

*S-PLUS virtual meeting*

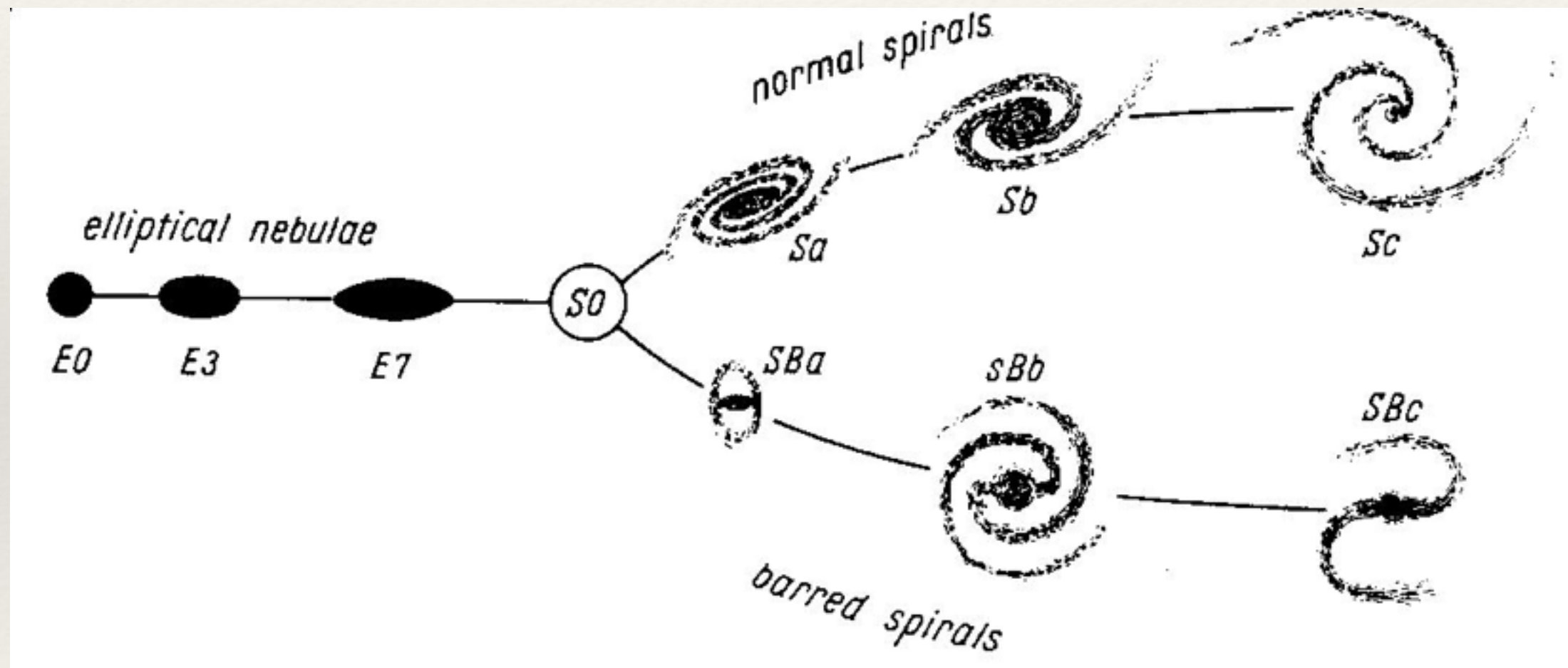
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# Characterizing galaxies' morphologies in the Fornax cluster using S-PLUS data

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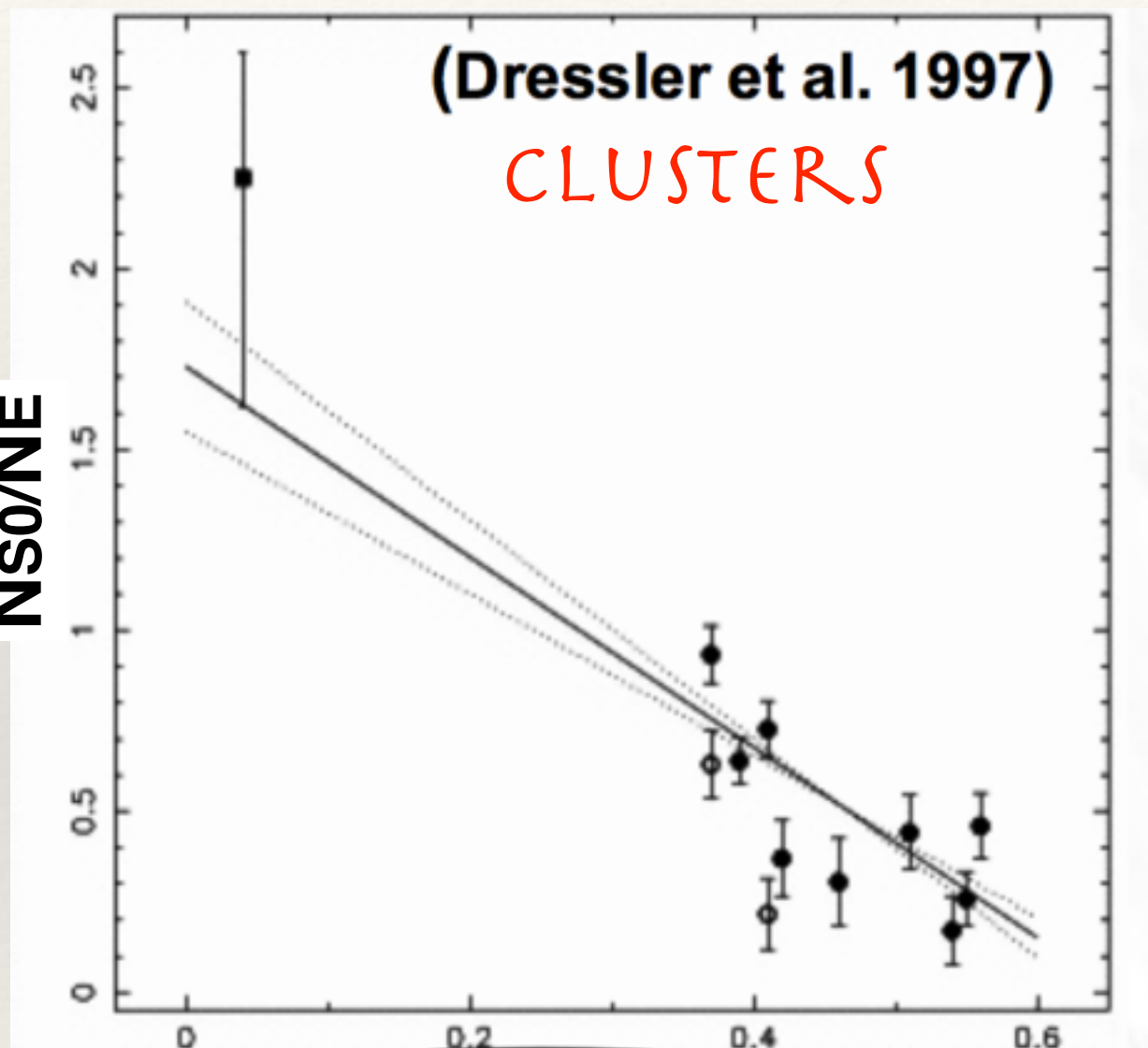
Arianna Cortesi, **Paola  
Dimauro**, Analia Smith, Fabio  
Herpic, Felipe de Almeida  
Fernandes,  
Fabricio Ferrari, Geferson  
Lucatelli, Clecio De Bom

# Galaxies

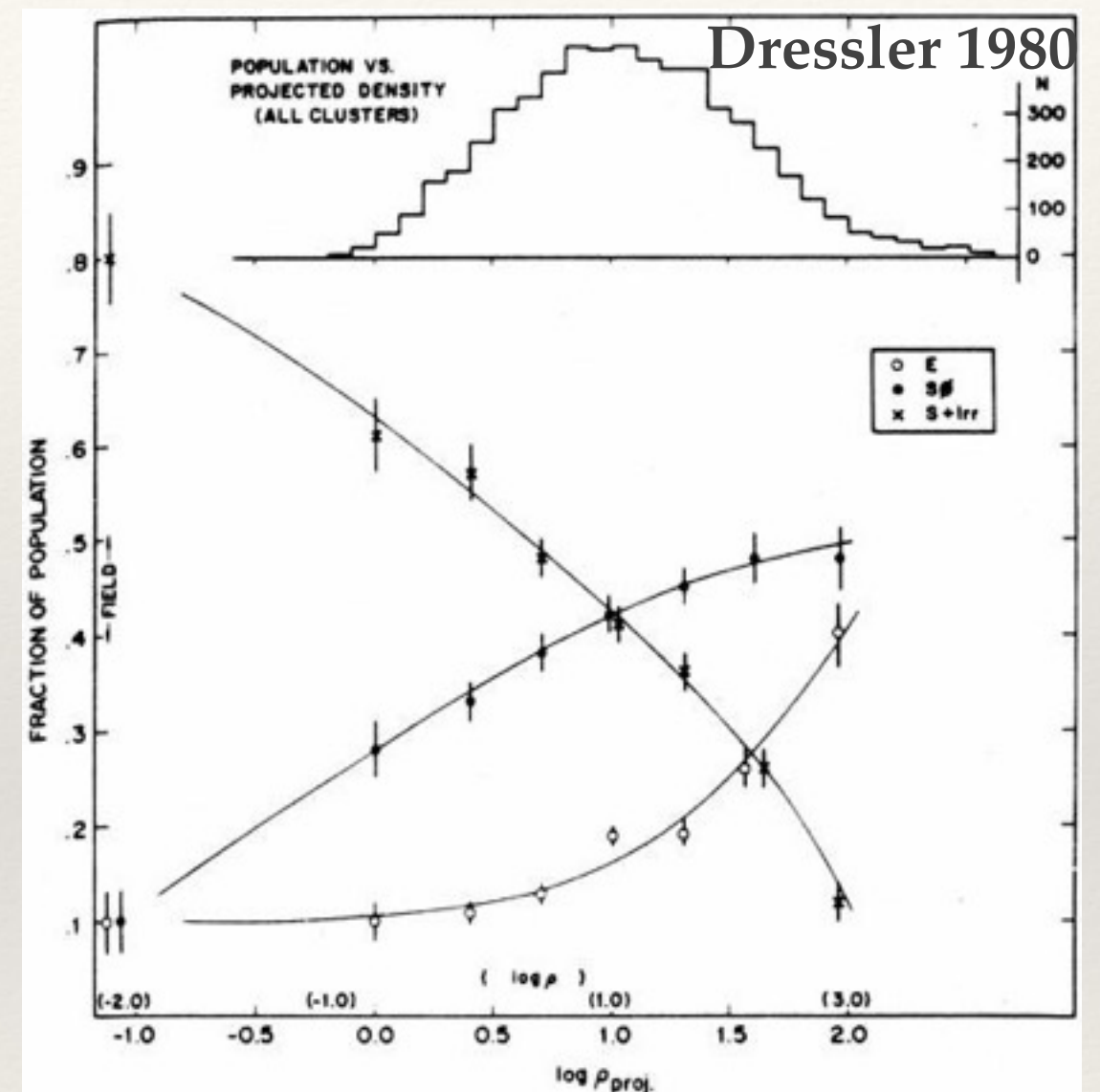


# Galaxies formation histories and their environment

NS0/NE



z



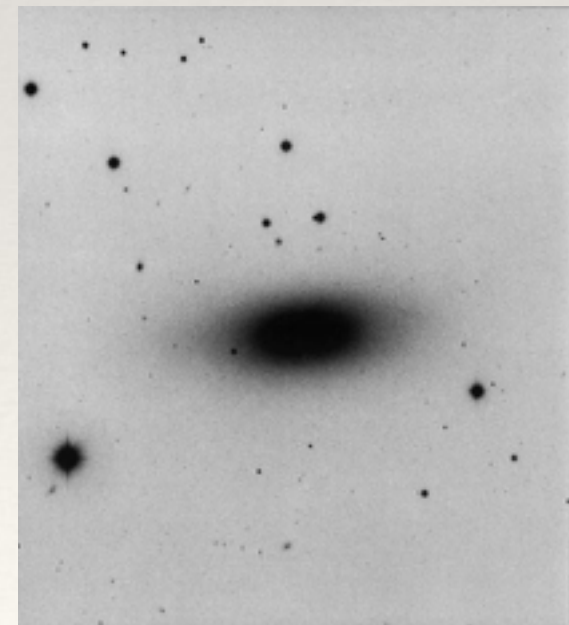
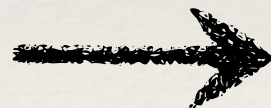


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# Different environment different formation histories

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- ❖ clusters: ram pressure stripping, strangulation ....
- ❖ groups: minor mergers, harassment
- ❖ field: secular evolution, fossil groups





# Different formation mechanism = different galaxy properties

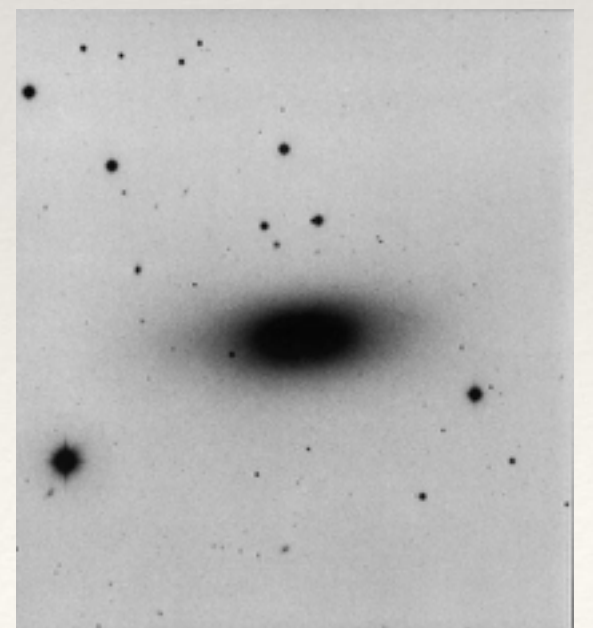
- ❖ clusters: disk fading, nothing happens to the bulge
- ❖ groups: disk fading, bulge enhancement, star formation
- ❖ field: presence of bars, pseudo bulge, diffuse light, shells

*bulge Sersic index*

*colour gradient bulge-disk*

*B/T*

*bars*



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# Unraveling galaxies structural parameters, colours, morphologies ...

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# Unraveling galaxies structural parameters, colours, morphologies ...

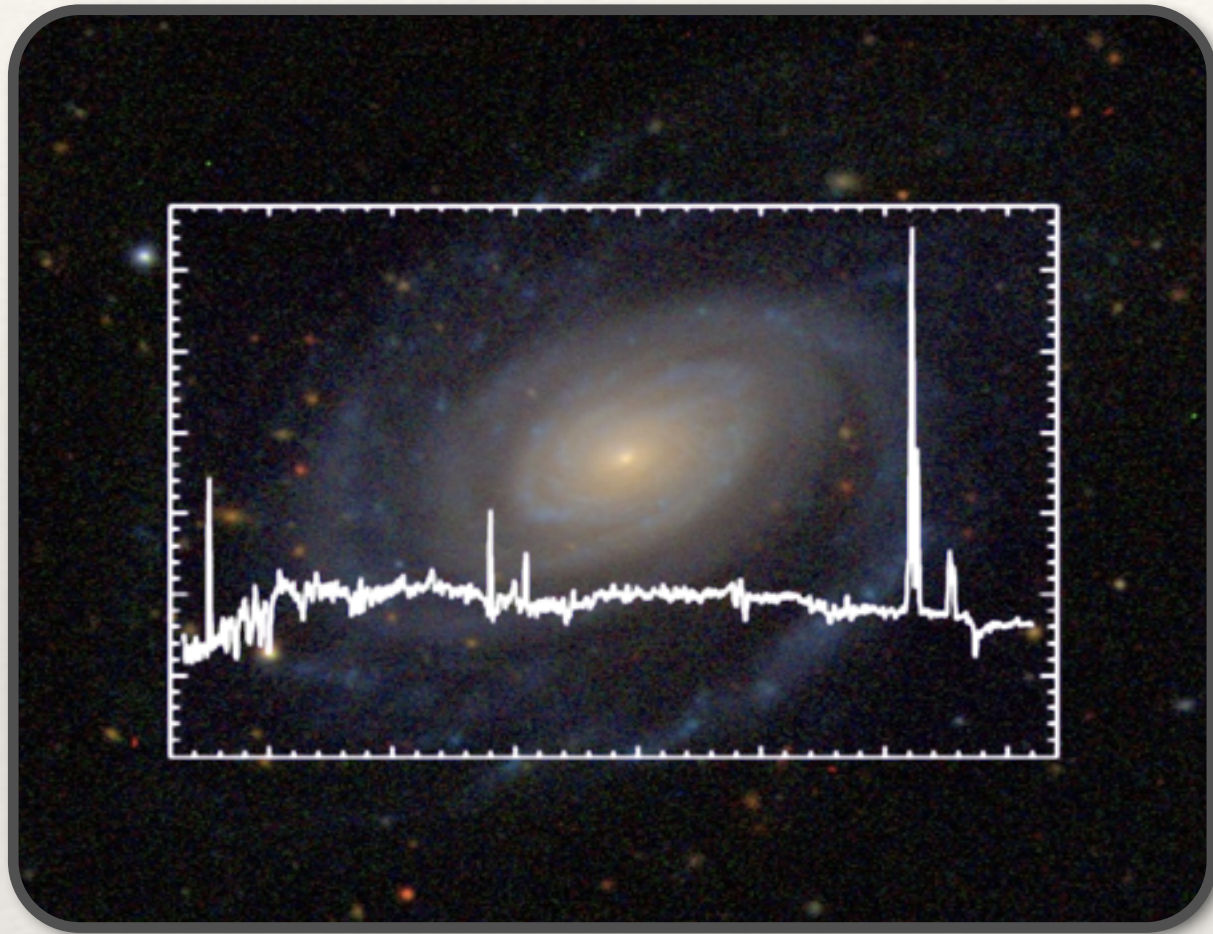
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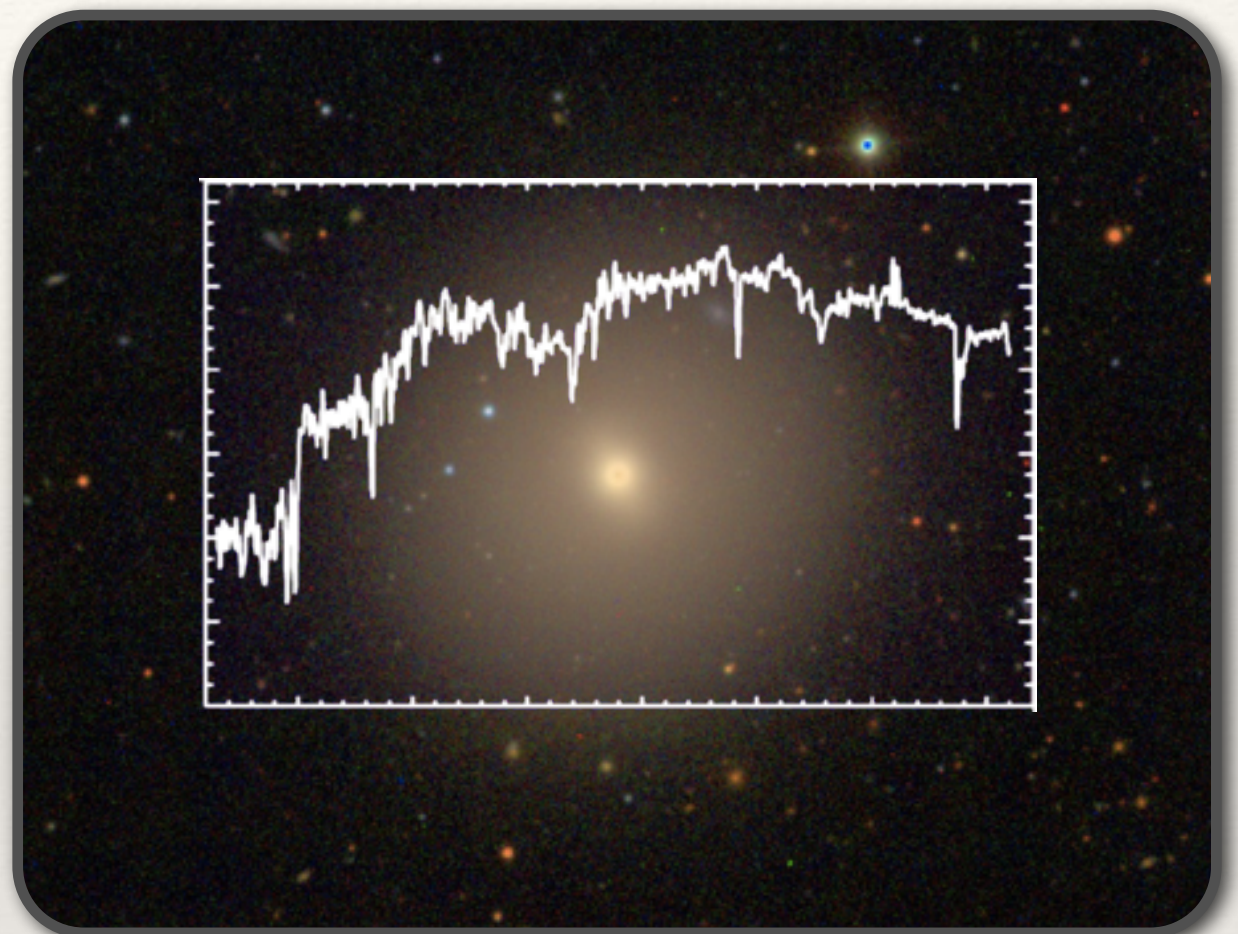
... understanding galaxies' formation histories



# Two types of galaxies?



spirals



ellipticals



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# Three types of galaxies?

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spirals



S0s



ellipticals



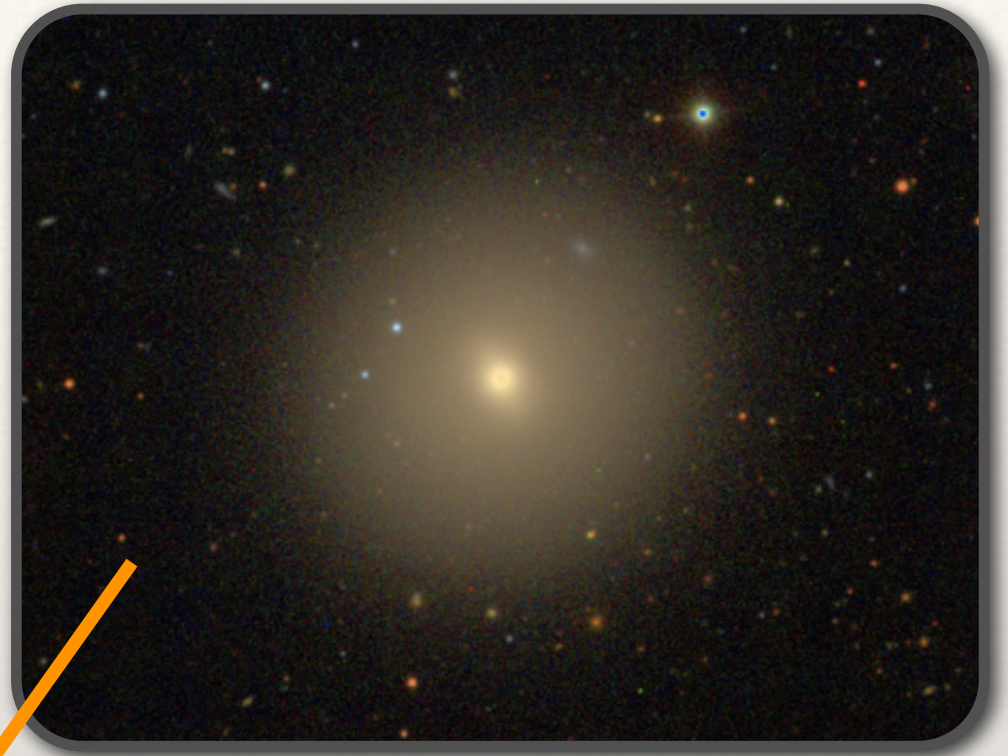
# Two distinct components



disks

*formed by  
cooling gas*

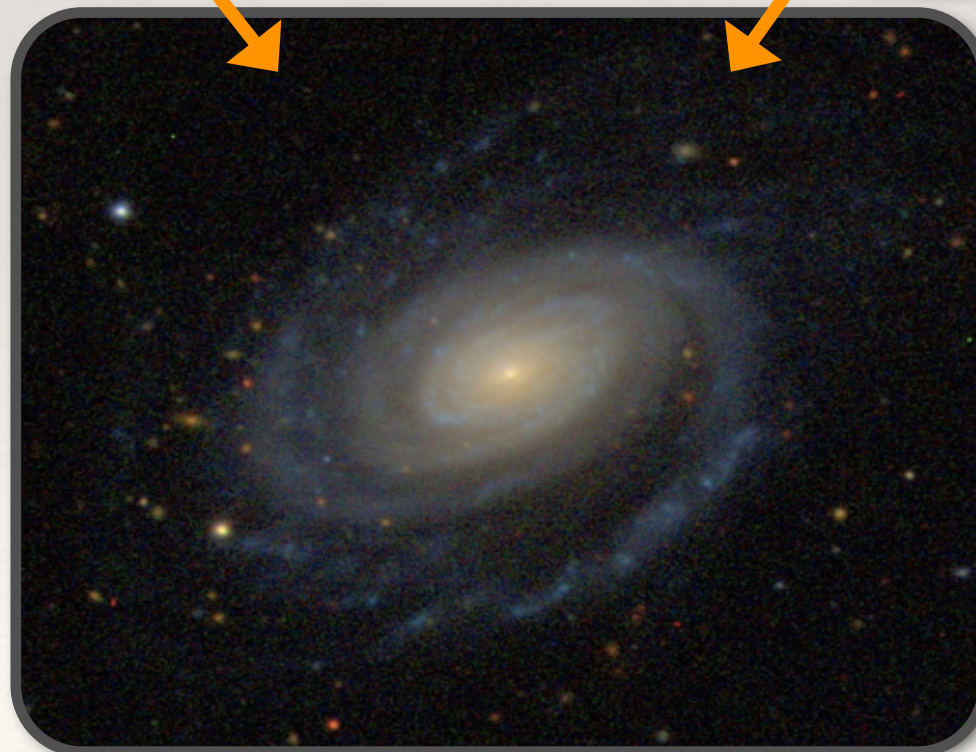
*rotational  
motions*



spheroids

*formed by  
mergers  
(& secular processes)*

*random  
motions*





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# MegaMorph

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- Address the issues with current software:
  - 1) Implement multi-band bulge-disk decomposition
  - 2) Incorporate non-parametric components
  - 3) Enable accurate model selection
  - 4) Ensure fast enough to process large surveys  
(although probably needing supercomputer)
- Collaboration between astronomers, statisticians and computer scientists
- Funded by Qatar National Research Fund

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# MegaMorph

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- This method extends current single-band fitting (GALFIT3) process by simultaneously using multiple images of the same galaxy to constrain a wavelength-dependent model.
- Explore accurate model selection and increase accuracy
- Implement multi-band bulge-disk decomposition
- Allows to push to fainter objects
- Improves fitting at high redshift
- Ensure fast enough to **process large surveys**

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# MegaMorph

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Building upon existing, tried and tested, software:

**GALAPAGOS**

by Marco Barden, et al.

**SEtractor**

by Emmanuel Bertin

**GALFIT**

by Chien Peng

***MultiNest***

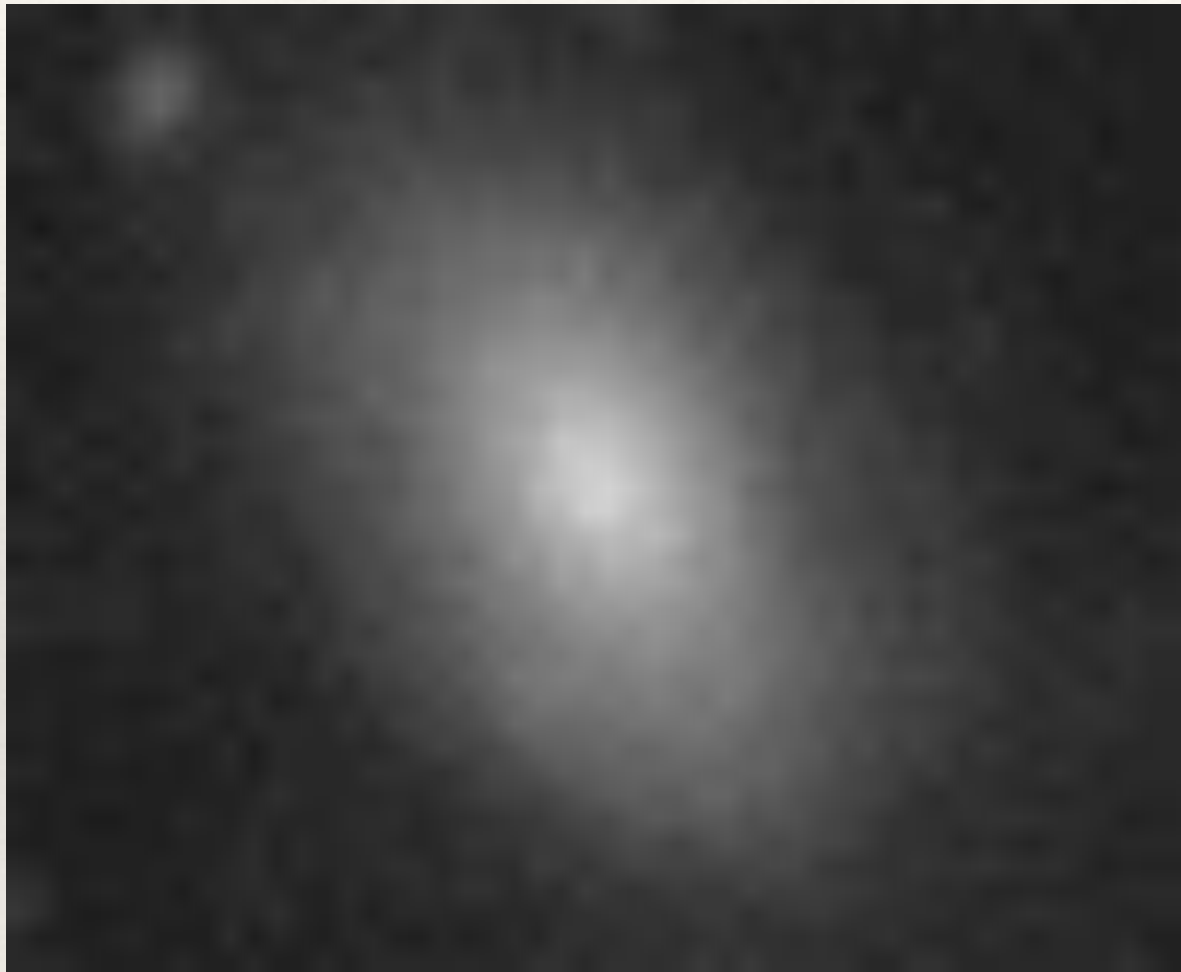
by Farhan Feroz & Mike Hobson



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# The value of colour information

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*simulated monochromatic observations*

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# The value of colour information

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*simulated colour observations*

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# Simplest assumption

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- Each structural component has a single homogeneous SED
  - components have no wavelength dependence



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# Simplest assumption

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- Each structural component has a single homogeneous SED
- components have no wavelength dependence

But...

- not true (*gradients*)
- not practical (*too many components*)

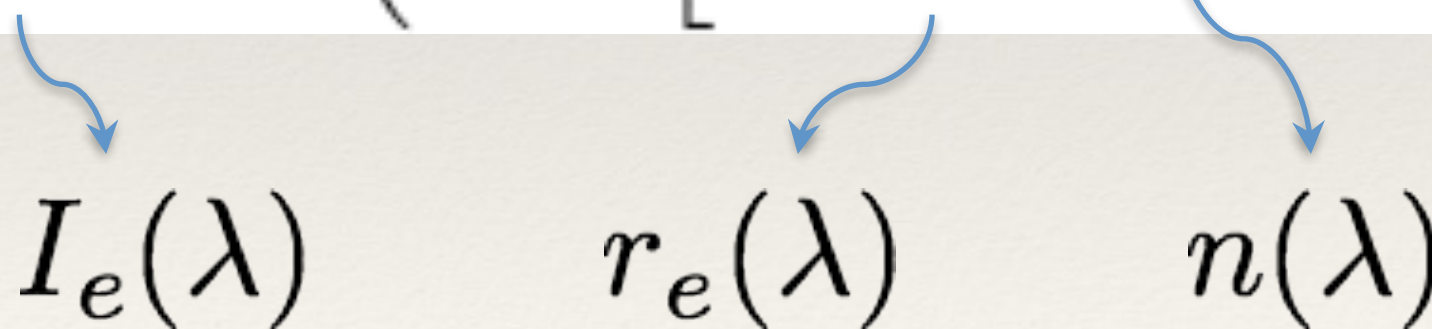
# Wavelength dependent structures

$$f(\lambda) = \sum_{i=0}^m c_i T_i(\lambda)$$

Each standard GALFIT parameter

→ polynomial function of wavelength

$$I(r) = I_e \exp \left( -b_n \left[ (r/r_e)^{1/n} - 1 \right] \right)$$


$$I_e(\lambda)$$

$$r_e(\lambda)$$

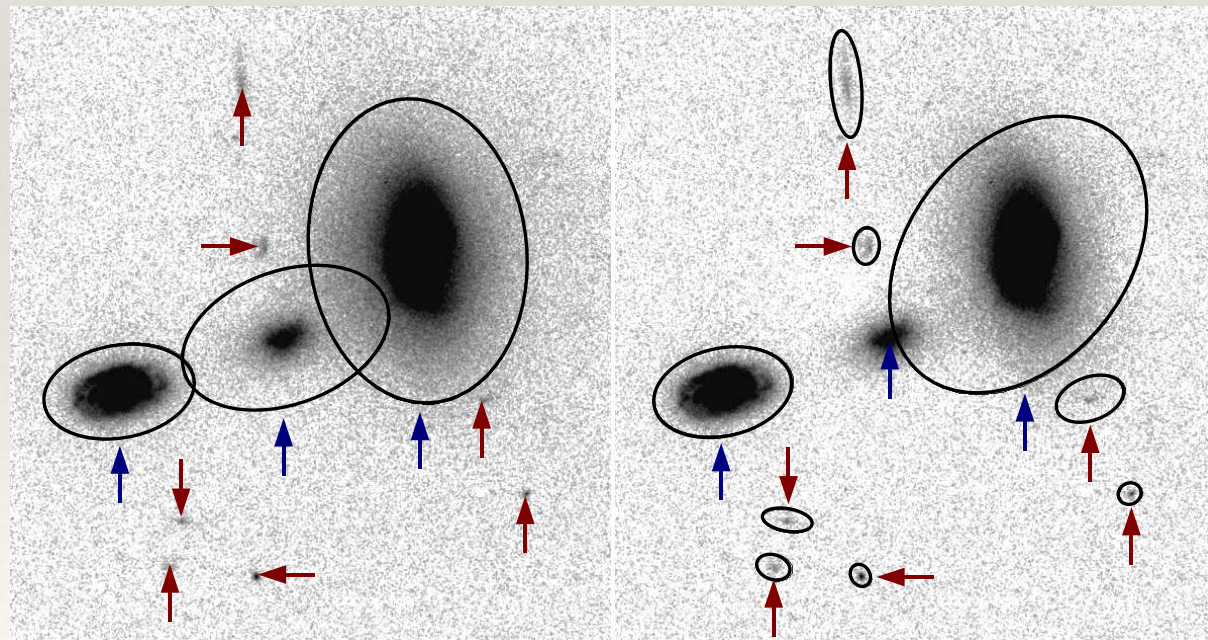
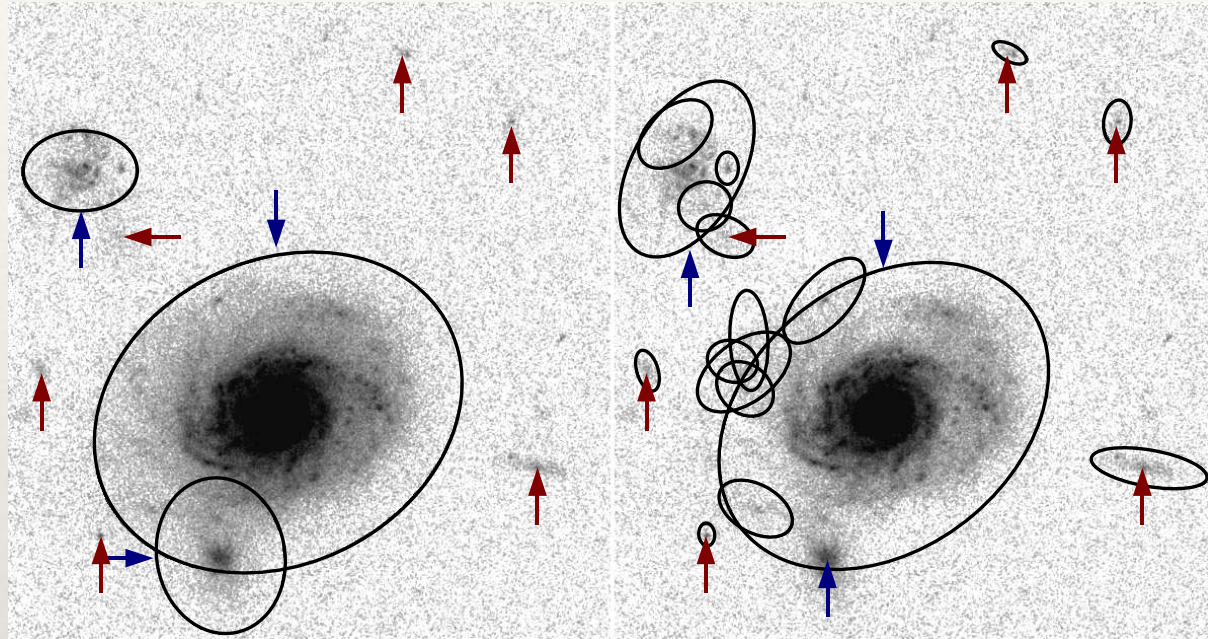
$$n(\lambda)$$







# Cutting stamps



COLD

HOT

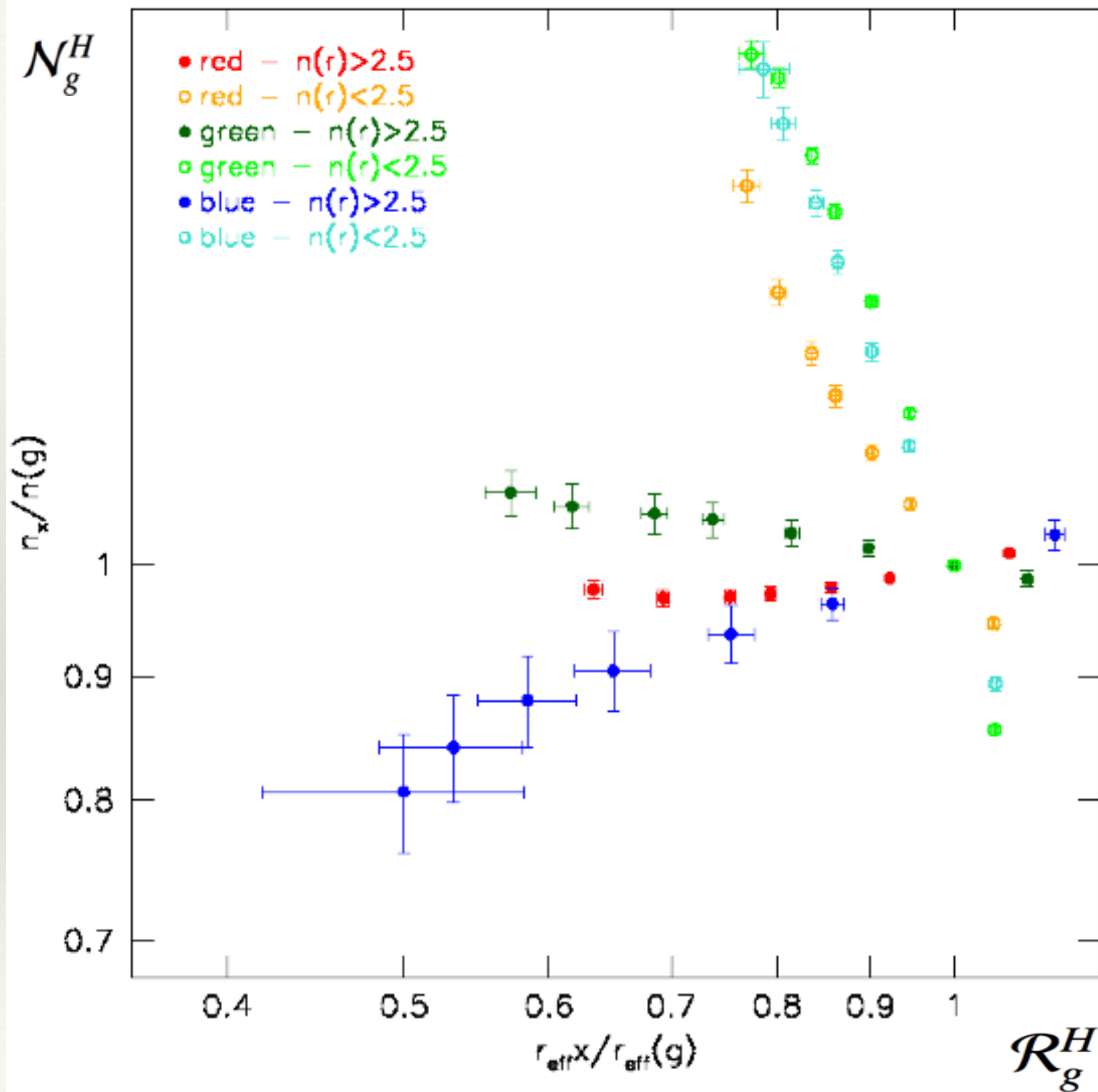
SExtractor:

cold (blue) and hot (red) catalogue extracted  
from reference image (high S/N)

calculate correct background (input for  
GALFIT)

calculate galaxy center

find neighbours (fit them if brighter than a  
certain threshold - including stars)



Median of the  
N - R distribution

$r < 19.8$  mag

$M_r < -21.2$  mag at  $z < 0.3$

volume-limited  
sample of 14,274

low-n spheroid and disk

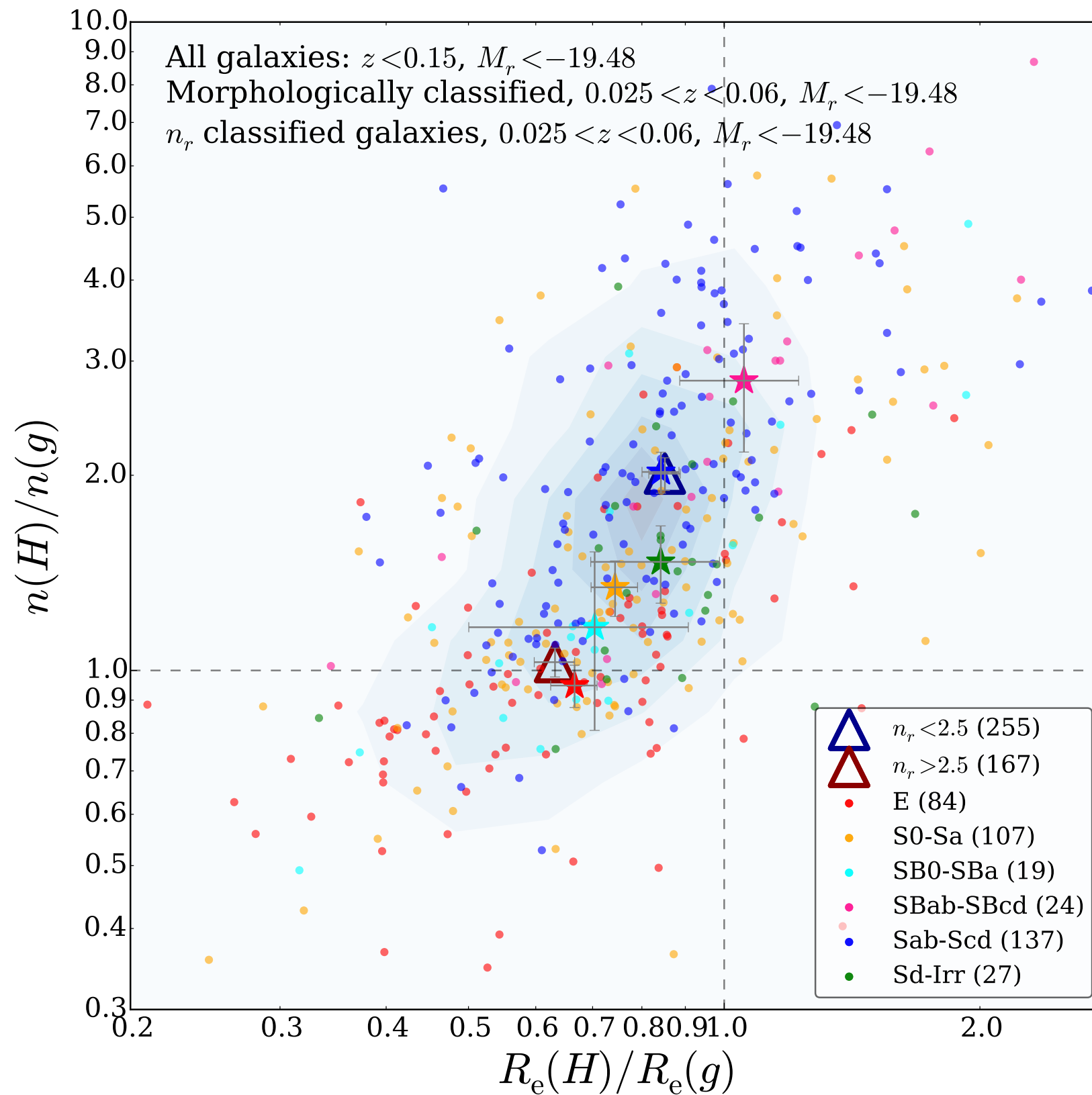
high-n galaxies spheroids

$N \sim 1$  similar shape at all wavelengths  
 $R \sim 1$  indicates a constant color with radius

implication for galaxy evolution ...  
careful DUST!

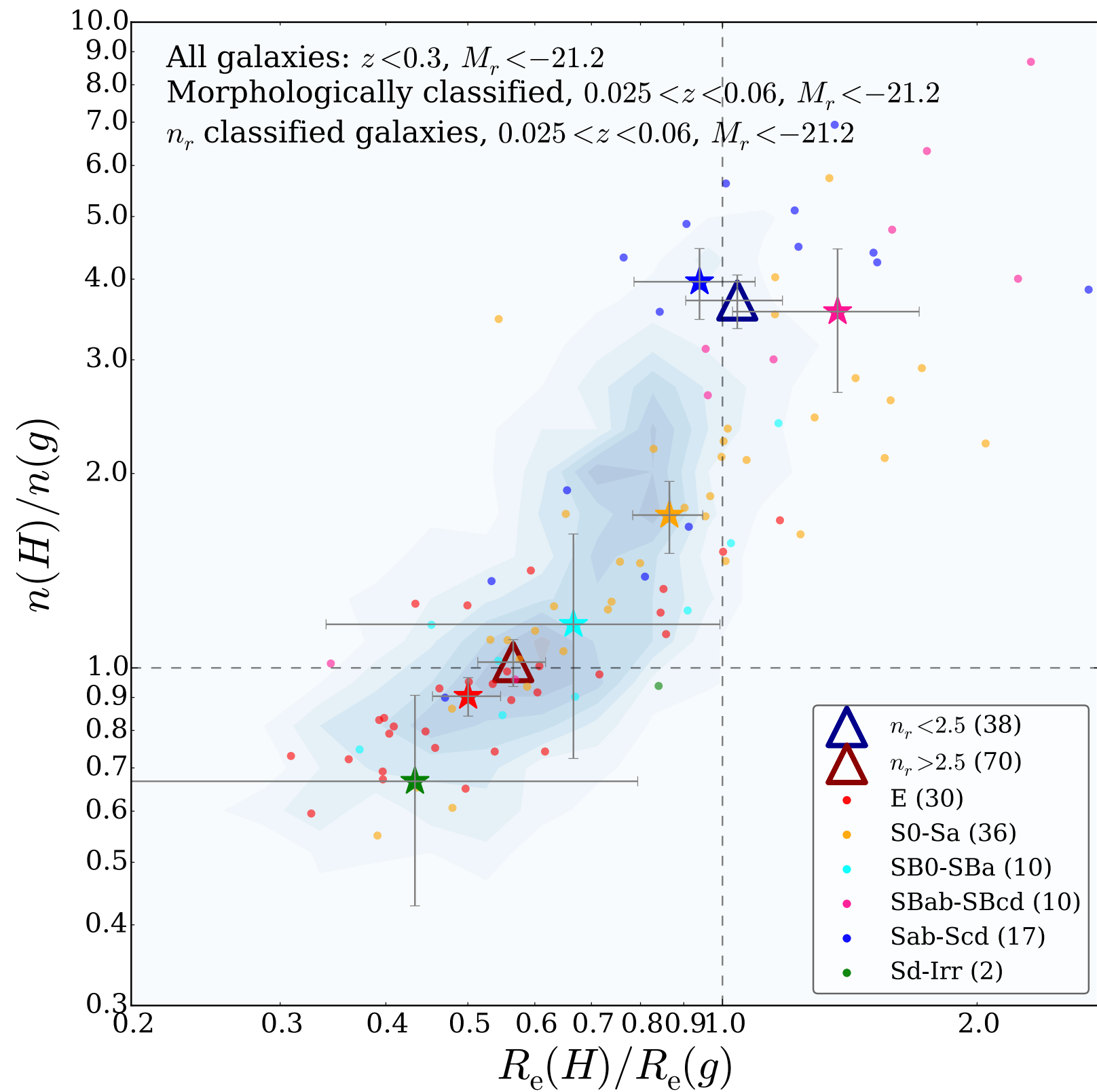


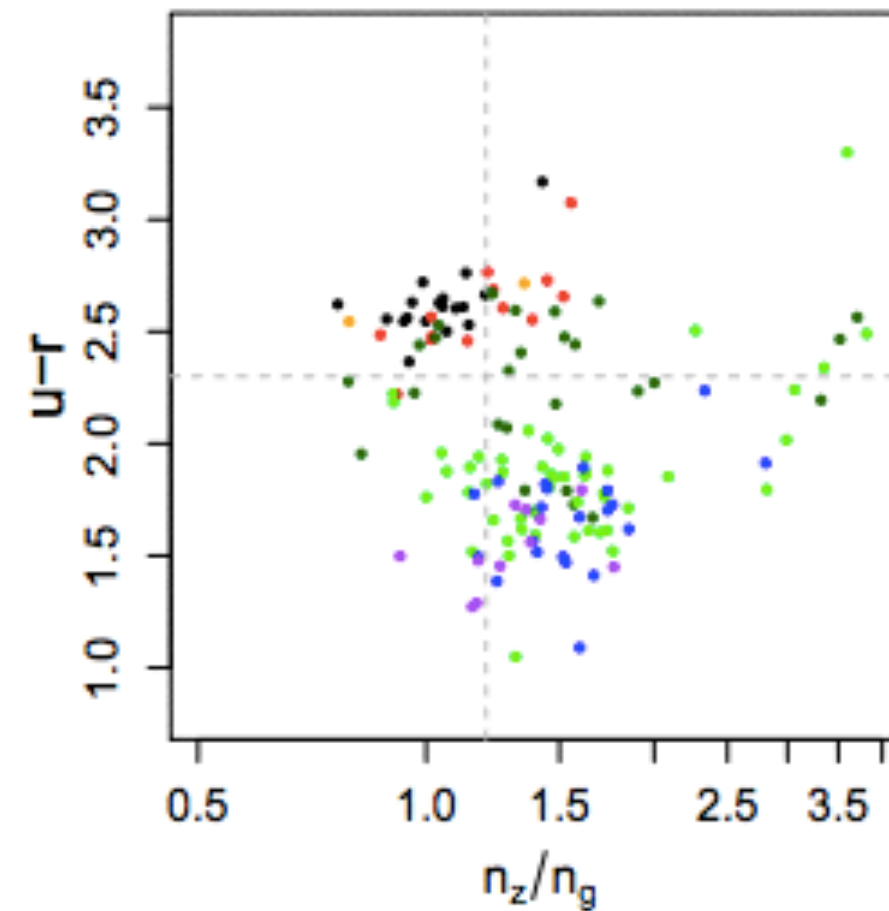
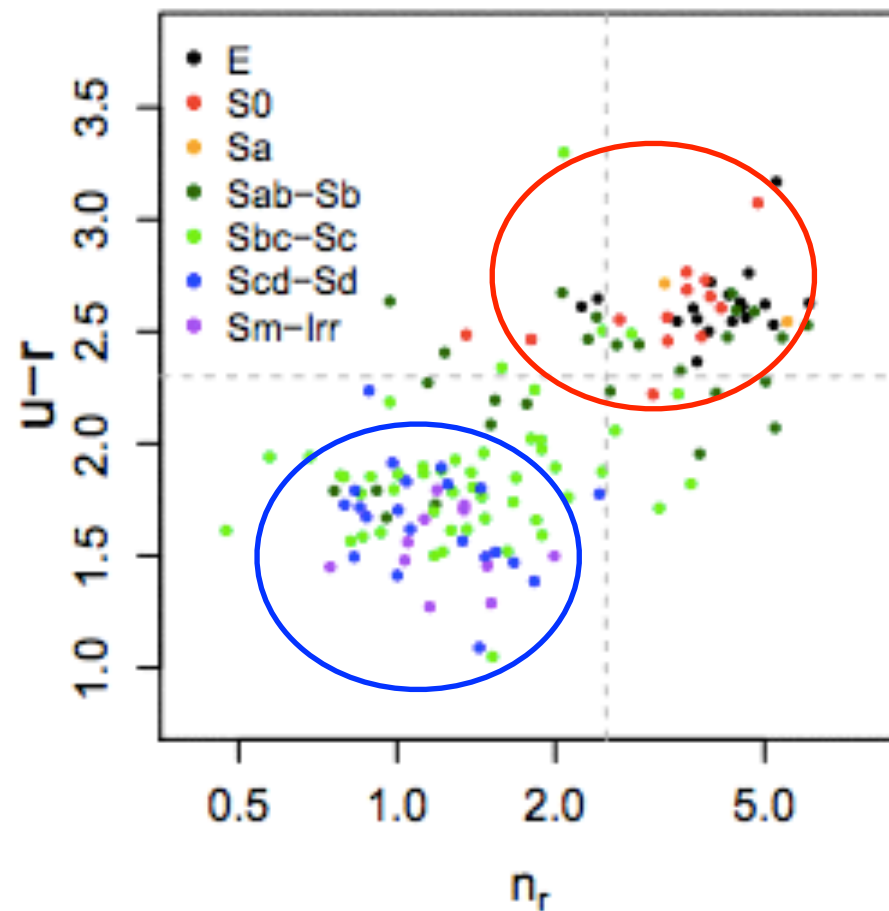
# High Luminosity





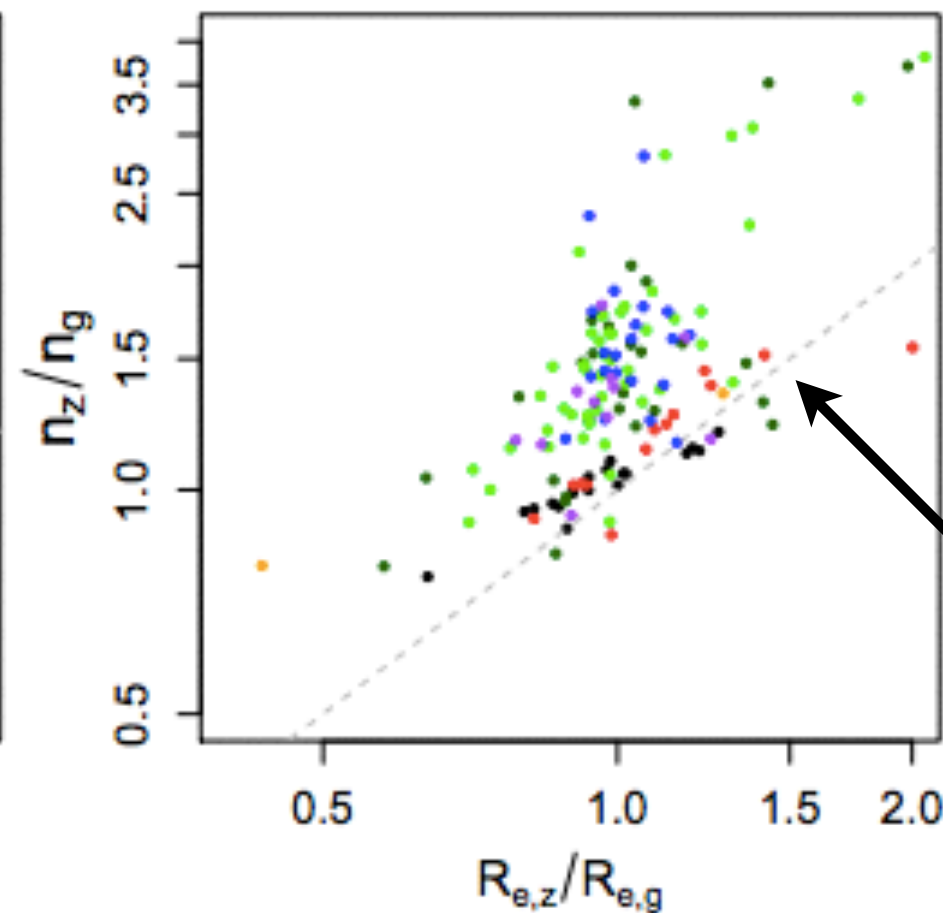
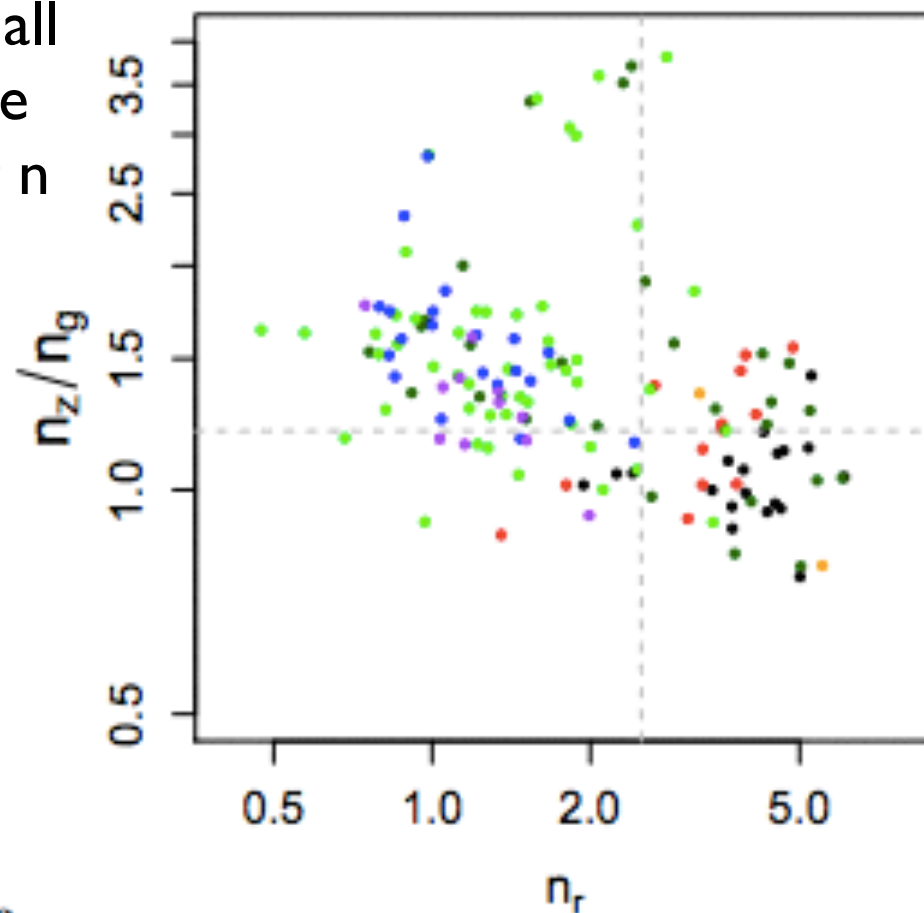
# Low Luminosity





reduces late type in the red cloud

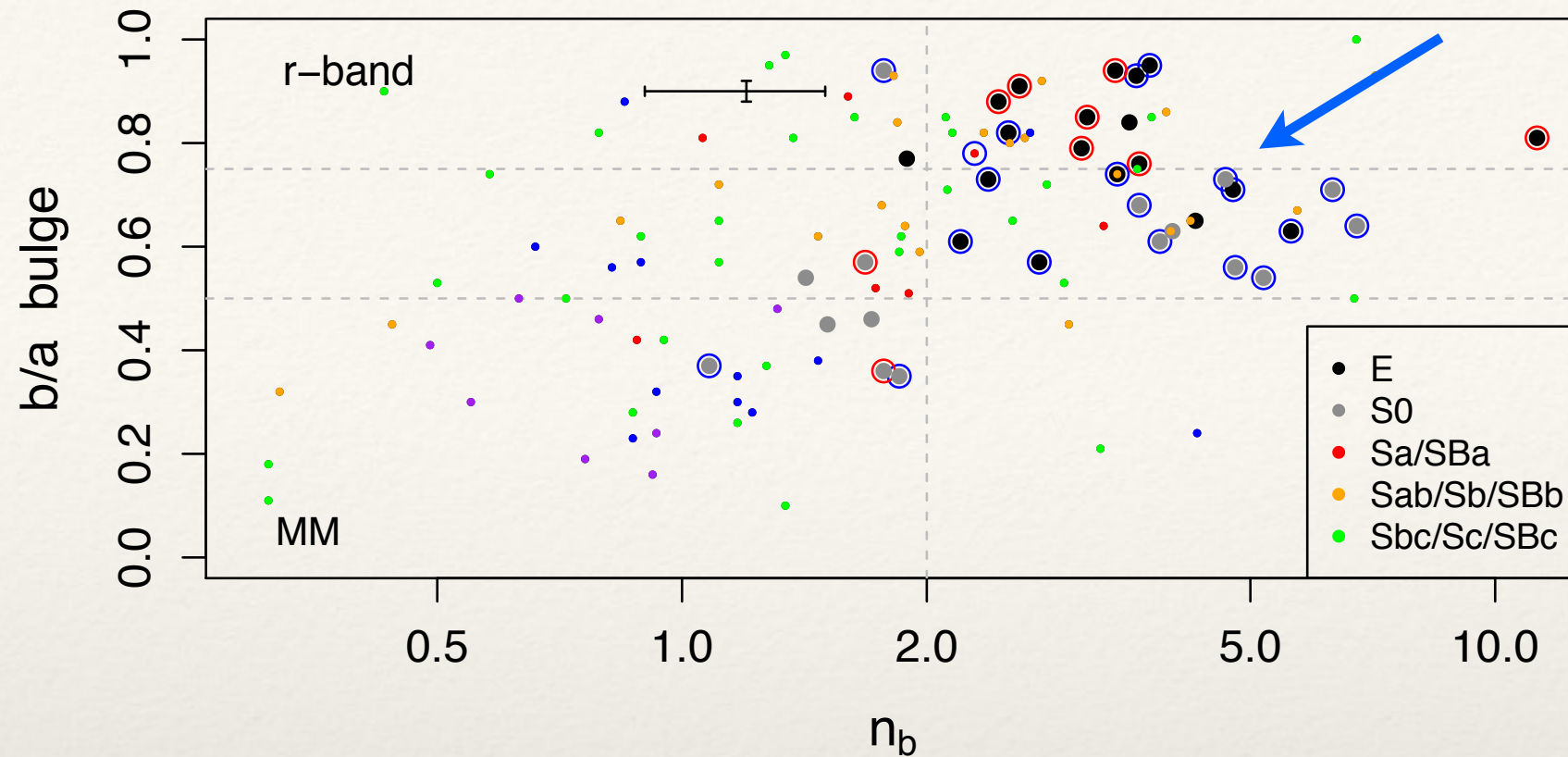
gal with small  $n_r$  change more their  $n$



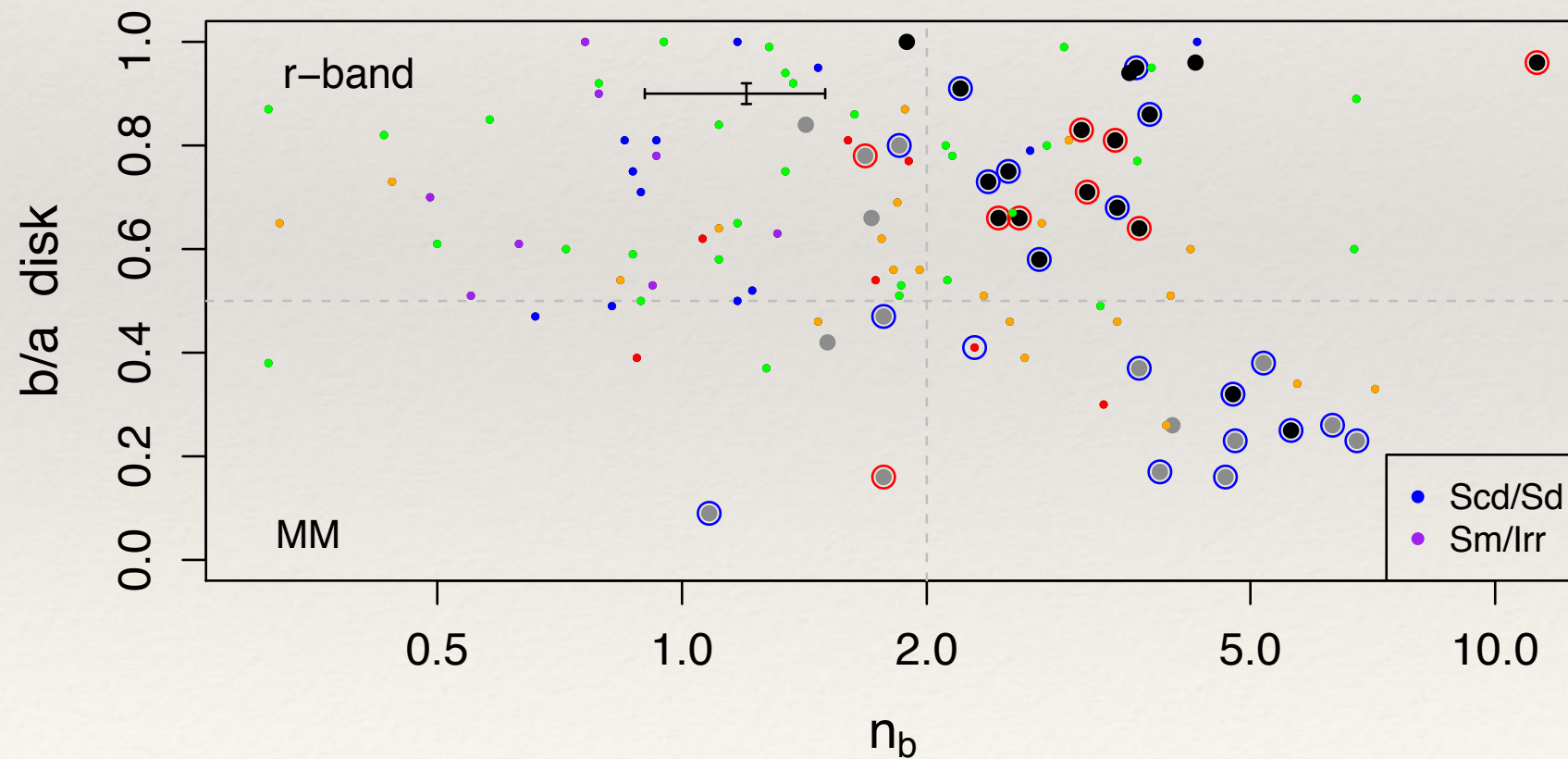
E and S0  
1:1 line

Vika 2014

fast rotators



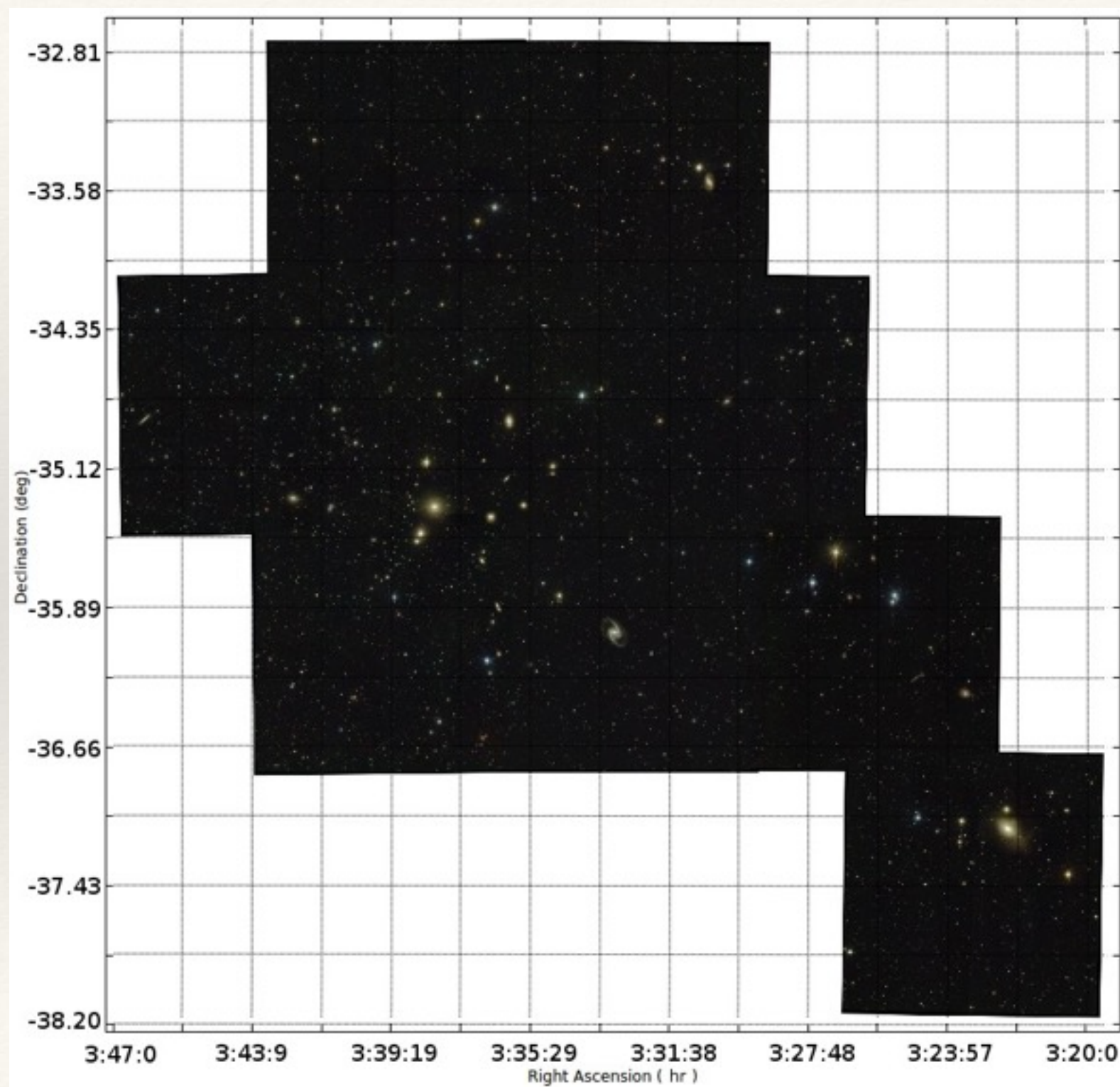
slow rotators



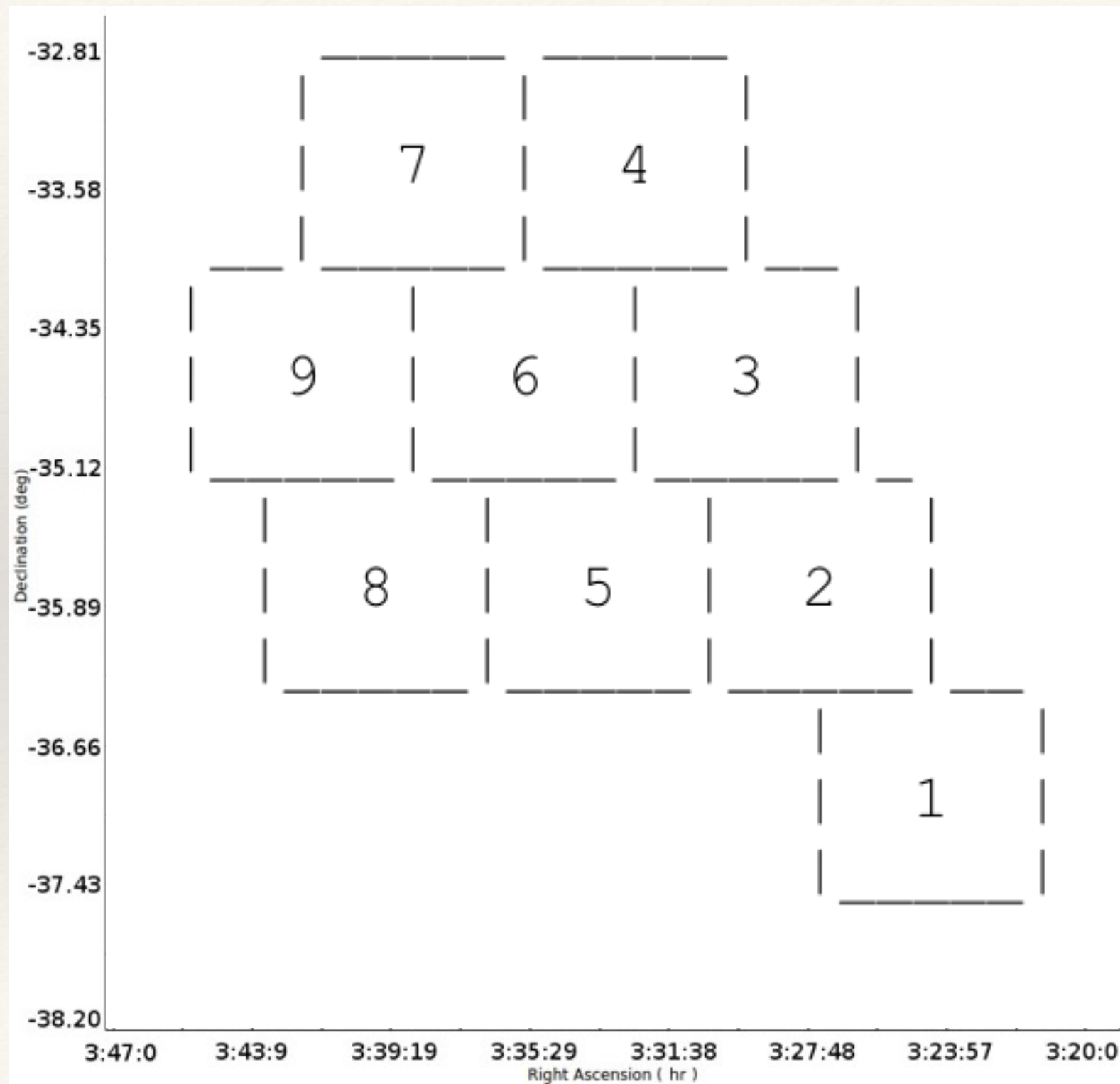
early-type galaxy ( $(b/a)$ )  $\longrightarrow$  disc  $< \sim 0.5$  S0



# Fornax - SPLUS

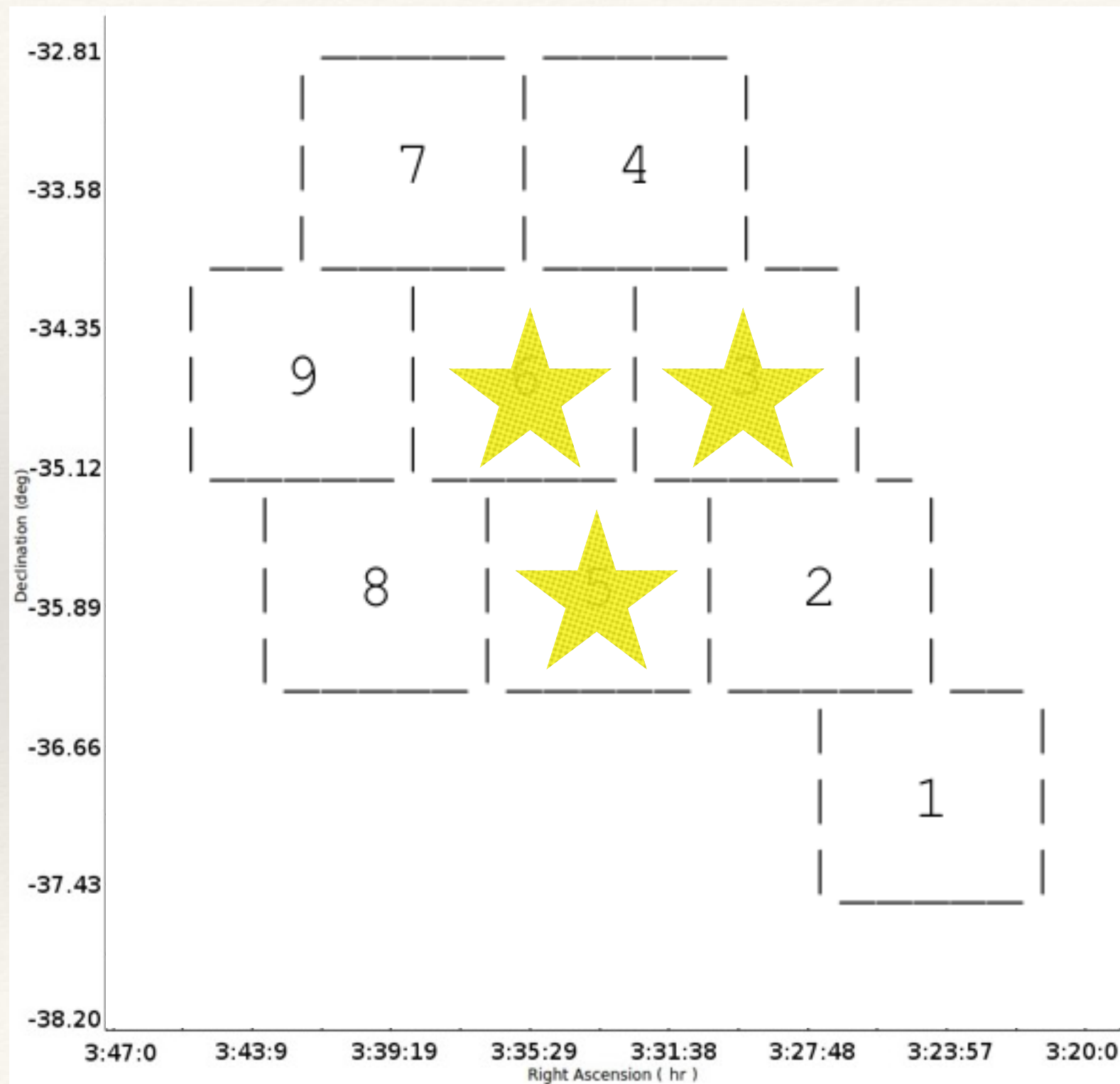


# Fornax - SPLUS





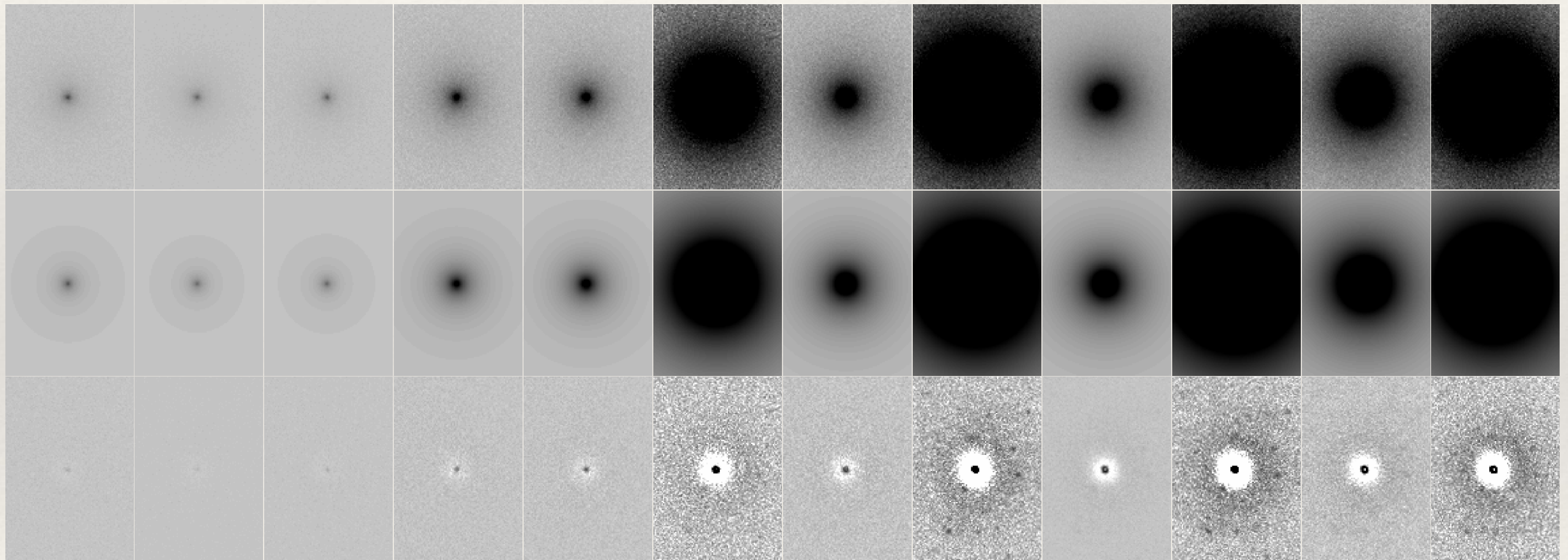
# Fornax - SPLUS



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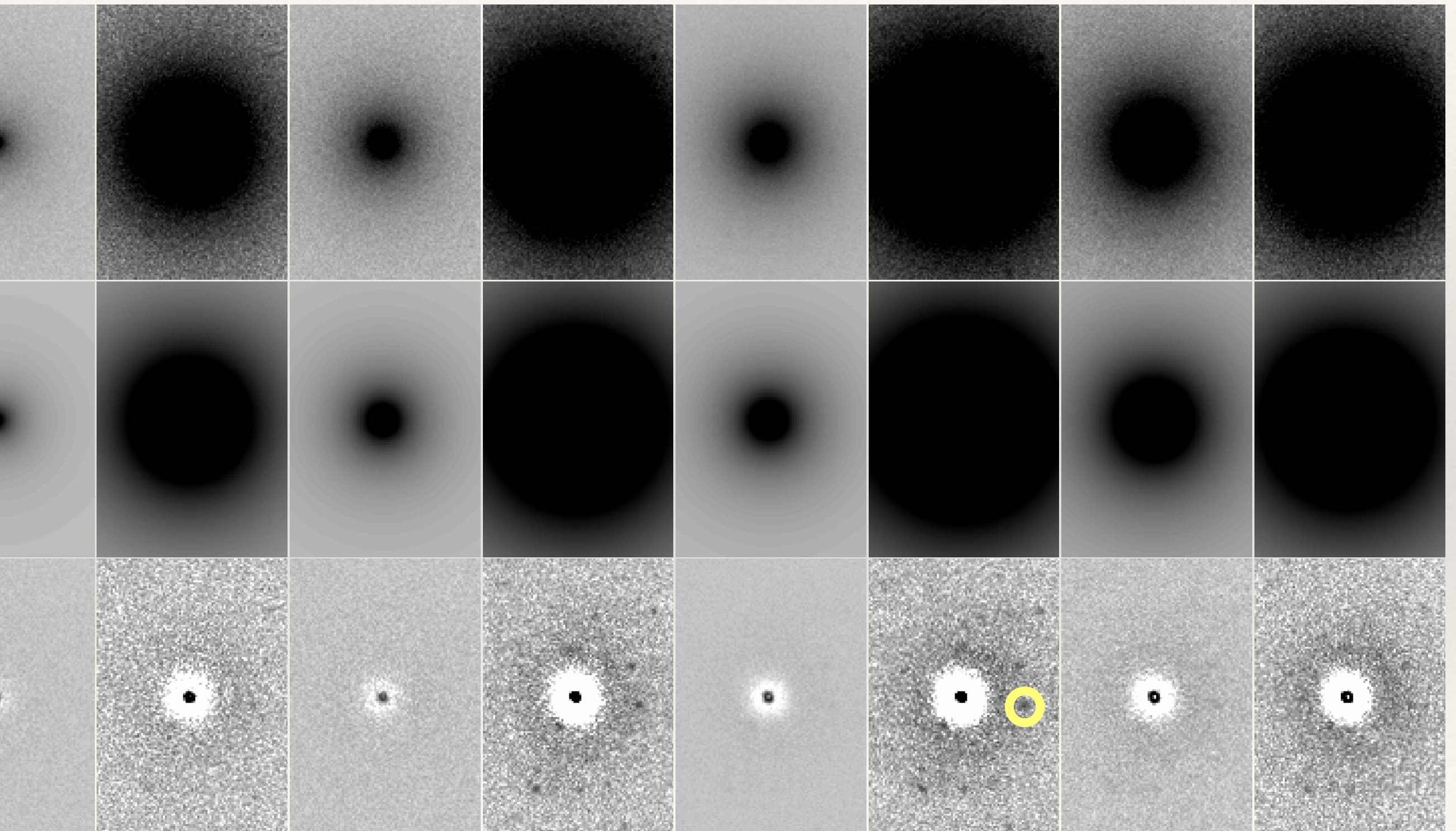
# An example SS

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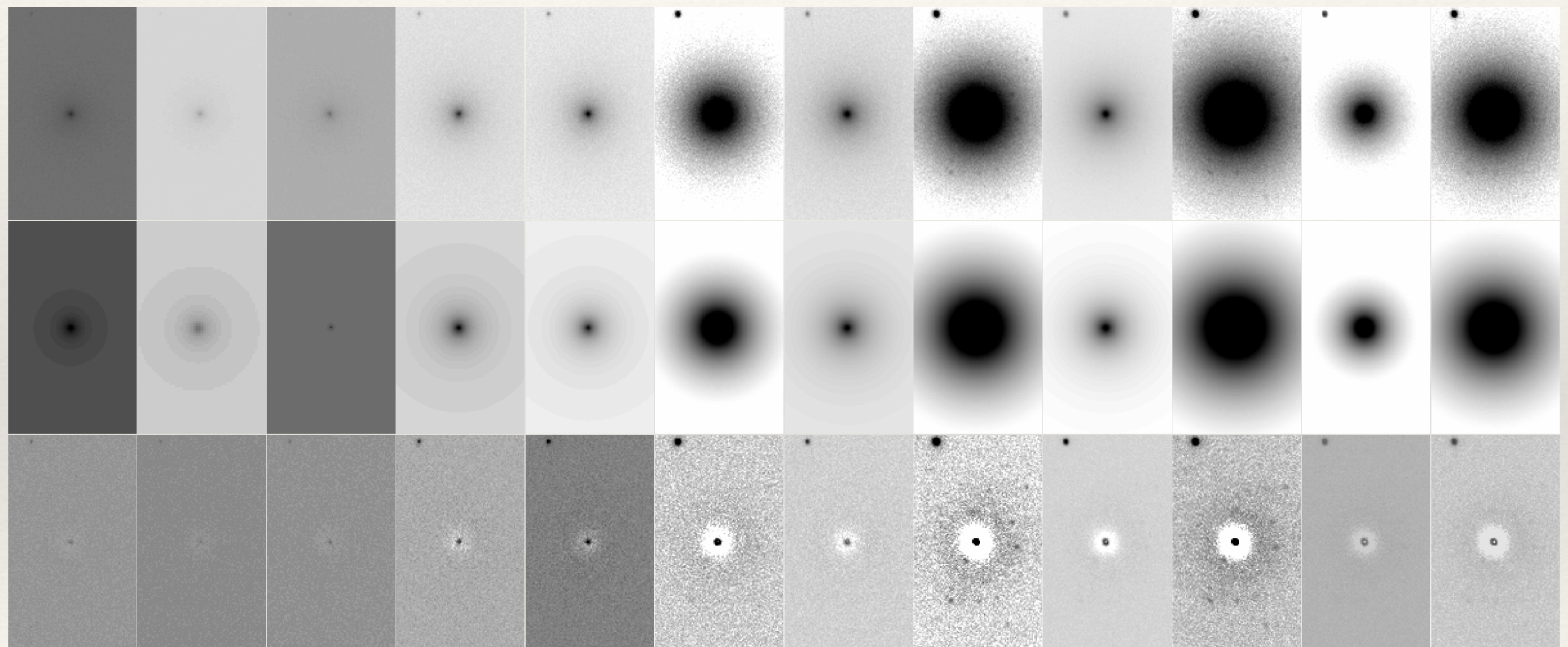
# An example SS: residuals



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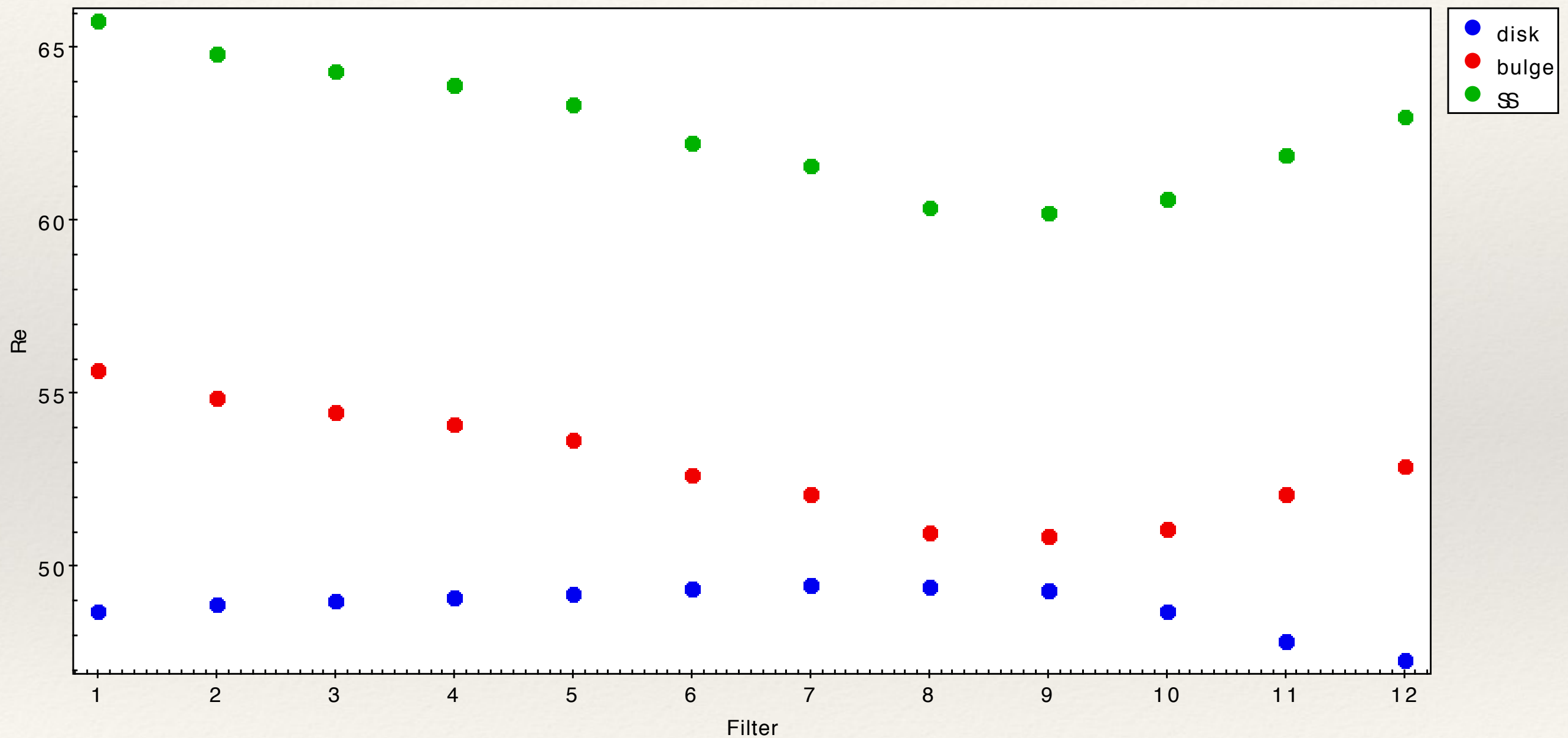
# An example BD

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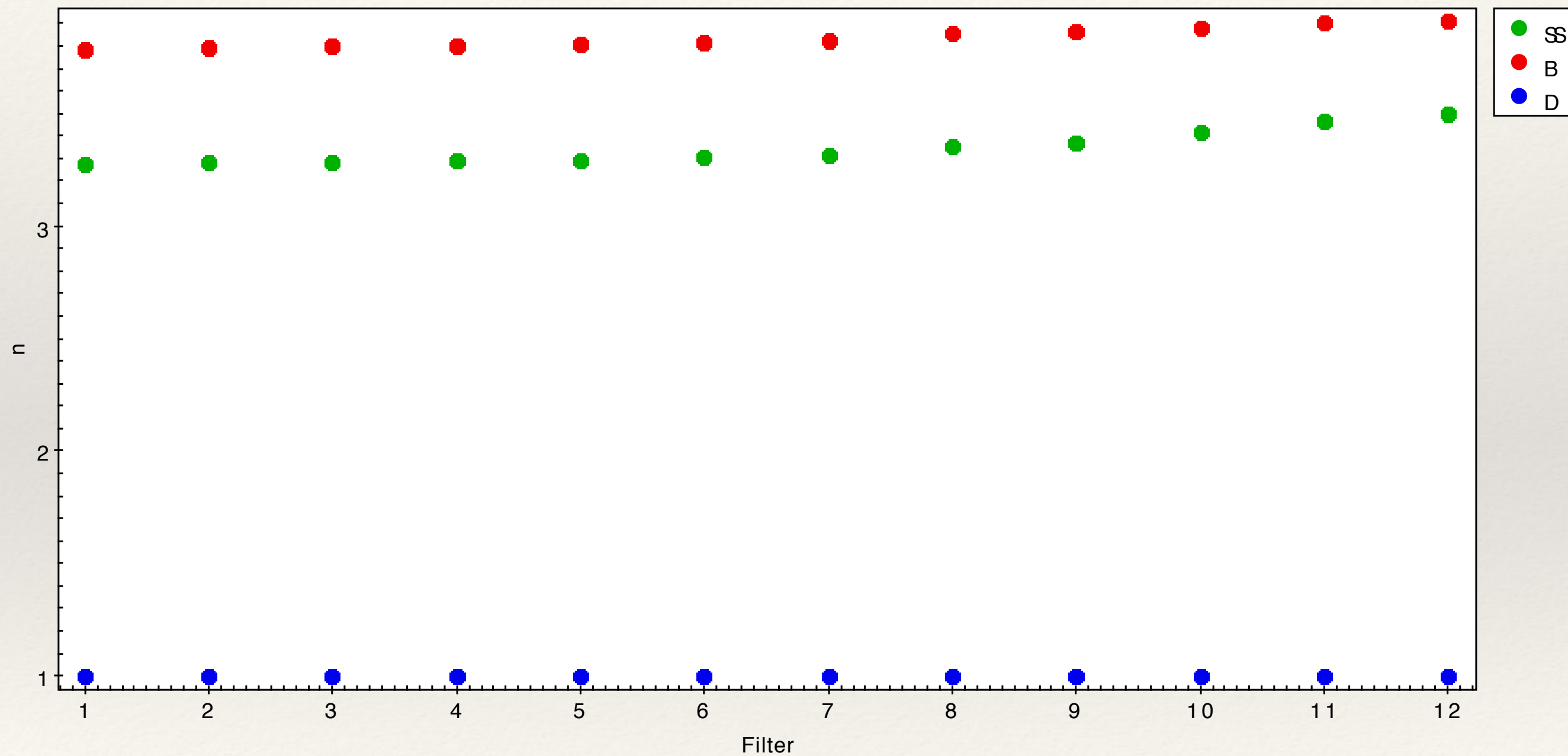




# Variations of parameters with wavelengths

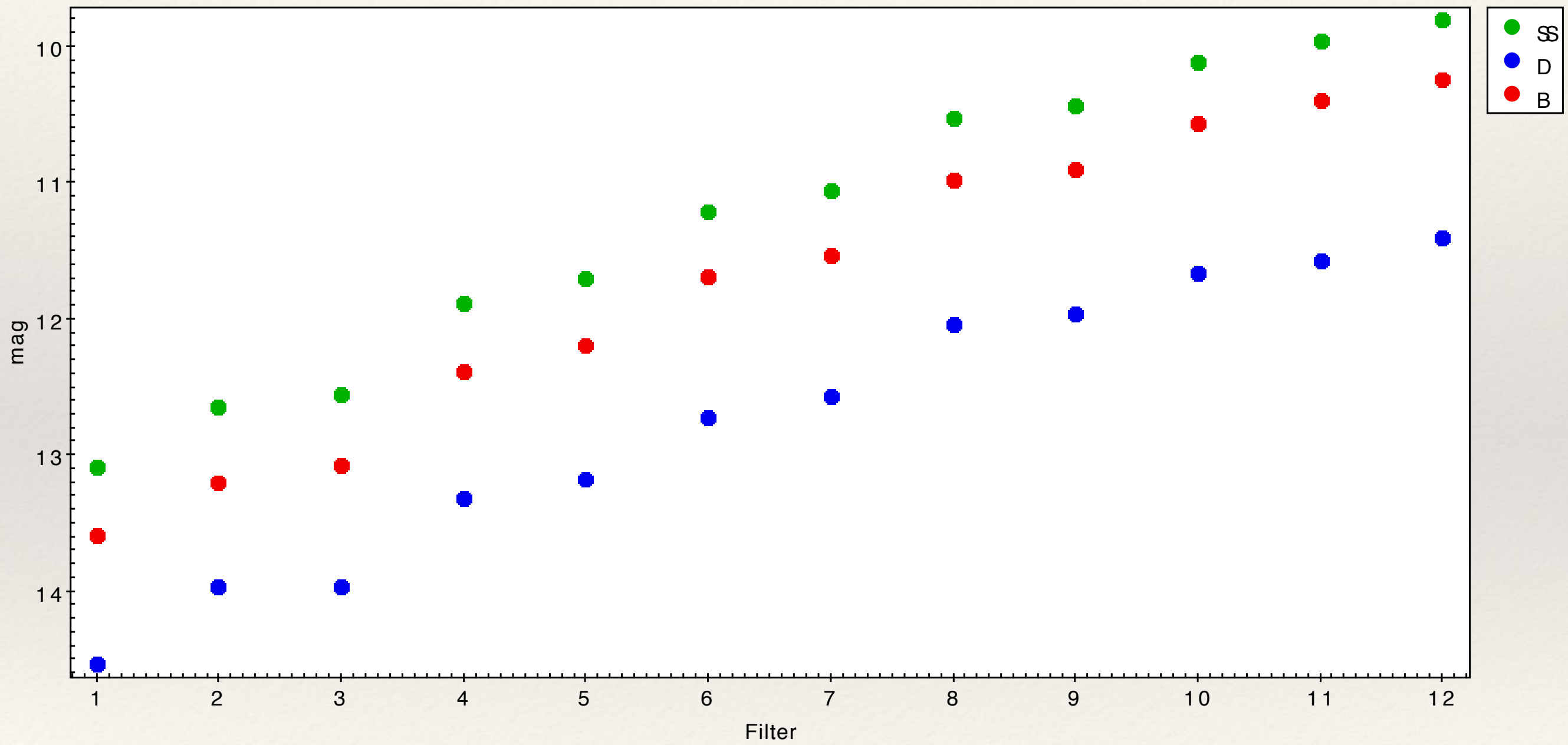


# Variations of parameters with wavelengths

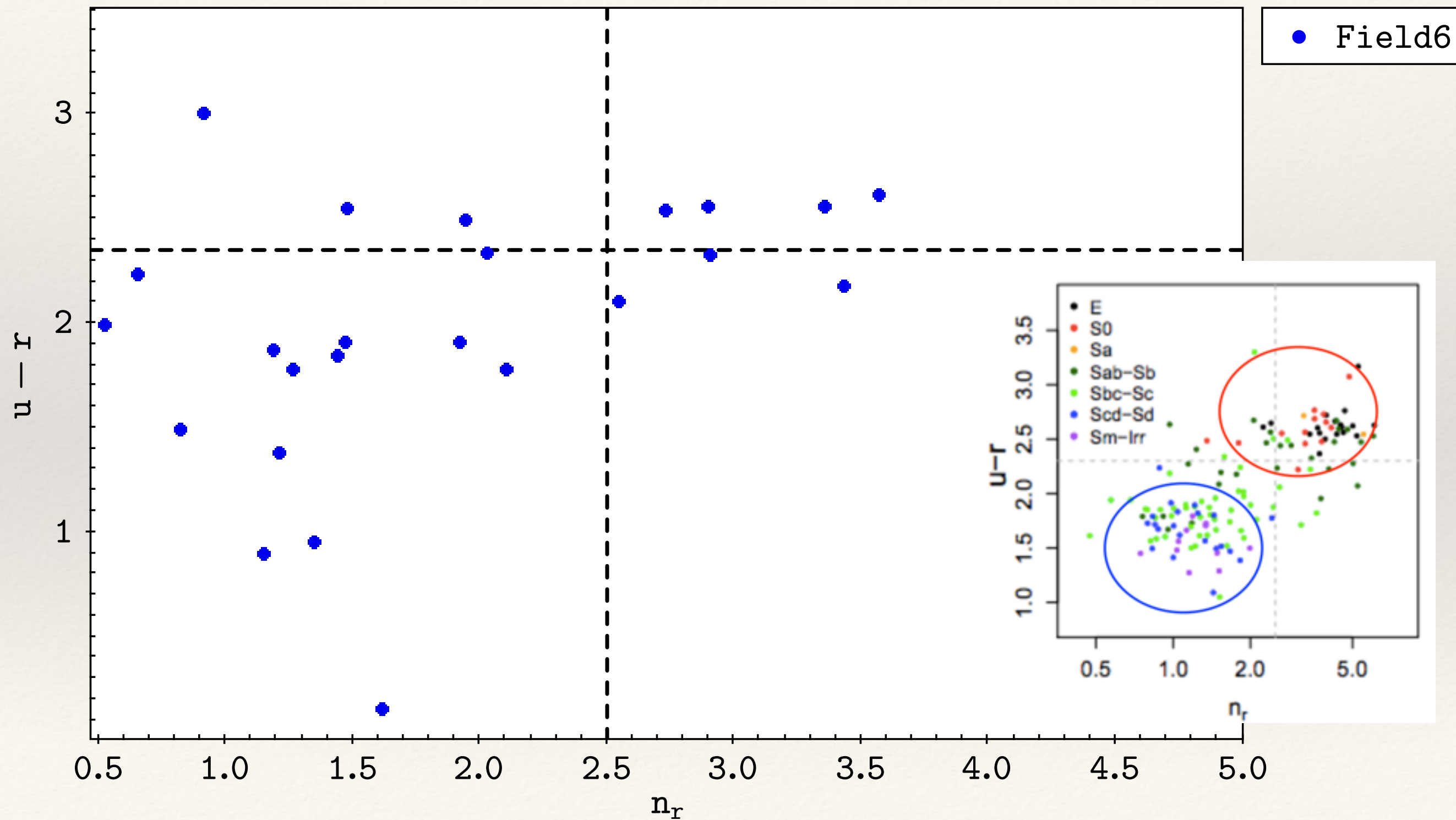




# SEDs

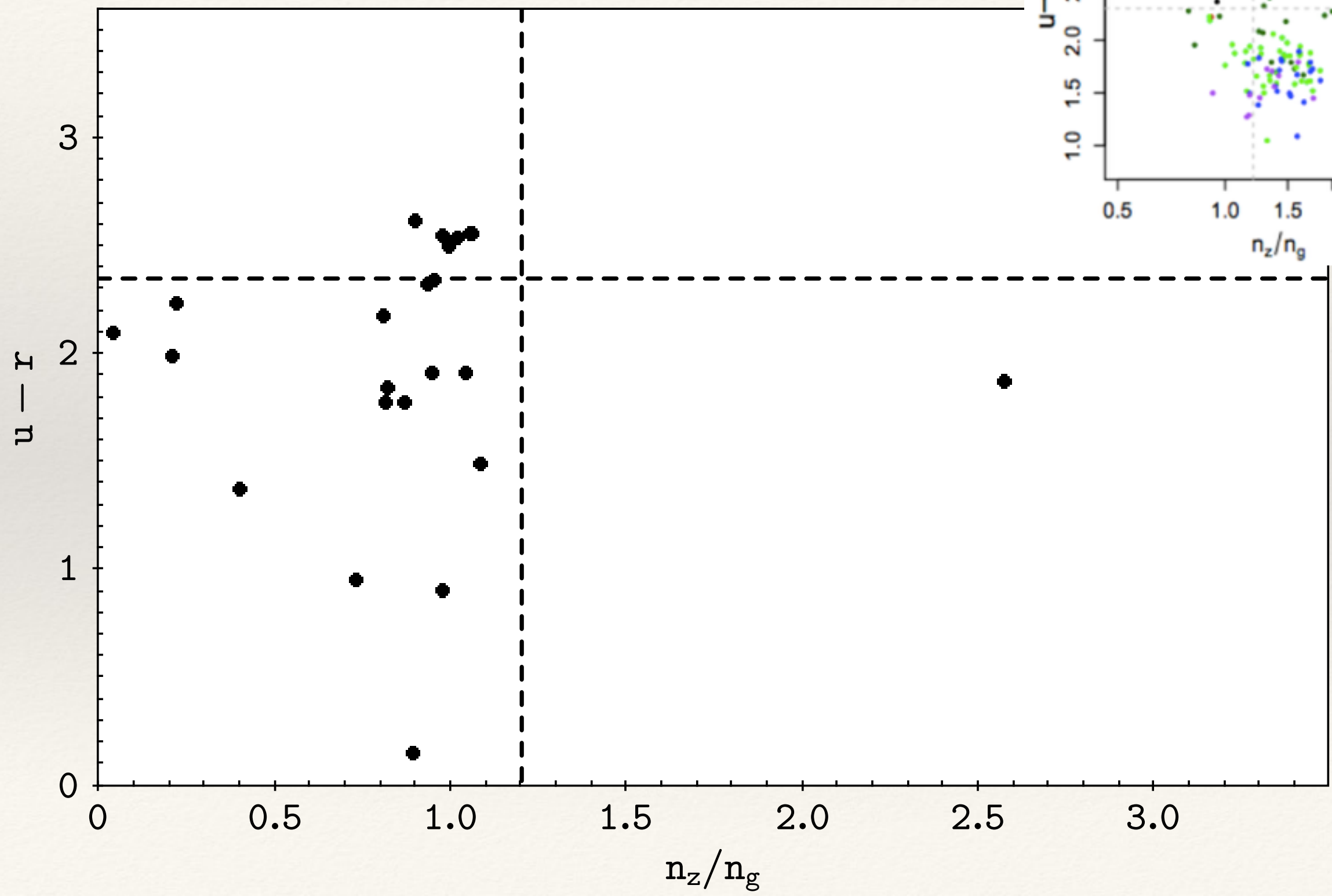


# Extremely Preliminary



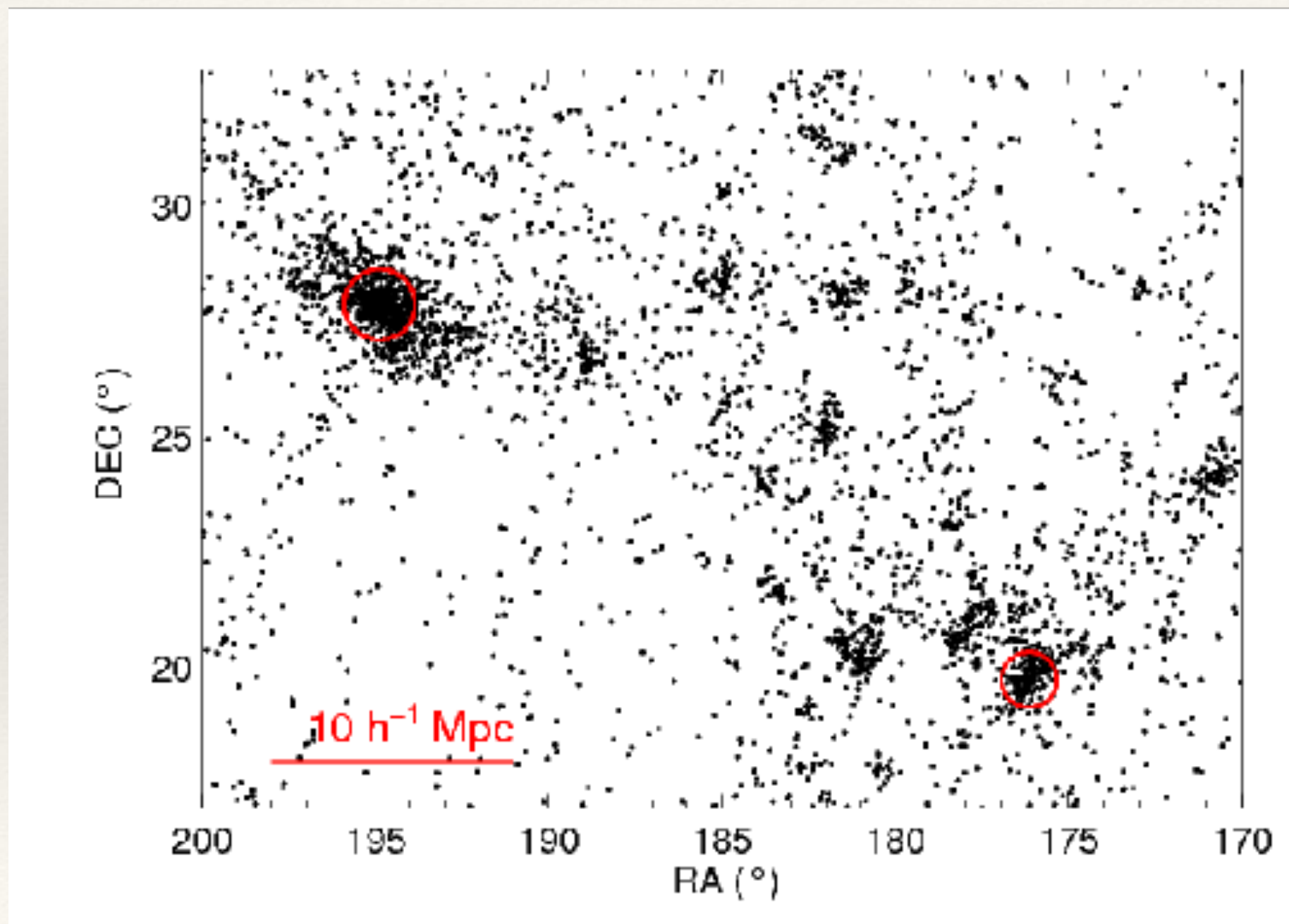


# Extremely Preliminary



# Synergies

## ENVIRONMENT





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# Thank you

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