

GAMA-SIGMA: Exploring Galaxy Structure Through Modelling

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University
of
St Andrews



International
Centre for
Radio
Astronomy
Research



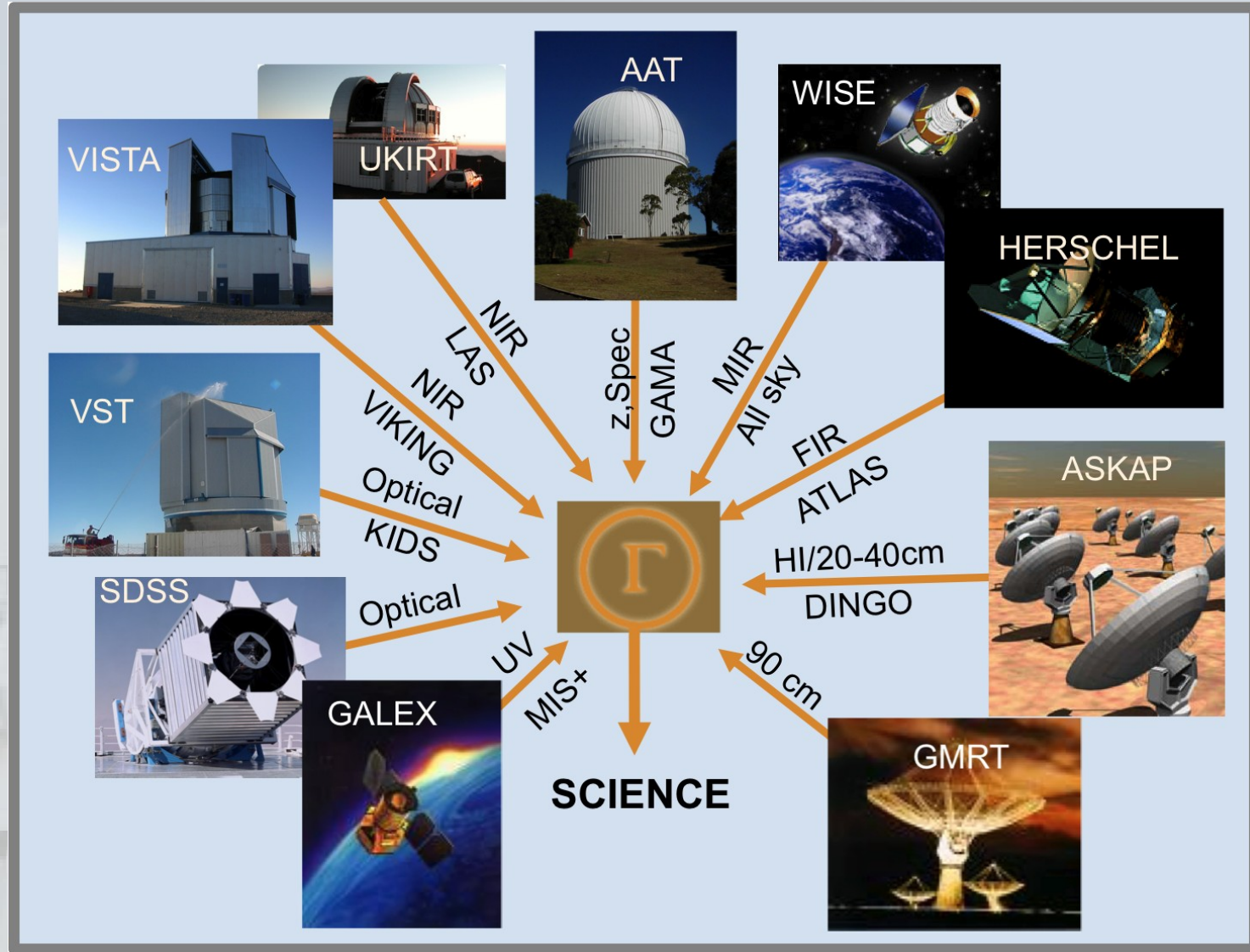
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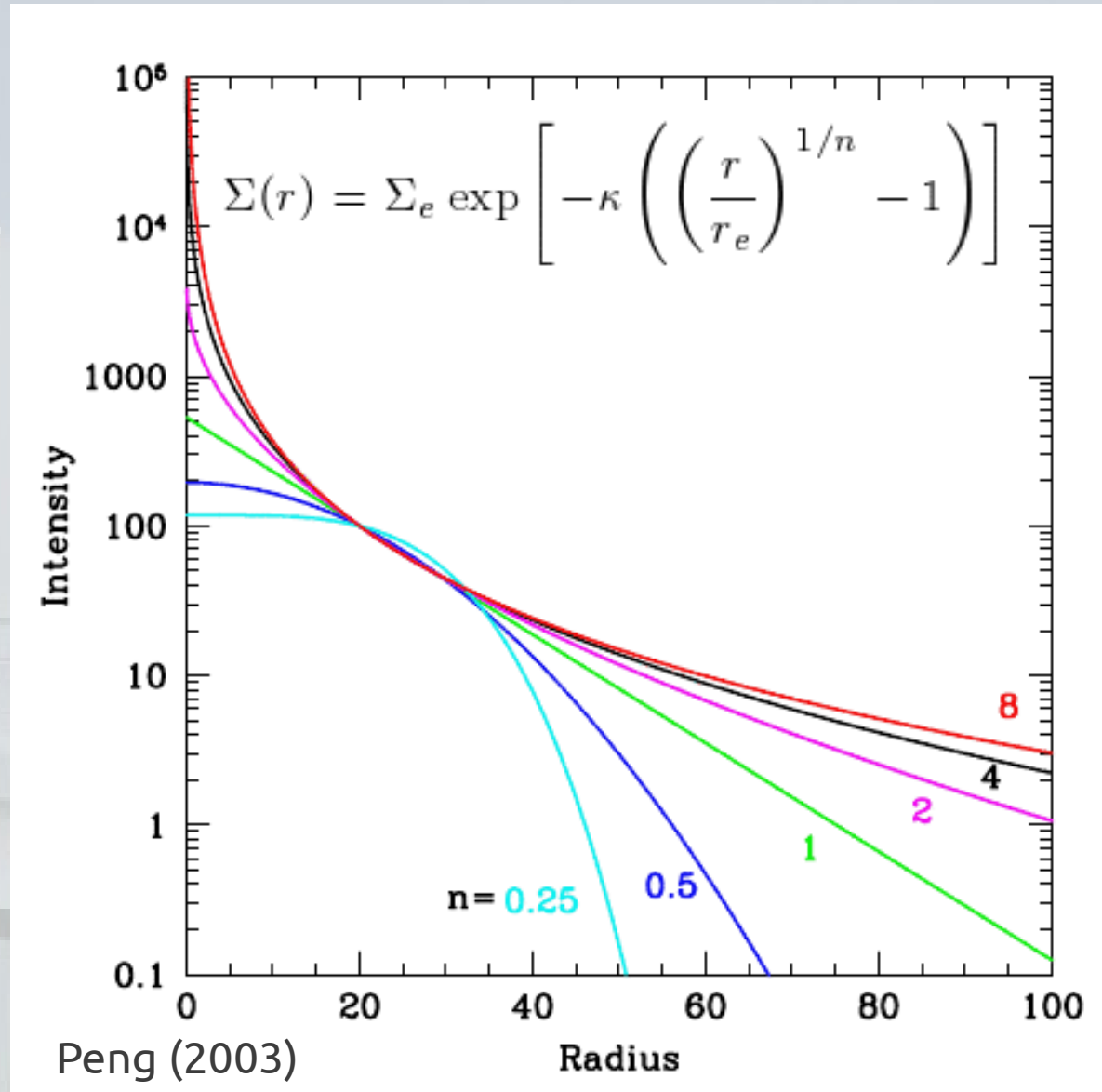
Science Goals

- Do galaxies form in two phases: bulge → disk?
- Are ellipticals and bulges essentially the same?
- How is stellar mass distributed between structures?
- How does environment shape galaxy structure?

Galaxy and Mass Assembly

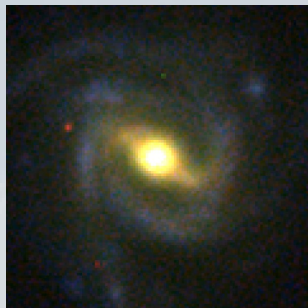


The Sérsic Profile



Jose Luis Sérsic, 1963

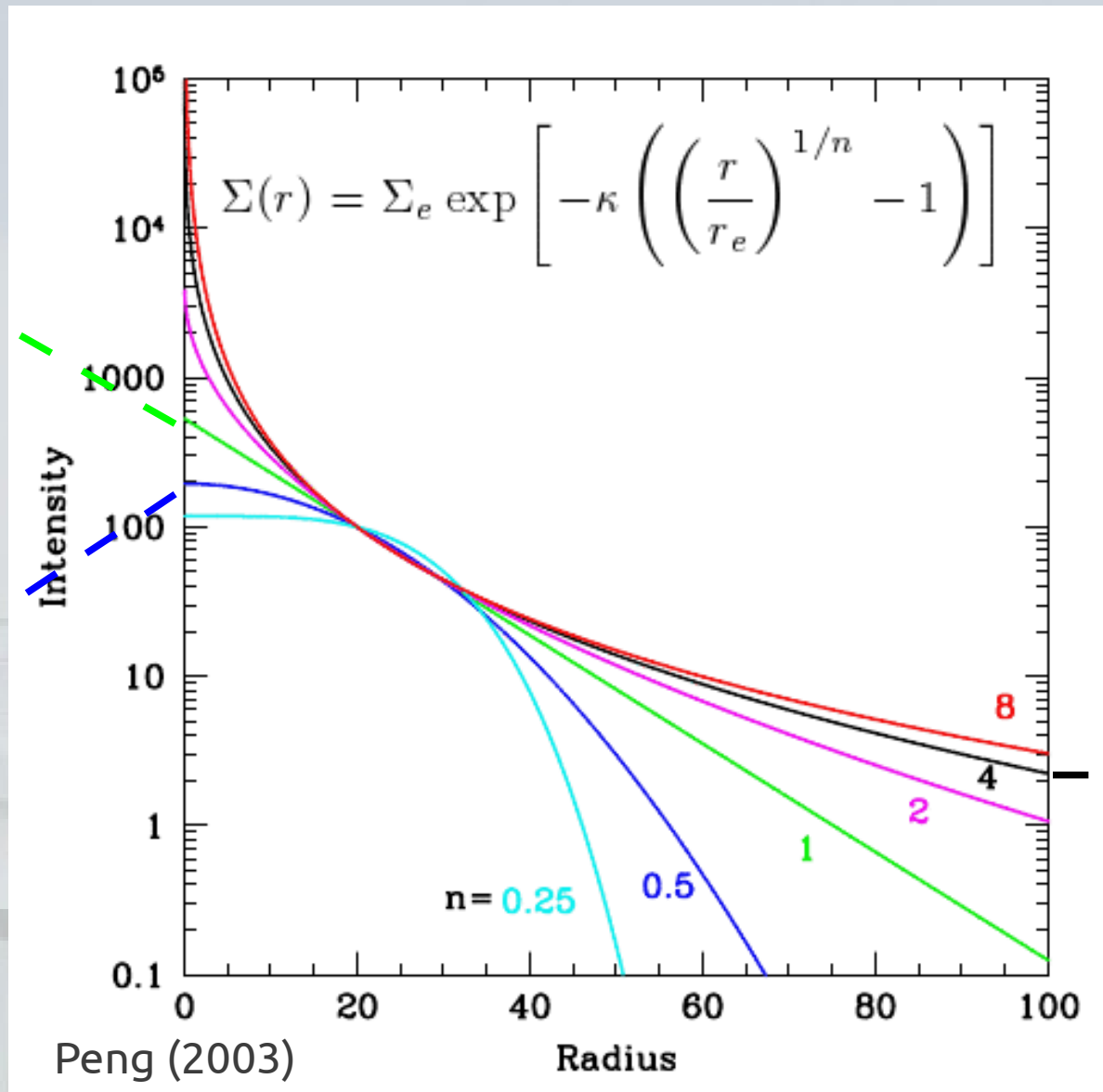
The Sérsic Profile



Exponential
(e.g. - disks)



Gaussian
(e.g. - stars)



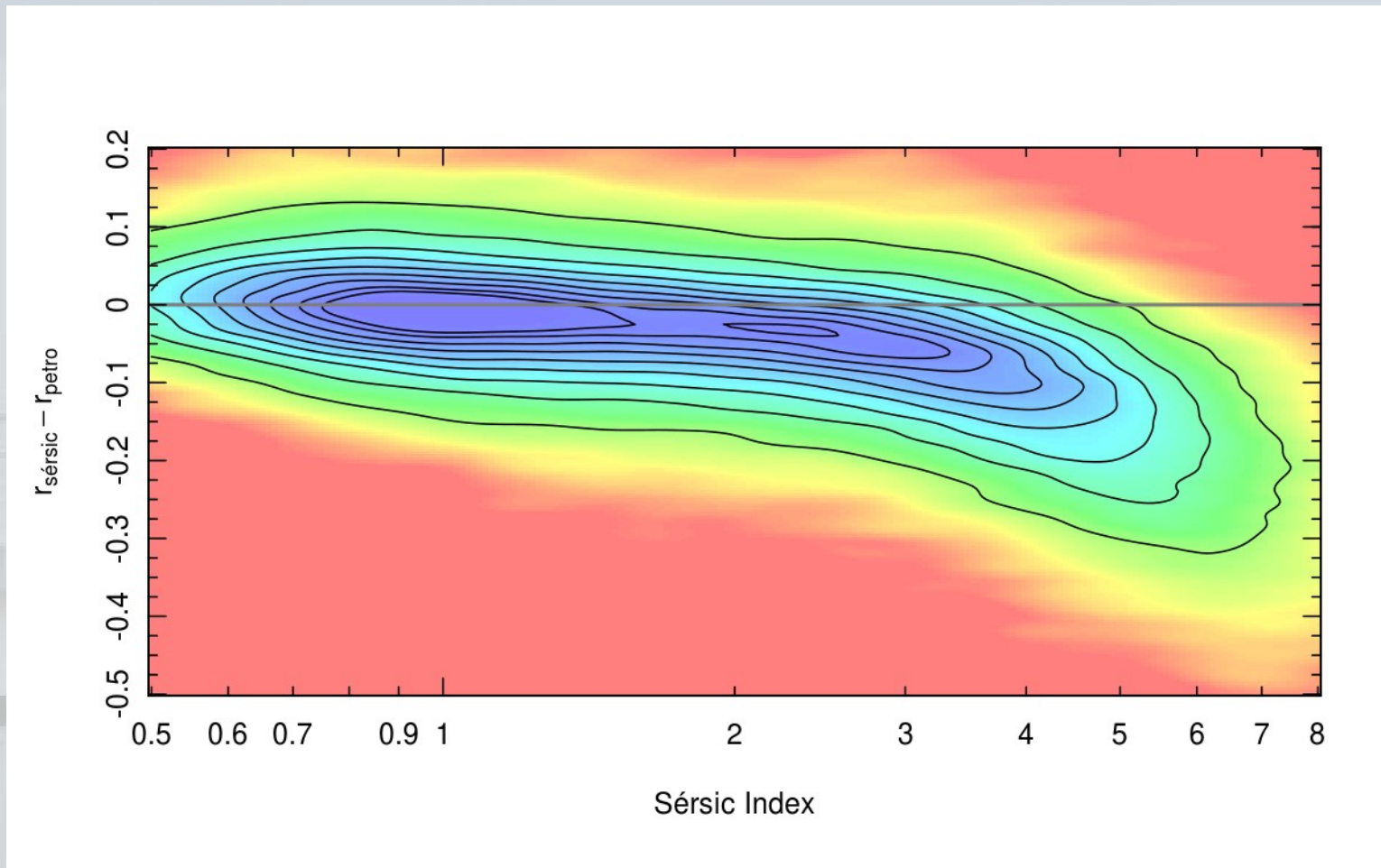
Jose Luis Sérsic, 1963



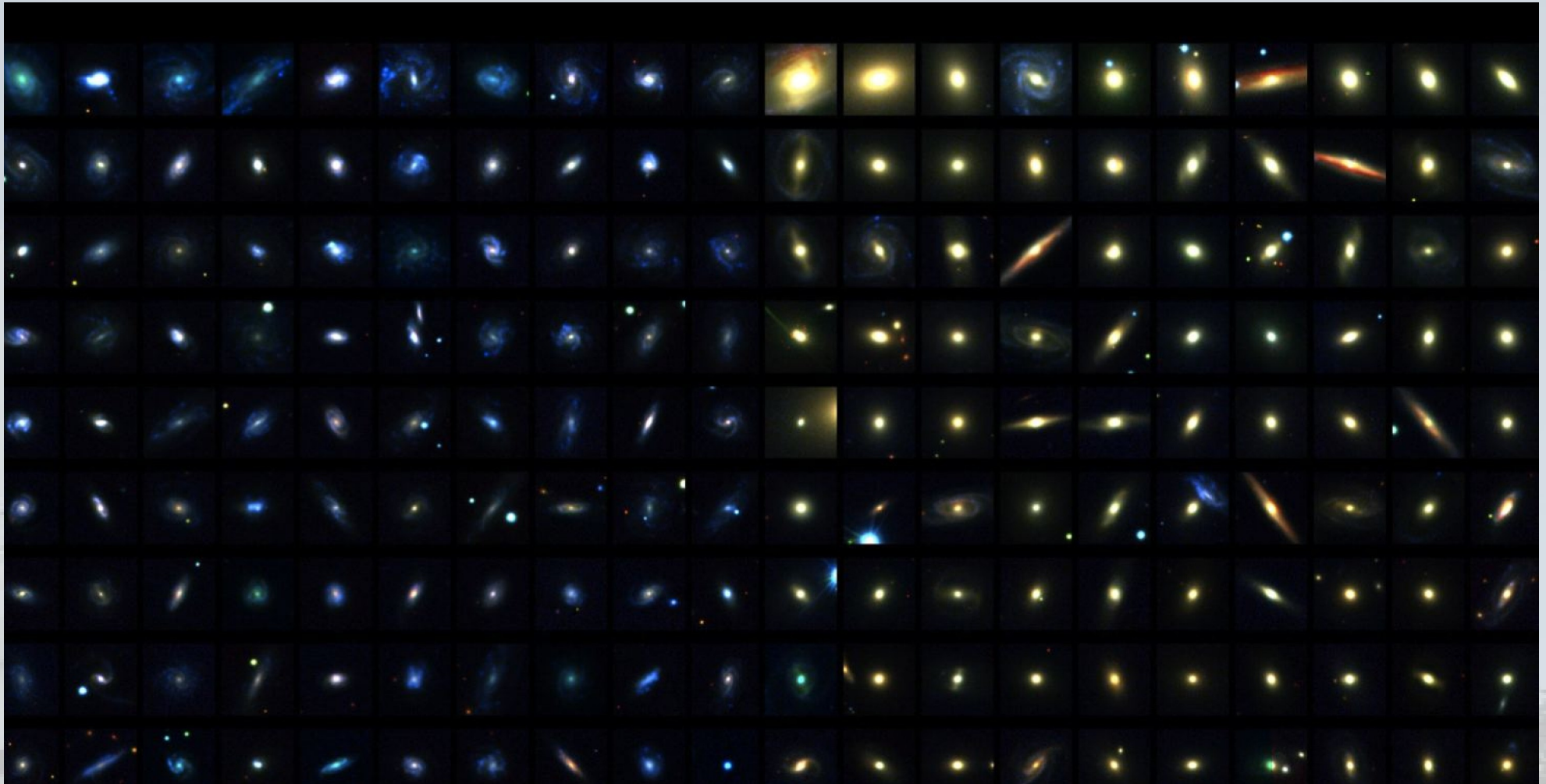
de Vaucouleur
(e.g. - ellipticals/
bulges)

Sérsic Motivation

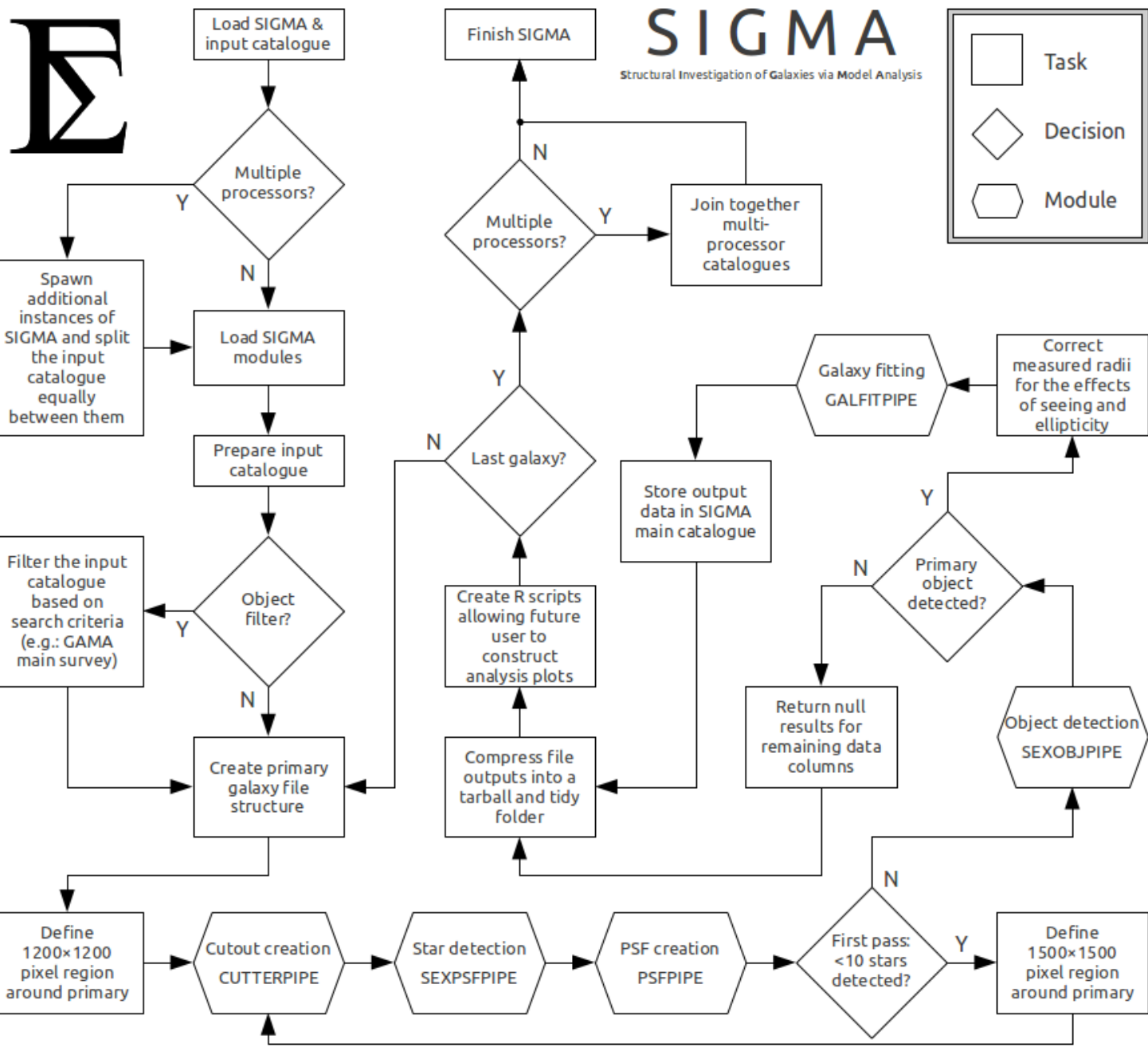
Sérsic photometry accounts for “missing” light in the wings of galaxies not usually picked up by other aperture definitions.



Sérsic Problem



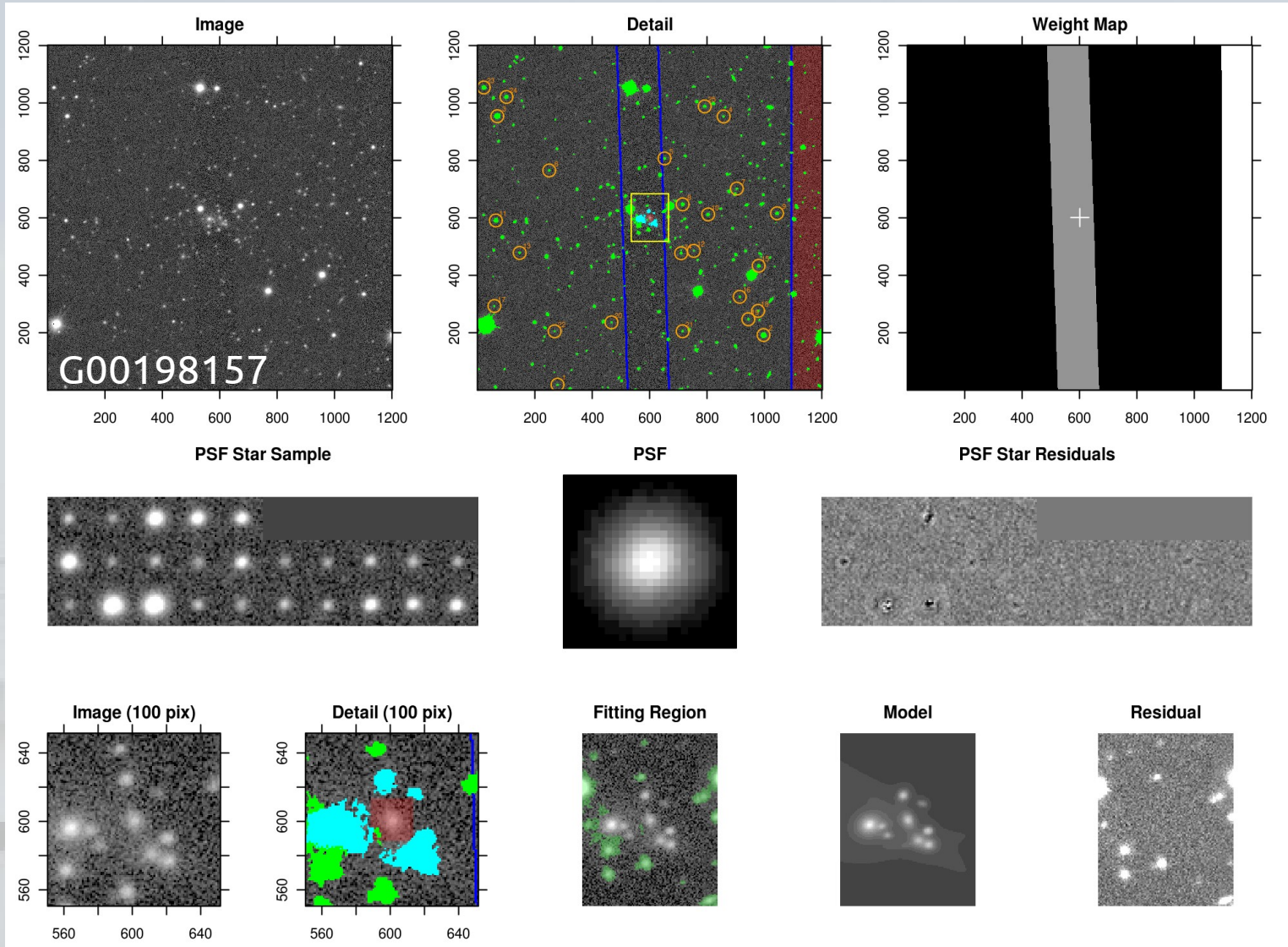
How do you model these galaxies quickly and accurately?



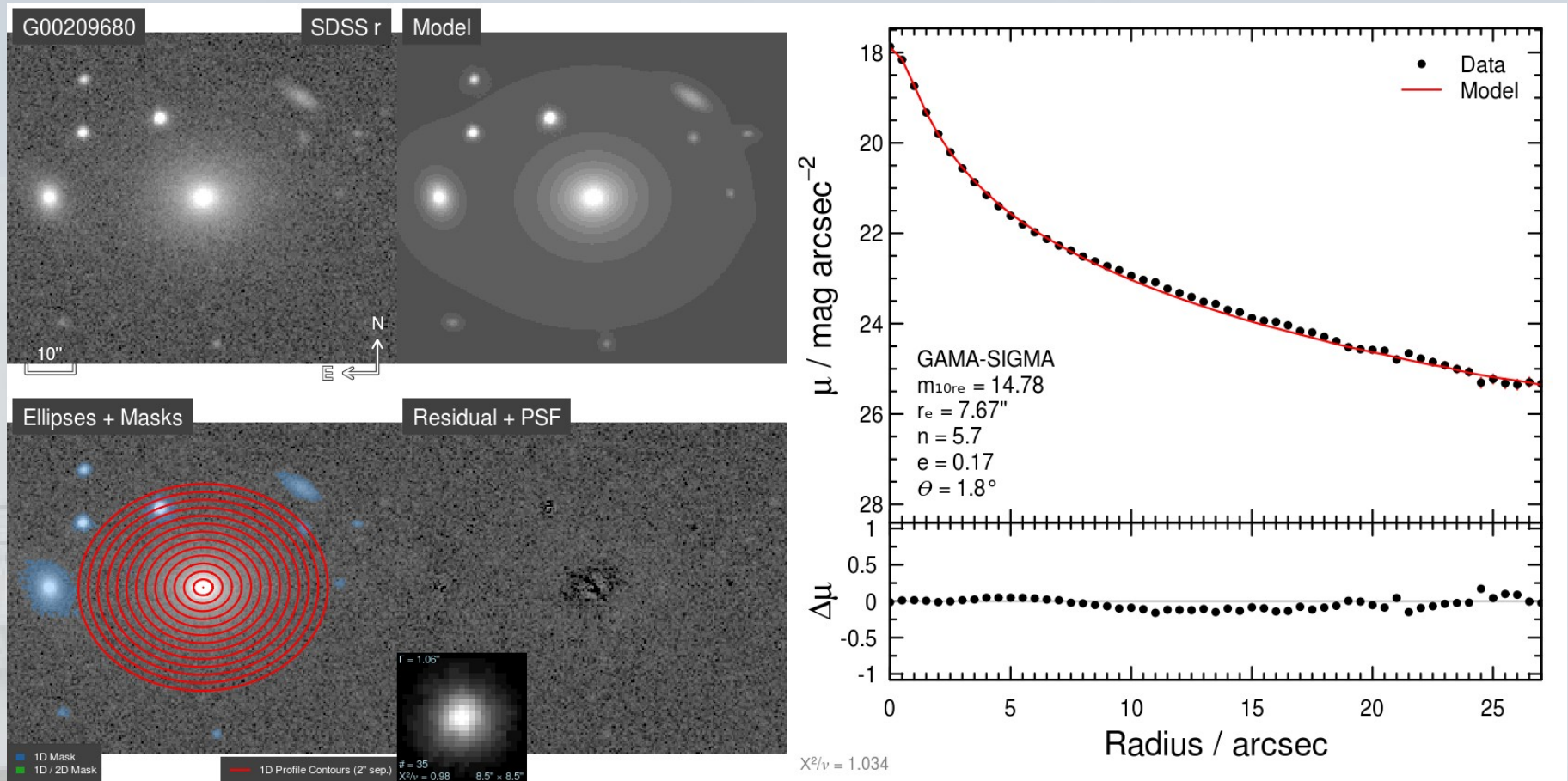
GAMA-SIGMA

→ Written in R
 → Each galaxy: 20 sec!

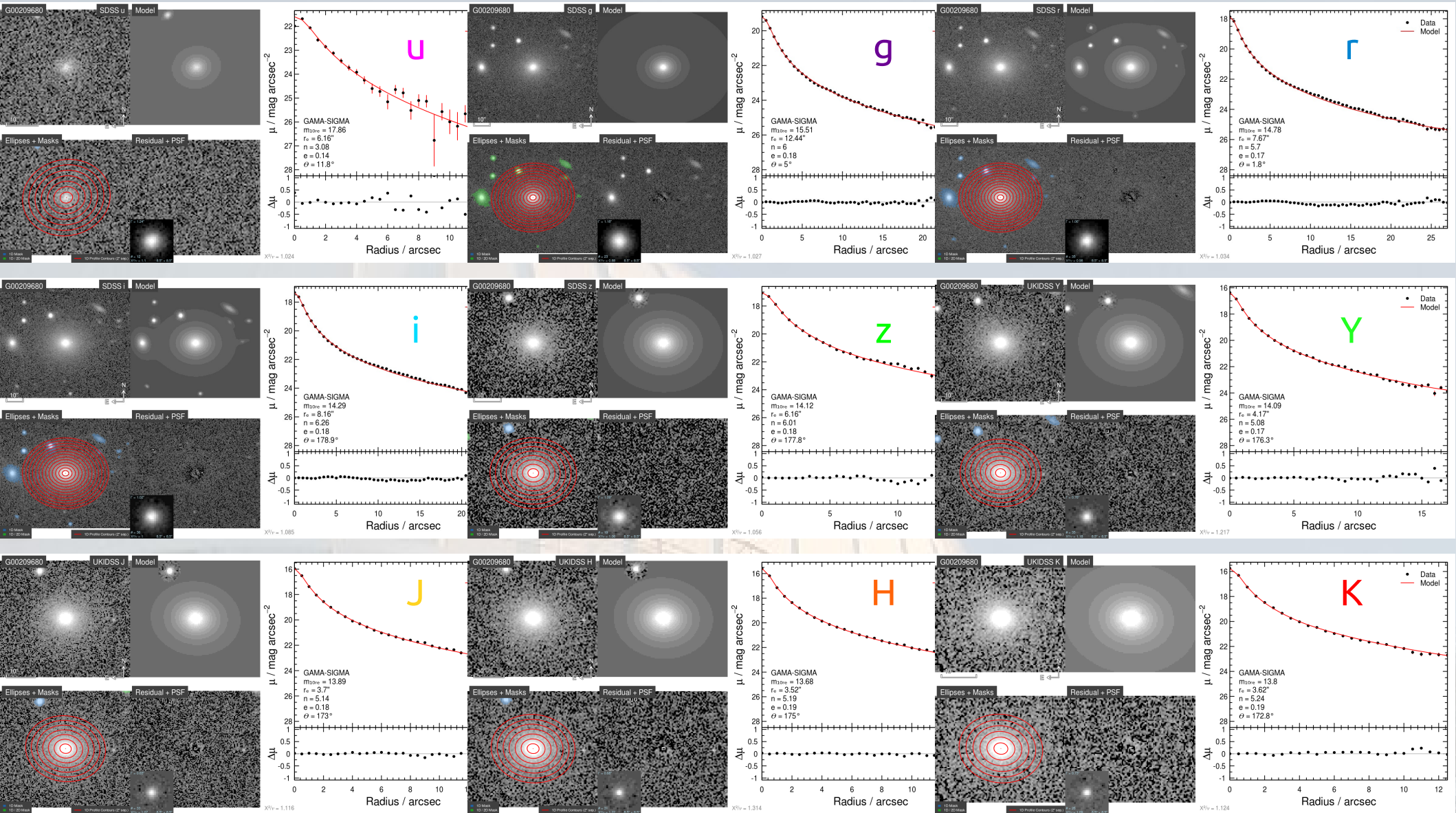
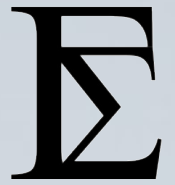
- Magnitude
- Sérsic Index
- Half-Light Radius
- Position Angle
- Ellipticity
- PSF



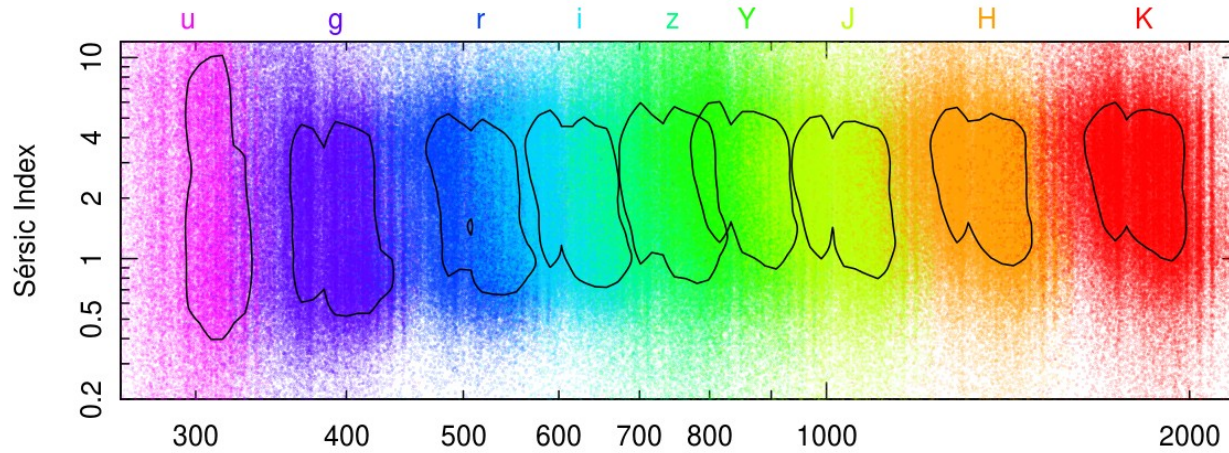
Example Profile



Example Profile: u → K

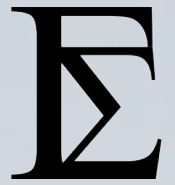
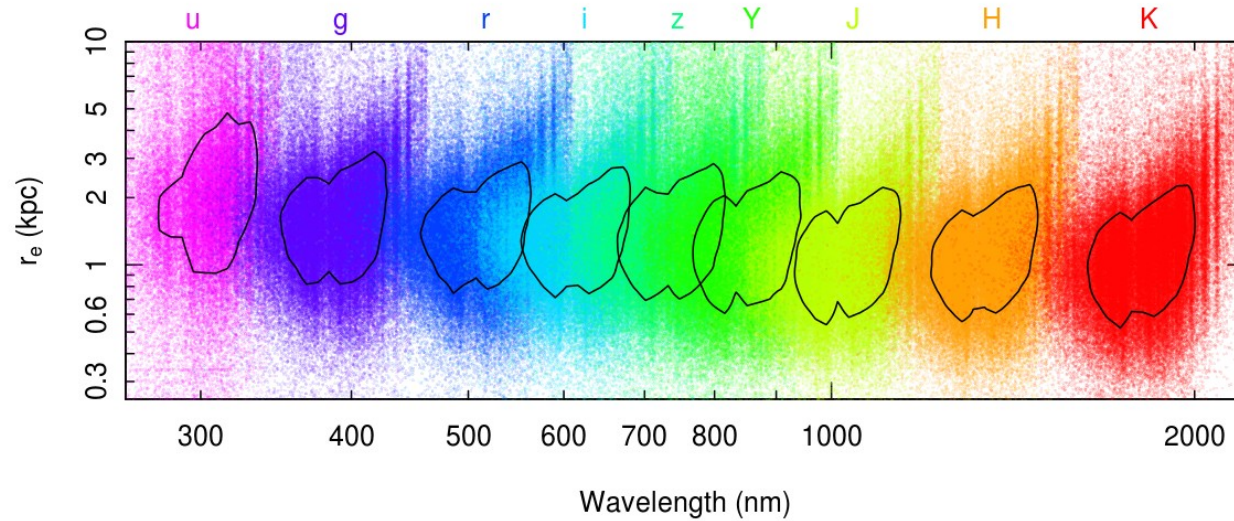


Global Distributions



u → K:

→ Increasing n, Decreasing r_e



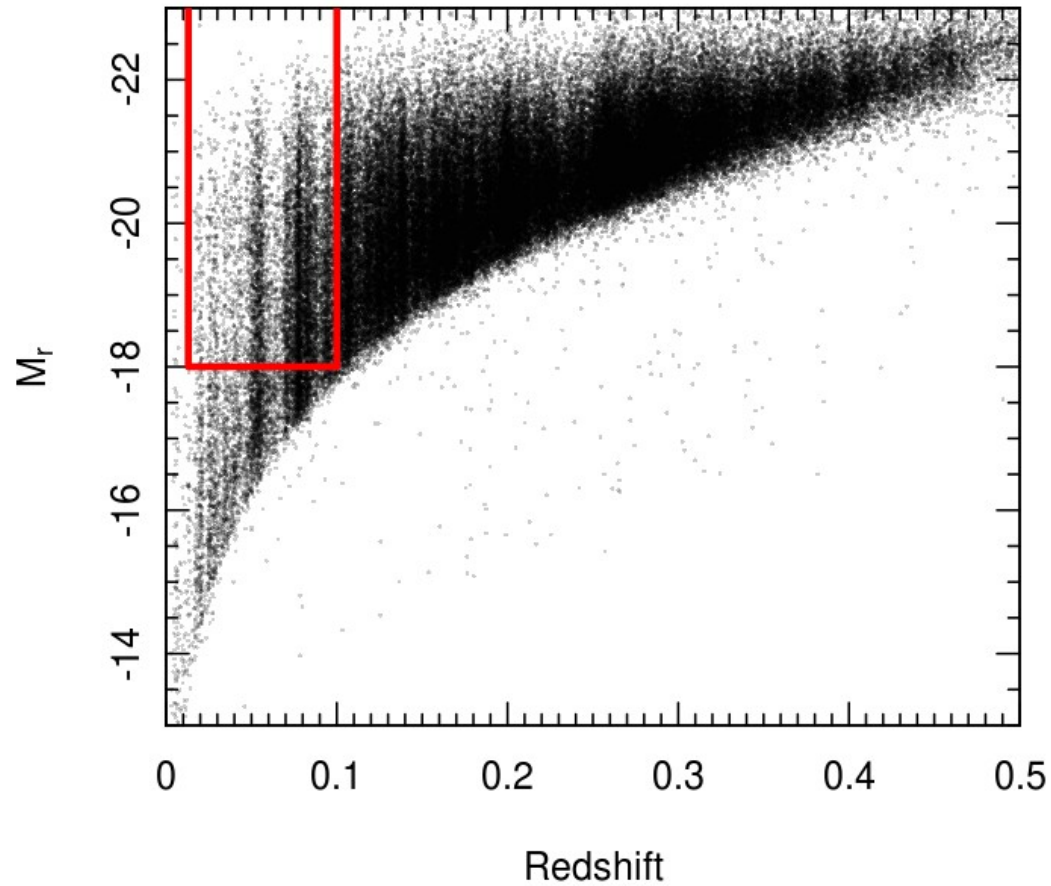
~150,000 galaxies
in each band

SDSS → ugriz

UKIDSS → YJHK

$$\lambda/1+z$$

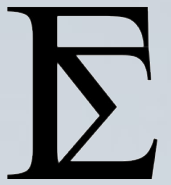
Volume Limited Sample



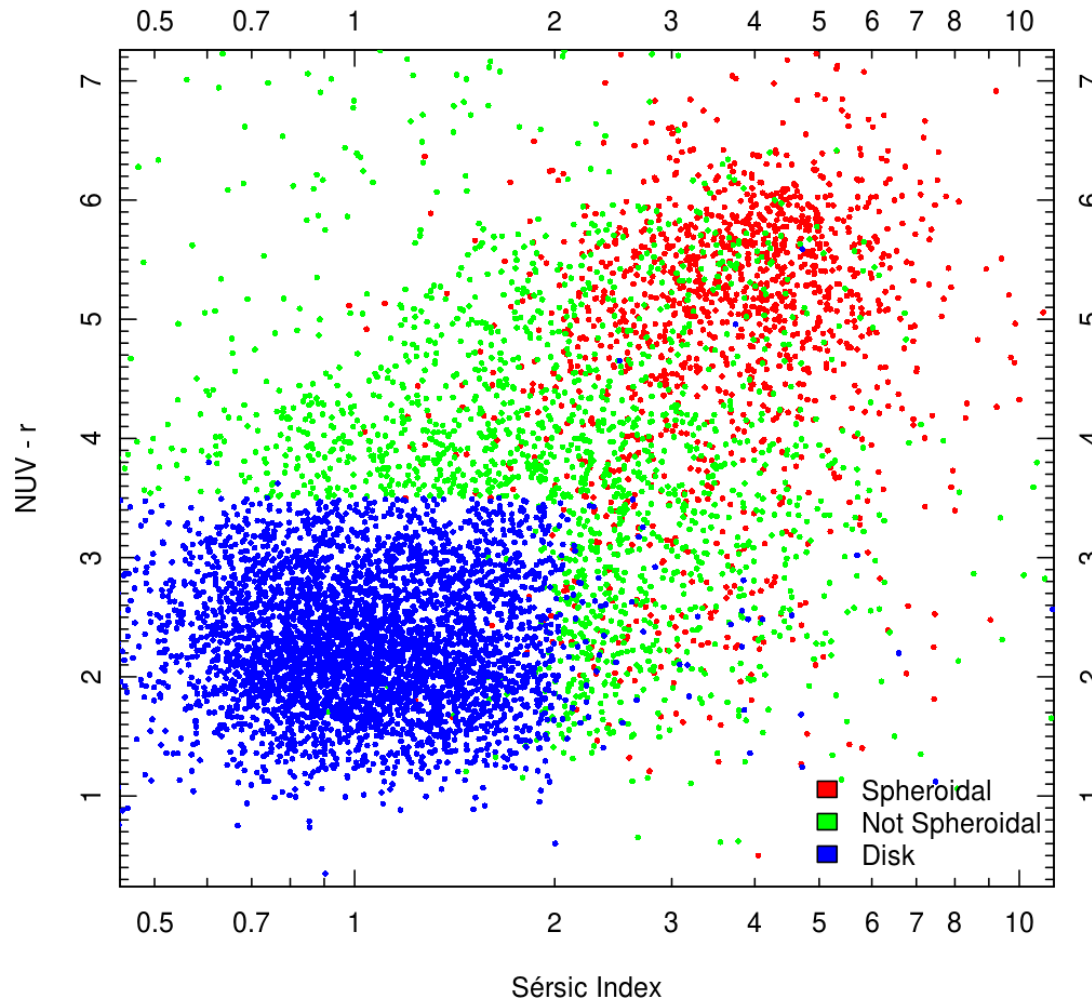
- $M_r < -18$
- $0.013 < z < 0.1$
- $nQ > 2$
- Coverage = ugrizYJHK
+ NUV/FUV

→ ~7,500 galaxies

Classifications



Driver et al. (2011; in prep)



- $M_r < -18$
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→ ~7,500 galaxies

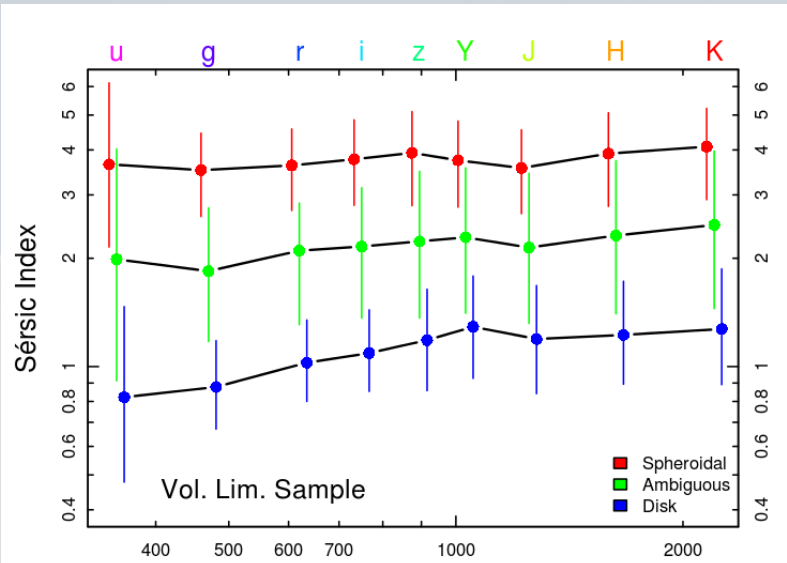
Vol. Lim. Results



Stability of elliptical shape at all λ

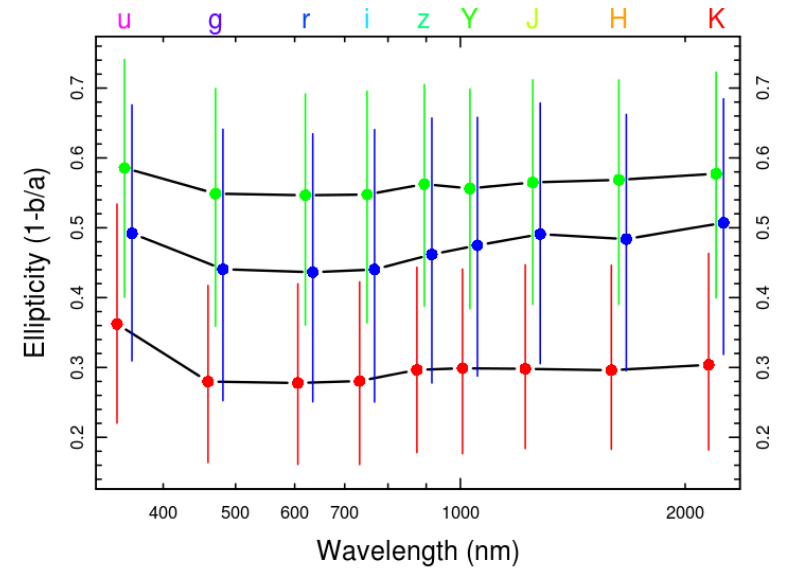
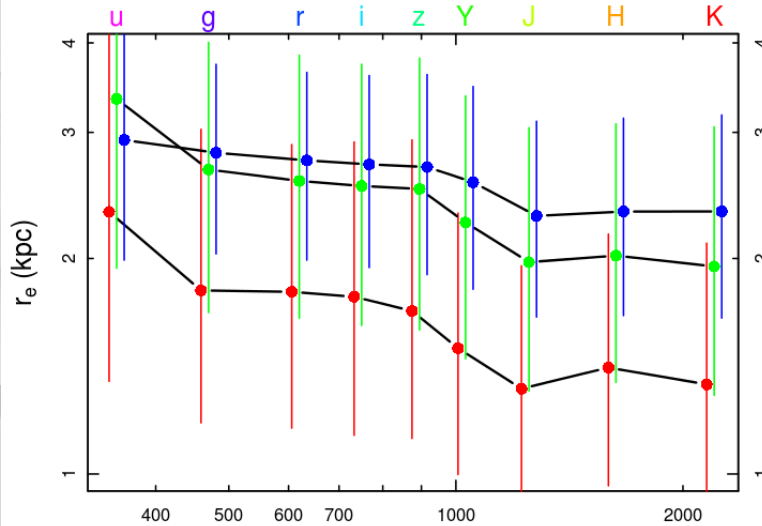
Size evolution of ellipticals and disks u \rightarrow K

Stability of ellipticity for all morph. types

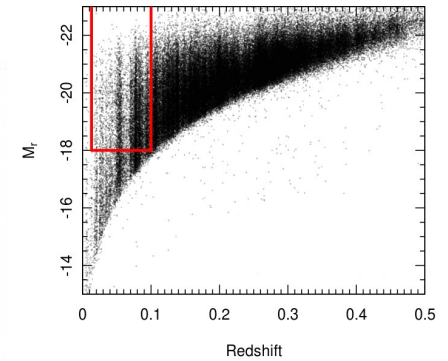
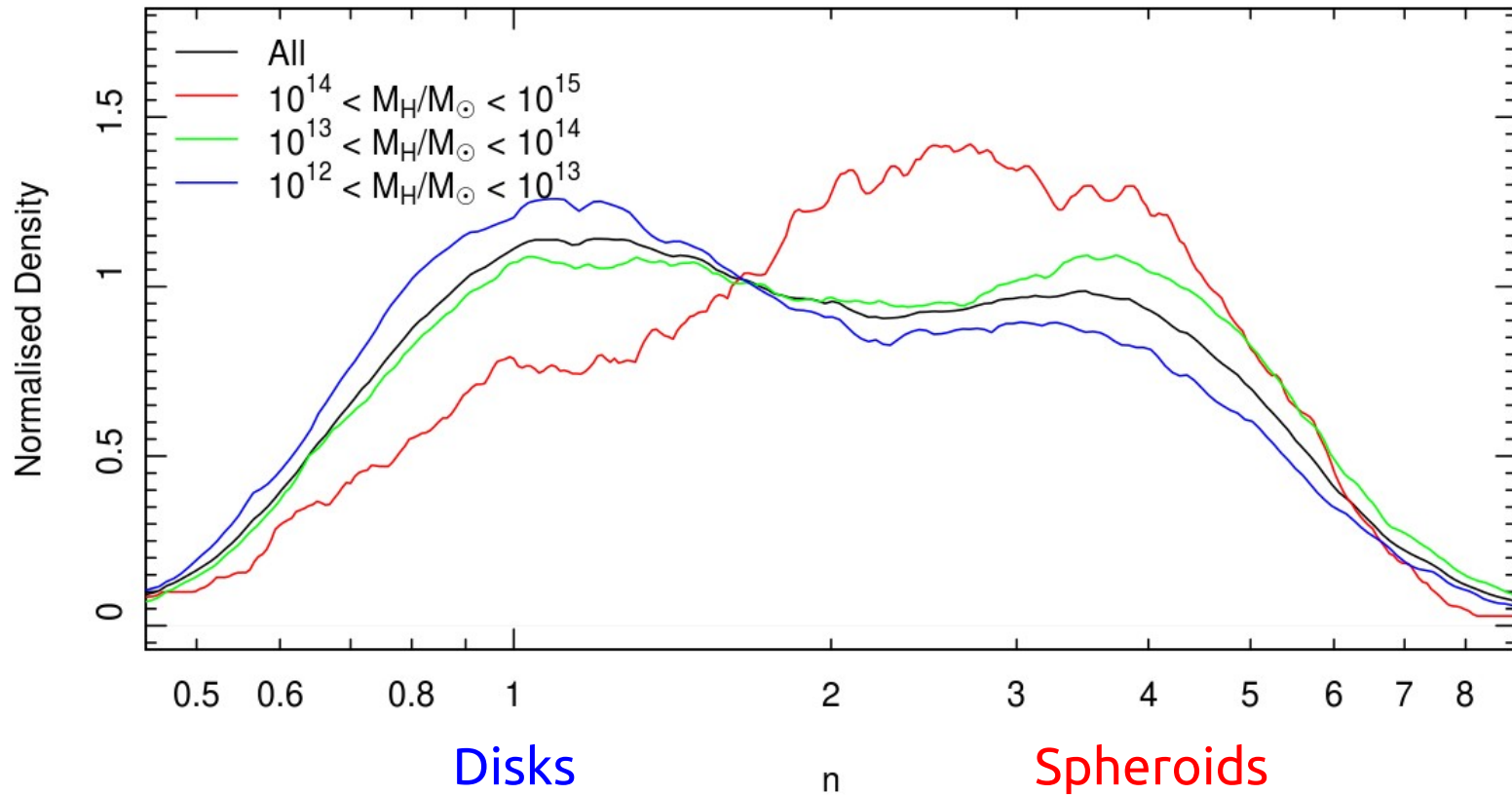


- $M_r < -18$
- $0.013 < z < 0.1$
- $nQ > 2$
- Coverage = ugrizYJHK + NUV/FUV

$\rightarrow \sim 7,500$ galaxies

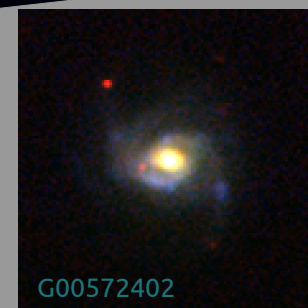
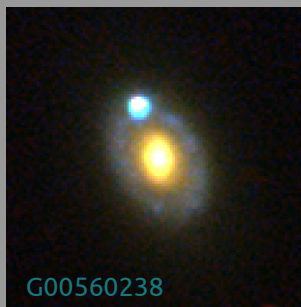


Halo Masses: Aaron Robotham



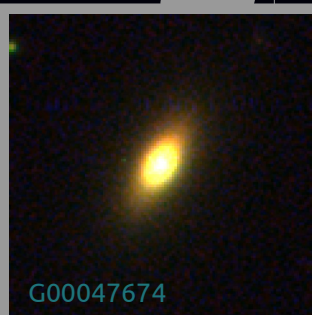
Galaxy And Mass Assembly (GAMA) Hubble Tuning-Fork

Groups/
Mergers



Unbarred Spirals

Ellipticals

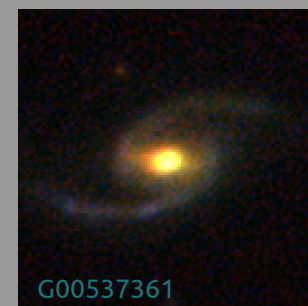
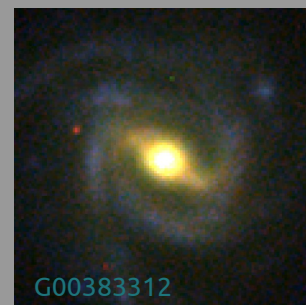
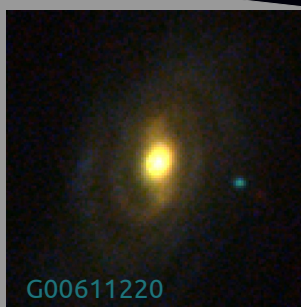
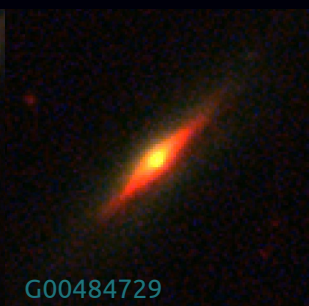


GAMA



Irregulars

Edge-on
Spirals



Barred Spirals

Lee Kelvin

Kru 40"×40"

www.gama-survey.org

Galaxy And Mass Assembly (GAMA) Hubble Tuning-Fork

G00609396 G00508412 G00272822

Groups/
Mergers

G00238211 G00303096

G00560238

G00230636

G00572402

Unbarred Spirals

Ellipticals

G00055143

G00230675

G00047674

GAMA



G00238952

G00600168

Irregulars

Edge-on
Spirals

G00583427

G00484729

G00240202

Barred Spirals

G00611220

361

Is structural decomposition required?

How do you morphologically classify these galaxies automatically?

G00229306

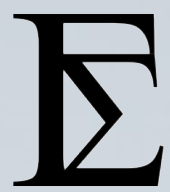
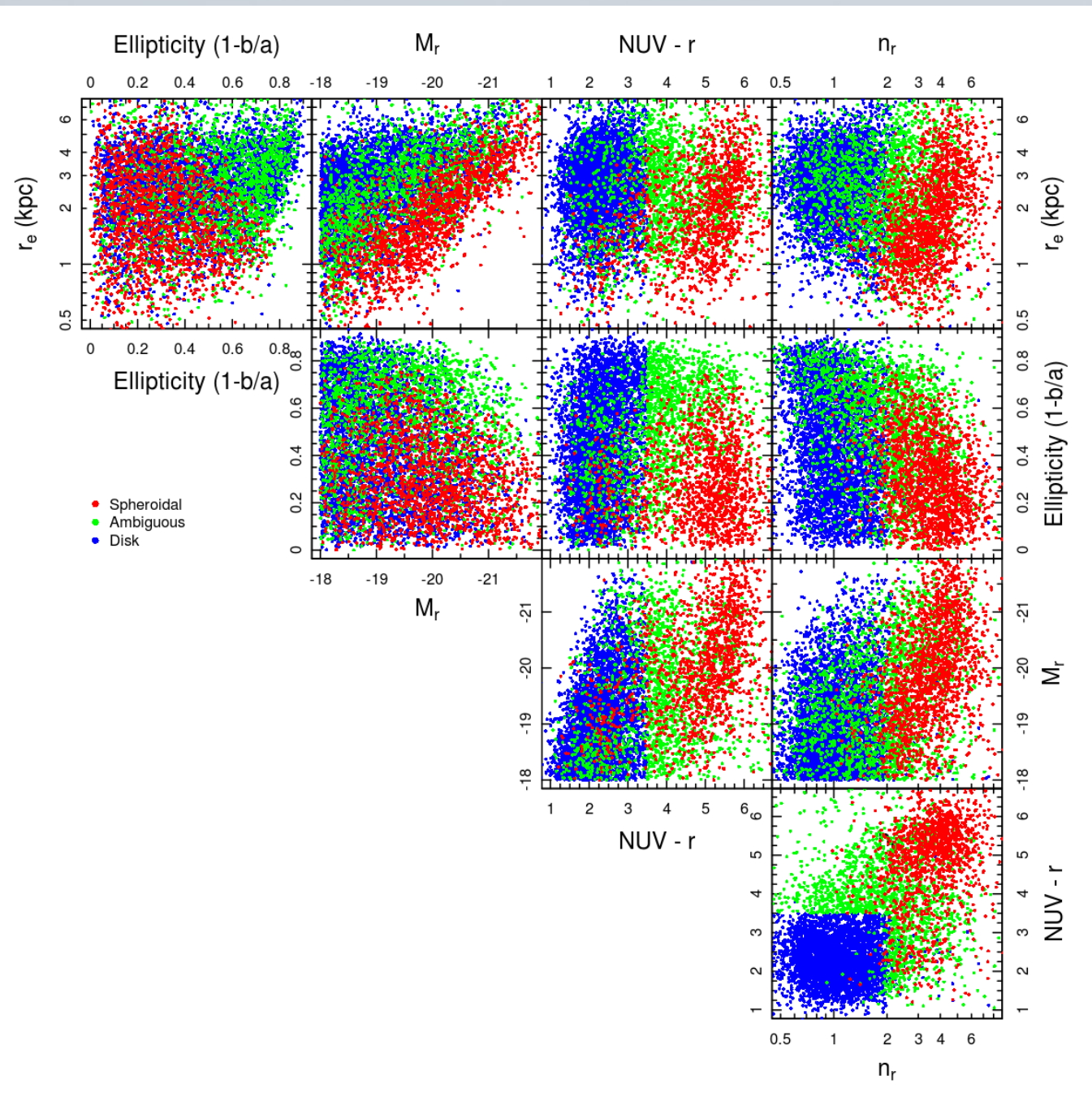
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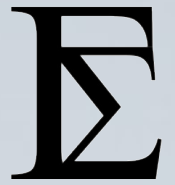
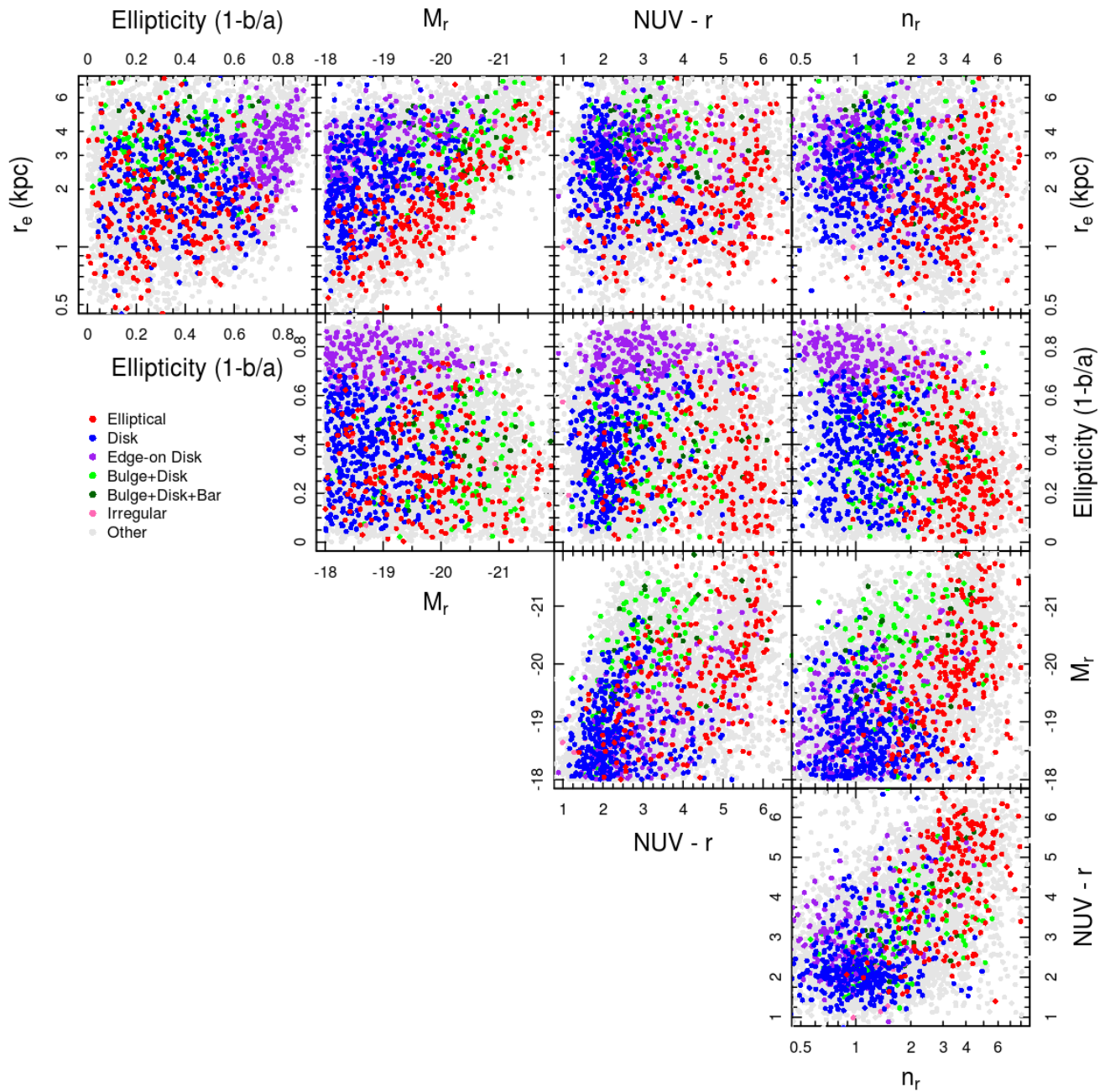
Kru 40"×40"

www.gama-survey.org

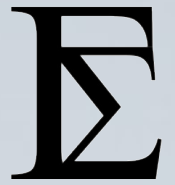
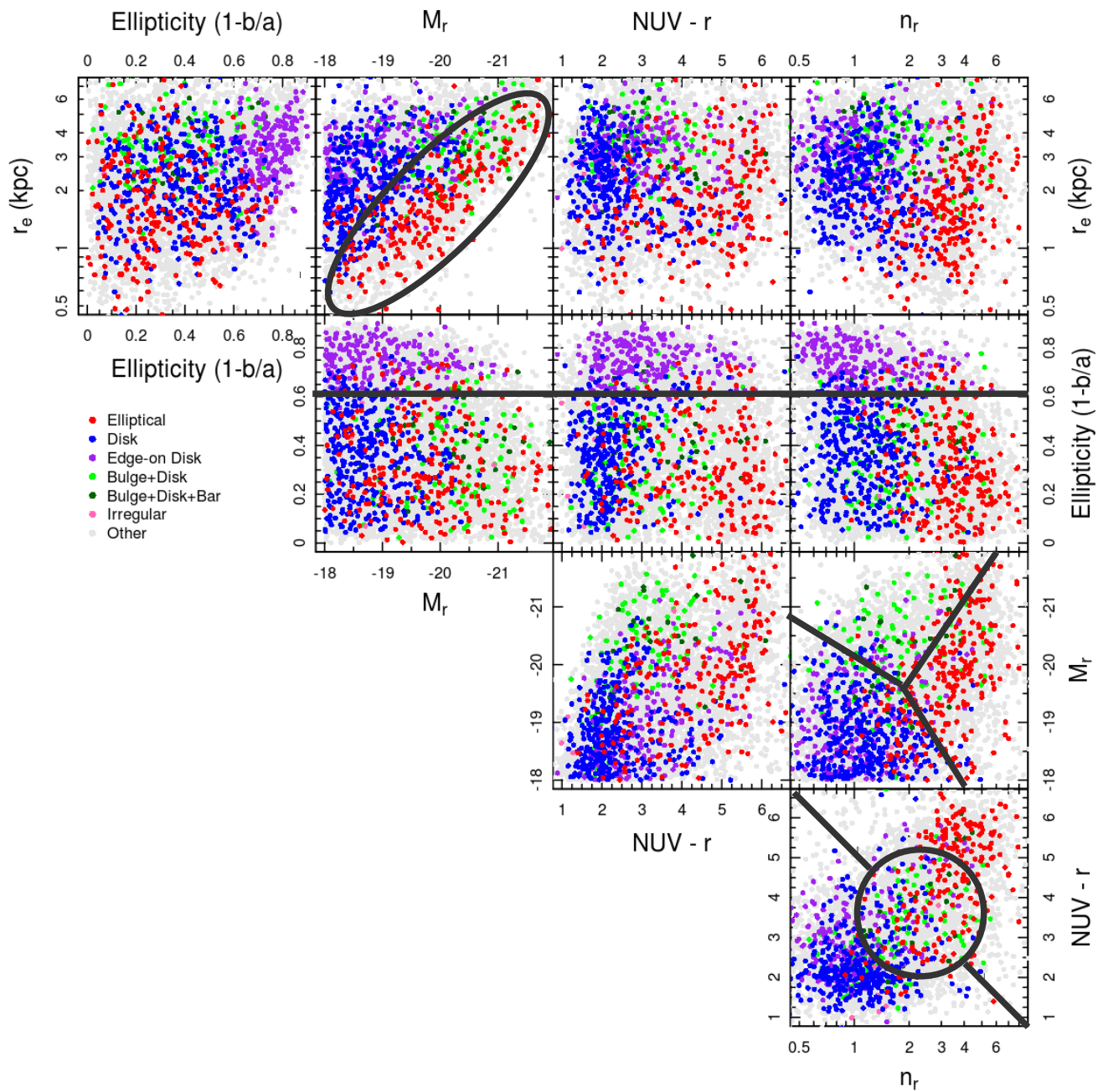
All vs All



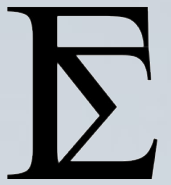
All vs All (Updated)



All vs All (Updated)

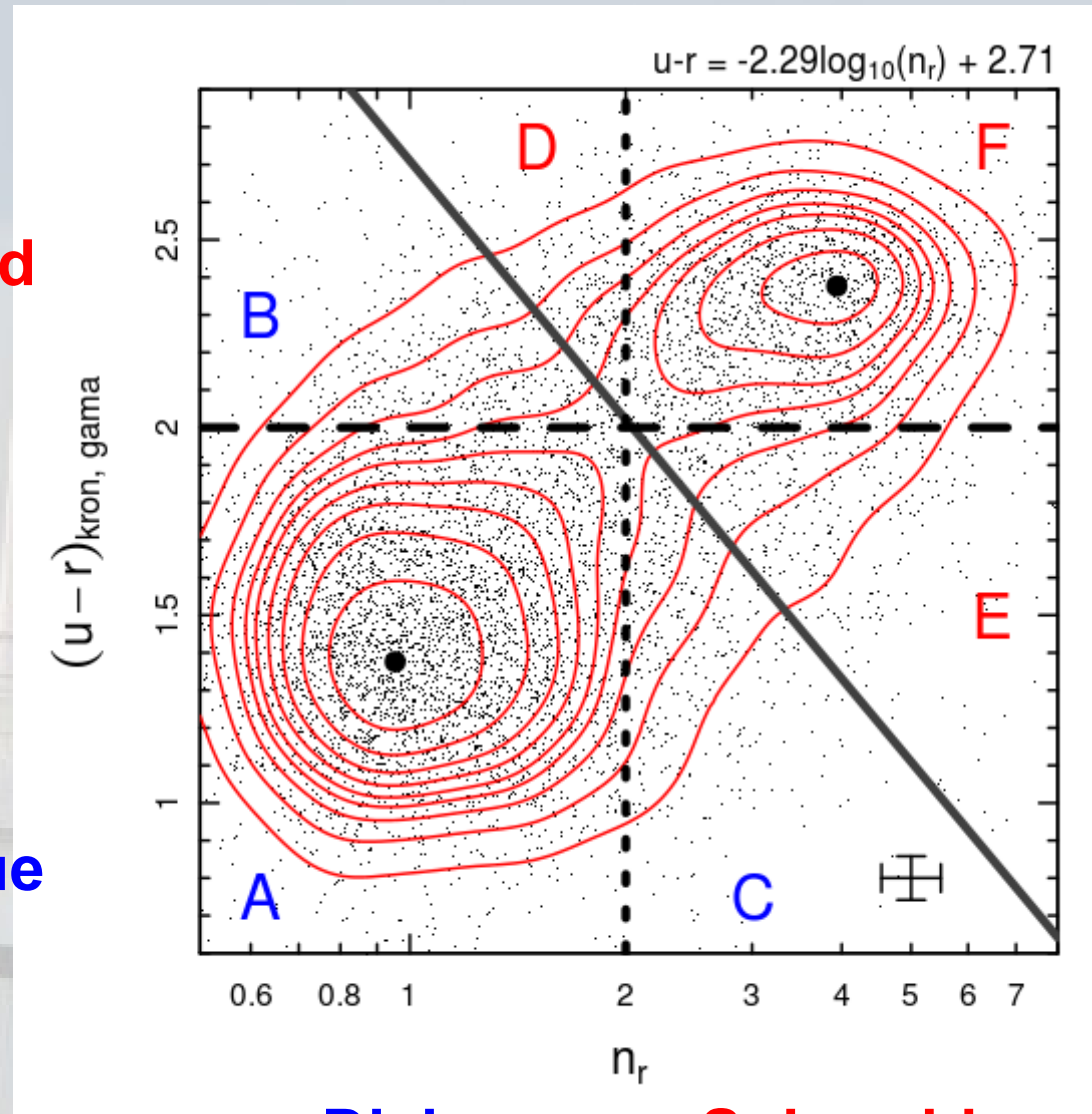


Automated Classification



Red

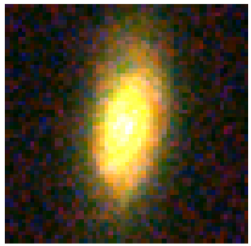
Blue



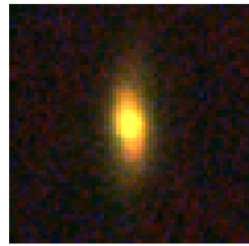
Disks

Spheroids

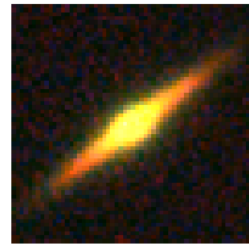
Automated Classification



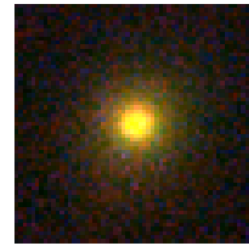
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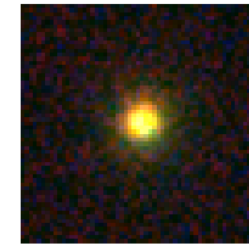
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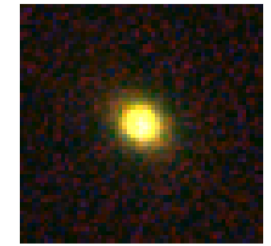
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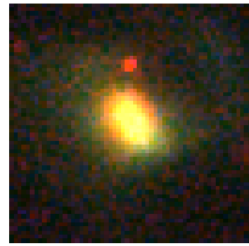
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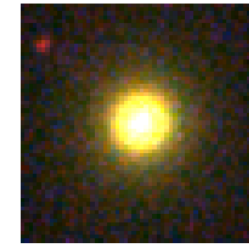
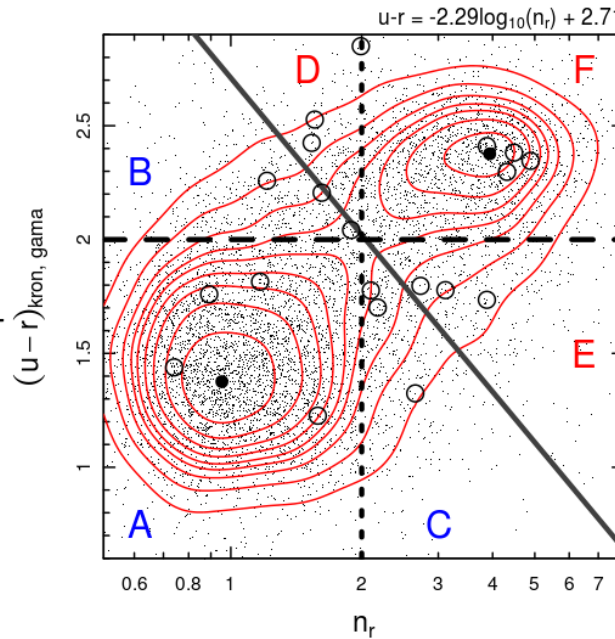
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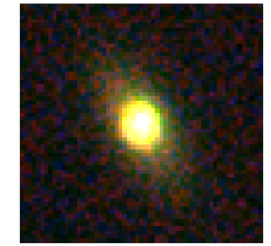
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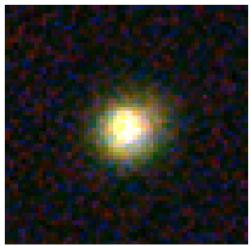
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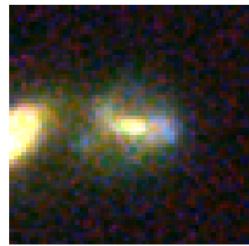
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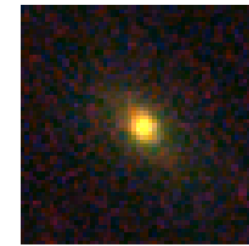
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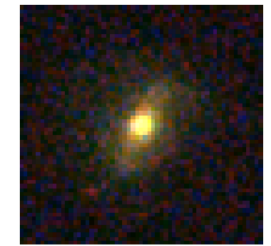
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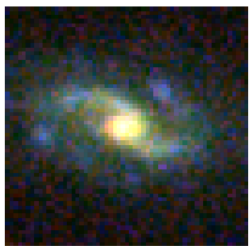
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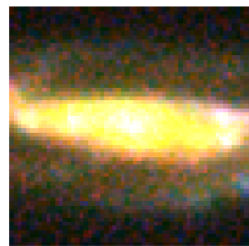
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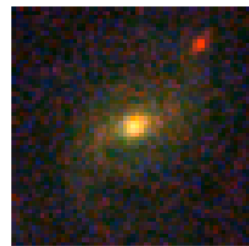
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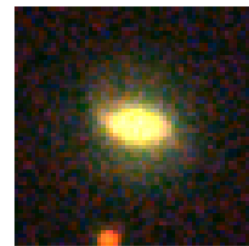
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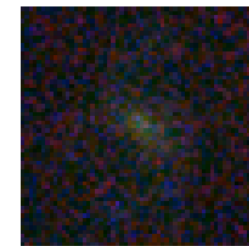
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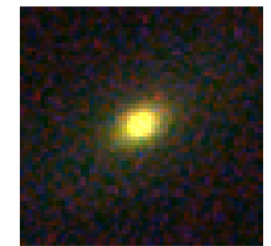
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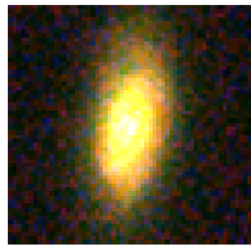


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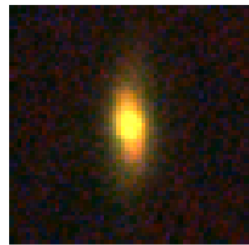


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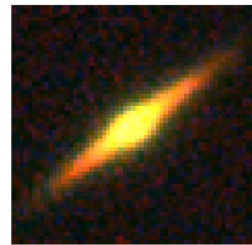
Automated Classification



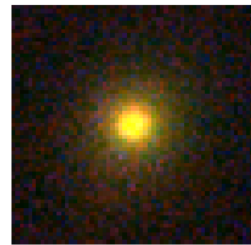
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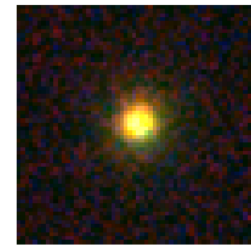
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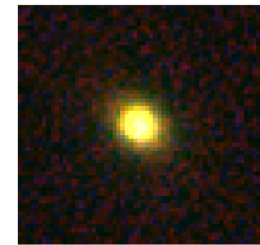
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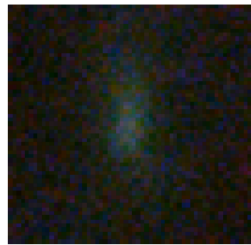
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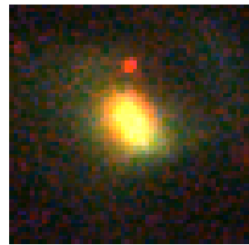
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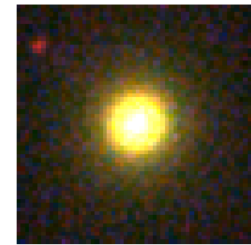
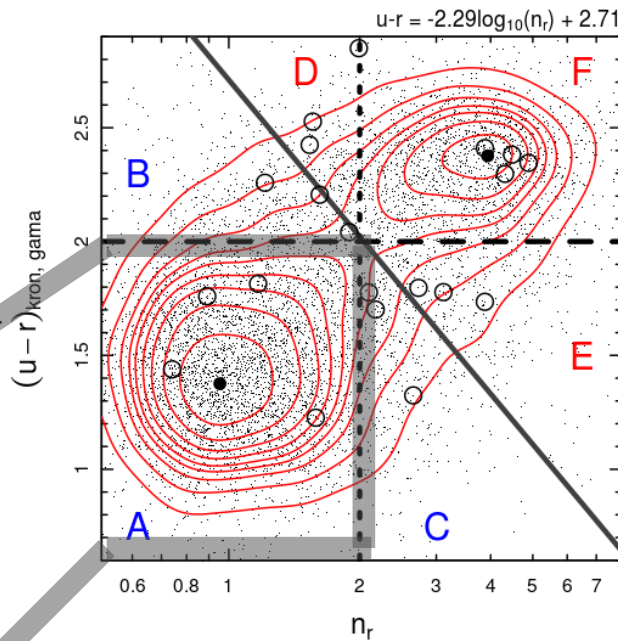
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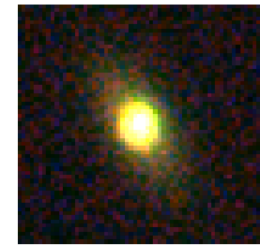
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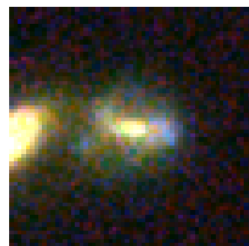
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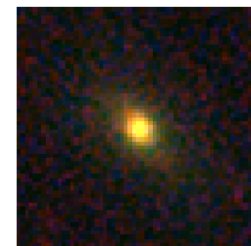
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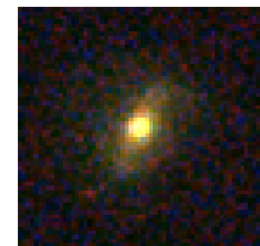
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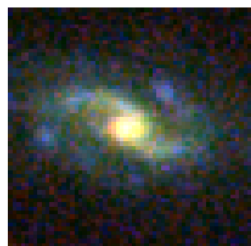
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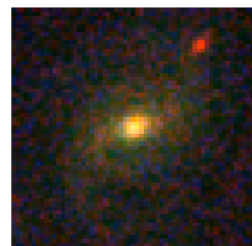
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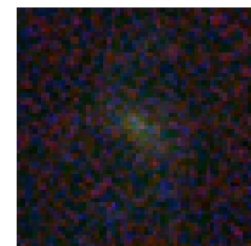
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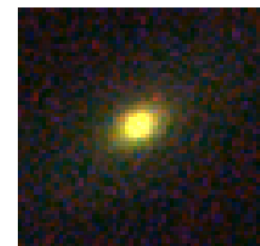
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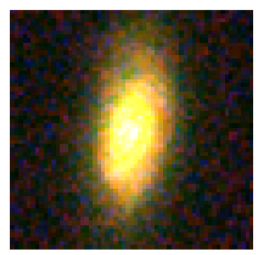


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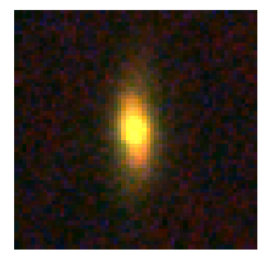


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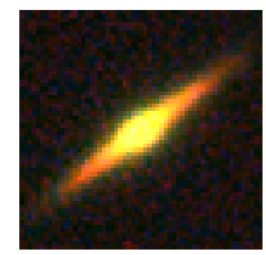
Automated Classification



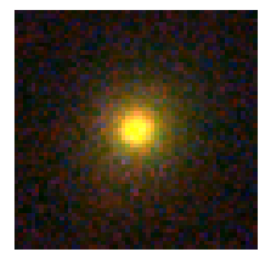
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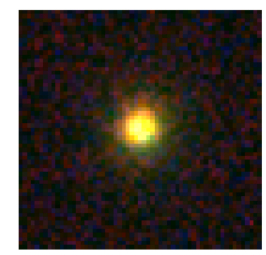
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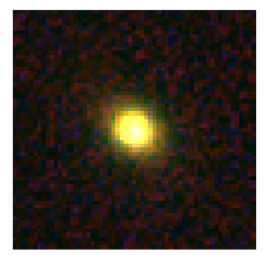
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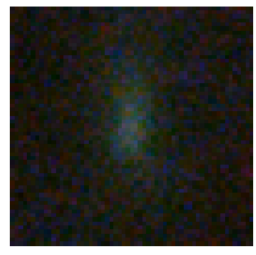
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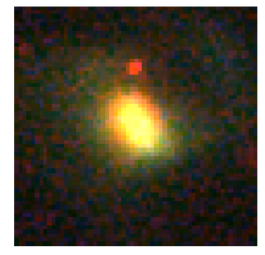
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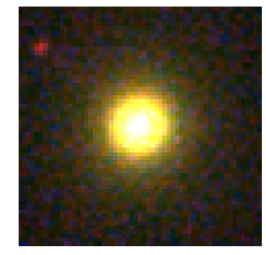
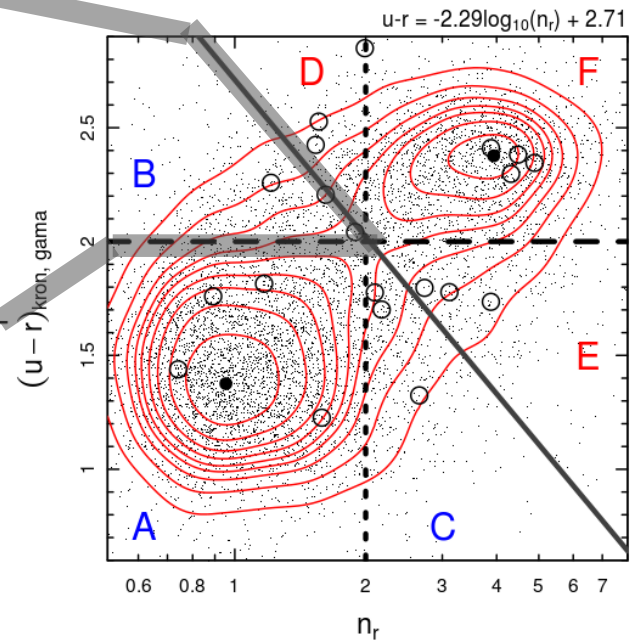
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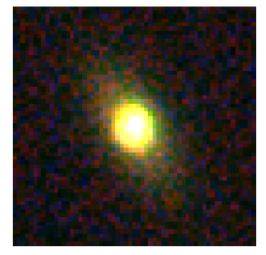
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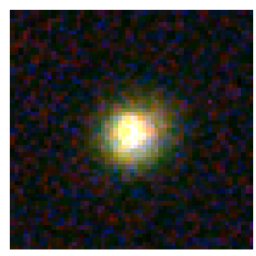
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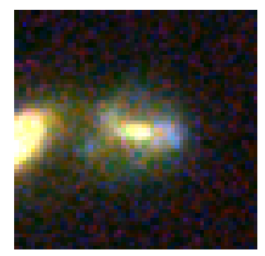
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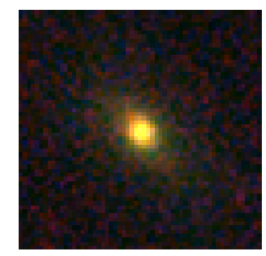
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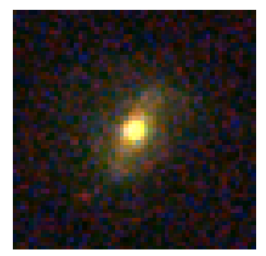
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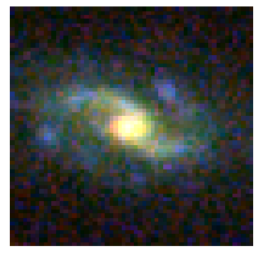
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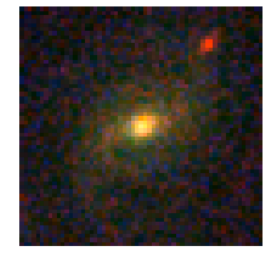
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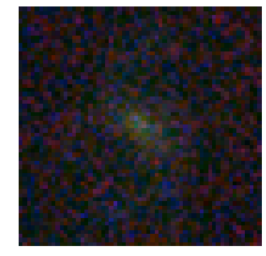
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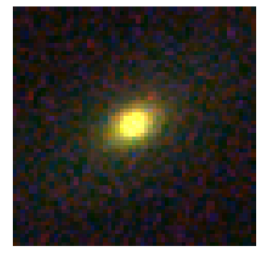
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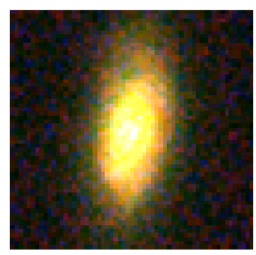


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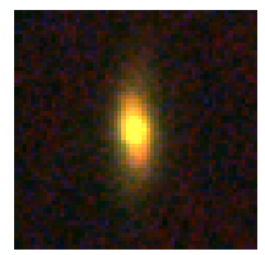


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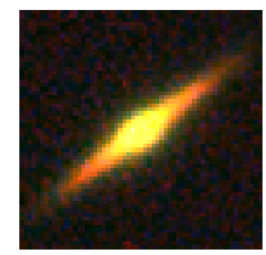
Automated Classification



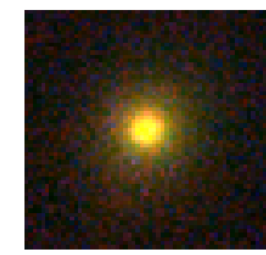
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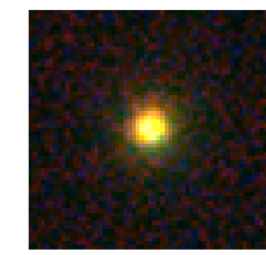
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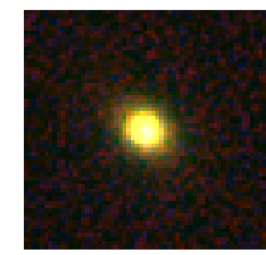
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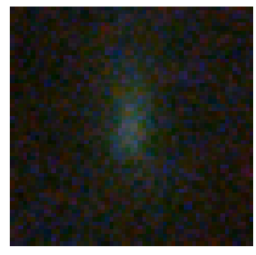
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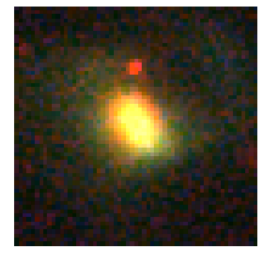
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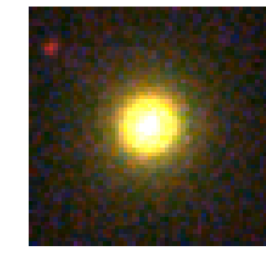
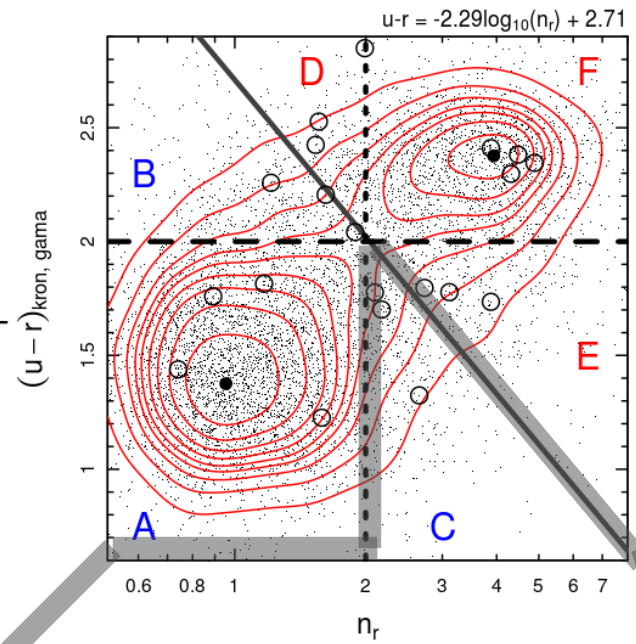
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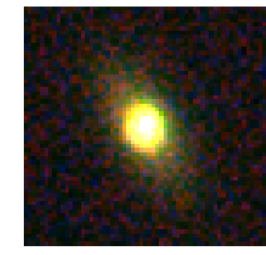
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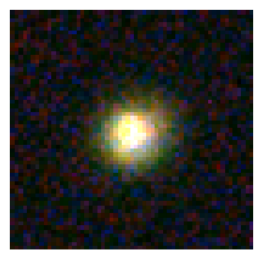
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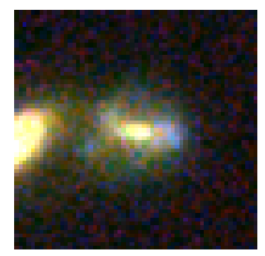
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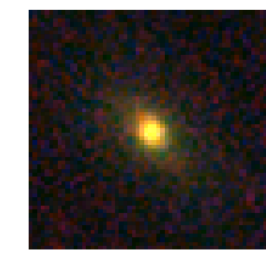
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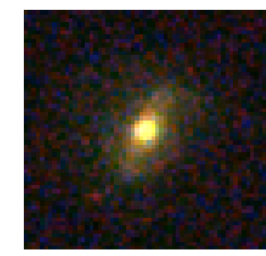
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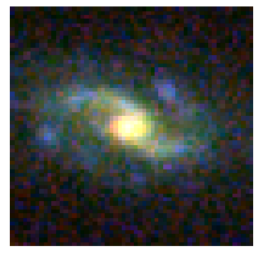
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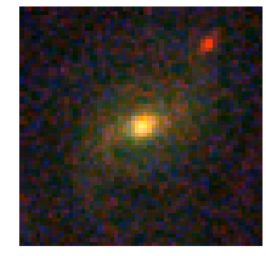
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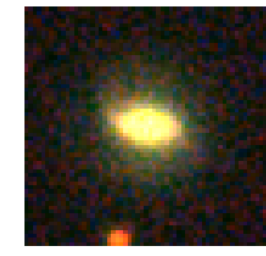
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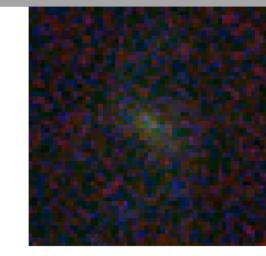
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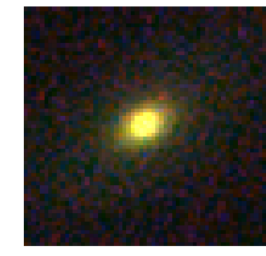
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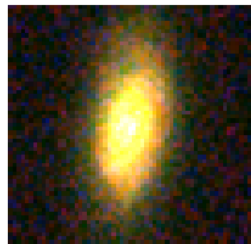


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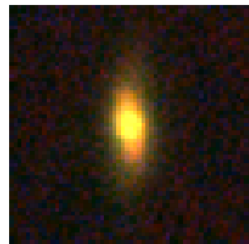


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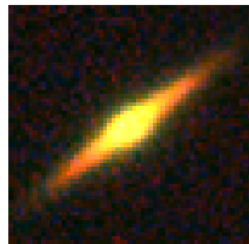
Automated Classification



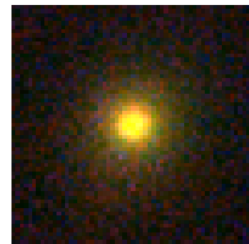
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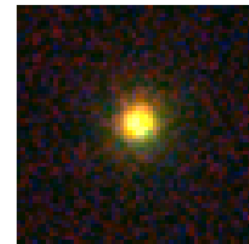
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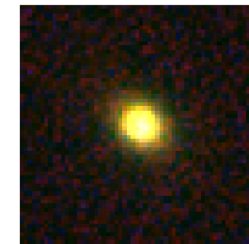
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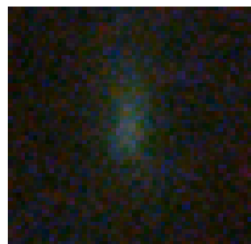
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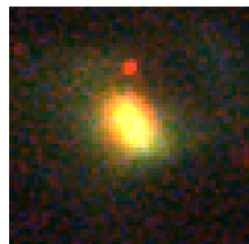
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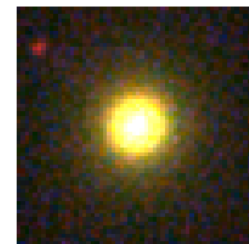
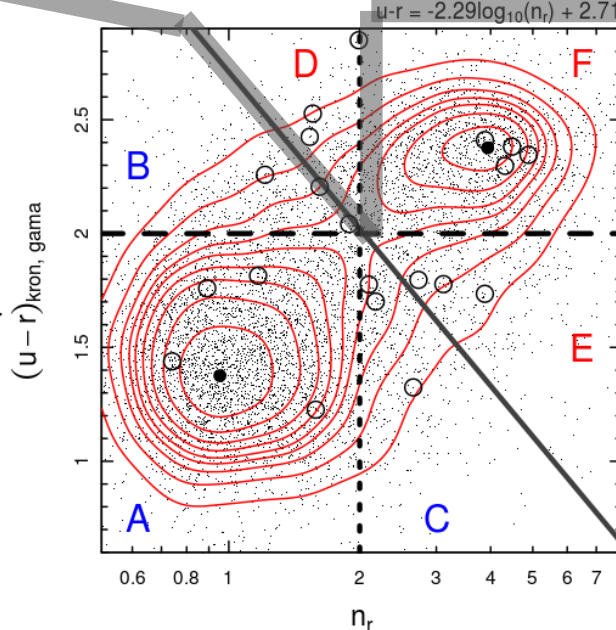
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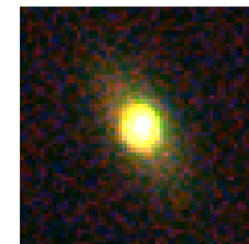
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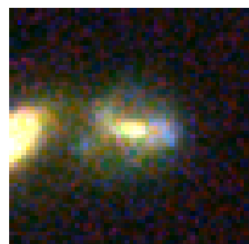
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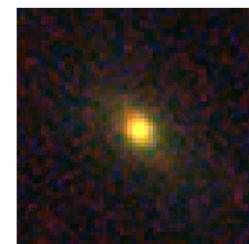
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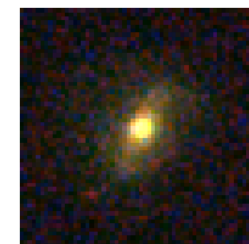
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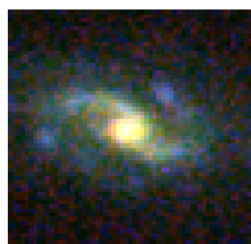
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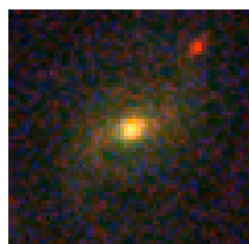
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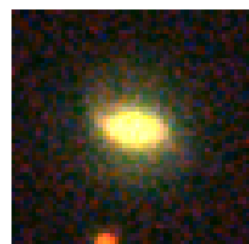
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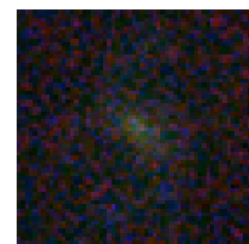
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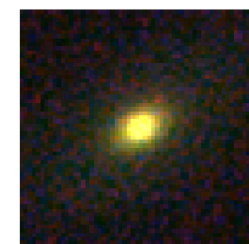
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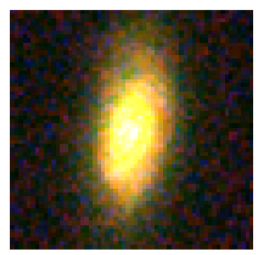


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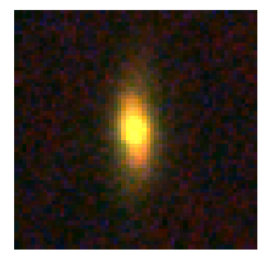


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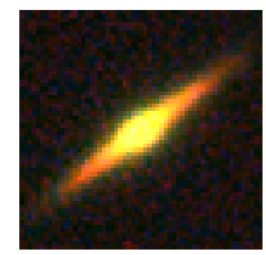
Automated Classification



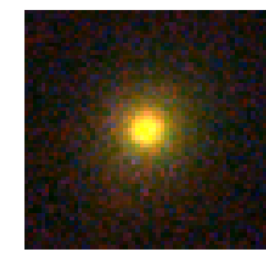
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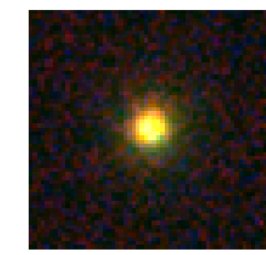
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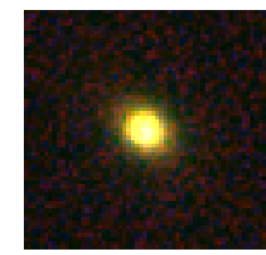
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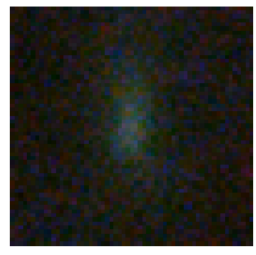
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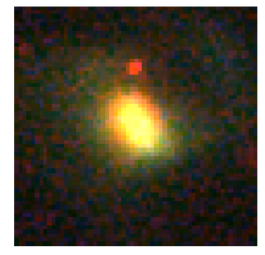
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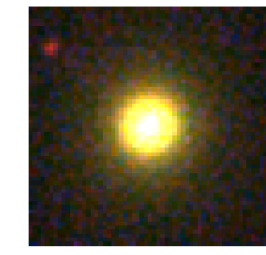
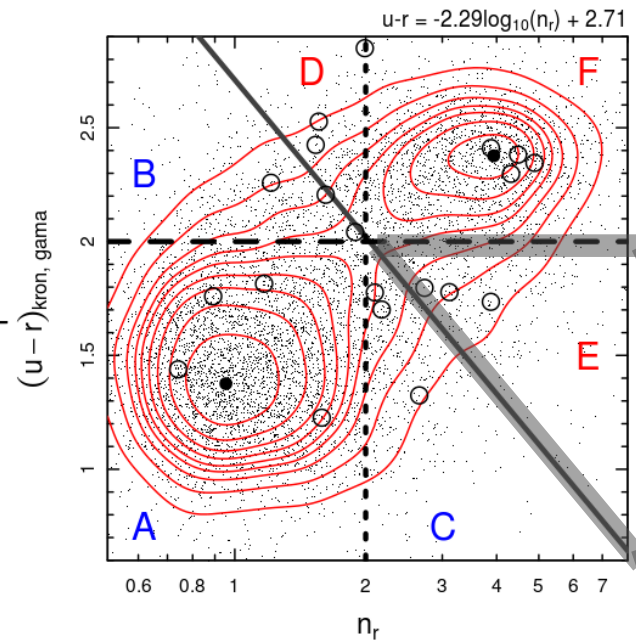
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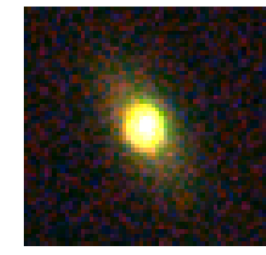
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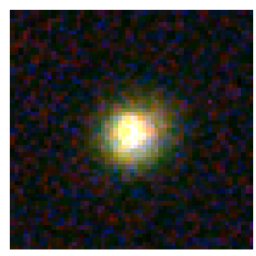
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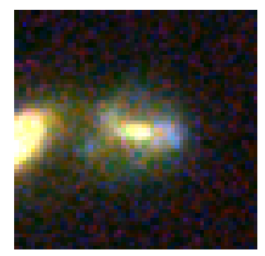
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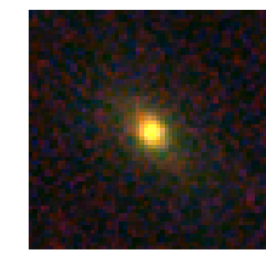
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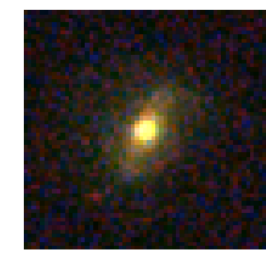
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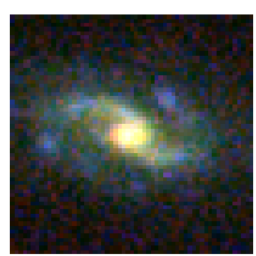
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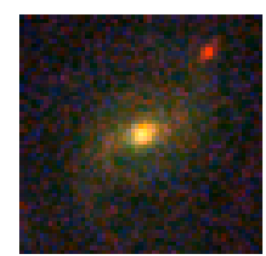
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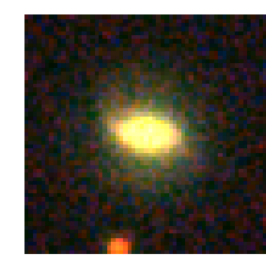
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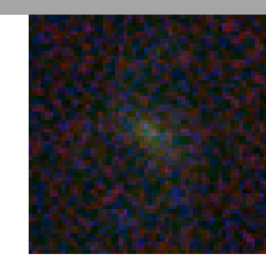
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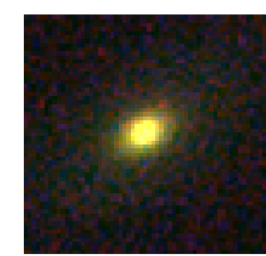
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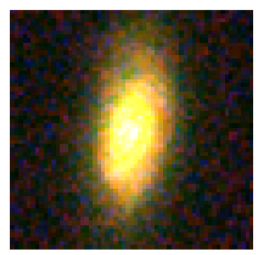


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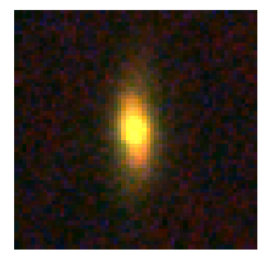


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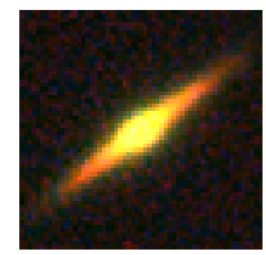
Automated Classification



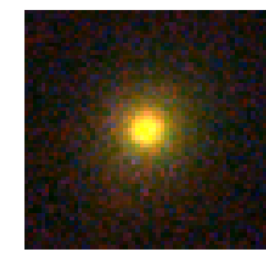
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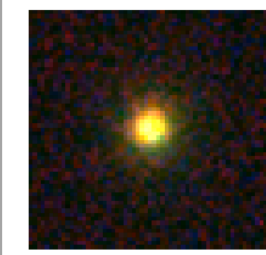
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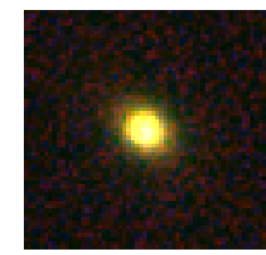
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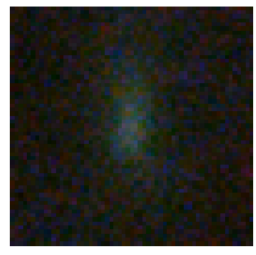
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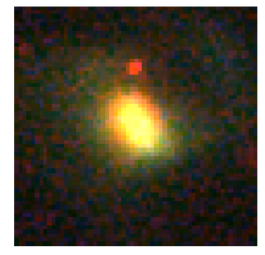
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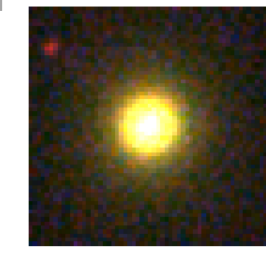
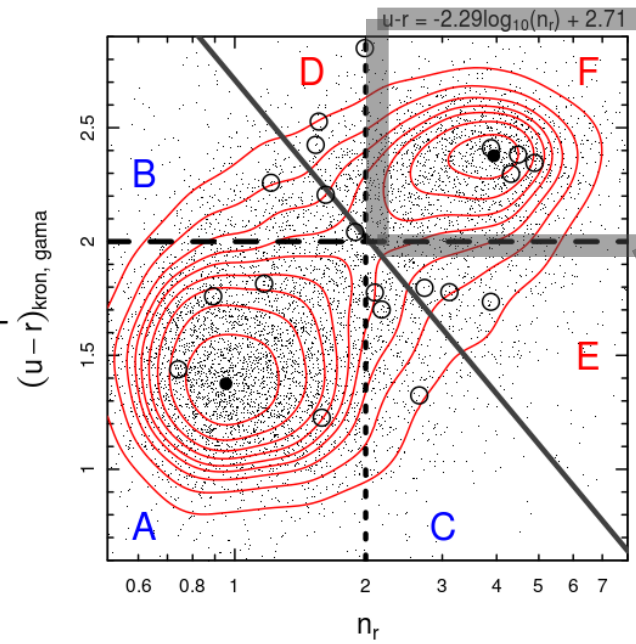
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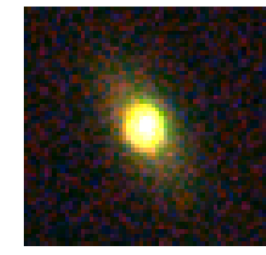
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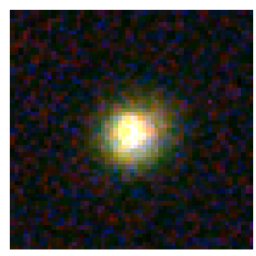
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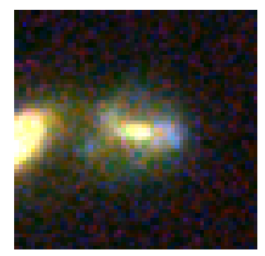
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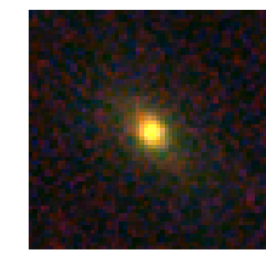
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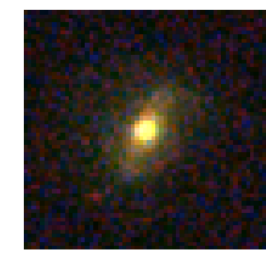
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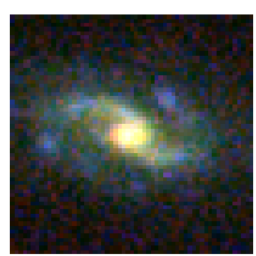
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G00507974



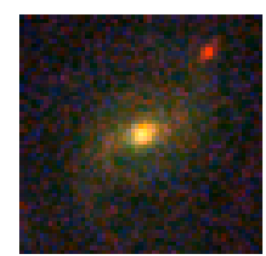
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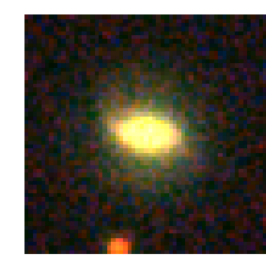
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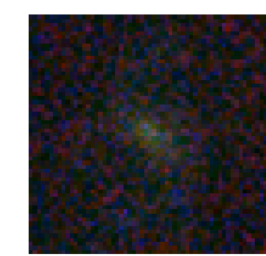
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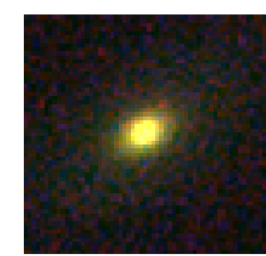
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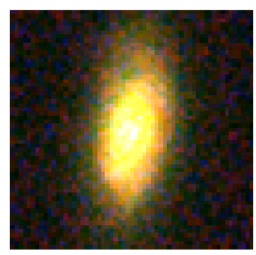


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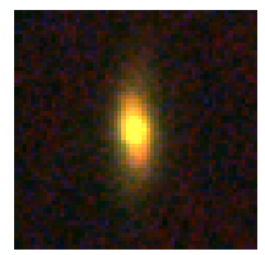


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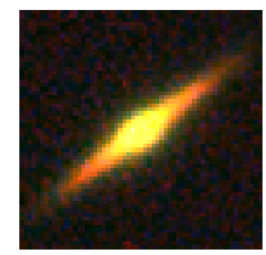
Automated Classification



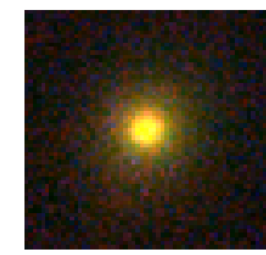
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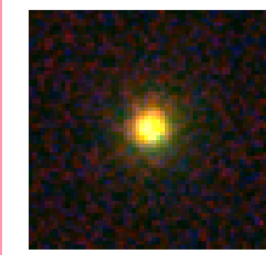
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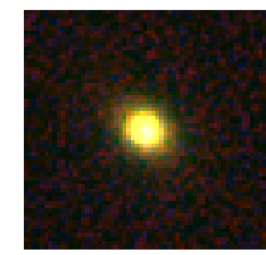
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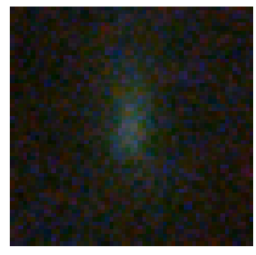
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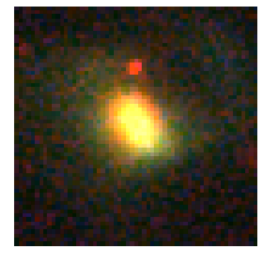
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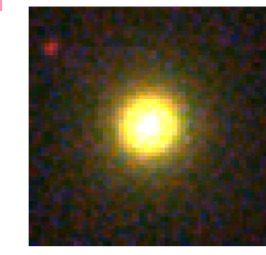
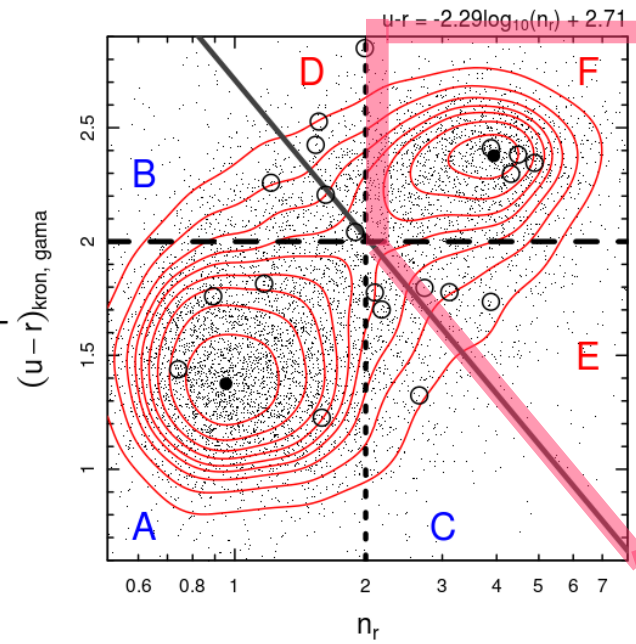
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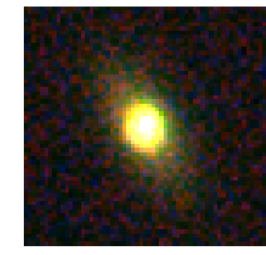
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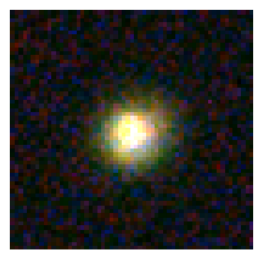
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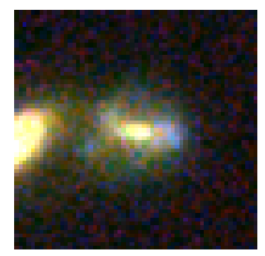
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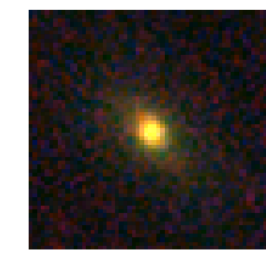
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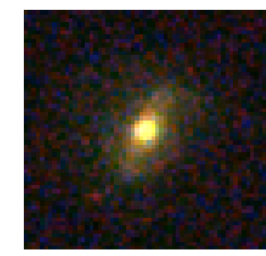
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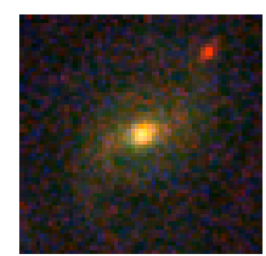
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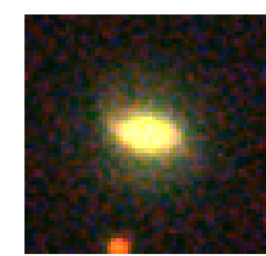
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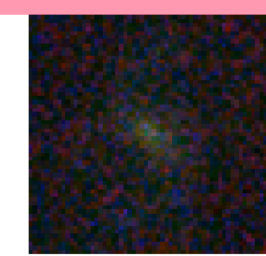
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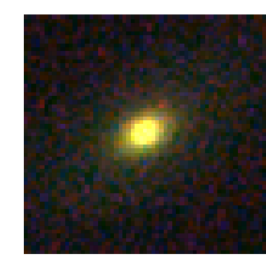
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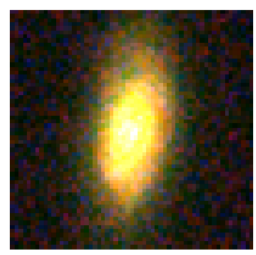


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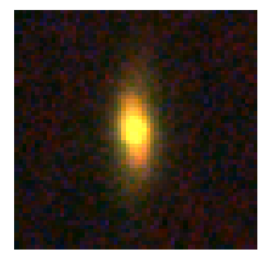


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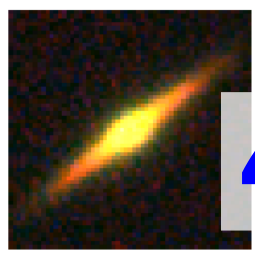
Stellar Mass Distribution



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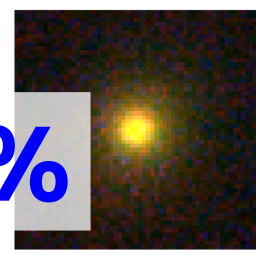


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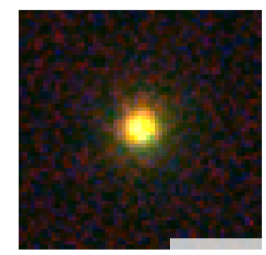


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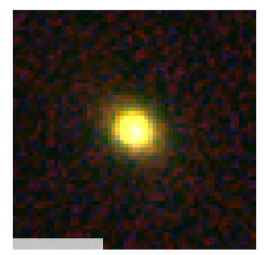


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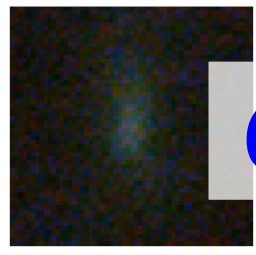


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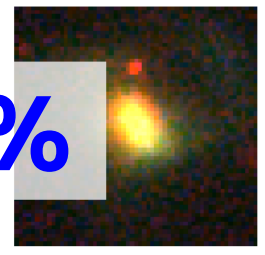


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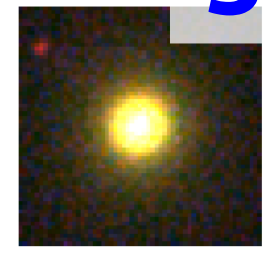
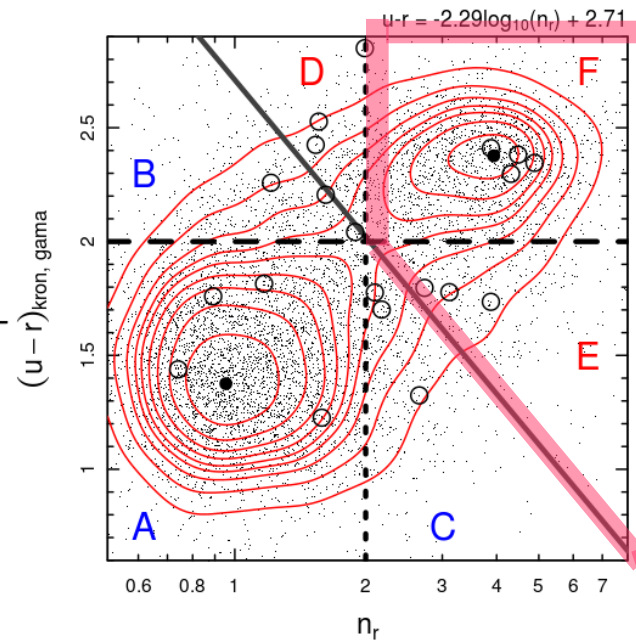


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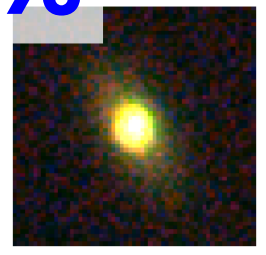
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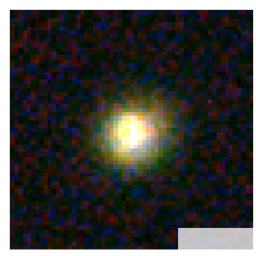
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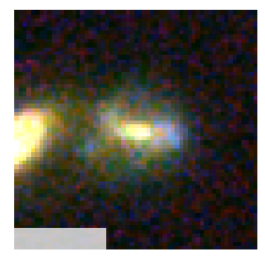


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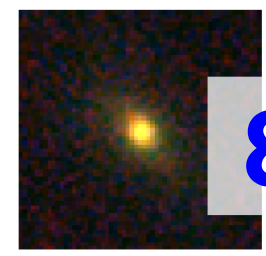


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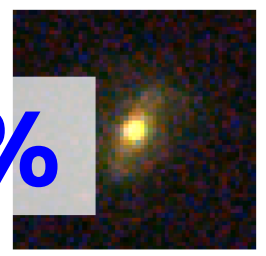


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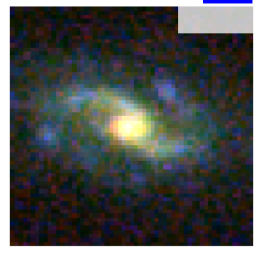


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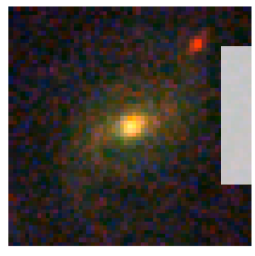
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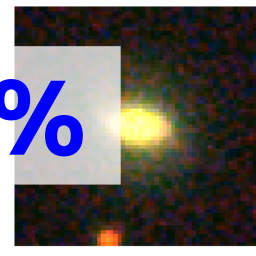


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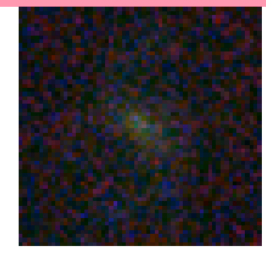


G00375793

4%



G00085960



Stellar Masses: Ned Taylor

Science Goals

- Do galaxies form in two steps: bulge → disk?
→ ...
- Are ellipticals and bulges essentially the same?
→ **Structural decomposition required!**
- How is stellar mass distributed between structures?
→ **~2/3 in spheroidal dominated types**
- How does environment shape structure?
→ **More massive clusters host earlier type galaxies**

- SIGMA → measurements of ~150,000 galaxy structural params
- Single Sérsic → Recovers “missing” light in the wings of galaxies
- Multi- λ → Important in probing different stellar populations
- Morphology → Automation possible, essential for large surveys
- Structural Decomposition → Essential next step

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P31

Measuring the energy output of the nearby Universe with GAMA

Simon P. Driver and the GAMA team