Absolute Photometric Calibration in Space and on the Ground

08/011/13

Jay Holberg

Lunar and Planetary Laboratory, University of Arizona

LSST Collaborators

NOAO

Gautham Naryan
Thomas Matgheson
Abhijit Saha

STScI

Ralph C. Bohlin
Susana Deustua

Cycle 20 HST GO program - PI , A. Saha

- Large Synoptic Survey Telescope (LSST)
- Establish a Network of Absolute Standard Stars
- A Lasting Legacy

Large Synoptic Survey Telescope - LSST

Engineering First Light 2019?

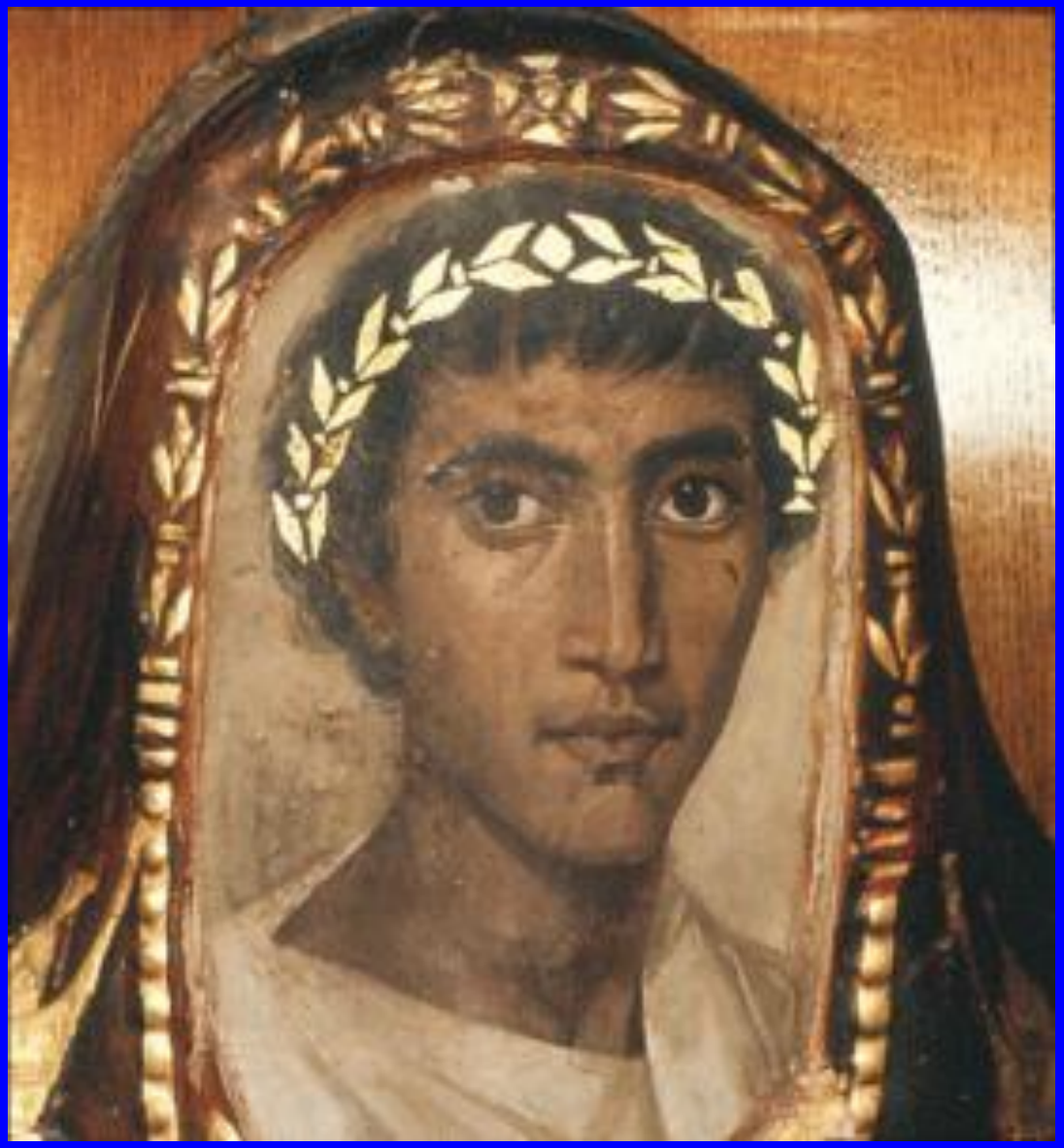
08/011/13

How do you (Photometrically) Calibrate LSST?

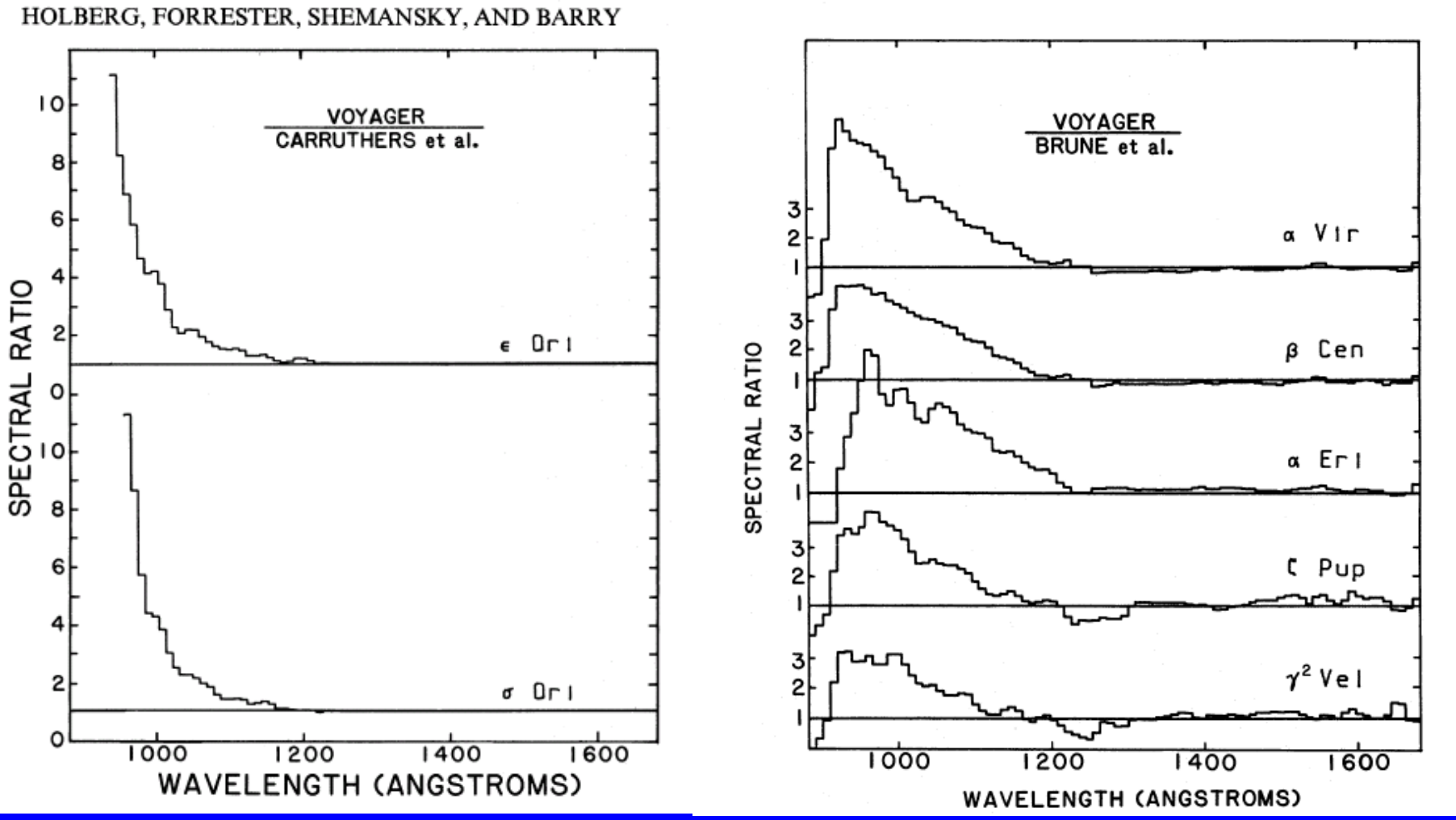
- 1% for Absolute Fluxes
- 0.5% for Relative Fluxes
- In six bands: *ugrizy*
- Over half the sky
- For magnitudes > 16

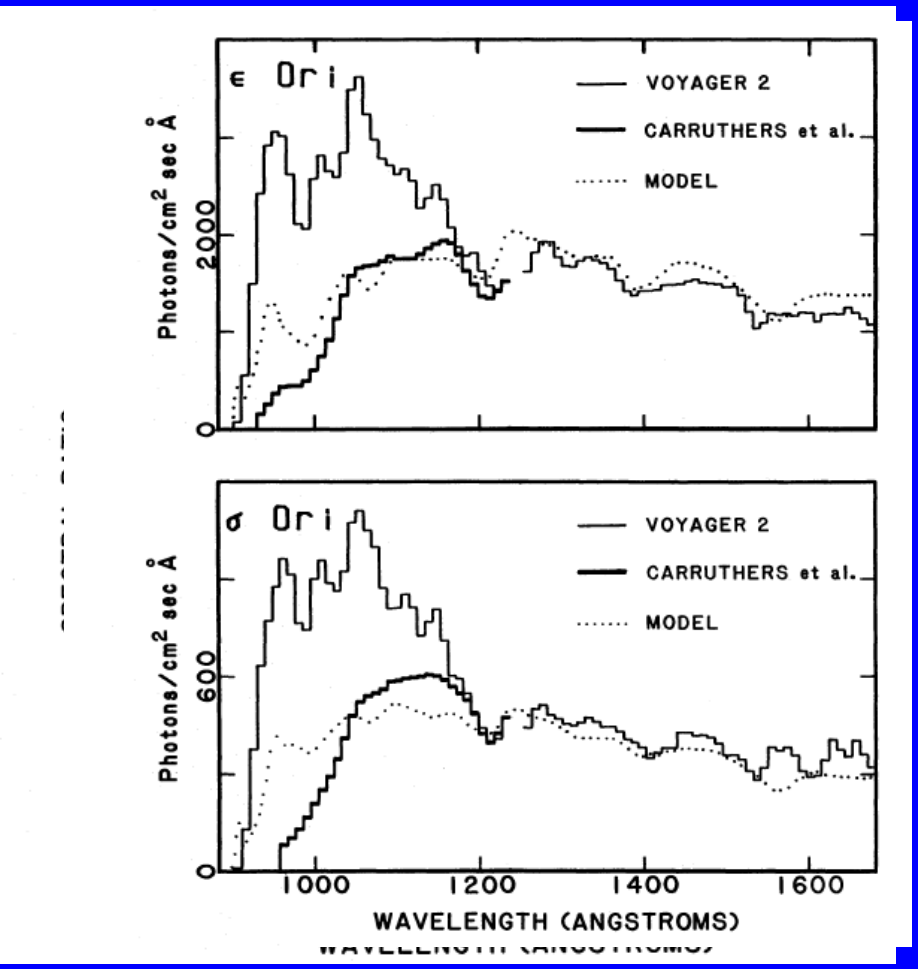
The prerequisites for this Do Not Exist!

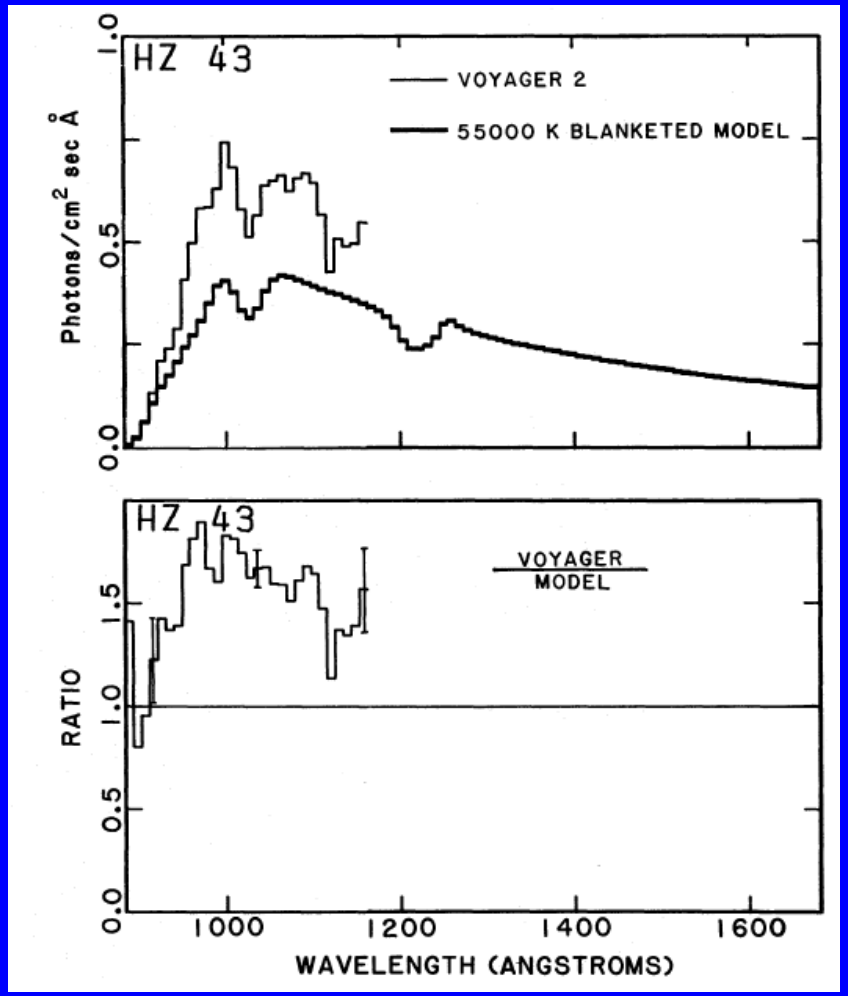
But! First some Ancient History



Holberg et al. (1982)
Calibration of the Voyager UV Spectrometers




ε Ori
VOYAGER 2
CARRUTHERS et al.
MODEL
Photons/cm² sec Å
2000
0
σ Ori
VOYAGER 2
CARRUTHERS et al.
MODEL
Photons/cm² sec Å
600
0
1000
1200
1400
1600
WAVELENGTH (ANGSTROMS)


HZ 43
VOYAGER 2
55000 K BLANKETED MODEL
Photons/cm² sec Å
1.0
0.5
0.0
HZ 43
VOYAGER
MODEL
RATIO
1.5
1.0
0.5
0.0
1000
1200
1400
1600
WAVELENGTH (ANGSTROMS)

Hot DA White Dwarfs

1. Fully Radiative Photospheres
2. Pure-H Photospheres
3. Reliable Modeled Atmospheres
4. Synthetic Photometry
   (Holberg & Bergeron 2006) *

1. Photometricaly Stable
2. Wavelength Coverage (EUV to NIR)
3. Relatively Low Reddening (amended*)
4. Widely Observable

Cycle 20 White Dwarf Targets

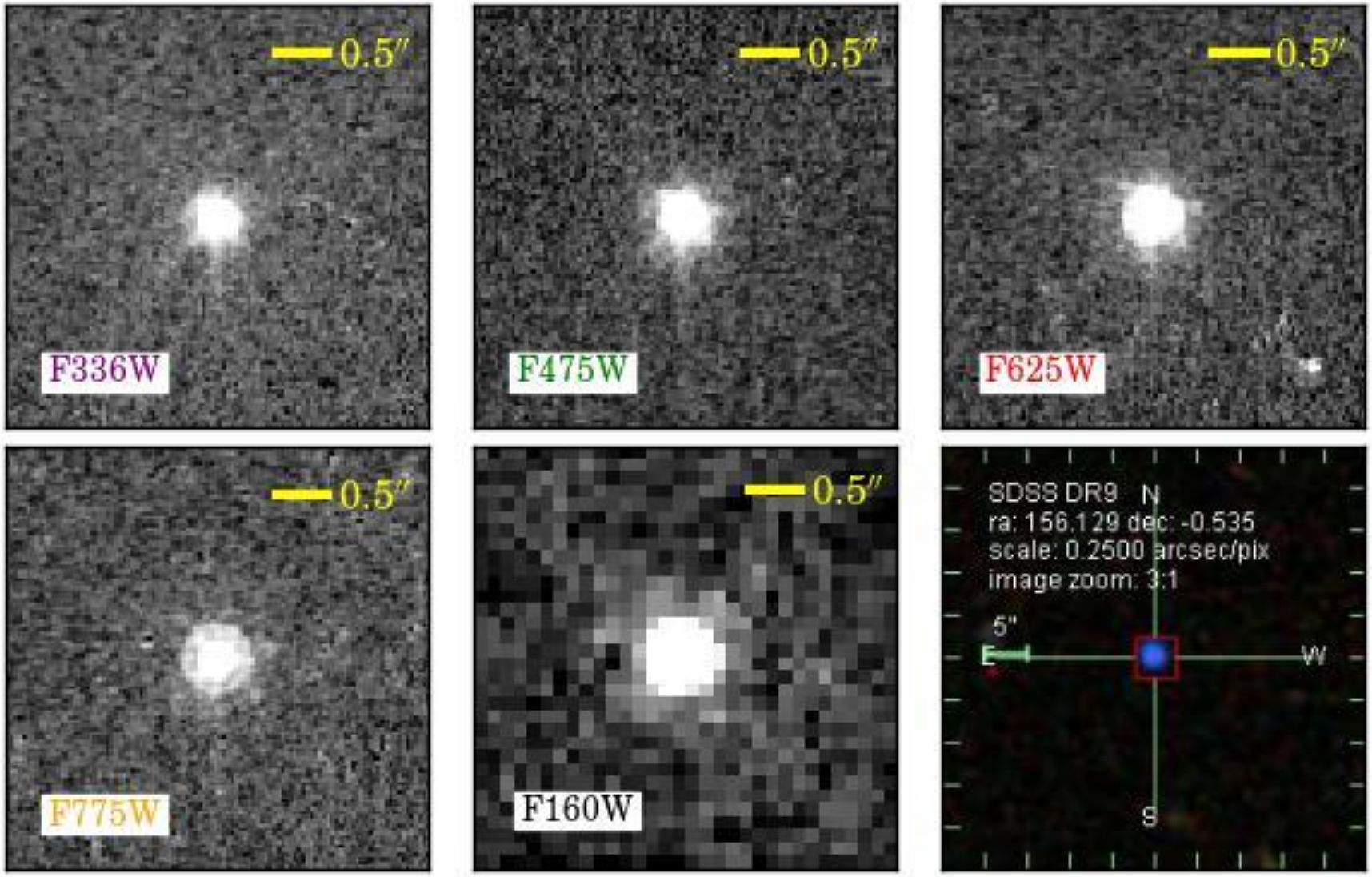
WD	S DSS-J	Sp	g	T_{eff}	log g	dist	E(B-V)
WD0100-006	010322.19-002047.6	DA0.7	19.09	71160	7.73	1547	0.04
WD0225-086	022817.17-082716.4	DA2.3	19.97	22321	7.89	785	0.03
WD0408-066	041053.63-063027.8	DA0.8	19.09	71160	7.73	1540	
WD0812+076	081508.78+073145.8	DA1.5	19.68	32287	6.81	2532	0.03
WD1021-002	102430.93-003207.0	DA1.2	18.88	41386	7.74	918	0.11
WD1204+023	120650.41+020142.4	DA2.0	18.65	24926	7.98	488	0.02
WD1300+104	130234.43+101238.9	DA1.2	16.98	42076	7.91	398	0.03
WD1312-029	131445.04-031415.6	DA1.1	19.05	46560	7.77	1540	0.05
WD1511+009	151421.26+004752.8	DA1.7	16.10	28999	7.81	161	0.04
WD1635+008	163800.36+004717.8	DA0.8	18.83	61806	7.19	505	0.08
WD1719+297	172135.97+294016.0	DA5.3	19.62	9426	8.26	239	0.00
WD2034-053	203722.17-051303.1	DA1.3	18.91	37833	7.89	791	0.09
WD2059-059	2010150.66-054551.0	DA1.7	18.66	28816	7.78	651	0.03
WD2327-000	232941.33+001107.9	DA2.4	18.12	21266	7.88	328	0.07

Method

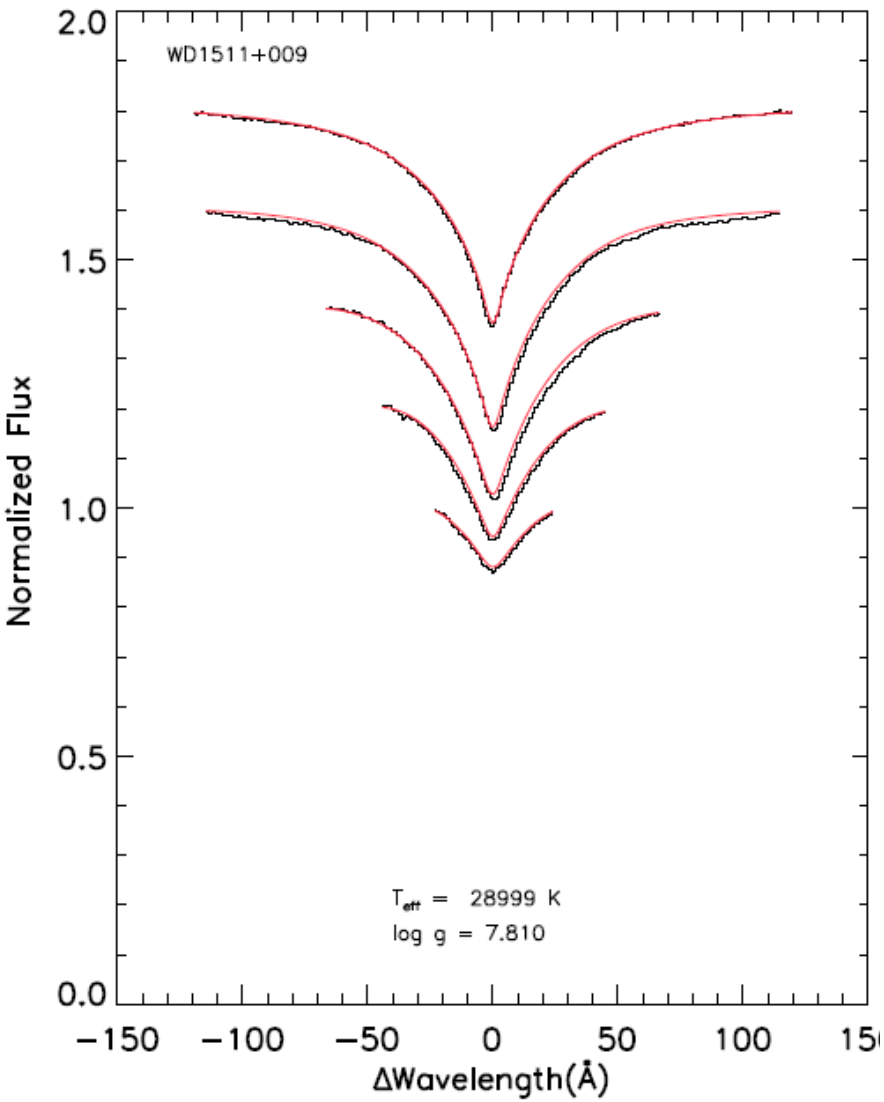
- **WFP3 Fluxes in 5 Bands (HST Scale)**
- **GMOS Balmer Spectra → T_{eff} , *log g***
- **NLTE Model Grid → *F(λ) detailed spectrum***
- **Determine Reddening**
- **Absolutely Calibrated Standard Stars**

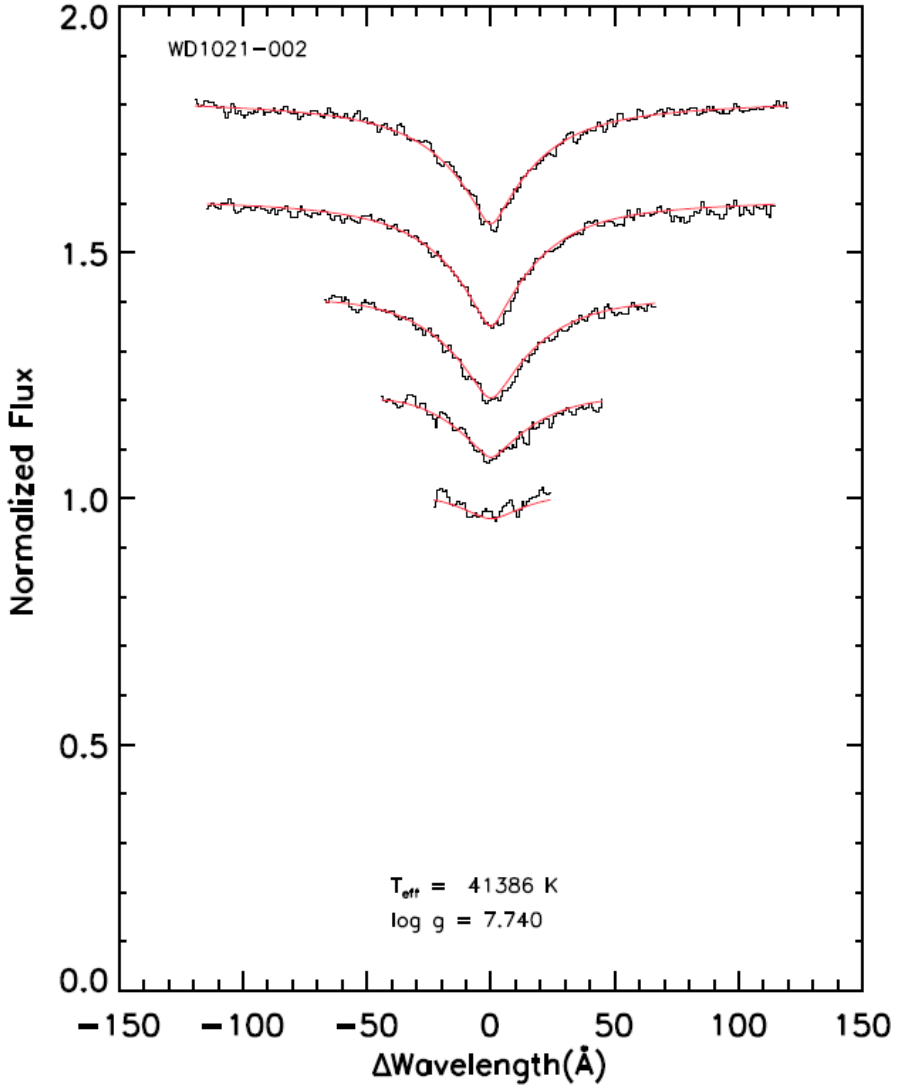
SDSS-J102430.93-003207.0

WD 1021-002



GMOS Spectra

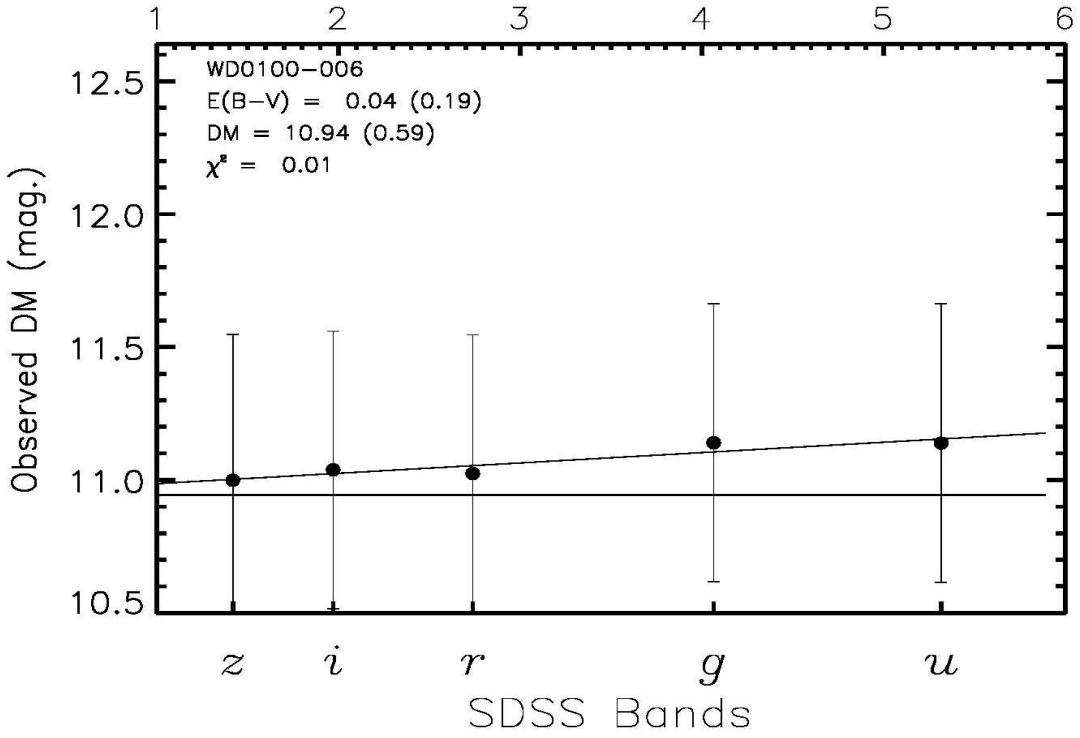




Interstellar Reddening

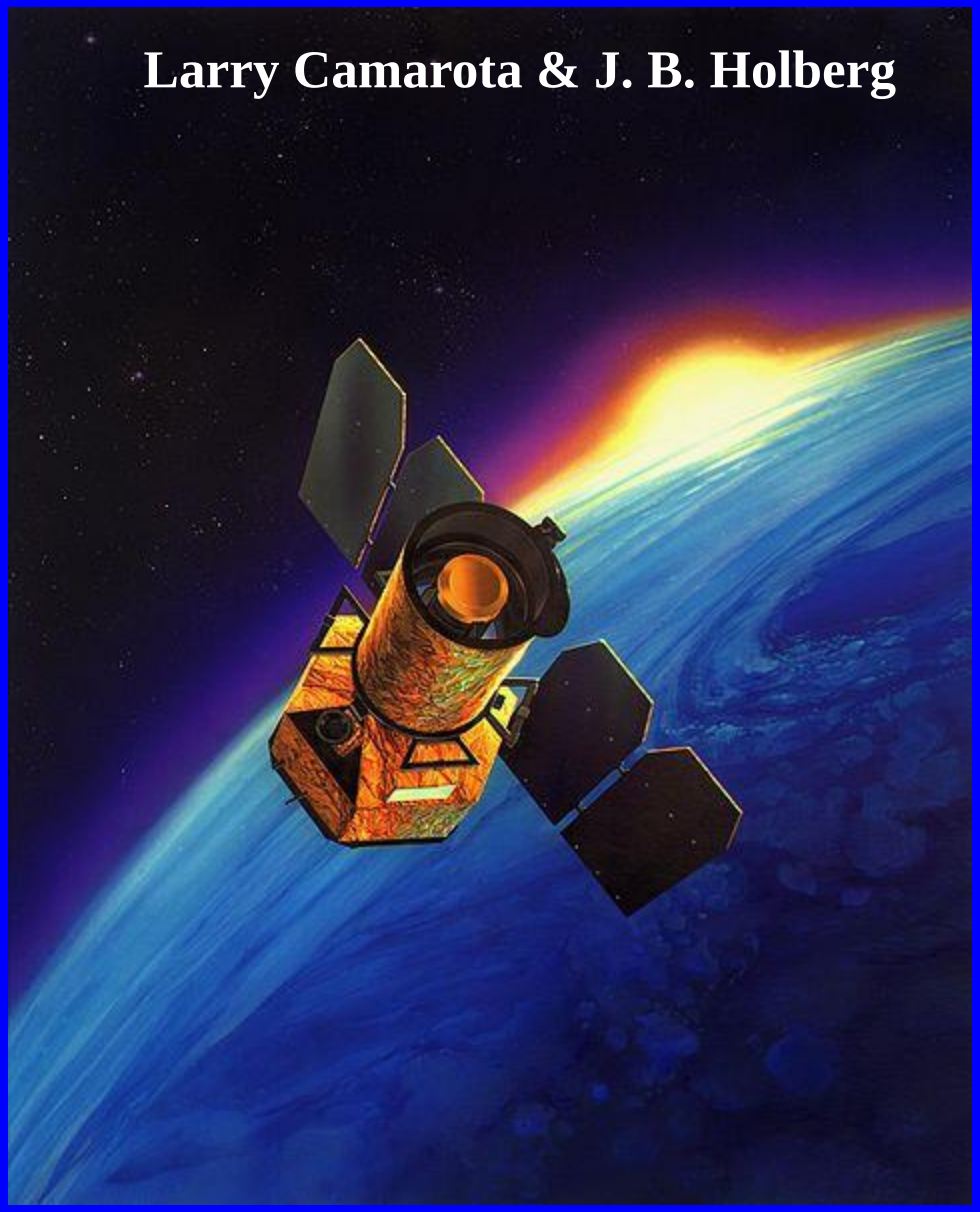
$$\mu_{DM} = \mu_0 + \vec{A}_\lambda \times E(B-V)$$

$\vec{A}_\lambda$ *Band Pass Weighted Extinction*



Revising GALEX Photometric Calibration

Larry Camarota & J. B. Holberg



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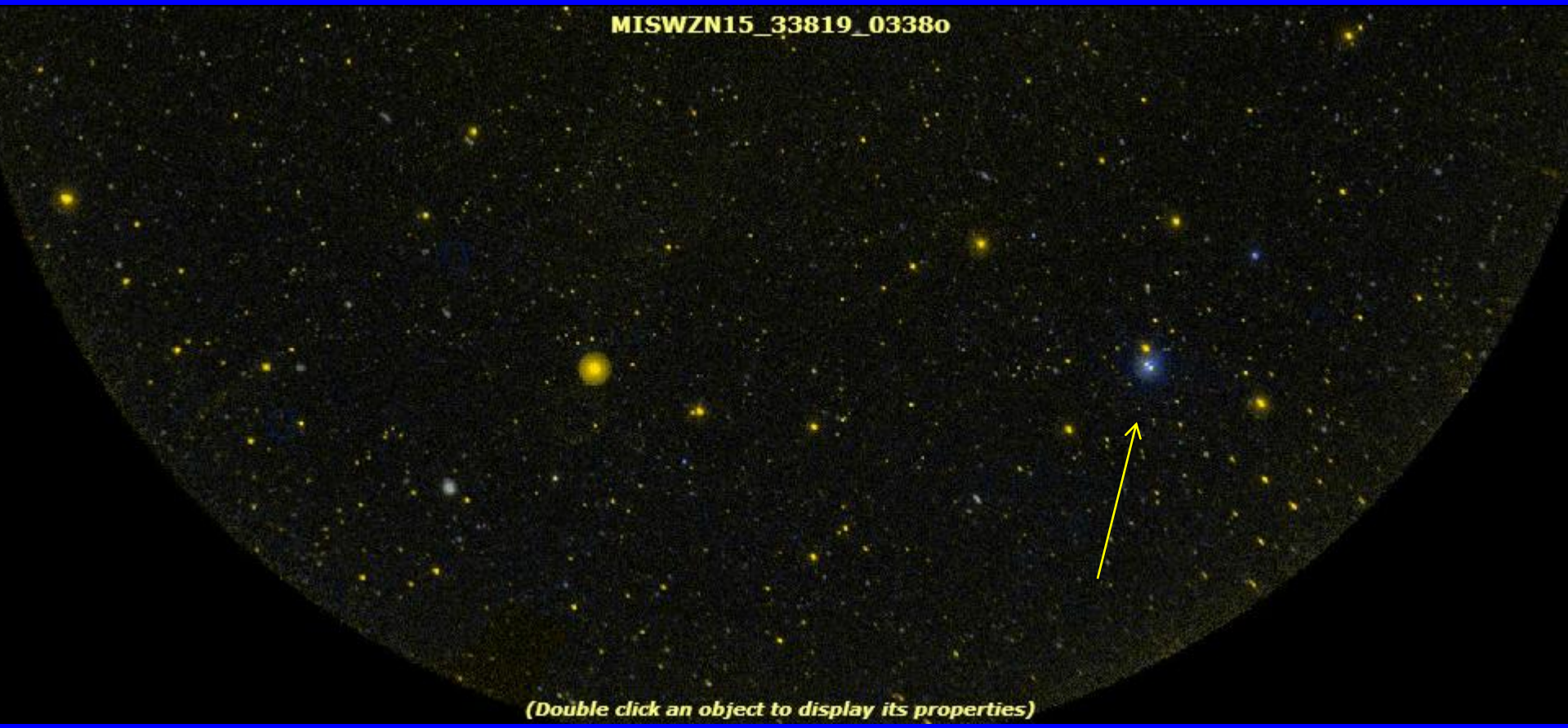
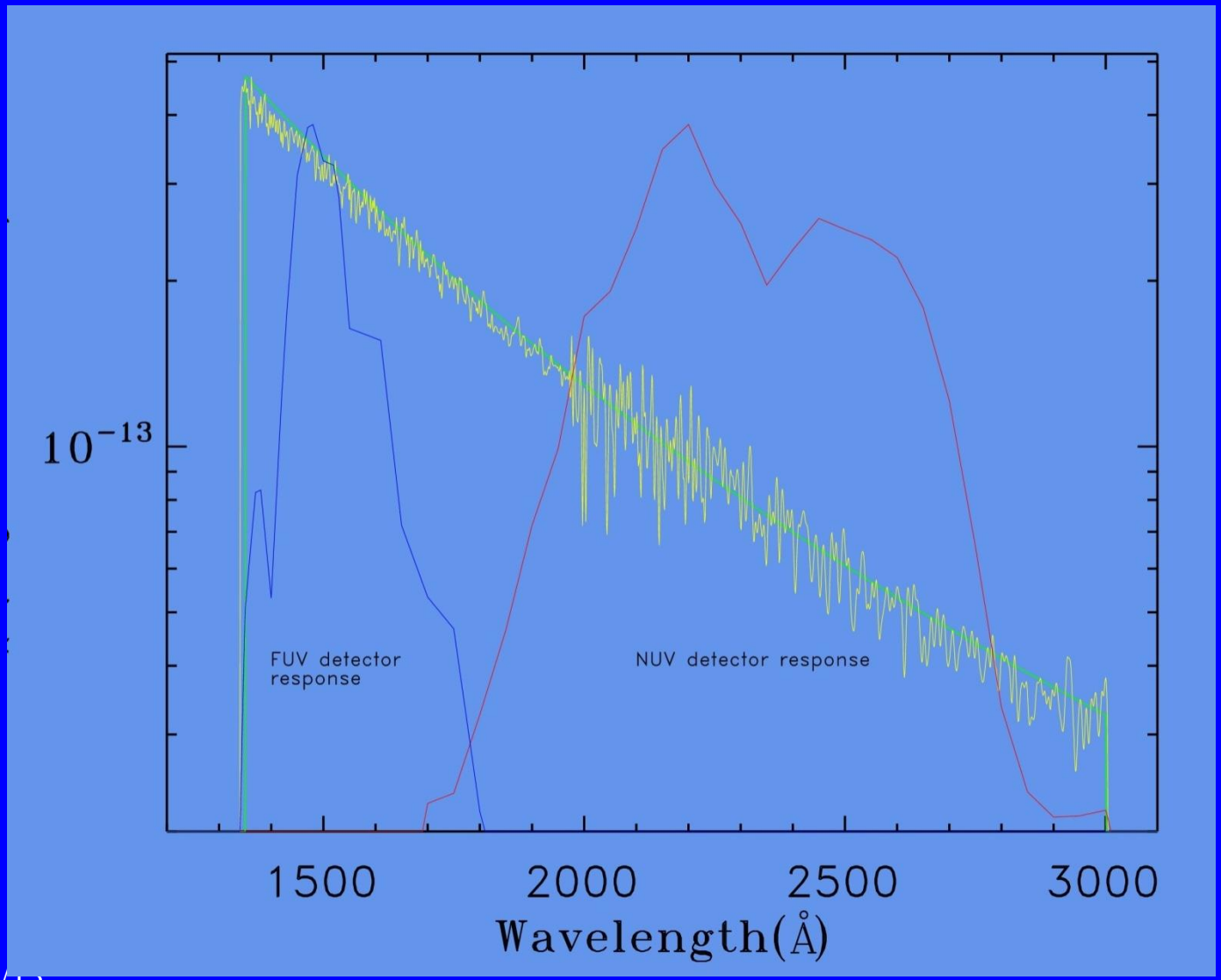
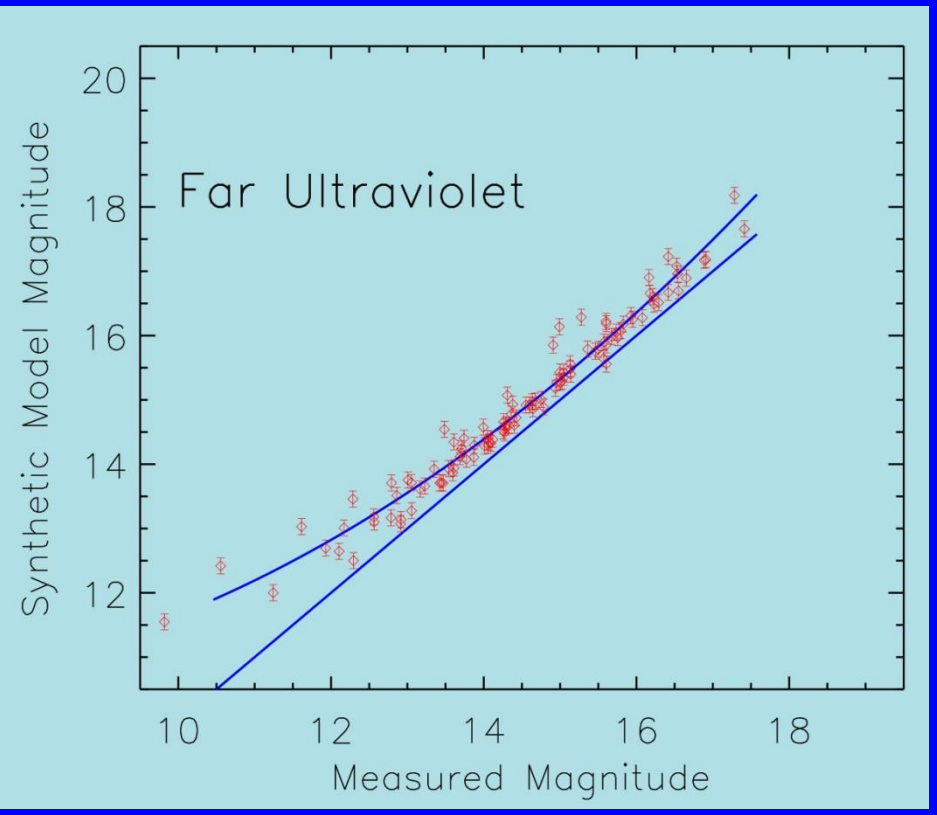
GALEX Image of WD1511+009

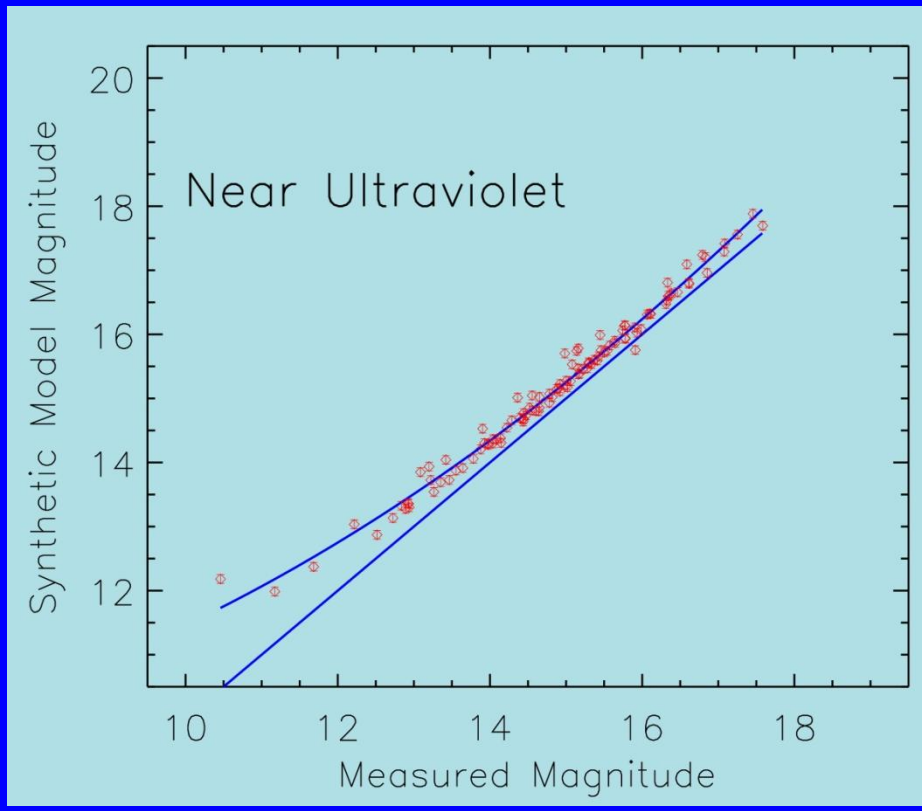


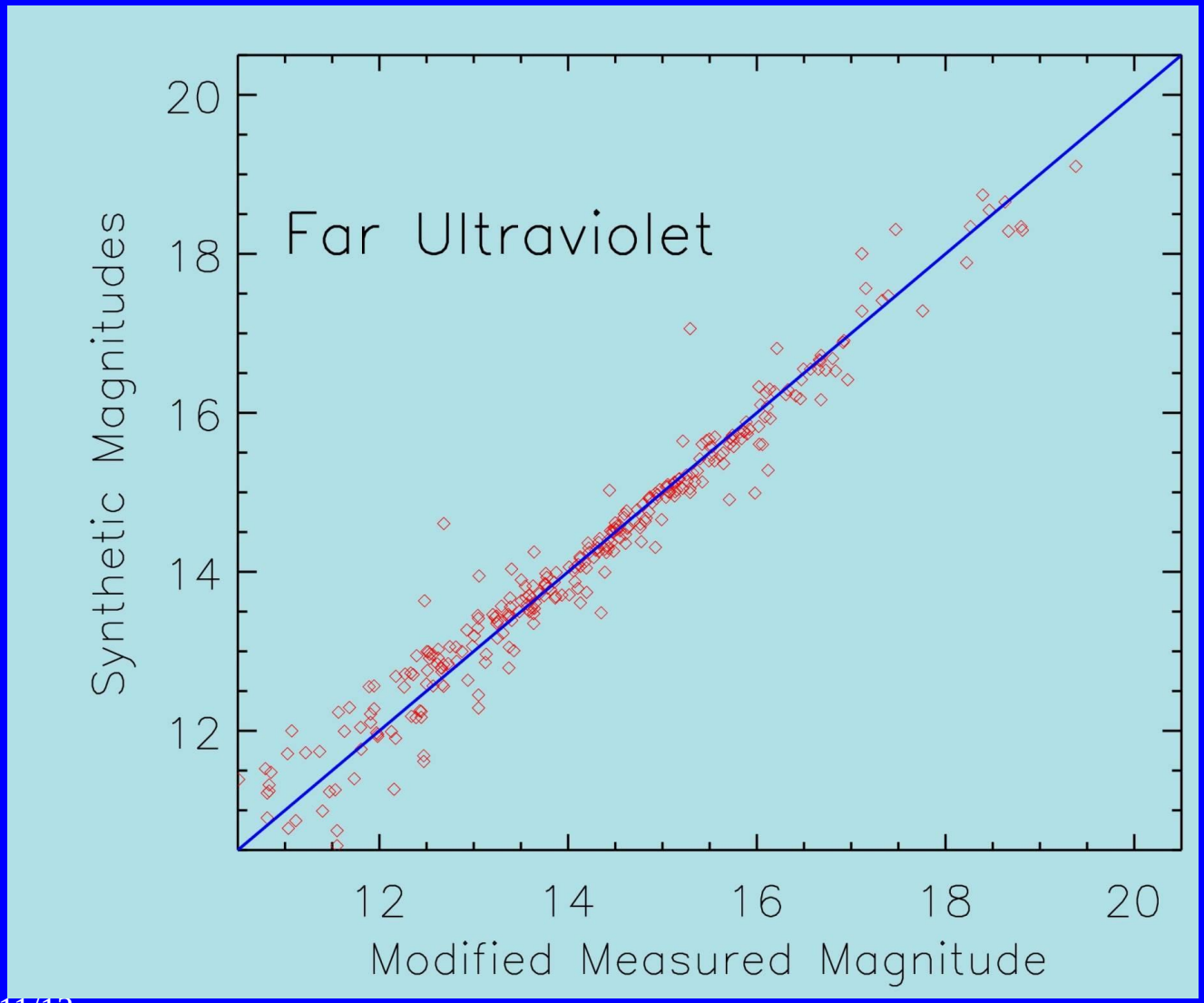
GALEX Pass bands With WD SED

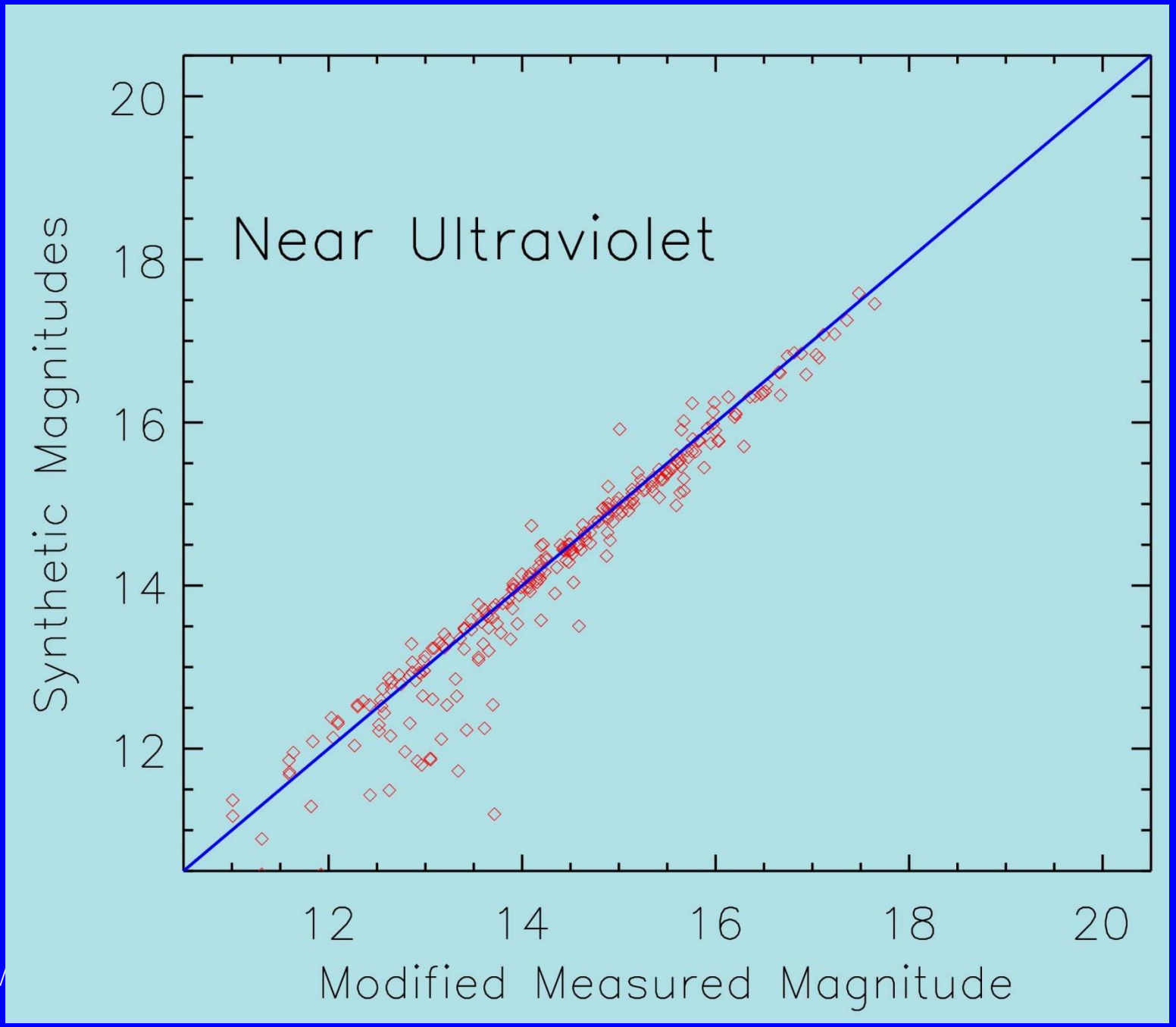


GALEX *Observed (measured)* vs *Expected*






Far Ultraviolet
Synthetic Magnitudes
Modified Measured Magnitude
12
14
16
18
20
12
14
16
18
20


Near Ultraviolet
Synthetic Magnitudes
Modified Measured Magnitude
12
14
16
18
20
12
14
16
18
20

Conclusions

- **A New Generation of faint Standards**
- **Photometric and Spectrophotometric**
- **Wide Range of λ**
- **Arbitrary Resolution – Noiseless**
- **Directly Tied to HST Scale**

Do it right. It will out live us all.