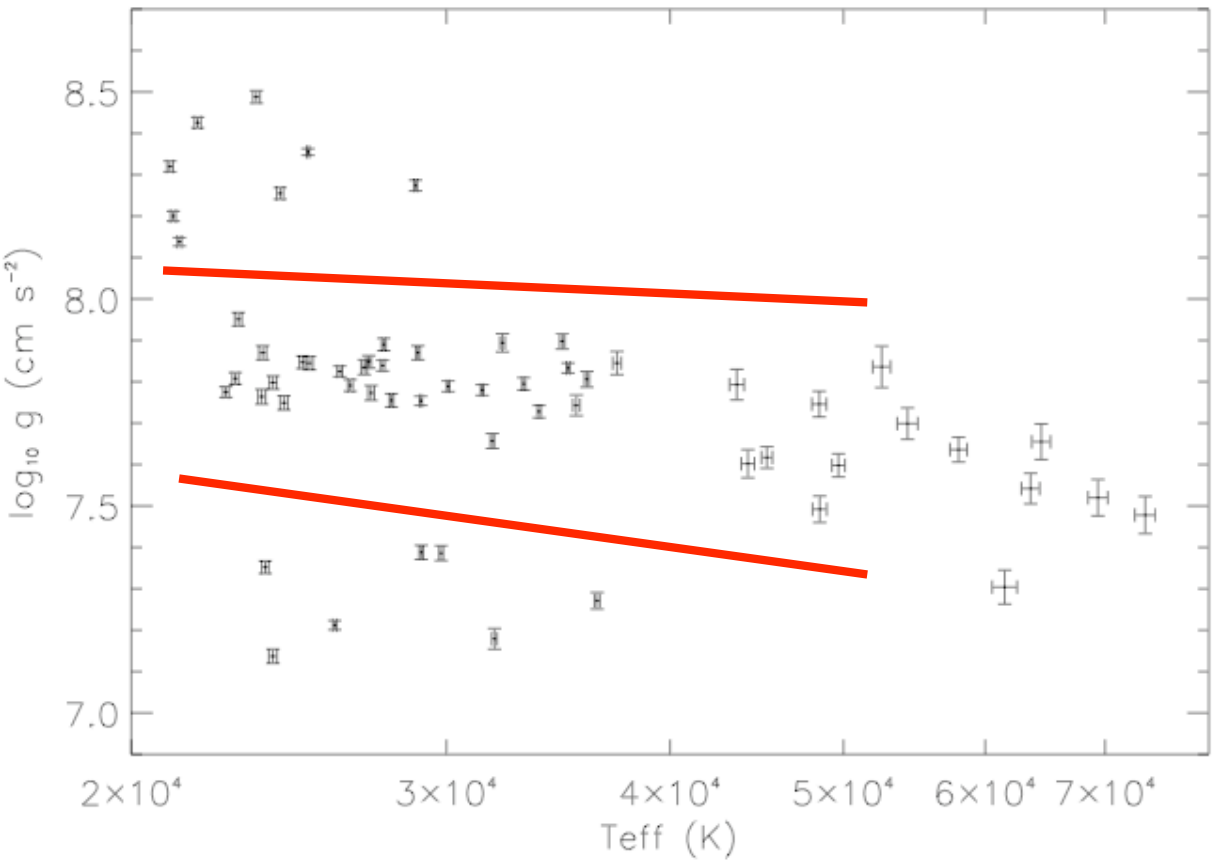


Eisenstein et al. 2006

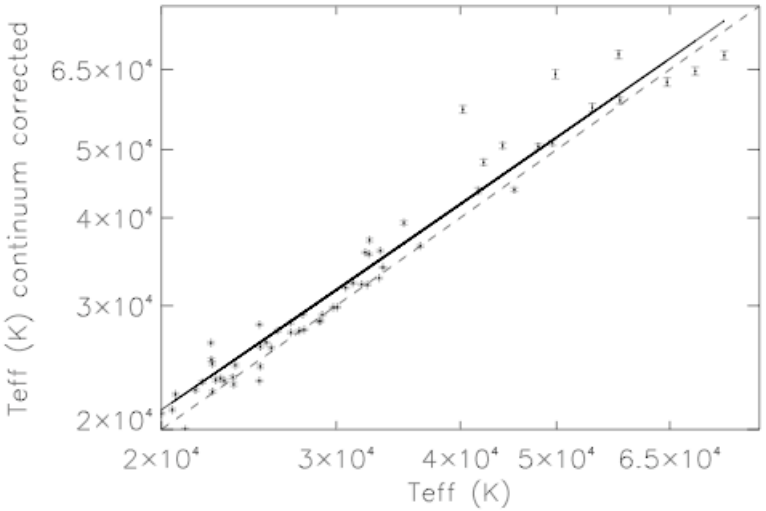
Sample fittings

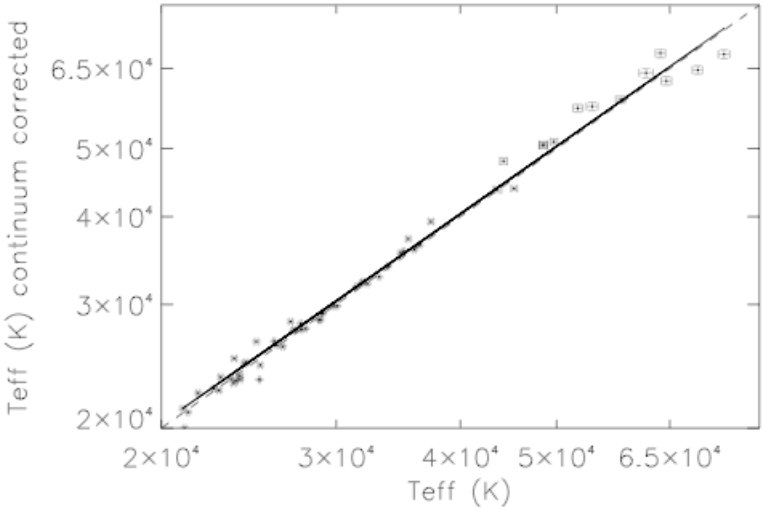


Derived Parameters

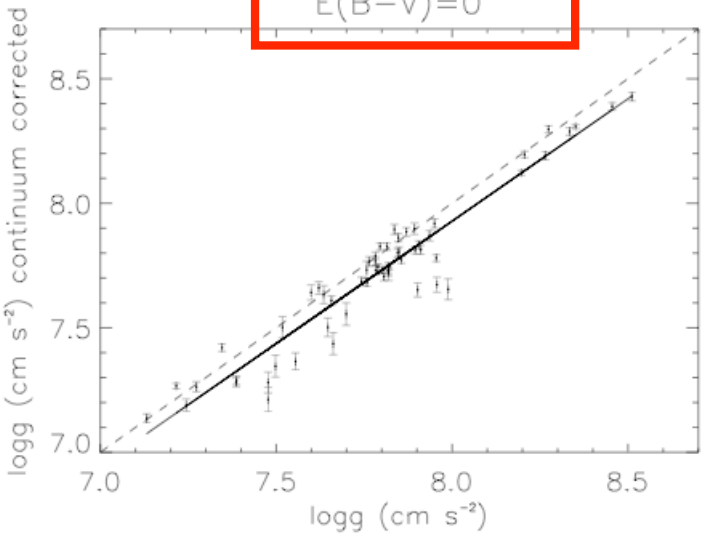


Ignoring E(B-V)?

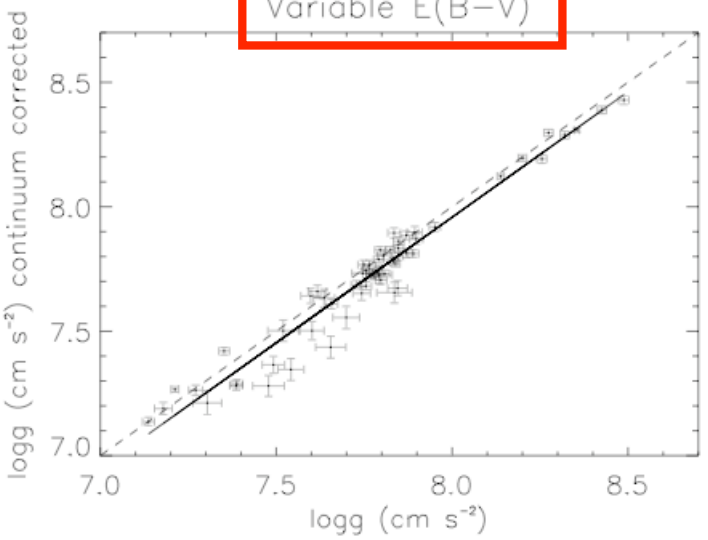




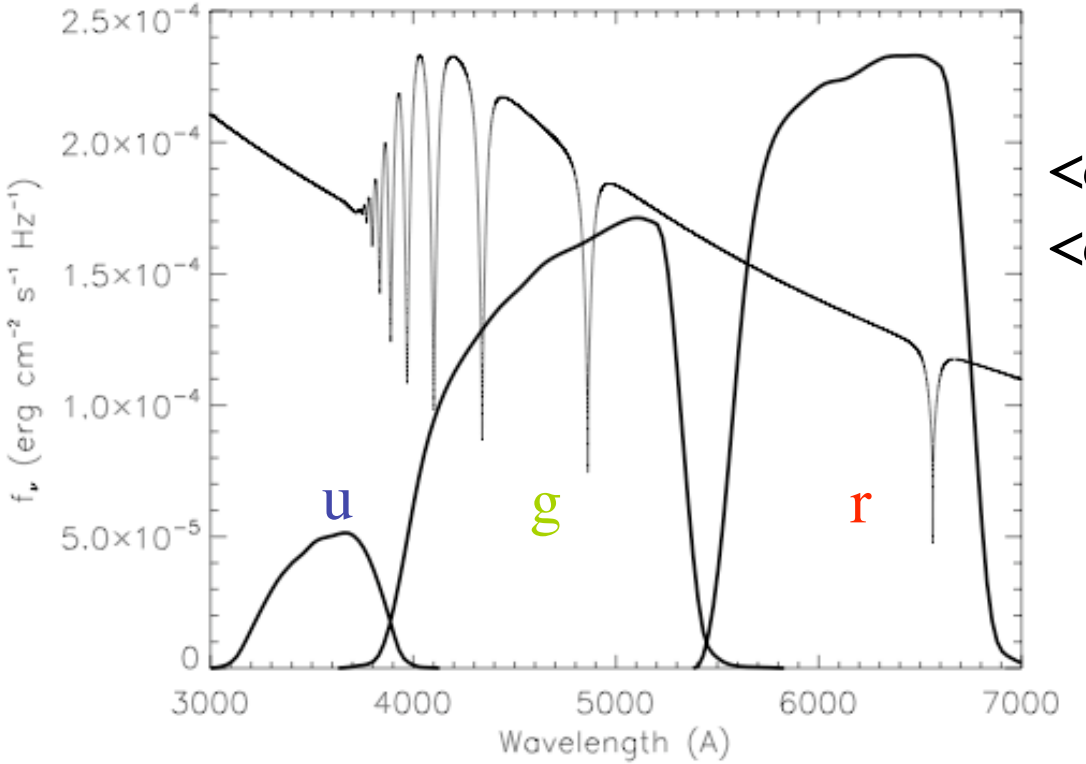
E(B−V)=0



Variable E(B−V)



Scaling the theoretical models



<δu- δg>=+0.0590 (0.0056)

<δg- δr>= -0.0068 (0.0052)

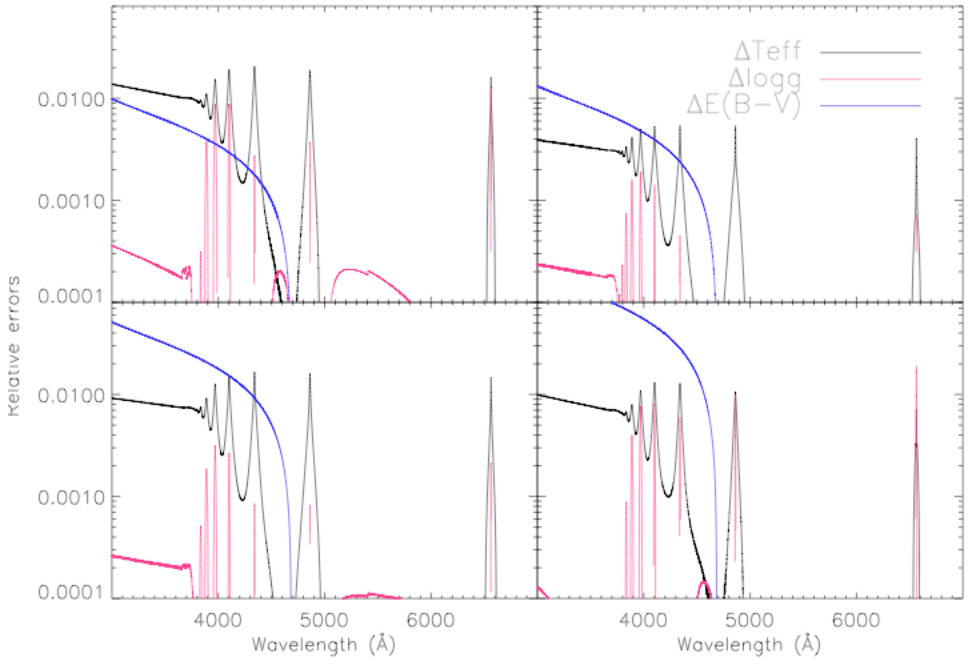
$$\delta m \equiv m - \mathrm{m} = -2.5 \log \left(\frac{R}{d}\right)^2$$

Observed — Computed

Scaling should not depend
Much on wavelength

Error budget

- Models (~1%)
- Uncertainties in inferred parameters (1%- several%)



- Uncertainties in the scaling factors (1% to a few %)

9 new proposed flux standards

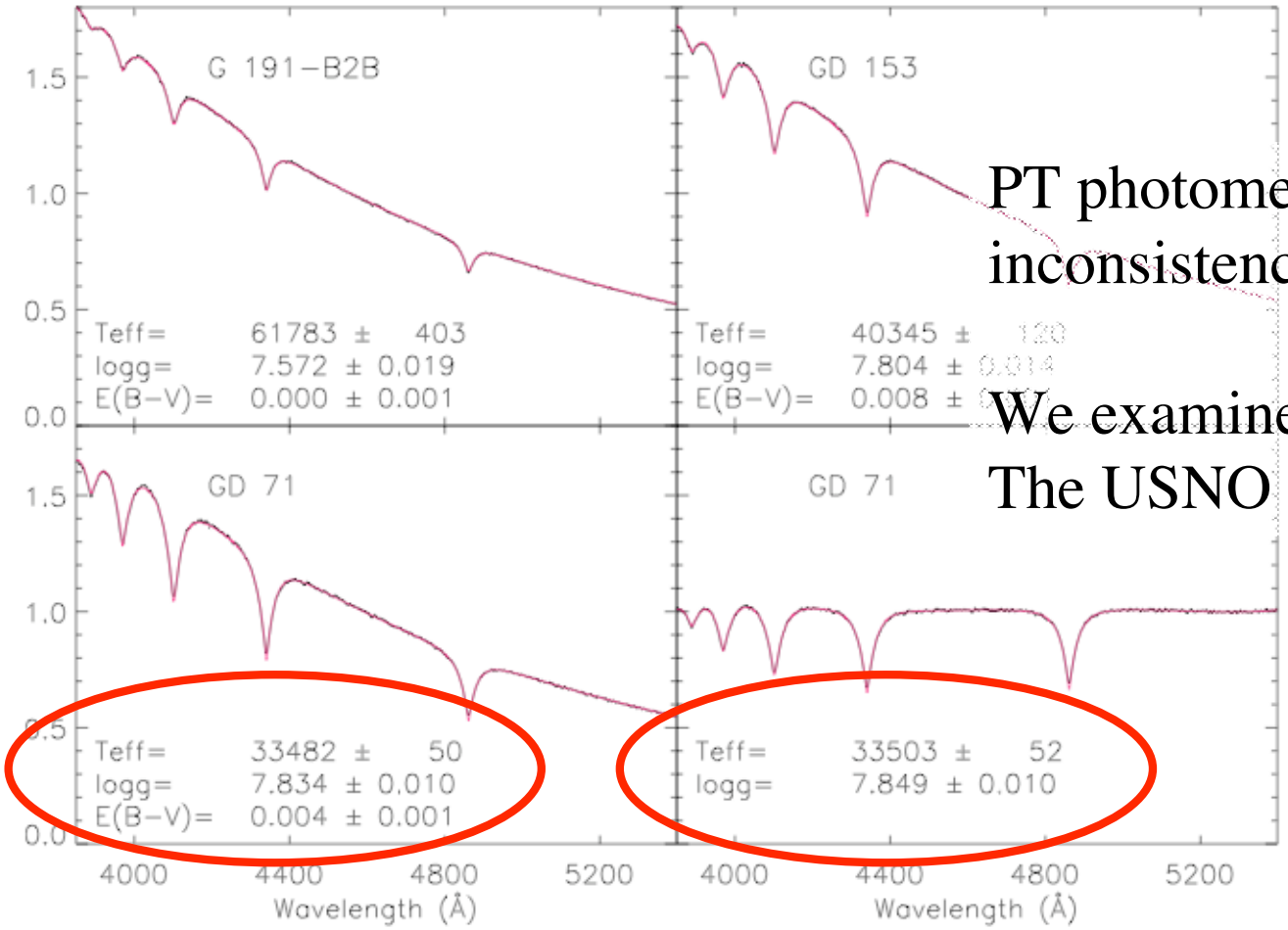
Table 3. Proposed spectrophotometric standards and expected fractional errors in their fluxes.

Name	g	$\sigma_{\lambda=3500}$	$\sigma_{\lambda=4500}$	$\sigma_{\lambda=5500}$	$\sigma_{\lambda=6500}$
SDSS J082346.15+245345.7	15.552	0.016	0.011	0.013	0.018
SDSS J094203.19+544630.2	16.934	0.015	0.010	0.010	0.010
SDSS J095230.44+114202.3	16.472	0.028	0.026	0.026	0.027
SDSS J132434.39+072525.3	16.581	0.016	0.015	0.015	0.016
SDSS J143315.92+252853.1	16.772	0.020	0.015	0.016	0.020
SDSS J145415.84+551152.3	15.813	0.014	0.011	0.011	0.011
SDSS J145600.81+574150.8	16.191	0.012	0.010	0.010	0.010
SDSS J151421.26+004752.8	15.687	0.013	0.010	0.012	0.014
SDSS J212412.14+110415.7	16.792	0.020	0.014	0.016	0.020

<3% estimated errors

Fluxes provided at
http://hebe.as.utexas.edu/std/

A sanity check, the HST standards

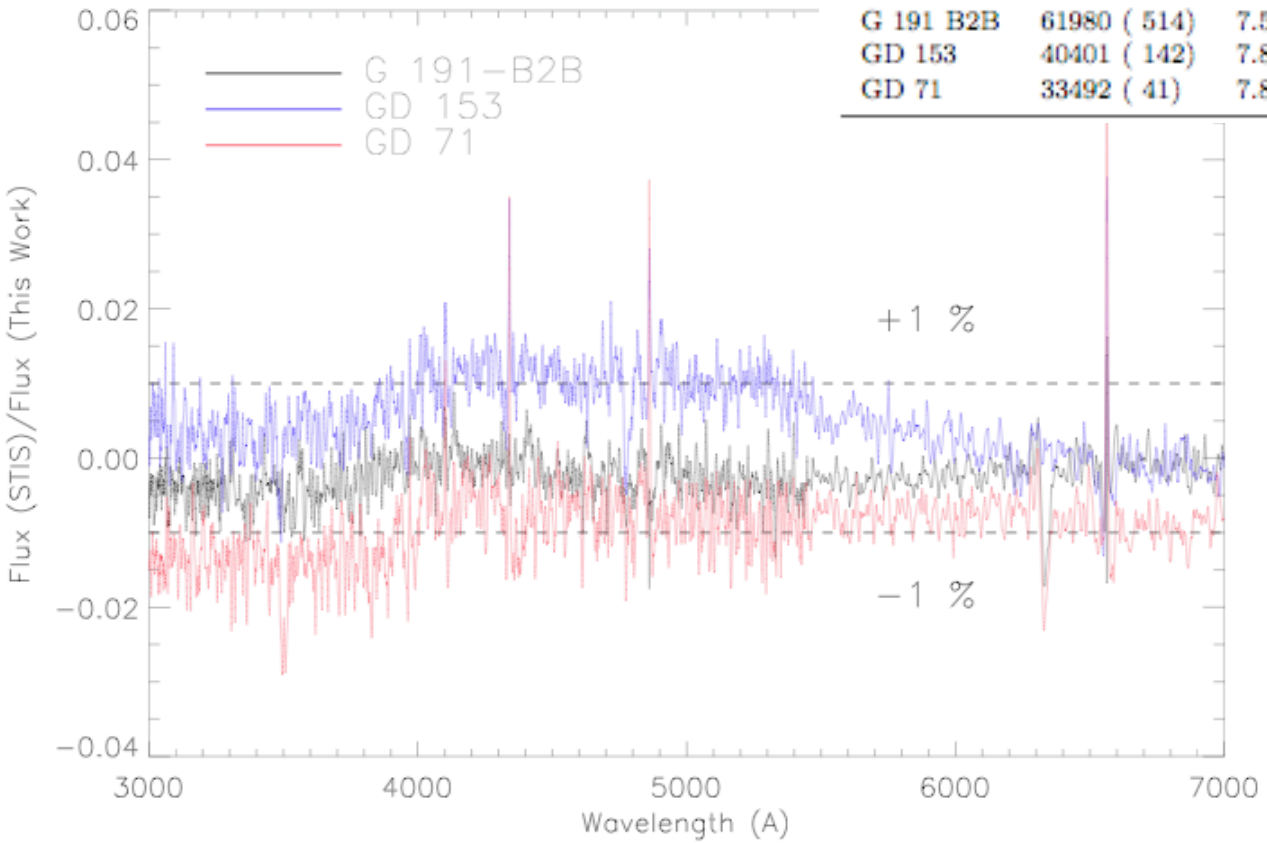


PT photometry indicated some inconsistencies.

We examined newer data from The USNO 1.0-m

Satisfactorily passed

Name	$T_{\rm eff}$ (K)	log g (dex)	E(B-V) (mag)
G 191 B2B	61980 (514)	7.555 (0.042)	0.000 (0.001)
GD 153	40401 (142)	7.812 (0.018)	0.008 (0.001)
GD 71	33492 (41)	7.841 (0.017)	0.004 (0.001)



Conclusions

- Concept works well, one can spectroscopically analyze and identify potential new DA standards increase sky density, going deeper
- A disappointingly large fraction of stars in the right (u-g,g-r) range did not make the quality cut (500s, 50s, and then 9)
- Application of the same procedure to the HST standards confirms their pedigree (and further validates the method, remember Vega!)
- G191 B2B is not a pure DA and that can no longer be ignored