“Understanding” Milky Way Dust with Precursor Data

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LSST DESC Photometric Calibrations WG Co-Convener

Last kpc Workshop
December 15th, 2015

Large Synoptic Survey Telescope

DARK ENERGY SURVEY

Outline

- Phenomenological View of Dust
- Impact on red galaxy photo-*z*s
- SDSS, DES, and the Future

DESC Photometric Calibration

- New Large Synoptic Survey Telescope Dark Energy Survey Collaboration Photometric Calibrations Working Group
  - LSST DESC PC WG
- Co-Conveners: Myself & Nicolas Regnault
- Minimize systematic errors from PC residuals
  - Instrumental throughput
  - Atmospheric transmission
  - Galactic dust
- Work with LSST DM

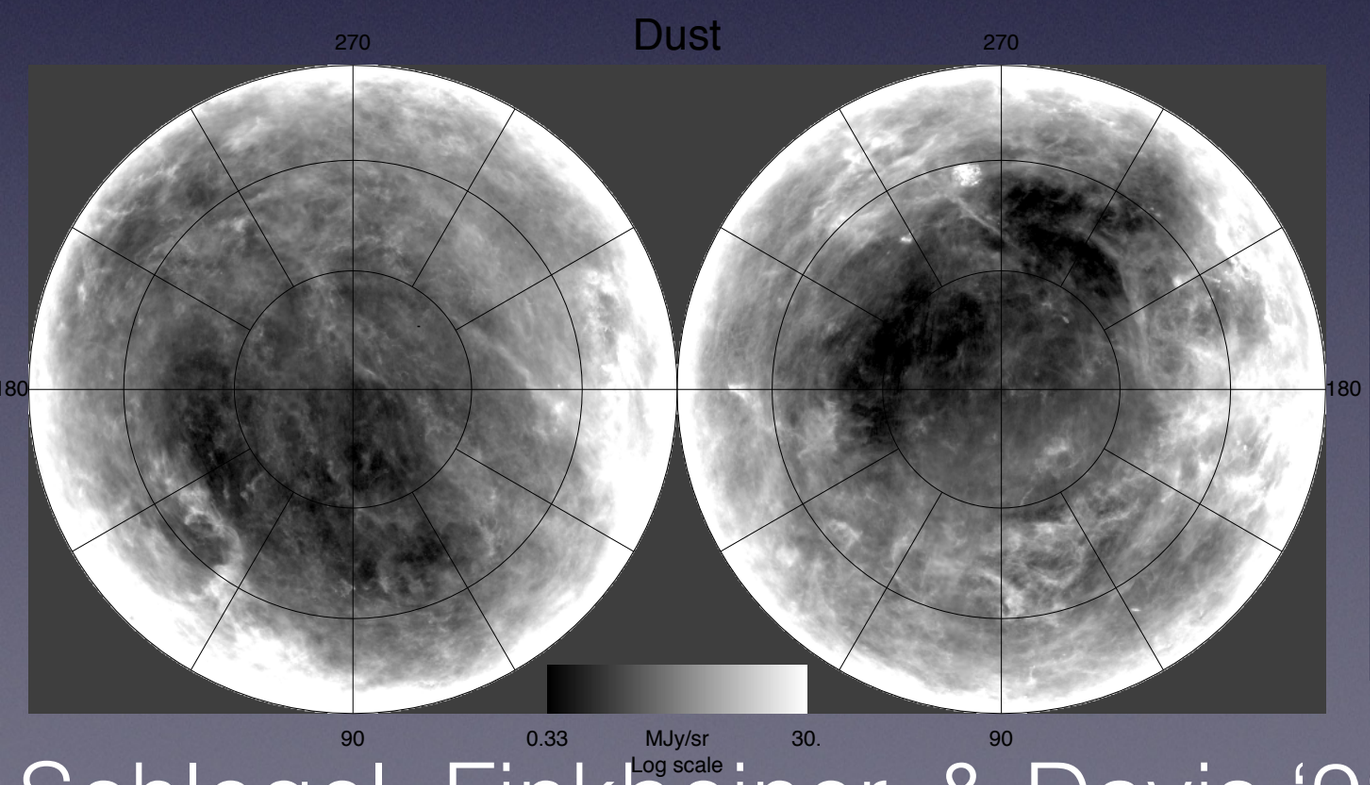
DESC Photometric Calibration

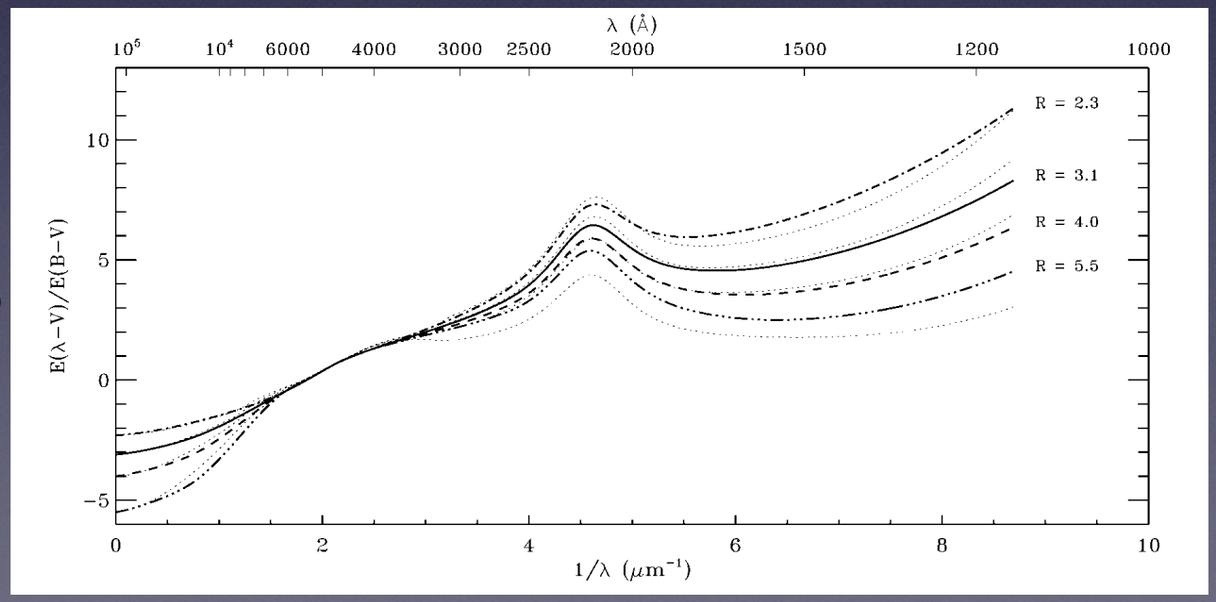
- If you are a DESC member, please subscribe to LSST-DESC-CALIB@slac.stanford.edu
- First telecon: This Thursday (Dec. 17) at 8am PST
- Please join us!

Practical Dust

- 100μm dust emission map from SFD98
- Dust absorption law from O'Donnell 94 or F99
- SFD98 on fine (5') scales gives total amount of dust; dust law gives color variations

$$R_V = \frac{A(V)}{E(B-V)}$$



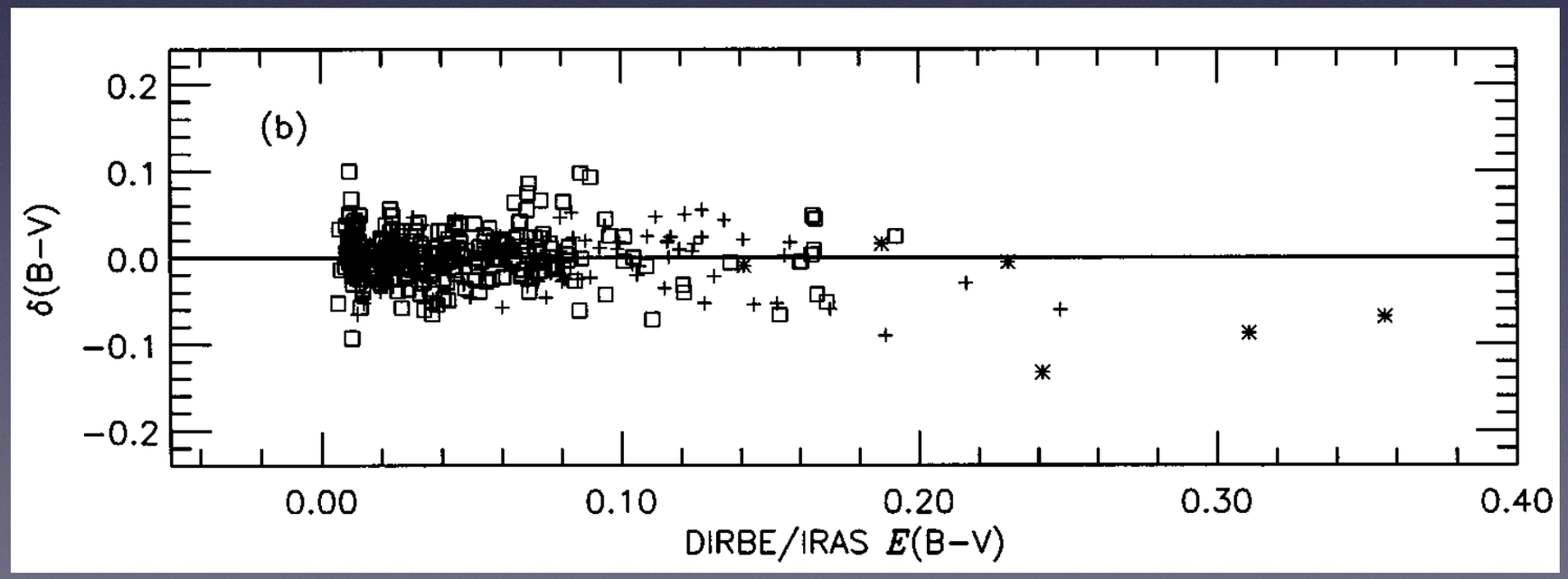


Schlegel, Finkbeiner, & Davis '98

Fitzpatrick 99

Practical Dust II

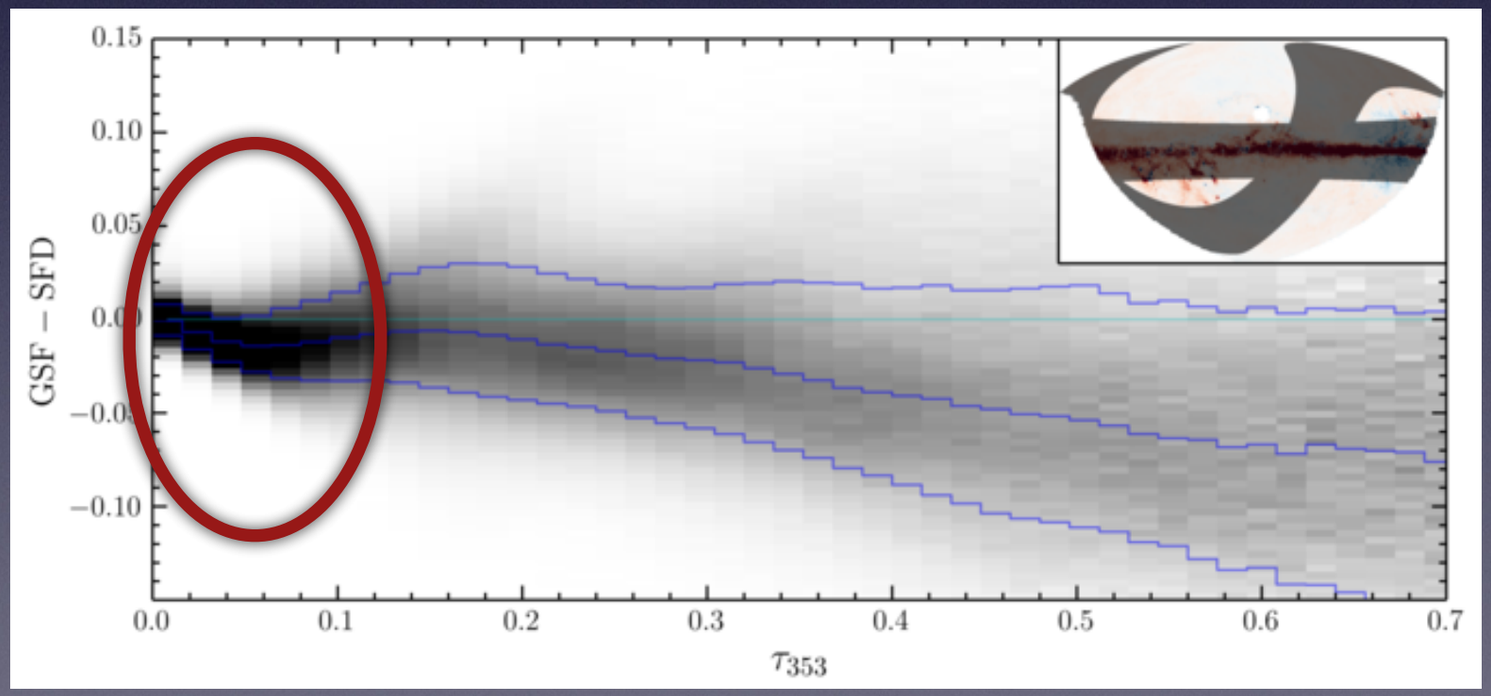
- How do you go from 100μm dust emission to dust absorption?
  - Use red galaxies
  - *B-R* Colors (172 galaxies) and Mg_2 to *B-V* (389 galaxies)
- Determine single constant



SFD98

Or Can Use Stars…

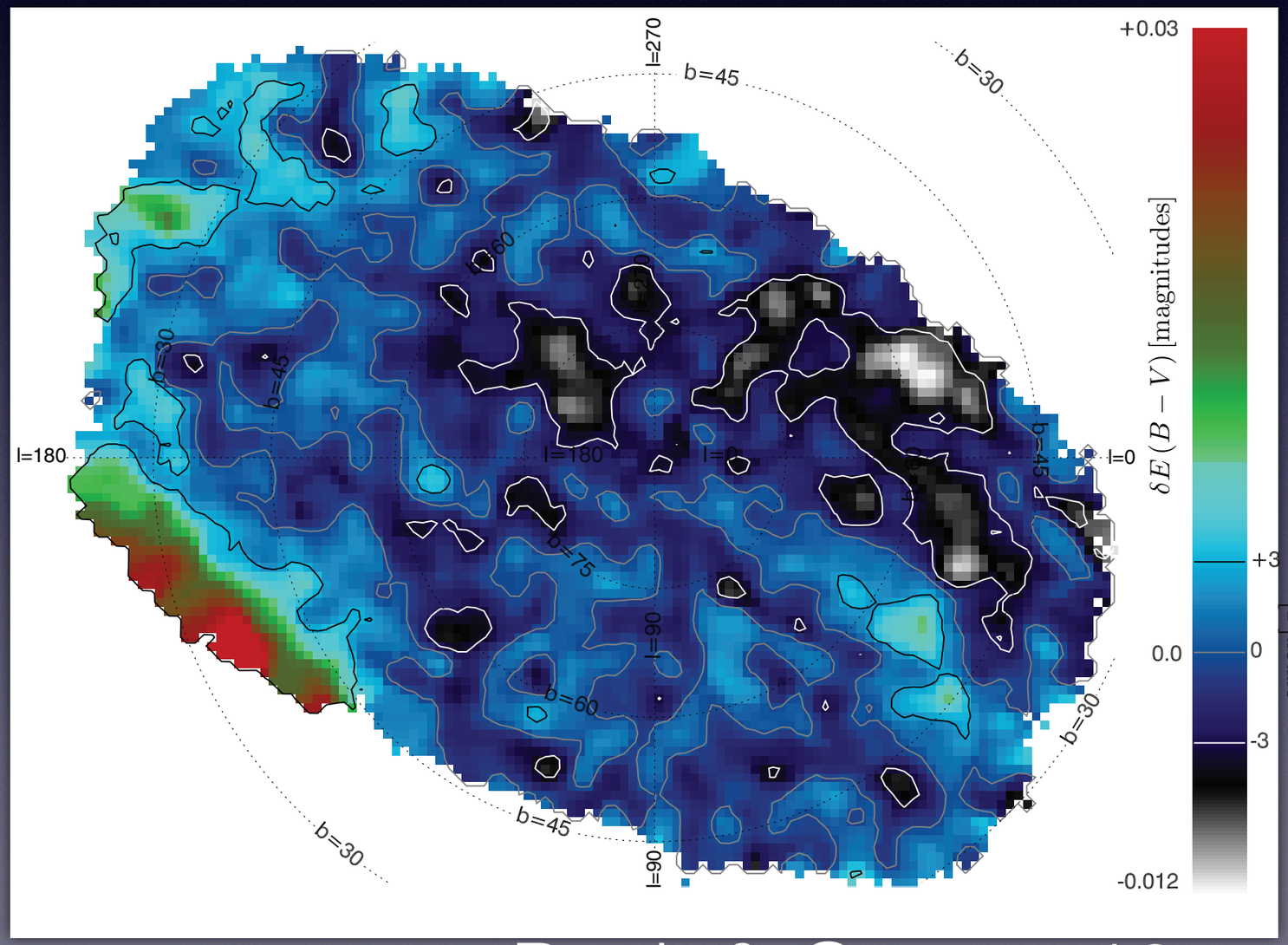
- Green, Schlafly, Finkbeiner et al. use spectroscopic stars to make 3D dust map
  - Assume constant, uniform reddening law
- What's going on there at low reddening?



Green+15 (see poster)

Or Red Galaxies

- PG10 use spectroscopic red galaxies in SDSS to get corrections to SFD98 map
  - Assume constant, uniform reddening law
- Deviations typically <3mmag, up to 45 mmag



Peek & Graves 10

But…

- See Doug Funkbeiner's talk from Monday

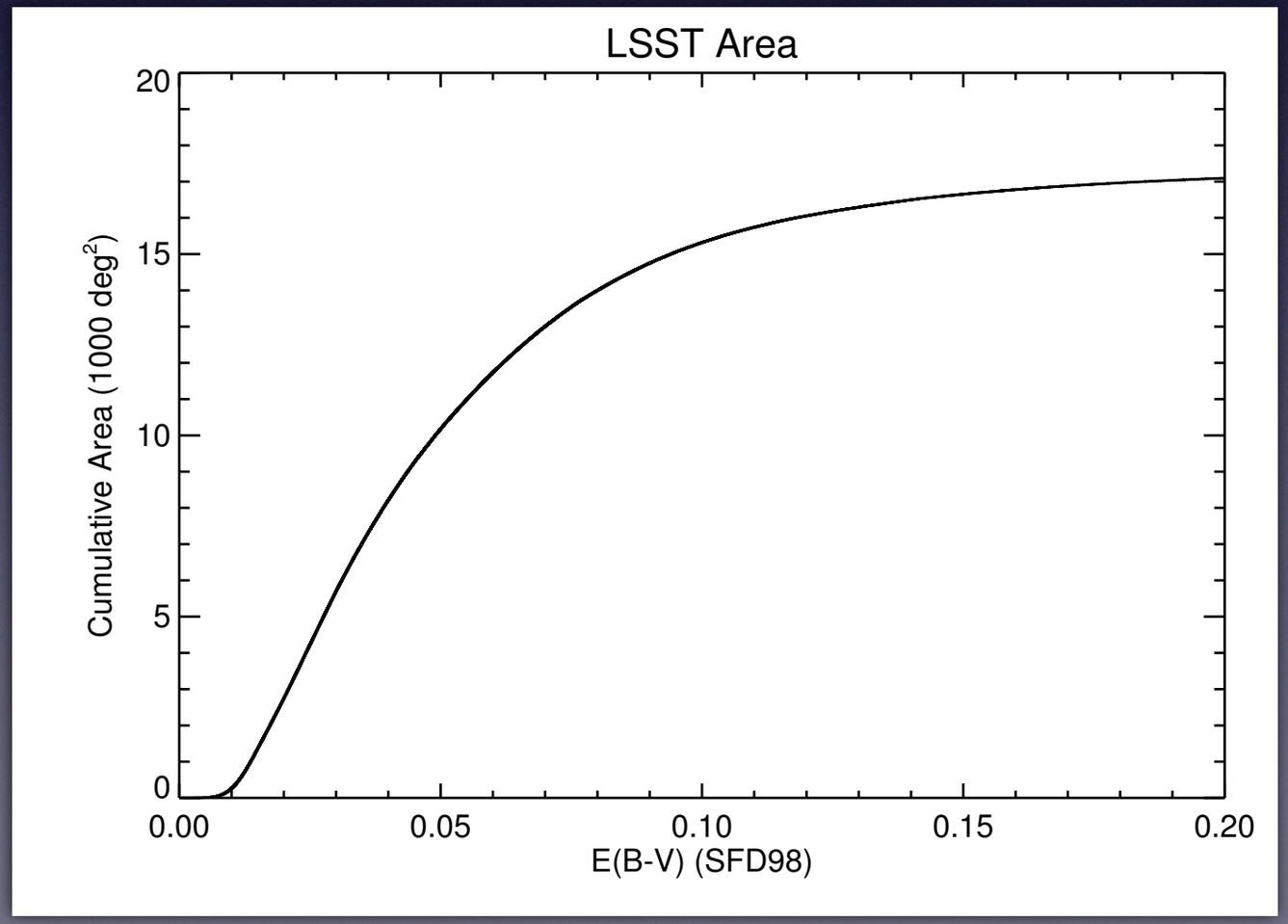
- Star constraints are noisy
  - Also dependent on quality of calibration

- Far IR emission constraints have large-scale structure leakage (ouch)
  - Also dependent on (independent) calibration

- What about varying dust law (see Schlafly poster; also Nataf et al. 2015)

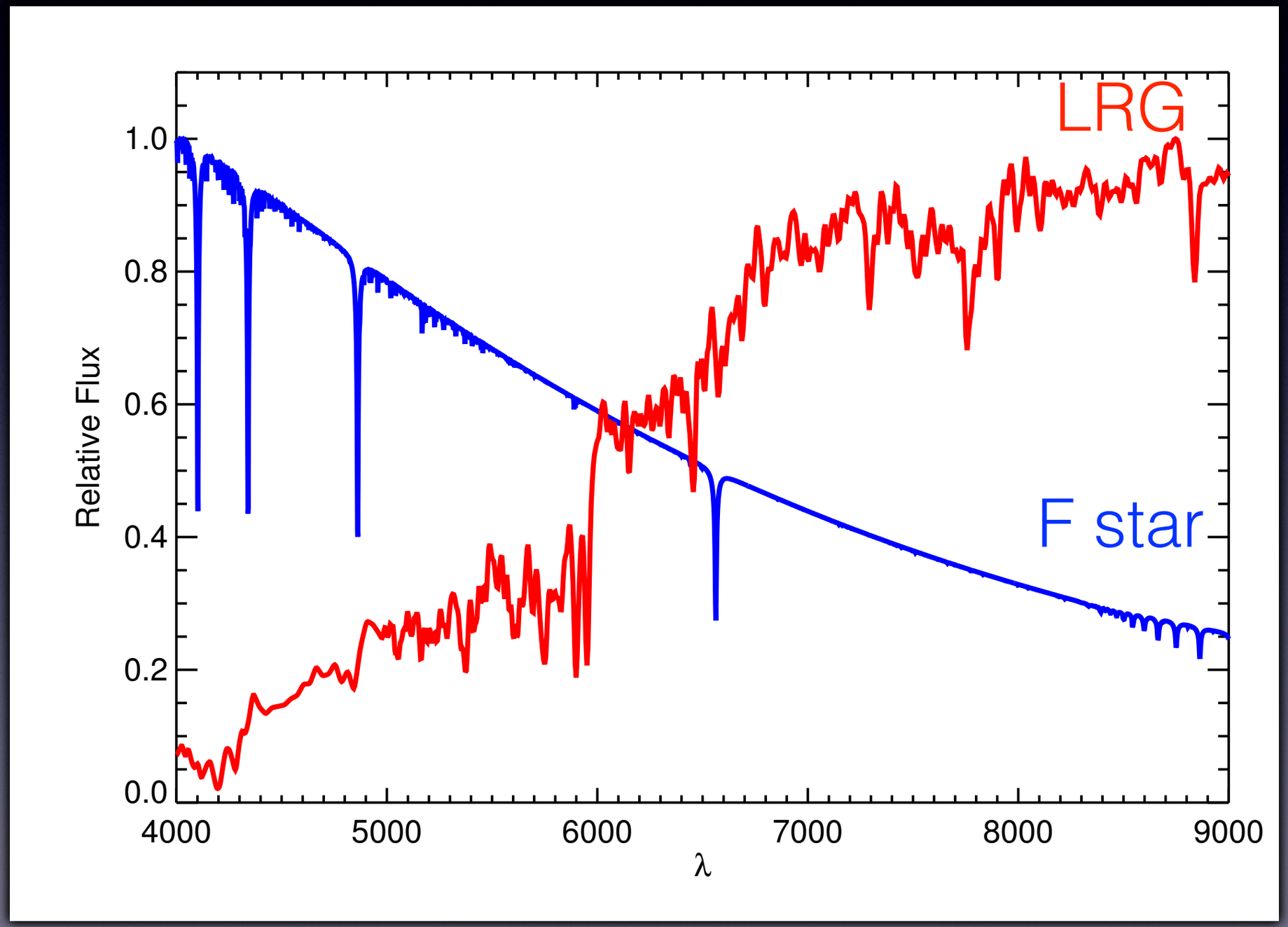
Impact on LSST

- How much area would we lose?
  - Can we just throw out half the LSST footprint
    - Maybe?
- "Yahata problem"
  - Does smoothing the map help?
- Note that LSST (& DES) footprint w/o wealth of spectra as in North



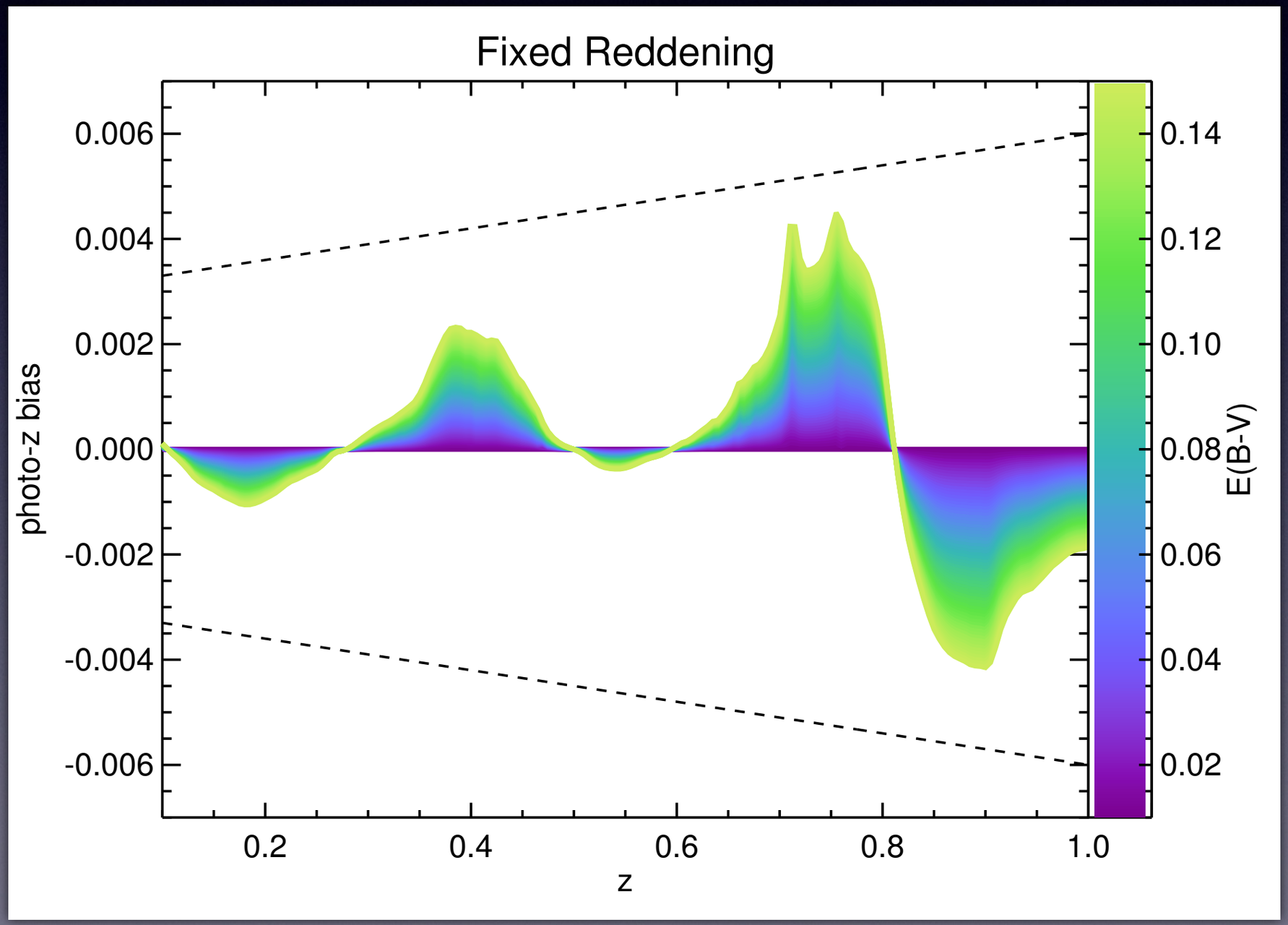
Looking at Galaxies

- Watch out: galaxies are not stars



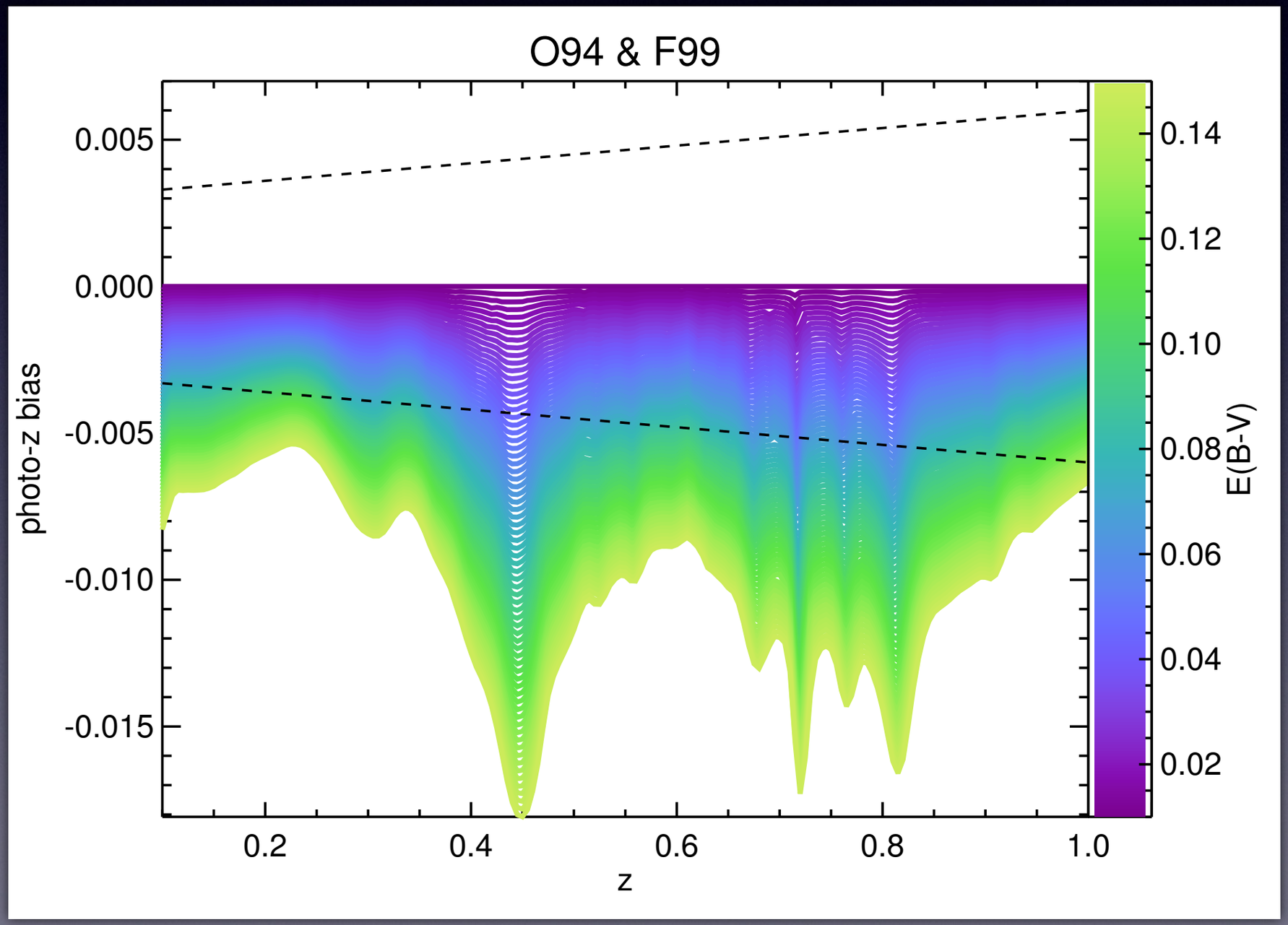
Integrating the Spectrum

- Impact on red galaxy photo-*z* (e.g. redMaGic from Rozo, Rykoff+15)



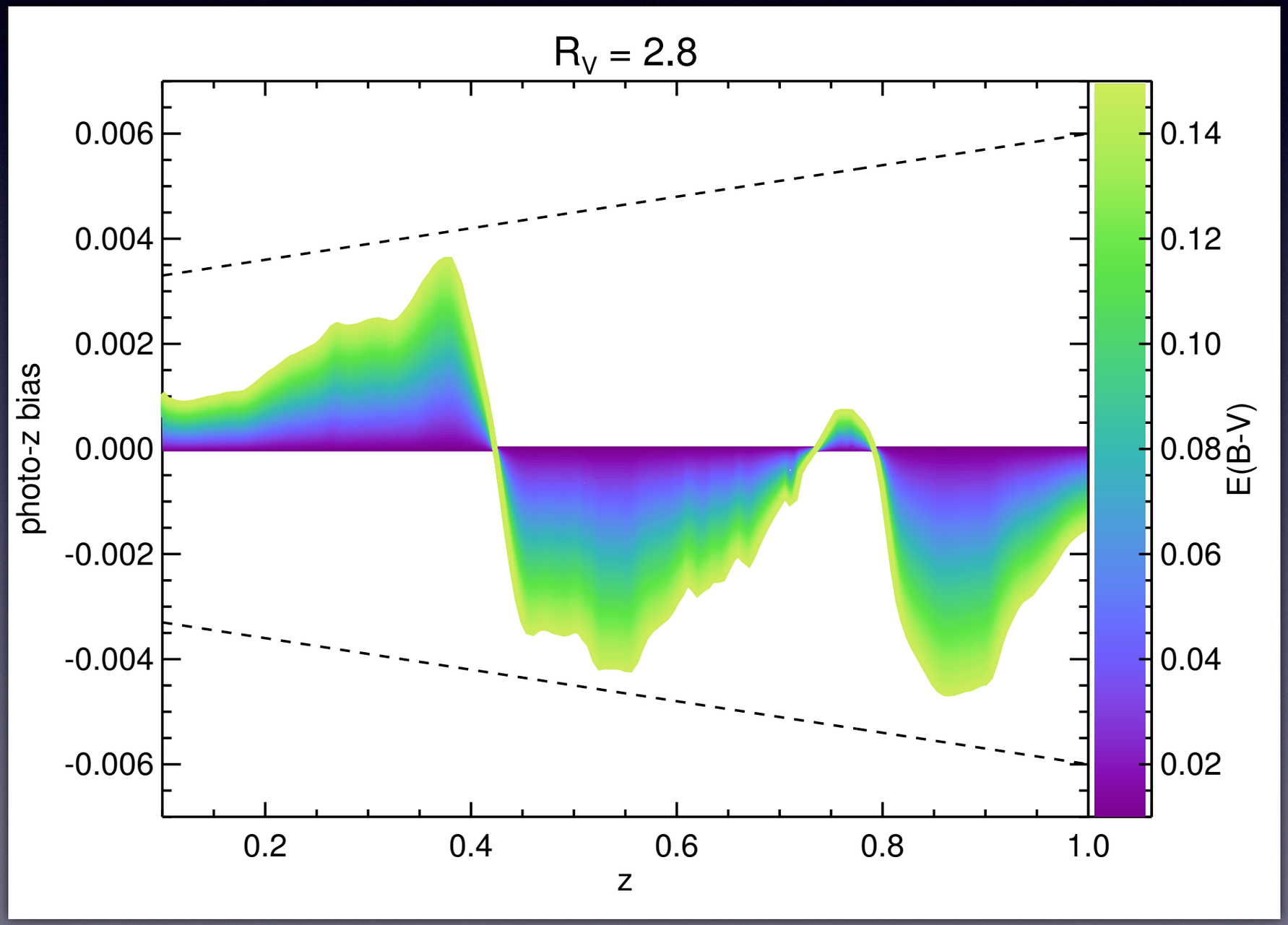
Wrong Reddening Law?

- What if we have the wrong reddening law?
  - DES griz magnitudes



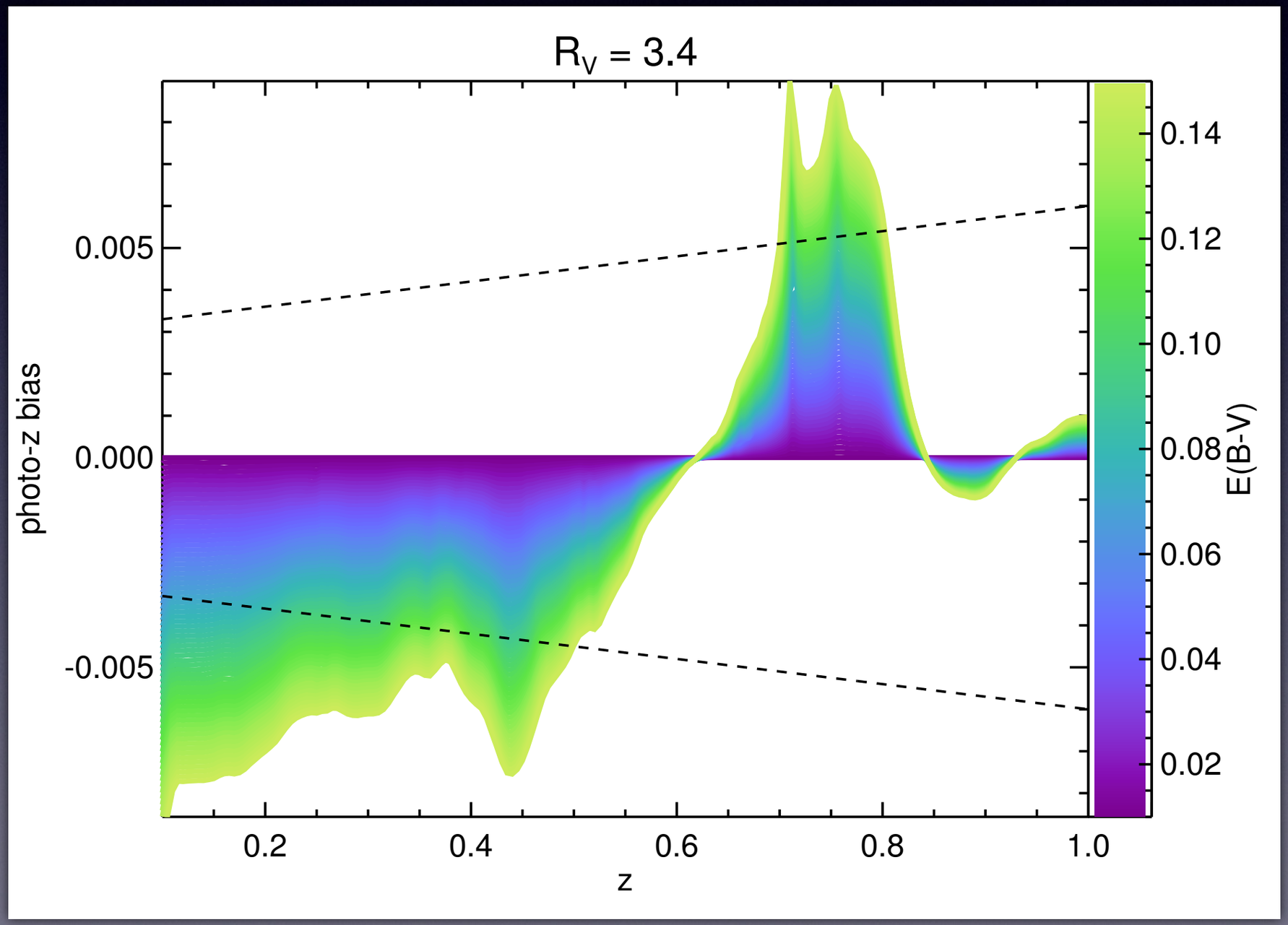
Wrong R_V?

- What if R_V=2.8, assume it's 3.1?
  - DES griz magnitudes



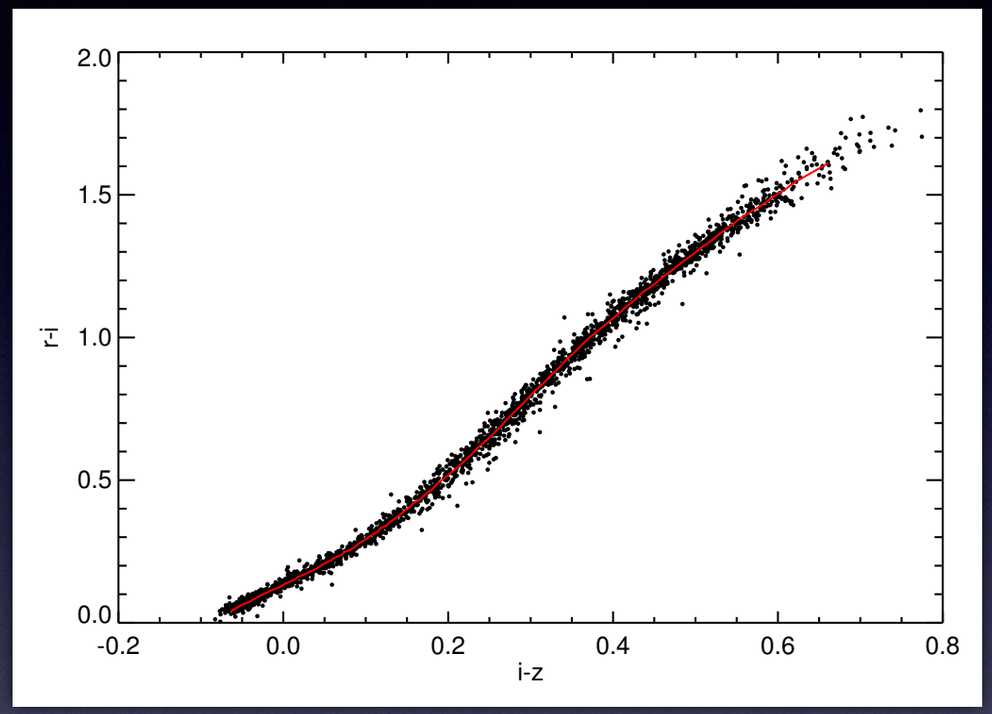
Wrong R_V?

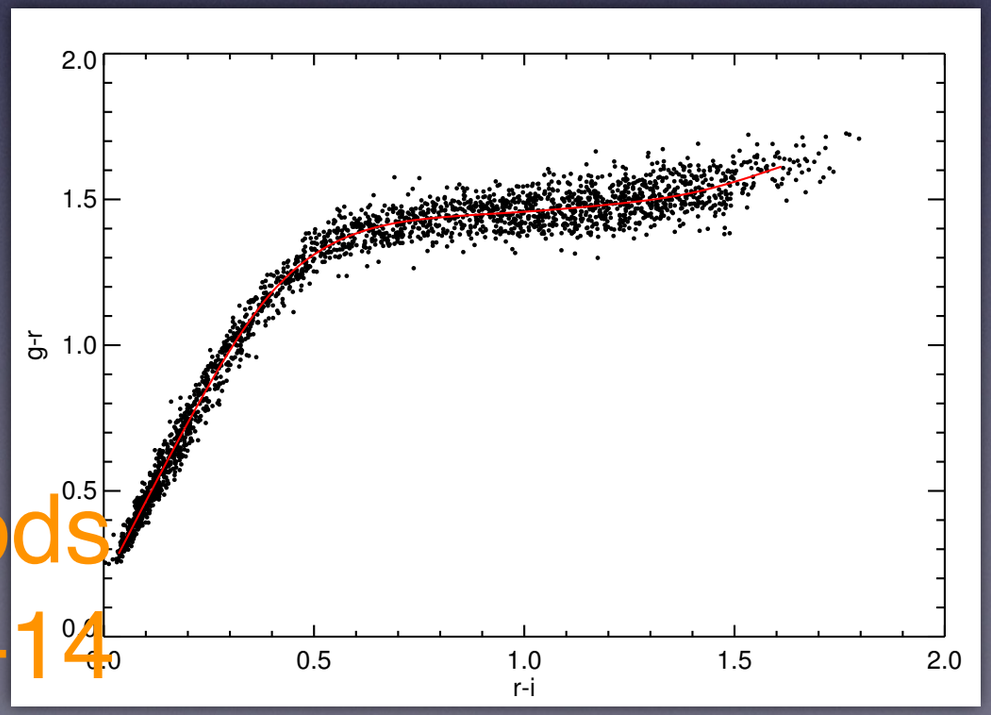
- What if RV=3.4, assume it's 3.1?
  - DES griz magnitudes

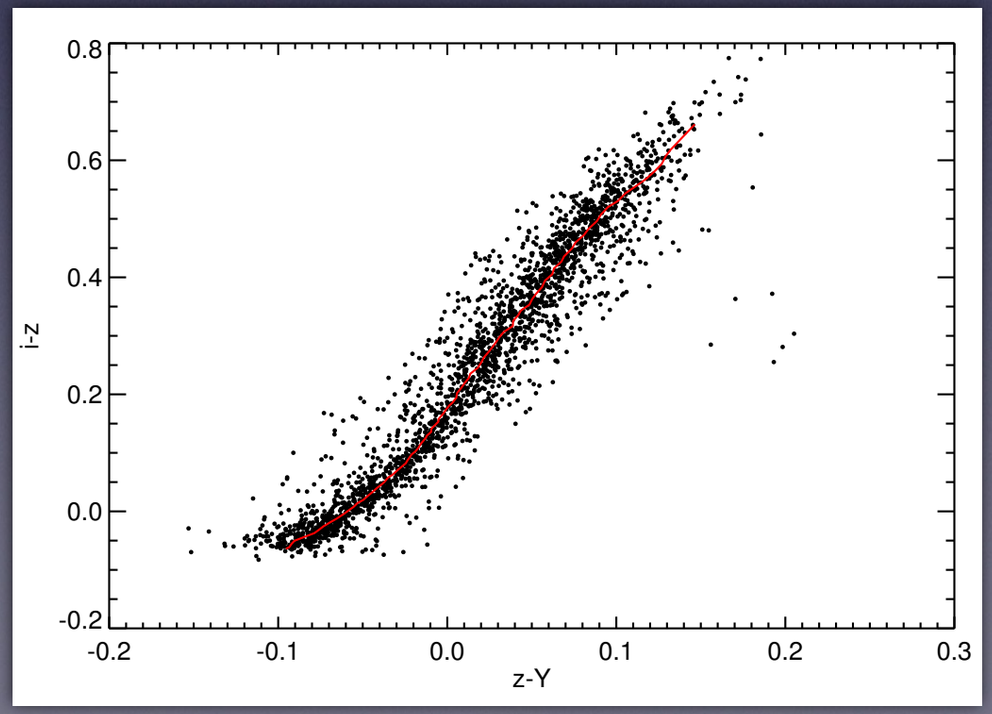


The Stellar Locus

- Stars are noisy…but maybe still useful?
- Stars are behind dust
- Pixelize the sky (14' resolution) and track color shifts — mix of calib. and reddening errors



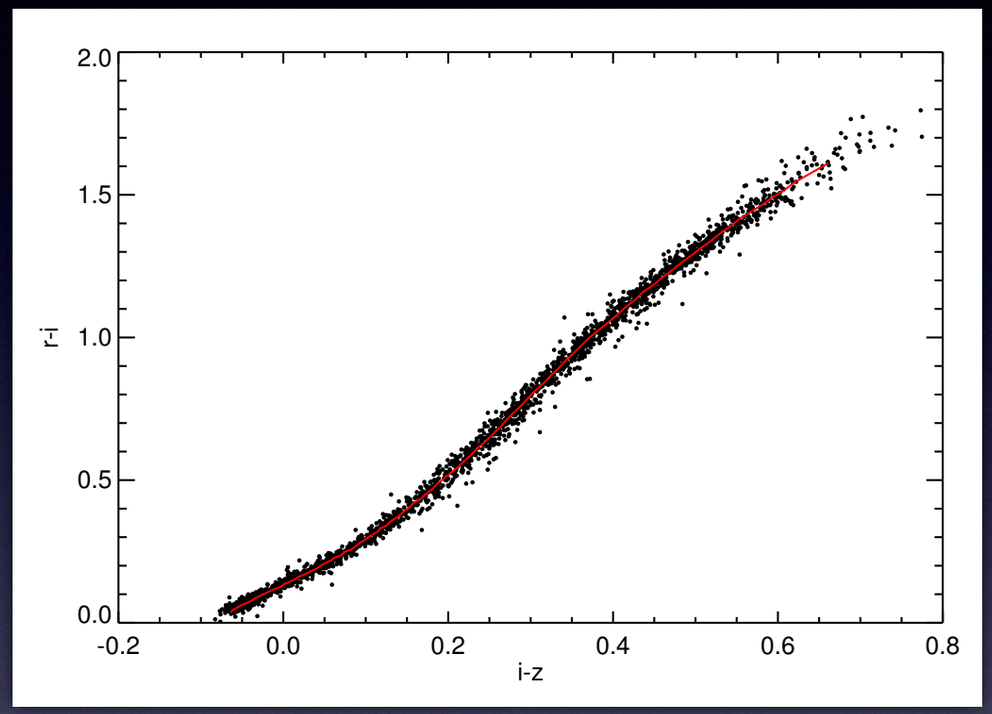


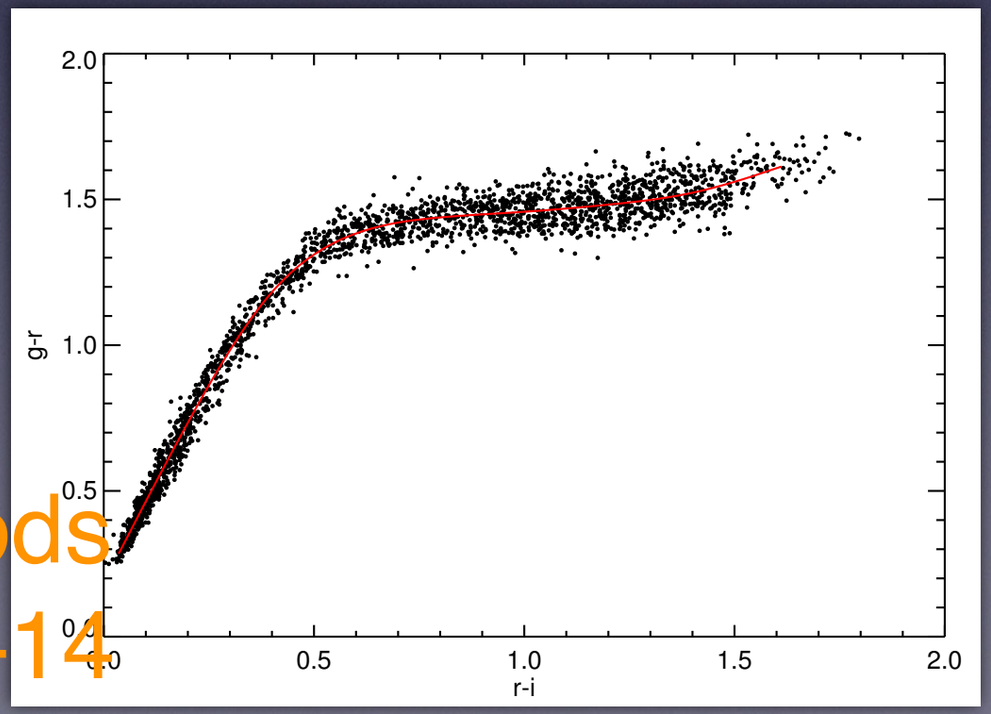


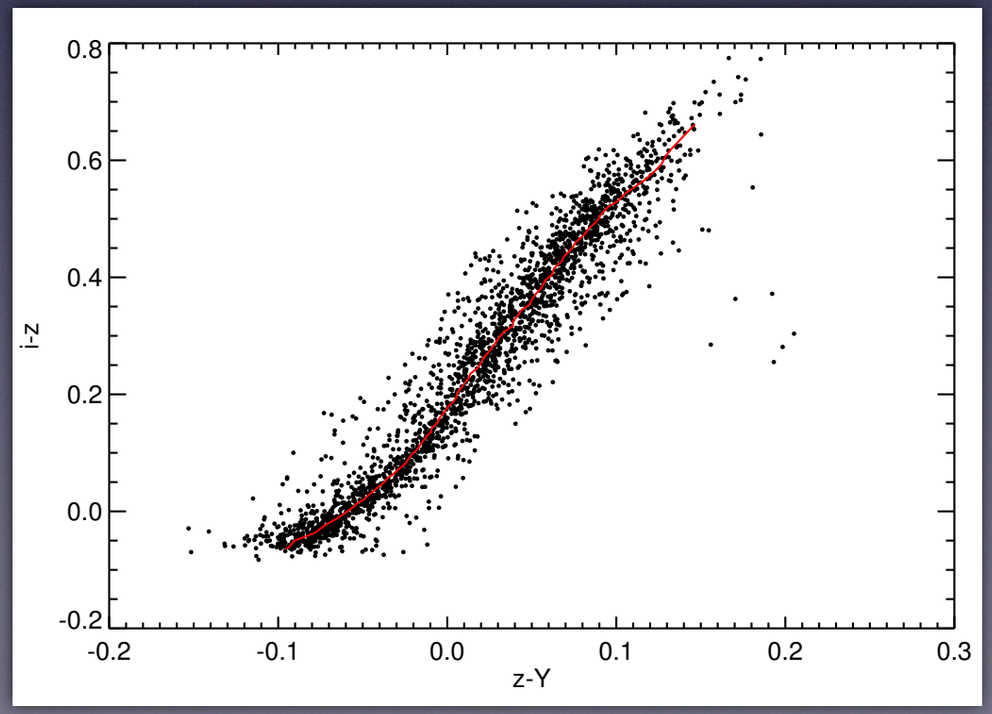
SLR methods from Kelly+14

The Stellar Locus

- Could be issues with metallicity (but Yuan+15 claims few mmag after correction)
  - I have not performed any metallicity corrections yet…



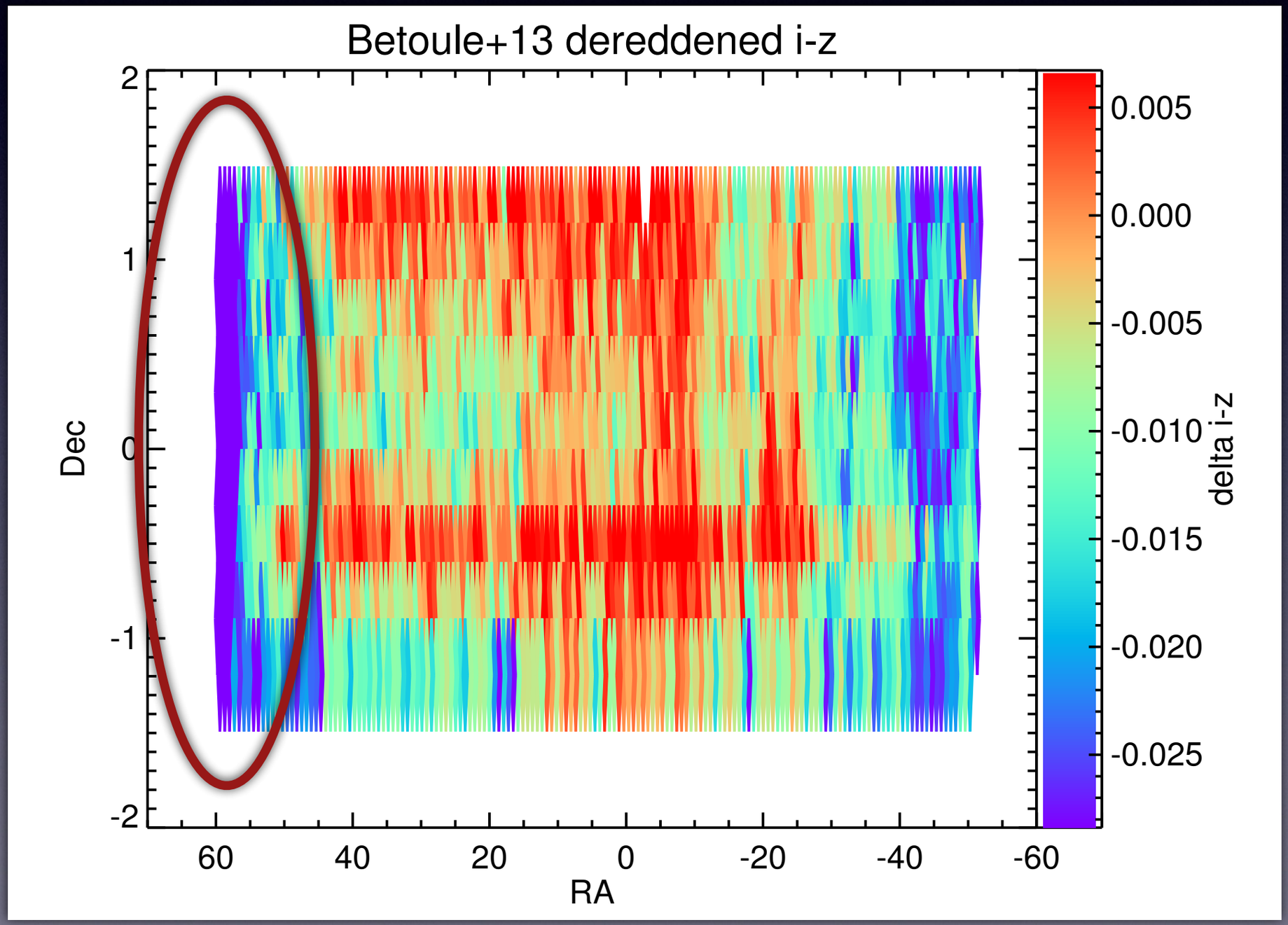




SLR methods from Kelly+14

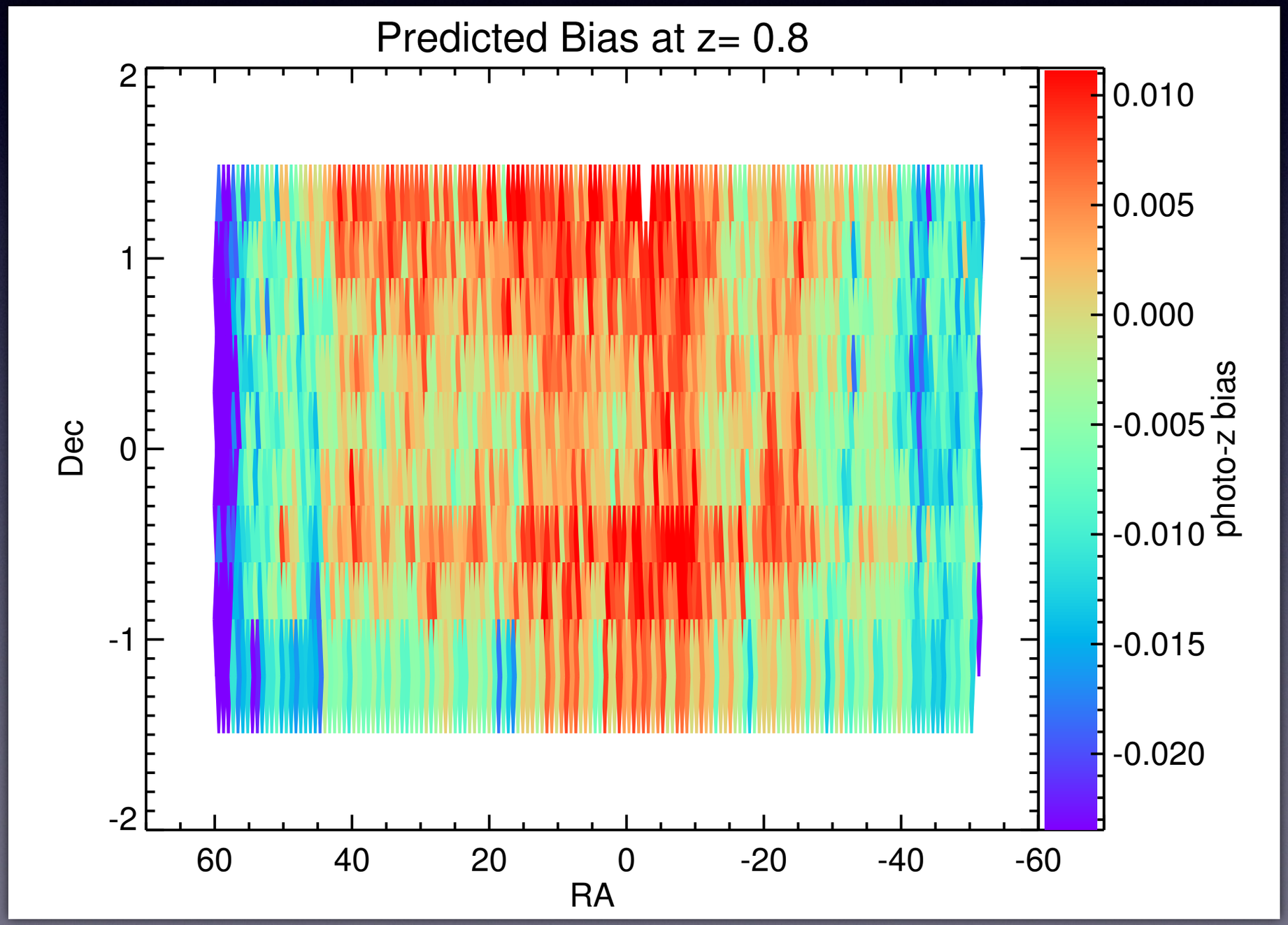
Betoule+13

- Betoule recalibration of MegaCam & S82
  - See also talk by David Burke



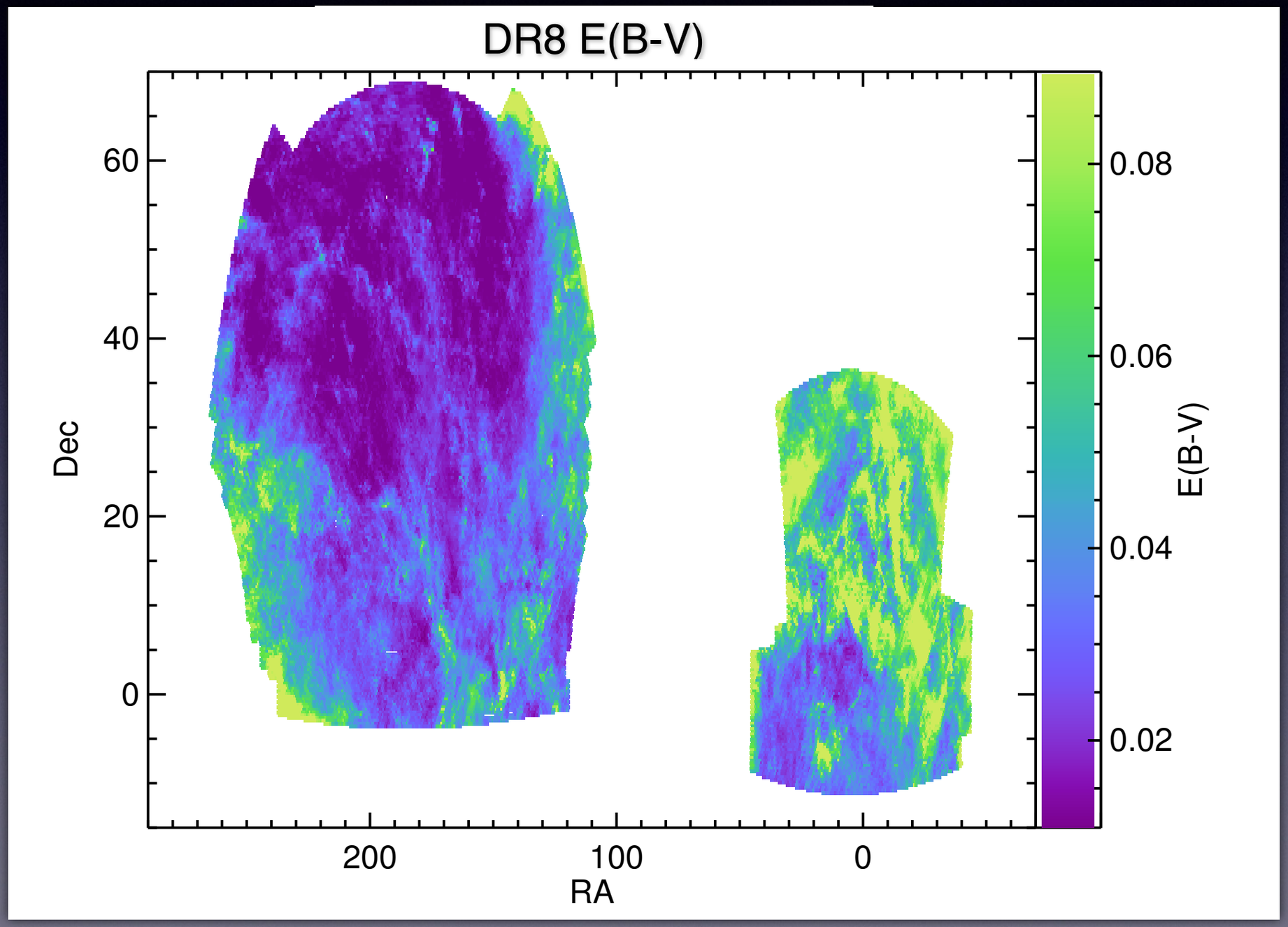
Betoule+13

- Spatially correlated photo-z residuals



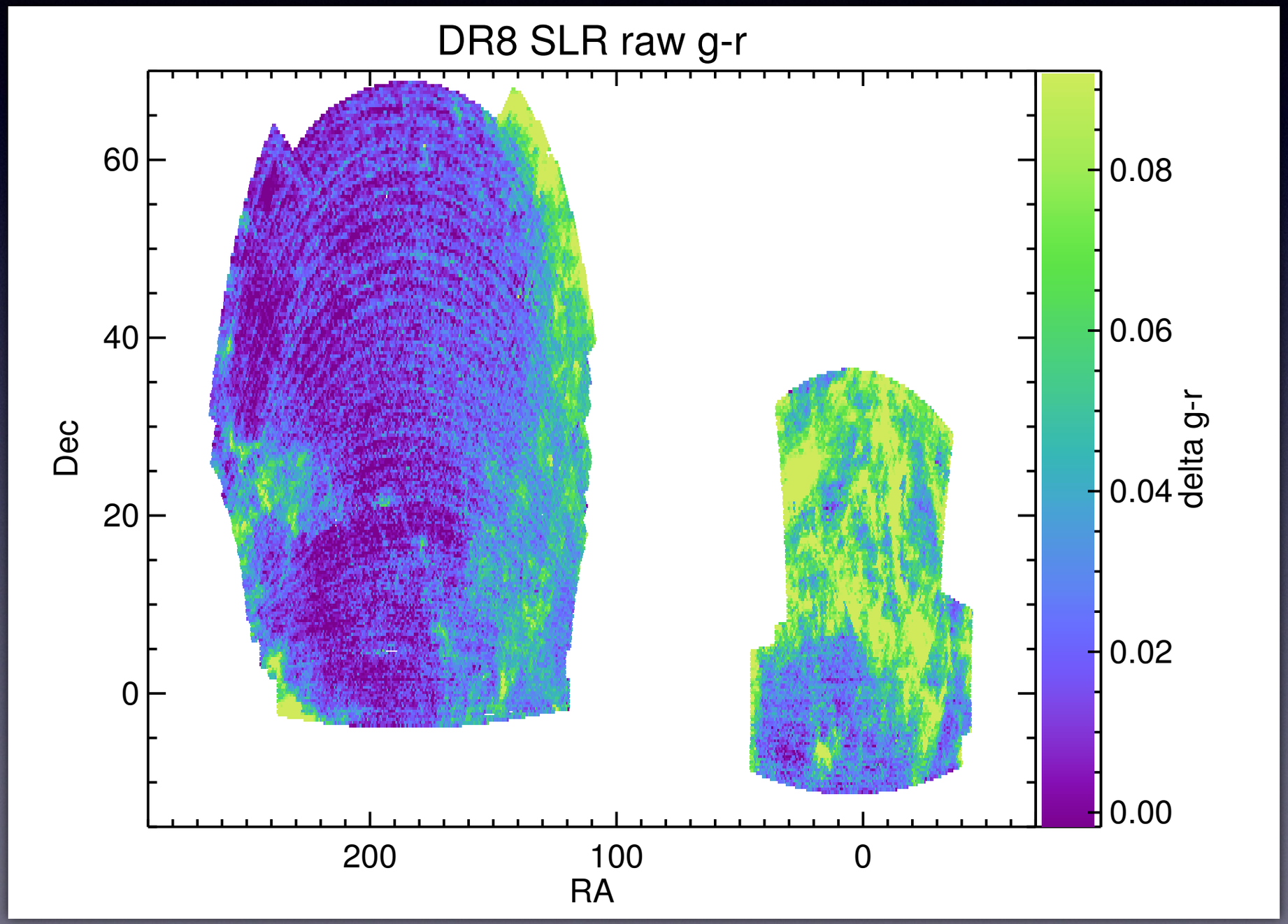
Back to SDSS

- The reddening from SFD98…



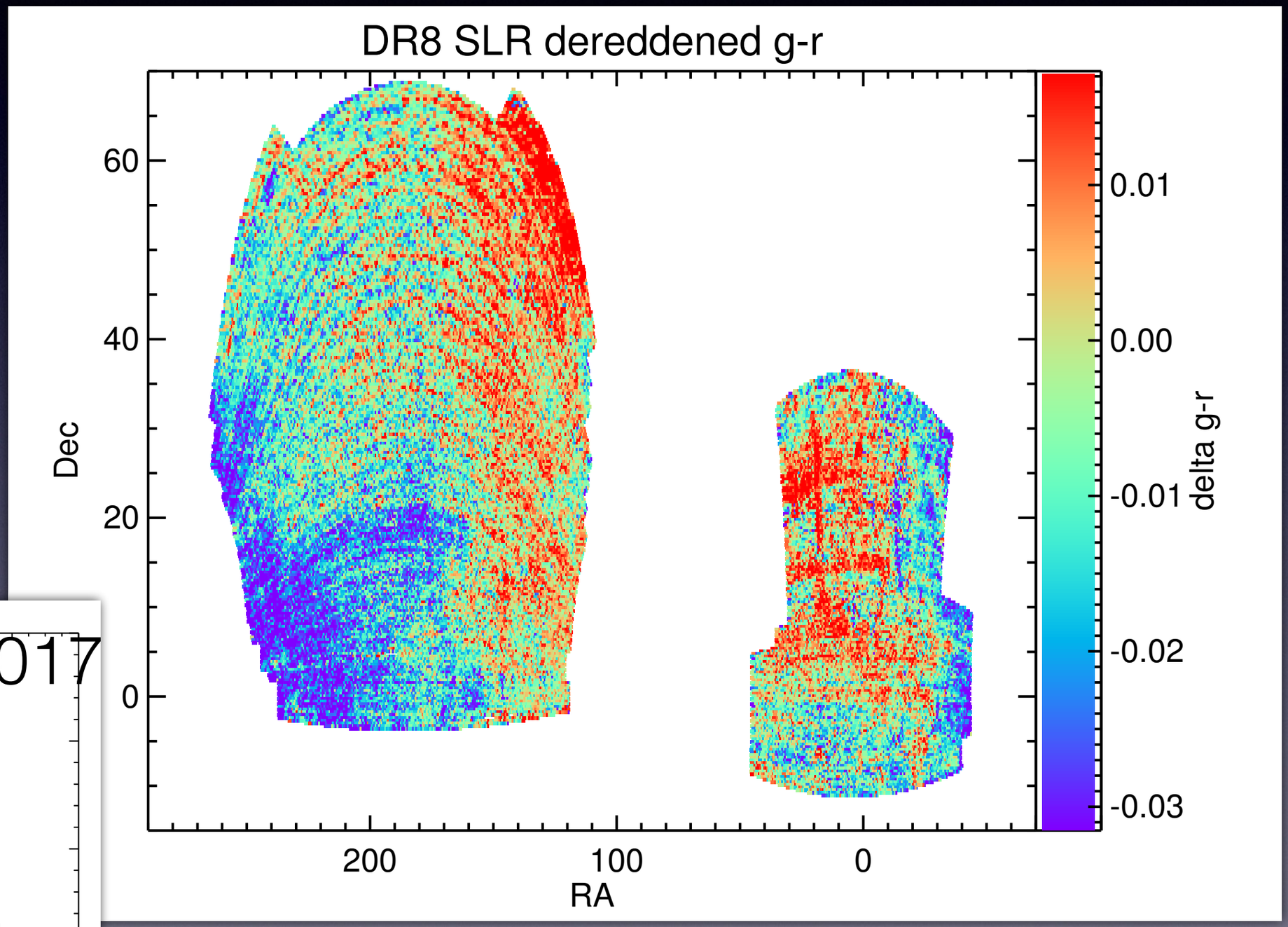
Back to SDSS

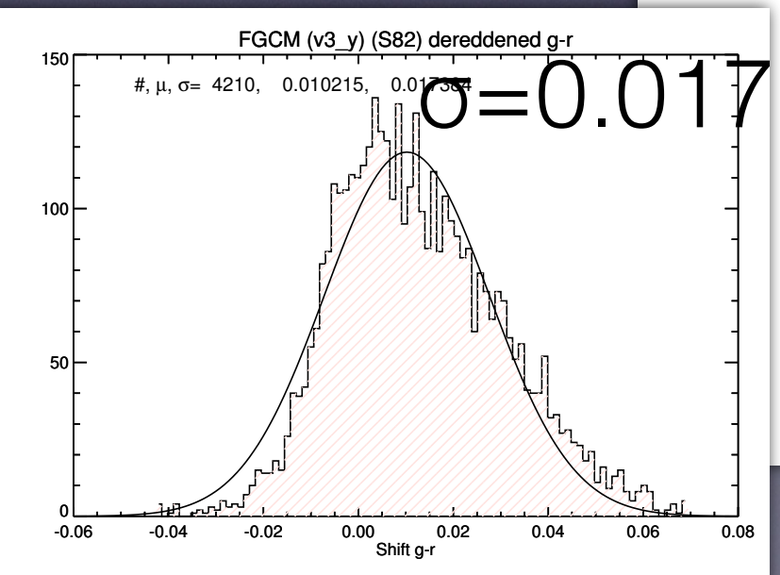
- …Looks like the star color shift (DR8)



Back to SDSS

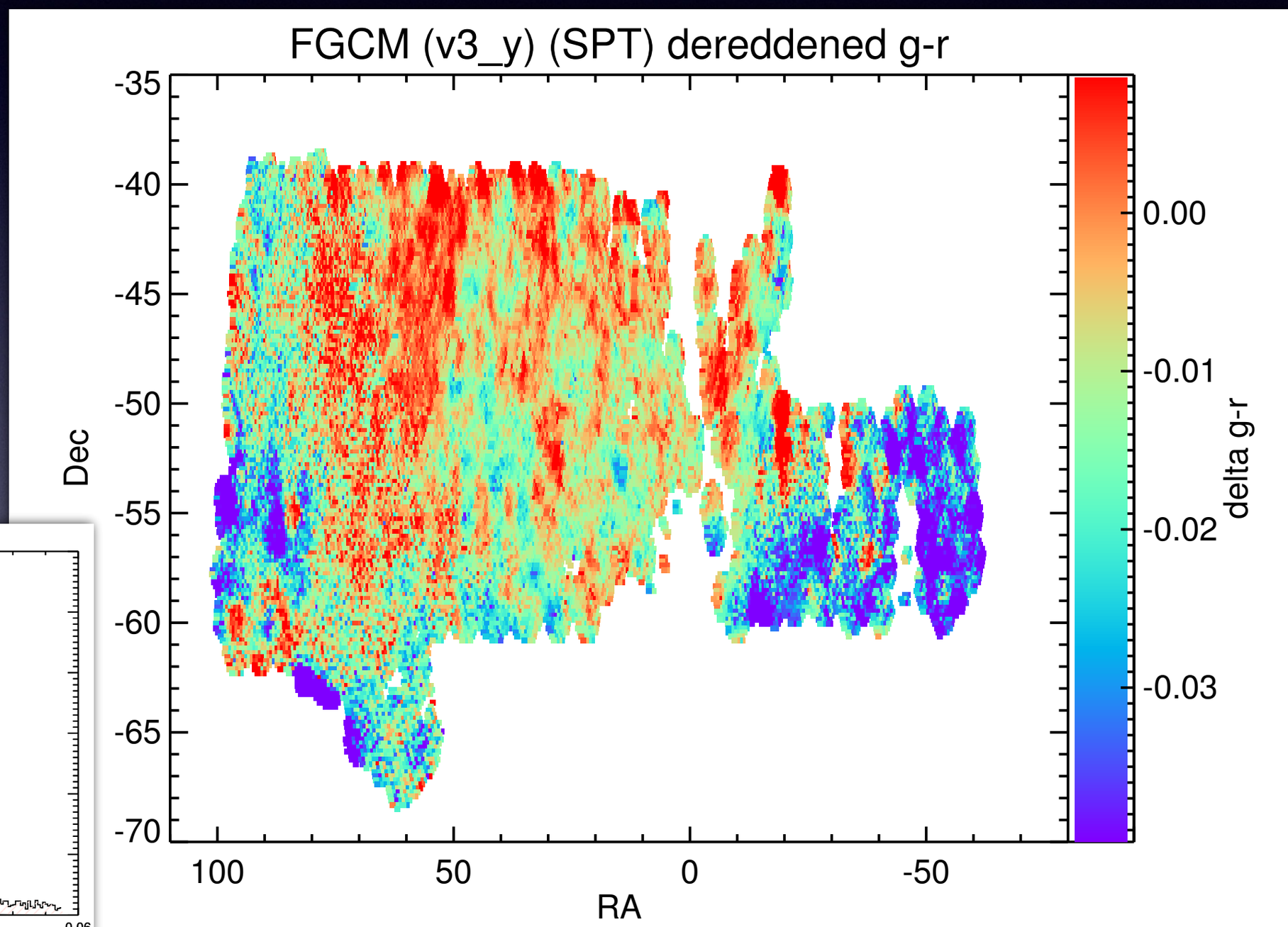
- But significant residuals remain.

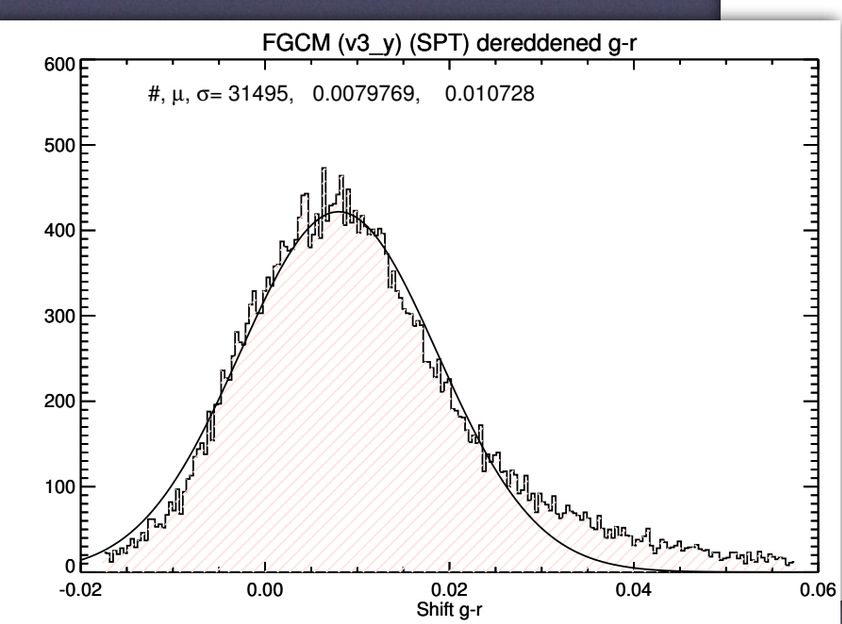




And DES

- See Steve Kent's poster
- Stars imply reddening law at RA~-50 is different





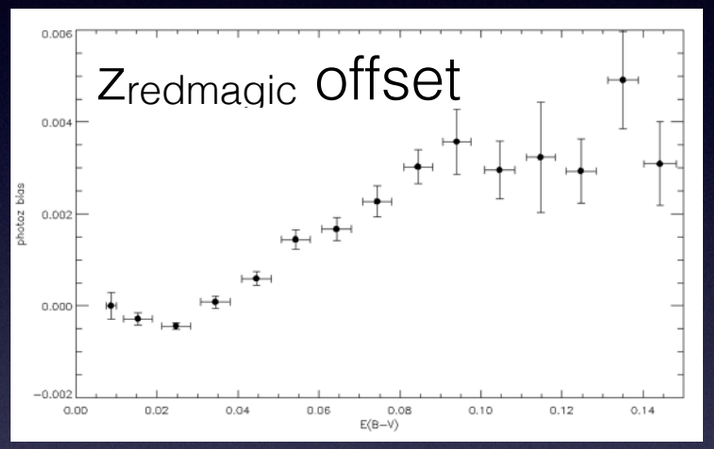
What About Galaxies?

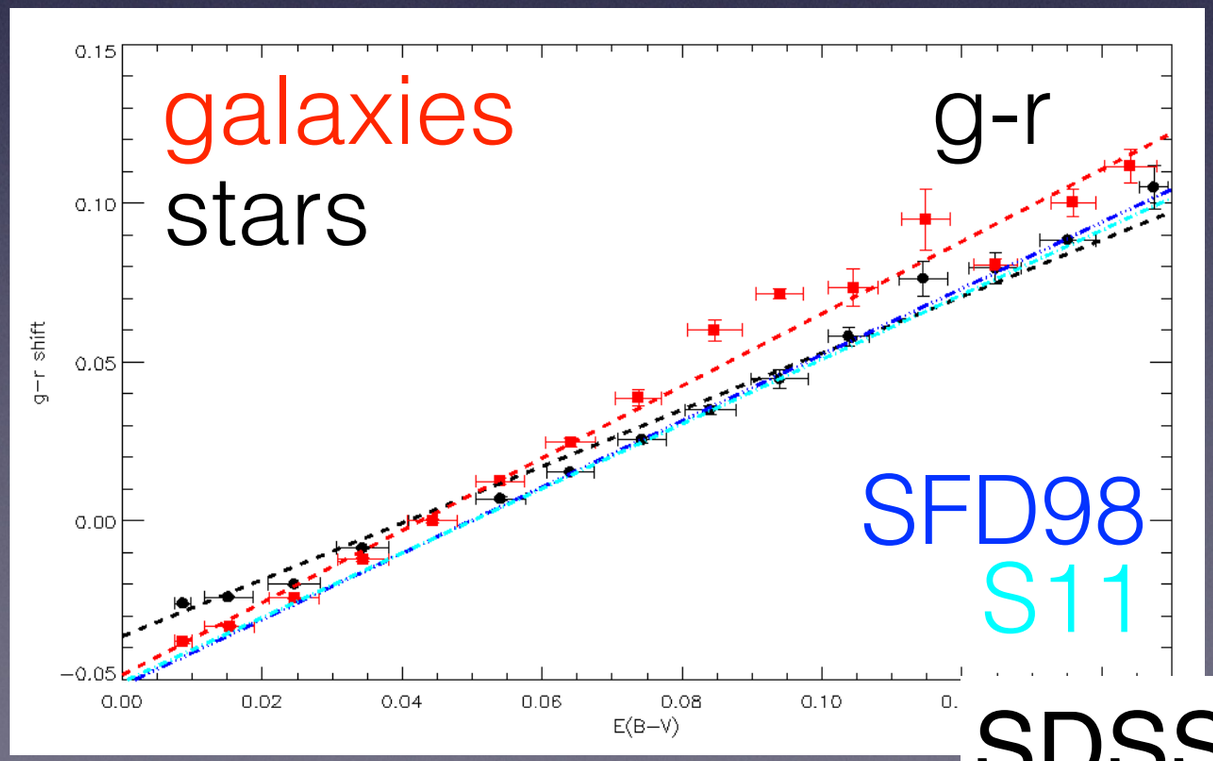
- Can we use (red) galaxies to trace the reddening?
- Use redMaGiC galaxies (Rozo, Rykoff+15)
- Look at color shifts as a function of reddening (SFD98 for now, but…could be problematic)
- Degeneracy in color-magnitude space between total reddening and color shift

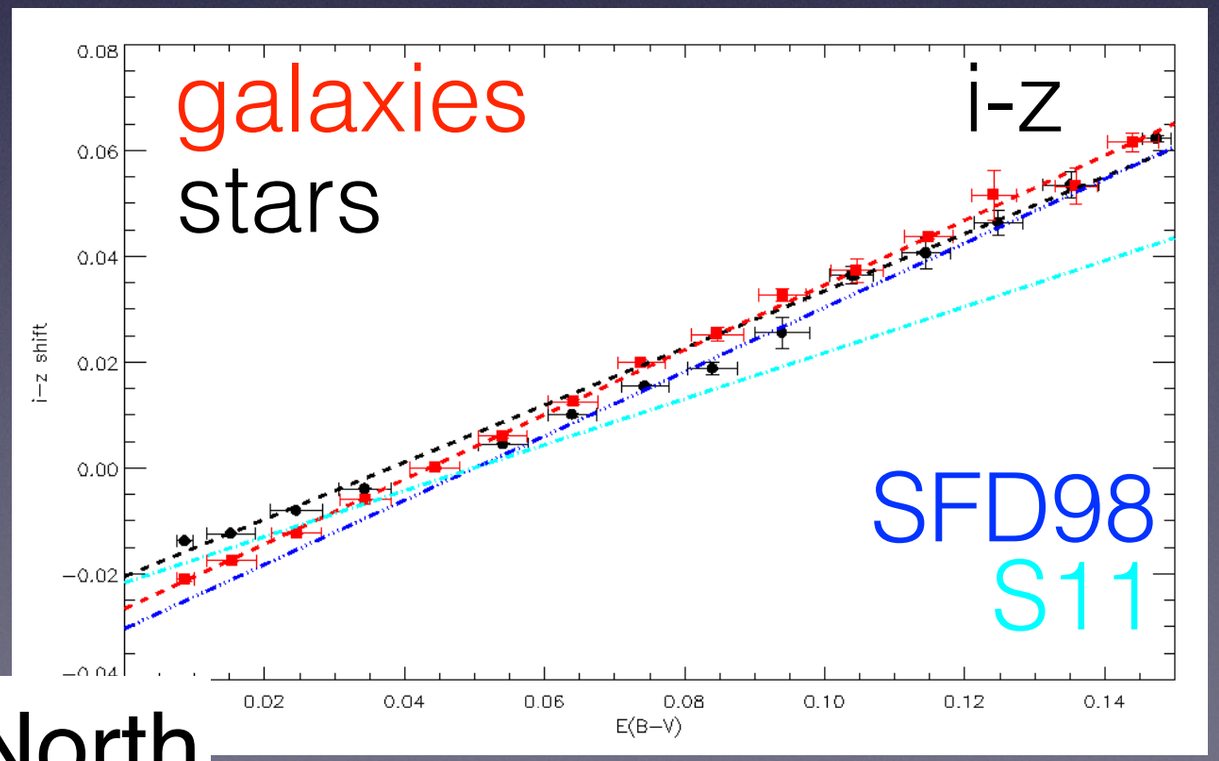
- How does this compare to the stars?

Stars & Galaxies

- Bin red galaxy color shift (requires spectra!) according to SFD98 emission map
- Bin stellar locus shift



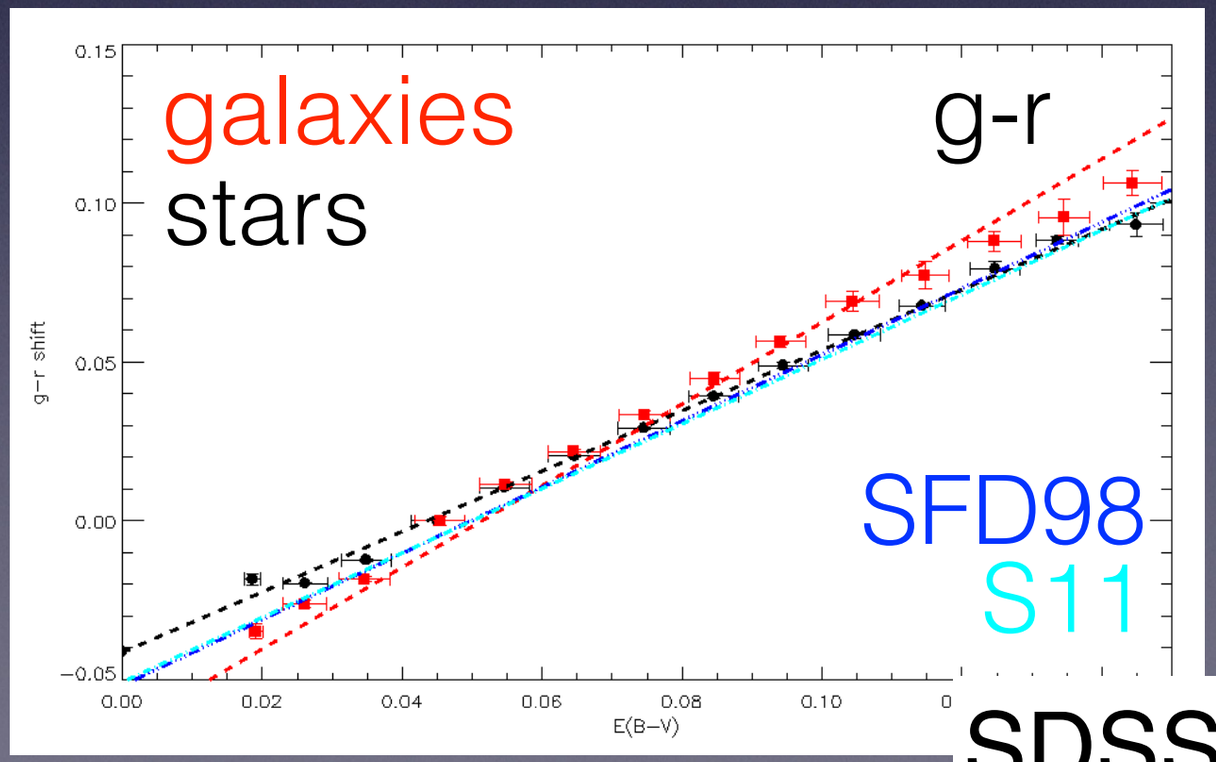


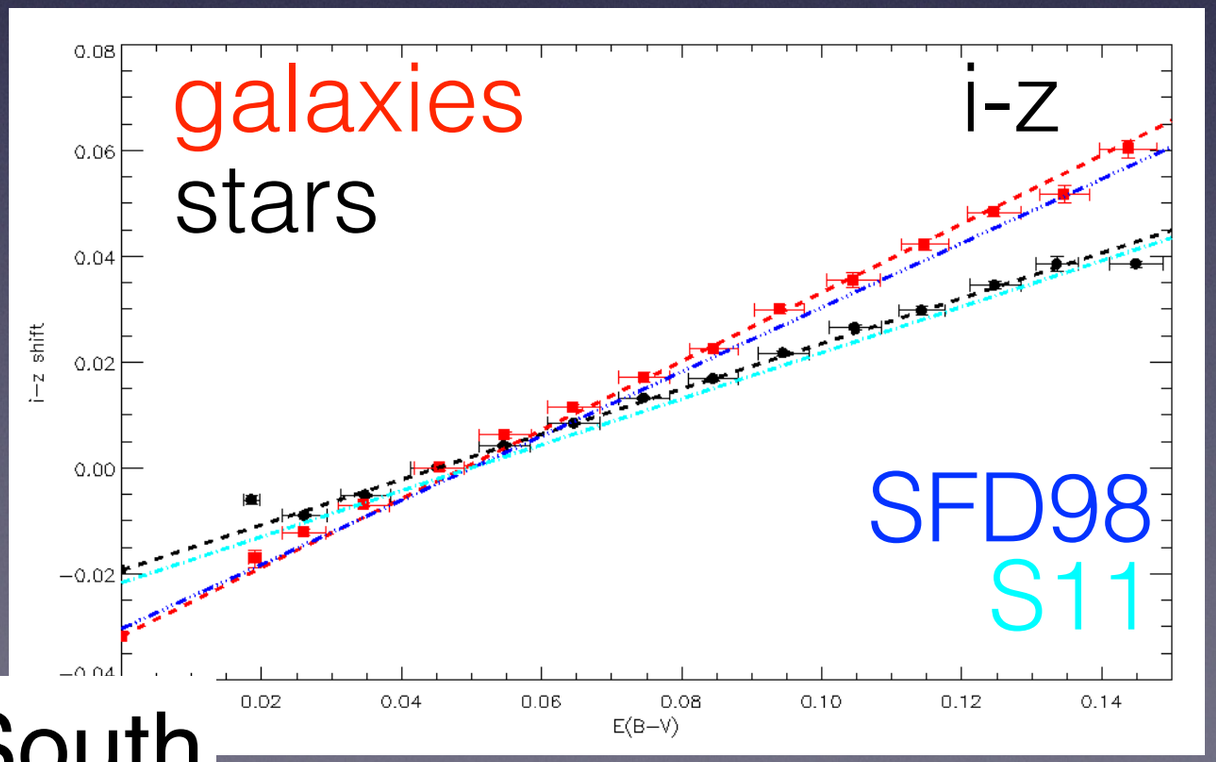


SDSS North

Stars & Galaxies

- Bin red galaxy color shift (requires spectra!) according to SFD98 emission map
- Bin stellar locus shift





SDSS South

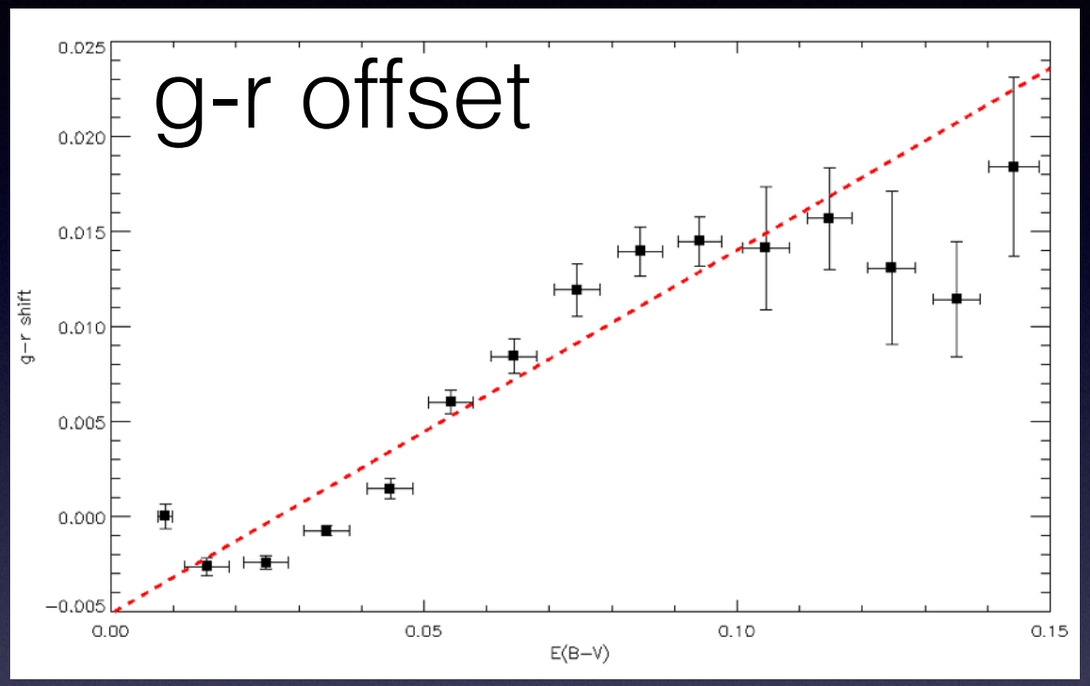
Summary

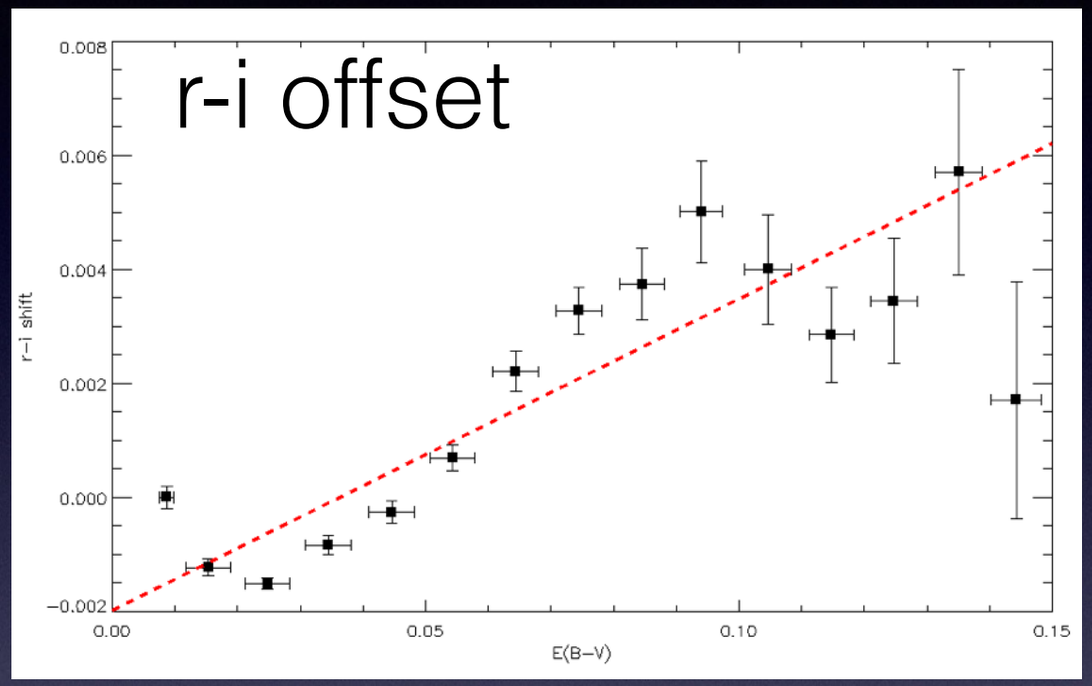
- Getting the reddening wrong (overall law, or even R_V) has significant impact on red galaxy photo-*z* estimation
- Can use stars…
  - But in SDSS, looks a bit different than galaxies
- Could just throw out half the footprint
  - Still would prefer if stars & galaxies agree

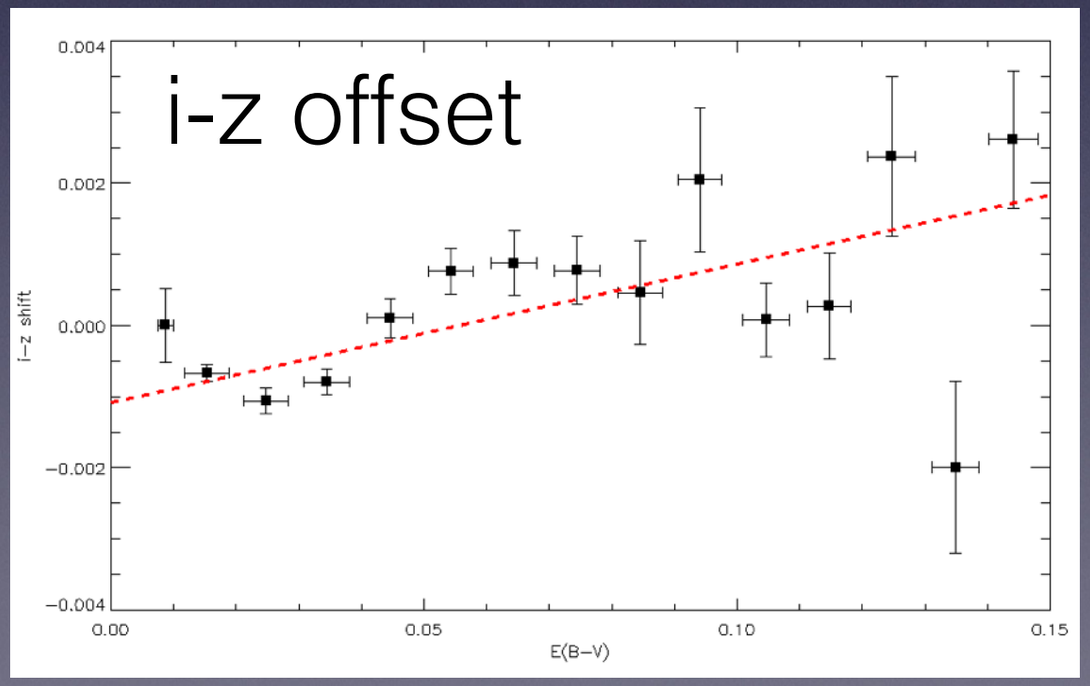
Extra Slides

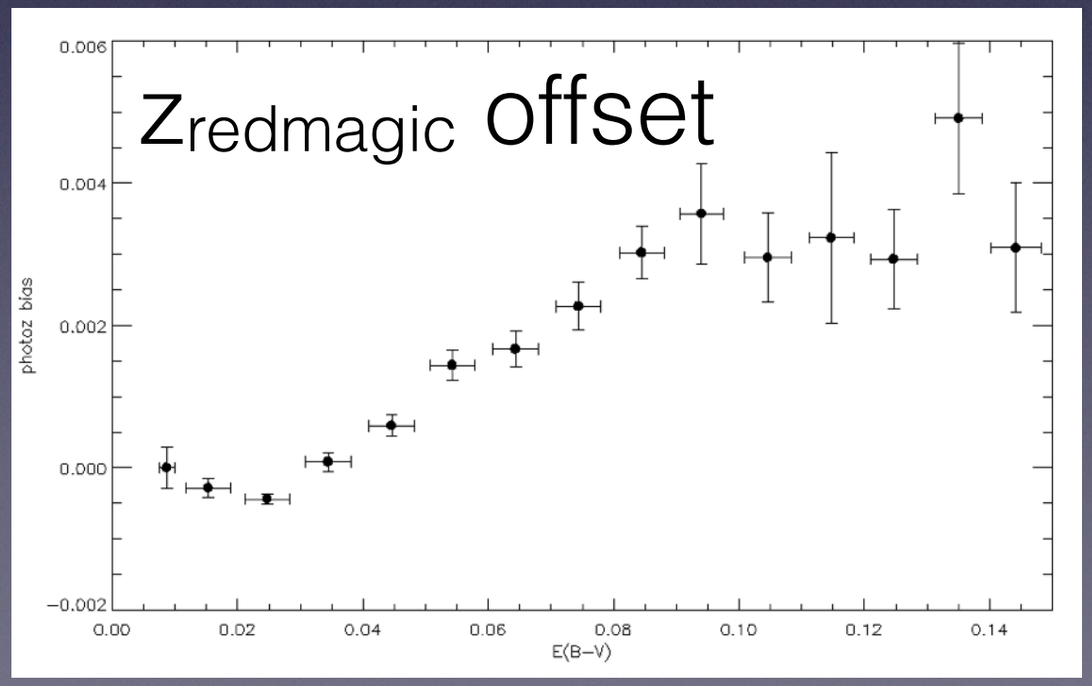
redMaGiC Colors

- Biases correlated with SFD98 E(B-V)

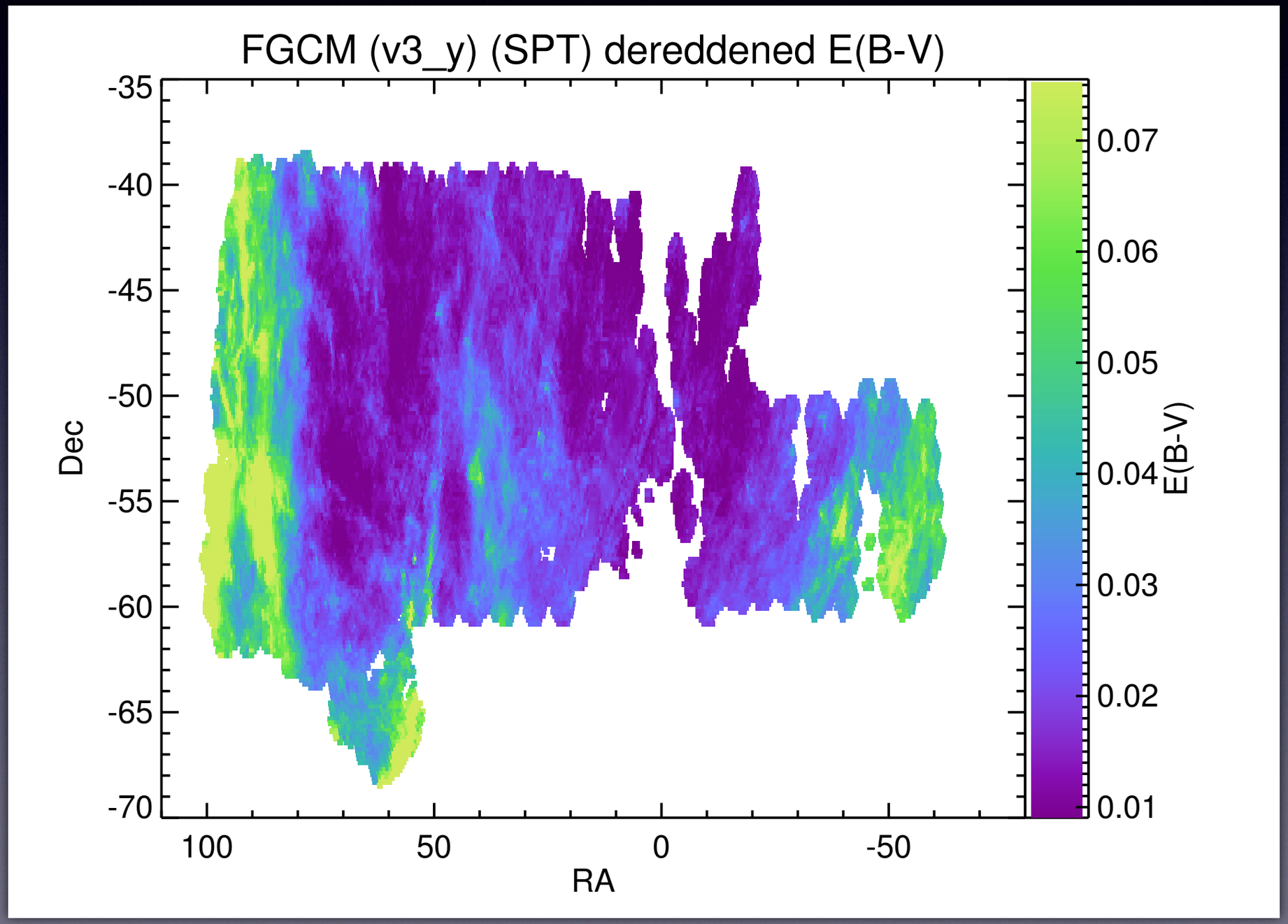




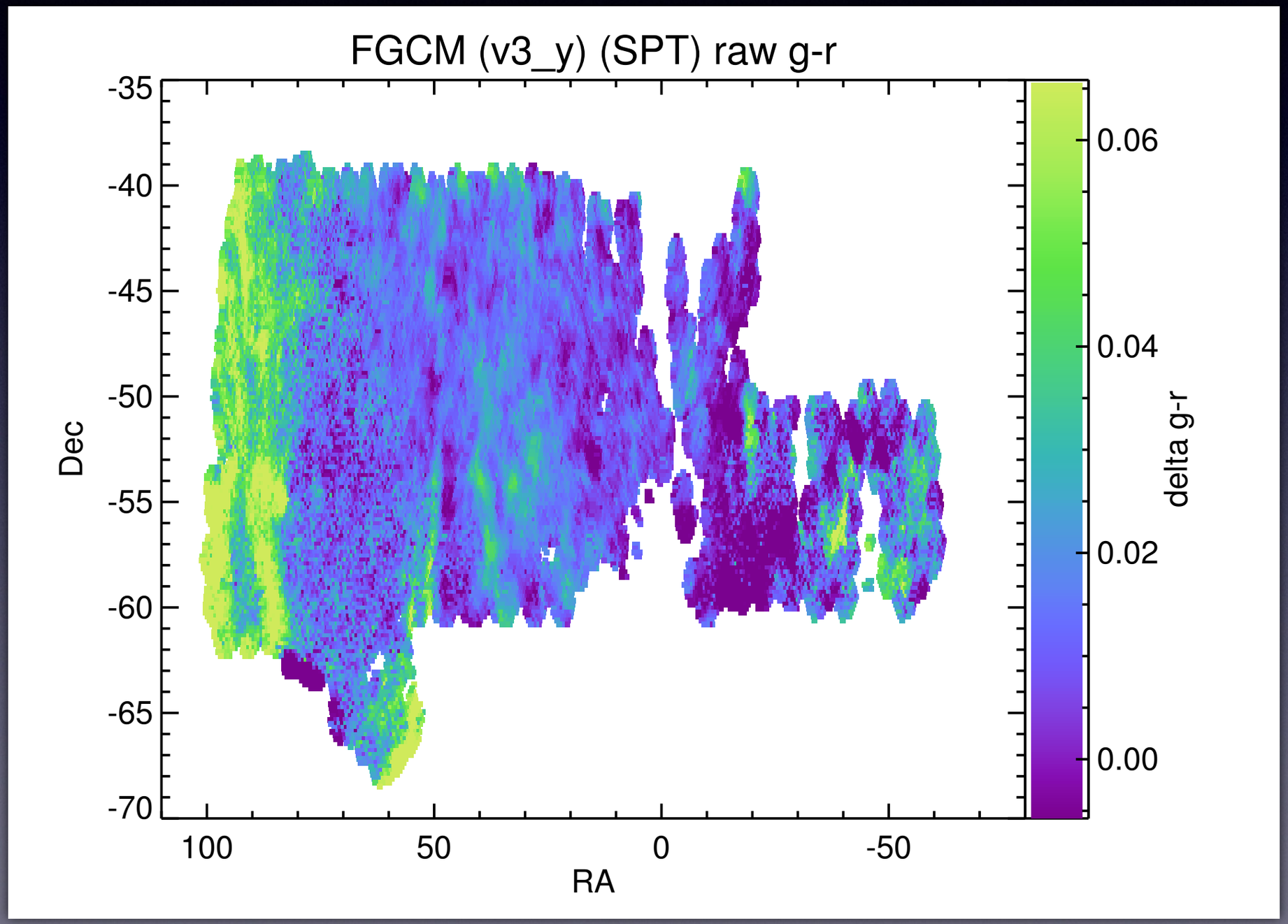




DES Y1A1


FGCM (v3_y) (SPT) dereddened E(B-V)
Dec
-35
-40
-45
-50
-55
-60
-65
-70
RA
100
50
0
-50
E(B-V)
0.07
0.06
0.05
0.04
0.03
0.02
0.01

DES Y1A1


FGCM (v3_y) (SPT) raw g-r
-35
-40
-45
-50
-55
-60
-65
-70
Dec
100
50
0
-50
RA
0.06
0.04
0.02
0.00
delta g-r