



# Structure, Morphology and Mass in GAMA

Lee Kelvin

University of St Andrews / ICRAR (UWA)



University  
of  
St Andrews



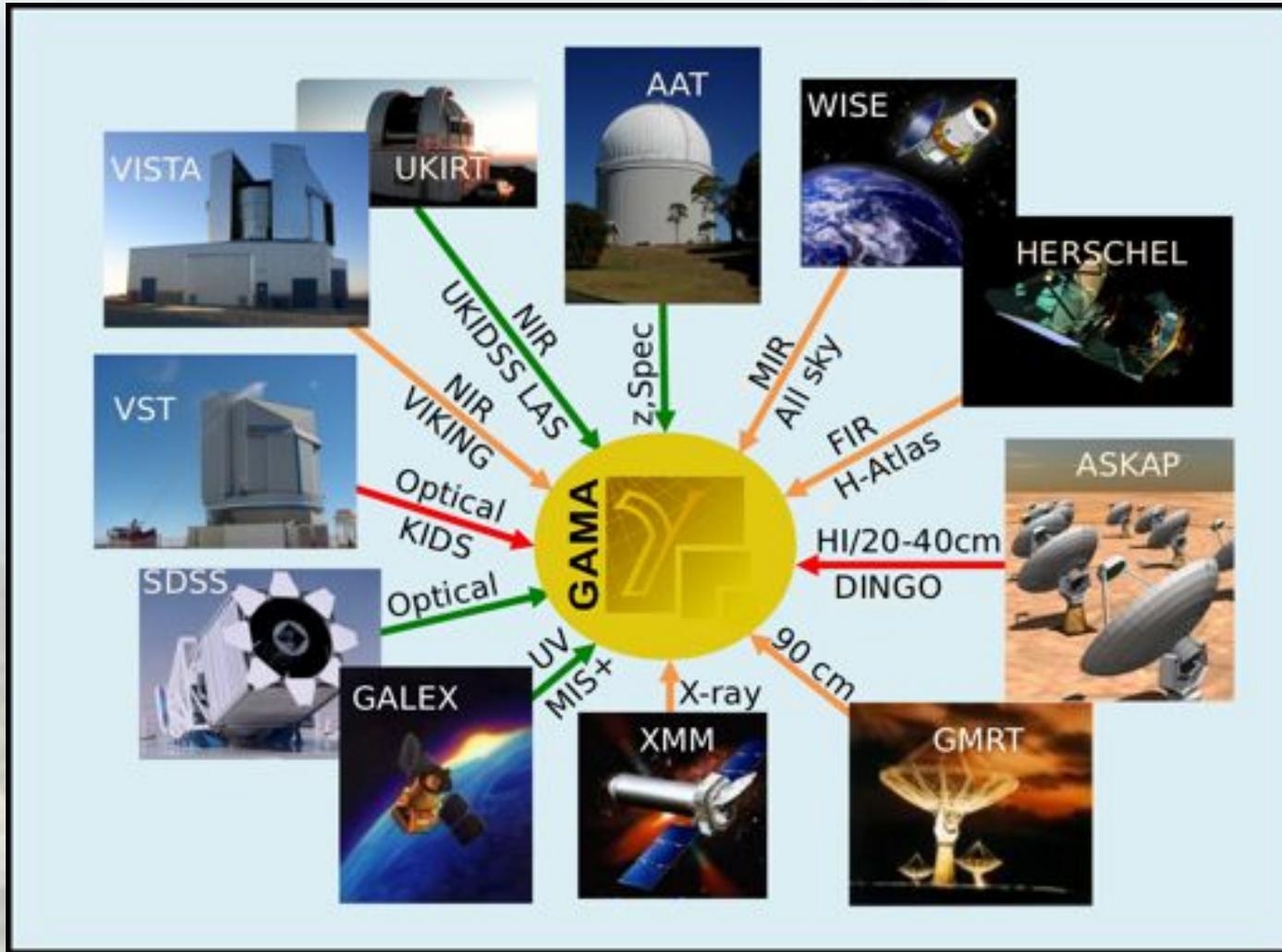
International  
Centre for  
Radio  
Astronomy  
Research



THE UNIVERSITY OF  
WESTERN AUSTRALIA

*Achieving International Excellence*

# Galaxy and Mass Assembly



- $\sim 340,000$  galaxies
- $r < 19.8$  mag
- $\sim 310$  deg<sup>2</sup>

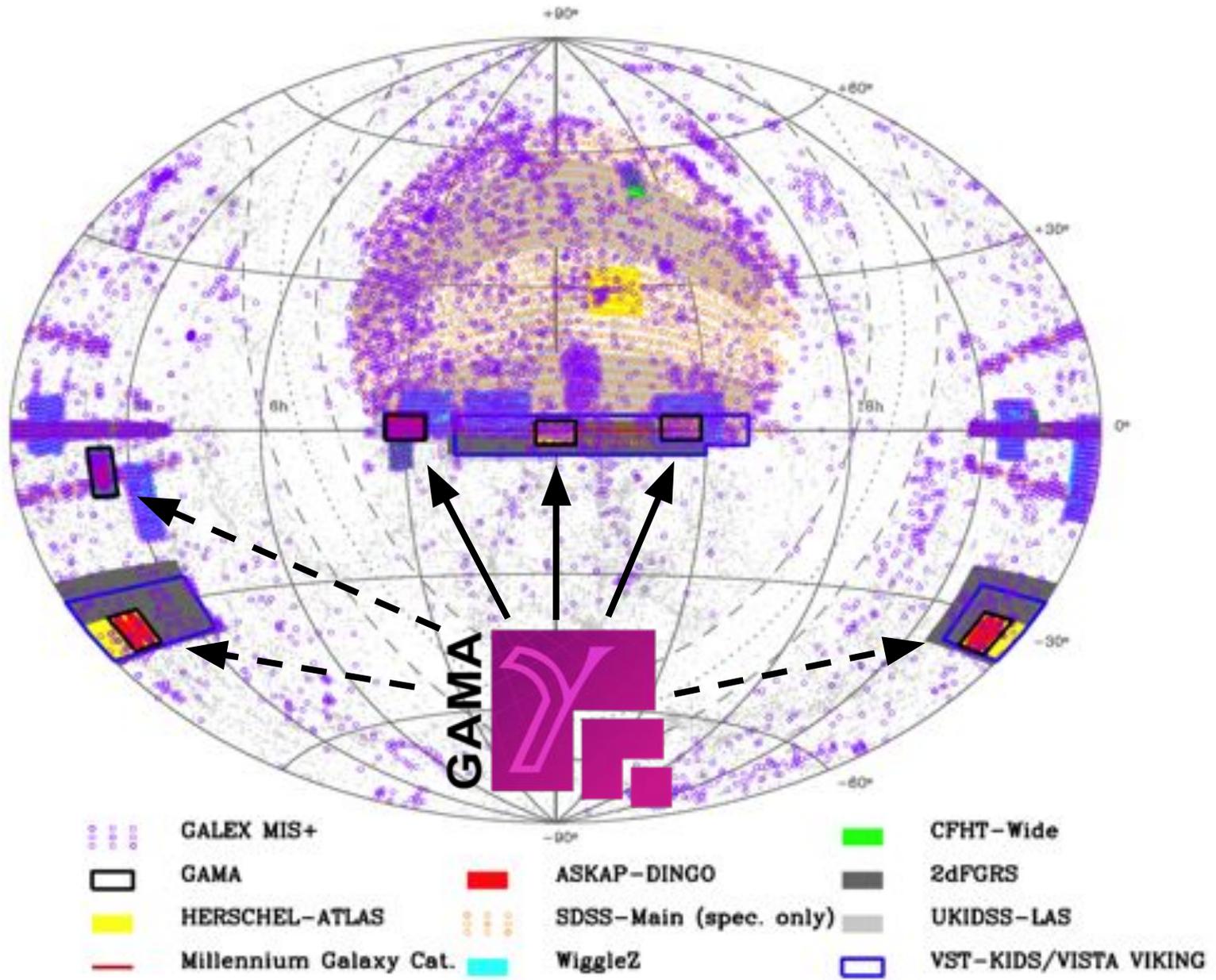
*"study structure on scales of 1 kpc to 1 Mpc"*

galaxy...  
 → clusters  
 → groups  
 → mergers  
 → structure

# GAMA People



# GAMA Regions



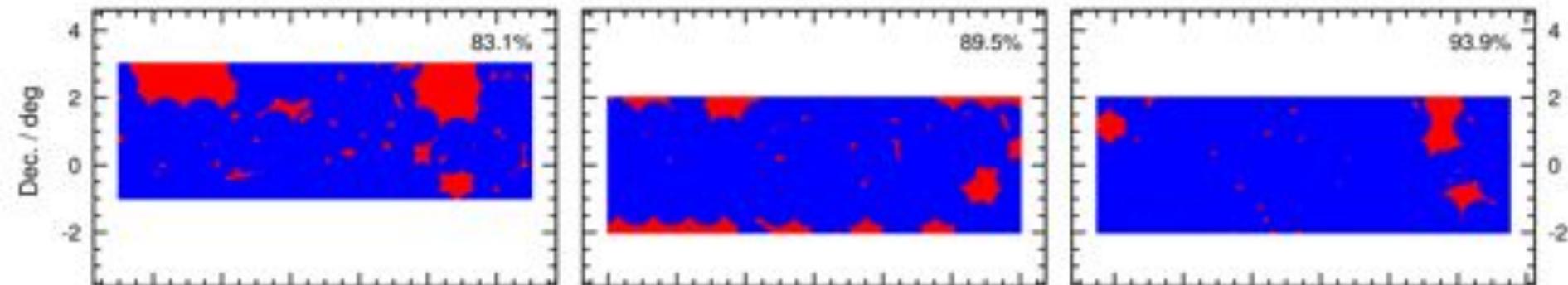
FUV/NUV

GALEX

G09

G12

G15



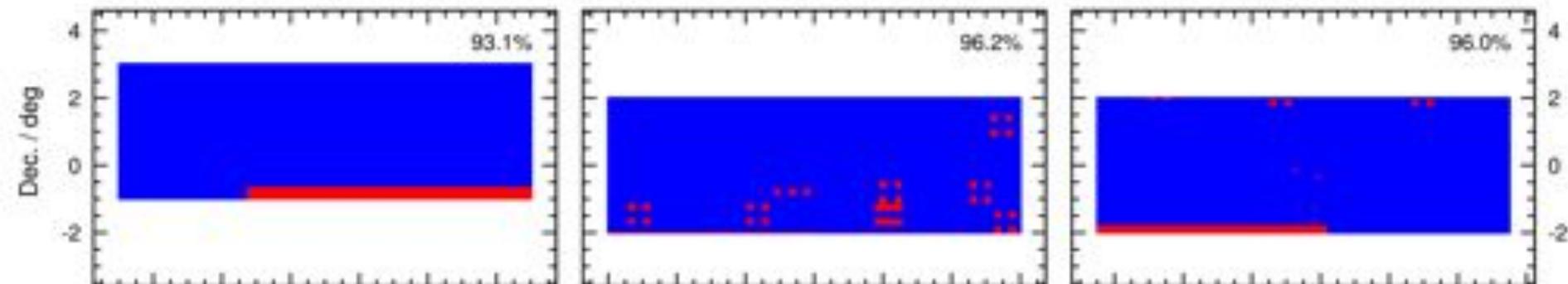
UKIDSS

G09

G12

G15

YJHK



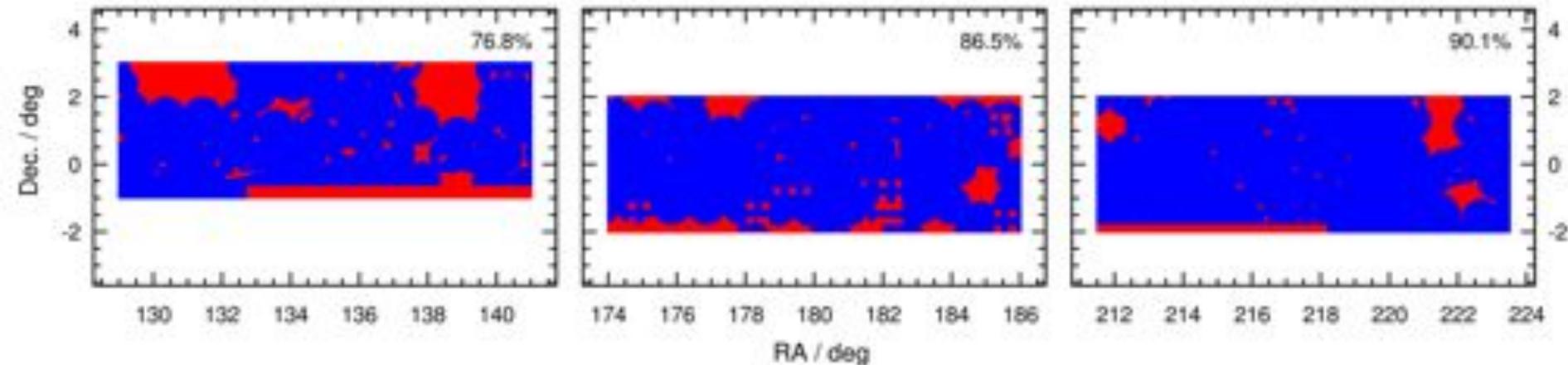
TOTAL

G09

G12

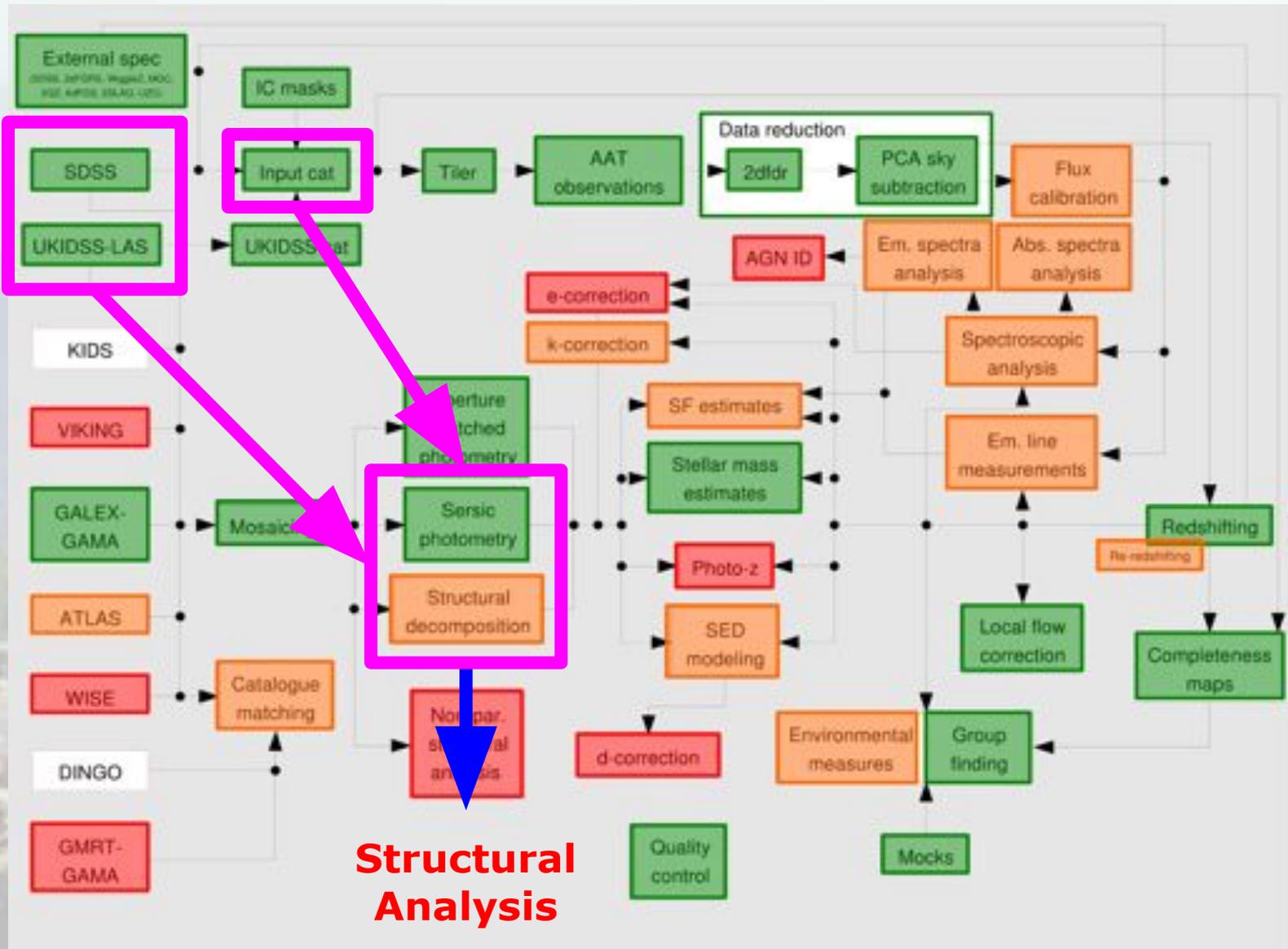
G15

FNugrizYJHK

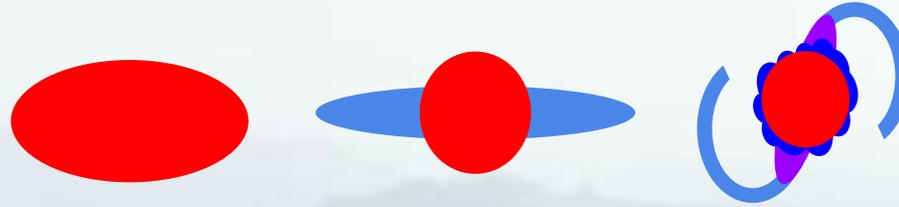




# GAMA Dataflow



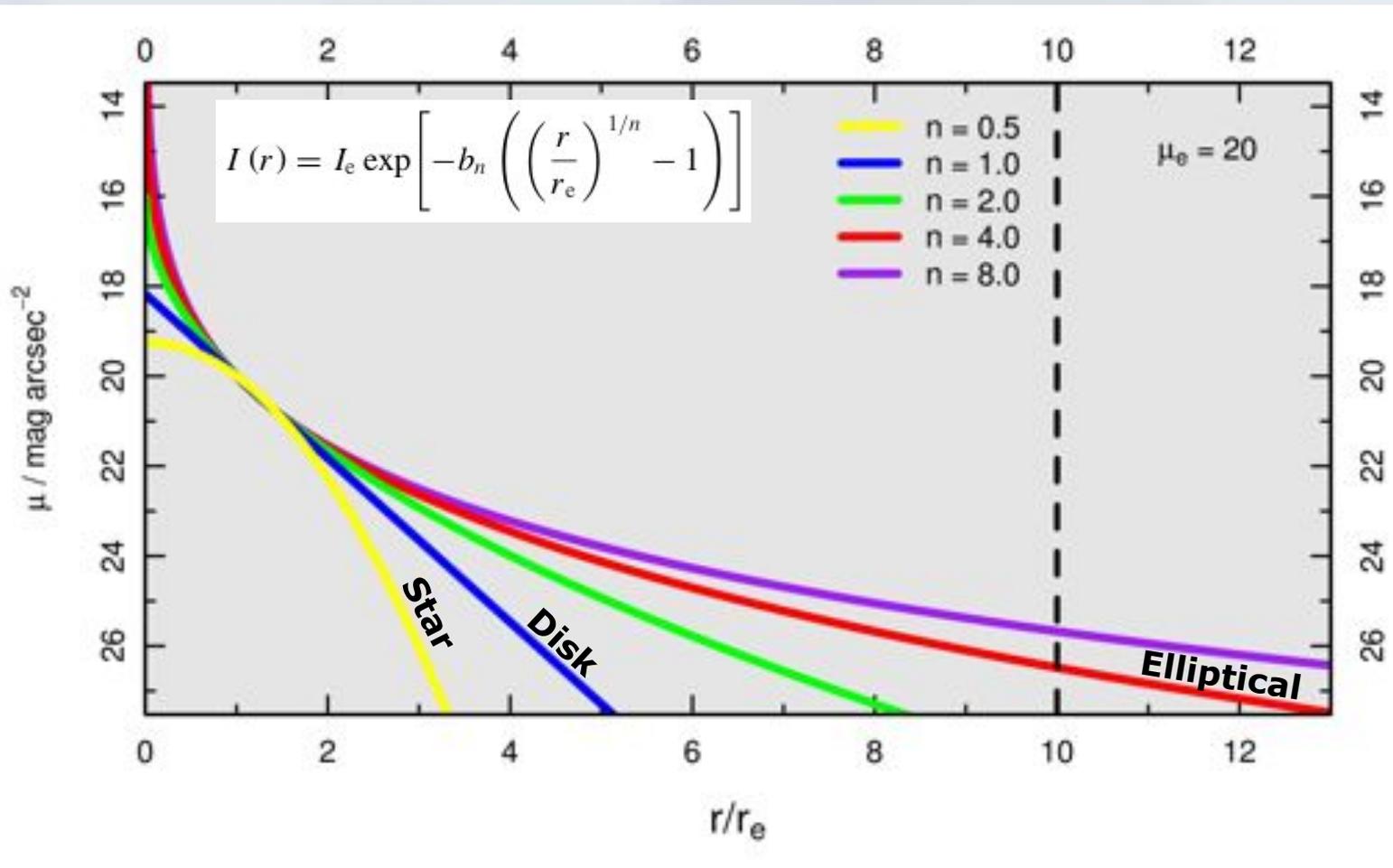
**Structural Analysis**



# Key Questions

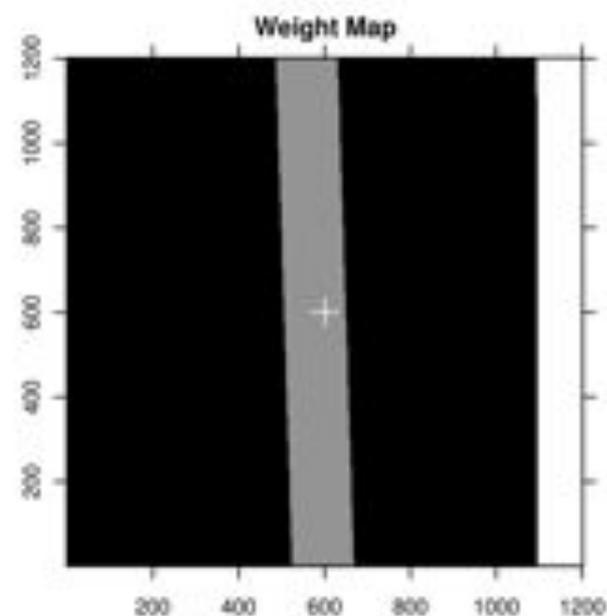
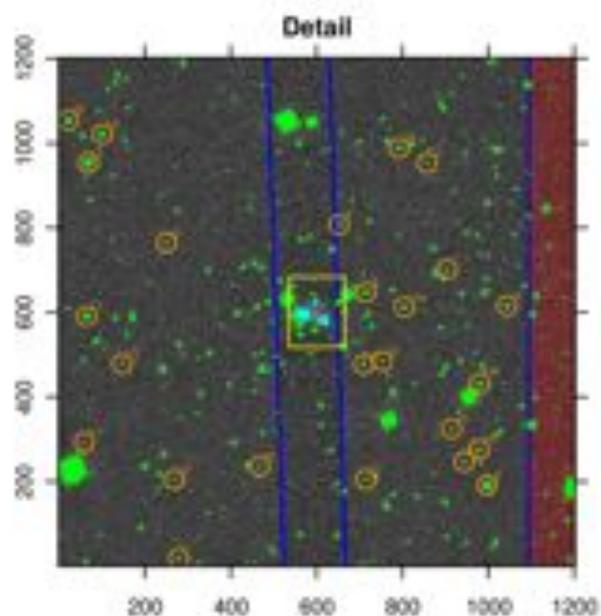
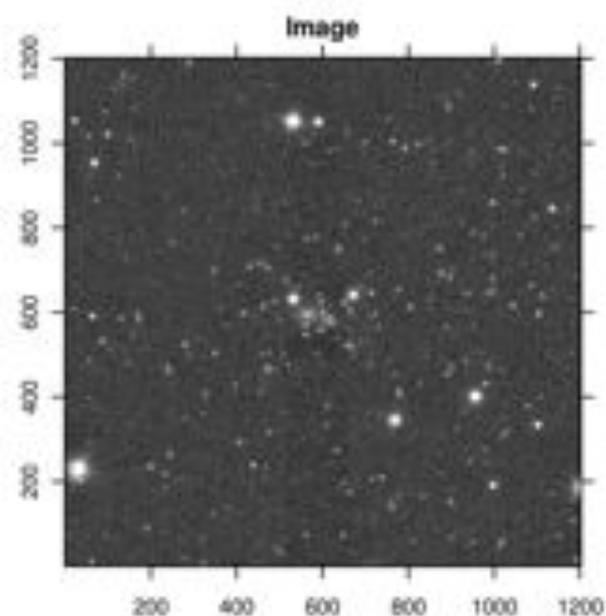
- How do structures form?
  - *bulge* → *disk* → *bar* → *pseudo-bulge*
- Are ellipticals and bulges essentially the same?
- How is stellar mass distributed between structures?
- How does environment shape galaxy structure?

# Sérsic Profile



José Luis Sérsic

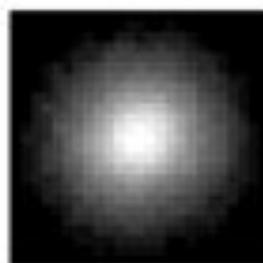
Varying the Sérsic index  $n$  allows many different galaxy profile shapes to be modelled



**PSF Star Sample**



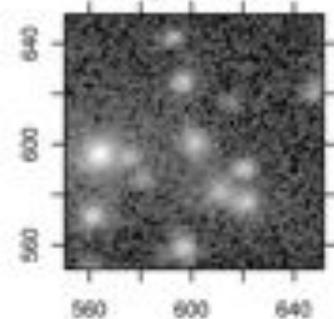
**PSF**



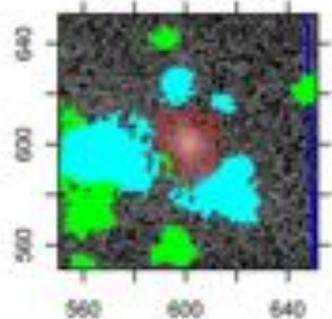
**PSF Star Residuals**



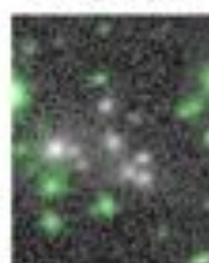
**Image (100 pix)**



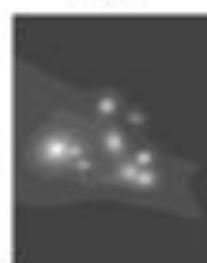
**Detail (100 pix)**



**Fitting Region**



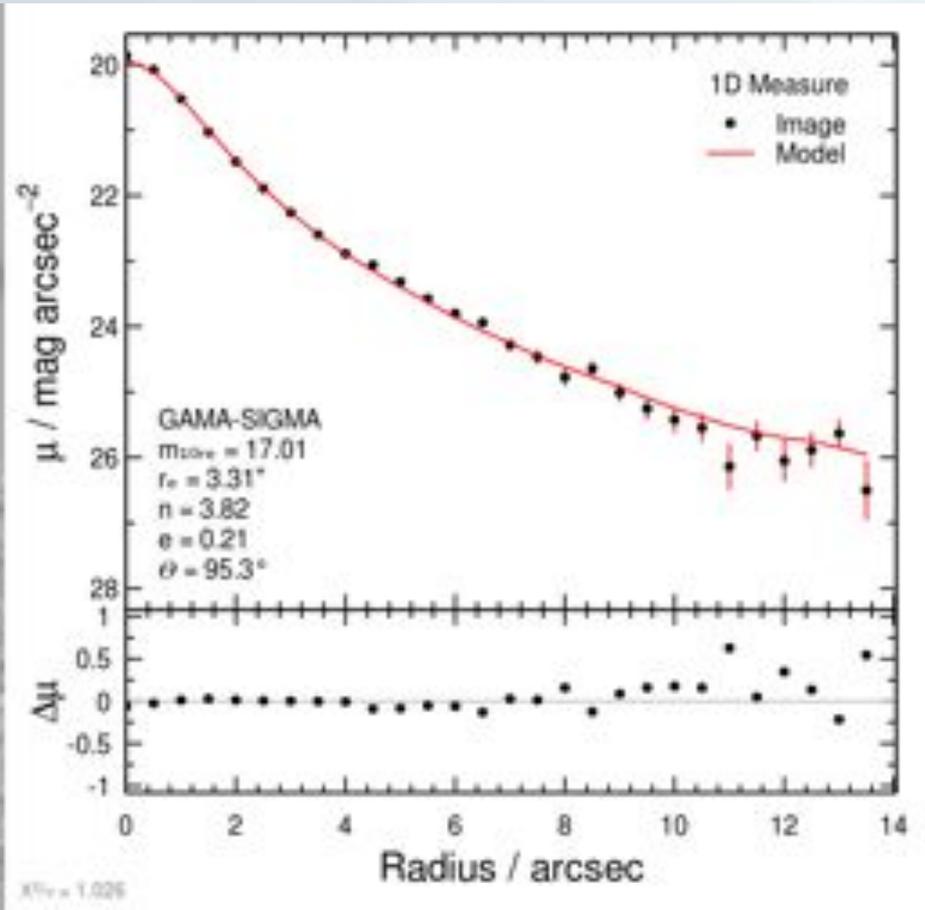
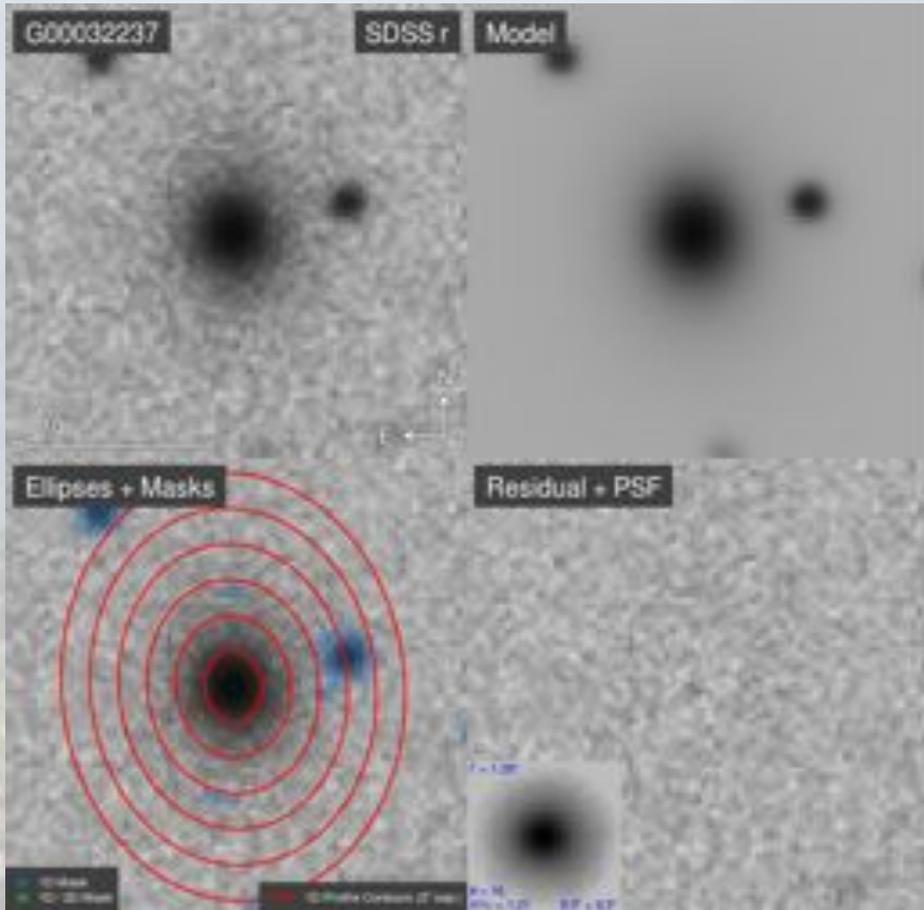
**Model**



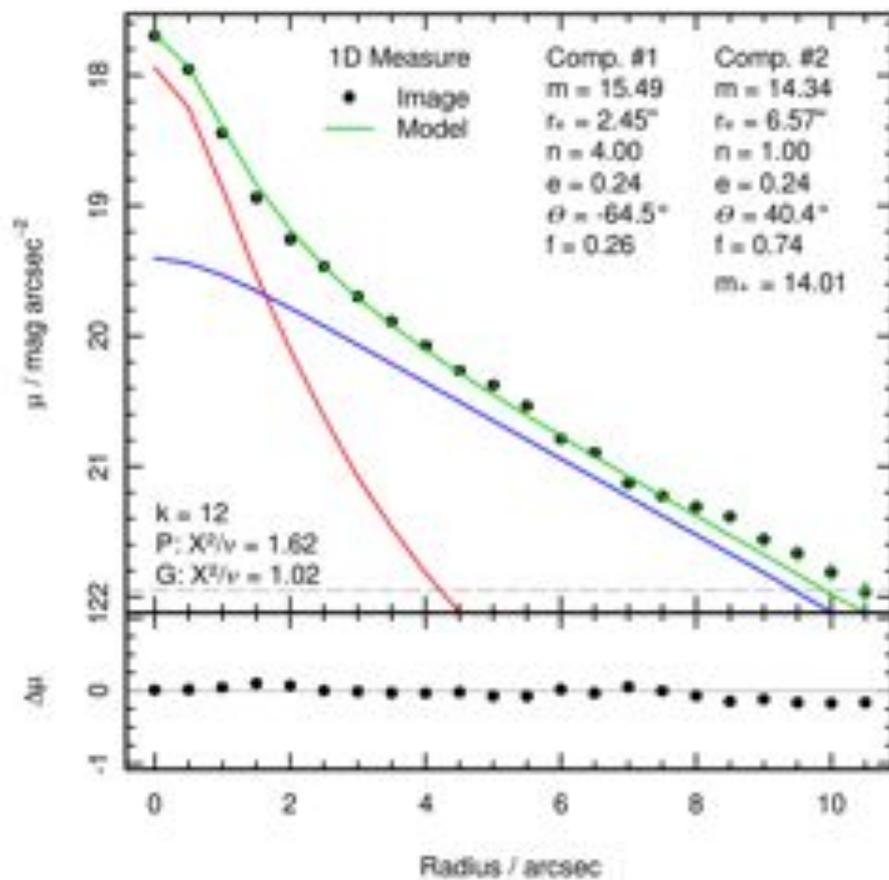
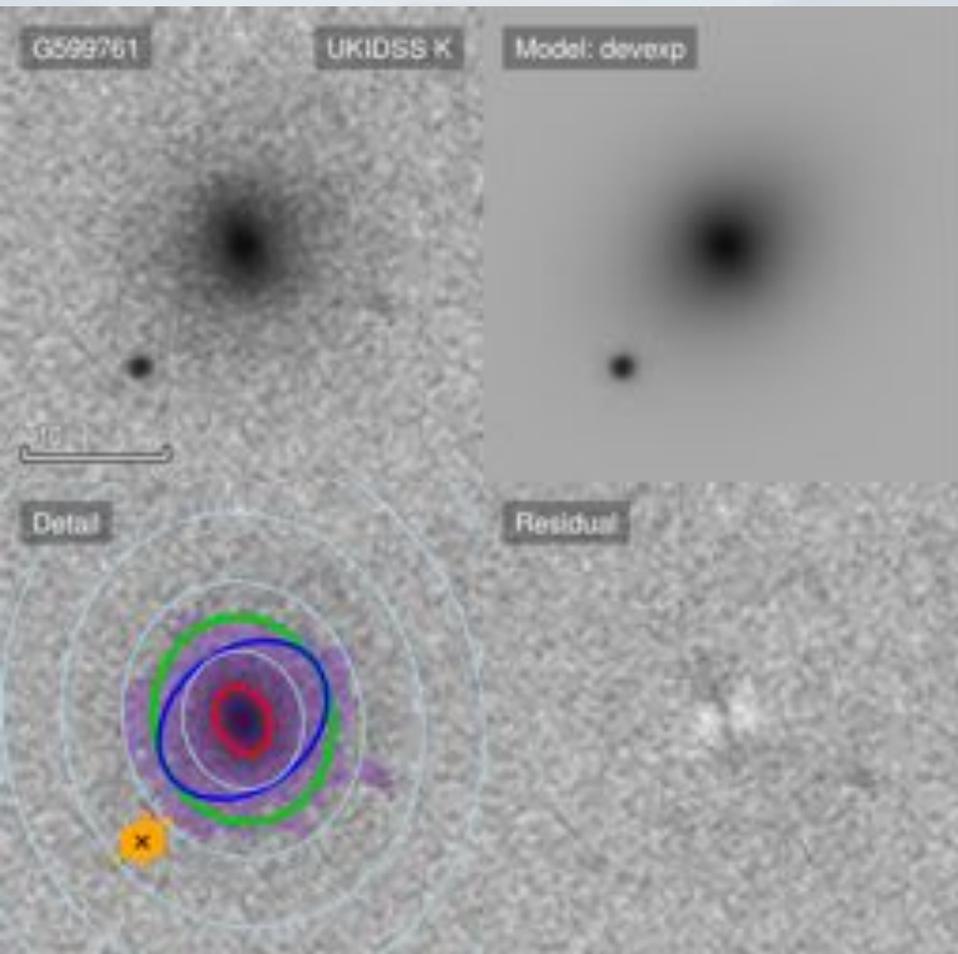
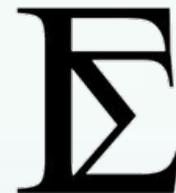
**Residual**



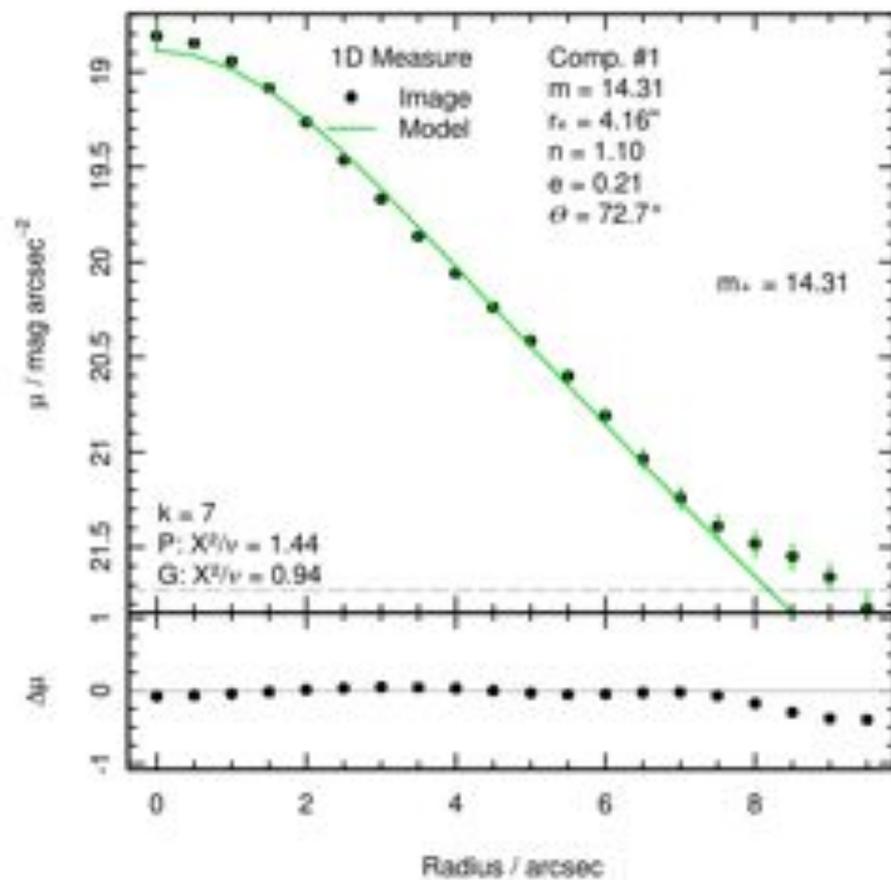
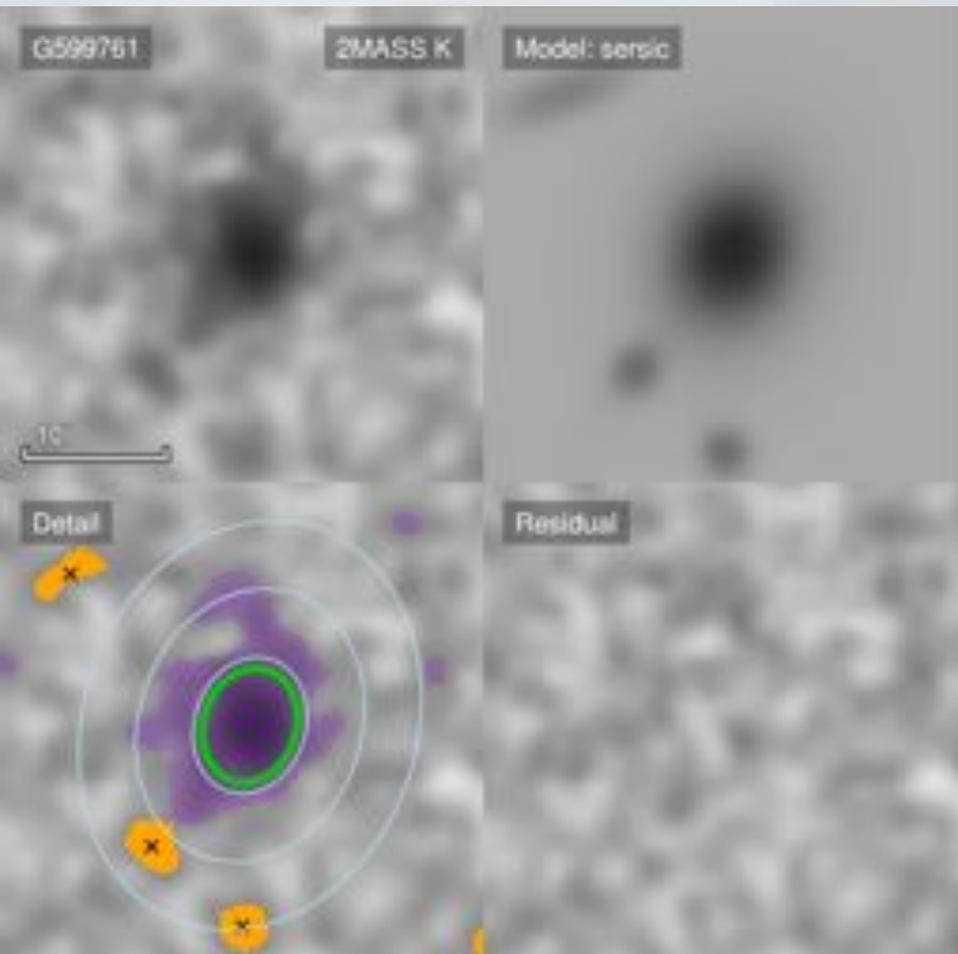
# Single Sérsic Profiling



# Sérsic Profiling +

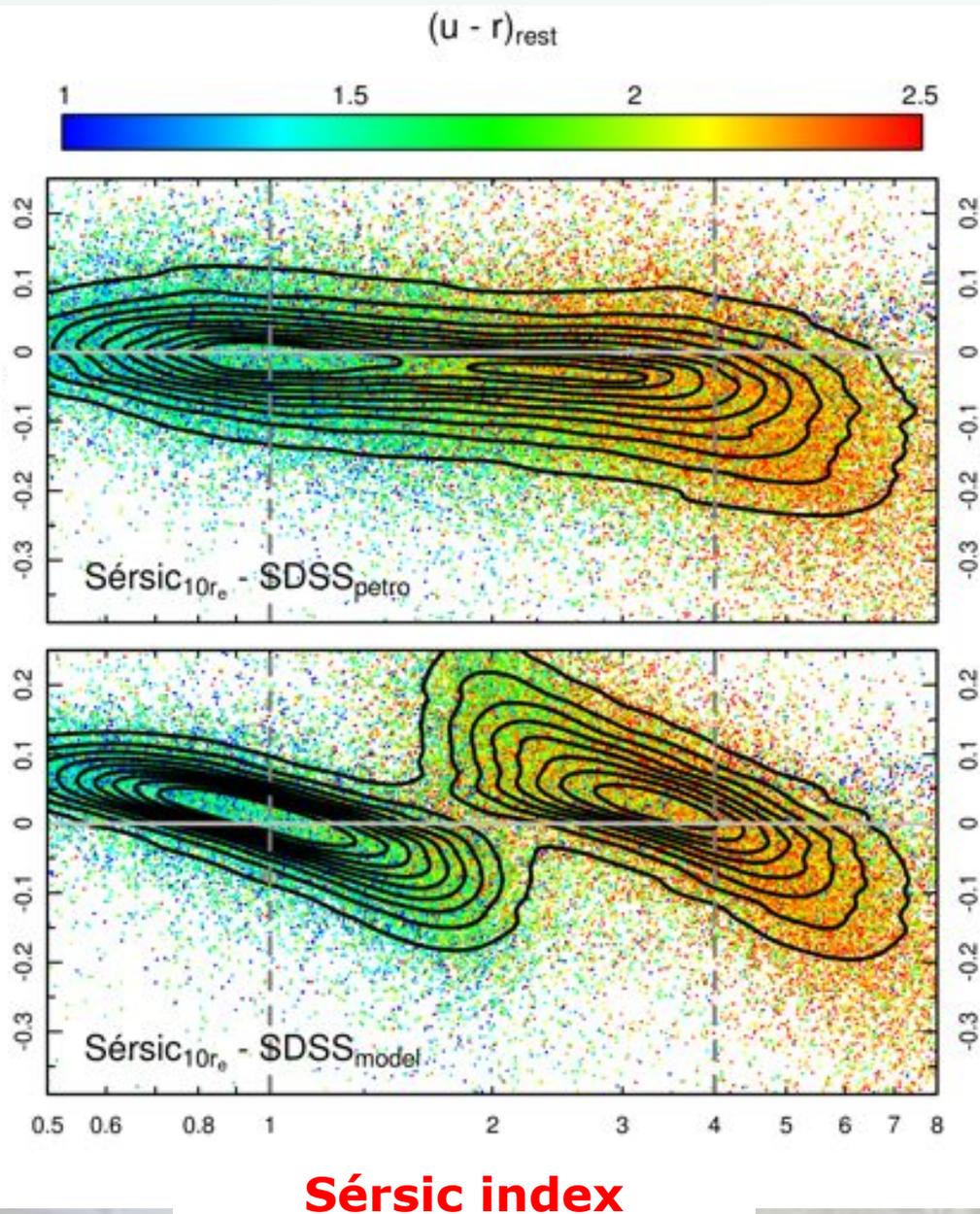


# Sérsic Profiling (2MASS)



# Why Sérsic?

Magnitude difference (Sérsic - SDSS)



Sérsic index



Sérsic - SDSS  
Petrosian

Sérsic - SDSS  
Model

# Results: Index vs Colour

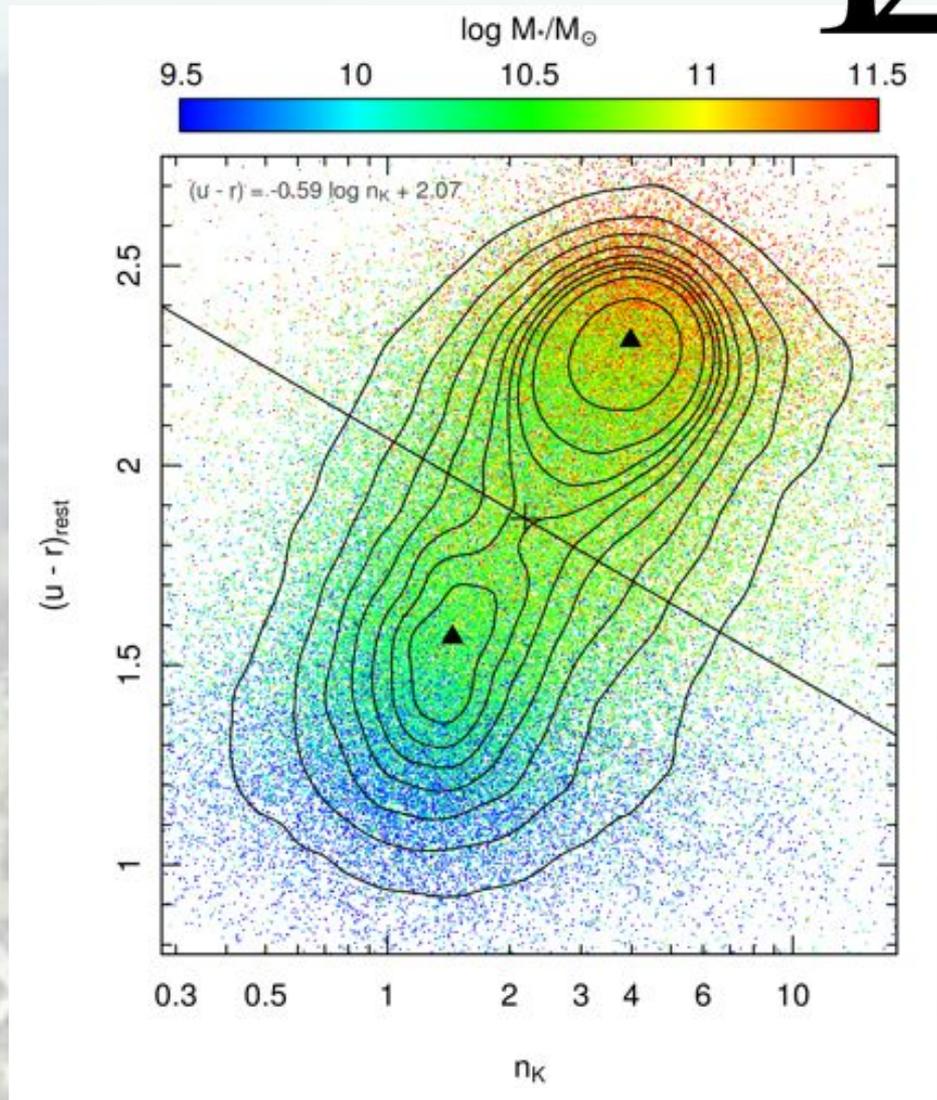


Two distinct populations

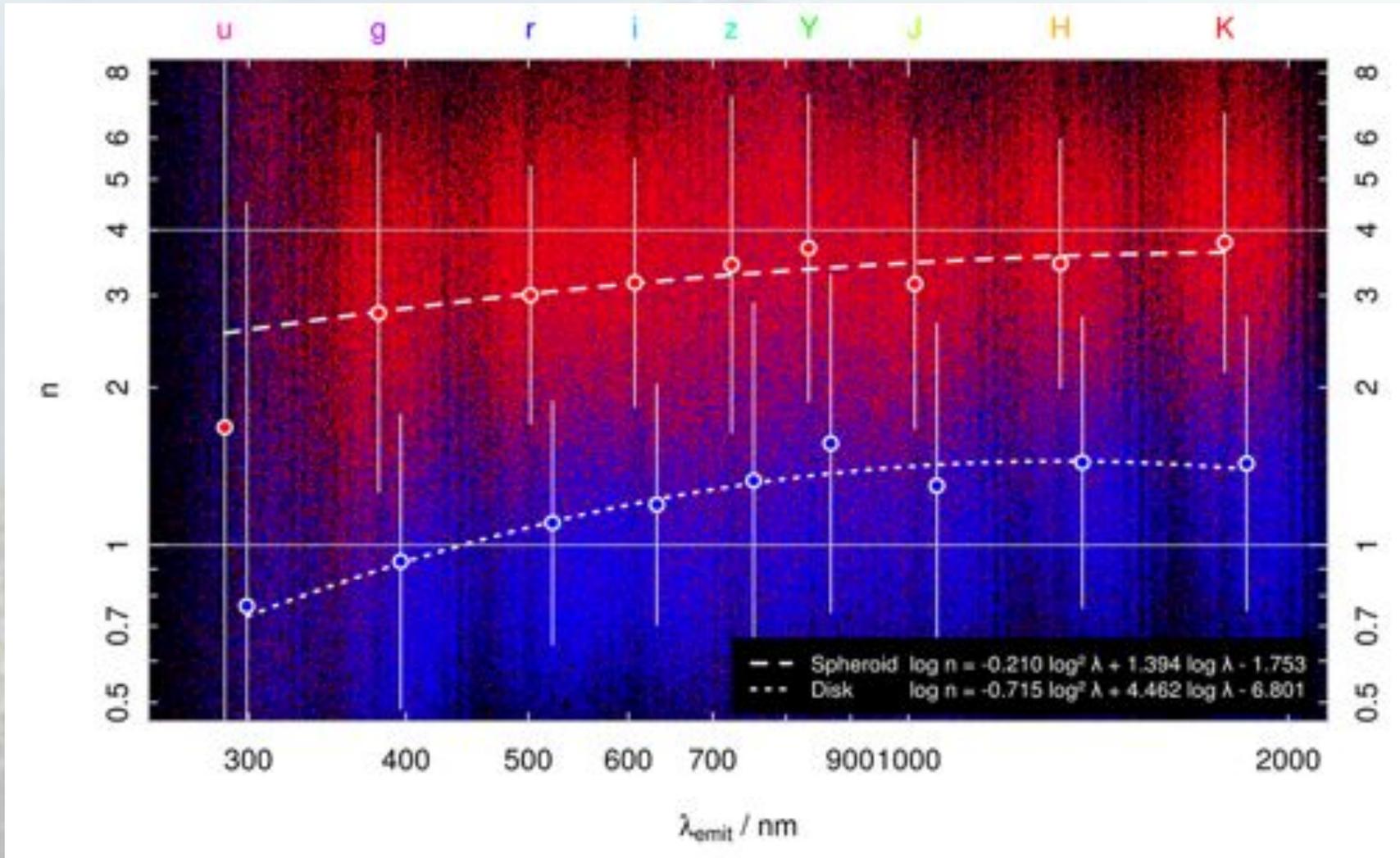
Concentrated, red, high mass, spheroid-dominated

Diffuse, blue, low mass disk-dominated

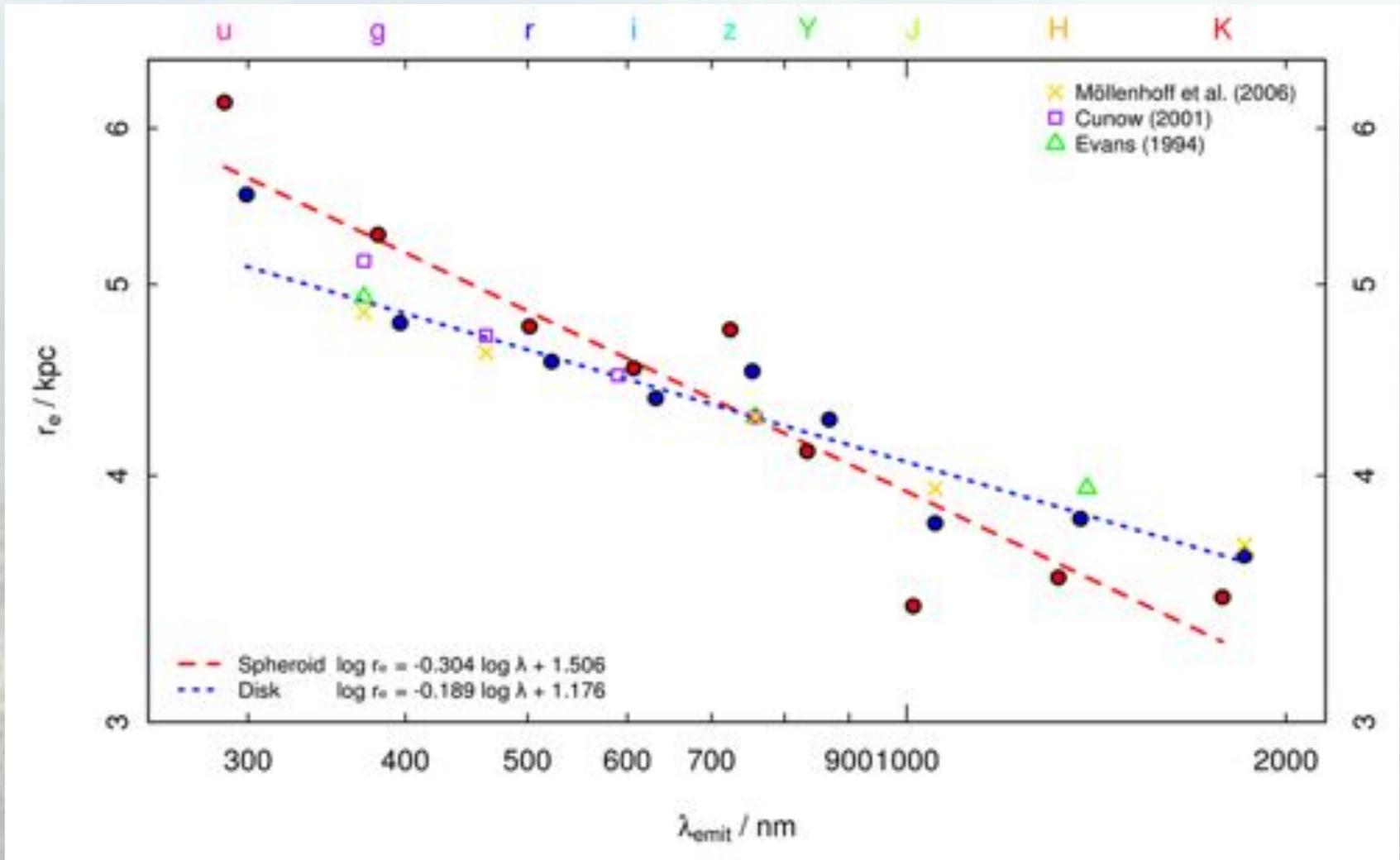
Stellar Masses from Taylor et al. (2011)



# Results: Index vs $\lambda$



# Results: Radius vs $\lambda$



# Volume-Limited Sample

Limits:

$$0.013 < z < 0.06$$

$$M_r < -17.4$$

AND

$$nQ > 2$$

$$\text{SURVEY\_CLASS} > 1$$

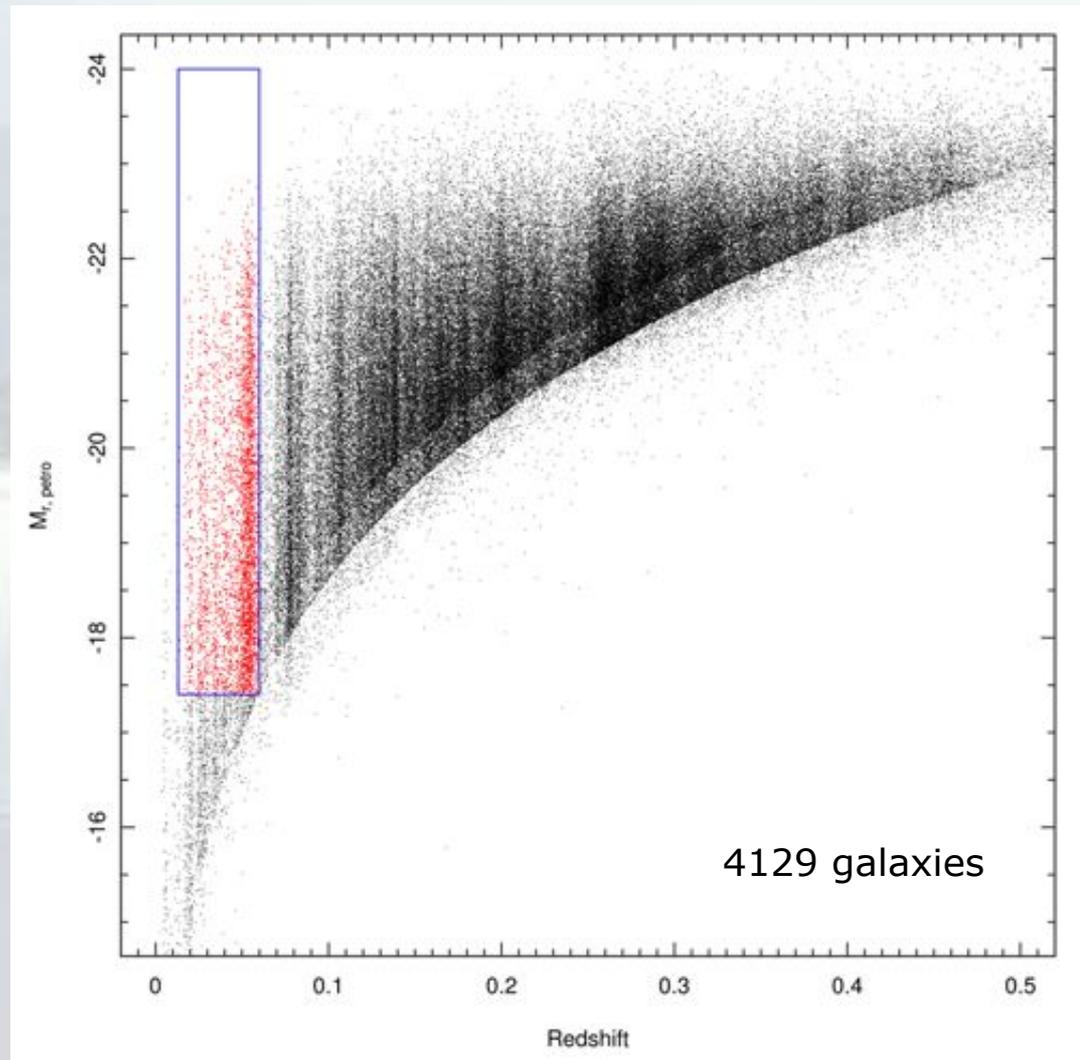
$$r < 19.8$$

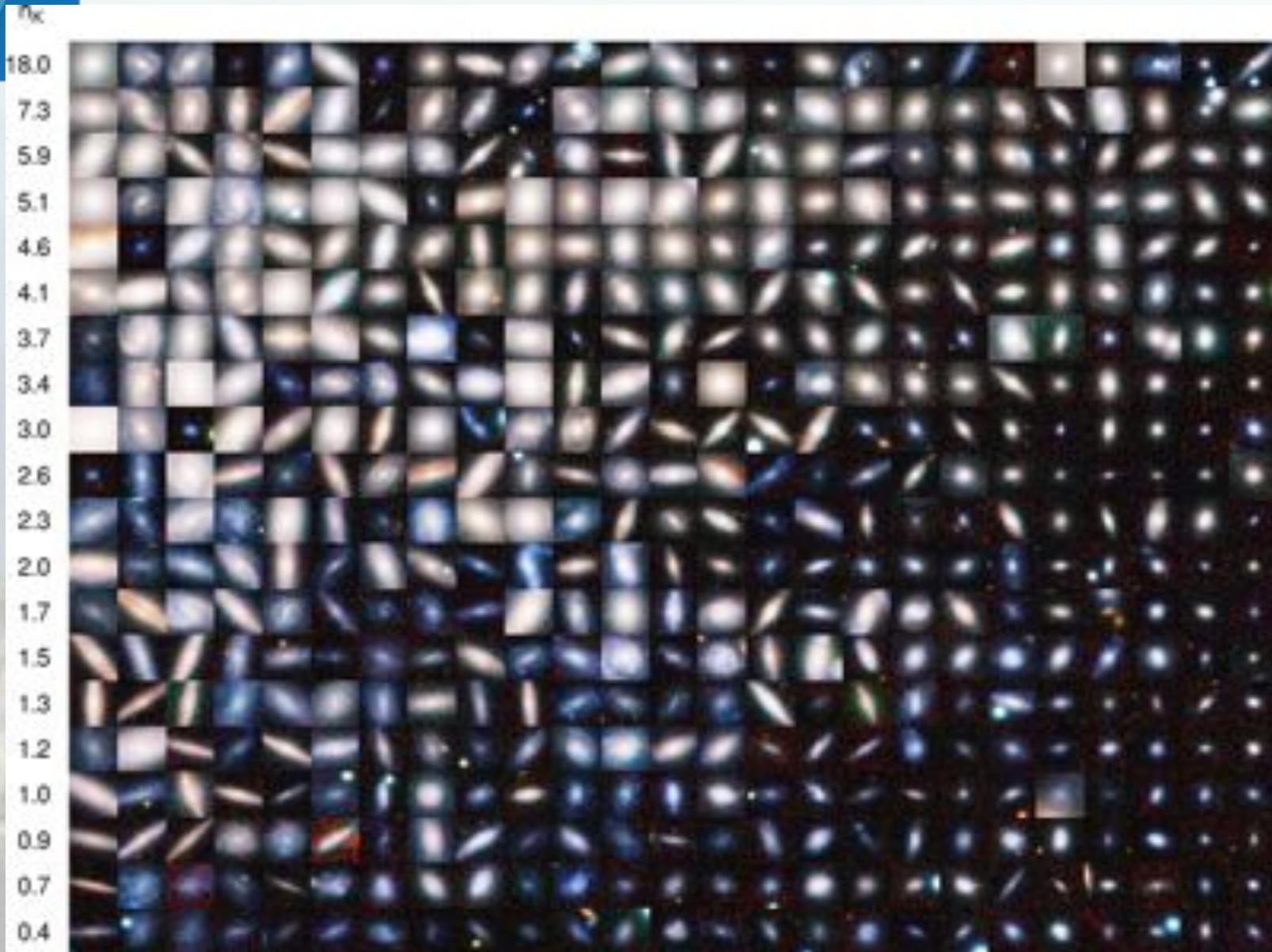
or

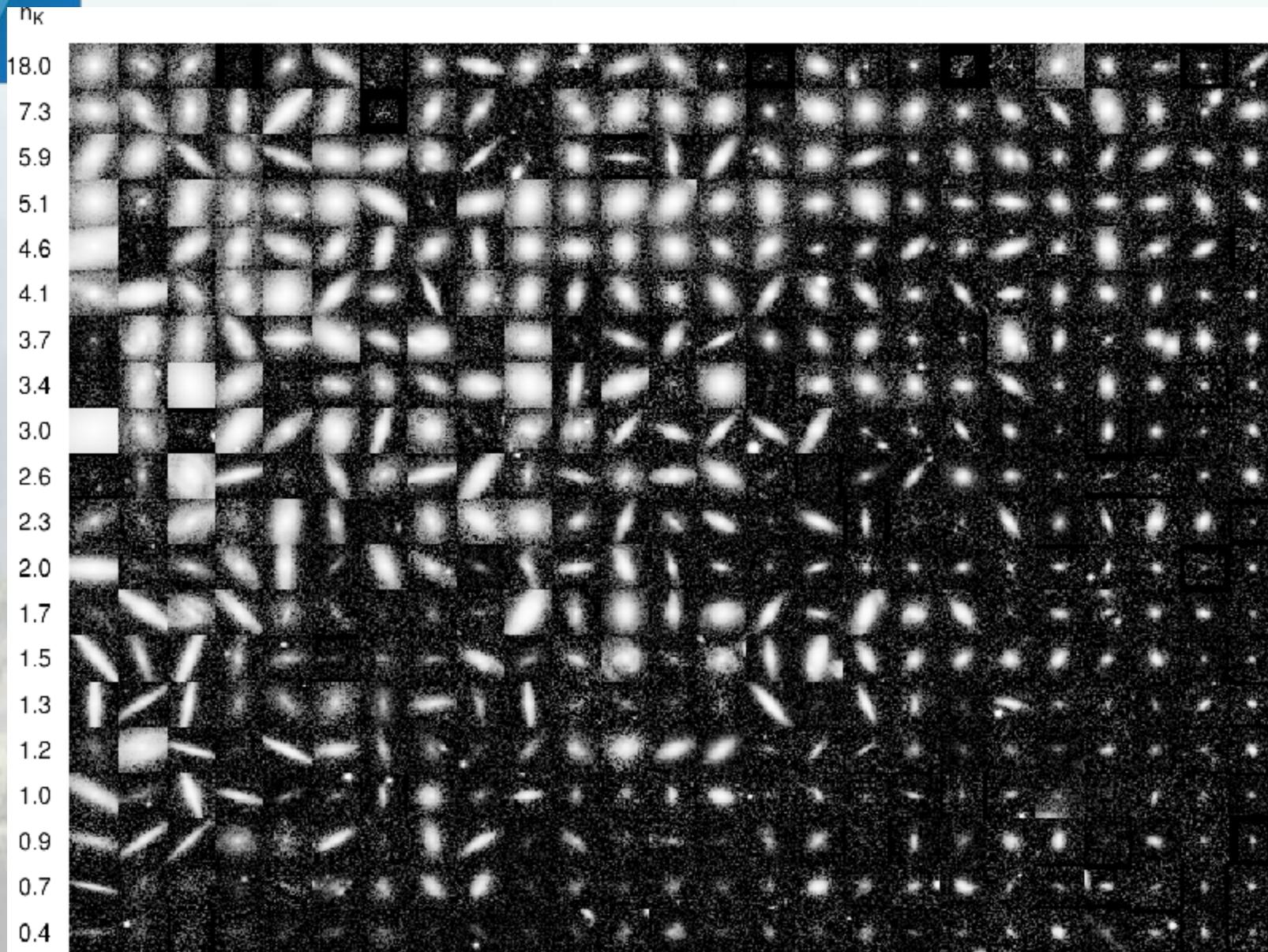
"High quality redshift"

"Definitely not a star"

"Definitely bright enough"



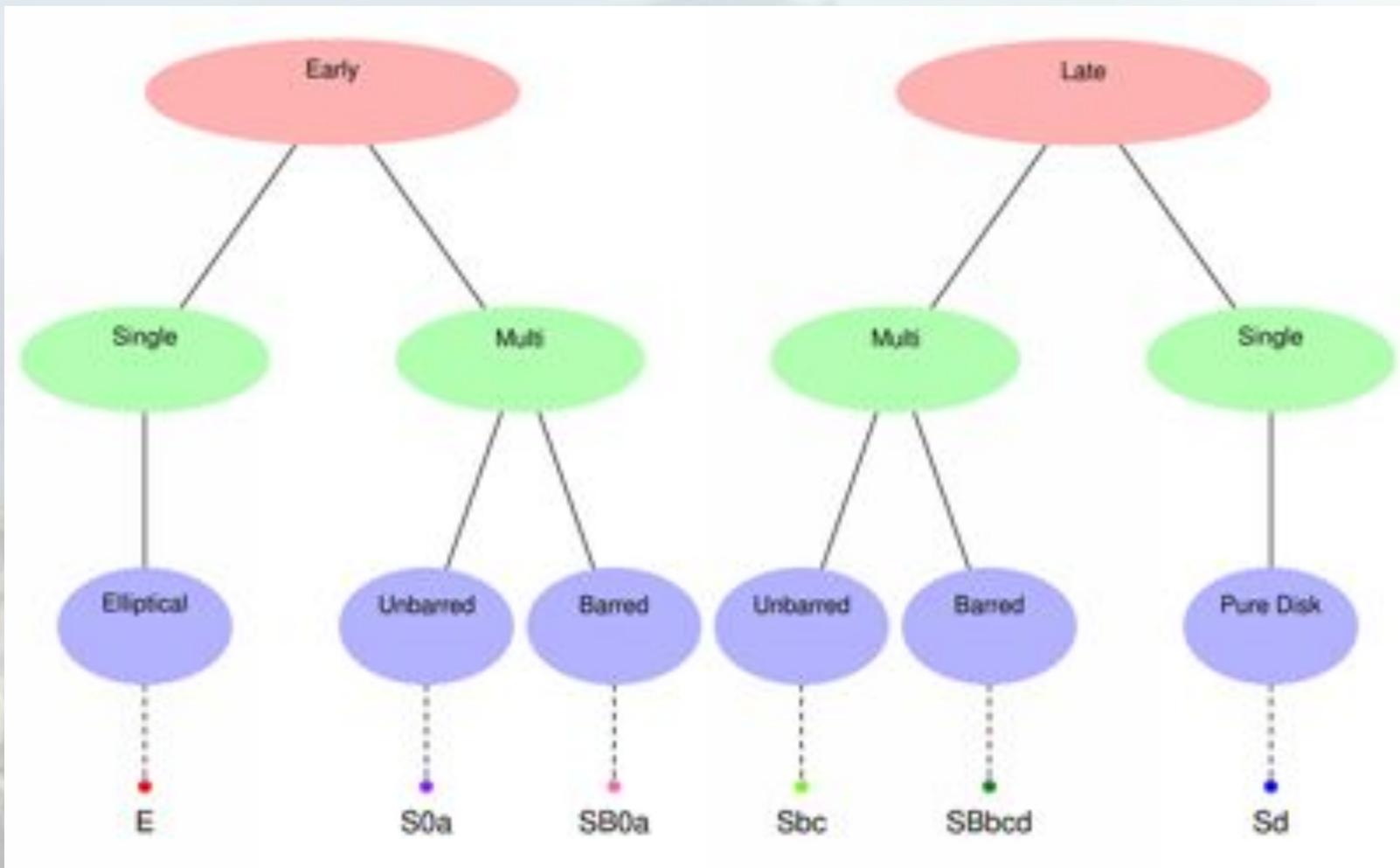








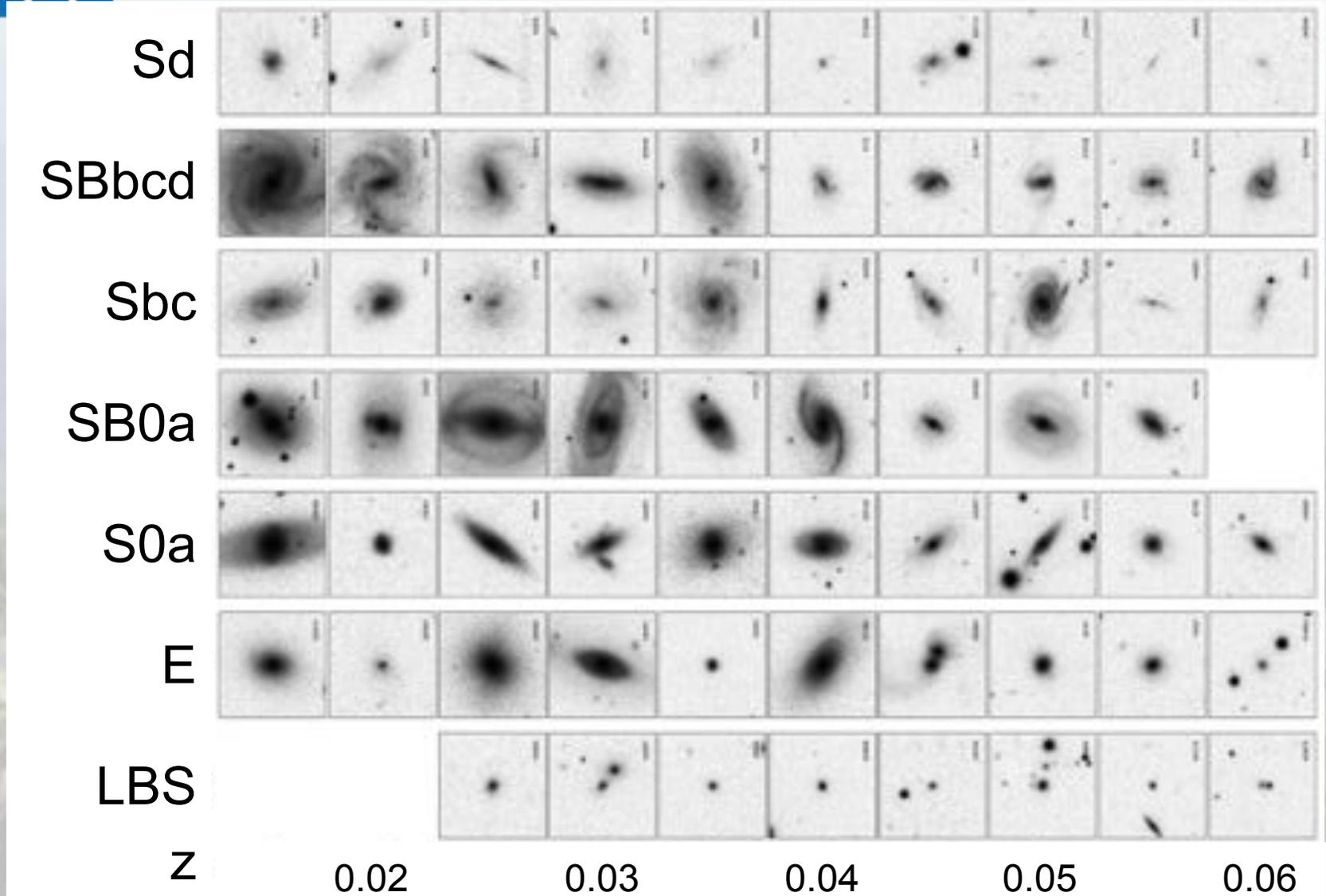
# Eyeball Classification



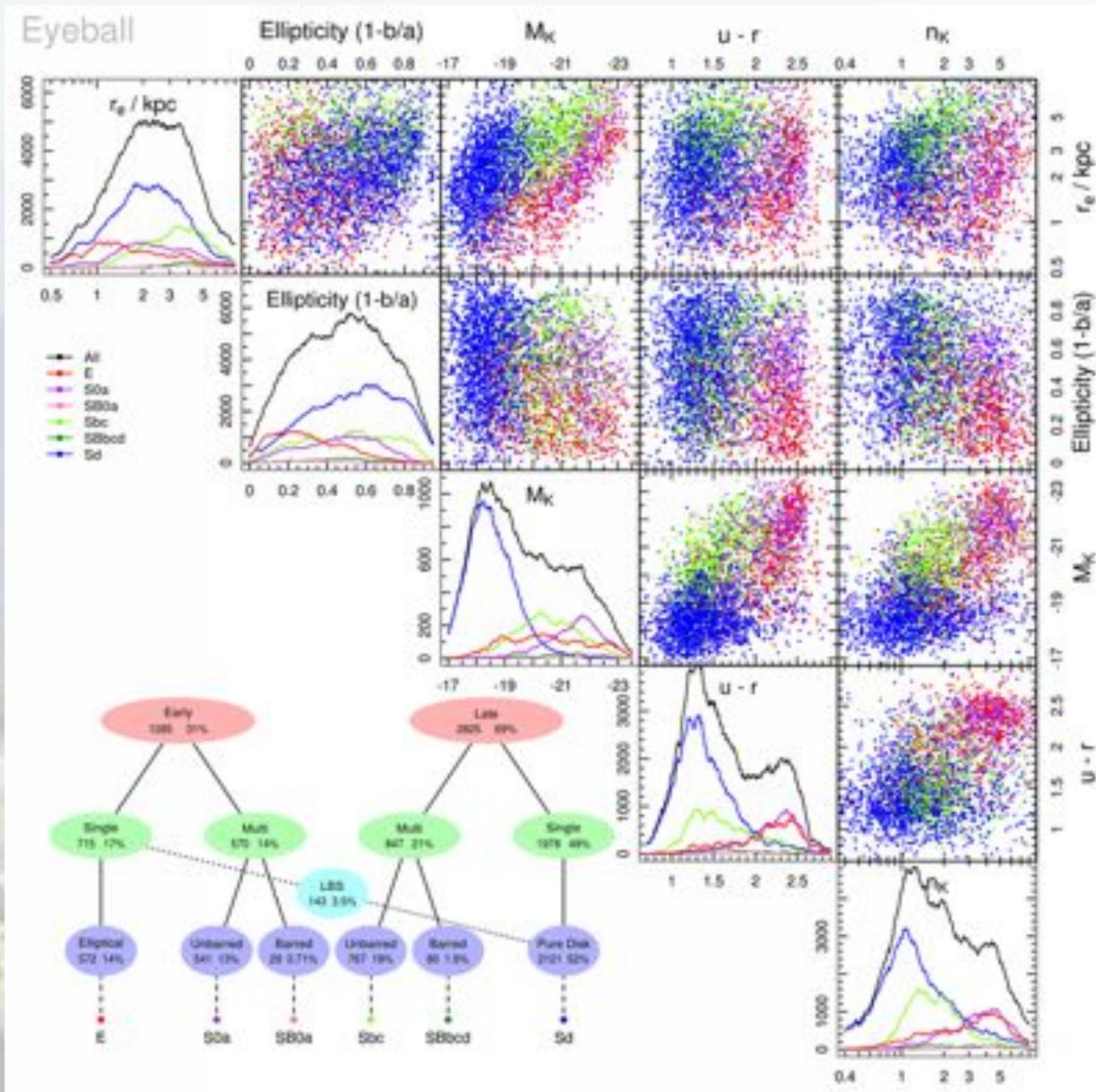
# Eyeball Classification



# Eyeball Classifications



# Correlation Matrix

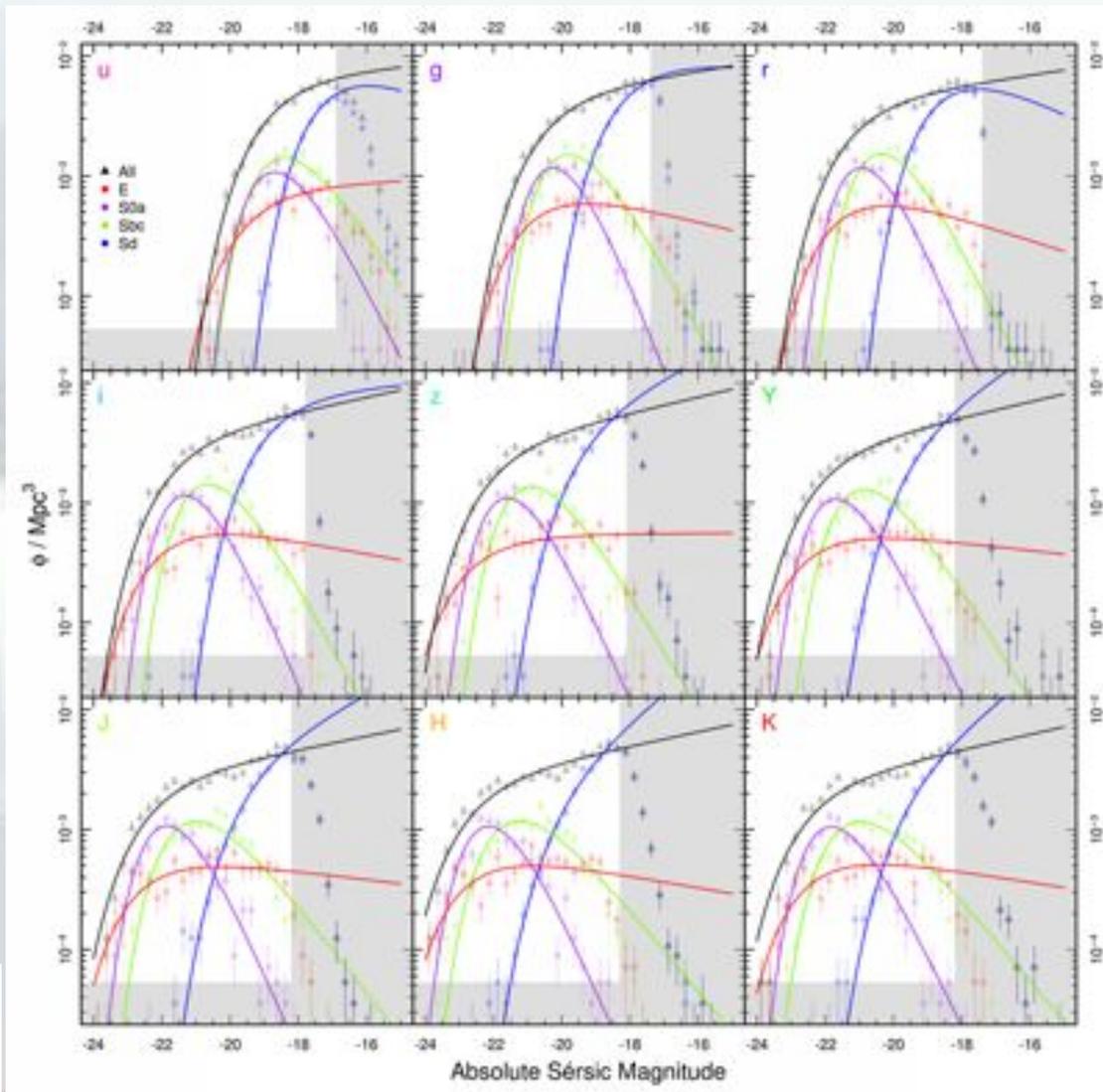


# Sérsic Luminosity Functions

Lower limit of  $n=3$

Faint limit defined relative to  $M_r = -17.4$  turnover

Bin width = 0.25 mag



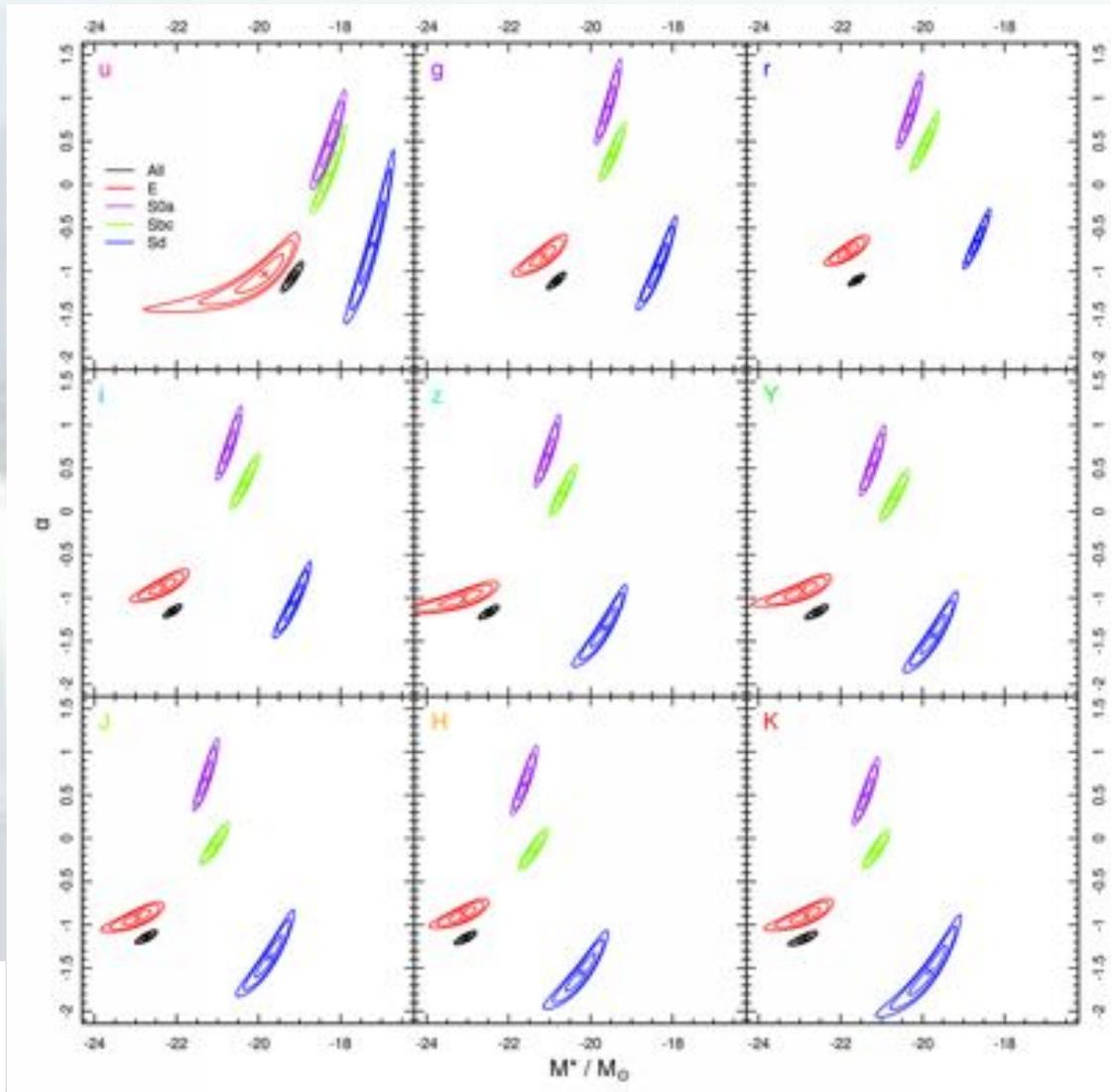
$$\phi(L)dL = \phi^* \left(\frac{L}{L^*}\right)^\alpha \exp\left(-\frac{L}{L^*}\right) d\left(\frac{L}{L^*}\right)$$

# Sérsic Luminosity Functions

r-band most well-constrained

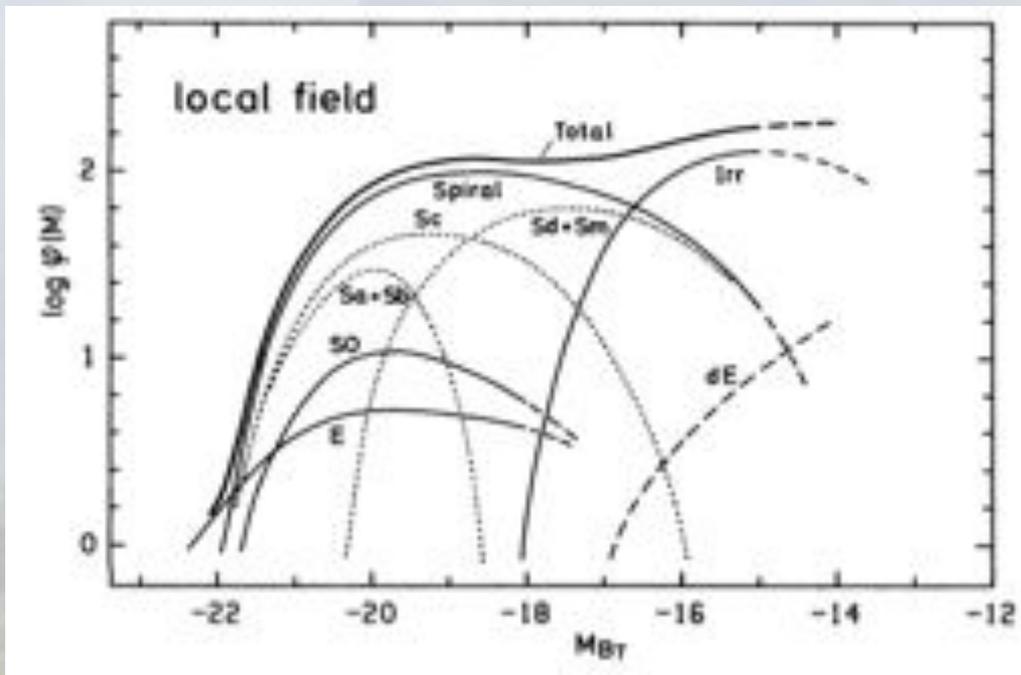
Significant uncertainty on value of  $\alpha$  for Sd galaxies

Global LF is typically well constrained

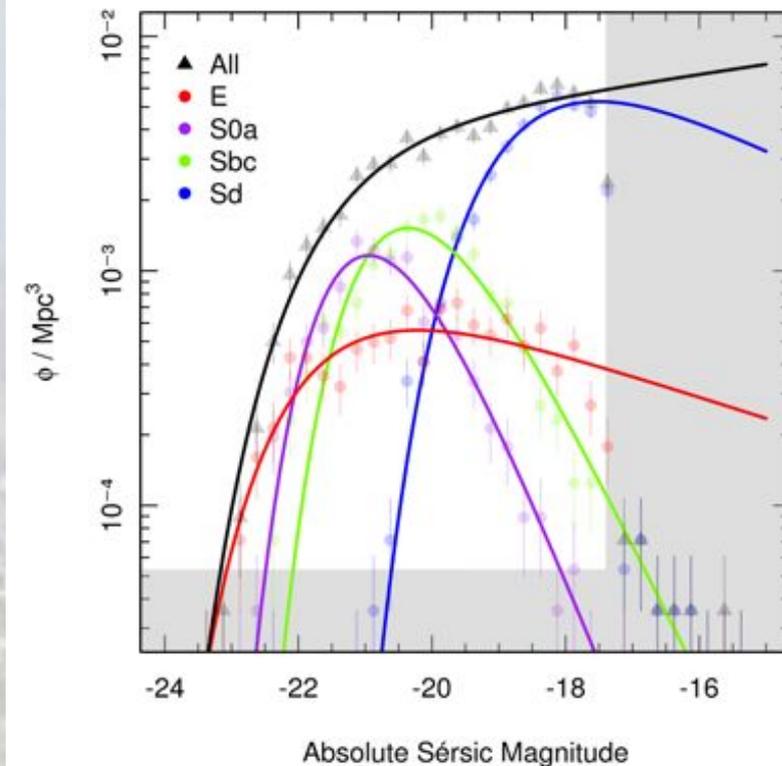


$$\phi(L)dL = \phi^* \left(\frac{L}{L^*}\right)^\alpha \exp\left(-\frac{L}{L^*}\right) d\left(\frac{L}{L^*}\right)$$

# Sérsic Luminosity Functions



Binggeli et al., 1988

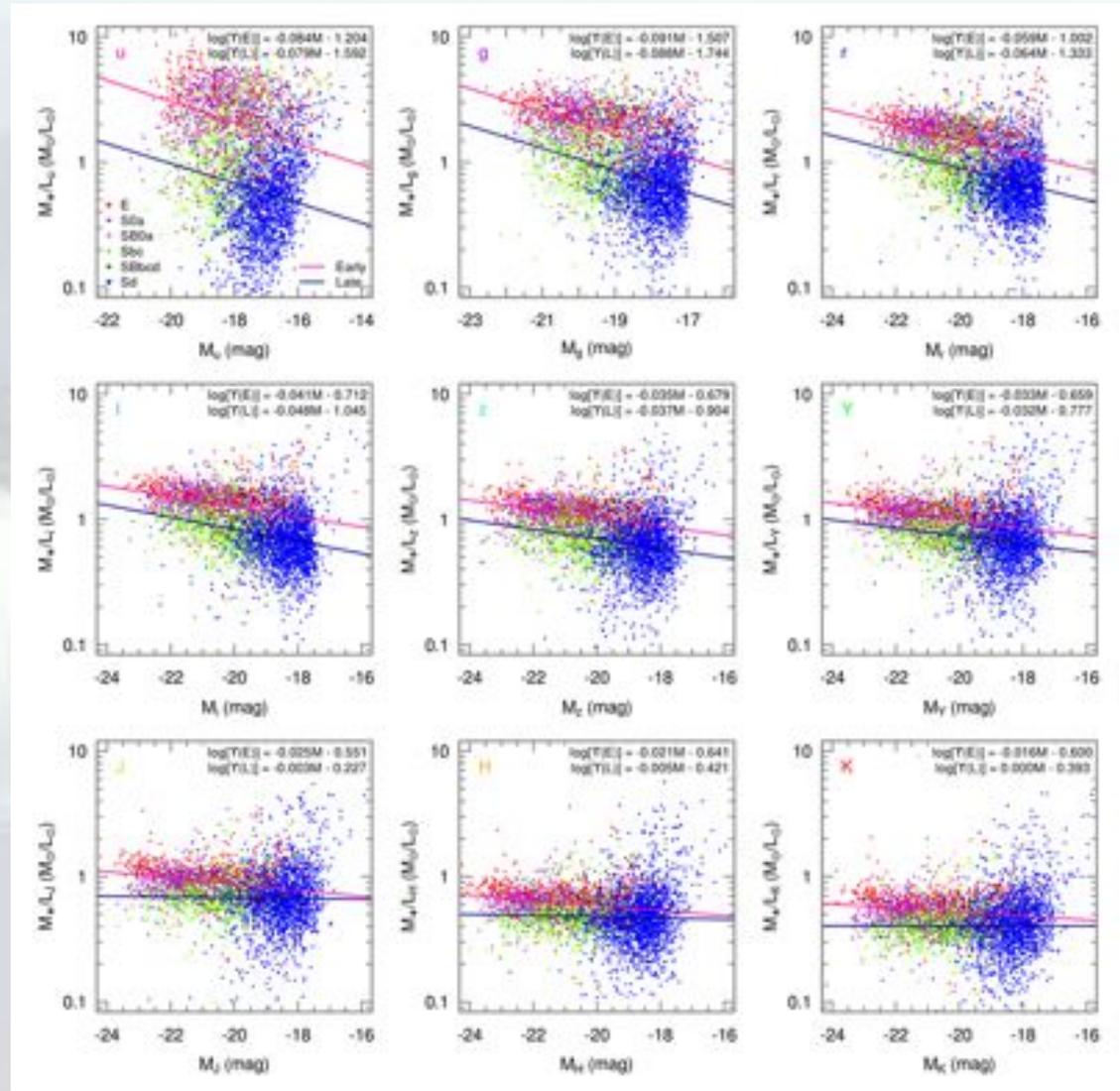


Kelvin et al., in prep. (2012)

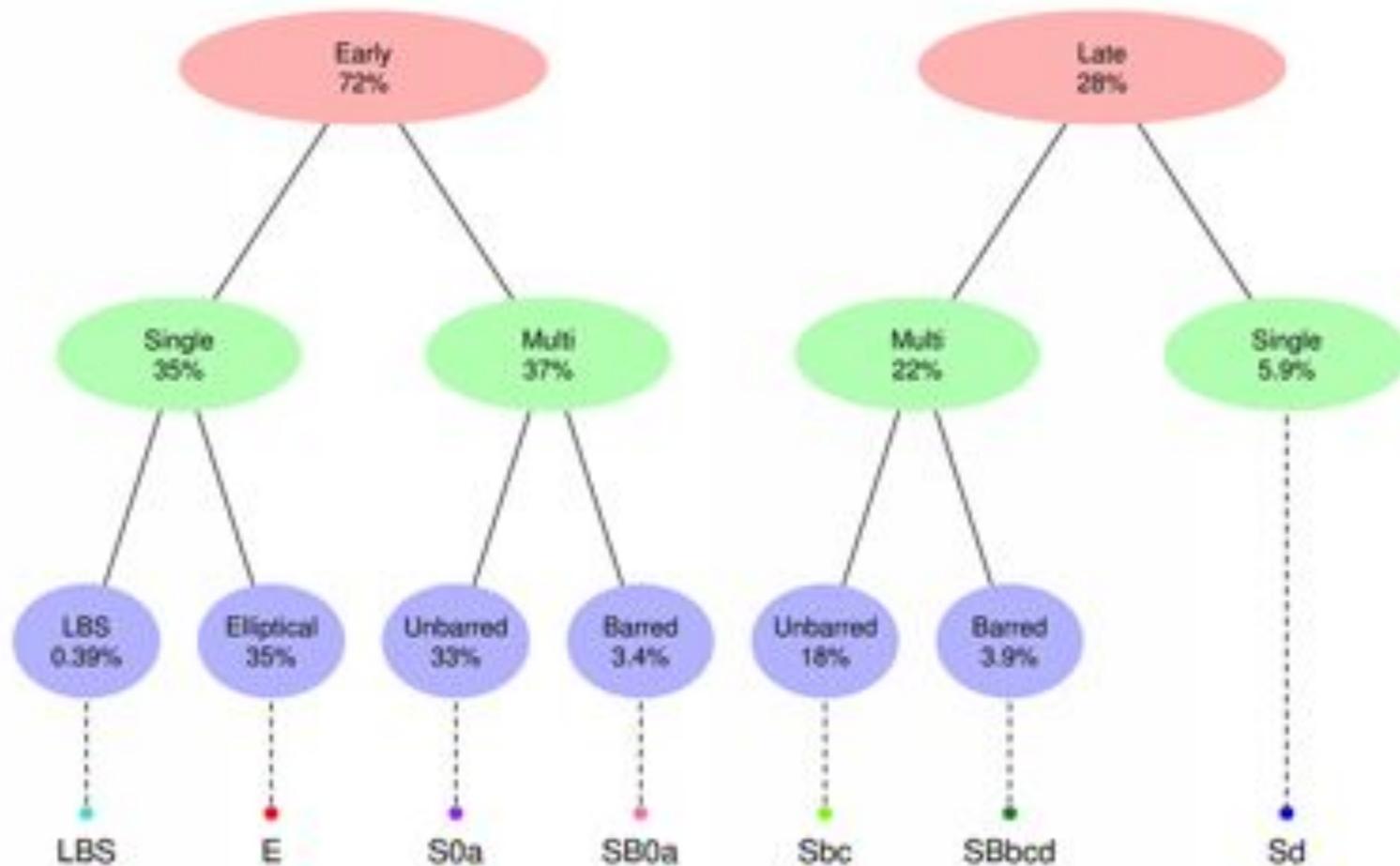
# Mass-to-Light Ratios

UKIDSS H-band is the best proxy for stellar mass

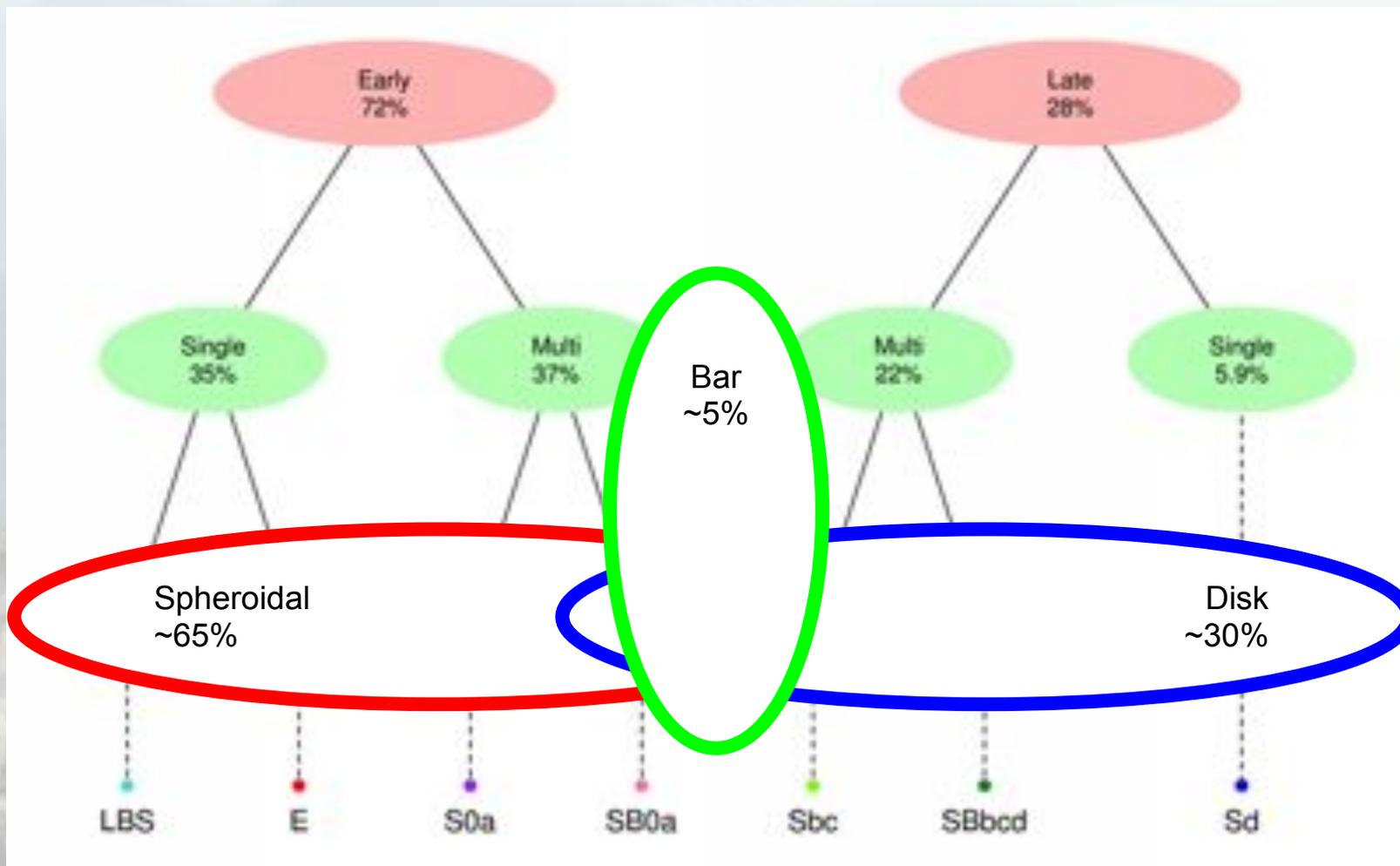
Can be used to estimate missing stellar mass values



# Where is all the mass?

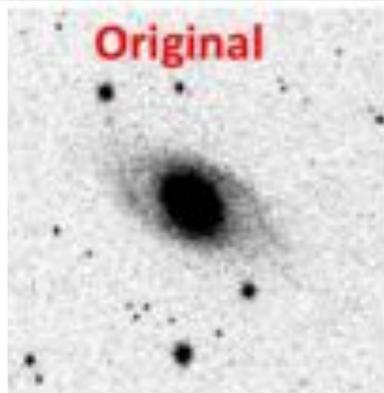


# Where is all the mass?

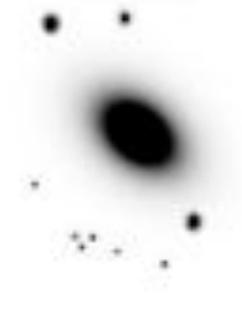


# Sneak Peek...

K-band



Model



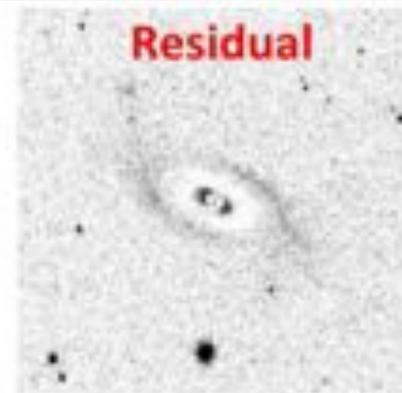
Bulge



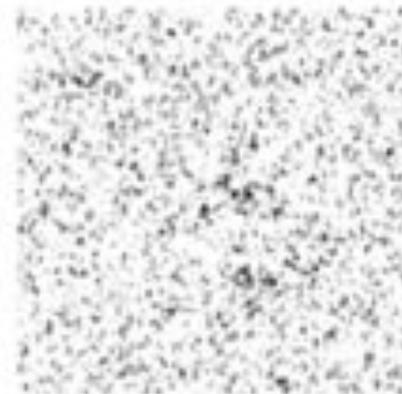
Disc



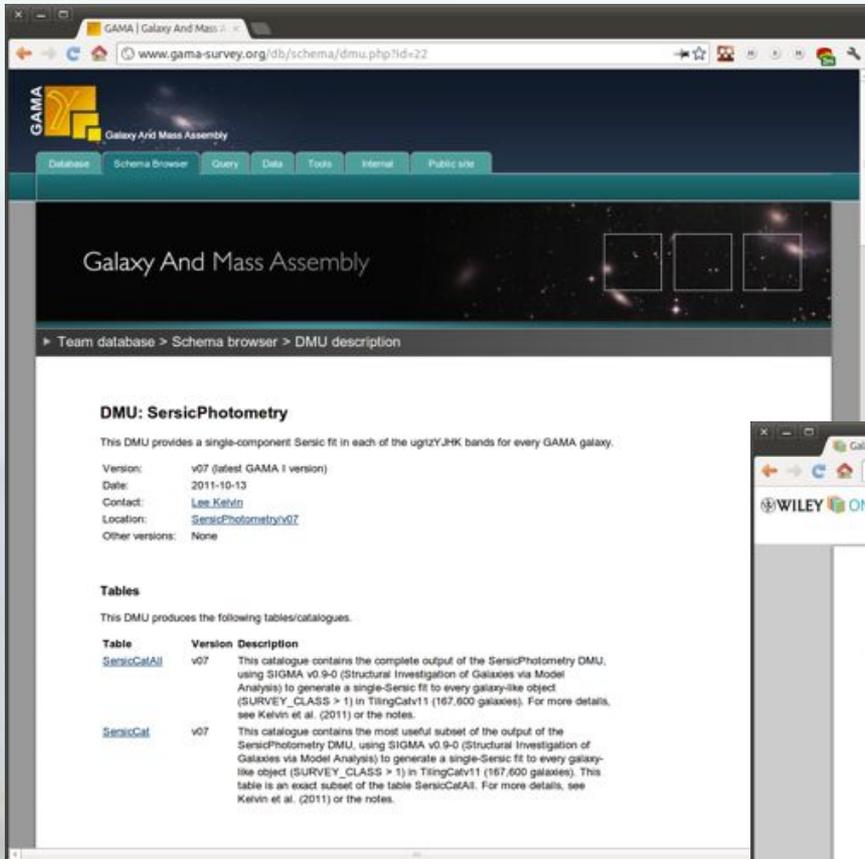
Residual



HST i-band



Bulge-Disk decomposition essential for a full understanding of galaxy structure and mass breakdown

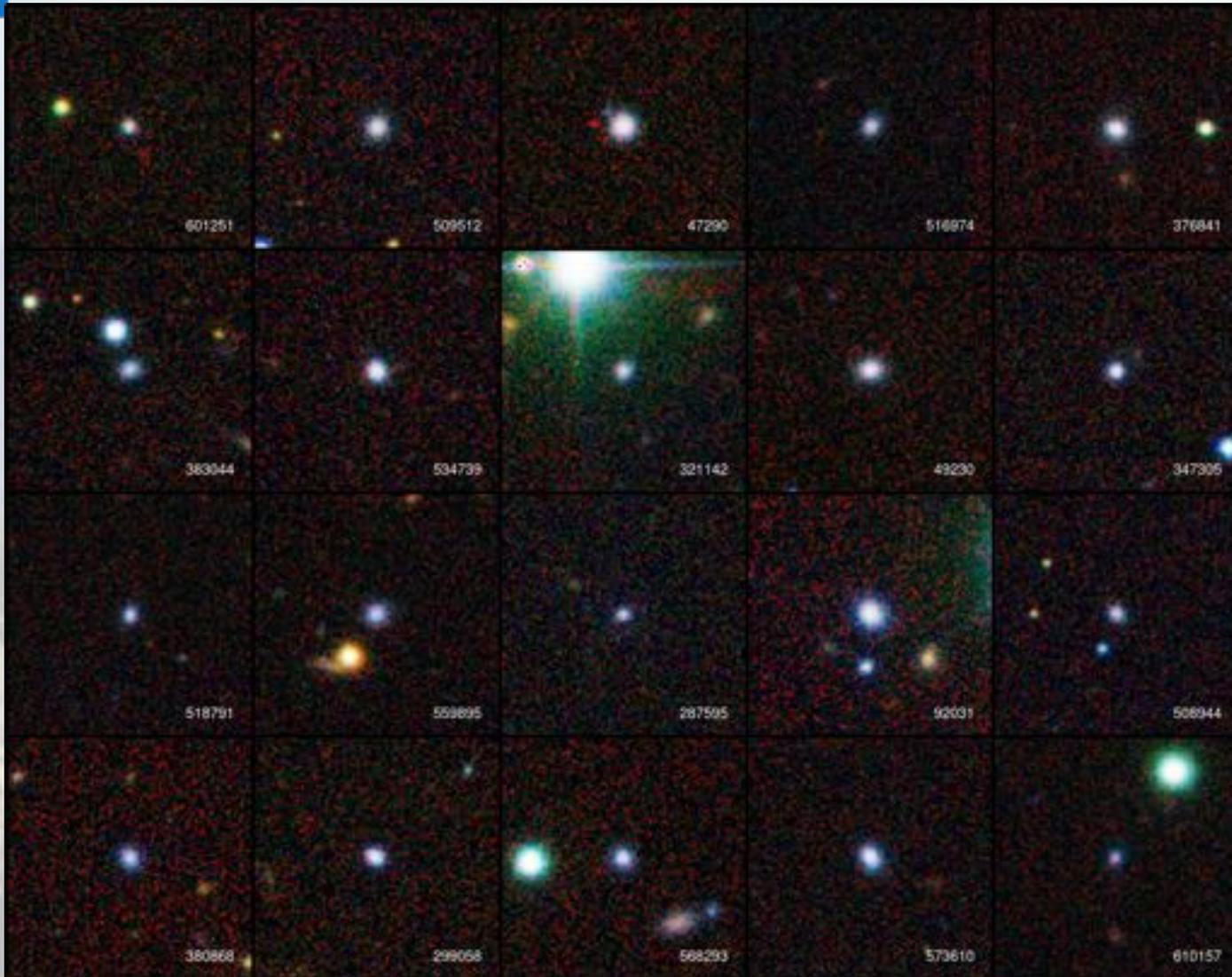


- PSF FWHM
- galaxy spectra
- morphological classifications

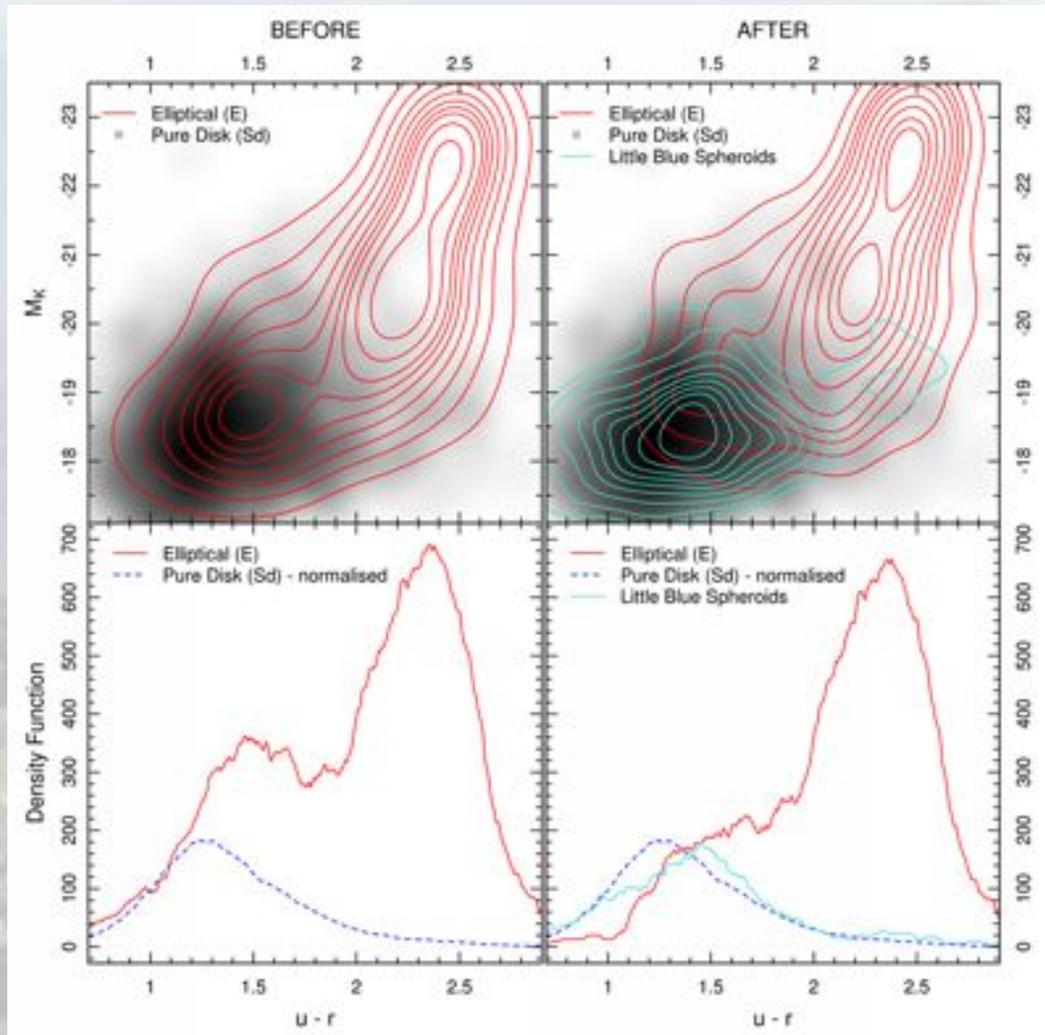


- pixel-matched imaging (SDSS/UKIDSS)
- multi-band matched-aperture photom.
- Sérsic measurements (r50, n, m, PA, e)
- redshifts
- Stellar masses
- group information

# 'Little Blue Spheroids'



# 'Little Blue Spheroids'



Initially classified as

- early-type
- single-component

Closer inspection:

- star-forming
- blue

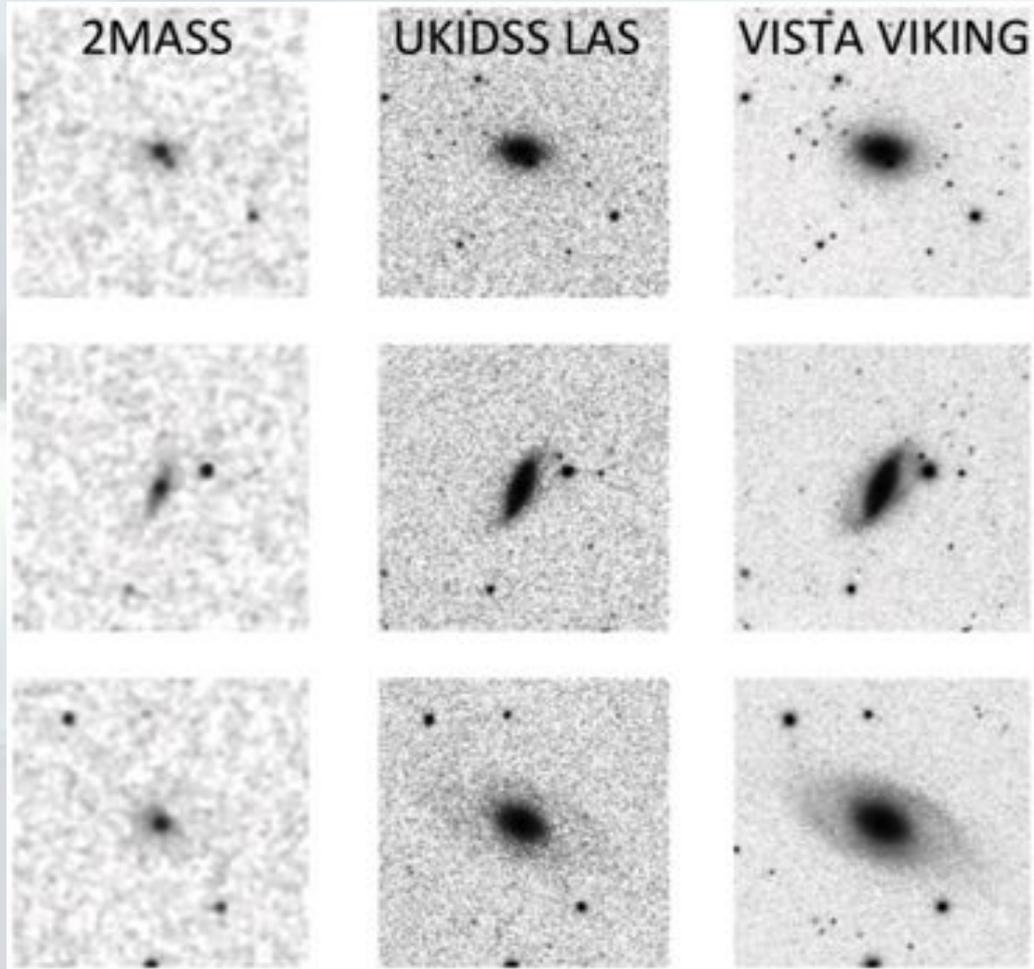
Also noted as 'Little Blue Fuzzies' in Brough et al. (2011)

Reassigned → disk

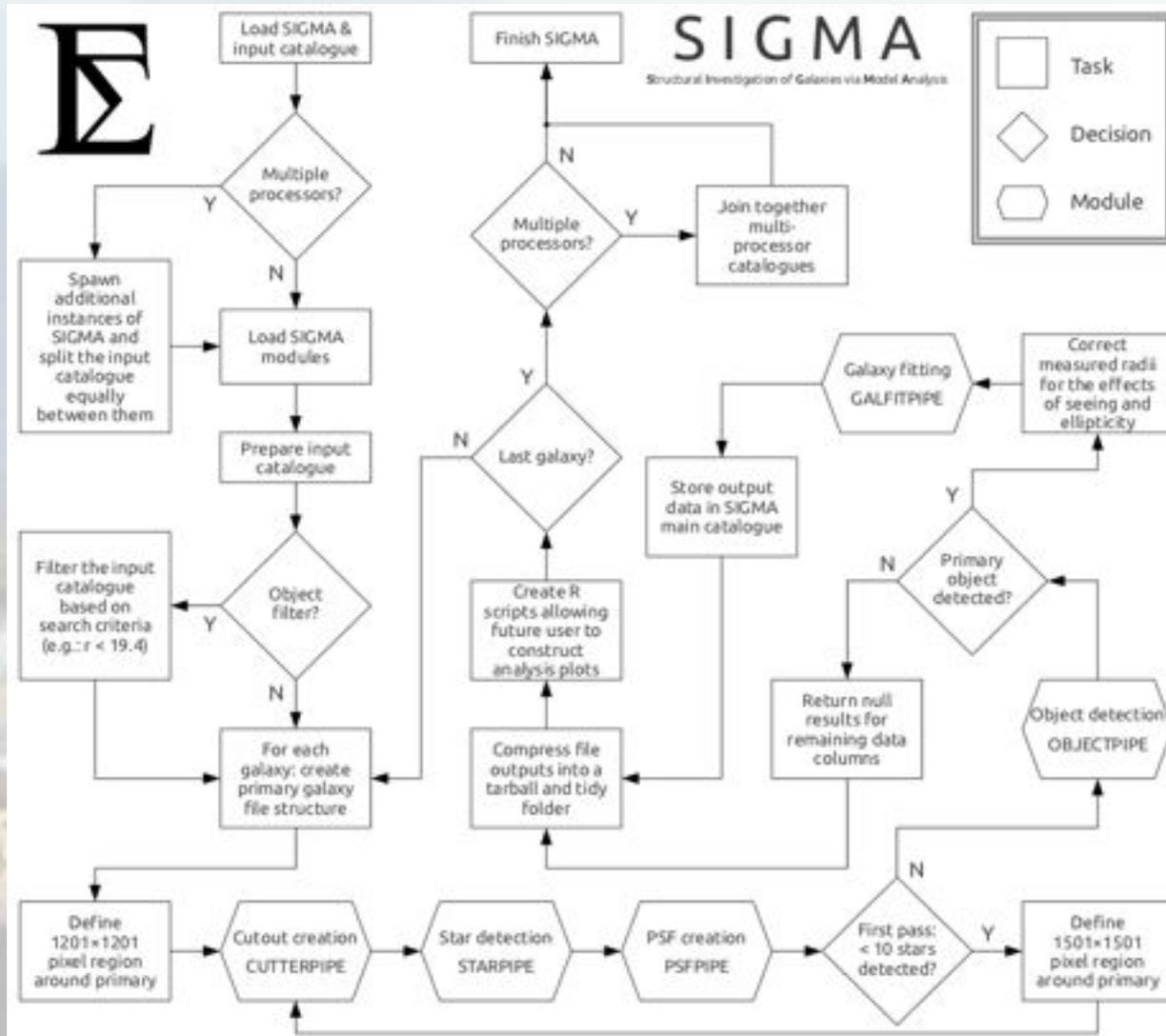
# 2MASS - UKIDSS - VIKING



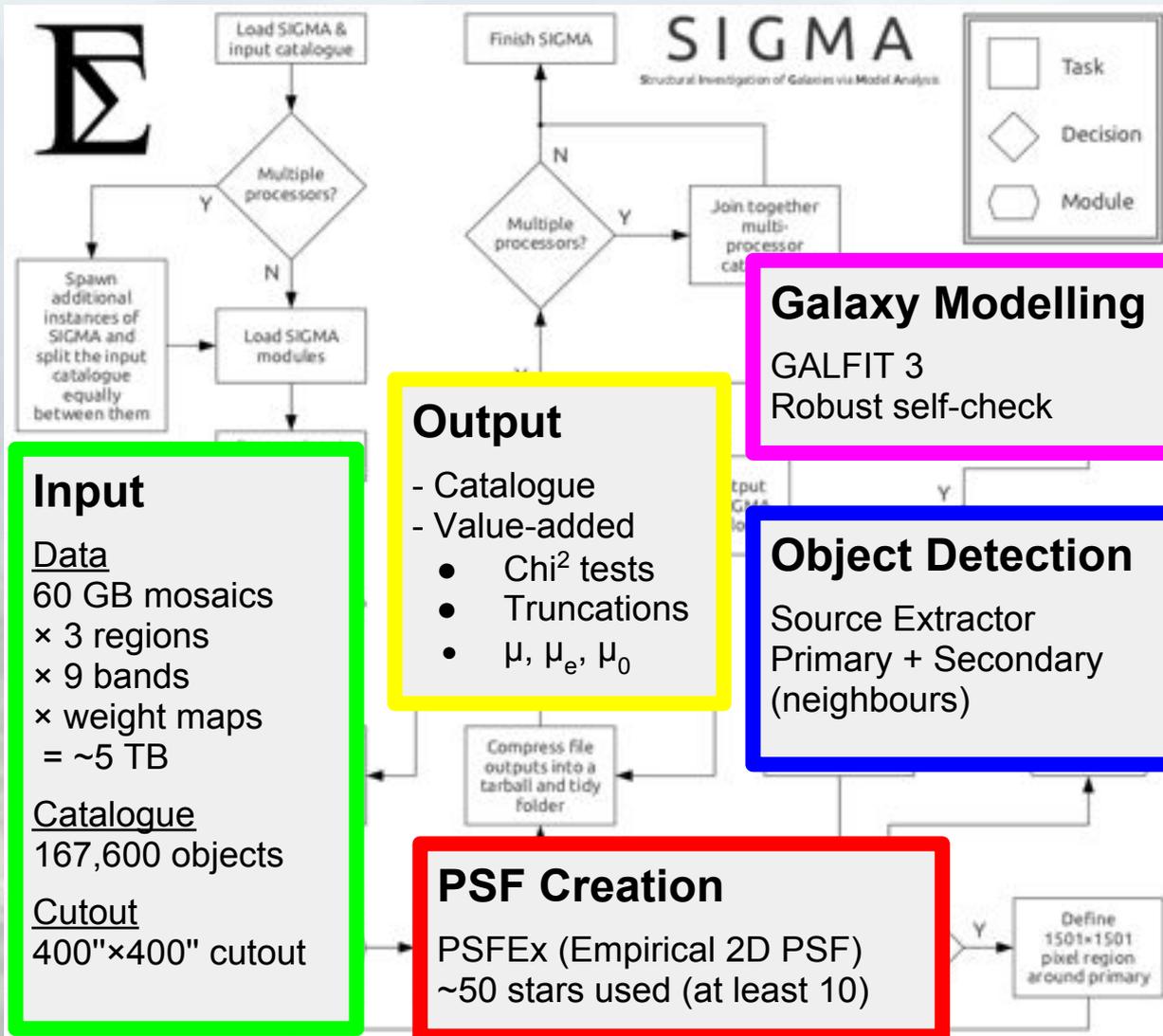
Significant improvements in structural measurements when moving from **previous-generation** to **current-generation** to **next-generation** survey data



# SIGMA: Structural Pipeline



# SIGMA: Structural Pipeline



**R** Wrapper:

- Source Extractor
- PSF Extractor
- CFITSIO
- GALFIT 3

Speed:

**15 seconds**

per galaxy  
per passband  
per processor