Next Generation IR Standard Stars
Perfect Black Body Stars in the Sky

- Report on Intensive Program 2005-6 by Doi et al.

  a) Morokuma et al. 2010 (PASJ, 62, 19)

  b) Suzuki et al. 2012 (ApJ, 746, 85)

- Re-Calibration of SDF/SXDF Zeropoints

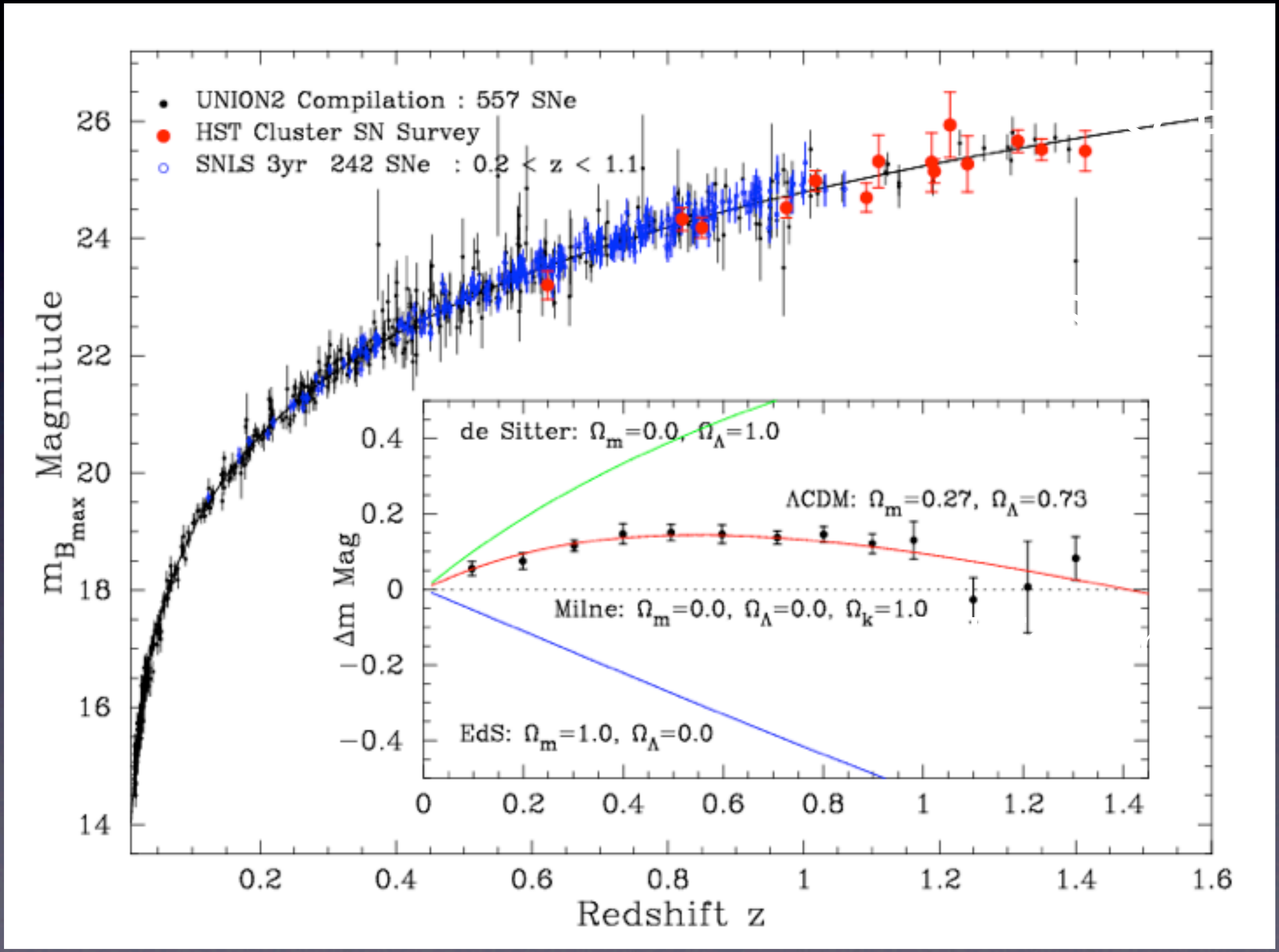
  c) Yagi et al. 2013 (PASJ, 65, 22)

- Next Generation IR Standard Stars

  Need for IR Standards

Nao Suzuki (LBNL=>Kavli IPMU)

SN Factory, Palomar Transient Factory (PTF), SuperNovaLegacySurvery (SNLS), Suprnova Cosmology Project (SCP)



HST Cluster Supernova Survey

1.Keck AO Photometry of z=1.3 SNIa (Melbourne et al. 2007)
2. IRAC Shallow Survey (Eisenhardt et al. 2008)
3. Color Magnitude at z=1 Cluster (Santos et al. 2009)
4. XMMXCS J2215.9-1738 at z-1.457 (Hilton et al. 2007)
5. Unusual Transient, SCP05-F006 (Barbary et al. 2009)
6. Multiply Imaged Lensed System (Huang et al. 2009)
7. X-ray from IRAC z=1.4 Cluster (Brodwin et al. 2011)
8. Weak Lensing Studies + Scaling Relation (Jee et al. 2011)

XMMU J2235-2557 z=1.4

9. Weak Lensing Study (Jee et al. 2009)
10. Multi-Wavelength Study (Rosati et al. 2009)
11. Galaxies Properties (Strazzullo et al. 2011)

HST Cluster SN Survey

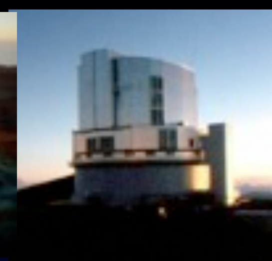
Nao Suzuki & SCP
PI: Saul Perlmutter

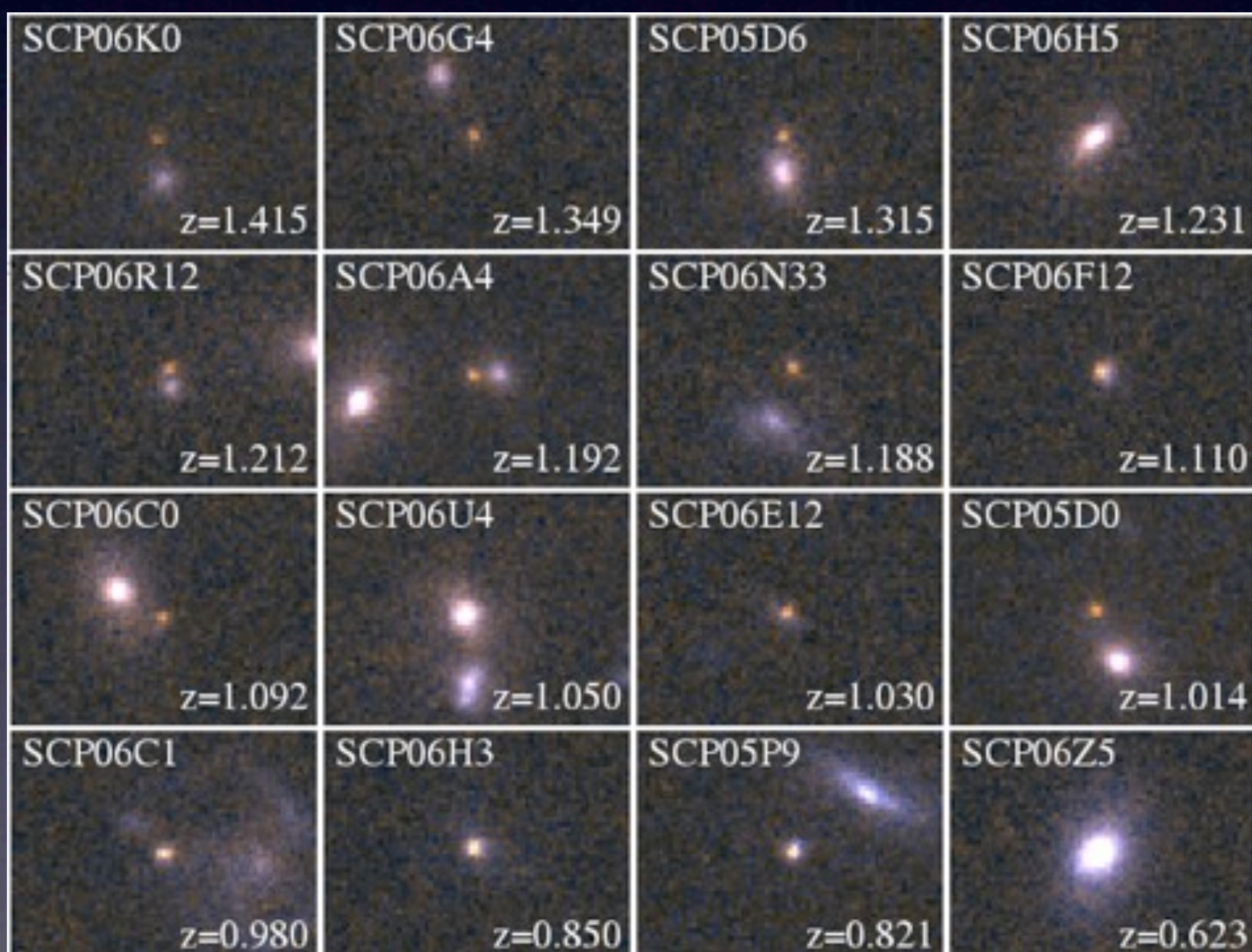
HST

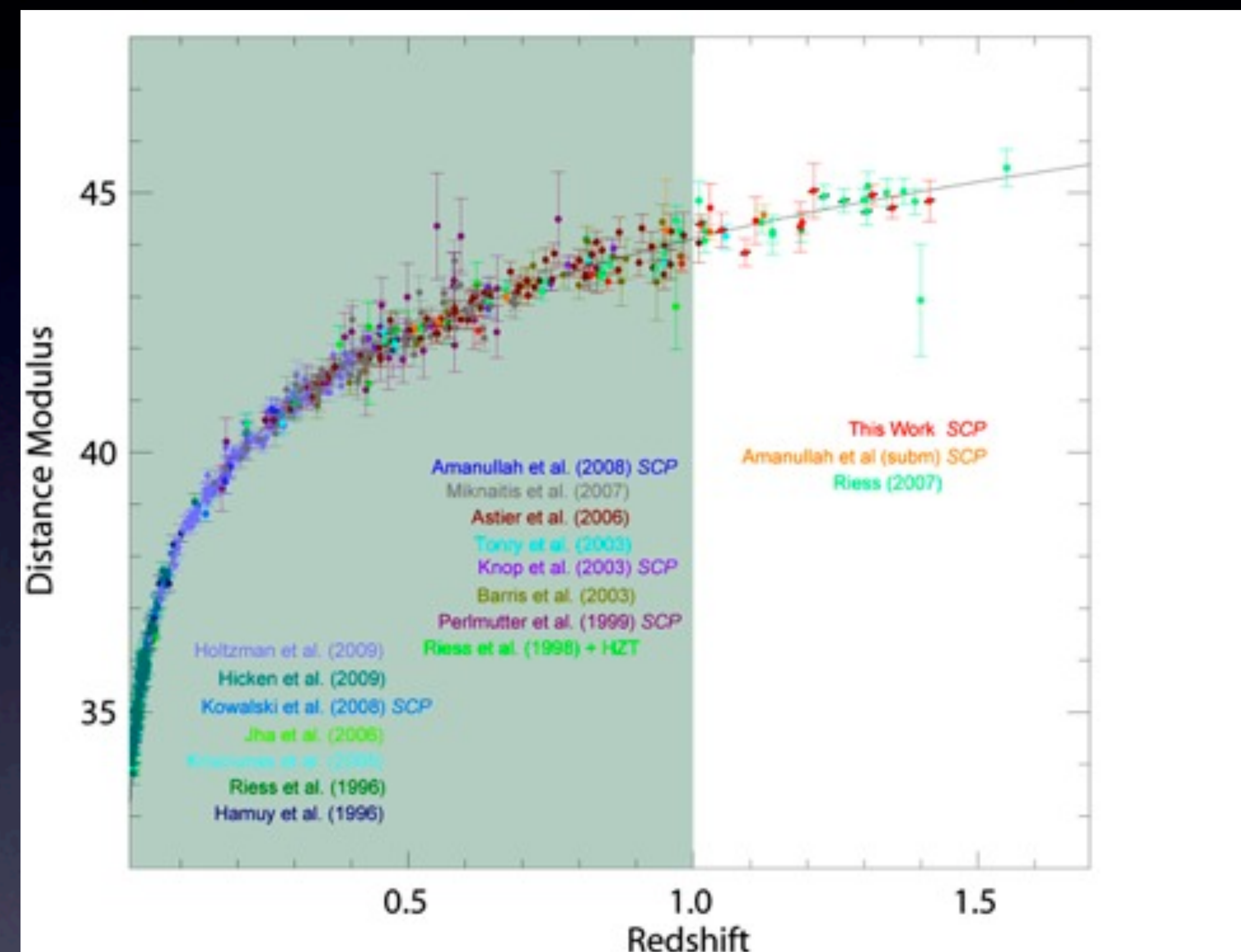
Keck

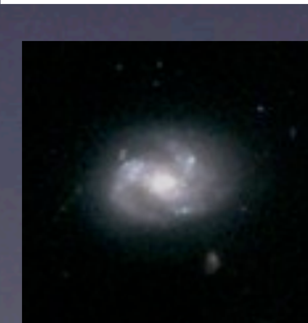
VLT

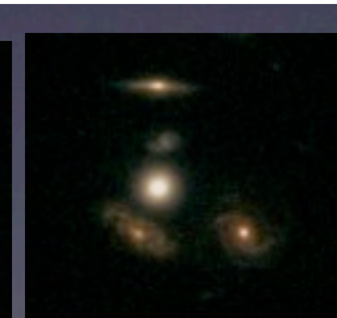
Subaru

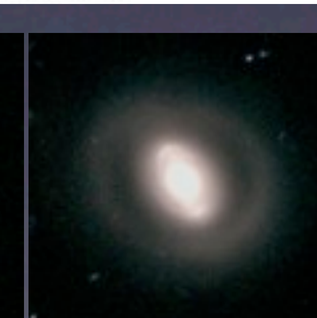


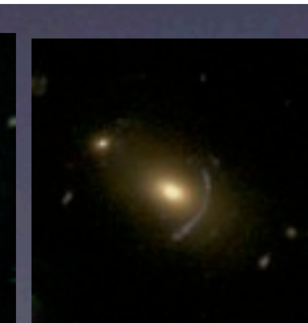












Unusual Transient SCP06-F6

Barbary et al. 2009 z=1.2 Superlumious Superova by Quimby

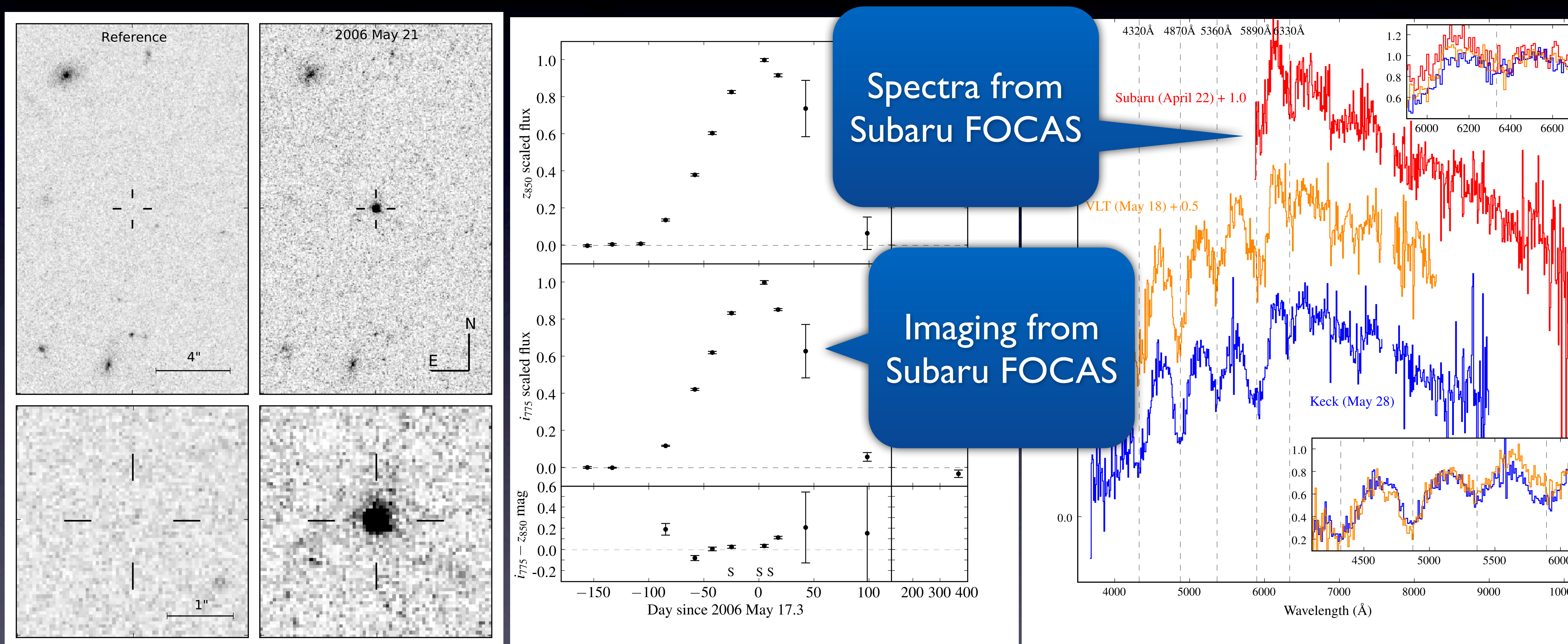
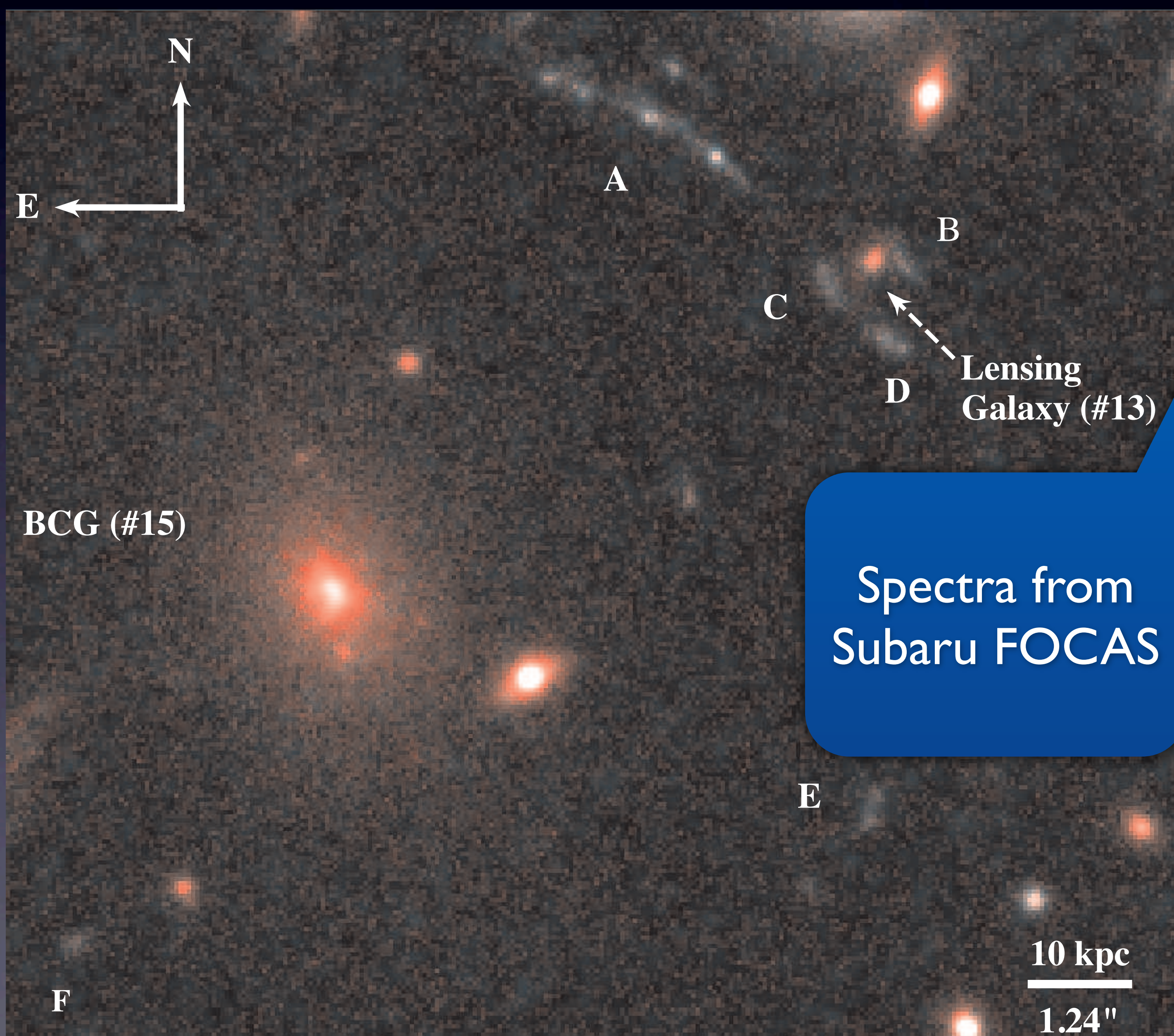


Image   Light Curve   Spectra

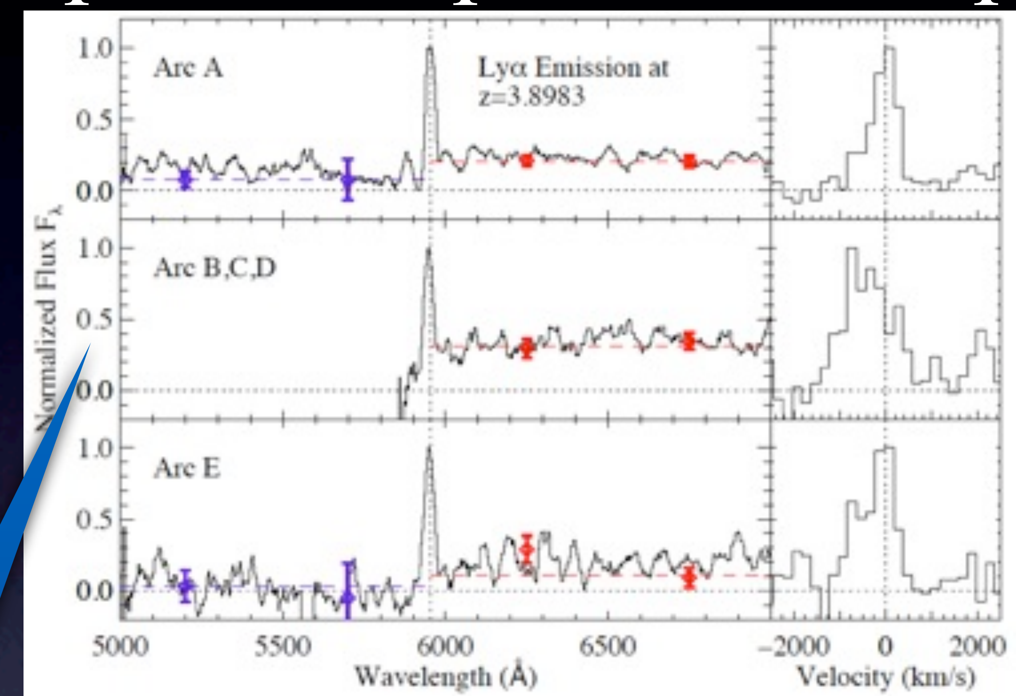
A z=3.9 Galaxy Lensed Twice

Xiaosheng Huang et al. 2011

WARPS J1415.1+3612 : z=1.026

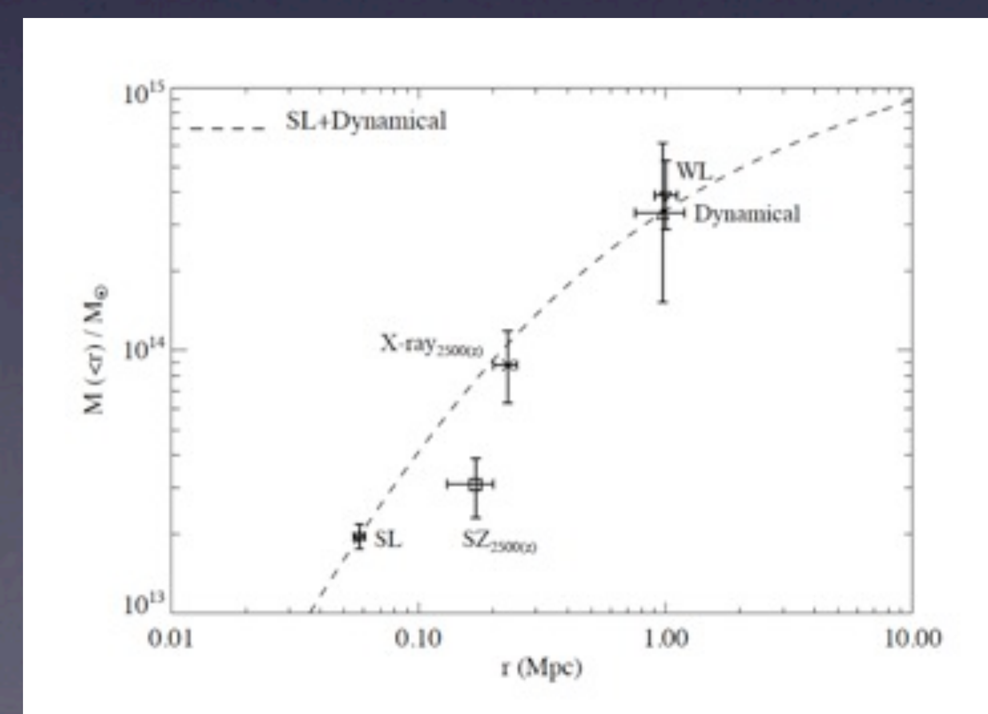


Spectroscopic Follow-up



Spectra from Subaru FOCAS

Cluster Mass Profile : NFW



The Astrophysical Journal, 745:1 (24pp), 2012 ??? doi:10.1088/0004-637X/745/1/1

THE *HUBBLE SPACE TELESCOPE* CLUSTER SUPERNOVA SURVEY. V. IMPROVING THE DARK-ENERGY CONSTRAINTS ABOVE $z > 1$ AND BUILDING AN EARLY-TYPE-HOSTED SUPERNOVA SAMPLE*

N. Suzuki[1,2], D. Rubin[1,2], C. Lidman[3], G. Aldering[1], R. Amanullah[2,4], K. Barbary[1,2], L. F. Barrientos[5], J. Botyanszki[2], M. Brodwin[6,41], N. Connolly[7], K. S. Dawson[8], A. Dey[9], M. Doi[10], M. Donahue[11], S. Deustua[12], P. Eisenhardt[13], E. Ellingson[14], L. Faccioli[1,2], V. Fadeyev[15], H. K. Fakhouri[1,2], A. S. Fruchter[12], D. G. Gilbank[16], M. D. Gladders[17], G. Goldhaber[1,2,42], A. H. Gonzalez[18], A. Goobar[4,19], A. Gude[2,20], T. Hattori[21], H. Hoekstra[22], E. Hsiao[1,2], X. Huang[1,2], Y. Ihara[10,43], M. J. Jee[23], D. Johnston[11,24], N. Kashikawa[25], B. Koester[17,26], K. Konishi[27], M. Kowalski[28], E. V. Linder[1,2], L. Lubin[23], J. Melbourne[29], J. Meyers[1,2], T. Morokuma[10,25,43], F. Munshi[2,30], C. Mullis[31], T. Oda[32], N. Panagia[12], S. Perlmutter[1,2], M. Postman[12], T. Pritchard[illegible], J. Rhodes[13,29], P. Ripoche[1,2], P. Rosati[34], D. J. Schlegel[1], A. Spadafora[1], S. A. Stanford[23,35], V. Stanishev[19,36], D. Stern[13], M. Strovink[1,2], N. Takanashi[25], K. Tokita[10], M. Wagner[37], L. Wang[38], N. Yasuda[39], and H. K. C. Yee[40]

(The Supernova Cosmology Project)

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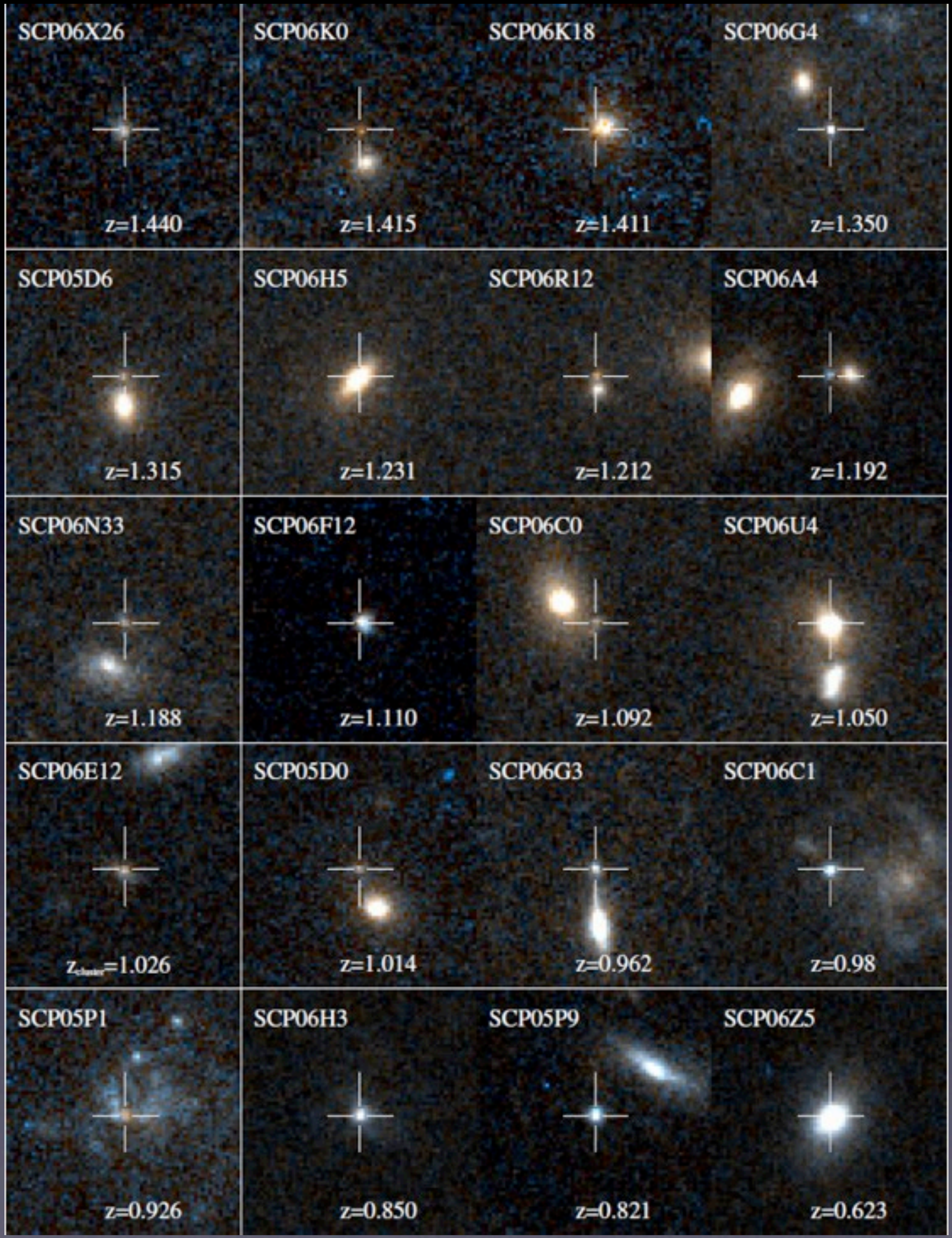
Received 2011 February 15; accepted 2011 July 6; published 2012 ???

ABSTRACT

We present Advanced Camera for Surveys, NICMOS, and Keck adaptive-optics-assisted photometry of 20 Type Ia supernovae (SNe Ia) from the *Hubble Space Telescope* (*HST*) Cluster Supernova Survey. The SNe Ia were discovered over the redshift interval $0.623 < z < 1.415$. Of these SNe Ia, 14 pass our strict selection cuts and are used in combination with the world's sample of SNe Ia to derive the best current constraints on dark energy. Of our new SNe Ia, 10 are beyond redshift $z = 1$, thereby nearly doubling the statistical weight of *HST*-discovered SNe Ia beyond this redshift. Our detailed analysis corrects for the recently identified correlation between SN Ia luminosity and host galaxy mass and corrects the NICMOS zero point at the count rates appropriate for very distant SNe Ia. Adding these SNe improves the best combined constraint on dark-energy density, $\rho_{DE}(z)$, at redshifts $1.0 < z < 1.6$ by 18% (including systematic errors). For a flat ΛCDM universe, we find $\Omega_\Lambda = 0.729 \pm 0.014$ (68% confidence level (CL) including systematic errors). For a flat *w*CDM model, we measure a constant dark-energy equation-of-state parameter $w = -1.013^{+0.068}_{-0.073}$ (68% CL). Curvature is constrained to ∼0.7% in the *ow*CDM model and to ∼2% in a

ACS Image Reduction v125



Λ Today

Combination of SNe with:

BAO (Percival et. al., 2010)

CMB (WMAP data, 2011)

For a flat Universe:

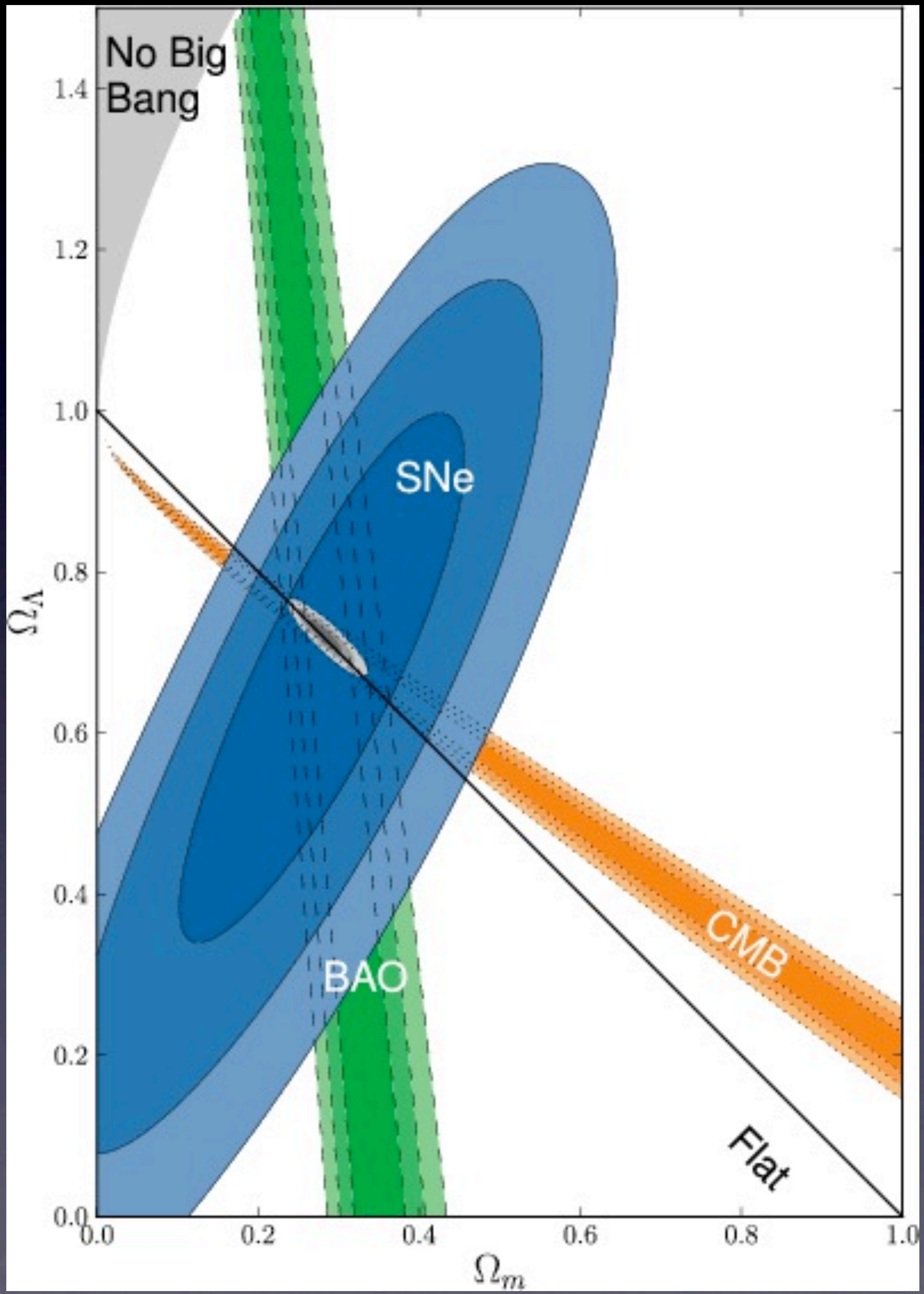
LCDM:

$\Omega_m = 0.271 \pm 0.012(\text{stat}) \pm 0.014(\text{sys})$

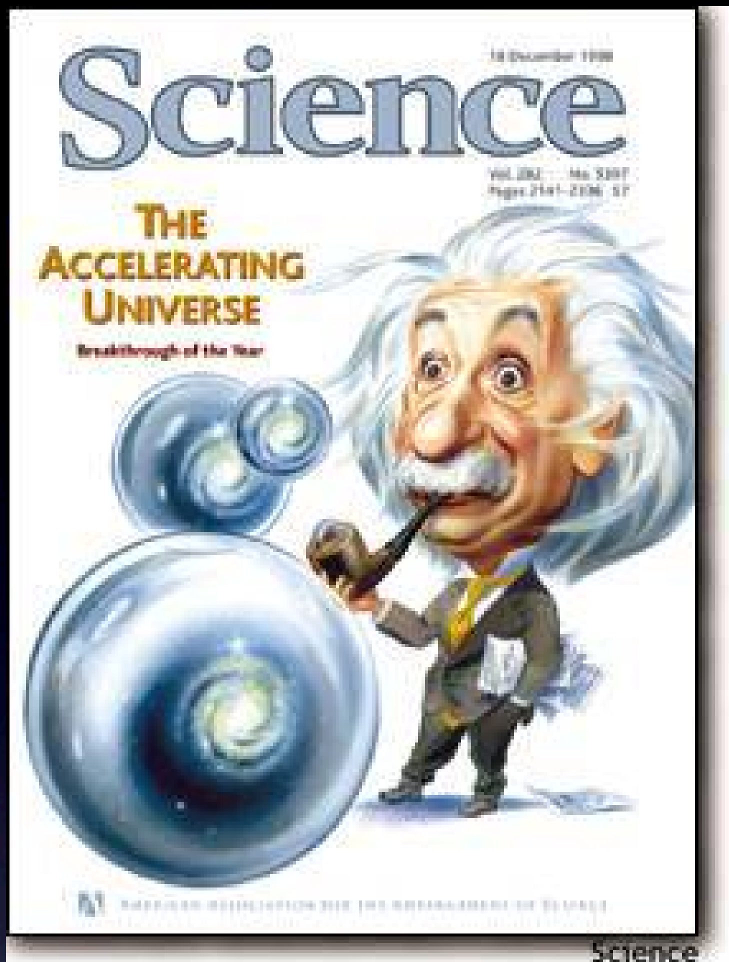
with curvature:

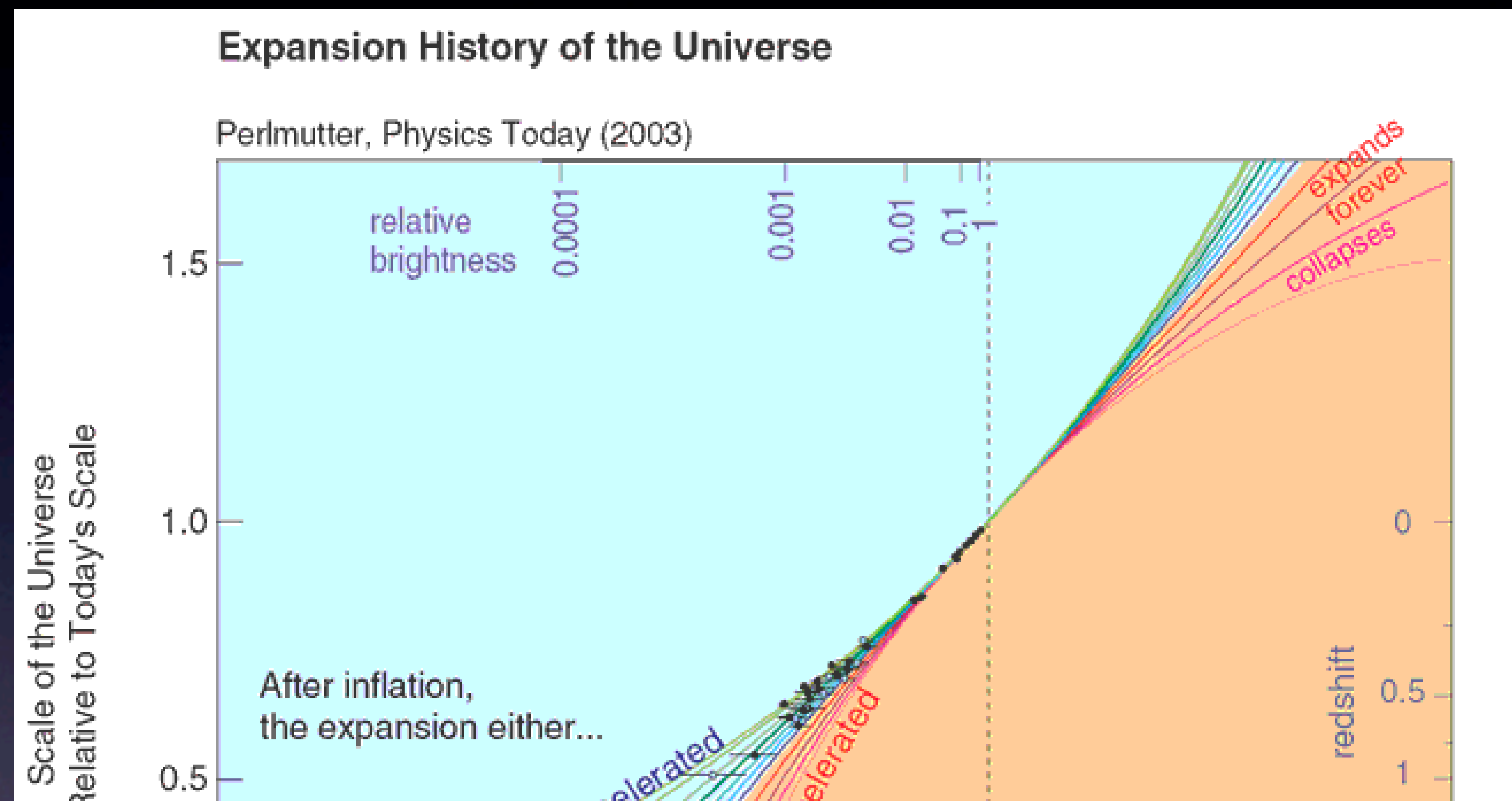
oLCDM:

$\Omega_k = 0.002 \pm 0.005(\text{stat}) \pm 0.005(\text{sys})$



Accelerating Universe





w=P/ρ : equation of state
Q. Is *w* -1?

*w*CDM:

w = −1.008 ± 0.052(stat)

−1.013 ± 0.070(sys)

SNe + BAO + CMB

.. and allowing for curvature: owCDM

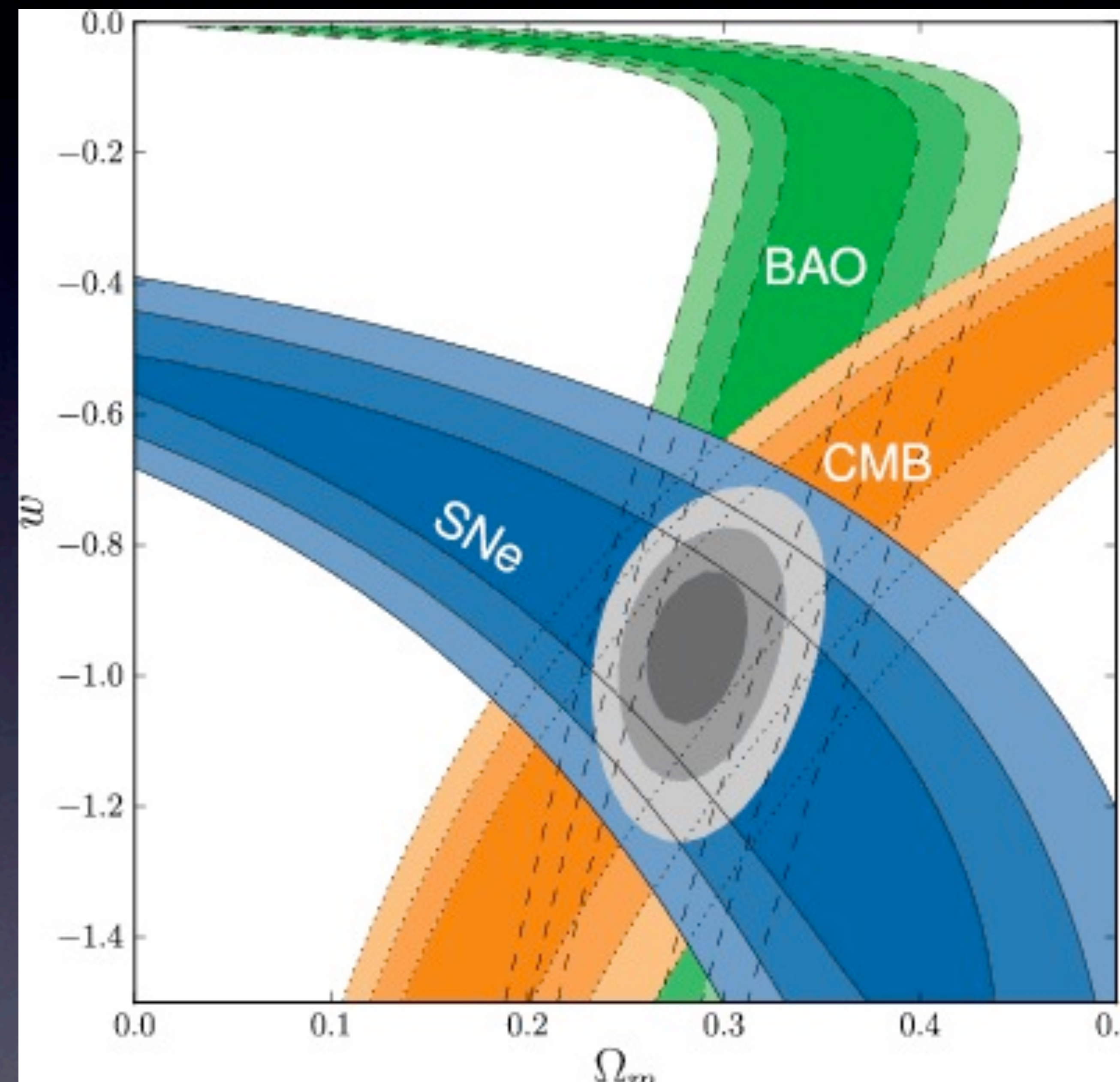
w = −1.006 ± 0.058(stat)

−1.003 ± 0.093(sys)

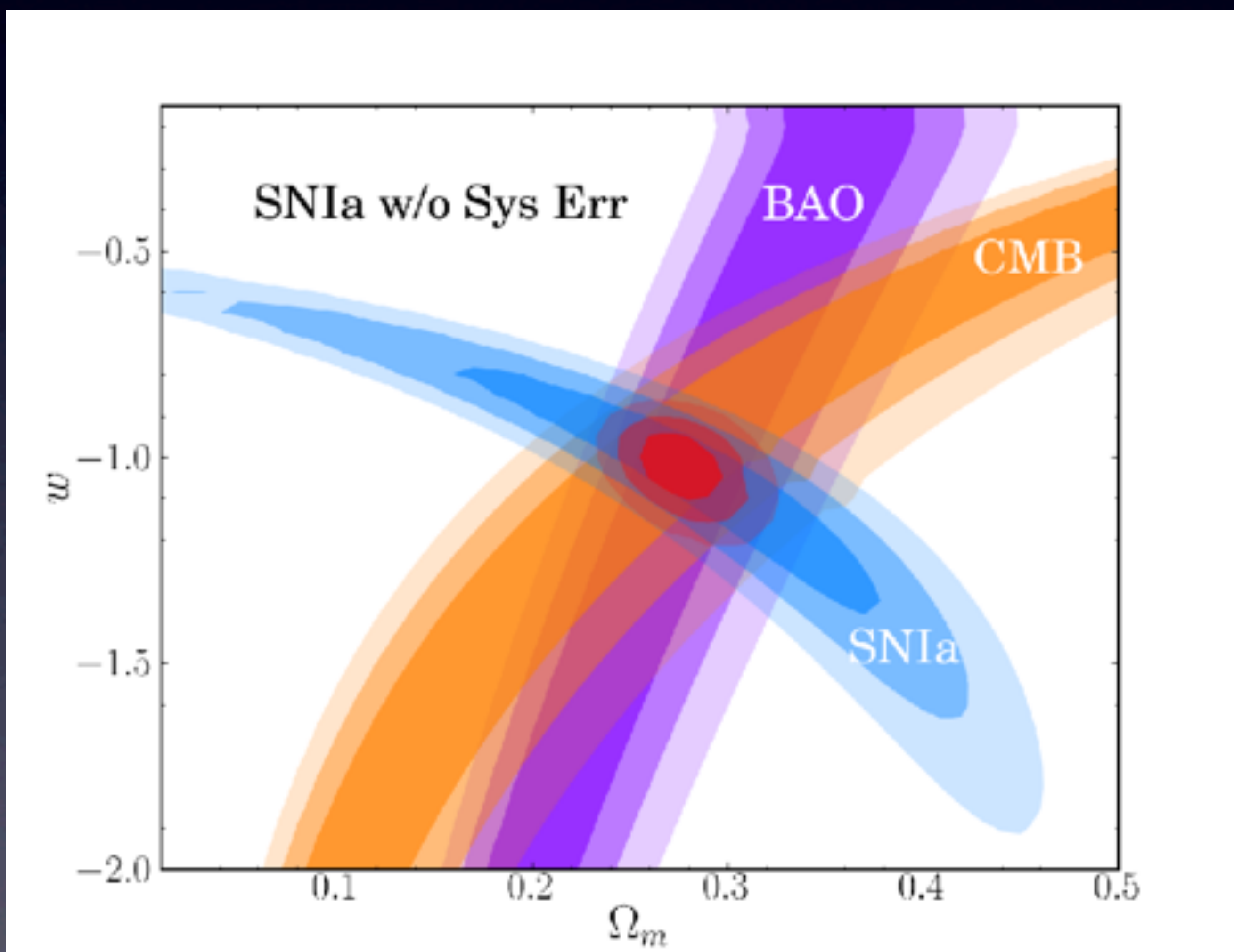
with systematics

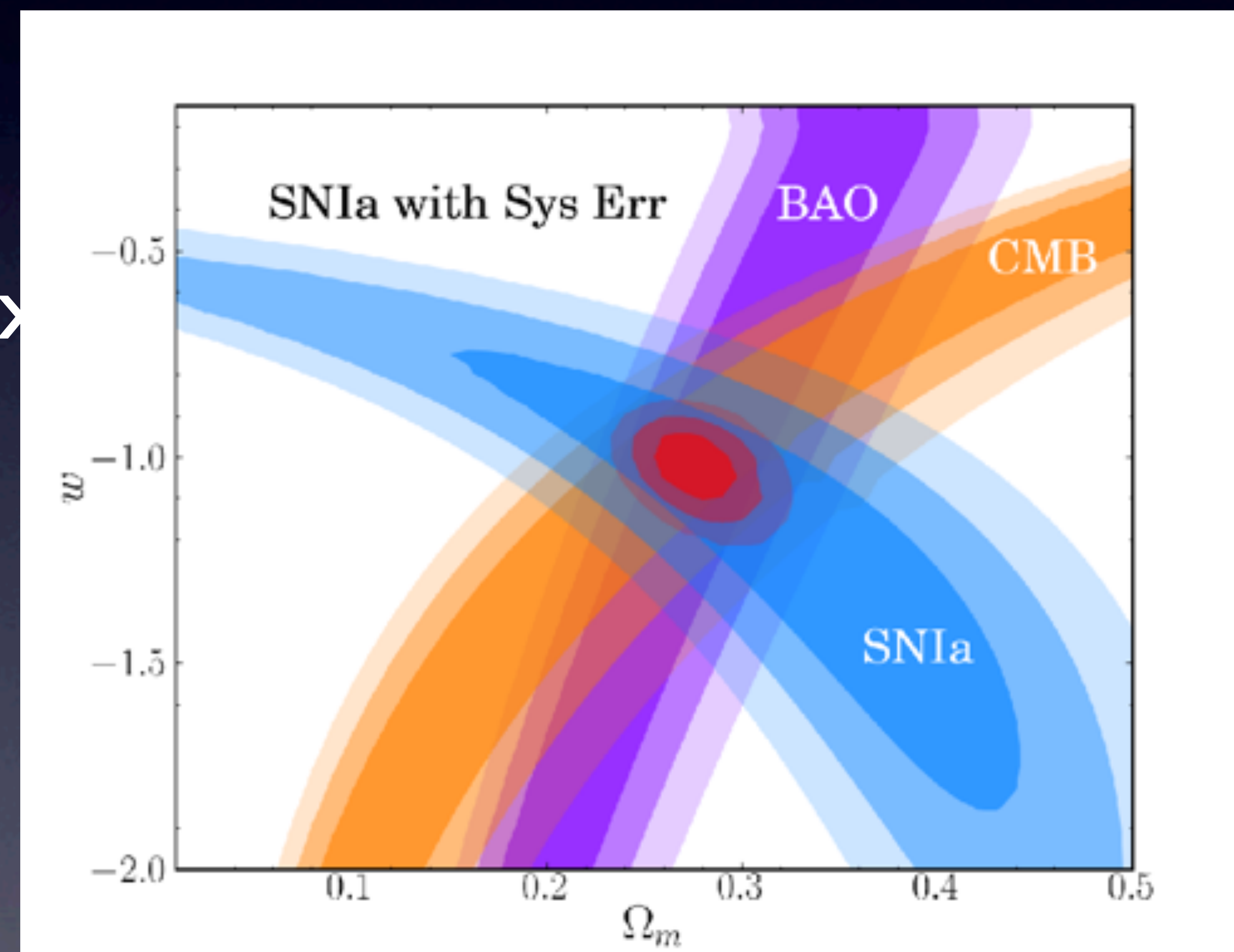
- w=-1 : cosmological constant
- w=0 : matter
- w=1/3: radiation

$$E \propto a^{-3(1+w)}$$



Systematic Error Limits the Precision Cosmology Today
Stat Err ~ 5%, Systematic Err ~ 5%





Suzuki et al 2012 (Supernova Cosmology Project)

PASJ: Publ. Astron. Soc. Japan **65**, 22, 2013 April 25

Re-Calibration of SDF/SXDS Photometric Catalogs of Suprime-Cam with SDSS Data Release 8

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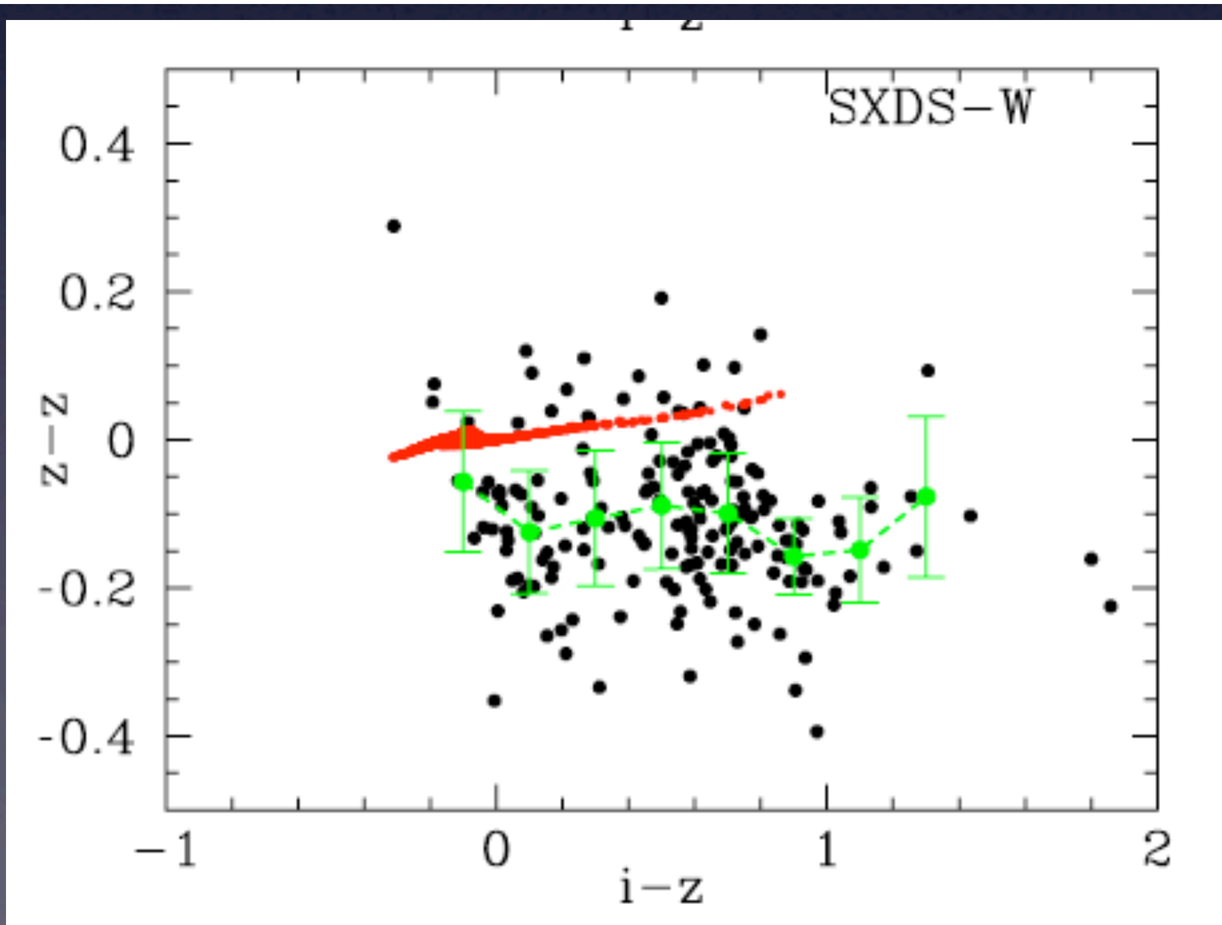
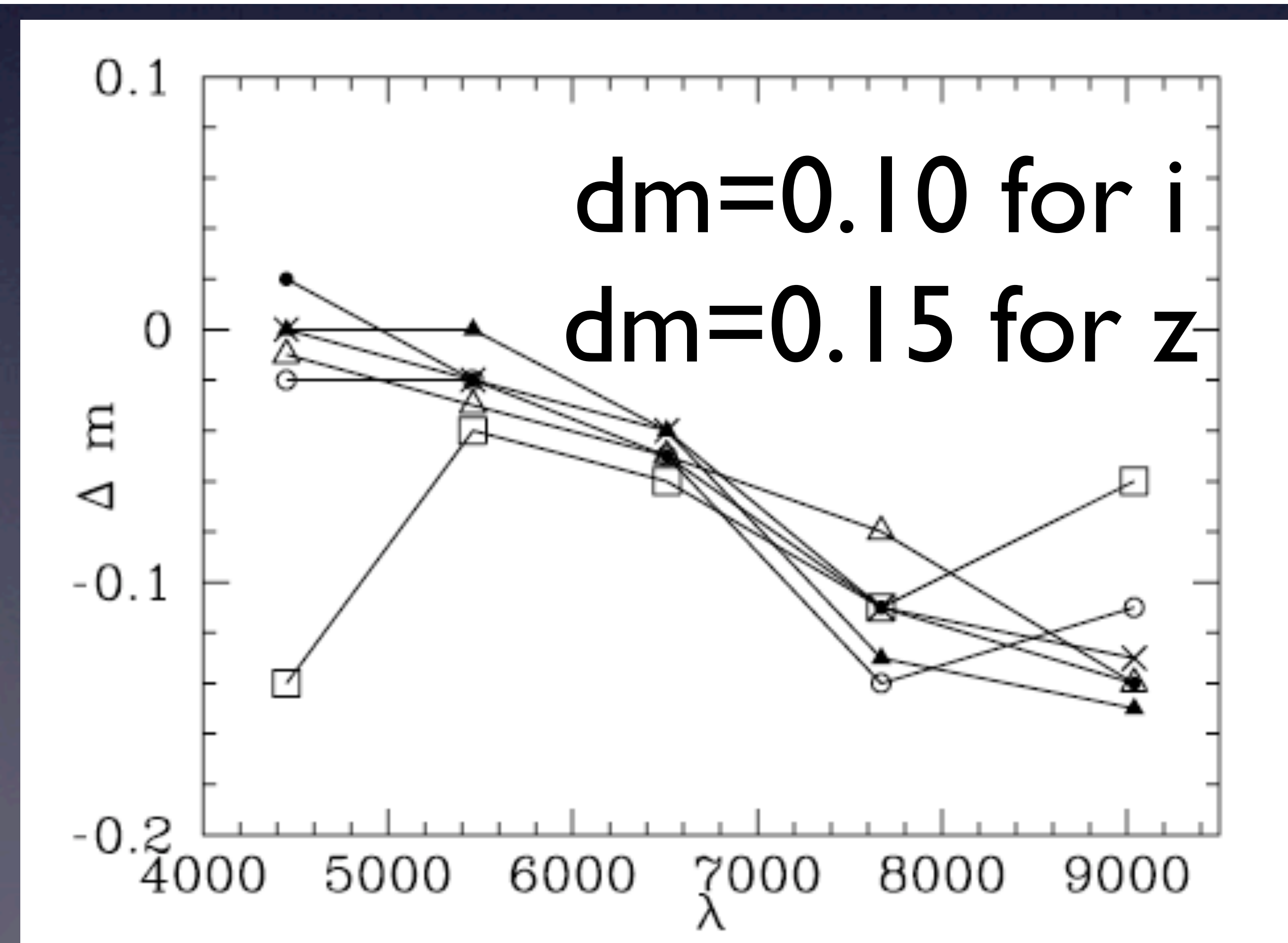
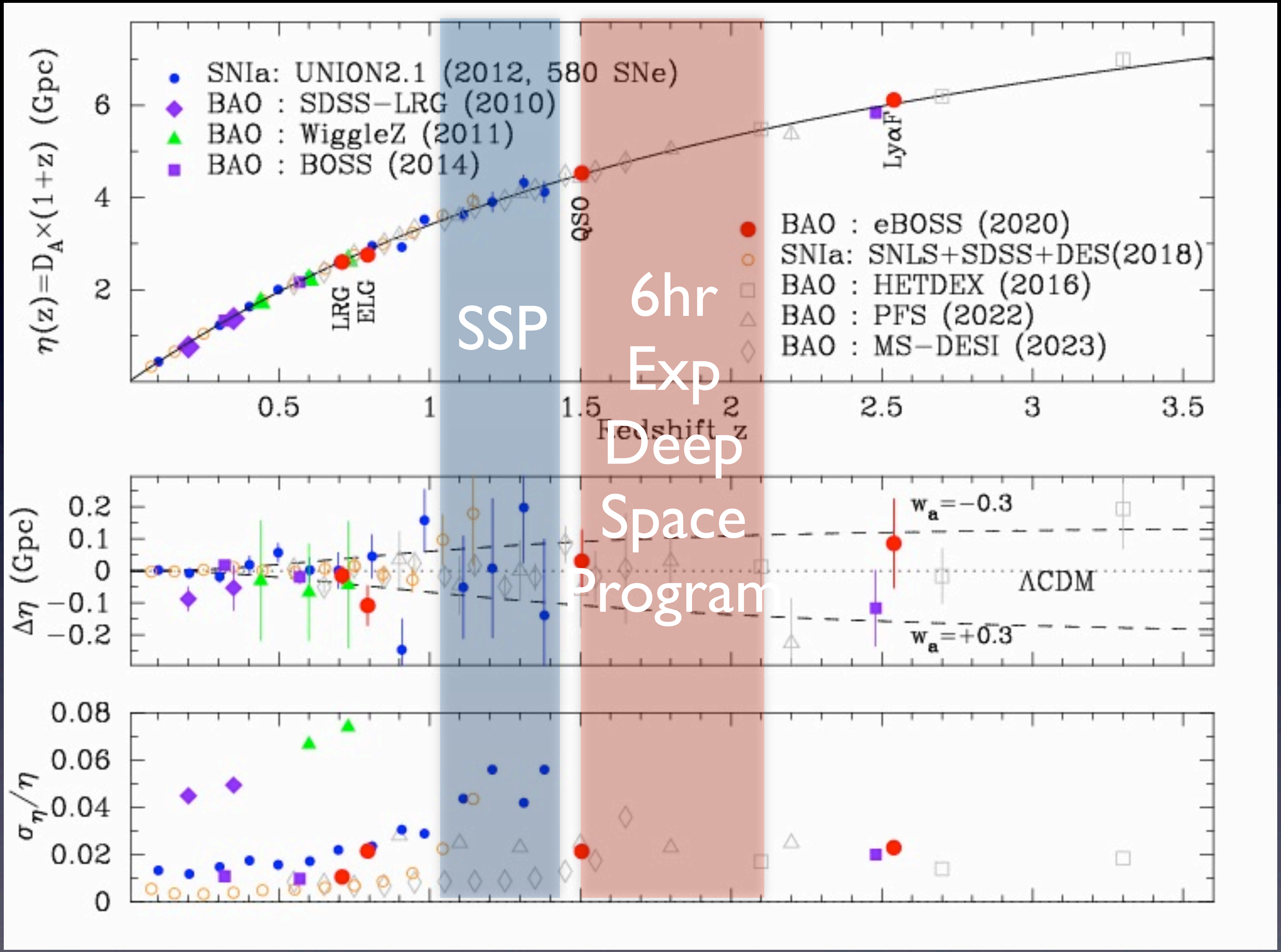




Cosmology in 10 years



None of standard stars from SNF will be used for HSC and others

- They are too bright (HSC/LSST saturates at 17-18th mag)
- No accurate IR coverage

THE ASTRONOMICAL JOURNAL, 116:2475–2488, 1998 November

A NEW SYSTEM OF FAINT NEAR-INFRARED STANDARD STARS

S. E. PERSSON,[1] D. C. MURPHY,[1] W. KRZEMINSKI,[1] M. ROTH,[1] AND M. J. RIEKE[2]
Received 1998 June 3; revised 1998 July 28

ABSTRACT

A new grid of 65 faint near-infrared standard stars is presented. They are spread around the sky, lie between 10th and 12th magnitude at *K*, and are measured in most cases to precisions better than 0.001 mag in the *J*, *H*, *K*, and K_s bands; the latter is a medium-band modified *K*. A secondary list of red stars suitable for determining color transformations between photometric systems is also presented.
Key words: infrared radiation — stars: general — techniques: photometric

TABLE 2

INFRARED STANDARD STARS

No.	*HST*	R.A. (J2000.0)	Decl. (J2000.0)	*J*	σ_m	*N*	*H*	σ_m	*N*	*K*	σ_m	*N*	K_s	σ_m	*N*	Note
9101	P525-E	00 24 28.3	07 49 02	11.622	0.005	16	11.298	0.005	16	11.223	0.008	10	11.223	0.005	17	4
9103	S294-D	00 33 15.2	−39 24 10	10.932	0.006	15	10.657	0.004	16	10.596	0.005	9	10.594	0.004	16	1
9104	S754-C	01 03 15.8	−04 20 44	11.045	0.005	17	10.750	0.005	17	10.693	0.010	8	10.695	0.005	17	2
9105	P530-D	02 33 32.1	06 25 38	11.309	0.010	8	10.975	0.006	8	10.897	0.006	7	10.910	0.005	8	1
9106	S301-D	03 26 53.9	−39 50 38	12.153	0.007	11	11.842	0.005	11	11.772	0.010	6	11.788	0.006	11	1
9107	P247-U	03 32 03.0	37 20 40	11.934	0.005	16	11.610	0.004	18	11.492	0.011	6	11.503	0.005	18	3
9108	P533-D	03 41 02.4	06 56 13	11.737	0.009	9	11.431	0.006	9	11.337	0.008	8	11.336	0.005	9	1

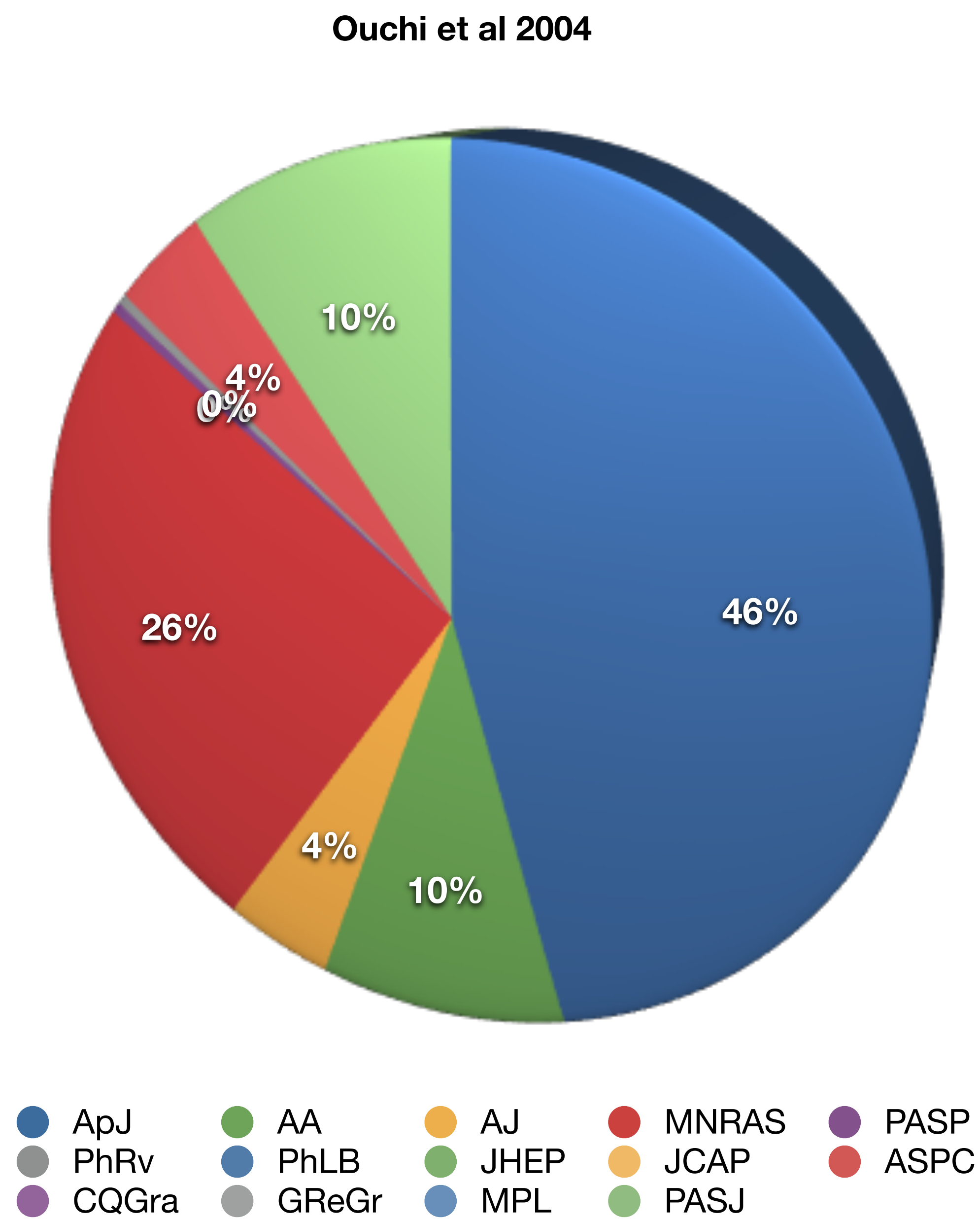
Top 10 Subaru Papers

#	Bibcode Authors	Cites Title	Date	List of Links Access Control Help	
1	2010ApJ...716..712A Amanullah, R.; Lidman, C.; Rubin, D.; Aldering, G.; Astier, P.; Barbary, K.; Burns, M. S.; Conley, A.; Dawson, K. S.; Deustua, S. E.; and 36 coauthors	652.000 Spectra and Hubble Space Telescope Light Curves of Six Type Ia Supernovae at $0.511 < z < 1.12$ and the Union2 Compilation	06/2010	A E F X D R C S N U	SNIa : Dark Energy
2	2007ApJS..172....1S Scoville, N.; Aussel, H.; Brusa, M.; Capak, P.; Carollo, C. M.; Elvis, M.; Giavalisco, M.; Guzzo, L.; Hasinger, G.; Impey, C.; and 12 coauthors	535.000 The Cosmic Evolution Survey (COSMOS): Overview	09/2007	A E F X D R C S U	COSMOS
3	2007ApJ...654..897B Belokurov, V.; Zucker, D. B.; Evans, N. W.; Kleyna, J. T.; Koposov, S.; Hodgkin, S. T.; Irwin, M. J.; Gilmore, G.; Wilkinson, M. I.; Fellhauer, M.; and 24 coauthors	415.000 Cats and Dogs, Hair and a Hero: A Quintet of New Milky Way Companions	01/2007	A E F X R C S N U	
4	2009ApJ...690.1236I Ilbert, O.; Capak, P.; Salvato, M.; Aussel, H.; McCracken, H. J.; Sanders, D. B.; Scoville, N.; Kartaltepe, J.; Arnouts, S.; Le Floc'h, E.; and 53 coauthors	411.000 Cosmos Photometric Redshifts with 30-Bands for 2-deg2	01/2009	A E F X D R C S U	COSMOS
5	2002PASJ...54..833M Miyazaki, Satoshi; Komiyama, Yutaka; Sekiguchi, Maki; Okamura, Sadanori; Doi, Mamoru; Furusawa, Hisanori; Hamabe, Masaru; Imi, Katsumi; Kimura, Masahiko; Nakata, Fumiaki; and 5 coauthors	398.000 Subaru Prime Focus Camera -- Suprime-Cam	12/2002	A E F X R C U	SuprieCam
6	2007ApJS..172...70L Lilly, S. J.; Le Fèvre, O.; Renzini, A.; Zamorani, G.; Scodeggio, M.; Contini, T.; Carollo, C. M.; Hasinger, G.; Kneib, J.-P.; Iovino, A.; and 67 coauthors	368.000 zCOSMOS: A Large VLT/VIMOS Redshift Survey Covering $0 < z < 3$ in the COSMOS Field	09/2007	A E F X D R C S N O U	COSMOS
7	2005Natur.434..871F Frebel, Anna; Aoki, Wako; Christlieb, Norbert; Ando, Hiroyasu; Asplund, Martin; Barklem, Paul S.; Beers, Timothy C.; Eriksson, Kjell; Fechner, Cora; Fujimoto, Masayuki Y.; and 9 coauthors	313.000 Nucleosynthetic signatures of the first stars	04/2005	A E X R C S U	HDS : Metal Poor Star
8	2007ApJS..172...99C Capak, P.; Aussel, H.; Ajiki, M.; McCracken, H. J.; Mobasher, B.; Scoville, N.; Shopbell, P.; Taniguchi, Y.; Thompson, D.; Tribiano, S.; and 48 coauthors	310.000 The First Release COSMOS Optical and Near-IR Data and Catalog	09/2007	A E F X D R C S N O U	COSMOS
9	2002ApJ...568L..75H Hu, E. M.; Cowie, L. L.; McMahon, R. G.; Capak, P.; Iwamuro, F.; Kneib, J.-P.; Maihara, T.; Motohara, K.	283.000 A Redshift z=6.56 Galaxy behind the Cluster Abell 370	04/2002	A E F X D R C S N O U H	
10	2004ApJ...611..660O Ouchi, Masami; Shimasaku, Kazuhiro; Okamura, Sadanori; Furusawa, Hisanori; Kashikawa, Nobunari; Ota, Kazuaki; Doi, Mamoru; Hamabe, Masaru; Kimura, Masahiko; Komiyama, Yutaka; and 6 coauthors	280.000 Subaru Deep Survey. V. A Census of Lyman Break Galaxies at z~=4 and 5 in the Subaru Deep Fields: Photometric Properties	08/2004	A E F X R C S N O U H	SDF

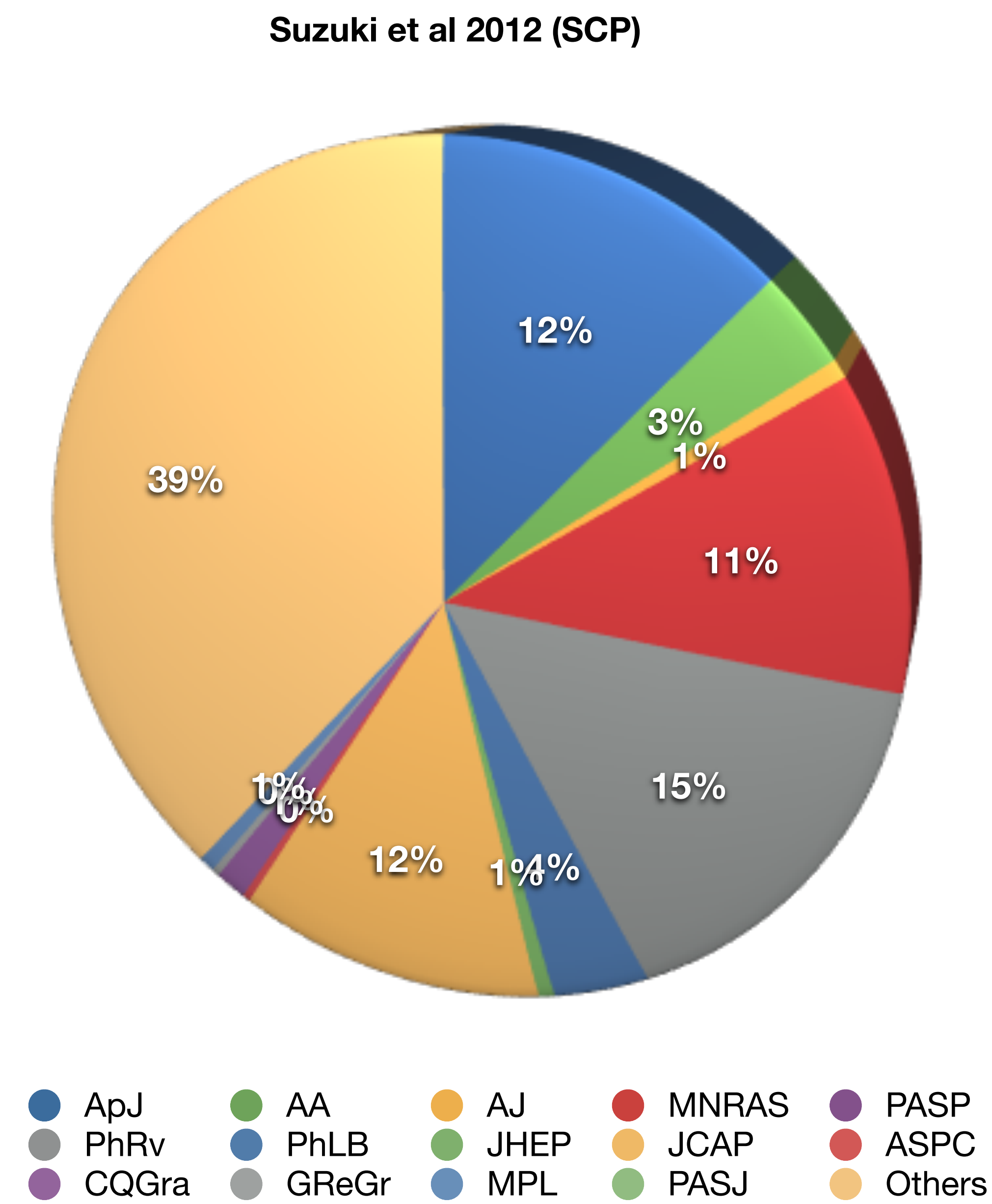
Top 10 Astro Papers in 2012 (ApJ, AA, Nature etc)

#	Bibcode Authors	Cites Title	Date	List of Links Access Control Help	
1	2012ApJS..199...31N Nolan, P. L.; Abdo, A. A.; Ackermann, M.; Ajello, M.; Allafort, A.; Antolini, E.; Atwood, W. B.; Axelsson, M.; Baldini, L.; Ballet, J.; and 227 coauthors	509.000 Fermi Large Area Telescope Second Source Catalog	04/2012	A E F X D R C S N O U	Fermi
2	2012ApJ...746...85S Suzuki, N.; Rubin, D.; Lidman, C.; Aldering, G.; Amanullah, R.; Barbary, K.; Barrientos, L. F.; Botyanszki, J.; Brodwin, M.; Connolly, N.; and 56 coauthors	316.000 The Hubble Space Telescope Cluster Supernova Survey. V. Improving the Dark-energy Constraints above $z > 1$ and Building an Early-type-hosted S	02/2012	A E F X D R C S N U	HST, Subaru, Keck, VLT
3	2012MNRAS.427.3435A Anderson, Lauren; Aubourg, Eric; Bailey, Stephen; Bizyaev, Dmitry; Blanton, Michael; Bolton, Adam S.; Brinkmann, J.; Brownstein, Joel R.; Burden, Angela; Cuesta, Antonio J.; and 67 coauthors	233.000 The clustering of galaxies in the SDSS-III Baryon Oscillation Spectroscopic Survey: baryon acoustic oscillations in the Data Release 9 spectroscopic	12/2012	A E F X R C S U	SDSS
4	2012ApJS..203...21A Ahn, Christopher P.; Alexandroff, Rachael; Allende Prieto, Carlos; Anderson, Scott F.; Anderton, Timothy; Andrews, Brett H.; Aubourg, Éric; Bailey, Stephen; Balbinot, Eduardo; Barnes, Rory; and 226 coauthors	206.000 The Ninth Data Release of the Sloan Digital Sky Survey: First Spectroscopic Data from the SDSS-III Baryon Oscillation Spectroscopic Survey	12/2012	A E F X D R C O U	SDSS
5	2012JCAP...08..007W Weniger, Christoph	206.000 A tentative gamma-ray line from Dark Matter annihilation at the Fermi Large Area Telescope	08/2012	A E X R C U	Fermi
6	2012ApJS..201...15H Howard, Andrew W.; Marcy, Geoffrey W.; Bryson, Stephen T.; Jenkins, Jon M.; Rowe, Jason F.; Batalha, Natalie M.; Borucki, William J.; Koch, David G.; Dunham, Edward W.; Gautier, Thomas N., III; and 57 coauthors	183.000 Planet Occurrence within 0.25 AU of Solar-type Stars from Kepler	08/2012	A E F X D R C S U	Kepler
7	2012A&A...537A.146E Ekström, S.; Georgy, C.; Eggenberger, P.; Meynet, G.; Mowlavi, N.; Wyttenbach, A.; Granada, A.; Decressin, T.; Hirschi, R.; Frischknecht, U.; and 2 coauthors	175.000 Grids of stellar models with rotation. I. Models from 0.8 to 120 $M_\odot$ at solar metallicity ($Z = 0.014$)	01/2012	A E F X D R C S O U	Stellar Model
8	2012JCAP...07..054B Bringmann, Torsten; Huang, Xiaoyuan; Ibarra, Alejandro; Vogl, Stefan; Weniger, Christoph	173.000 Fermi LAT search for internal bremsstrahlung signatures from dark matter annihilation	07/2012	A E X R C U	Fermi
9	2012MNRAS.422.1203B Boylan-Kolchin, Michael; Bullock, James S.; Kaplinghat, Manoj	144.000 The Milky Way's bright satellites as an apparent failure of ΛCDM	05/2012	A E F X R C S U	Simulation
10	2012MNRAS.427.2132P Padmanabhan, Nikhil; Xu, Xiaoying; Eisenstein, Daniel J.; Scalzo, Richard; Cuesta, Antonio J.; Mehta, Kushal T.; Kazin, Eyal	138.000 A 2 per cent distance to $z = 0.35$ by reconstructing baryon acoustic oscillations - I. Methods and application to the Sloan Digital Sky Survey	12/2012	A E F X R C U	SDSS

Mostly Astro Community



Only 37% from Astro Community

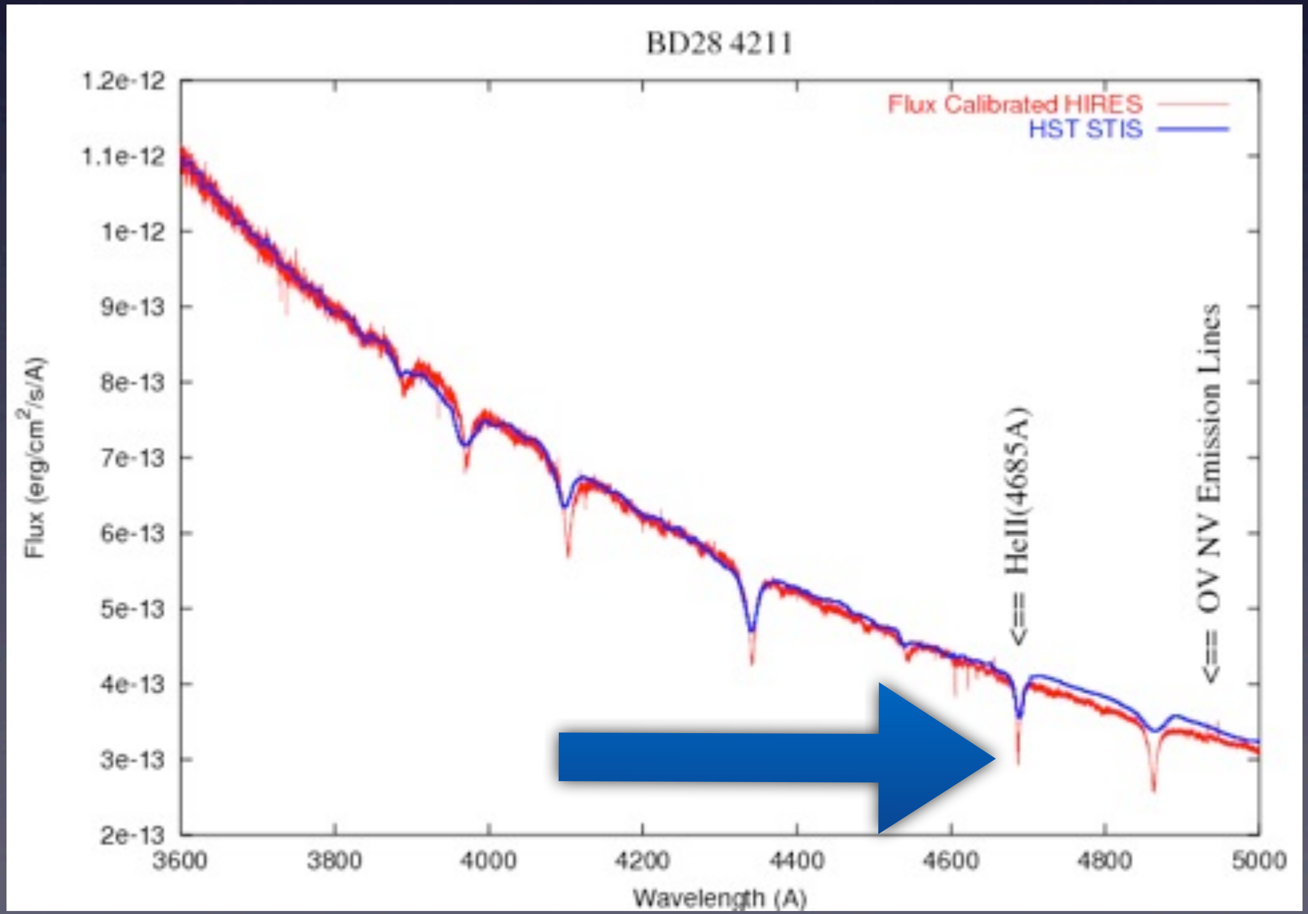


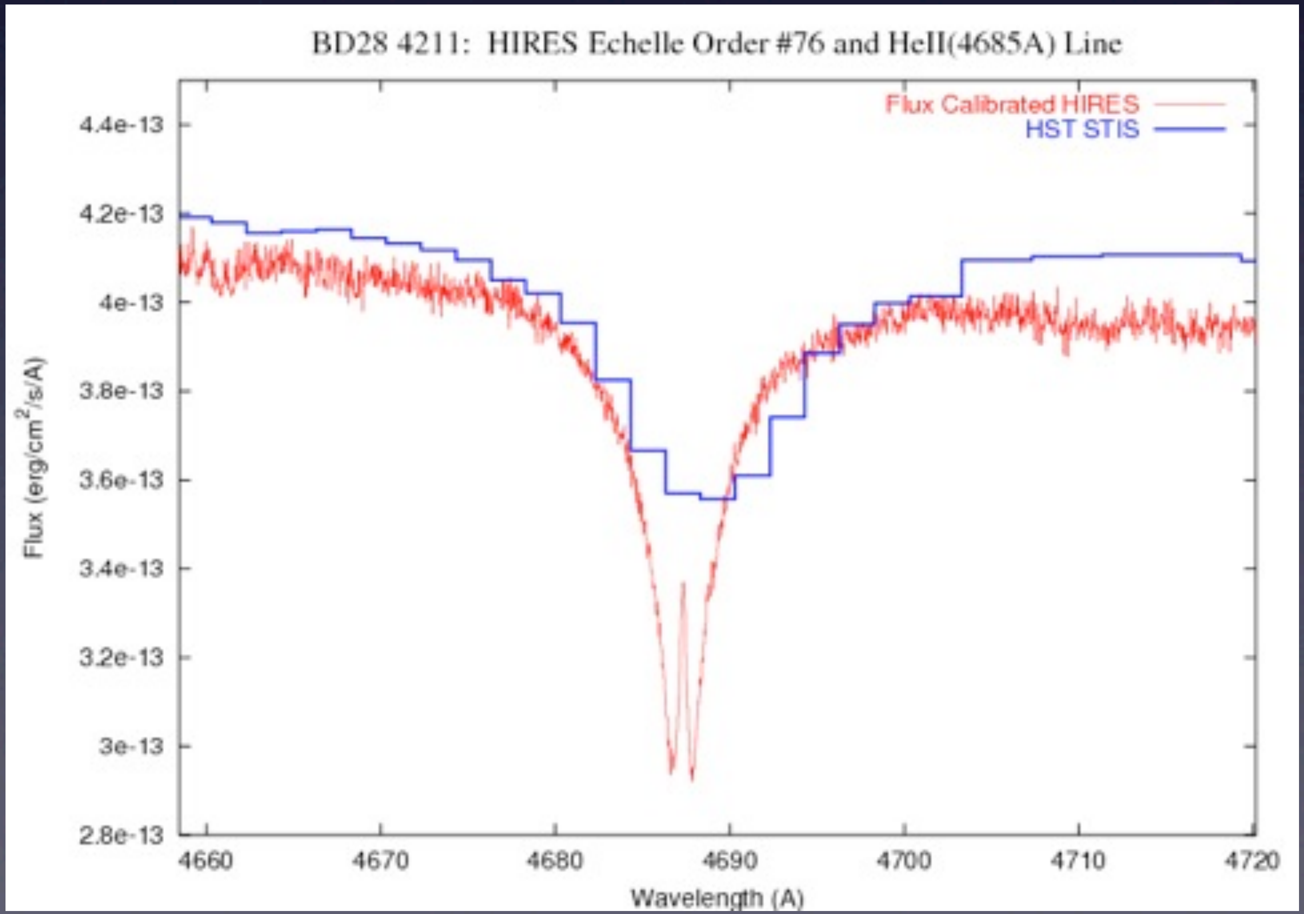
Precision Cosmology Requirements

- Precise Estimate of Errors
- Covariance Matrix
- Cross Calibrations & Cross Checks
- Reproducibility

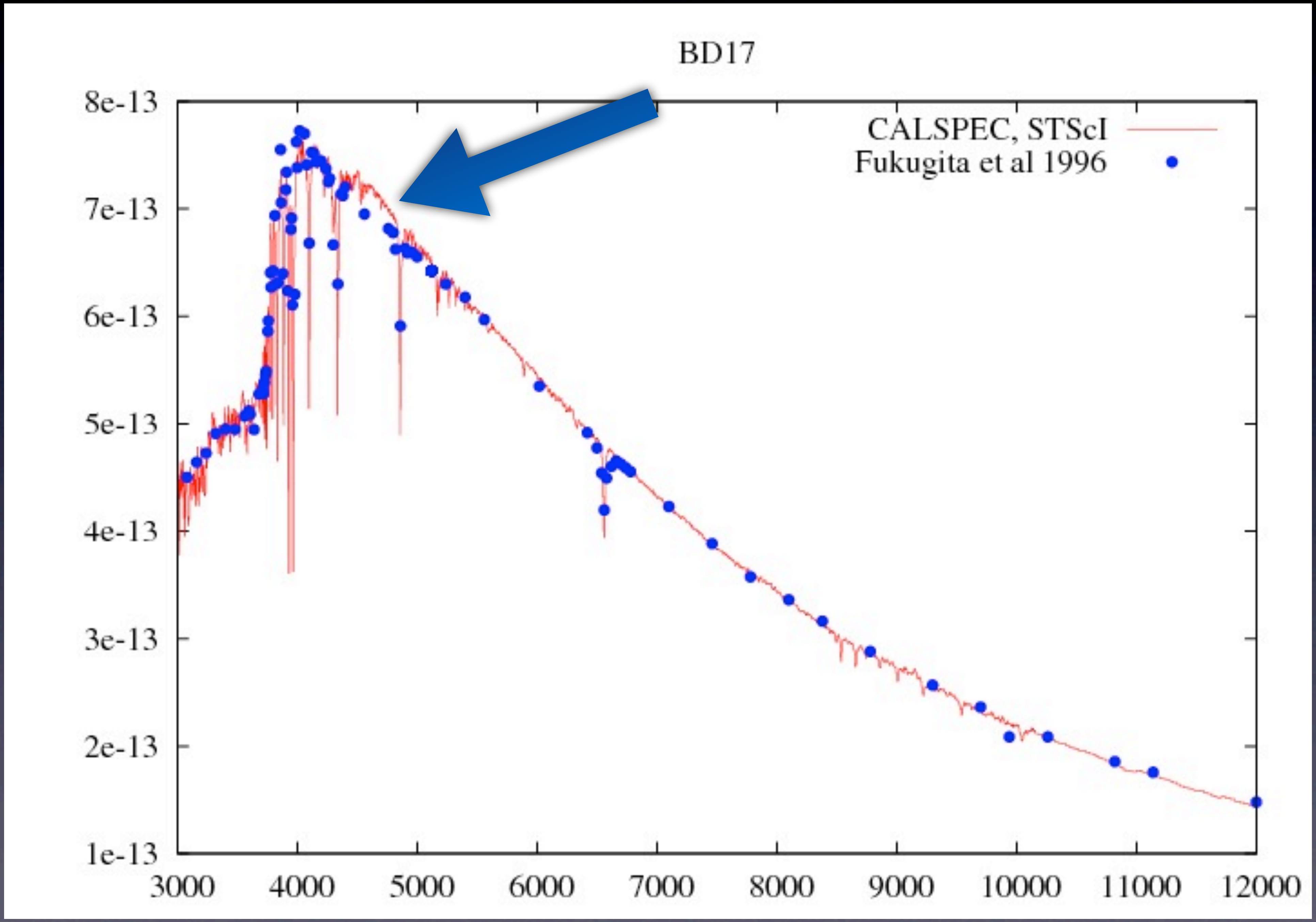
The Origins of Systematic Errors Today

- I : Zero Point is not accurate enough
- II : Standard Star Calibration (HST CALSPEC)is not accurate enough





BD17 : SDSS mag Definition
SDSS vs HST



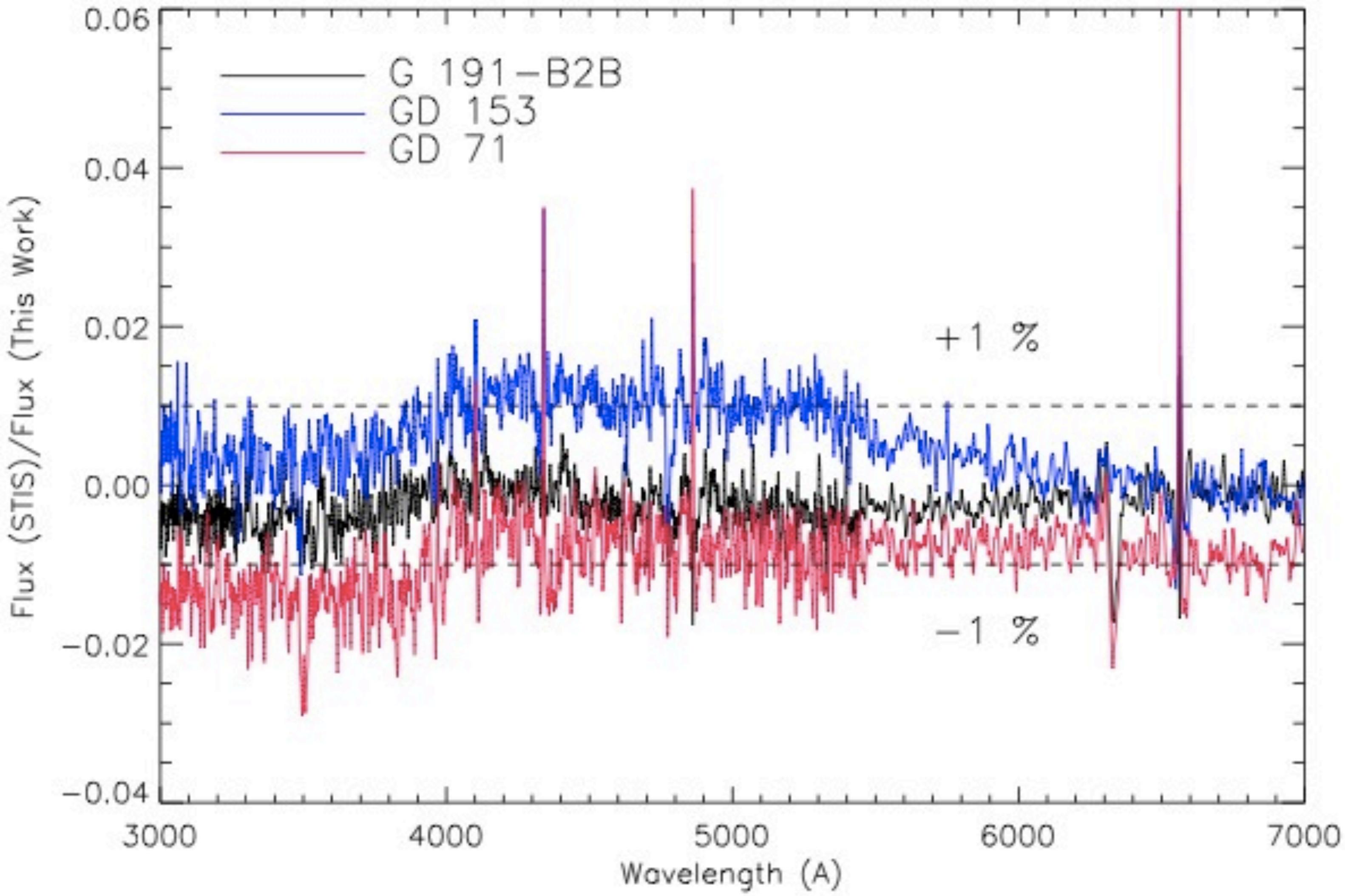
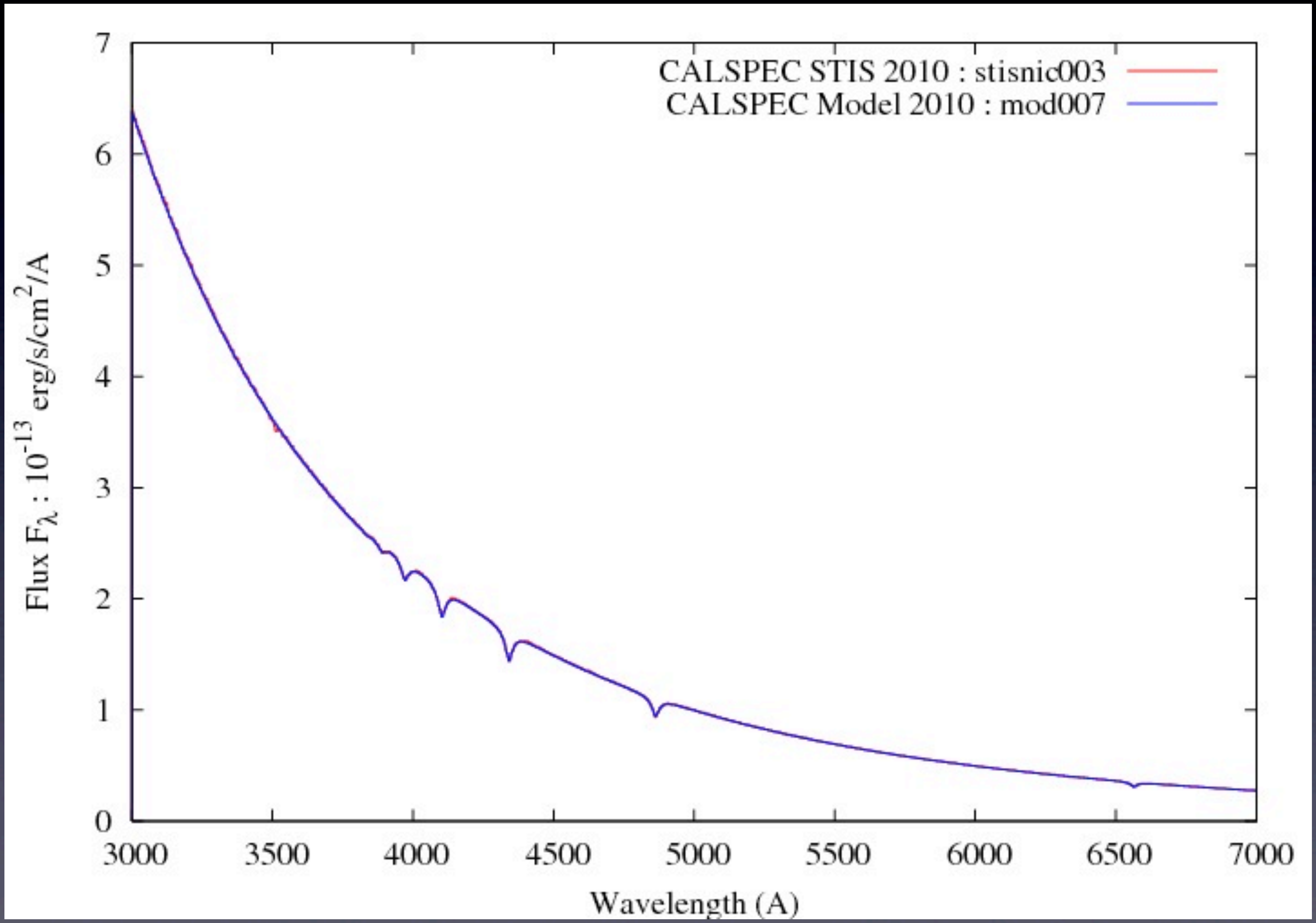


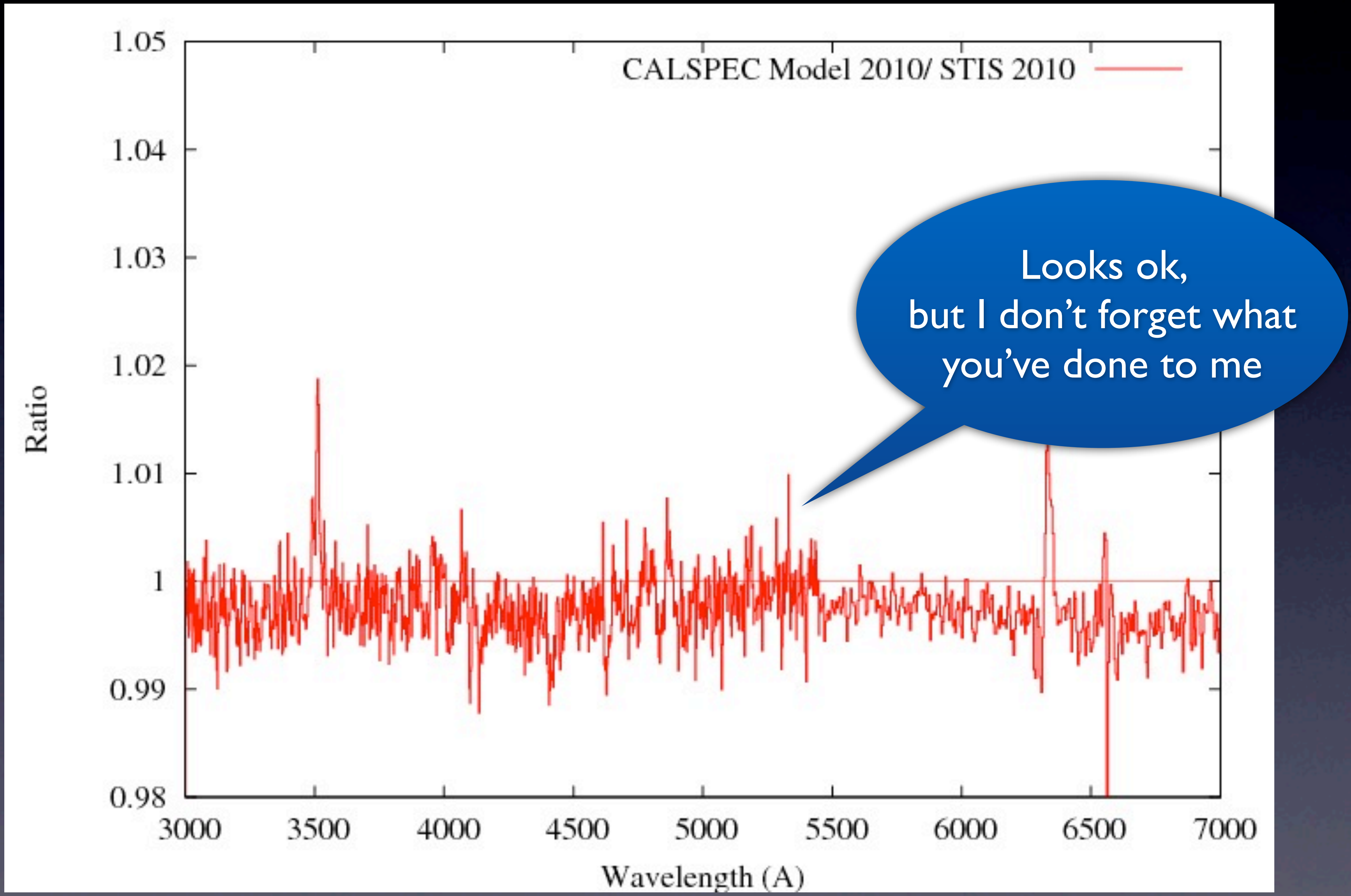
Figure 8. Ratio between the CALSPEC fluxes and those calculated here using redetermined atmospheric parameters for the HST primary standards. The zero point of the flux scale of the CALSPEC fluxes is given by Landolt *V*-band photometry, while here it is set by SDSS PT *ugr* photometry (but see text for an exception for GD 153). The two scales are inconsistent by 1.5 % for GD 71.

Allende Prieto, Carlos et al. 2009

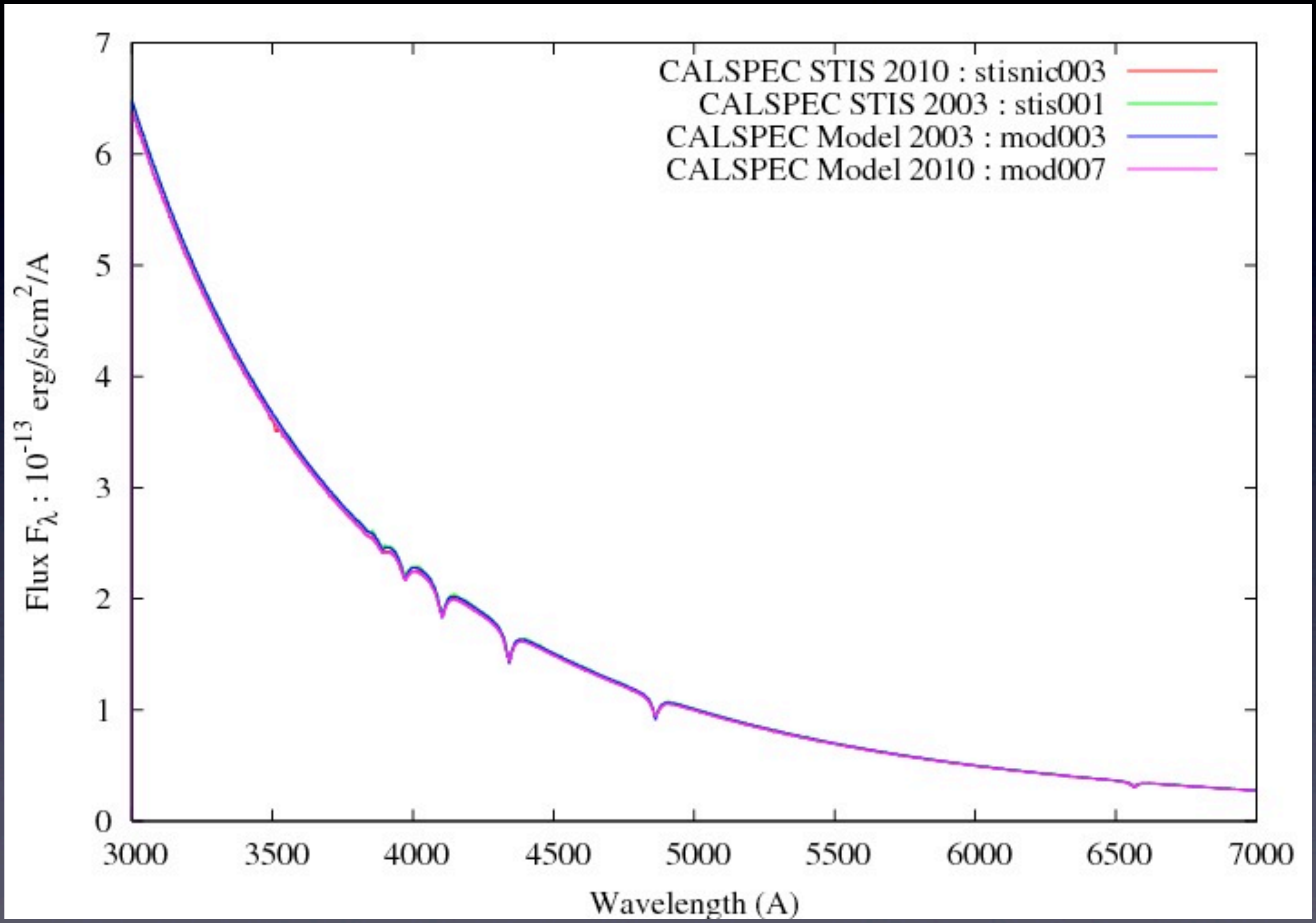
CALSPEC 2010: Model vs. STIS obs.



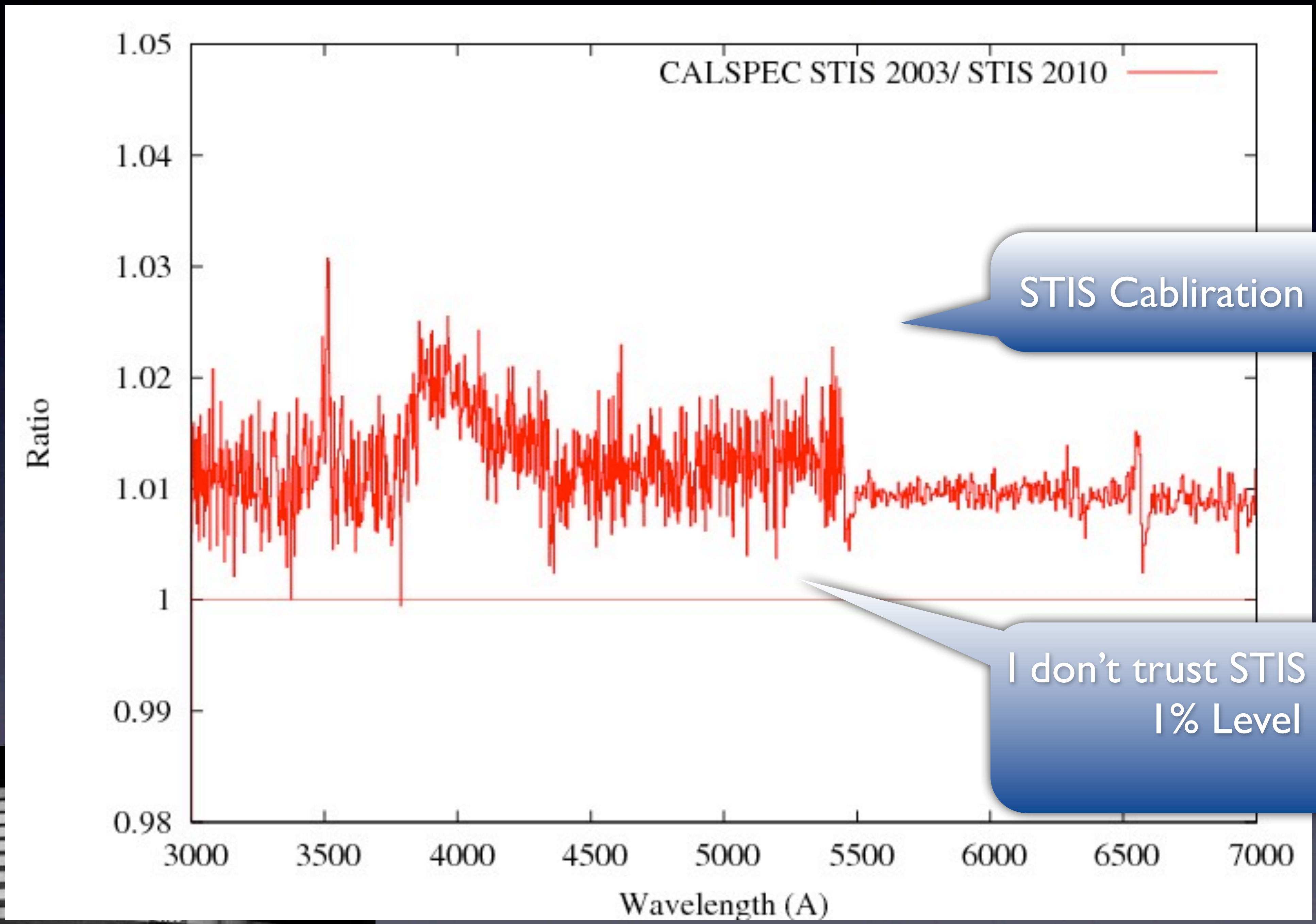
CALSPEC Model 2010 / STIS 2010



CALSPEC 2003-10: Model vs. STIS obs.

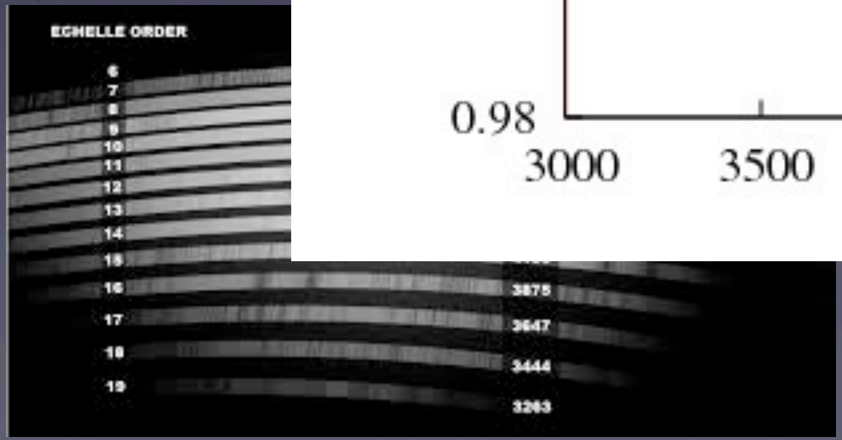


CALSPEC : STIS 2003 / STIS 2010

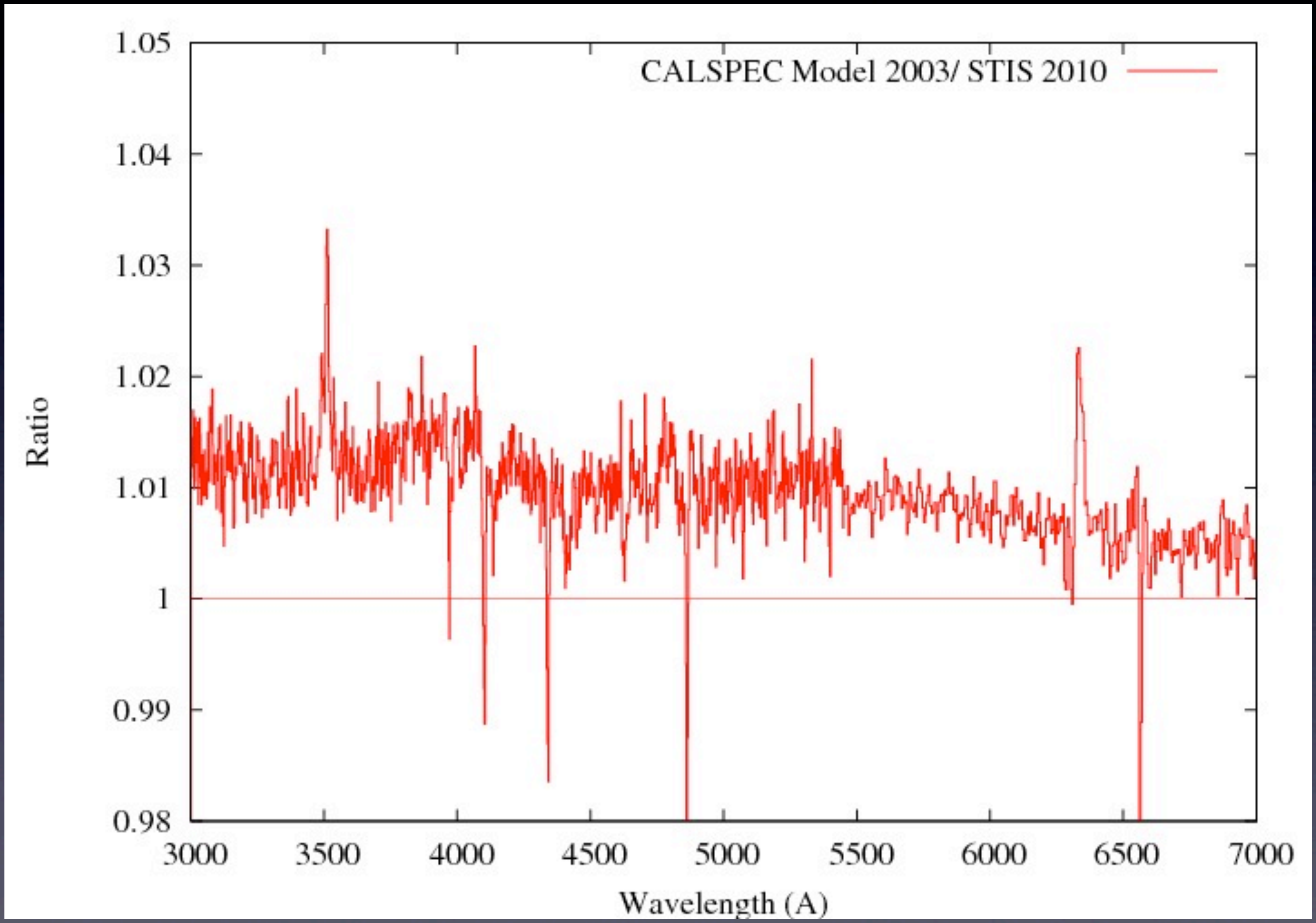


STIS Cabliration moves

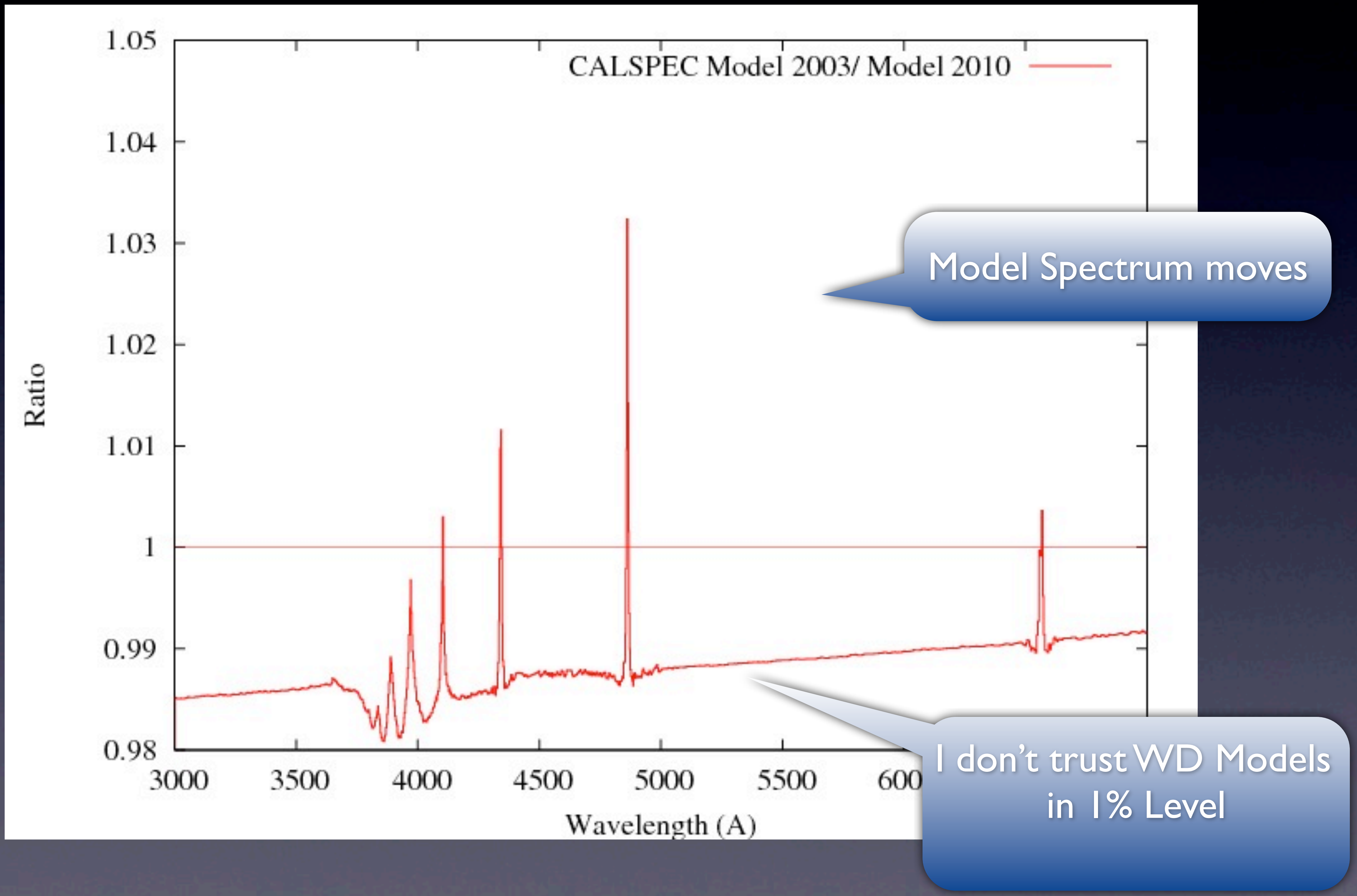
I don't trust STIS data in 1% Level



CALSPEC Model 2003 / STIS 2010



CALSPEC Model 2003 / Model 2010



Model Uncertanities

	V	$B-V$	$T_{\rm eff}$ [K]	$\log g$	spectral type
G191-B2B	11.781	−0.33	61193 (241)[a]	7.492 (0.012)[a]	DA0
			60929 (993)[b]	7.55 (0.05)[b]	
GD 153	13.346	−0.29	38686 (152)[a]	7.662 (0.024)[a]	DA1
			40320 (626)[b]	7.93 (0.05)[b]	
GD 71	13.032	−0.25	32747 (92)[a]	7.683 (0.023)[a]	DA1
			33590 (483)[b]	7.93 (0.05)[b]	

[a] (Finley et al., 1997)
[b] (Gianninas et al., 2011)

Nicolas Regnault

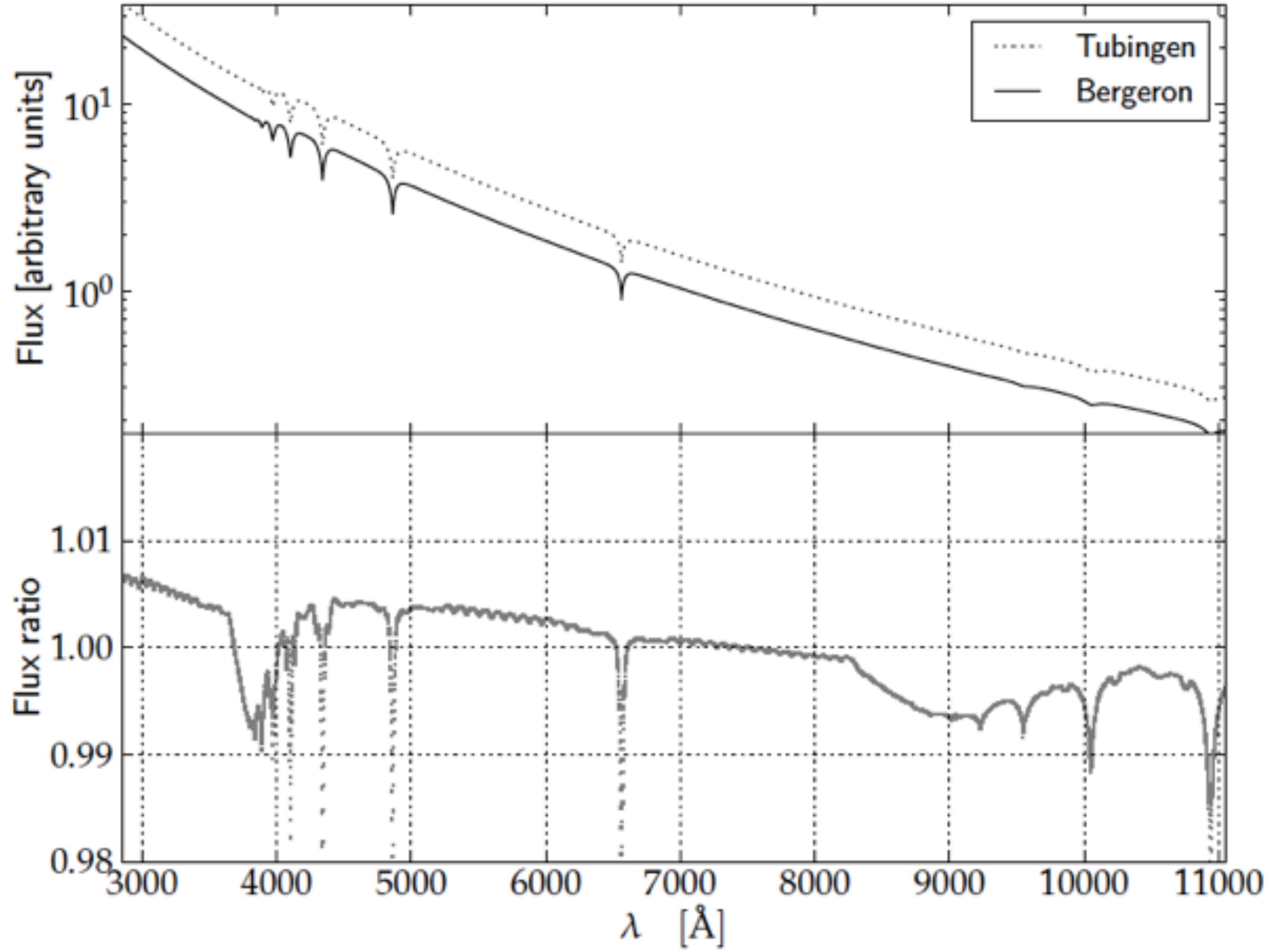
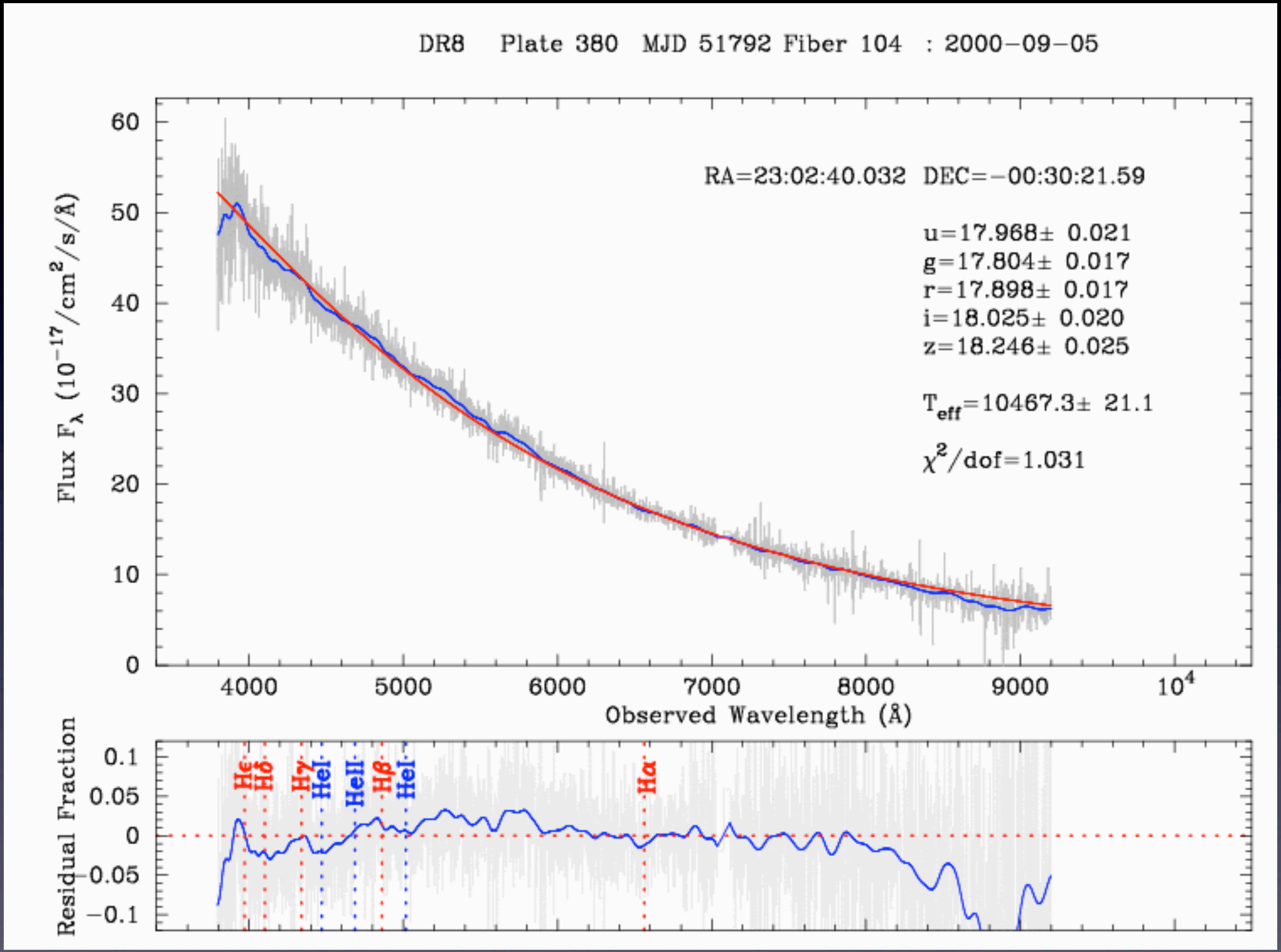


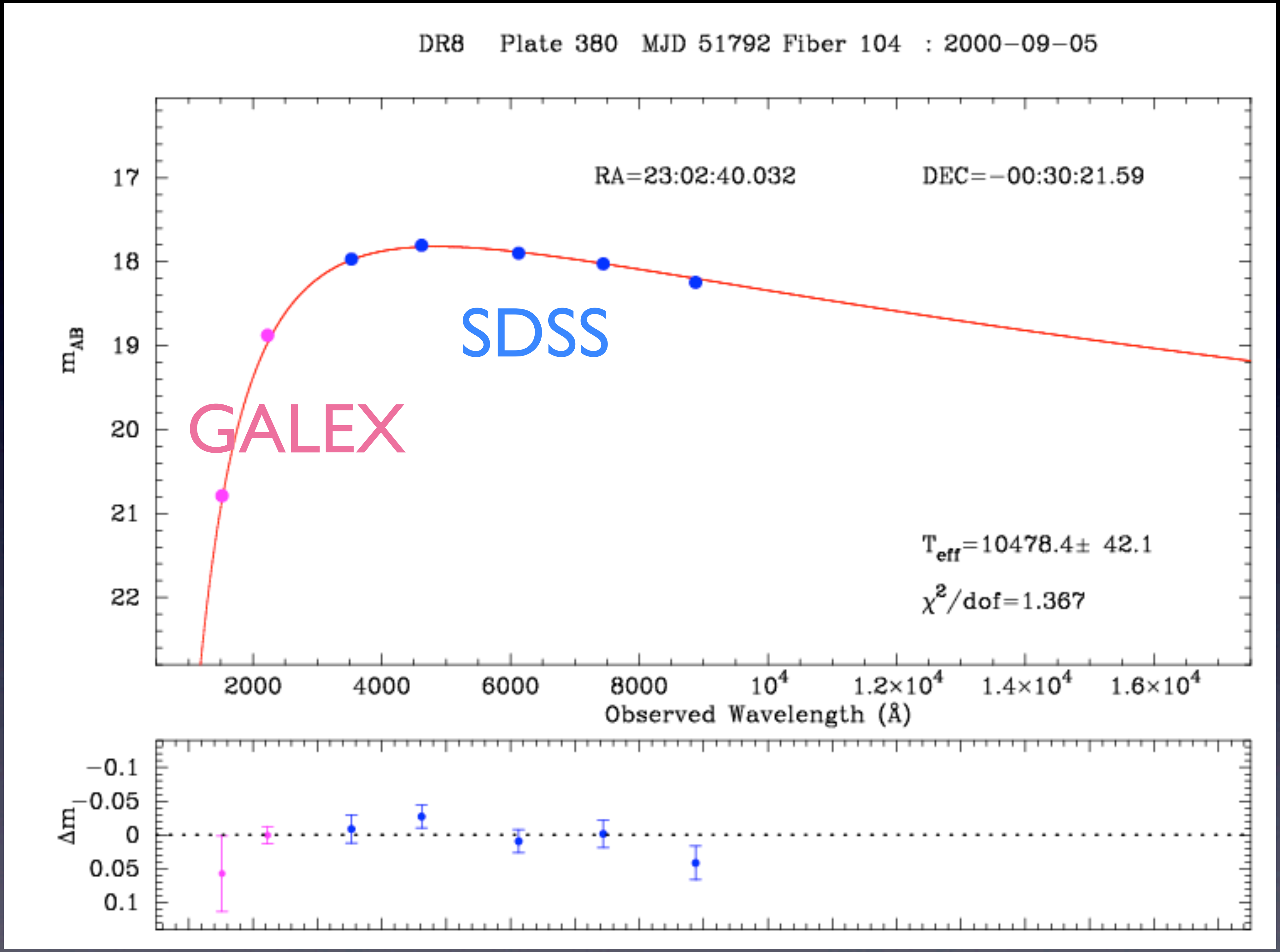
Figure 2.1.: Comparison between the Tübingen model (TMAW) and the Bergeron model for star GD 71. Both models were computed for pure hydrogen atmosphere, with $T_{\rm eff} = 33590K$ and $\log g = 7.93$. Upper panel: model spectra (shifted, to distinguish them). Lower panel: ratio.

Nicolas Regnault

Trust No One

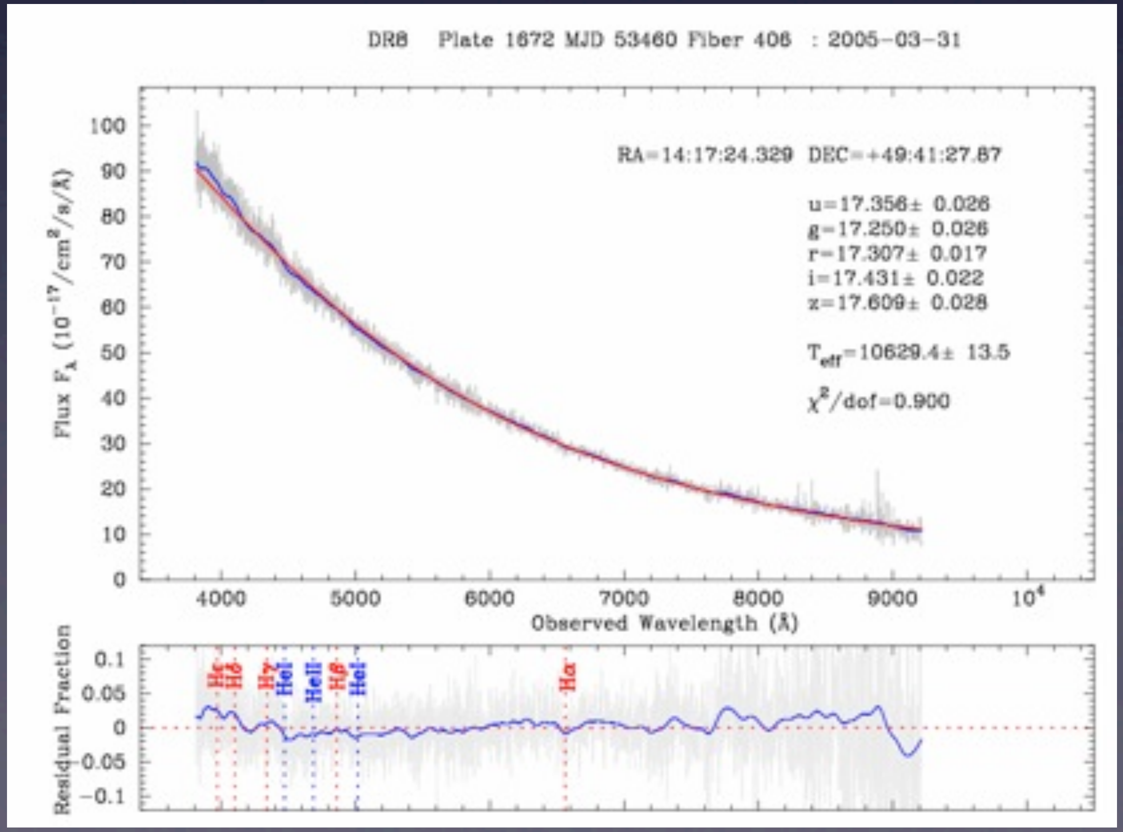
- I don’t Trust CALSPEC!
- I don’t Trust HST/STIS!
- I don’t Trust White Dwarf Models!

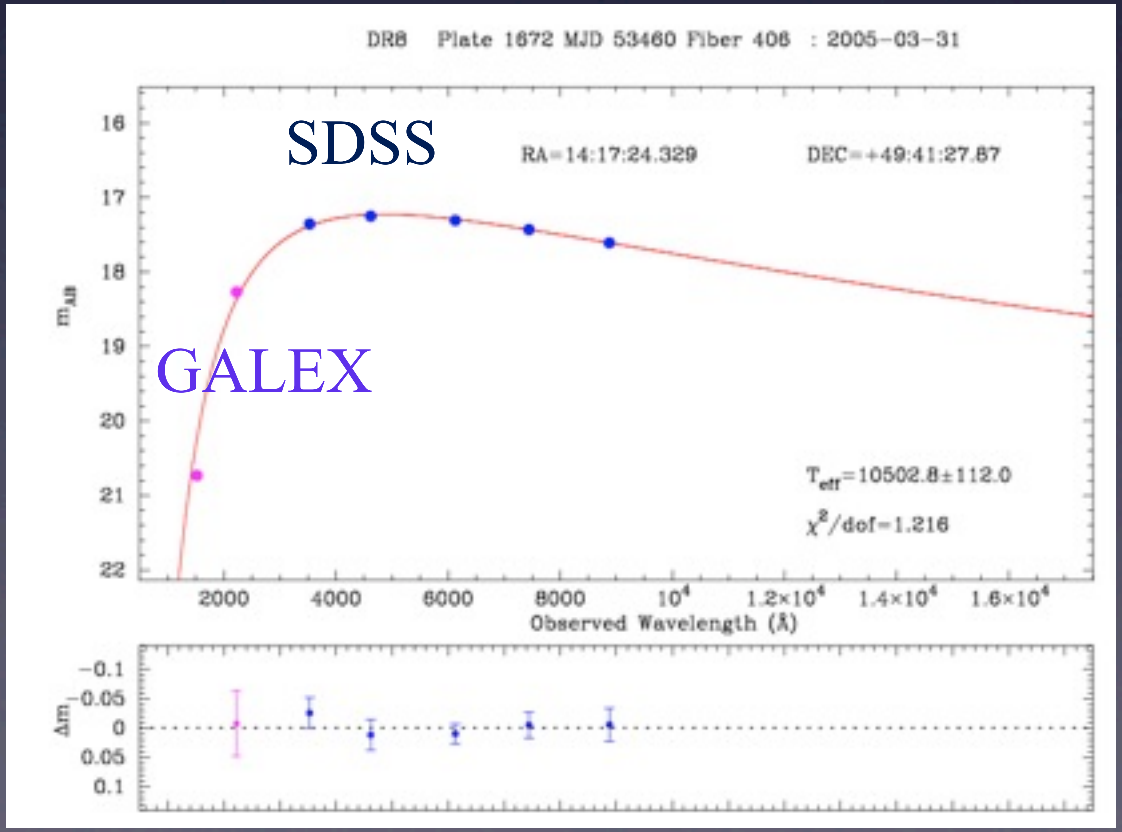

DR8 Plate 380 MJD 51792 Fiber 104 : 2000-09-05
RA=23:02:40.032 DEC=-00:30:21.59
u=17.968± 0.021
g=17.804± 0.017
r=17.898± 0.017
i=18.025± 0.020
z=18.246± 0.025
T_eff=10467.3± 21.1
χ²/dof=1.031
Flux F_λ (10^-17/cm²/s/Å)
Observed Wavelength (Å)
Residual Fraction
Hε
Hδ
Hγ
HeI
HeII
Hβ
HeI
Hα

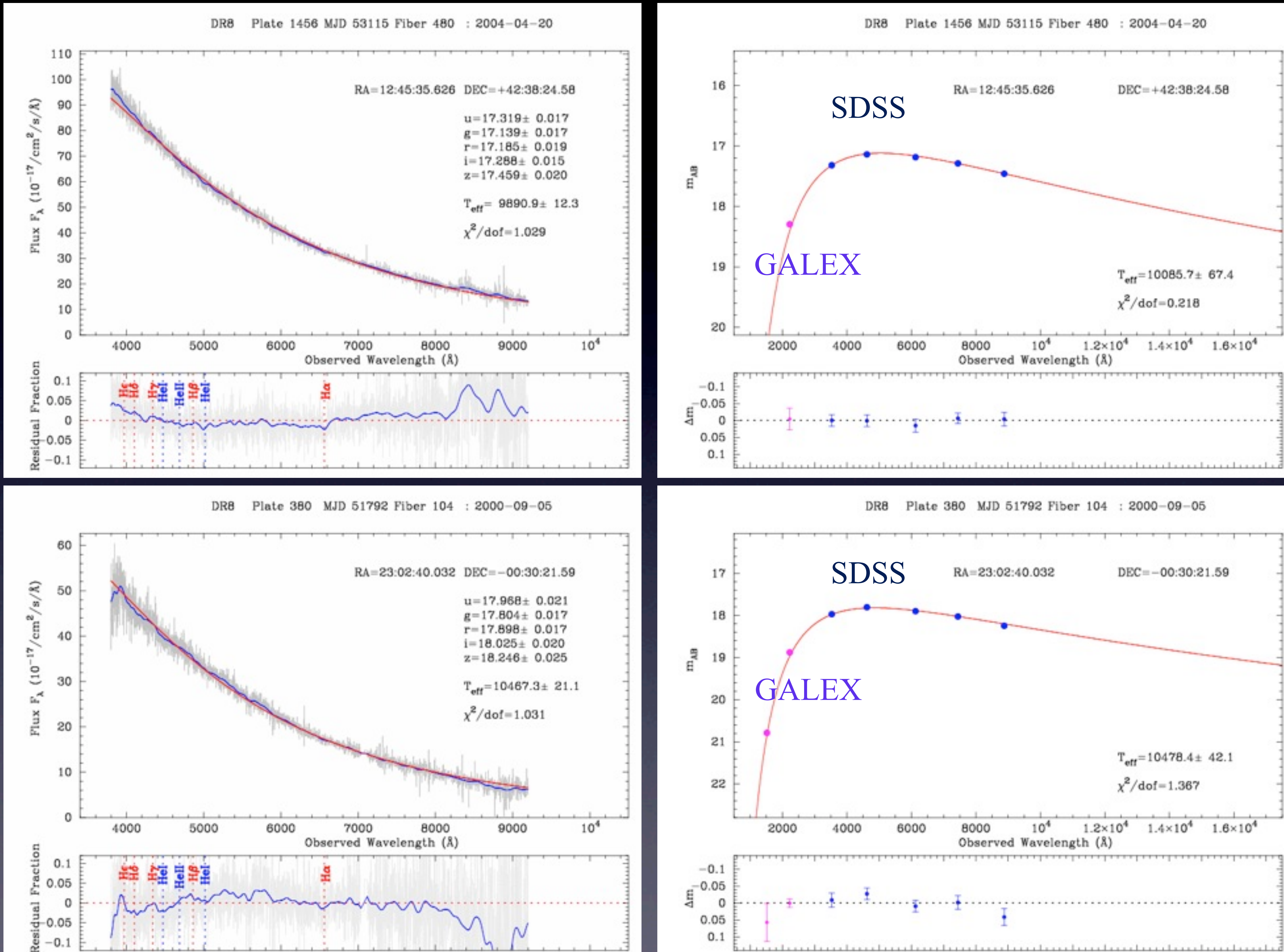

DR8 Plate 380 MJD 51792 Fiber 104 : 2000-09-05
RA=23:02:40.032
DEC=−00:30:21.59
SDSS
GALEX
T_{eff}=10478.4± 42.1
χ^2/dof=1.367
m_{AB}
Observed Wavelength (Å)
Δm_i

Discovery of Perfect Black Body Spectra: found as a Quasar Target Only 20 stars out of a million stars

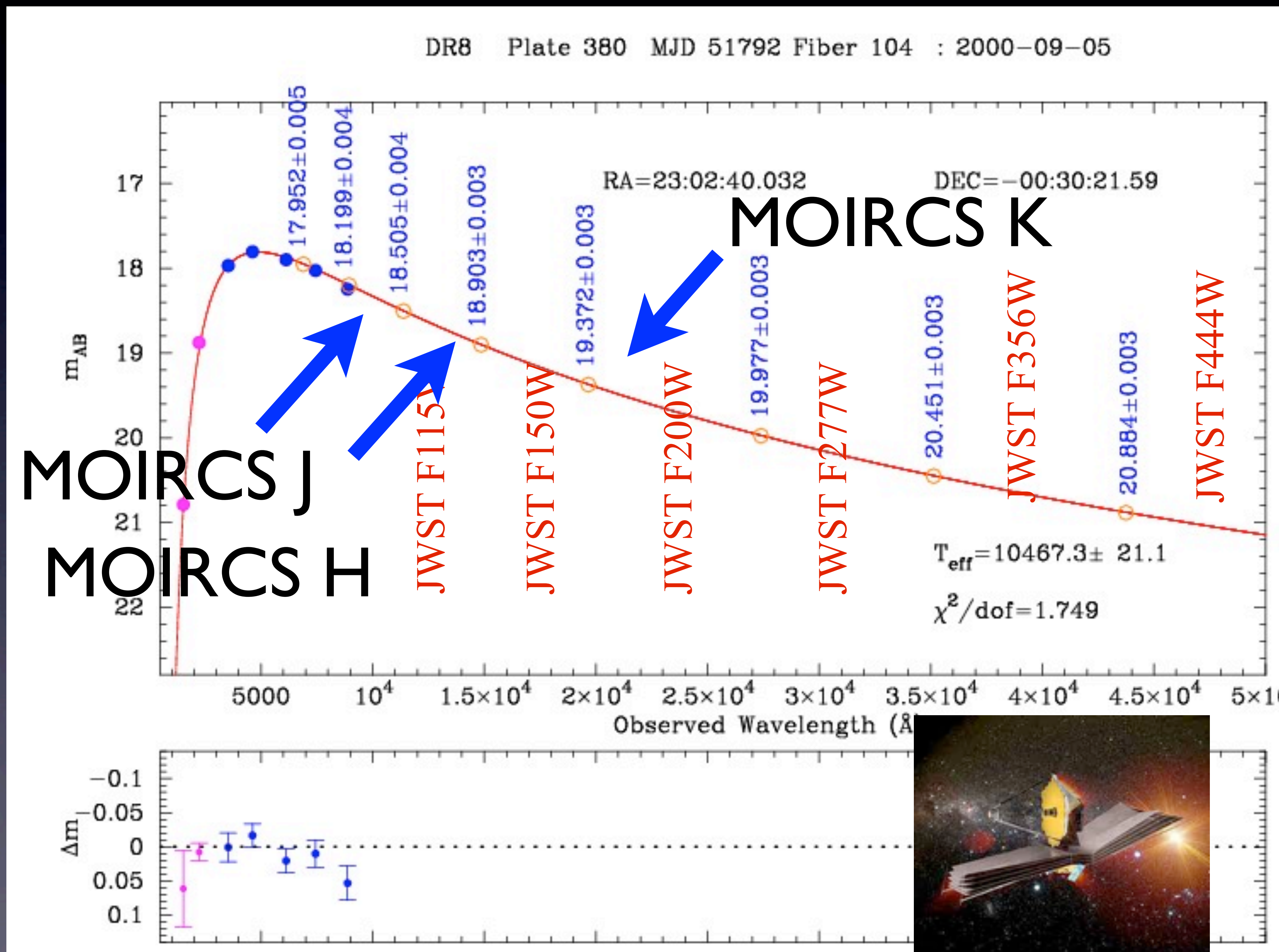
- DR8 : 605,772 stars => 5 stars
- DR9 : 110,929 stars=> 9 stars
- DR10: 81,892 stars=> 10 stars



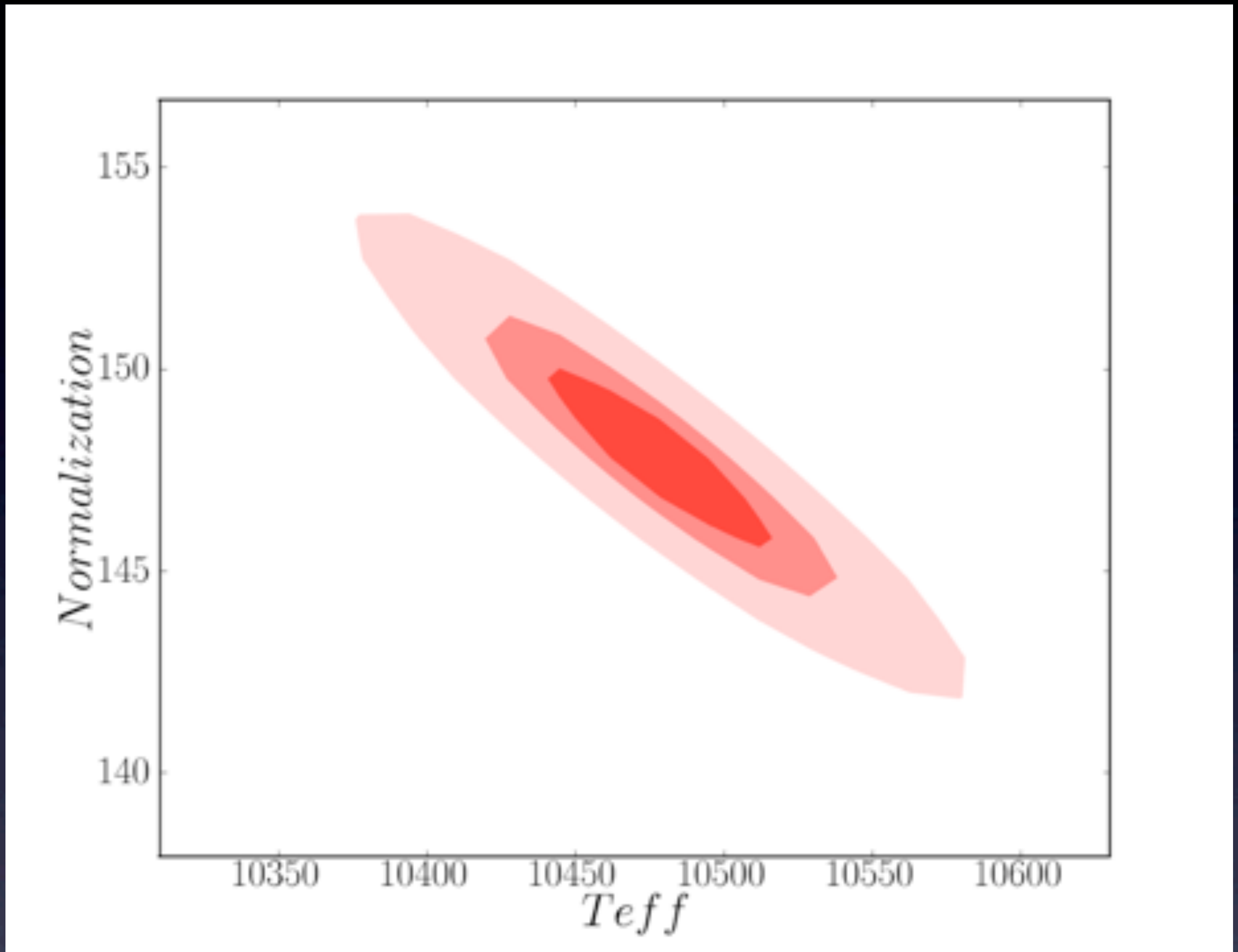


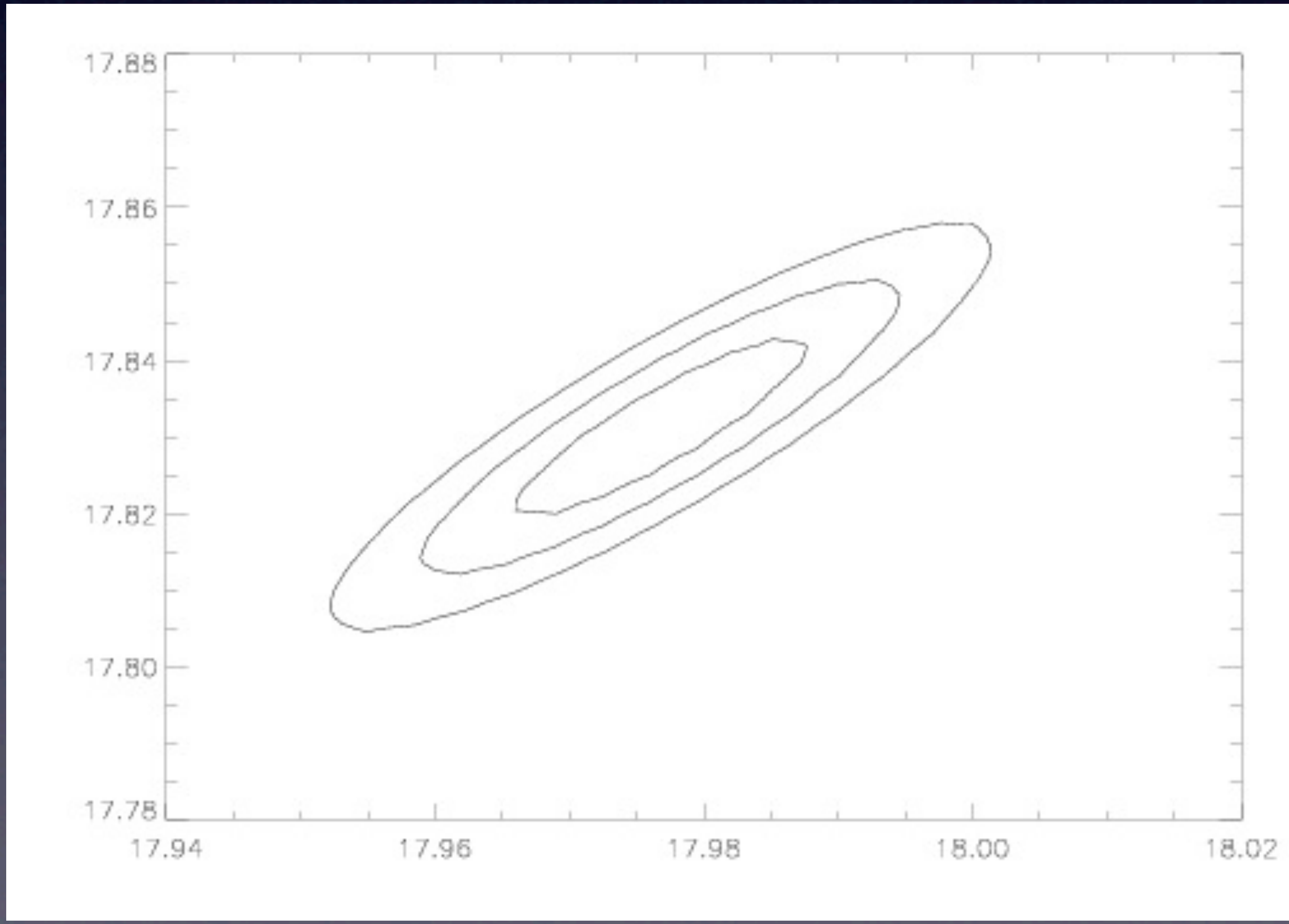

DR8 Plate 1456 MJD 53115 Fiber 480 : 2004-04-20
RA=12:45:35.626 DEC=+42:38:24.58
u=17.319± 0.017
g=17.139± 0.017
r=17.185± 0.019
i=17.288± 0.015
z=17.459± 0.020
T_eff= 9890.9± 12.3
χ²/dof=1.029
Flux F_λ (10^-17/cm²/s/Å)
Observed Wavelength (Å)
Residual Fraction
Hε Hδ Hγ HeI HeII Hβ HeI Hα
DR8 Plate 1456 MJD 53115 Fiber 480 : 2004-04-20
SDSS
GALEX
RA=12:45:35.626 DEC=+42:38:24.58
T_eff=10085.7± 67.4
χ²/dof=0.218
m_AB
Observed Wavelength (Å)
Δm
DR8 Plate 380 MJD 51792 Fiber 104 : 2000-09-05
RA=23:02:40.032 DEC=−00:30:21.59
u=17.968± 0.021
g=17.804± 0.017
r=17.898± 0.017
i=18.025± 0.020
z=18.246± 0.025
T_eff=10467.3± 21.1
χ²/dof=1.031
Flux F_λ (10^-17/cm²/s/Å)
Observed Wavelength (Å)
Residual Fraction
Hε Hδ Hγ HeI HeII Hβ HeI Hα
DR8 Plate 380 MJD 51792 Fiber 104 : 2000-09-05
SDSS
GALEX
RA=23:02:40.032 DEC=−00:30:21.59
T_eff=10478.4± 42.1
χ²/dof=1.367
m_AB
Observed Wavelength (Å)
Δm

Looking at the Future with JWST today 0.3%, but we can do 0.1%



Magnitude Errors are Correlated





u mag

g mag

Near Future plan:

- Dec 2013 : 8m-Subaru Time (approved)
- We will observe these stars with Subaru (MOIRCS) in K-band (2.2 micron)
- UH88 (approved) will have S/N=100 data
- Aim to Publish Discovery Paper in 2014
- If no IR excess is detected, we will write a discovery paper and send it to HST (cycle 22 proposal)
- We aim to re-calibrate SDSS photometry at 20th mag with 4 decimal numbers with 0.1% accuracy
- GAIA (2013-2020) will measure the distances to these stars

What I will do:

with M. Fukugita, Tim Beers and SDSS collaboration

- Step I : Replace BD17 by perfect black body spectra
- Step II : Re-establish SDSS mag in AB
- Step III : Re-measure zpt offset in covariance matrix form using 5-band SDSS photometry, 2-band GALEX photometry, and SDSS-I/II/III spectra for 320,751 F-stars
- Publish model spectra and synthetic mag of 320,751 F-stars (=20 stars / square degree)

New Observations Collaborators

- UH88 Fall 2013 (Postponed) : 1 night
- Subaru MOIRCS (H-, K-band) in Dec 2013
- HST/WFC3 Cycle 22 Proposal
- Establish F-Star Spectra Network
- M. Fukugita (IPMU), R. Bohlin, S. Deustua (STScI), T. Beers (NOAO), N. Regnault (LPNHE), A. Conley (Colorado), SDSS Friends, Your Name here

Let’s think outside the Box

“In 2020, which standard stars do we use?”

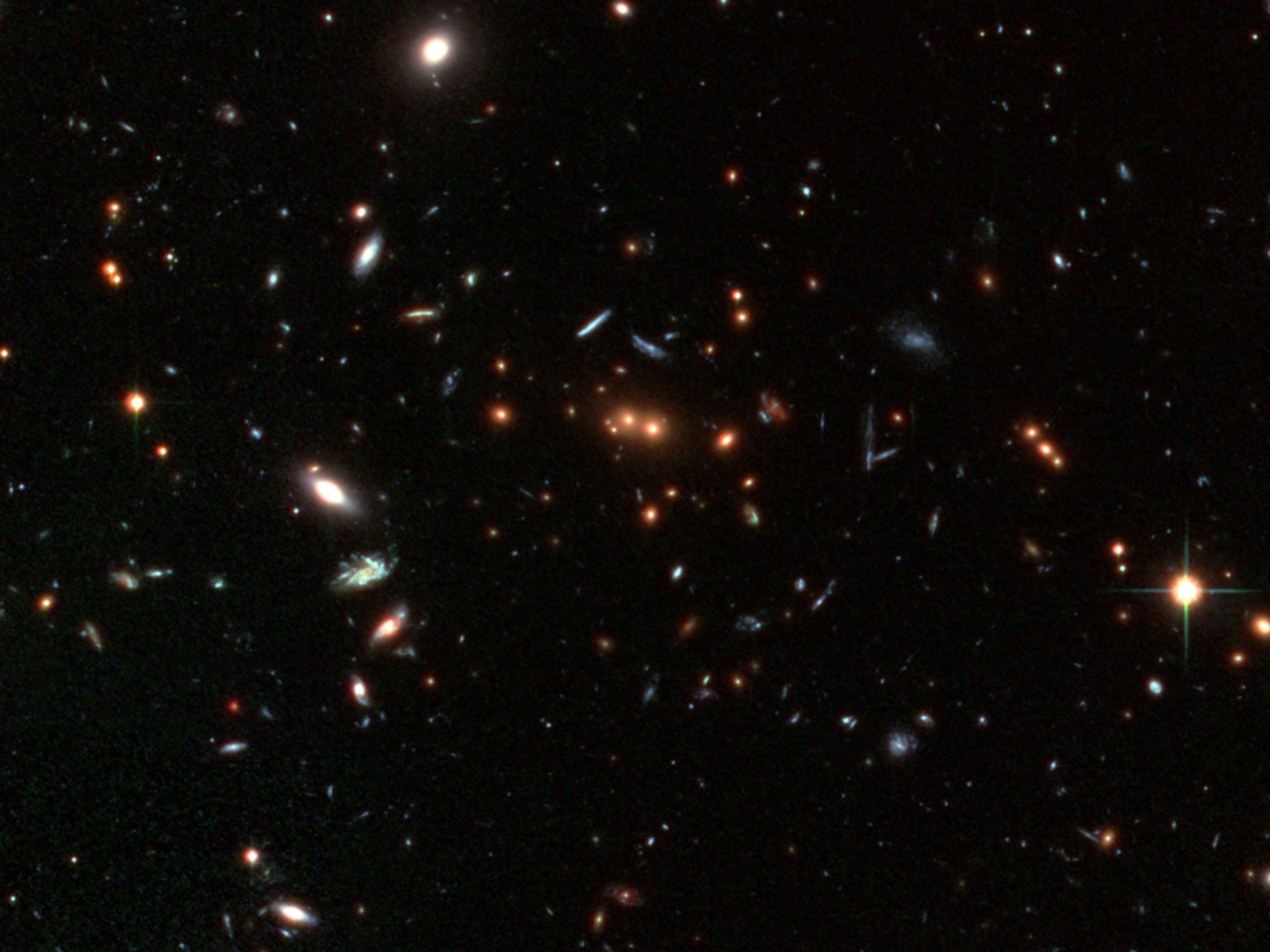
- JWST is coming in 5 years
- Imagine HyperSuprimeCam + JWST SNIa Survey at z =2.0 & Discovering PopIII
- GAIA (successful launch) will give us an excellent new stellar photometry and distances

Backup Slides

HST Cluster Supernova Survey

I. Survey Overview (Dawson et al. 2009)
II. SNIa Cluster Rates (Barbary et al. 2012)
III. SNIa Host Galaxy Studies (Meyers et al. 2012)
IV. NICMOS Non-Linearity (Ripoche et al. 2012)
V. SNIa Photometry & Cosmology (Suzuki et al. 2012)
VI. SNIa Field Rates (Barbary et al. 2012)

Spectroscopic Follow-up (Morokuma et al. 2010)
NICMOS Calibration (Hsiao et al. 2011)

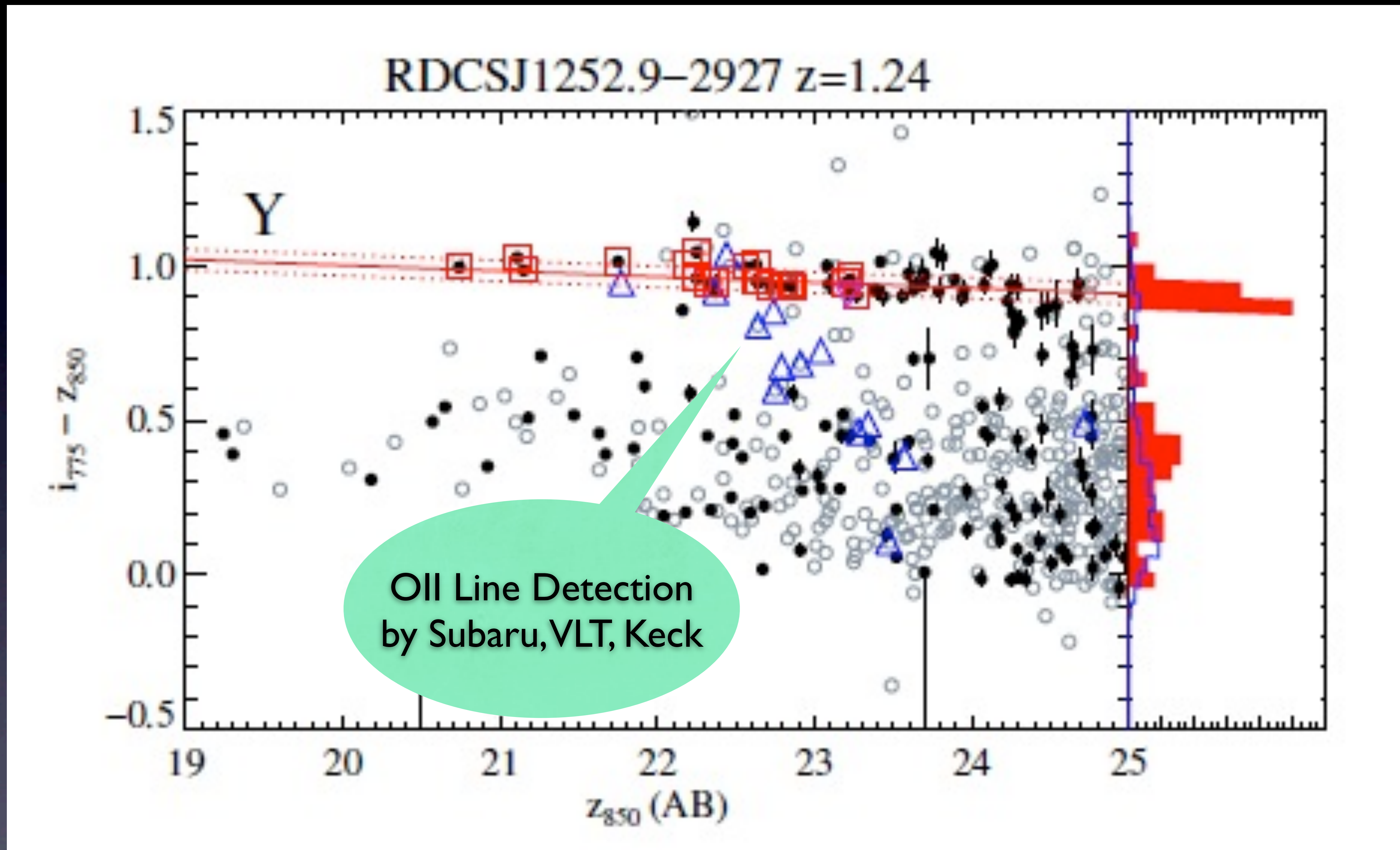


Joshua Meyers et al. 2012

Red

Color

Blue



Bright → Faint

Magnitude

SNIa Host Galaxy Studies

ers et al. 2012

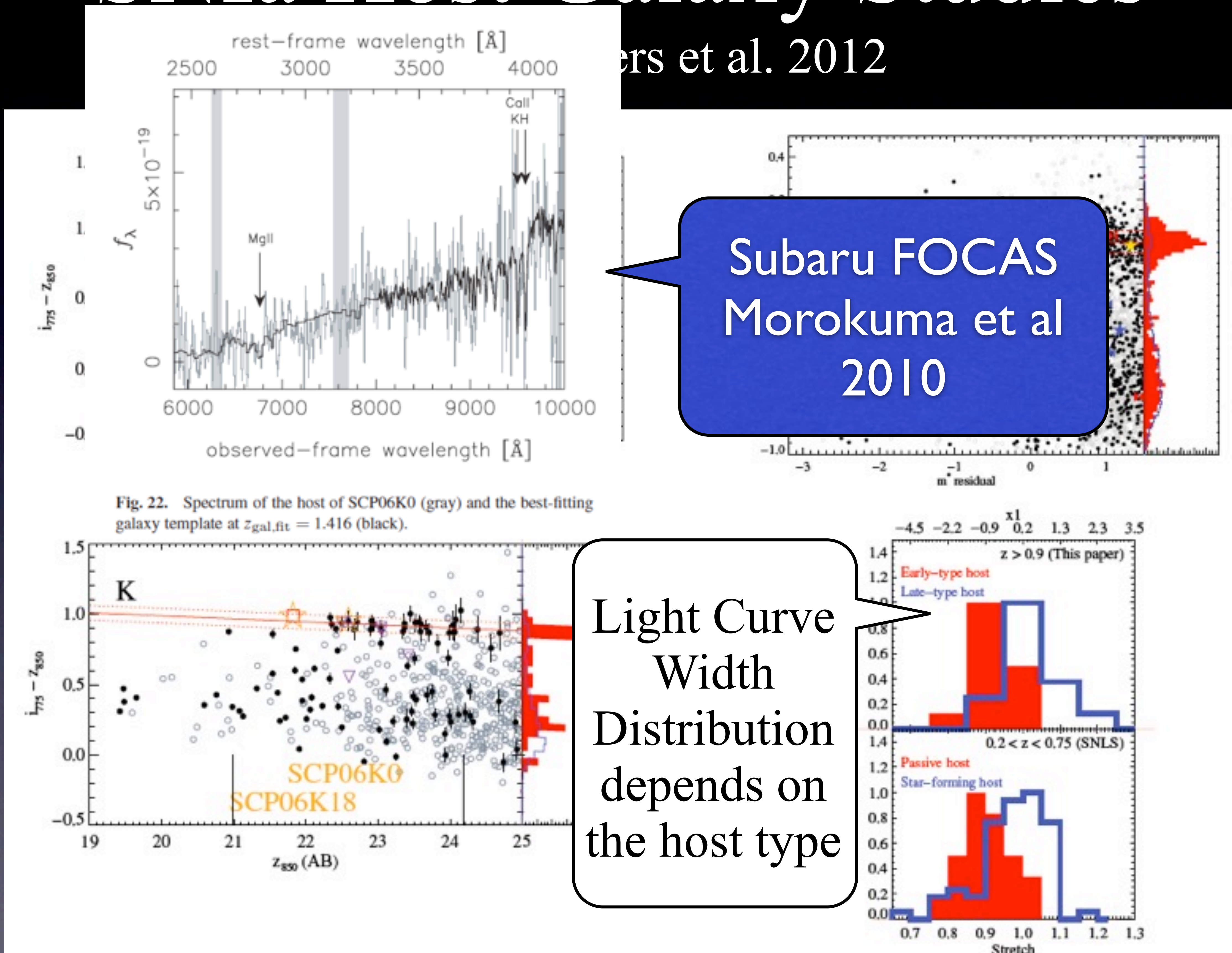


Fig. 22. Spectrum of the host of SCP06K0 (gray) and the best-fitting galaxy template at $z_{\mathrm{gal,fit}} = 1.416$ (black).

AB Magnitude Definition

$$ABmag = -2.5log_{10}\frac{\int R\frac{f_\nu}{\nu}d\nu}{\int \frac{R}{\nu}d\nu}$$ - 48.6

$$ABmag = -2.5log_{10}\frac{\int \lambda R f_\lambda d\lambda}{\int \frac{R}{\lambda}d\lambda} - 2.407948$$

AB Mag != SDSS Mag

$$ABmag(u) = -2.5log_{10}\frac{\int \lambda R f_\lambda d\lambda}{\int \frac{R}{\lambda} d\lambda} - 2.407948 - 0.042$$

$$ABmag(g) = -2.5log_{10}\frac{\int \lambda R f_\lambda d\lambda}{\int \frac{R}{\lambda} d\lambda} - 2.407948 + 0.036$$

$$ABmag(r) = -2.5log_{10}\frac{\int \lambda R f_\lambda d\lambda}{\int \frac{R}{\lambda} d\lambda} - 2.407948 + 0.015$$

$$ABmag(i) = -2.5log_{10}\frac{\int \lambda R f_\lambda d\lambda}{\int \frac{R}{\lambda} d\lambda} - 2.407948 + 0.013$$

$$ABmag(z) = -2.5log_{10}\frac{\int \lambda R f_\lambda d\lambda}{\int \frac{R}{\lambda} d\lambda} - 2.407948 - 0.002$$