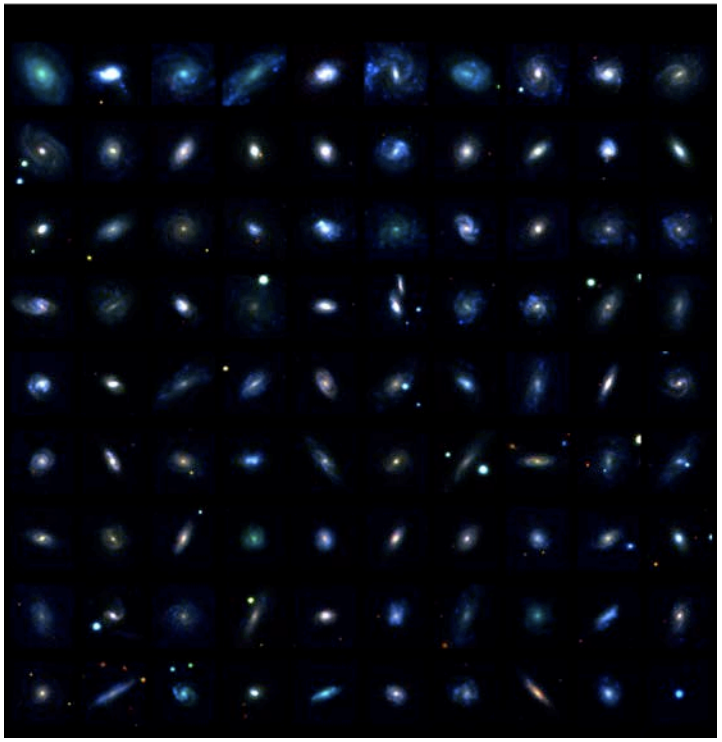
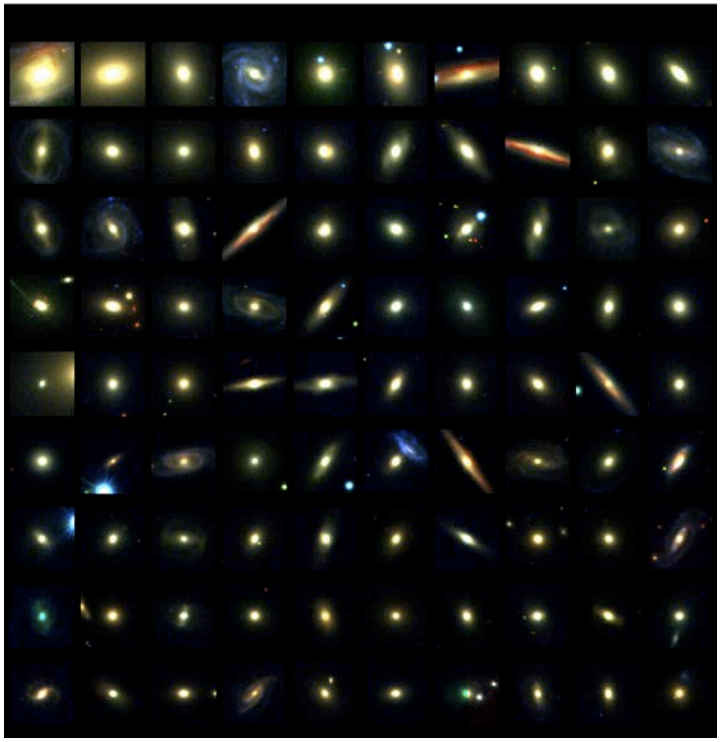
Ideas for galaxy photometry

Simon Driver

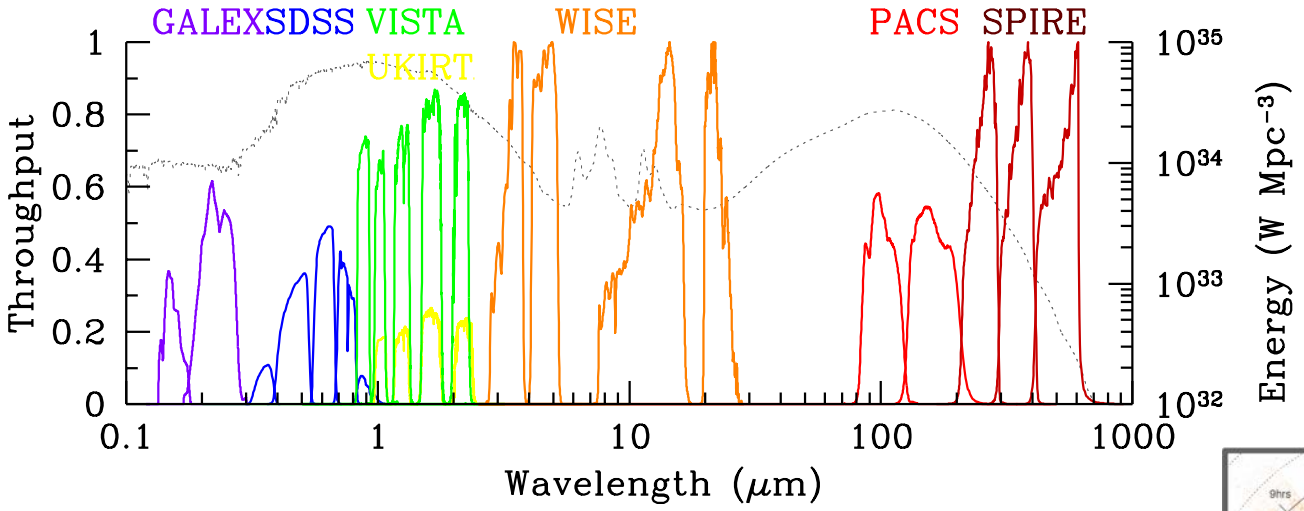
ICRAR/UWA



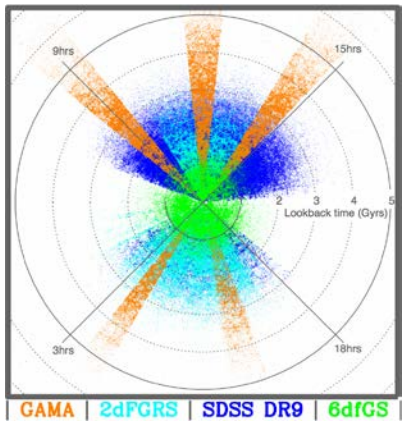


What do we do in GAMA

- 300sq deg 21 band photometry
  - GALEX, SDSS, VST, UKIDSS, VISTA, WISE, HERSCHEL

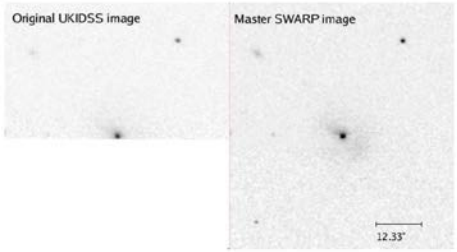


- IOTA – matched aperture photometry
- SIGMA – automated bulge-disc decomp
- LAMBDAR – panchromatic photometry



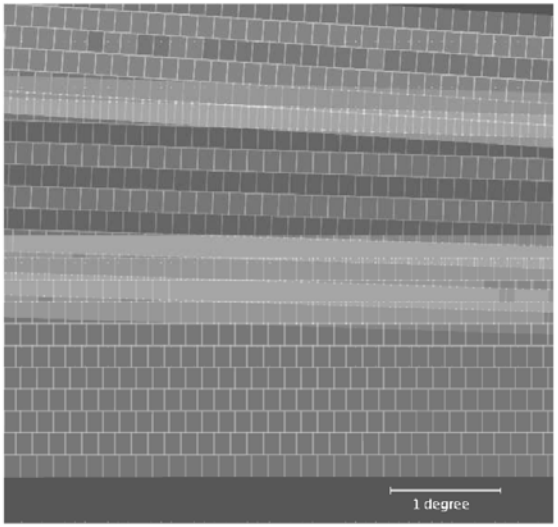
Data preparation: SWARPs

- To manage data across 6 distinct facilities we generate SWARPs
  - i.e., 80sq deg image of each GAMA region in each band (80Gbytes/image)
  - Typically stitching 10k-20k images per SWARP (simplifies boundary problems)

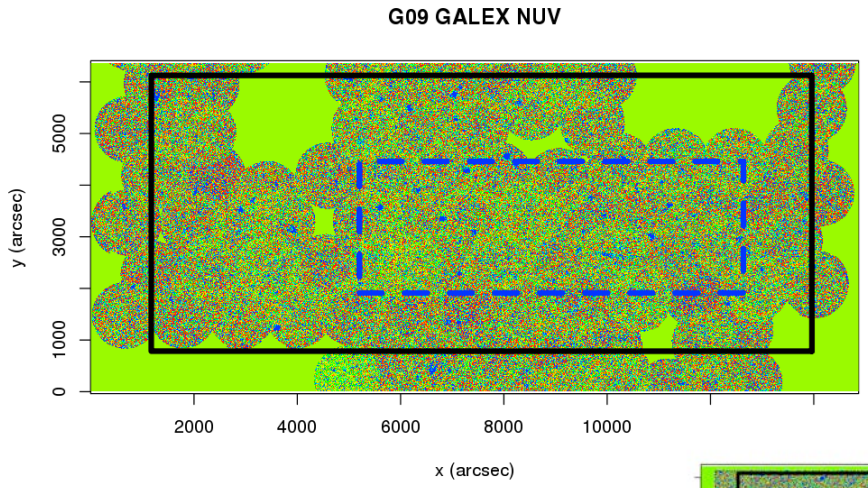


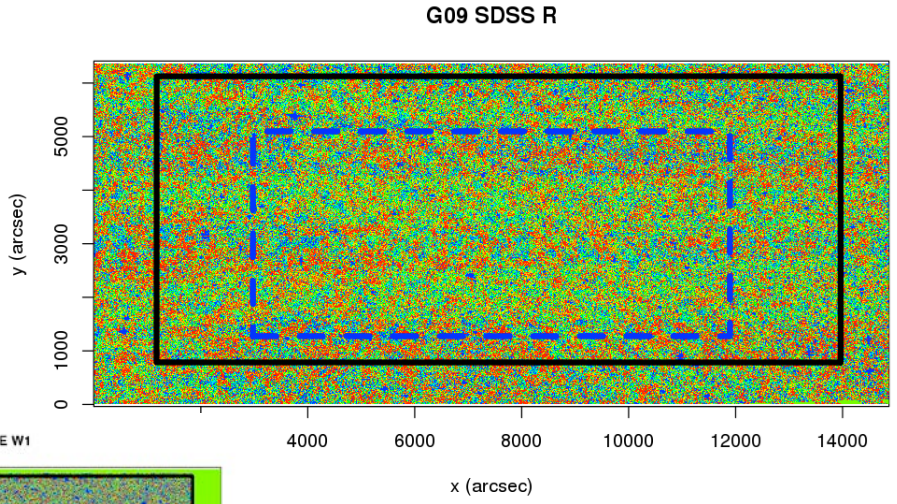
- Preparation:
  - Scale all frames to common zeropoint (30.0) [weeks]
  - Measuring PSF FWHM and convolve all frames to 2'' [months]

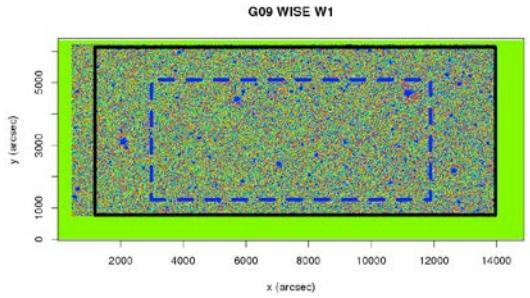
- SWARP (Terapix) [days]
  - Background subtract and regrid to 0.339''
  - Native SWARPs at native seeing
  - Convoled SWARPs at 1'' seeing (VST+VIKING)
  - Convolved SWARPs at 2'' seeing (SDSS+UKIDSS)

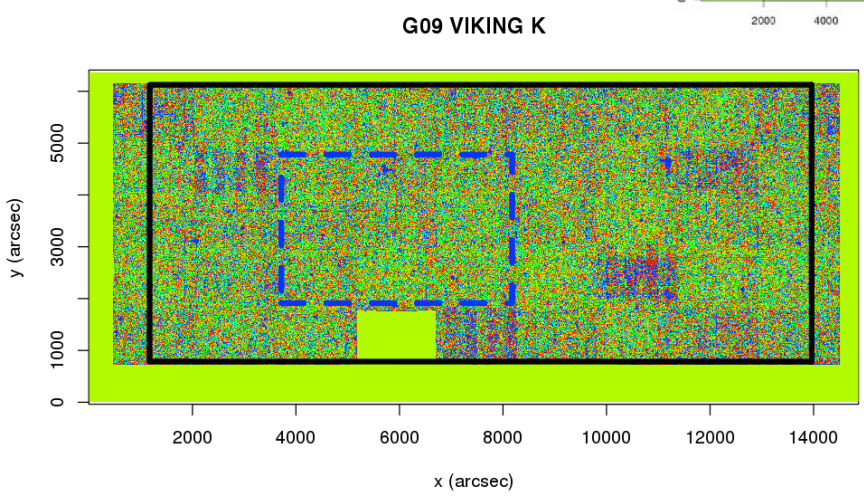


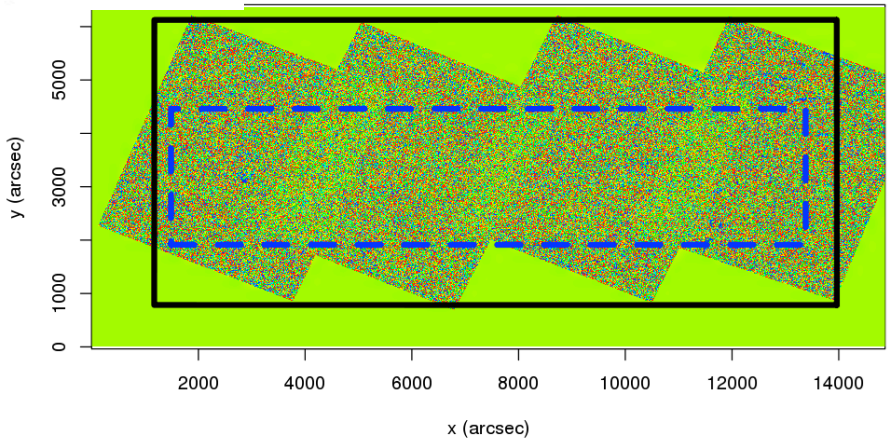
Examples highlighting backgrounds









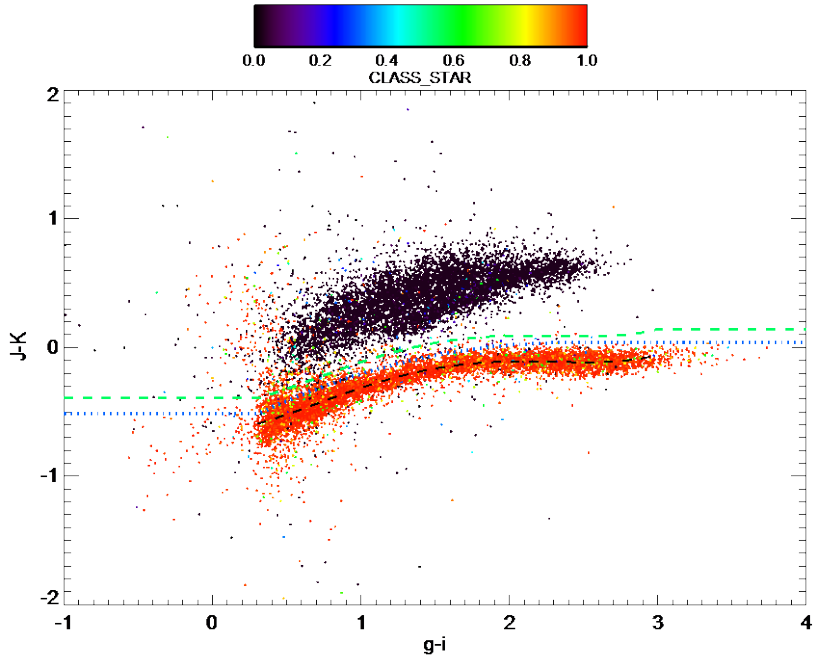


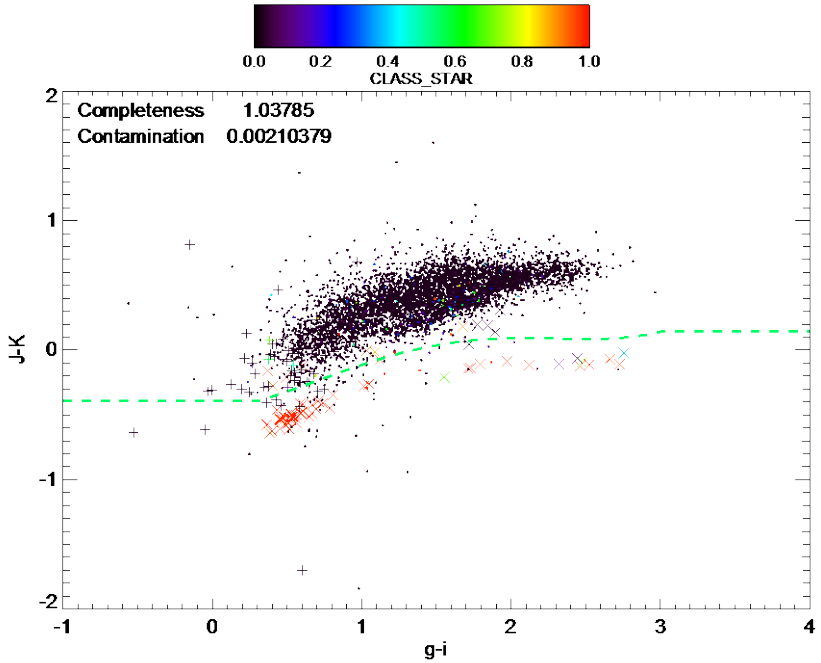
IOTA

- Use 2’’ seeing convolved SWARPS
- Use input cat provided by SDSS (GAMA input cat)
- Produce galaxy cutouts from SWARPs in 9 bands ugrizYJHK
- Run SExtractor on r-band
- Identify galaxy at centre of cutout
- Rerun SExtractor in dual aperture mode u-K
- Ensures u-K photom:
  - Identical aperture
  - Identical deblending
  - Identical seeing

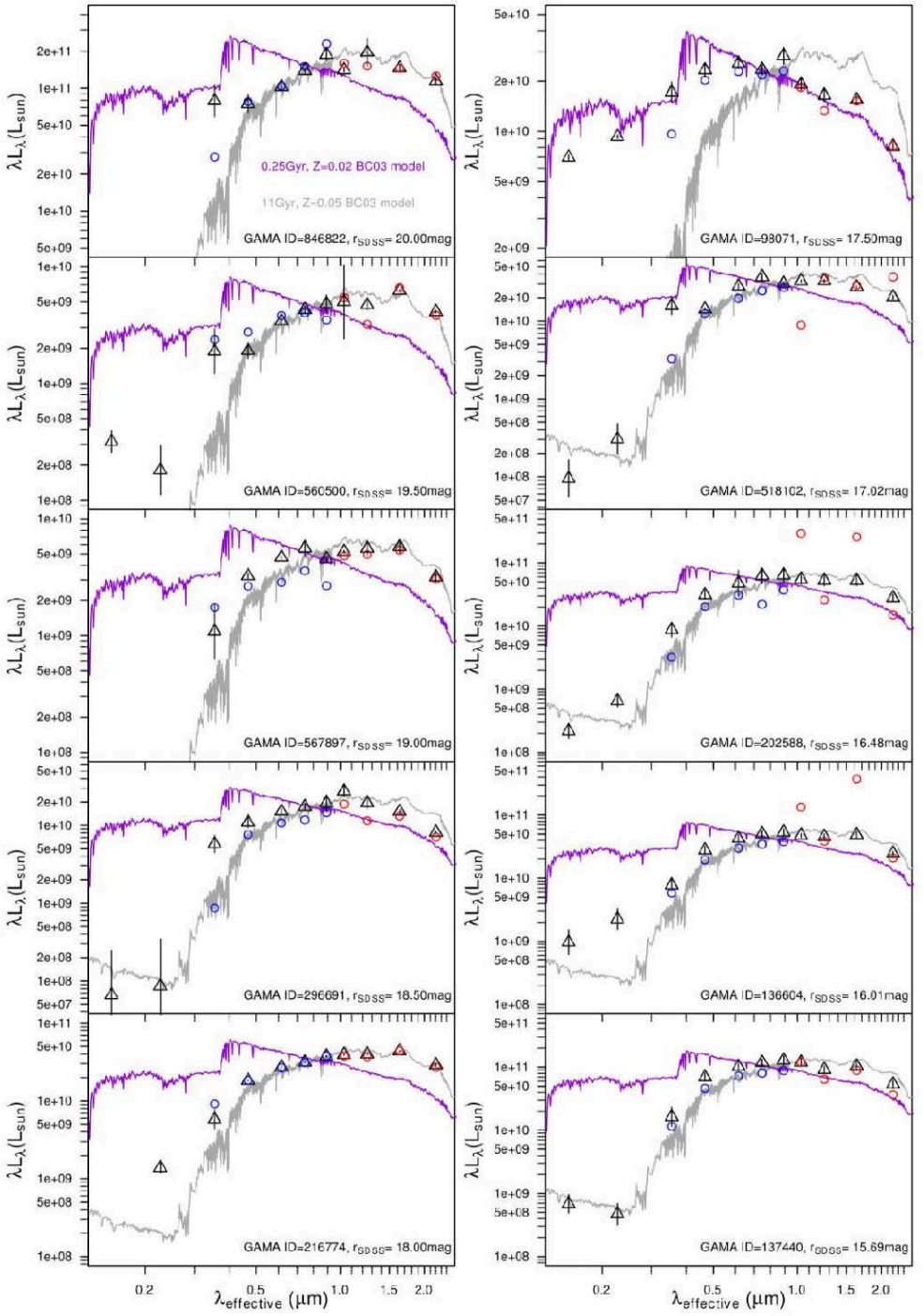
Hill et al (2011)

Star-galaxy separation

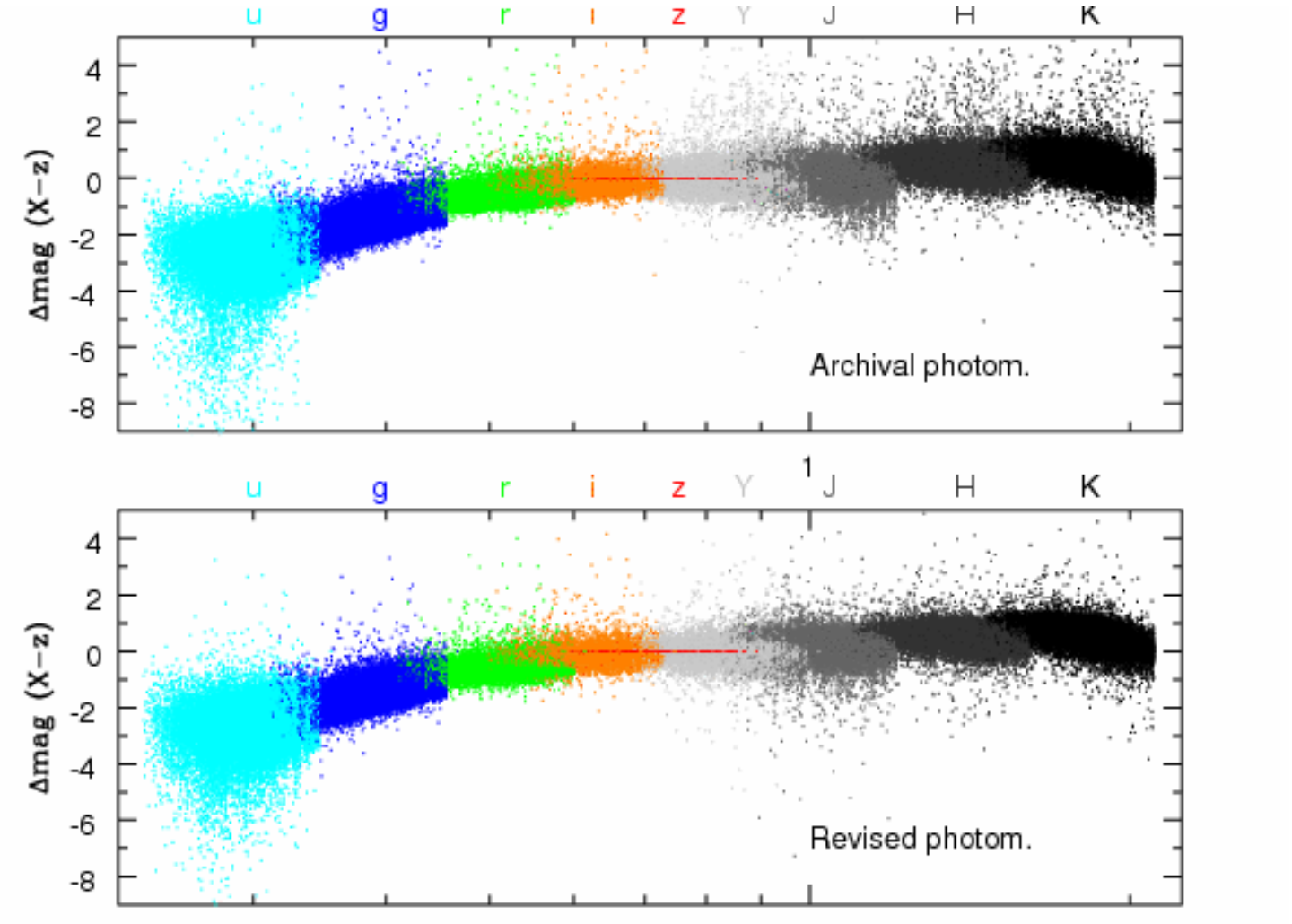




Individual examples

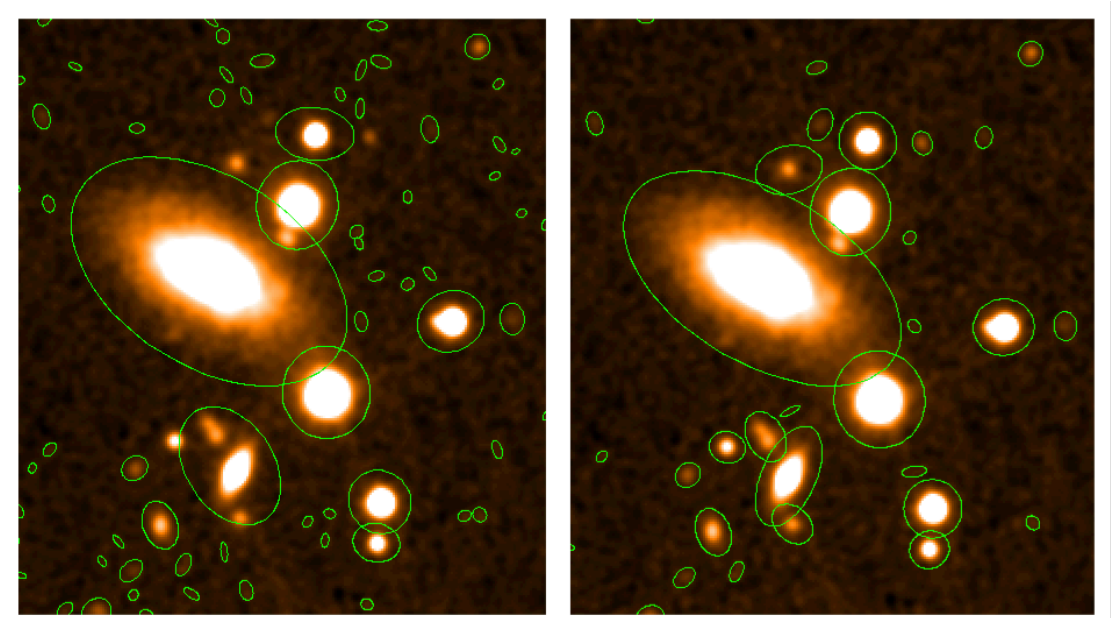


IOTA (SDSS+UKIDSS v GAMA)



Issues

- Colour gradients (galaxies half size in near-IR)
- Extended UV discs (often 3x larger than in r)
- Sextractor apertures can be off.
- Deblending needs tailoring
  - cannot optimise for both bright and faint (hot and cold mode)

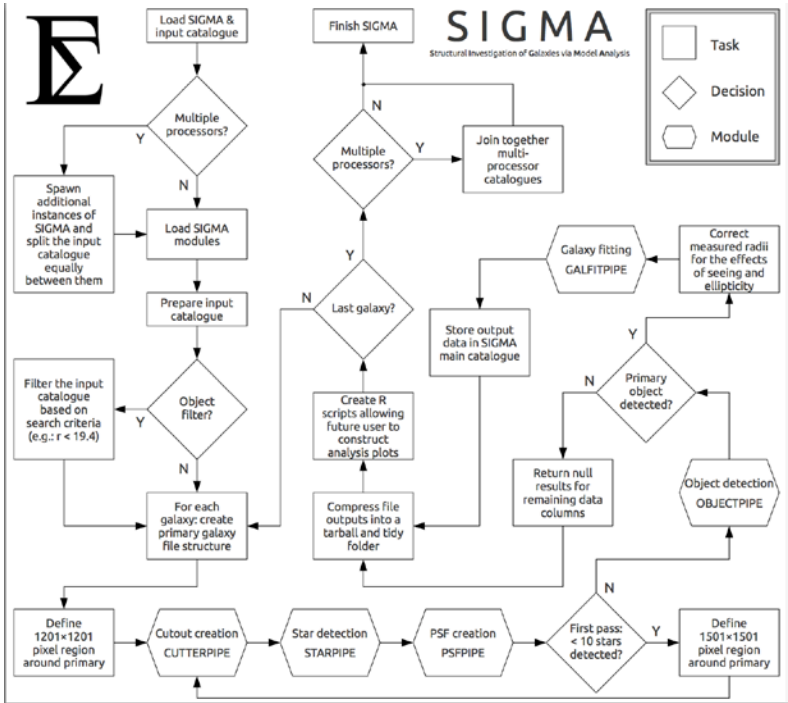


Default settings. IOTA settings.

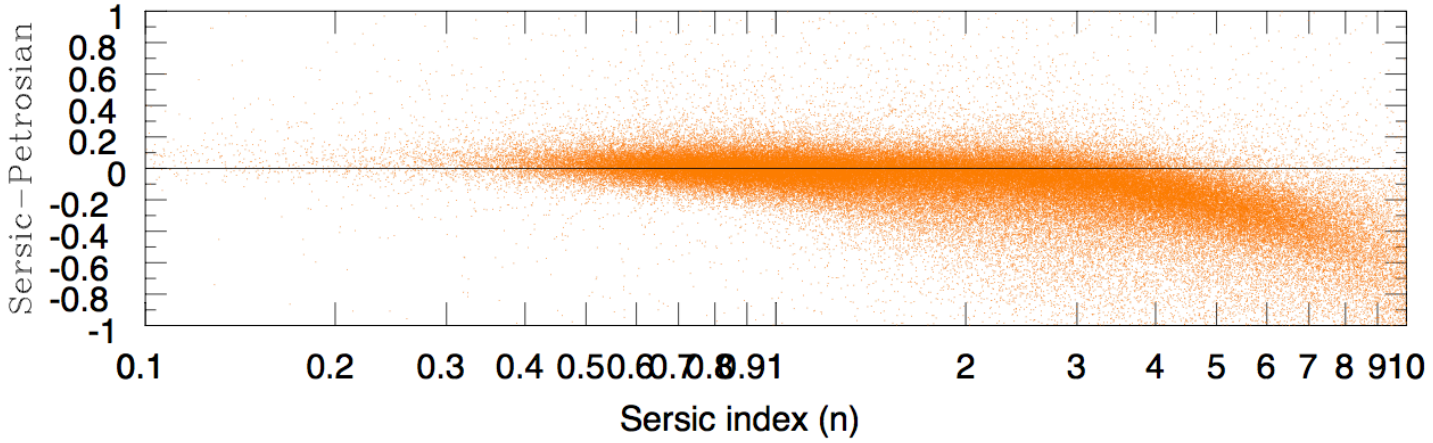
SIGMA

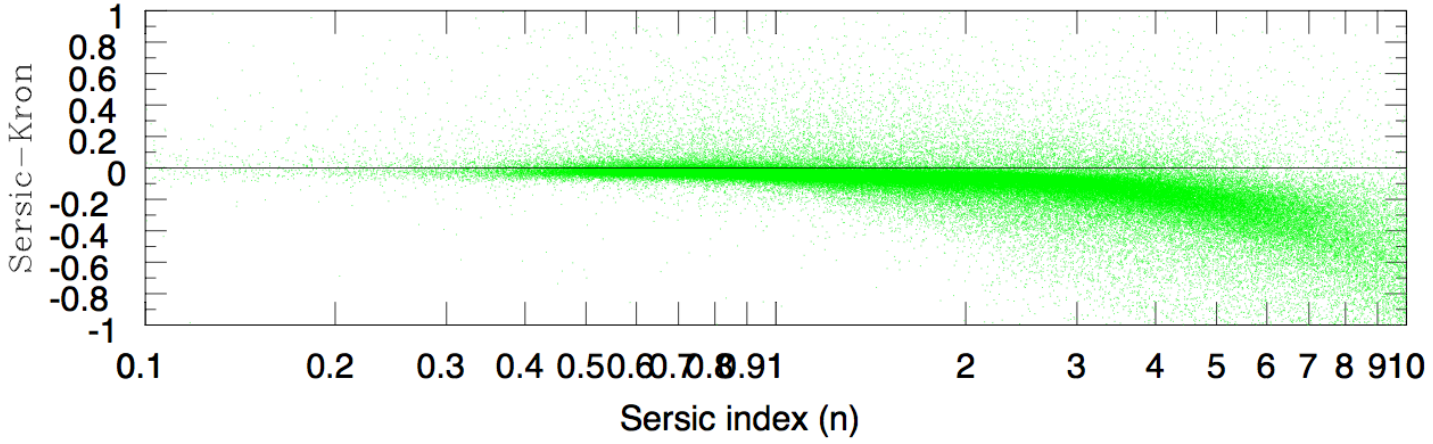
- Uses native SWARPs
- Use input list (defined by SDSS)
- Cut out region around galaxy in each band
- Detects stars from same original frame as target
- Model ~20 stars to get PSF at target location
- Cut out zoom region around galaxy
- Detect all objects
- Decided which objects to mask and model
- Run GALFIT3 using profile presets
- Assess profile and rerun of necessary
- Repeat in all 9 bands
- 20seconds per object (using single CPU)

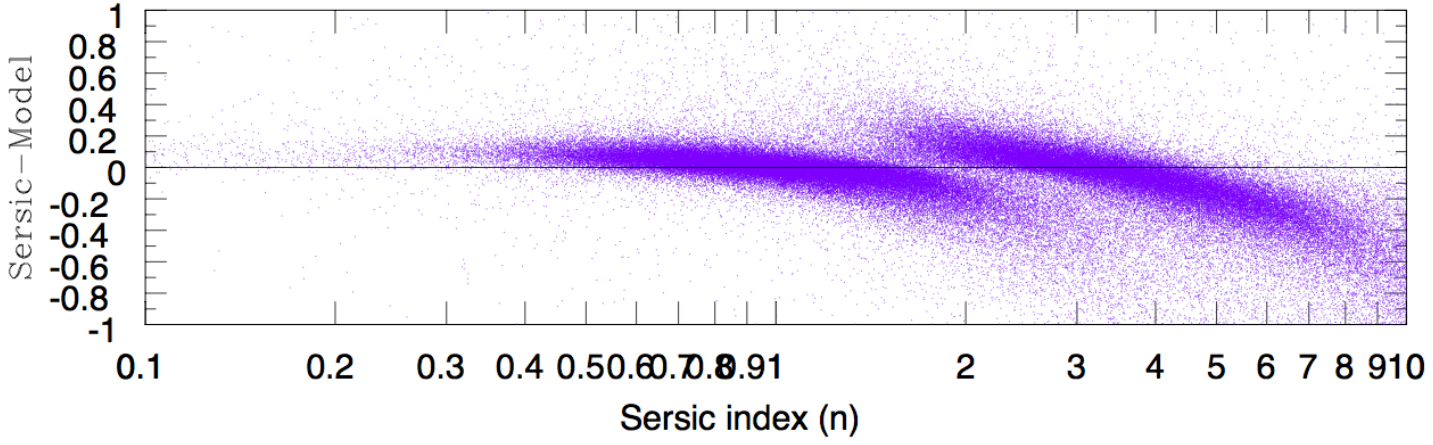
Kelvin et al (2012)



Sersic
v
Kron
v
Petrosian
v
Model

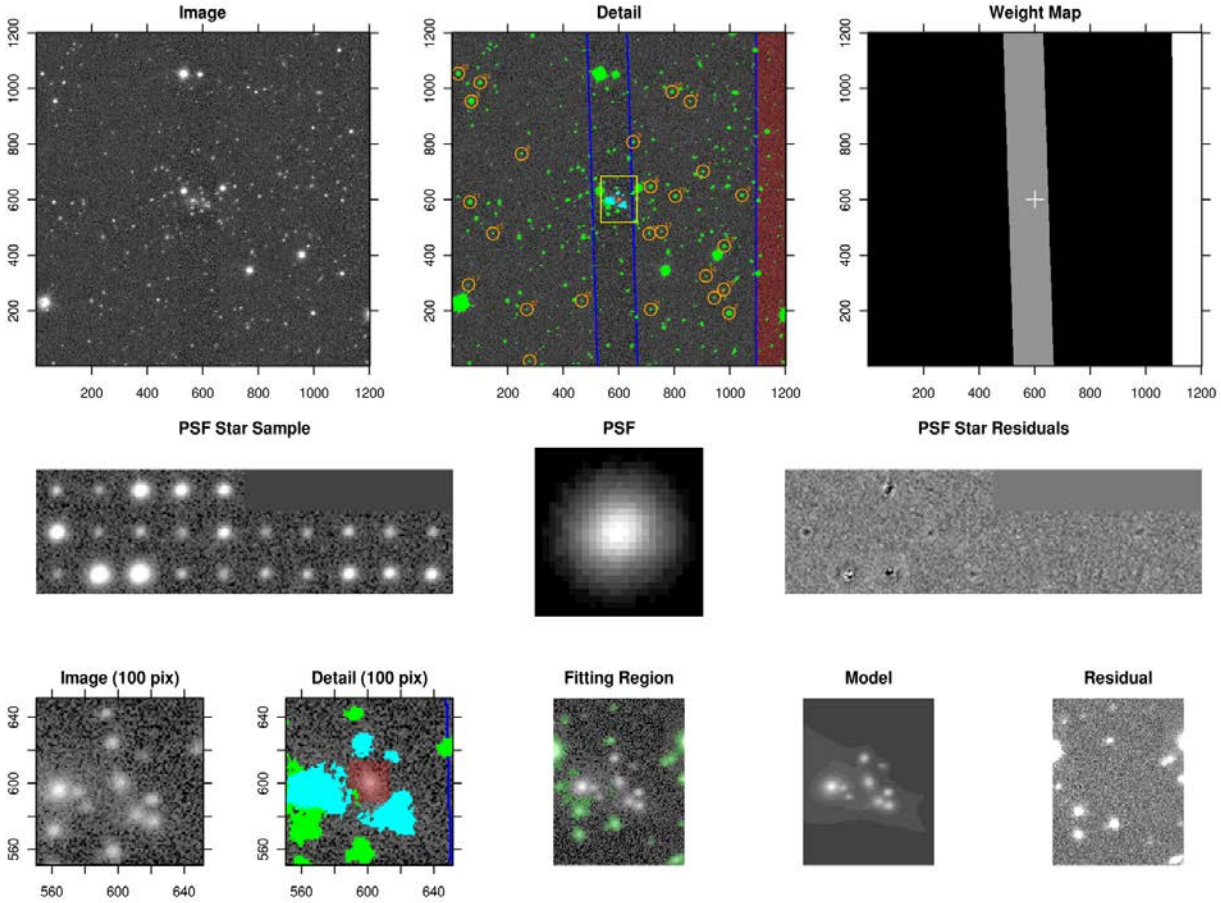






SIGMA

Structural Investigation of Galaxies via Model Analysis



SExtractor Bertin+ 1996

PSFEx Bertin 2011

GALFIT3 Peng+ 2010

Imaging & Pointing Data

400'' x 400'' cutout

Star identification

Empirical PSF

Galaxy detection

Sérsic modelling

Model self-check

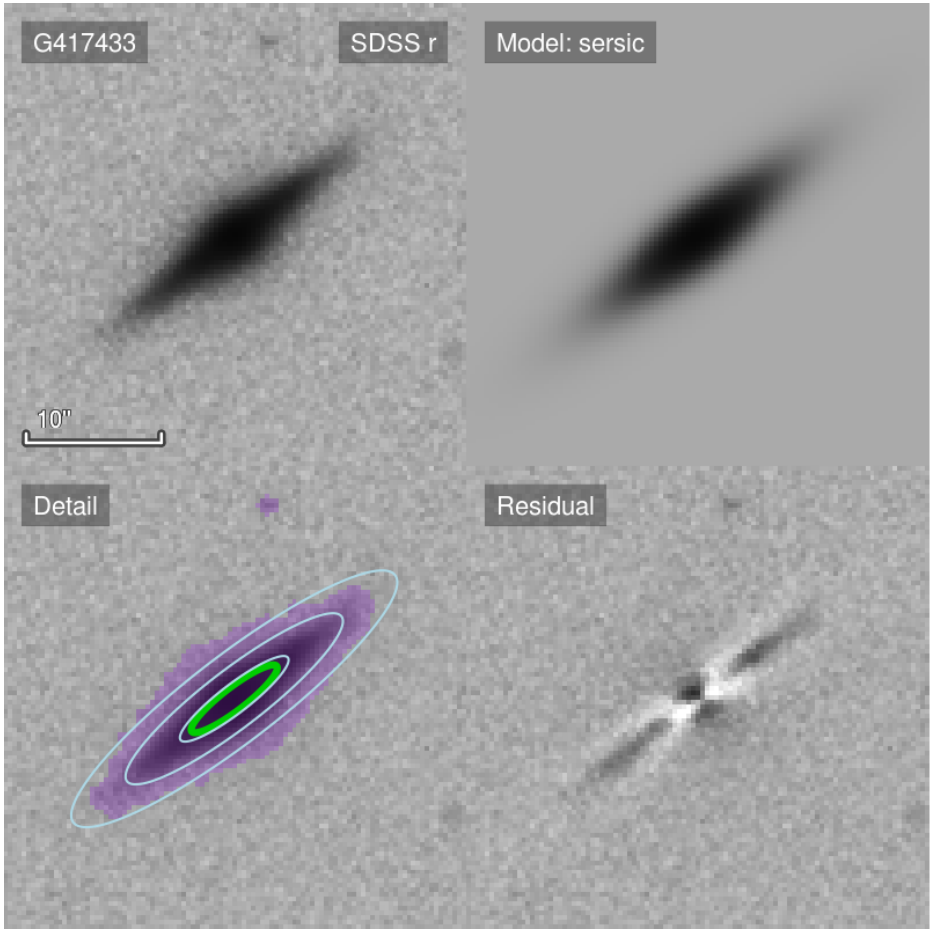
Value added results

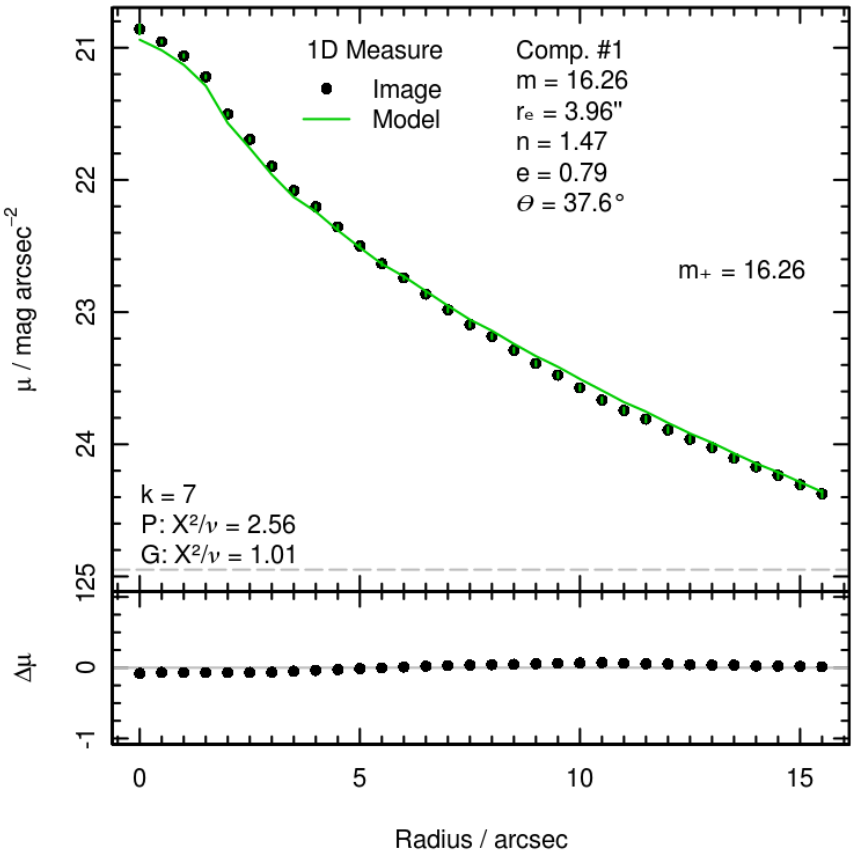
Model Fit Parameters

Kelvin et al (2012)

S0a: G417433

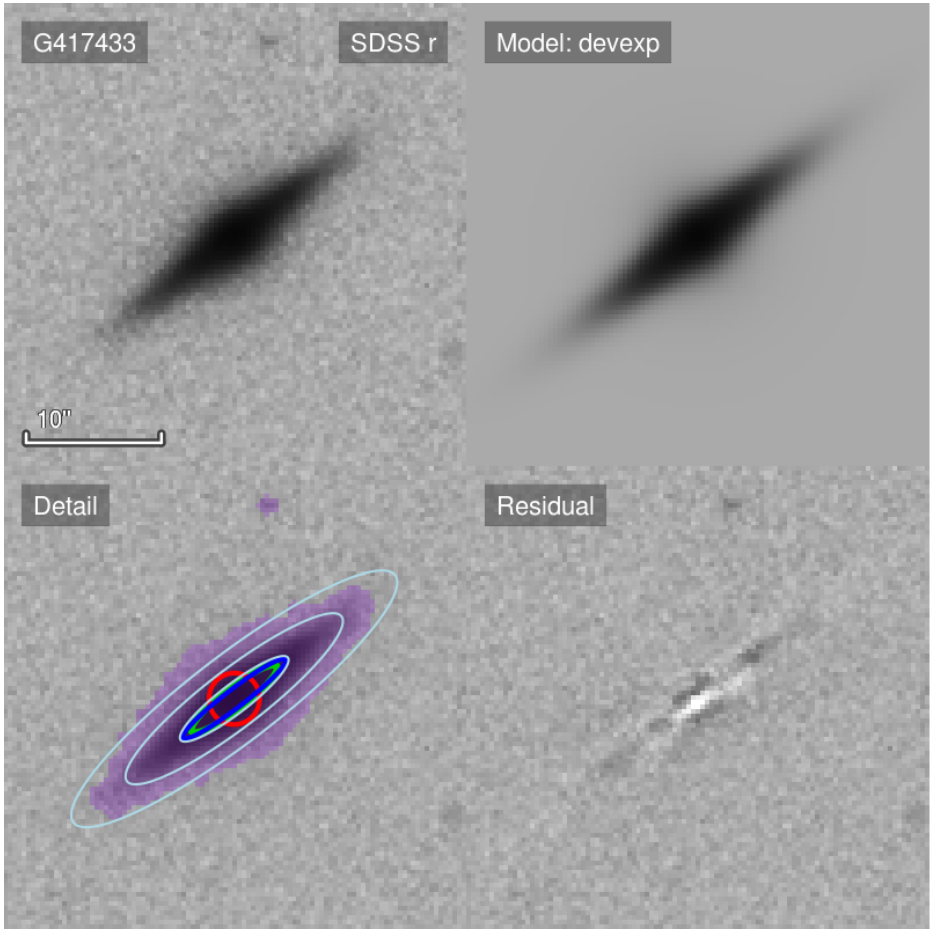
M01: Single-Sérsic

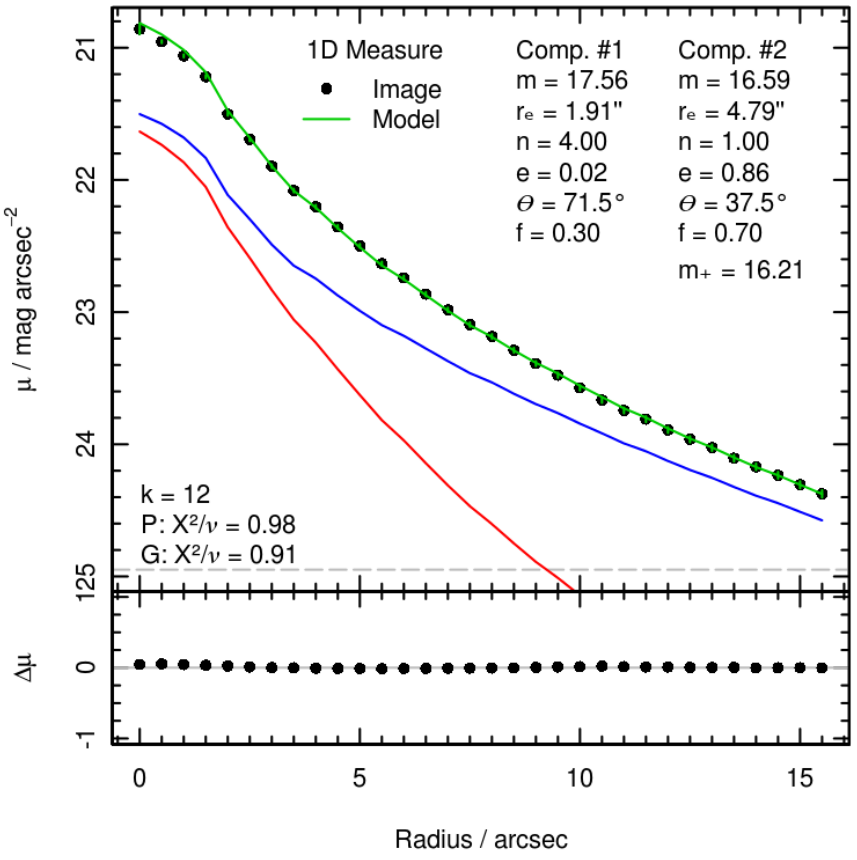




S0a: G417433

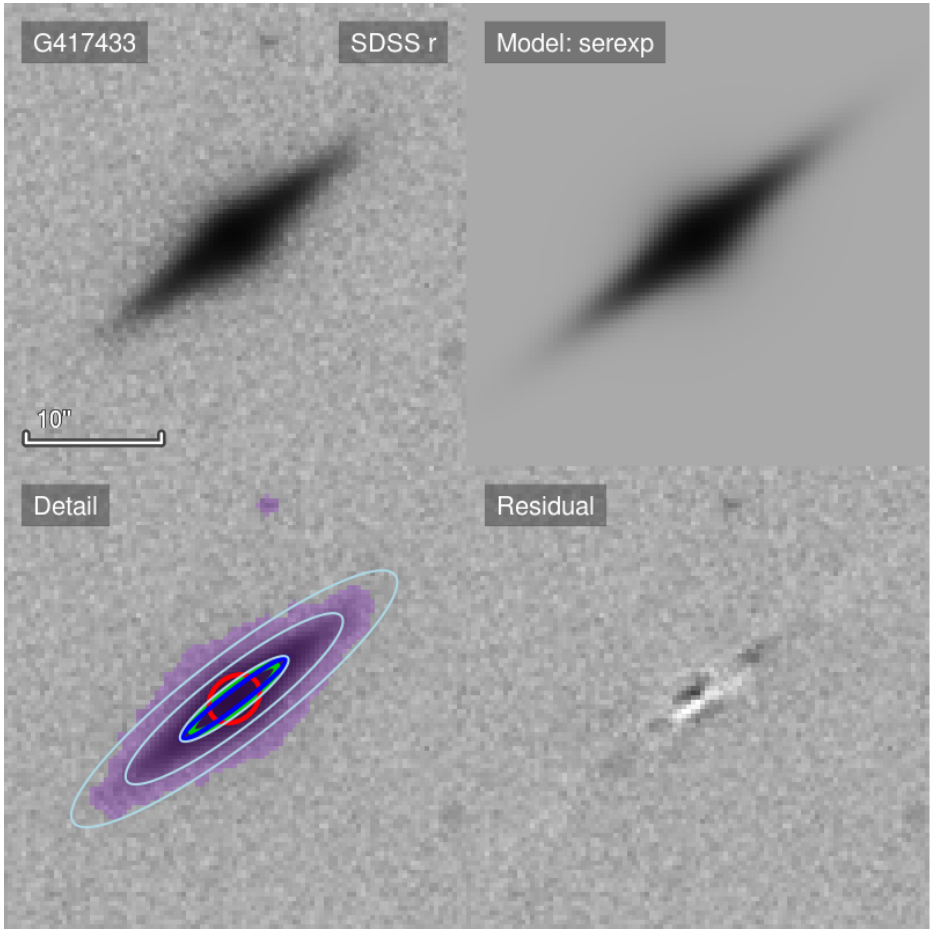
M02: De Vaucouleurs bulge + exponential disk

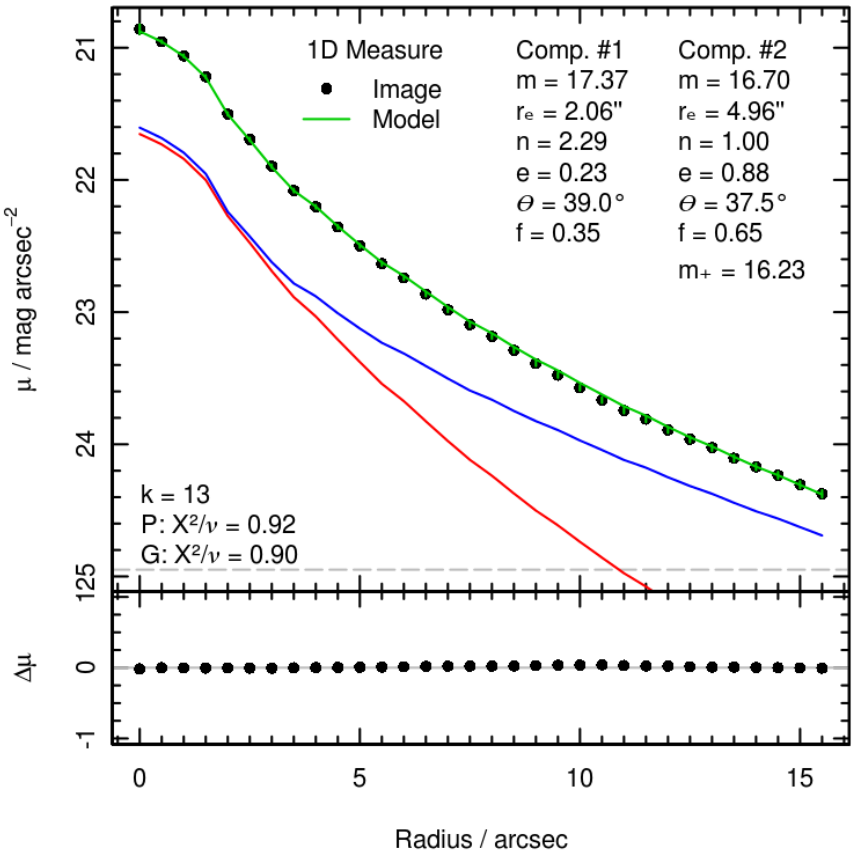




S0a: G417433

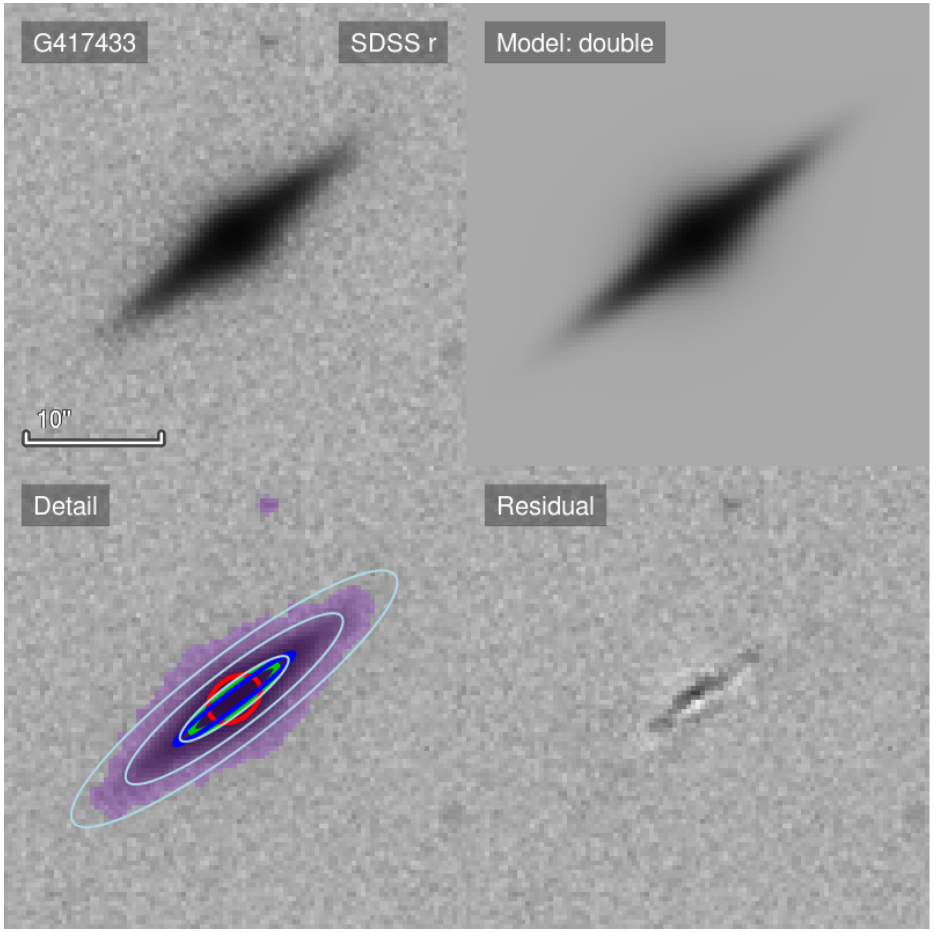
M03: Sérsic bulge + exponential disk

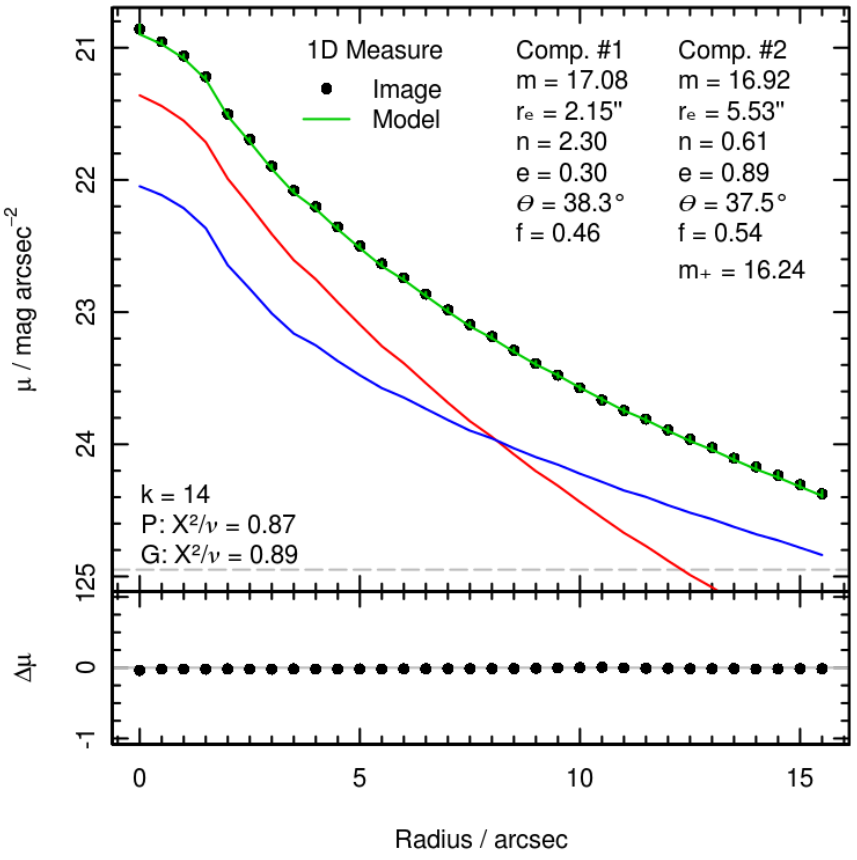




S0a: G417433

M04: Sérsic bulge + Sérsic disk

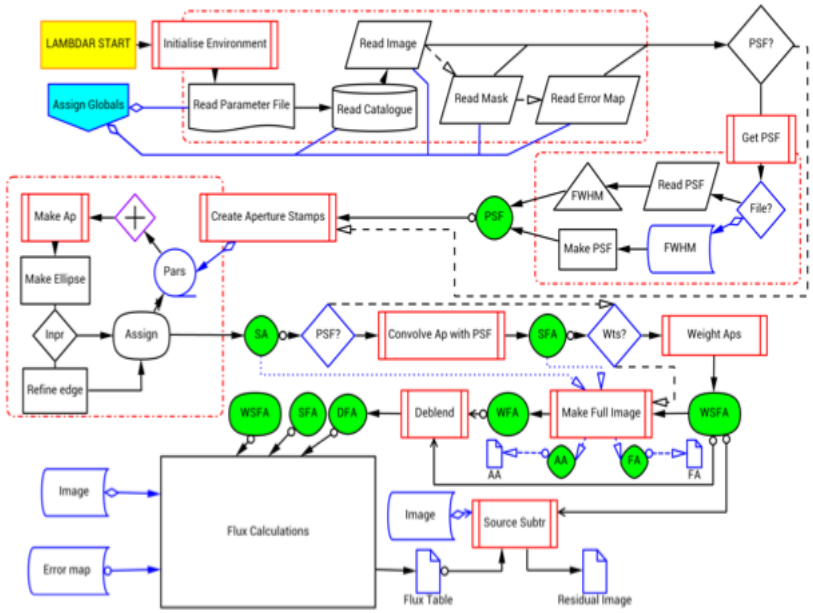




LAMBDAR

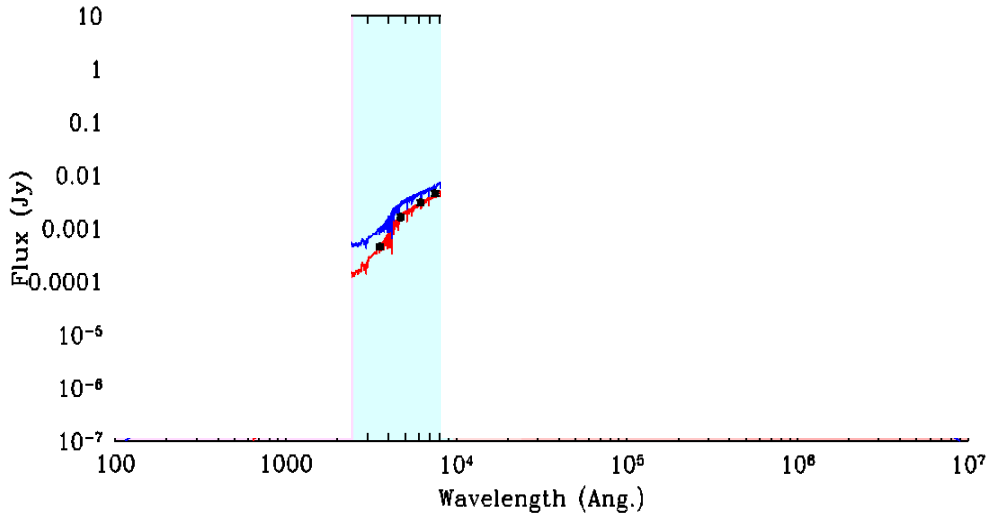
- Want a measurement in every band with error
- Need to use r-band prior across all wavelengths
- Data unresolved in some bands

- Convolved r-band aperture with PSF
- Share flux based on PSF convolved aperture
- Iterate using flux amplitudes

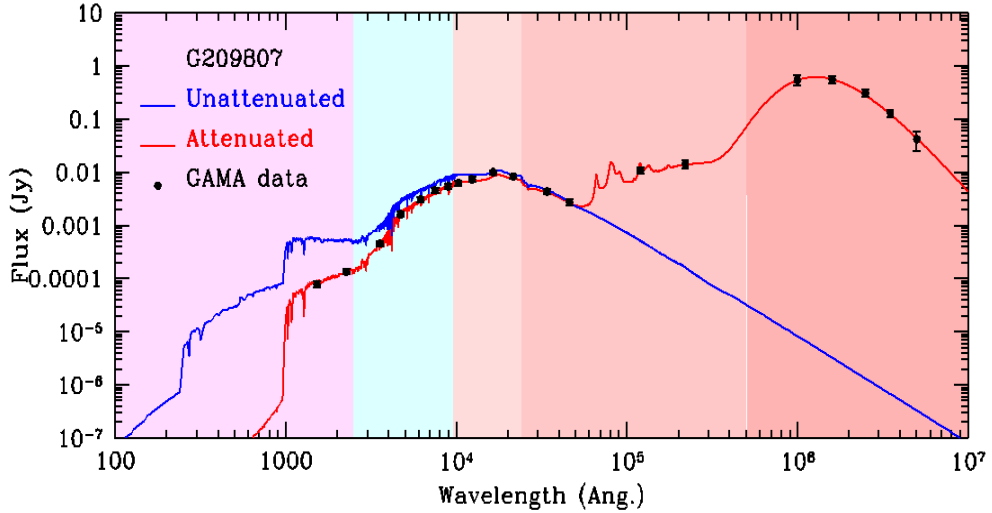


- **MULTI-WAVELENGTH ANALYSIS**

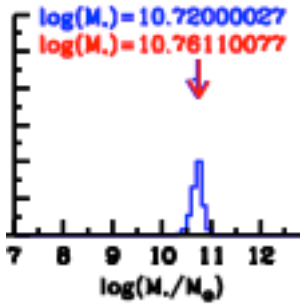
- The SDSS view of galaxies



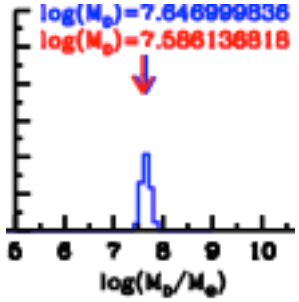
- **MULTI-WAVELENGTH ANALYSIS**
- The GAMA view of galaxies



Stellar Mass

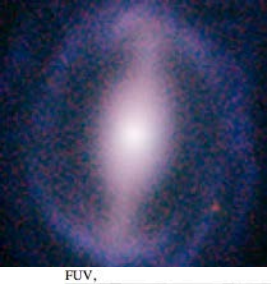


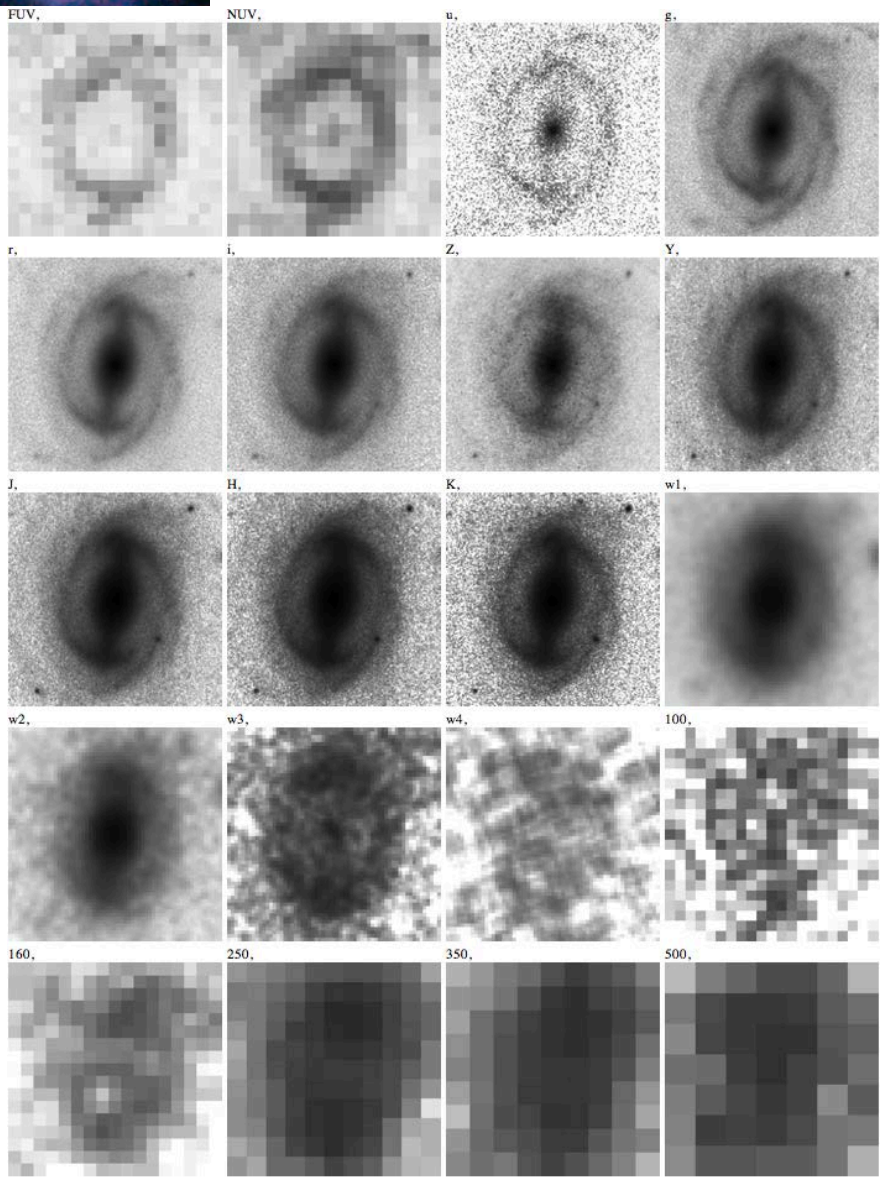
Dust Mass

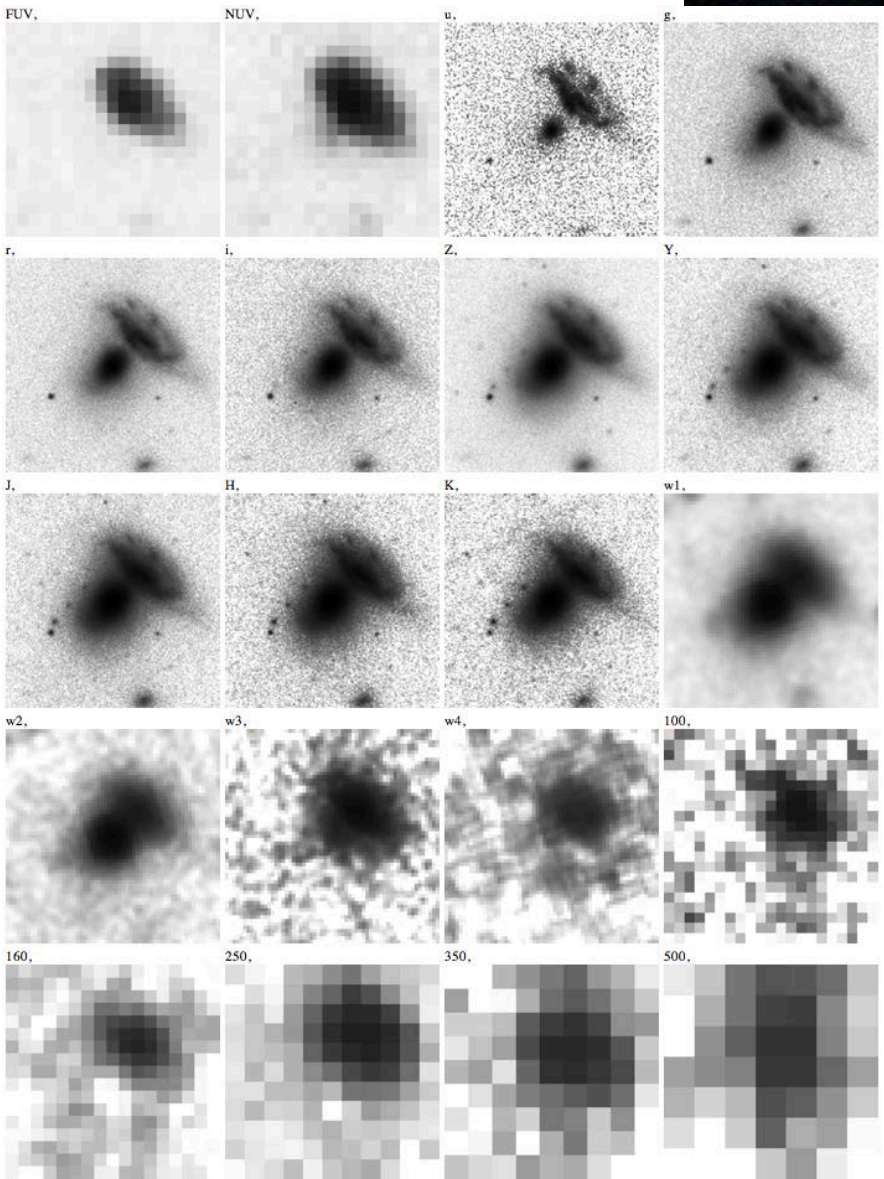


20band cutout tool for all 220k galaxies at: http://ict.icrar.org/cutout/
Will be transferred to GAMA database at ESO next month

Example galaxies

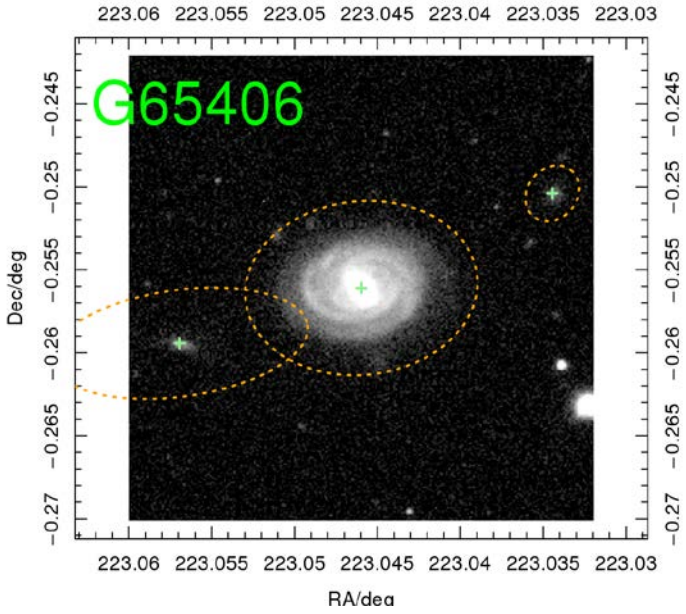


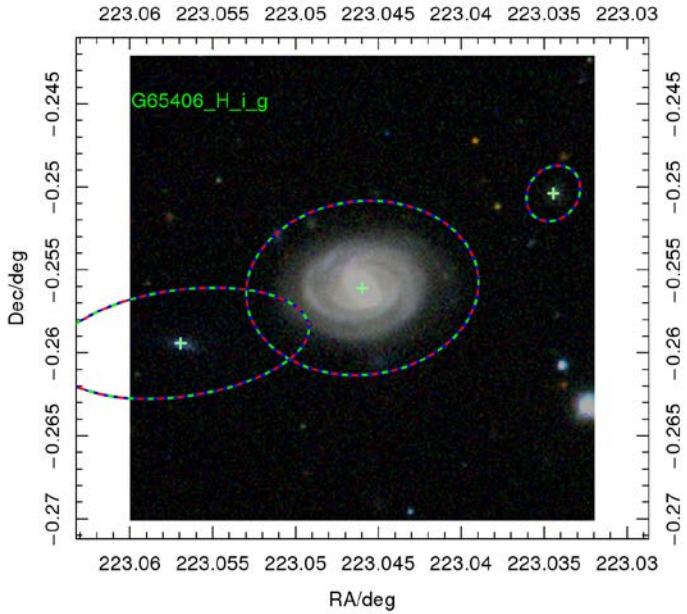


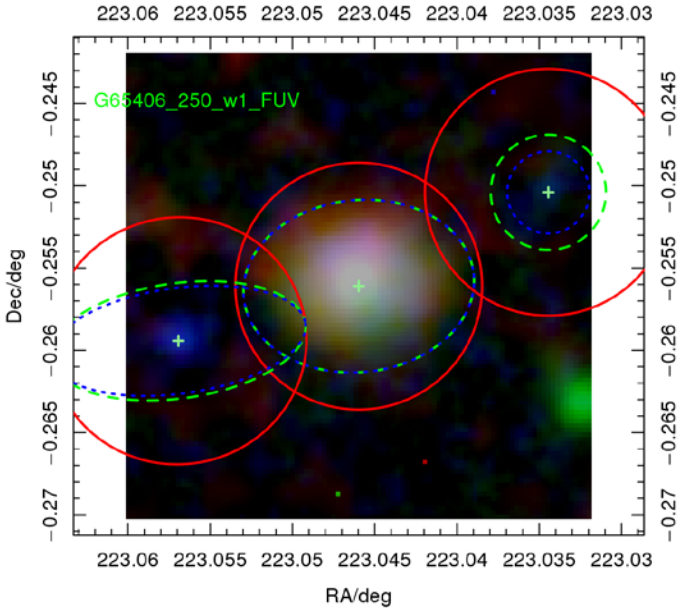


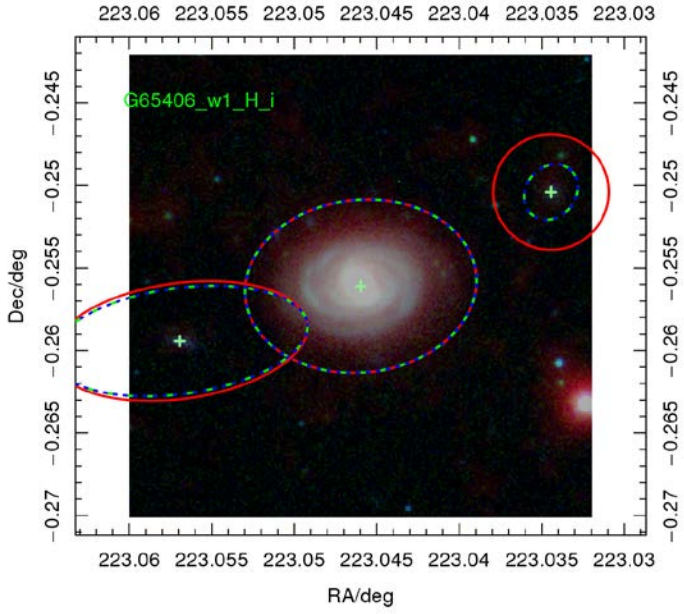
LAMBDAR only as good as your apertures

Real size variations?

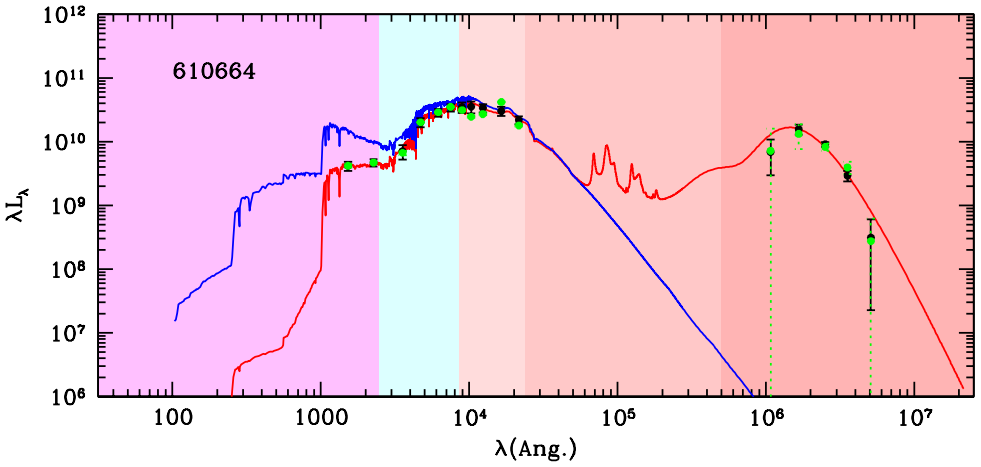


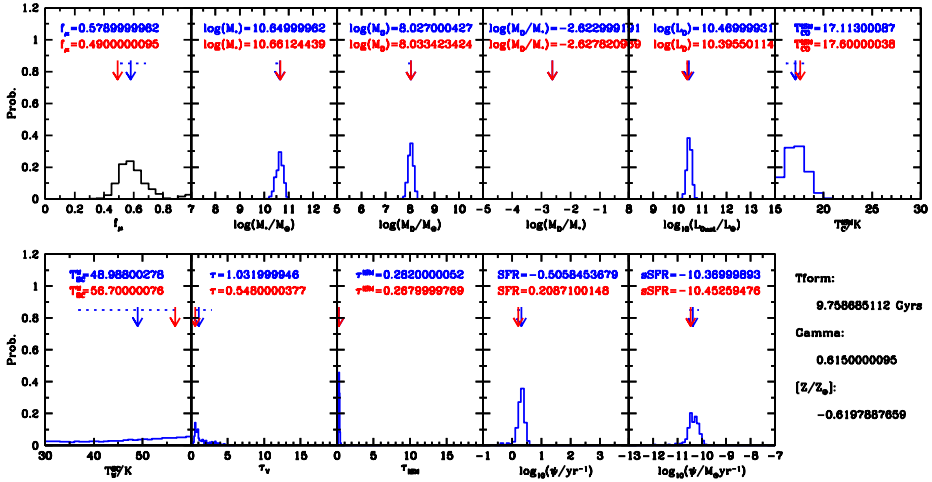


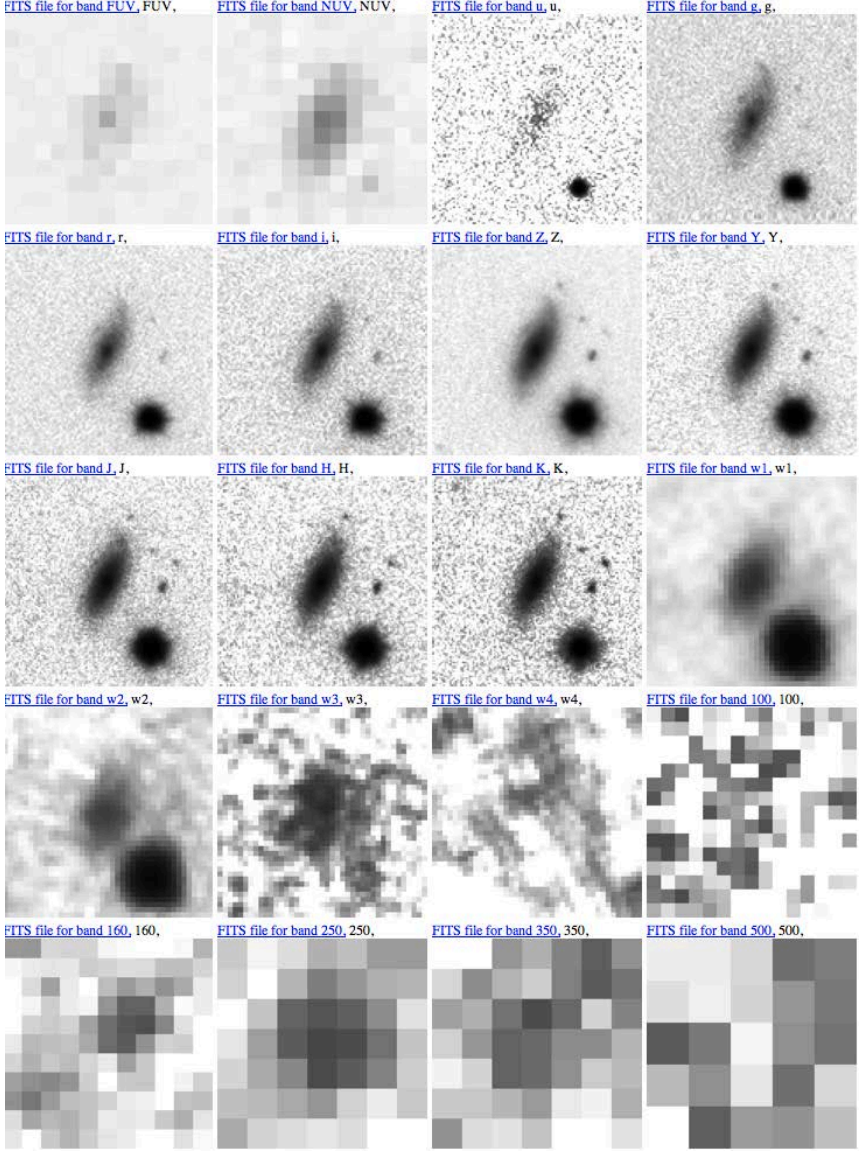




Comparison to Herschel Atlas data







Issues for SkyMapper

Is aim uvgriz or GALEX+SkyMapper+VHS+WISE?

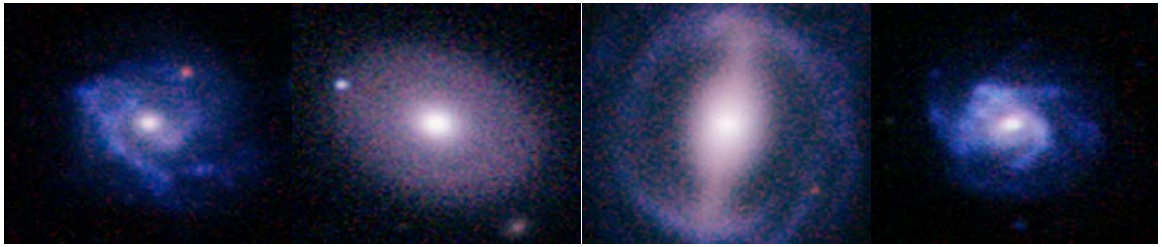
- TAIPAN = WISE selection?
- WALLABY/EMU benefit from combined catalogue
- A lot more science from the broader colours
  - pixel IFUs
  - photo-z
  - Better star-gal separation

Just photometry or profiles too?

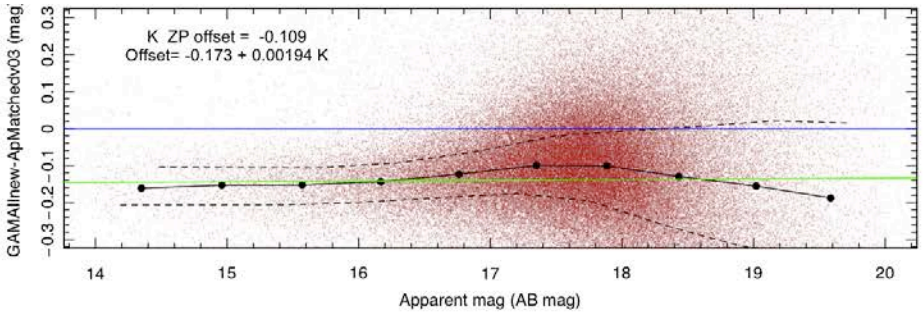
- Matched or independen photom, which band as master
- Profiles above some flux limit? (r<15), how many? ~100k

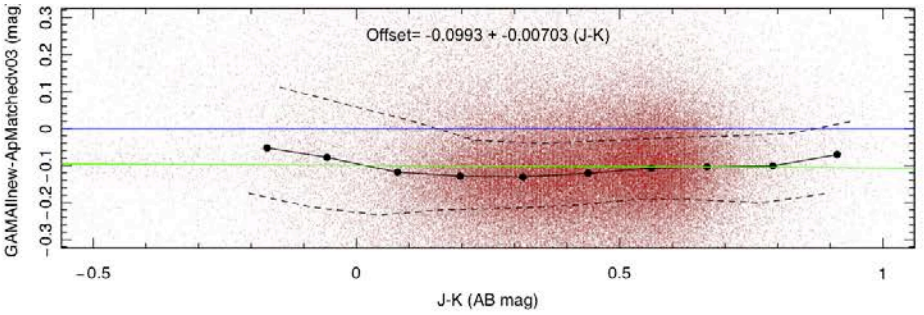
Recycle GAMA tools?

- IOTA
- SIGMA
- LAMBDAR

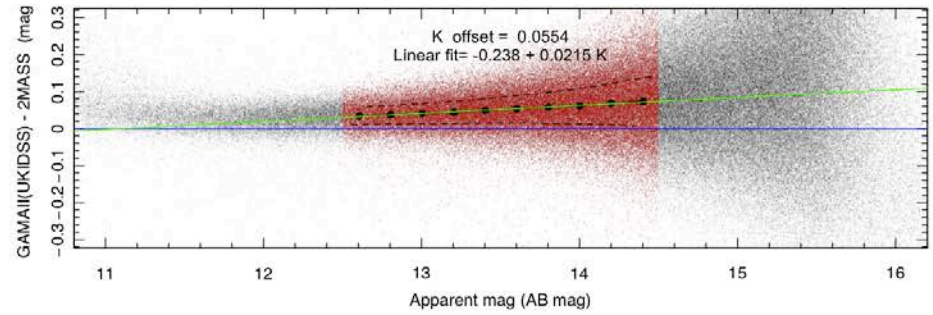


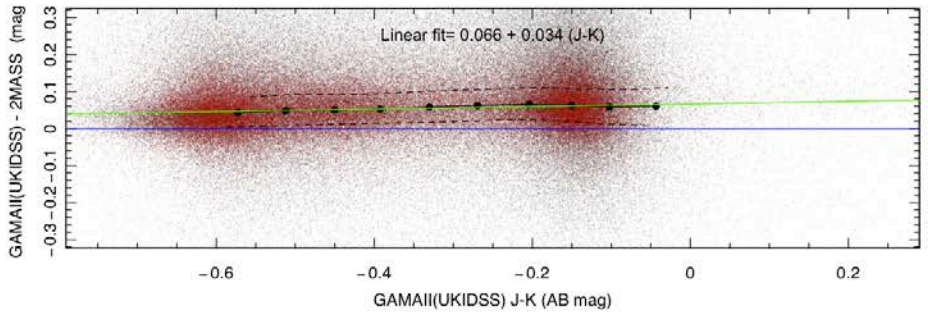
UKIDSS v VIKING

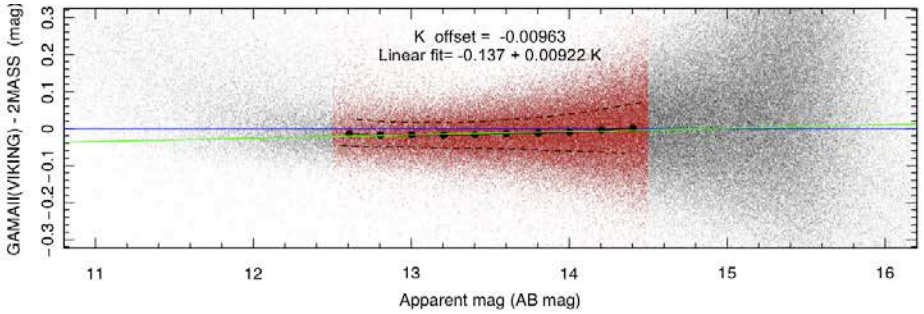


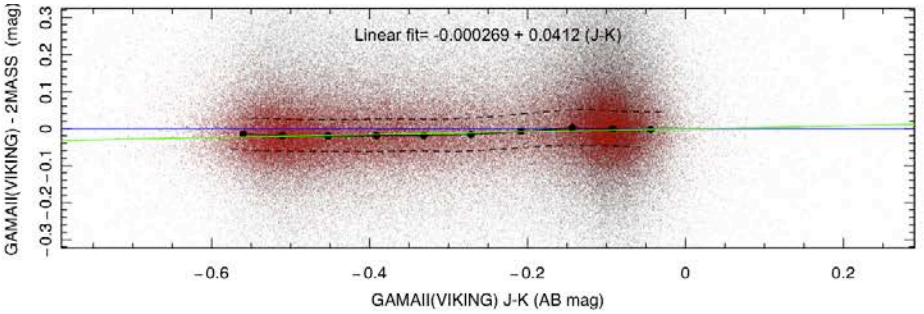


420k 2MASS stars



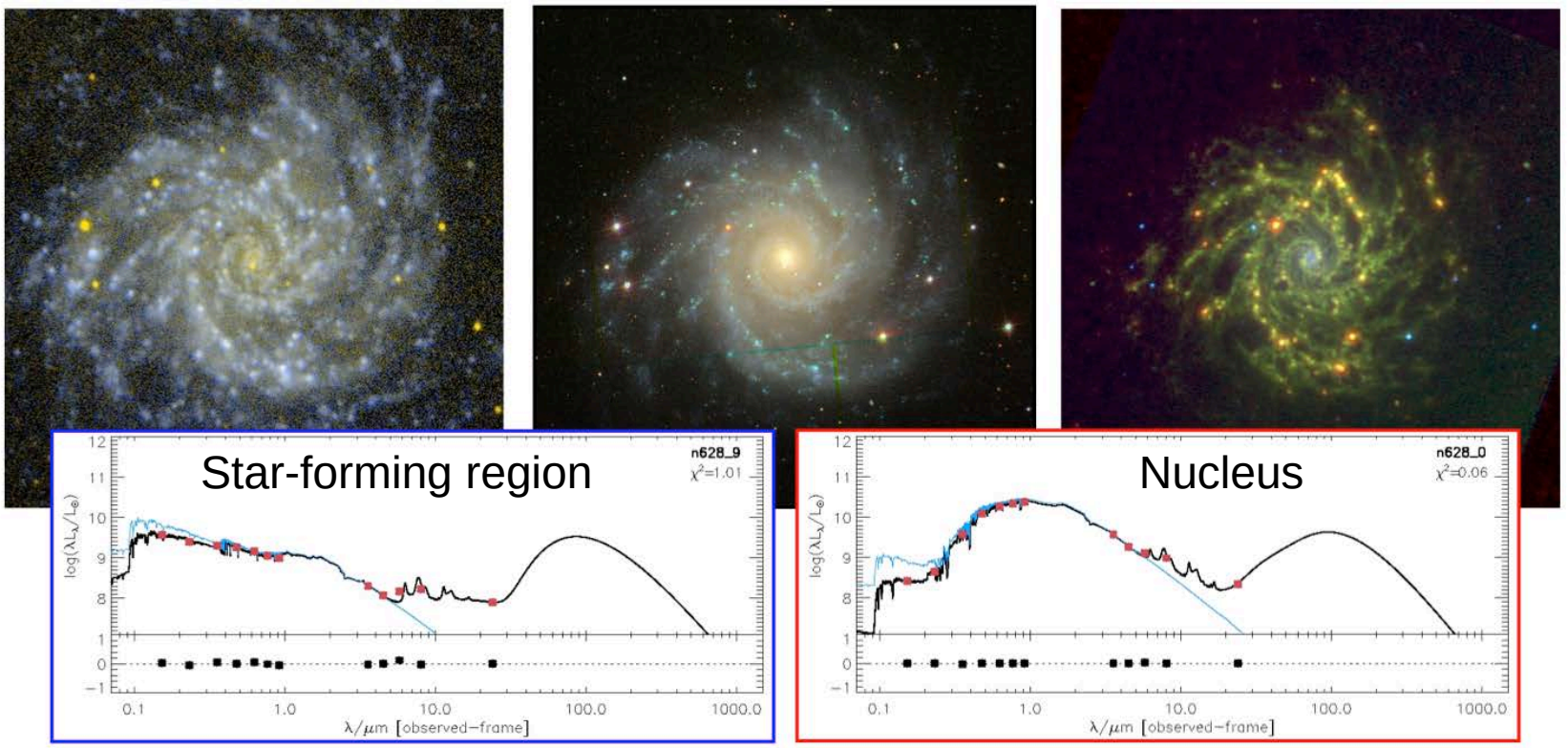






Pixel Mapping

- **POGS (MEURER, THILKER, VINSEN)**



Pixel mapping

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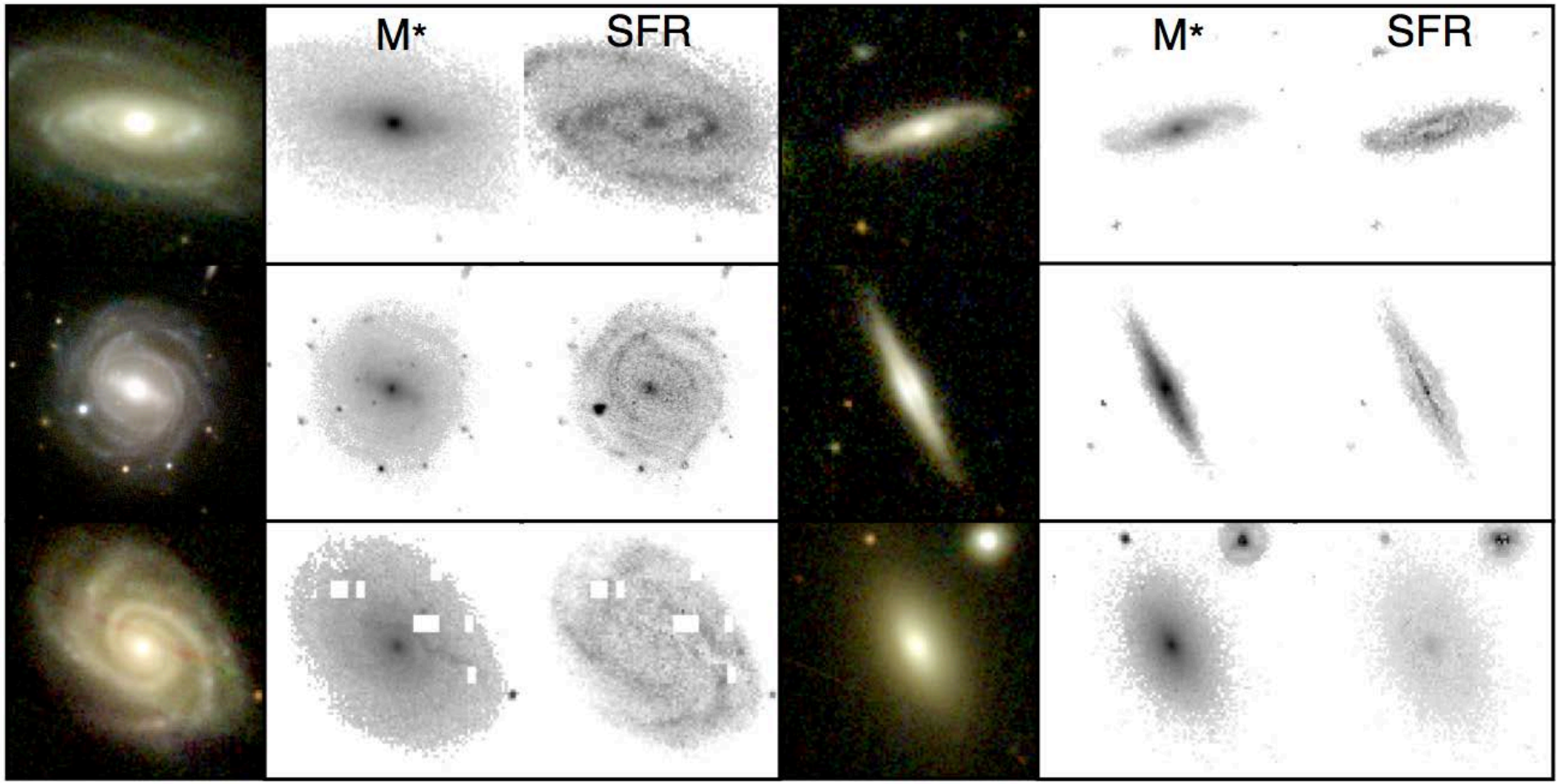
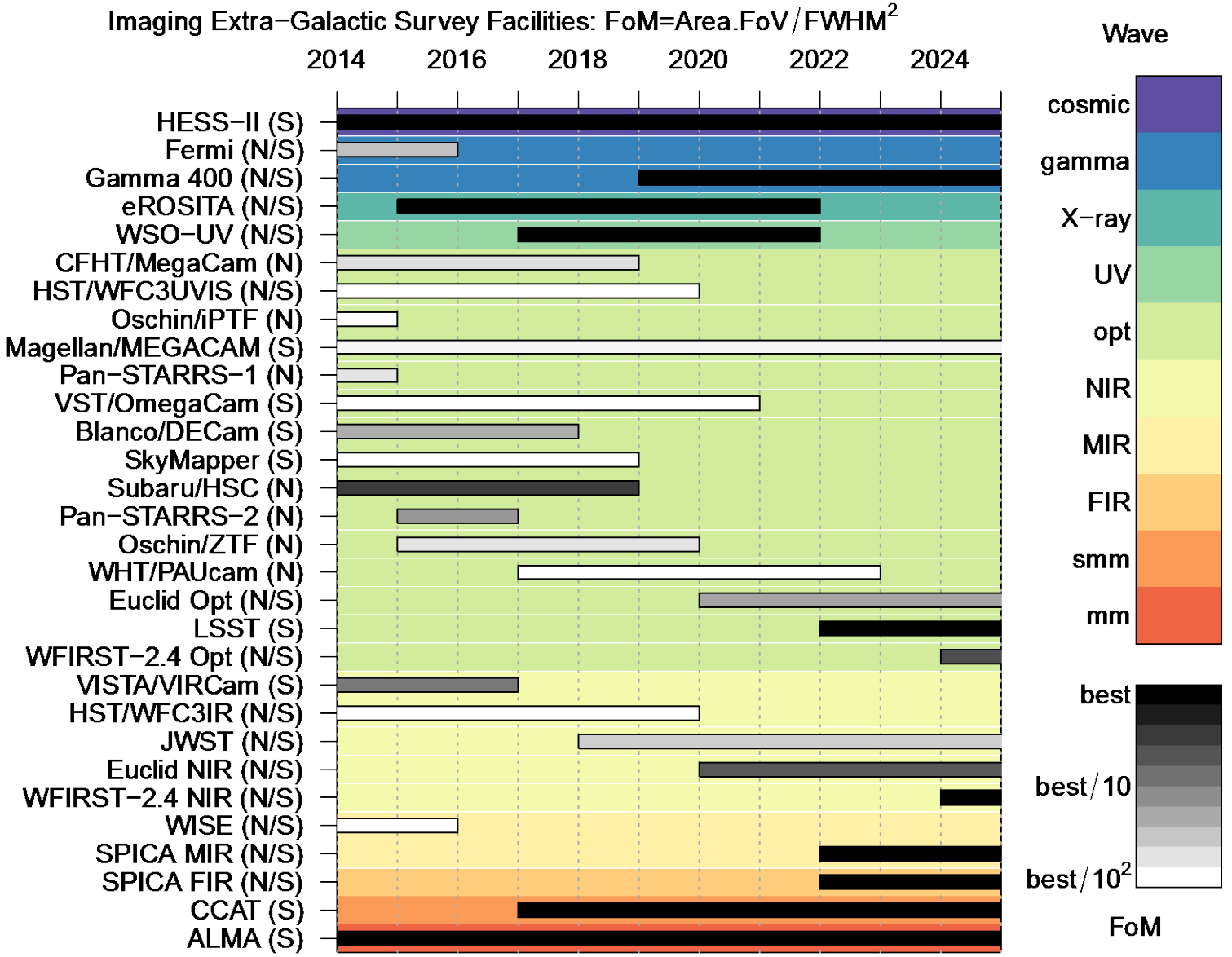
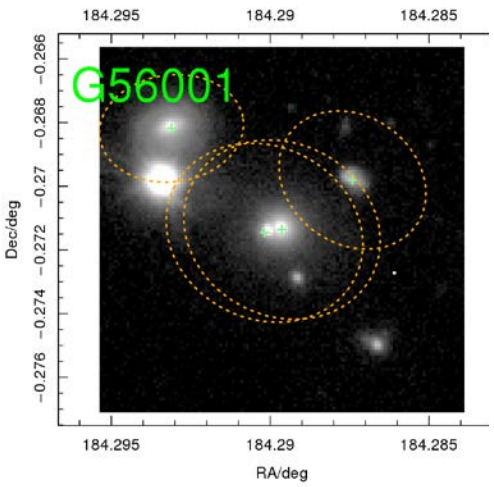
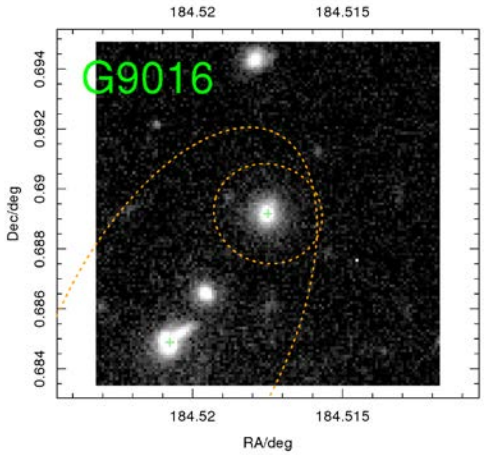


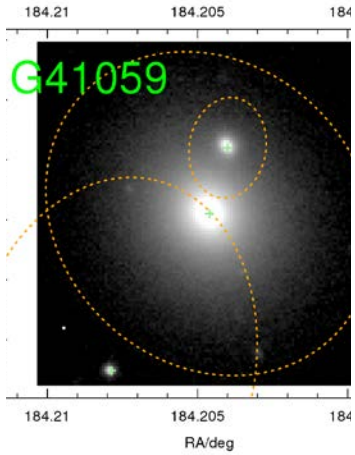
Imaging survey facilities

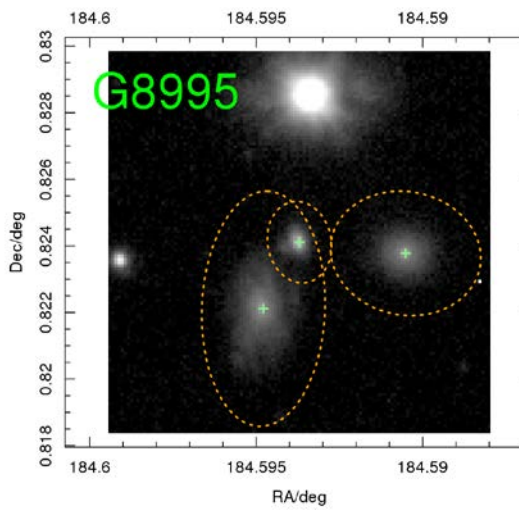


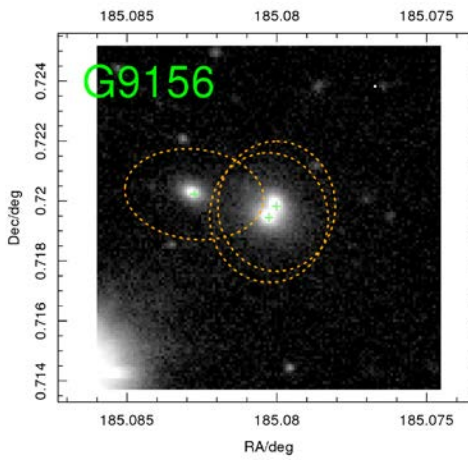
Watch our for bad apertures

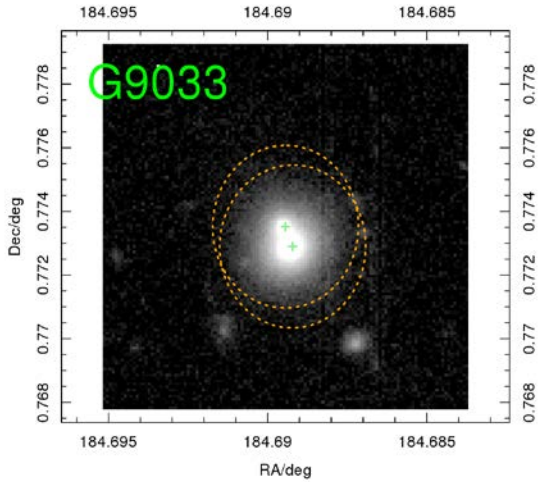


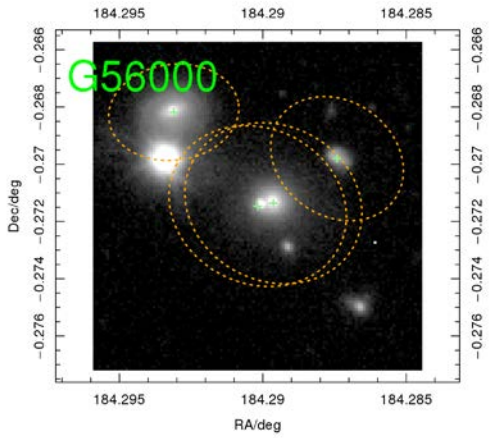




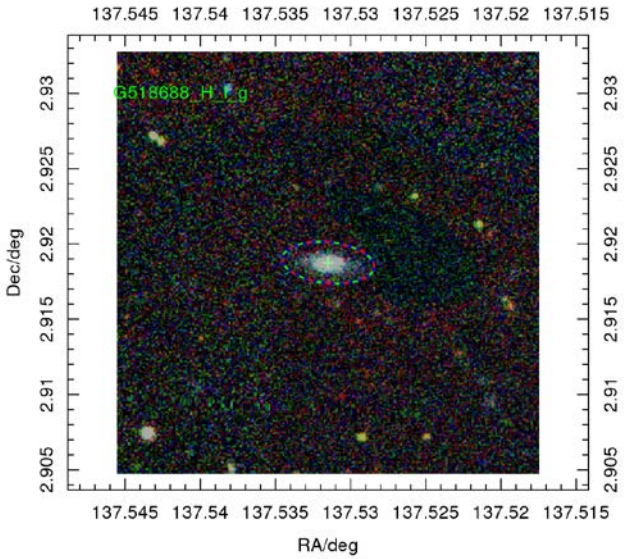


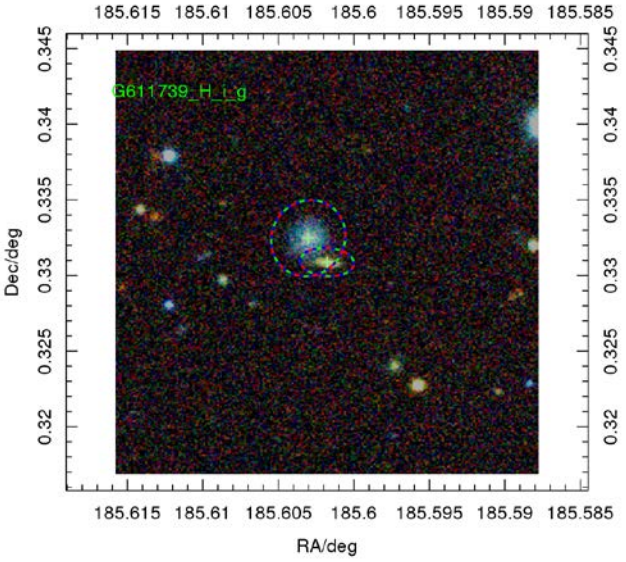


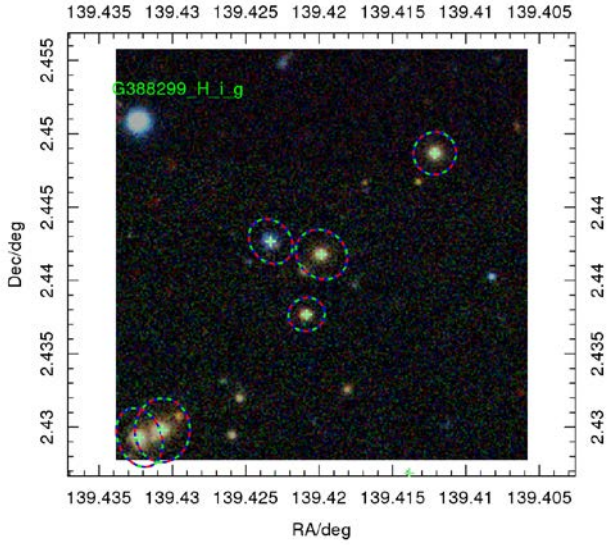


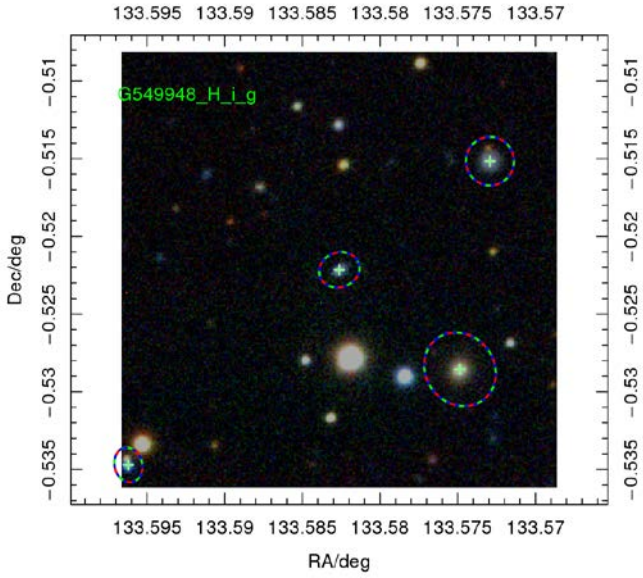


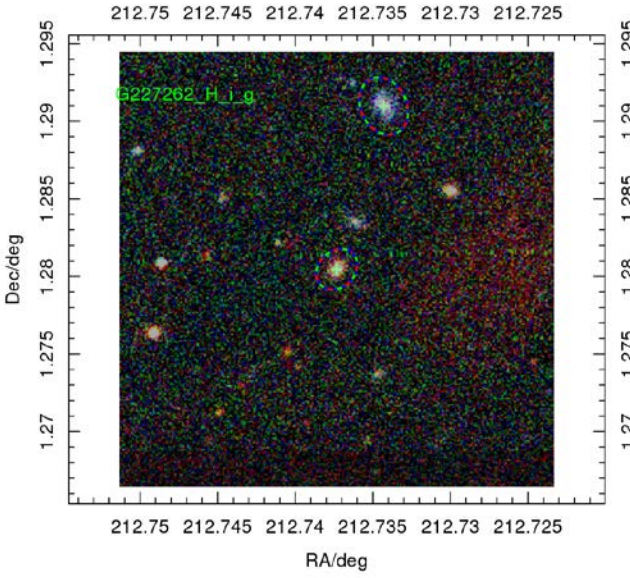
Random 5


G518688_H_i_g
137.545 137.54 137.535 137.53 137.525 137.52 137.515
2.93 2.925 2.92 2.915 2.91 2.905
Dec/deg
RA/deg

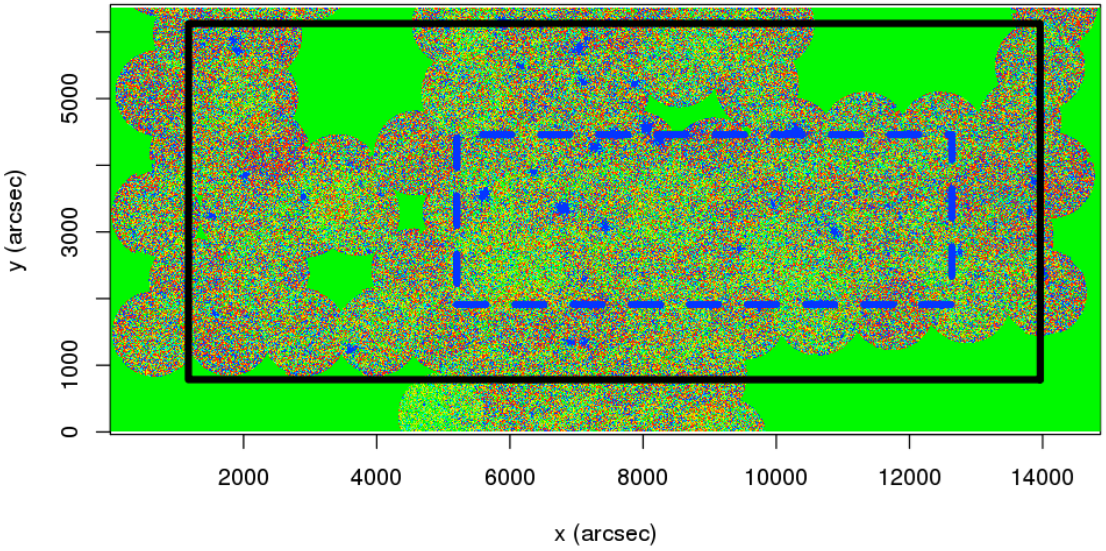

G611739_H_i_g
185.615 185.61 185.605 185.6 185.595 185.59 185.585
0.345 0.34 0.335 0.33 0.325 0.32
Dec/deg
RA/deg

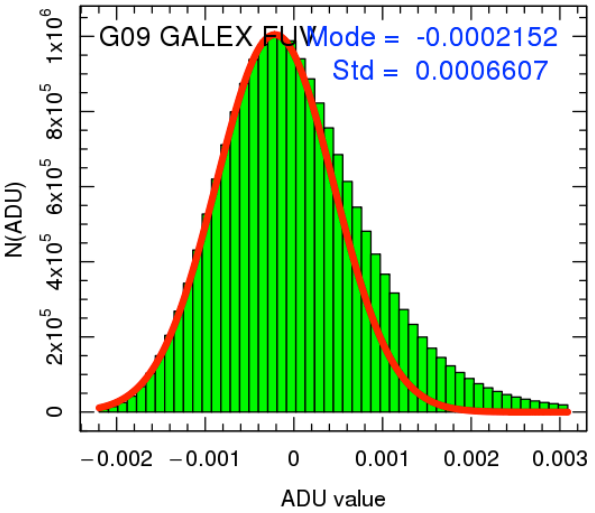

G388299_H_i_g
139.435 139.43 139.425 139.42 139.415 139.41 139.405
2.455 2.45 2.445 2.44 2.435 2.43
Dec/deg
RA/deg


G549948_H_i_g
133.595 133.59 133.585 133.58 133.575 133.57
−0.51 −0.515 −0.52 −0.525 −0.53 −0.535
Dec/deg
RA/deg

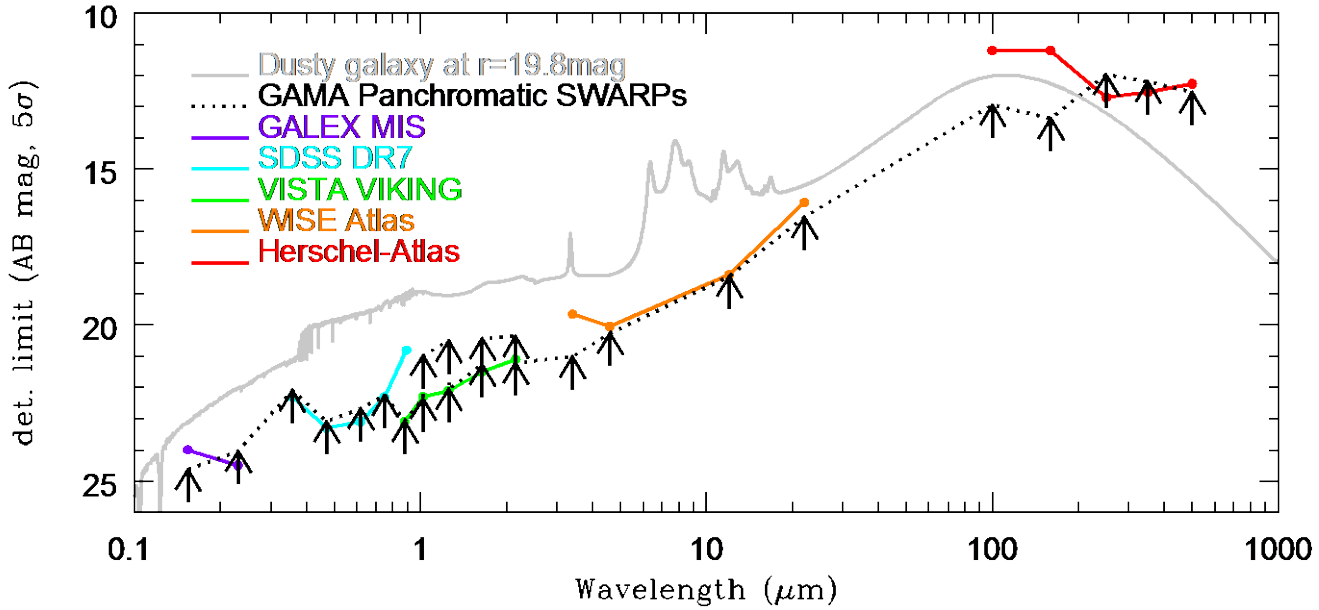

G227262_H_i_g
212.75 212.745 212.74 212.735 212.73 212.725
1.295 1.29 1.285 1.28 1.275 1.27
Dec/deg
RA/deg

Noise characteristics of the data

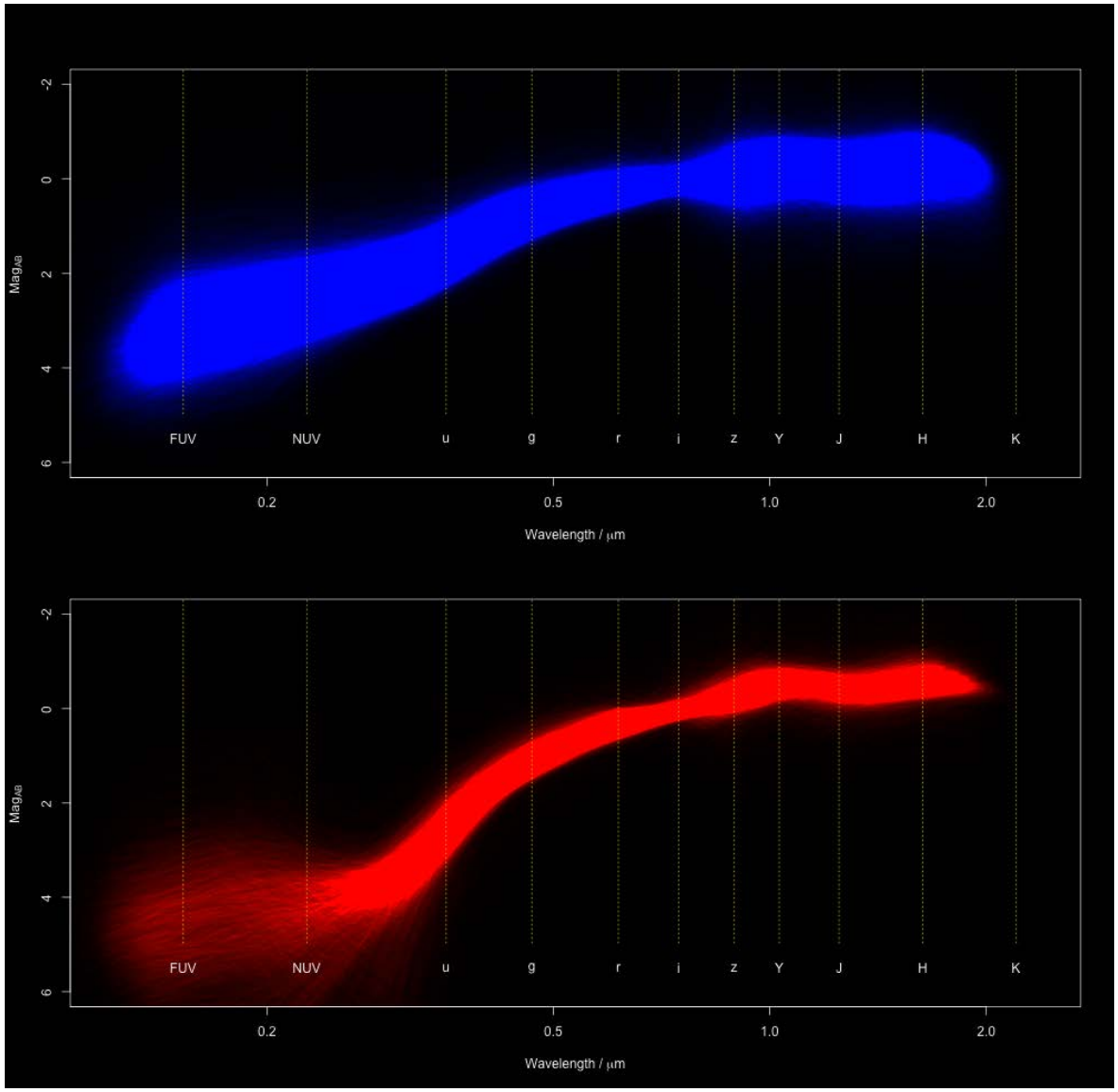




Use background noise to determine sky noise in aperture (errors) and limiting sensitivity for each band and compare to that predicted/listed for each facility



IOTA (SDSS+UKIDSS v GAMA)



OLD

NEW