SEPARATING EARLY-TYPE (SA/S0/E) GALAXIES IN LARGE SURVEYS

Marina Vika (Carnegie Mellon University, Qatar)
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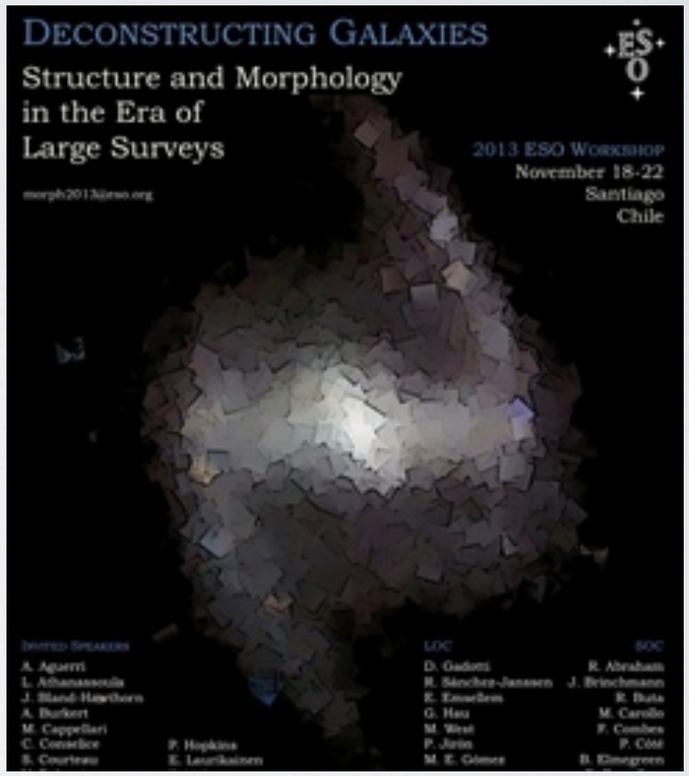
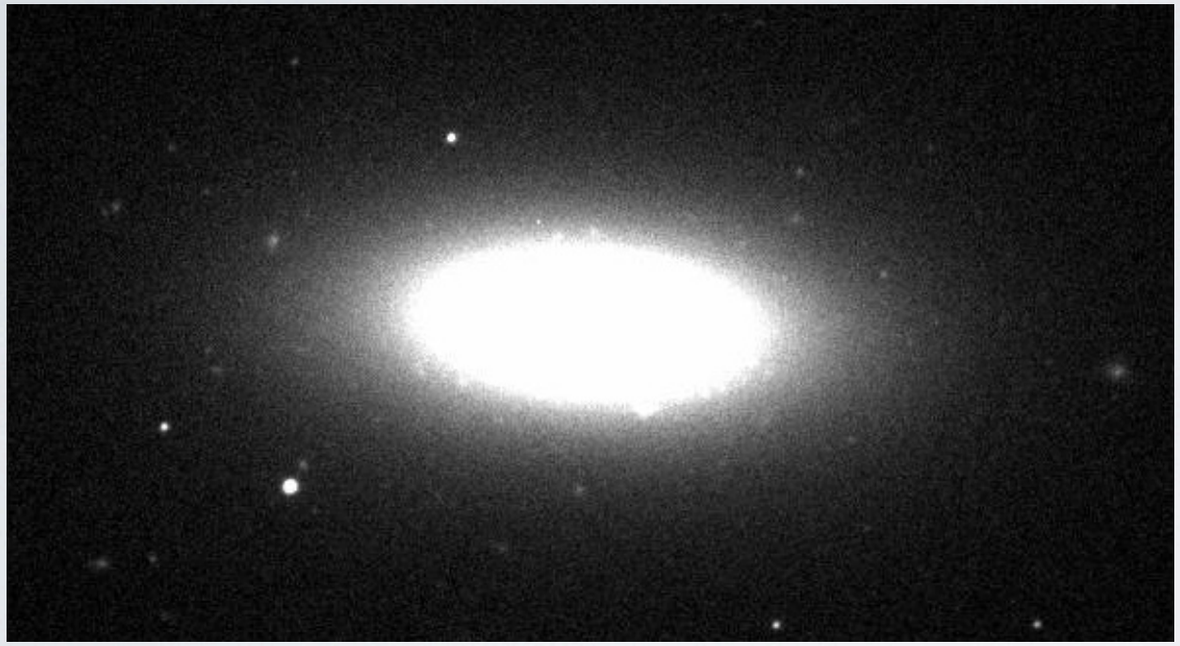
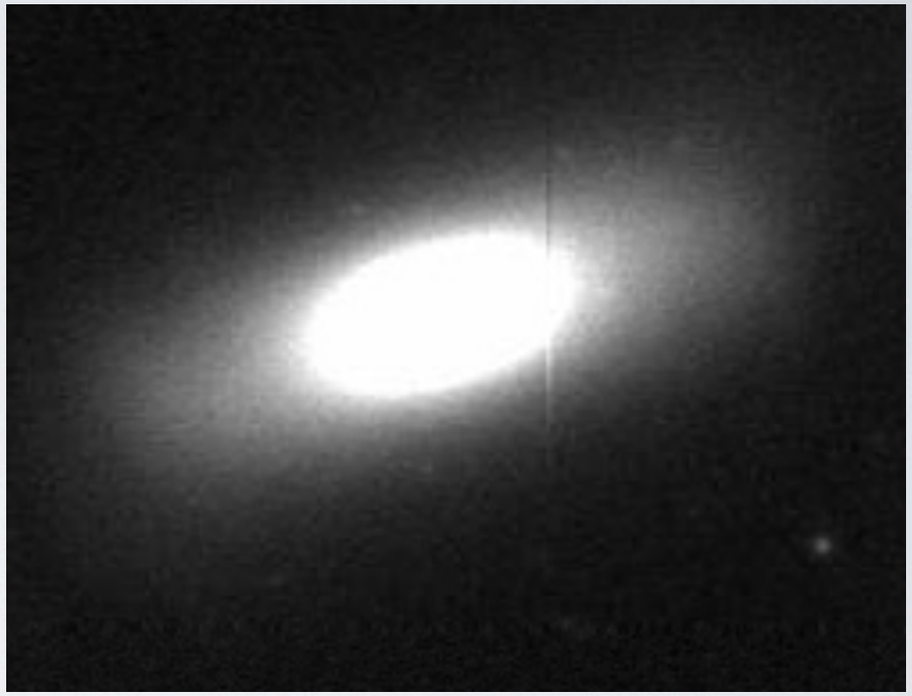
Boris Häußler (University of Oxford)

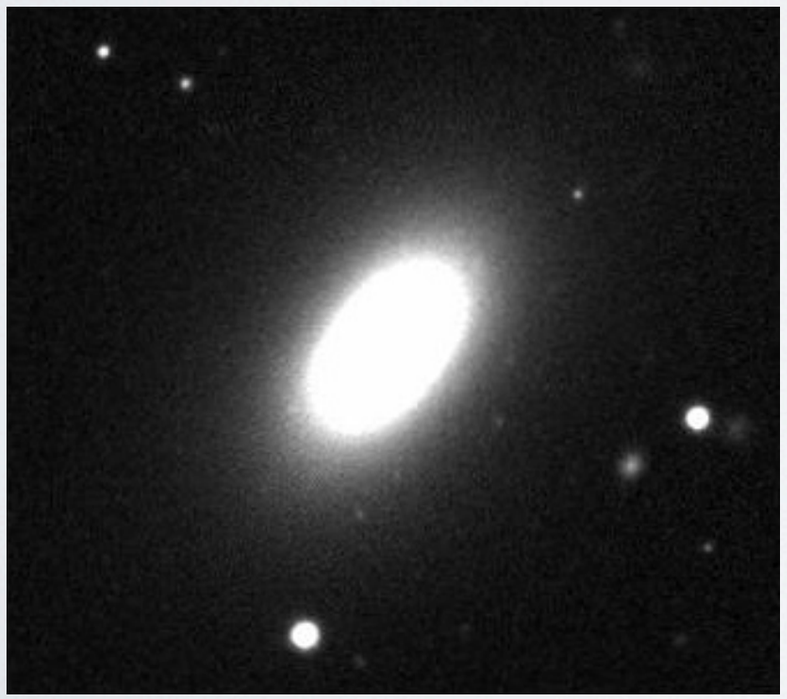


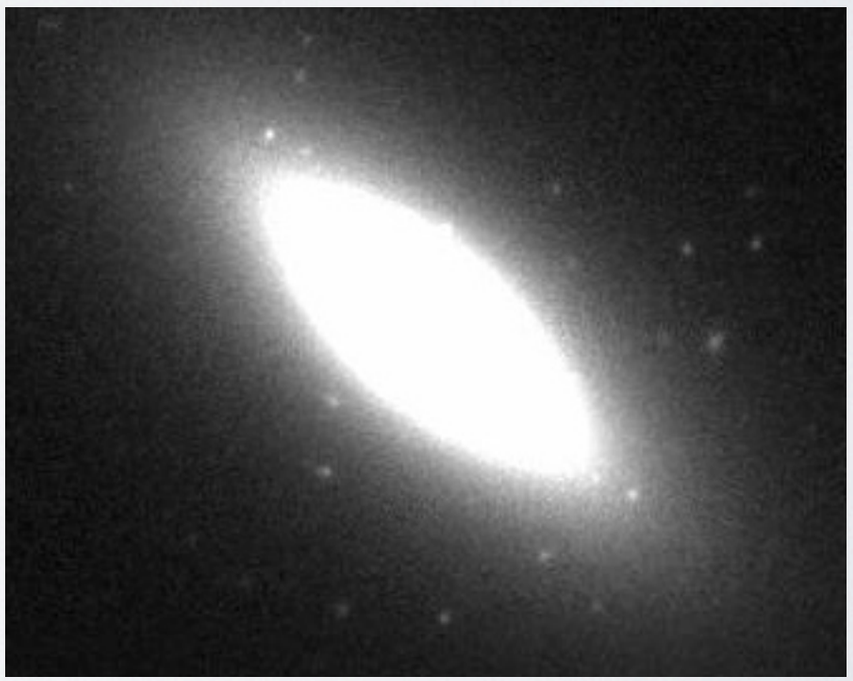
جامعة كارنيجي ميلون في قطر
Carnegie Mellon Qatar
مؤسسة قطر
Qatar Foundation
الصندوق القطري لرعاية البحث العلمي
Qatar National Research Fund
Member of Qatar Foundation

Early-type (S0/E) galaxies







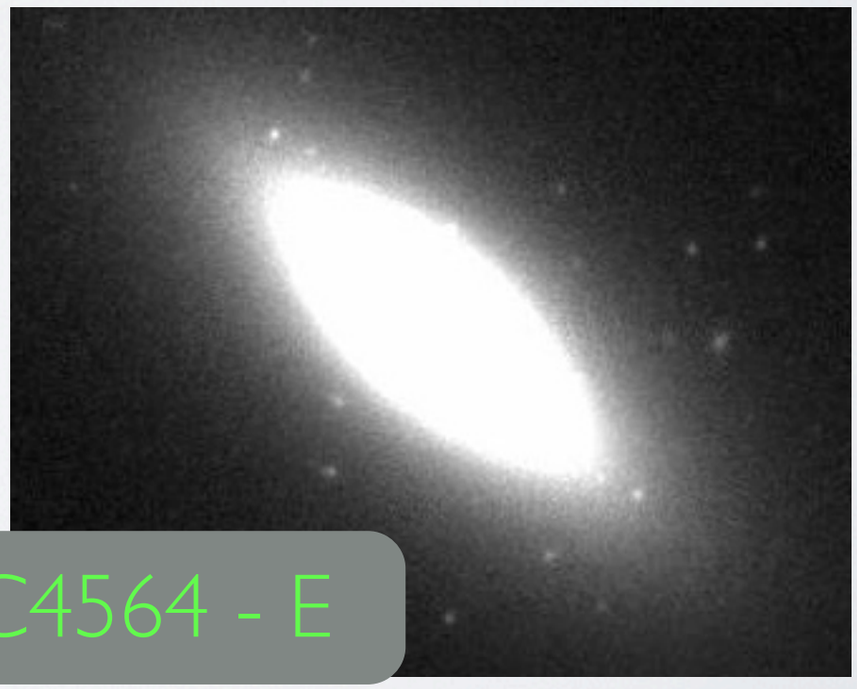


Early-type (S0/E) galaxies

NGC4281 - S0+ edge on

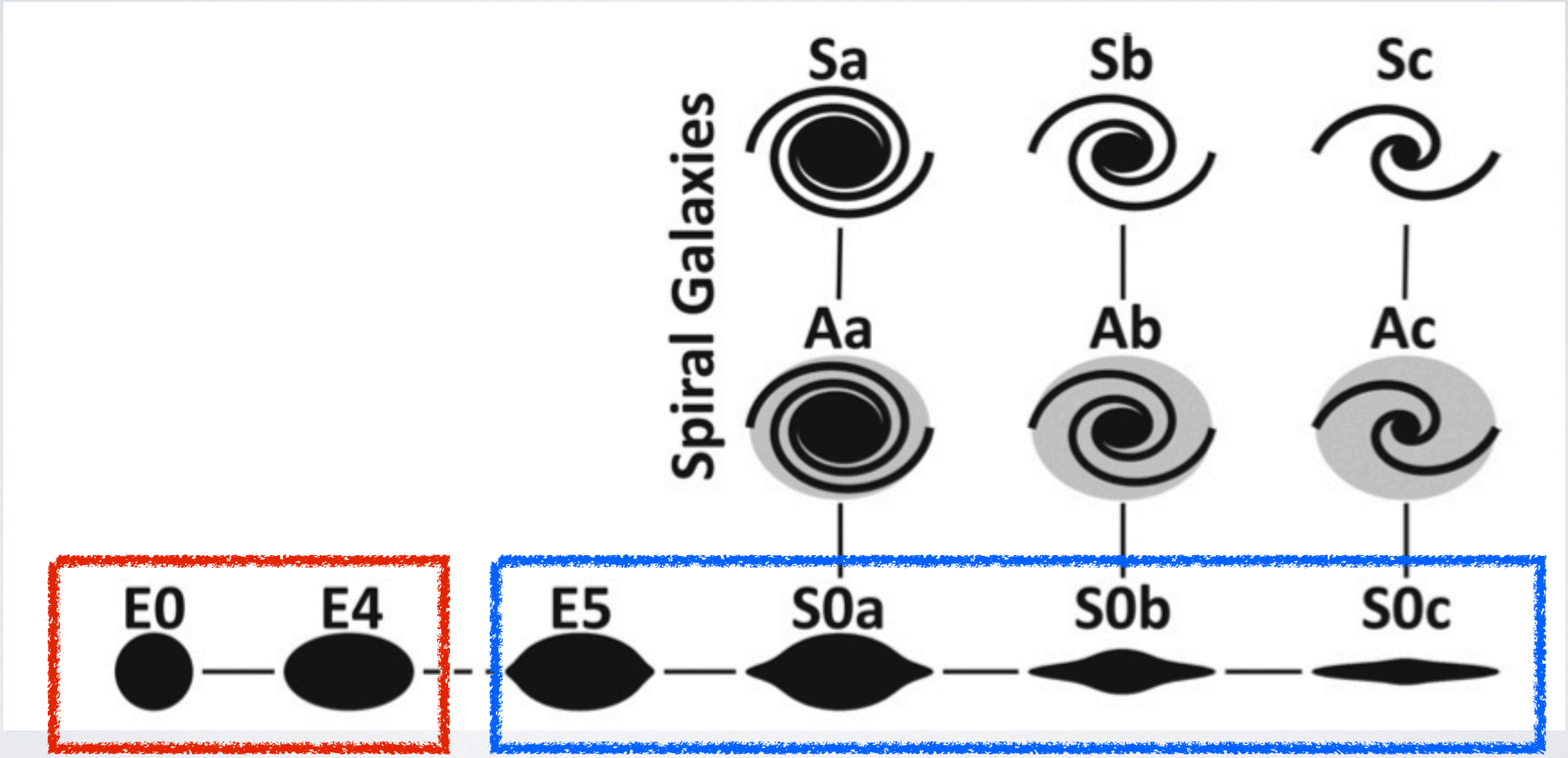
NGC4270 - S0

NGC4387 - E



NGC4564 - E

Early-type (S0/E) galaxies

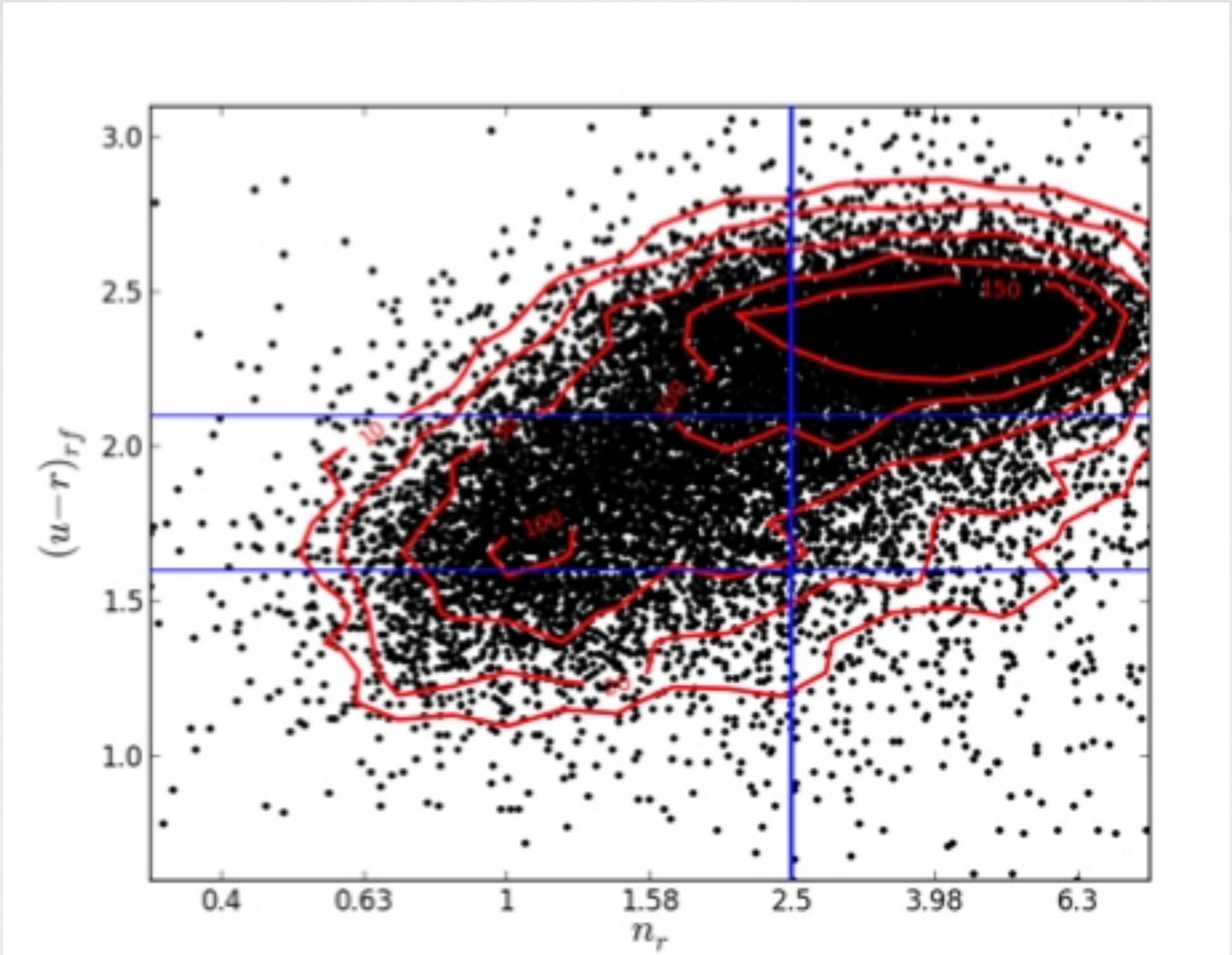


Slow Rotators

Fast Rotators

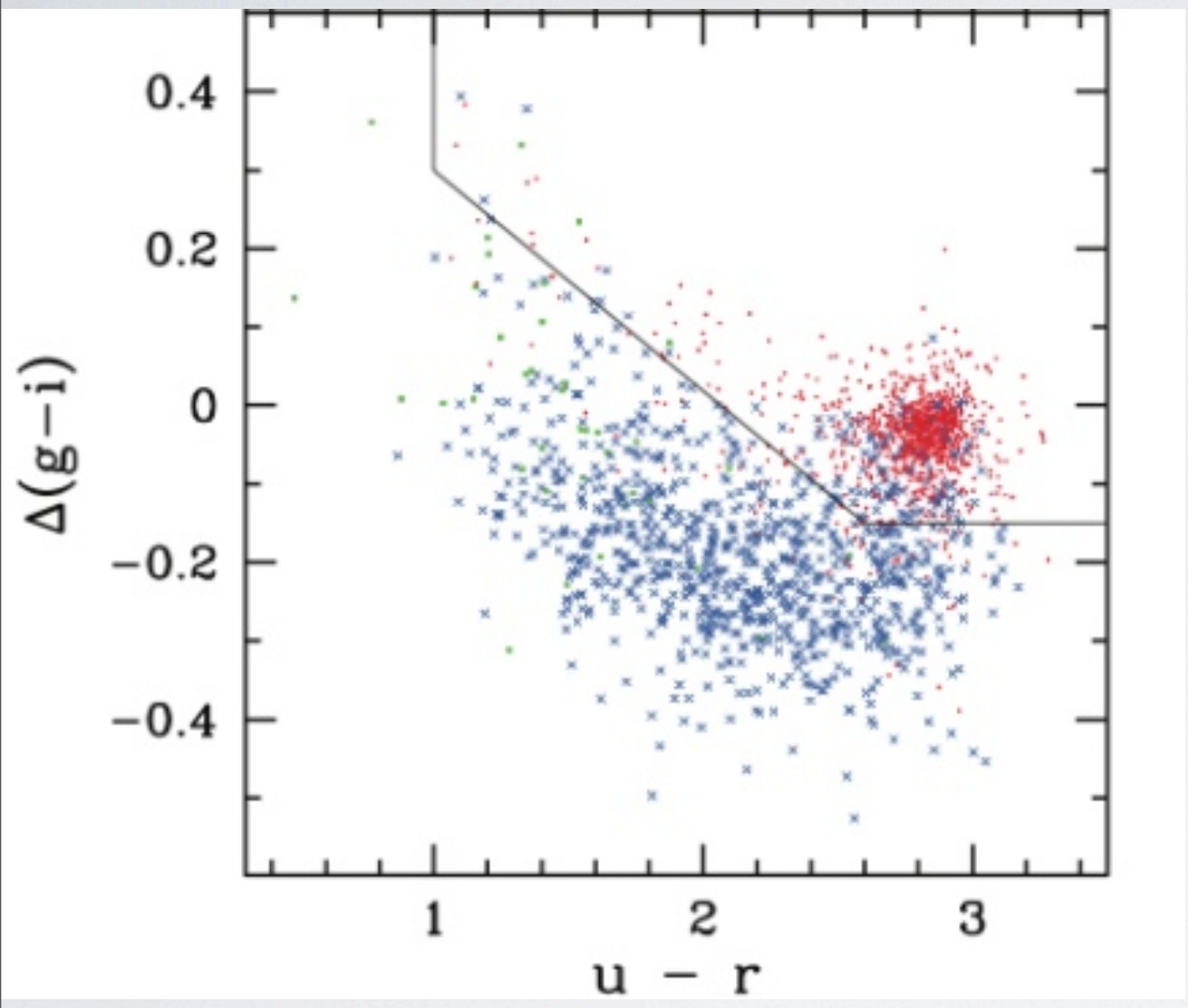
Cappellari et al 2011

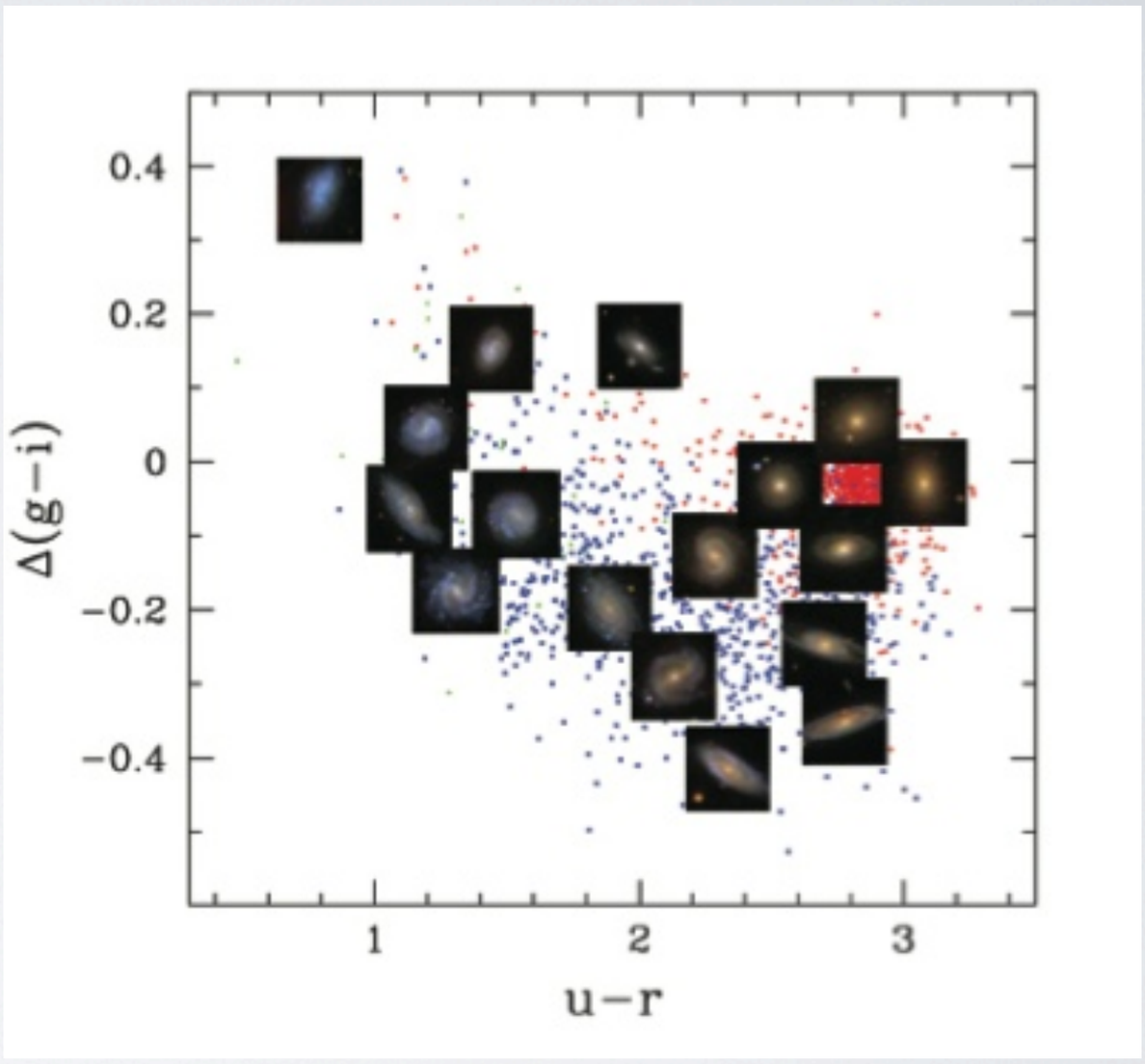
Early-type galaxies in large surveys



Vulcani et al 2014

Early-type galaxies in large surveys



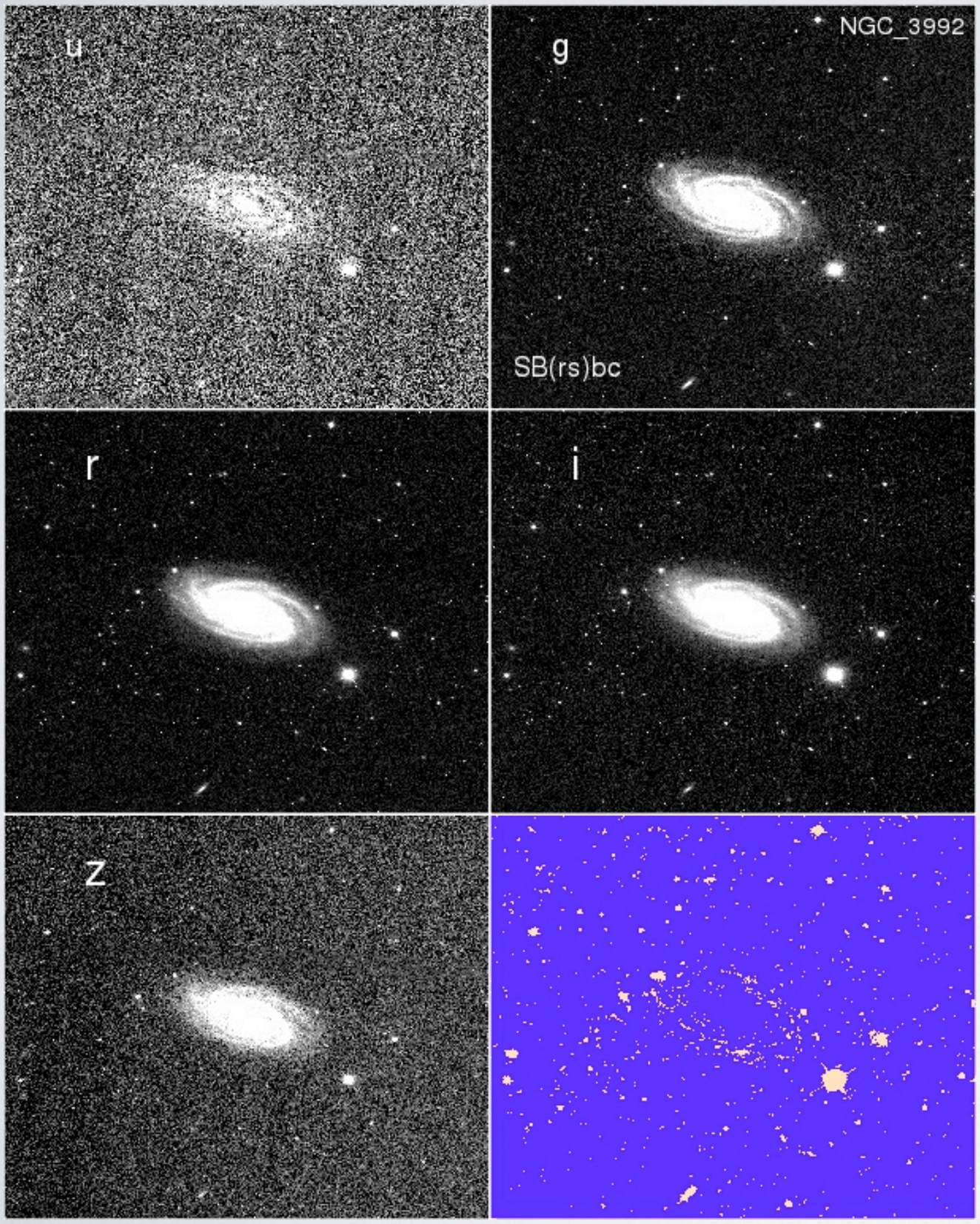


Park & Choi 2005

MULTI-WAVELENGTH MEASUREMENT OF GALAXY STRUCTURE:

SINGLE SÉRSIC PROFILE FITS (GALFITM)

Multi-Wavelength Sample

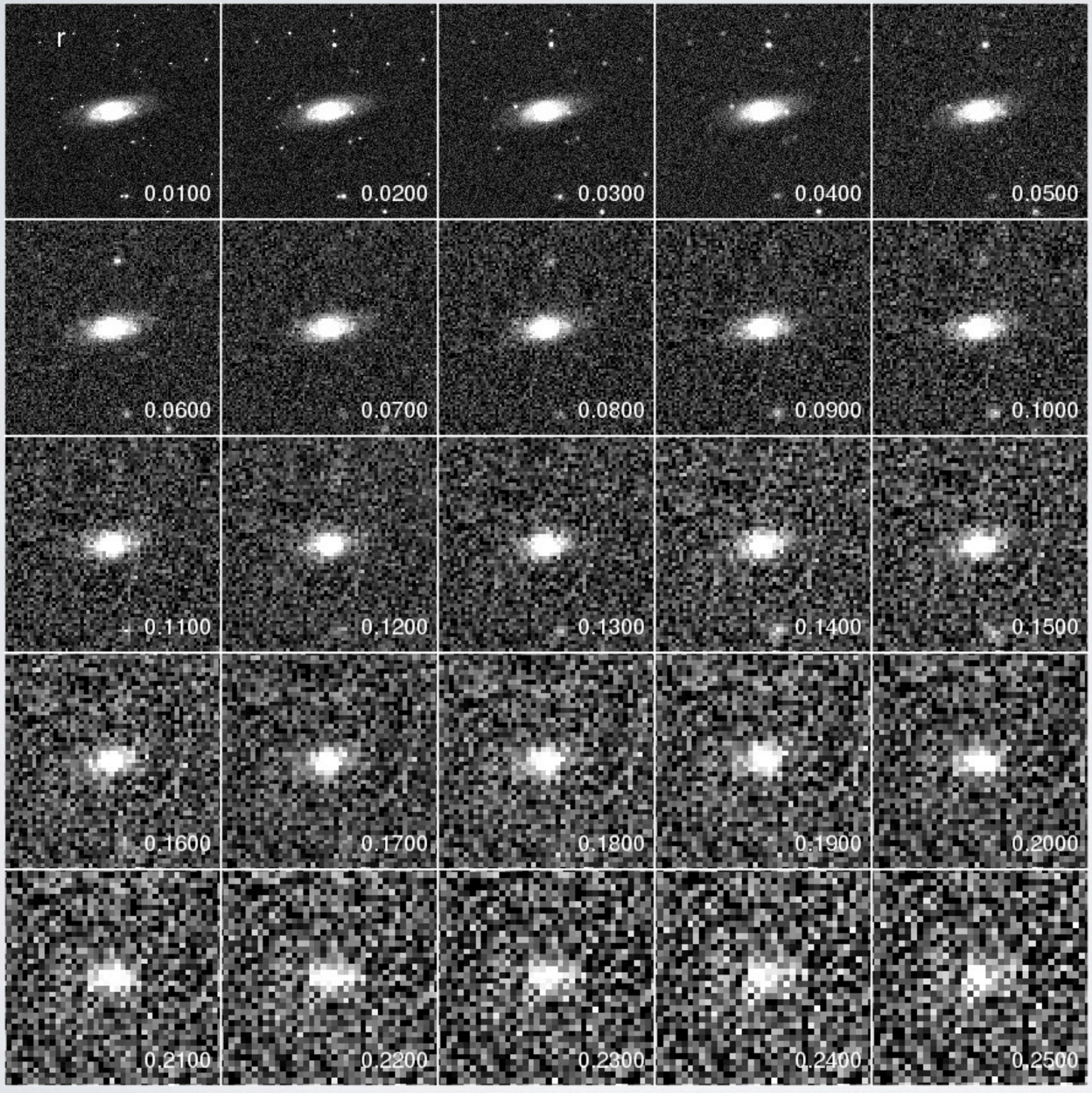


164 Galaxies
u,g,r,i,z bands
(SDSS)

- Mixed morphology
- Have been perviously studied in detail
- **Not** a complete sample

Vika et al 2013

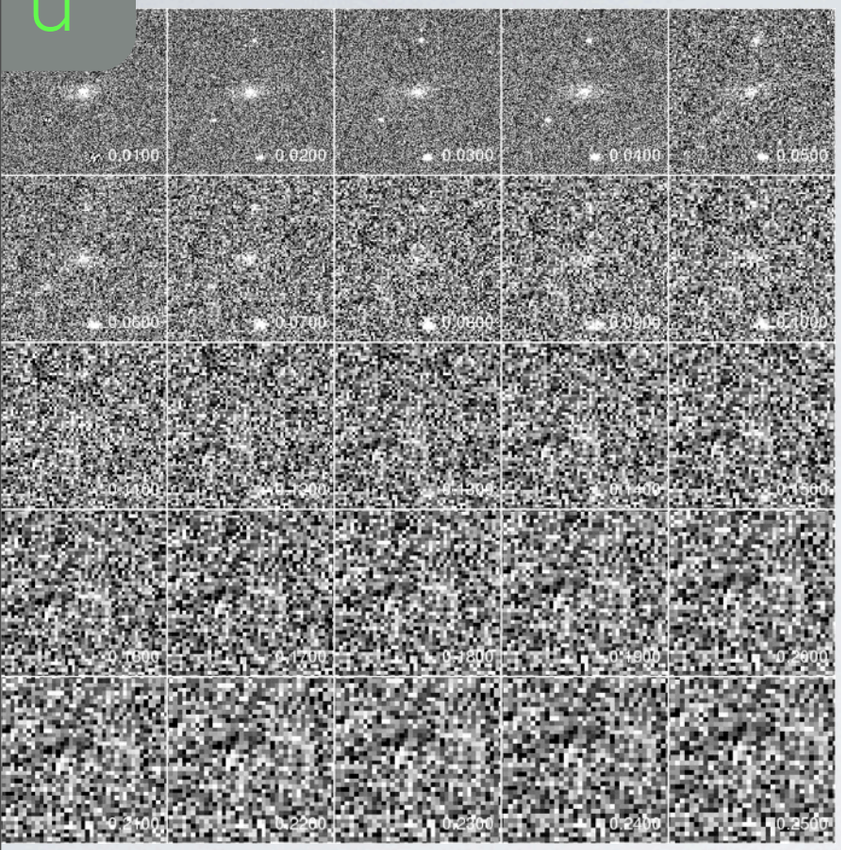
Artificially redshifted Sample



NGC 4274

We artificially redshift images using *FERENGI*

u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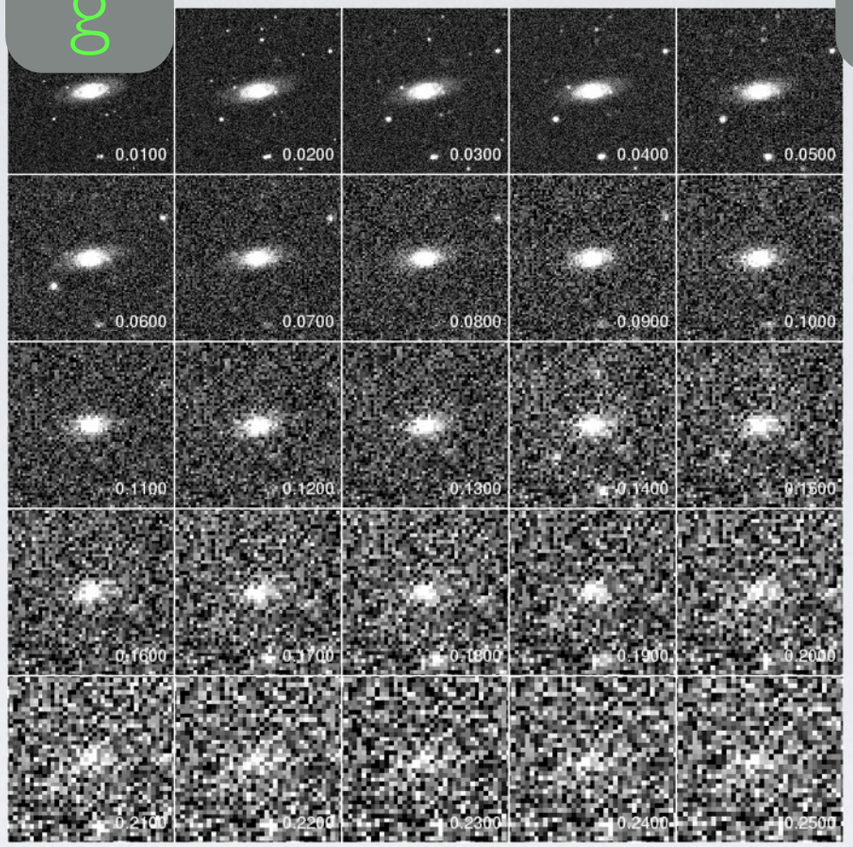
g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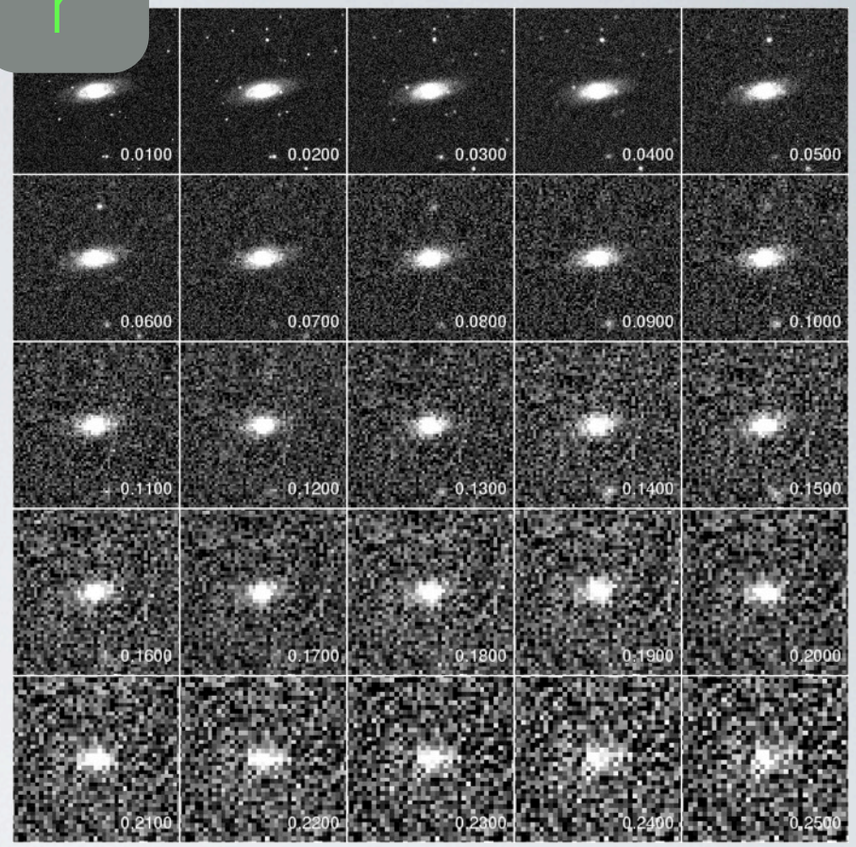
r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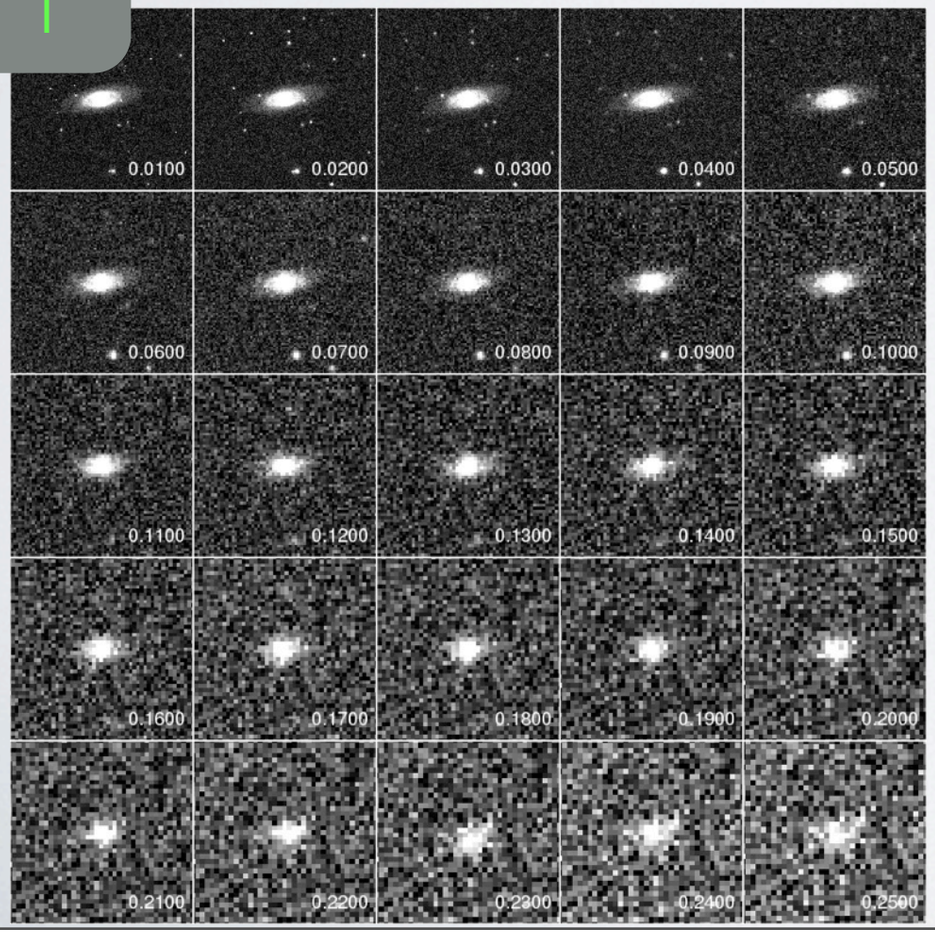
i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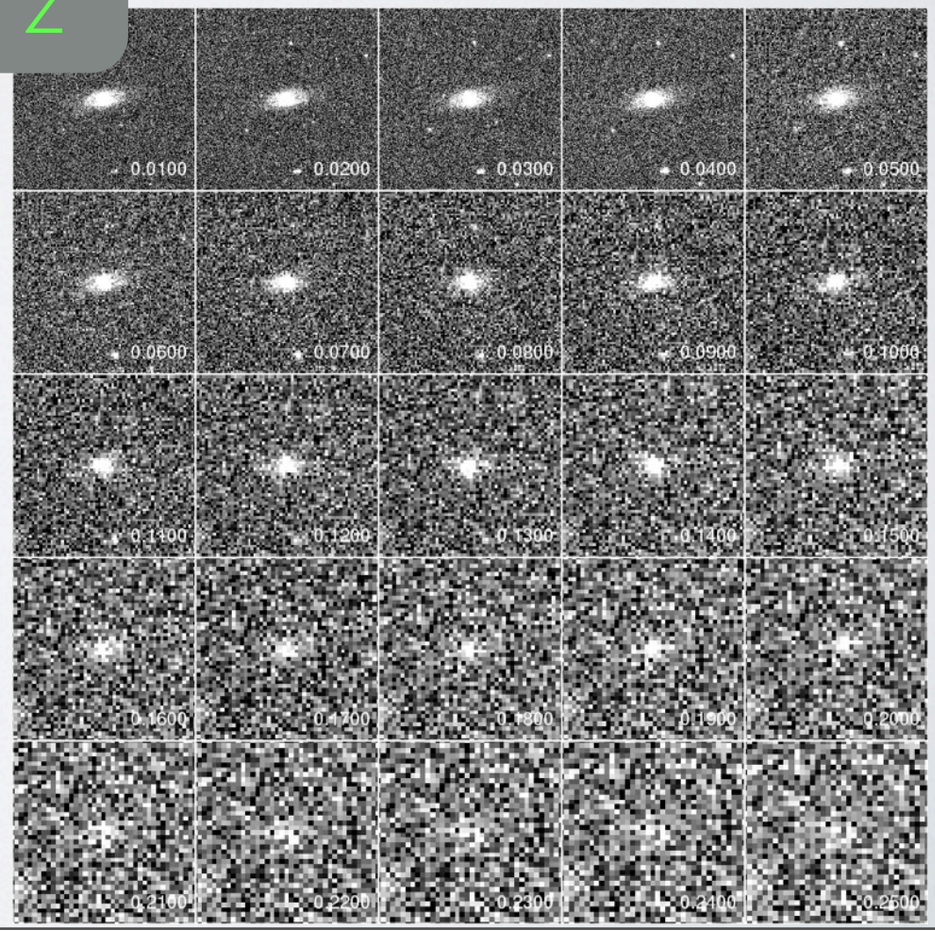
z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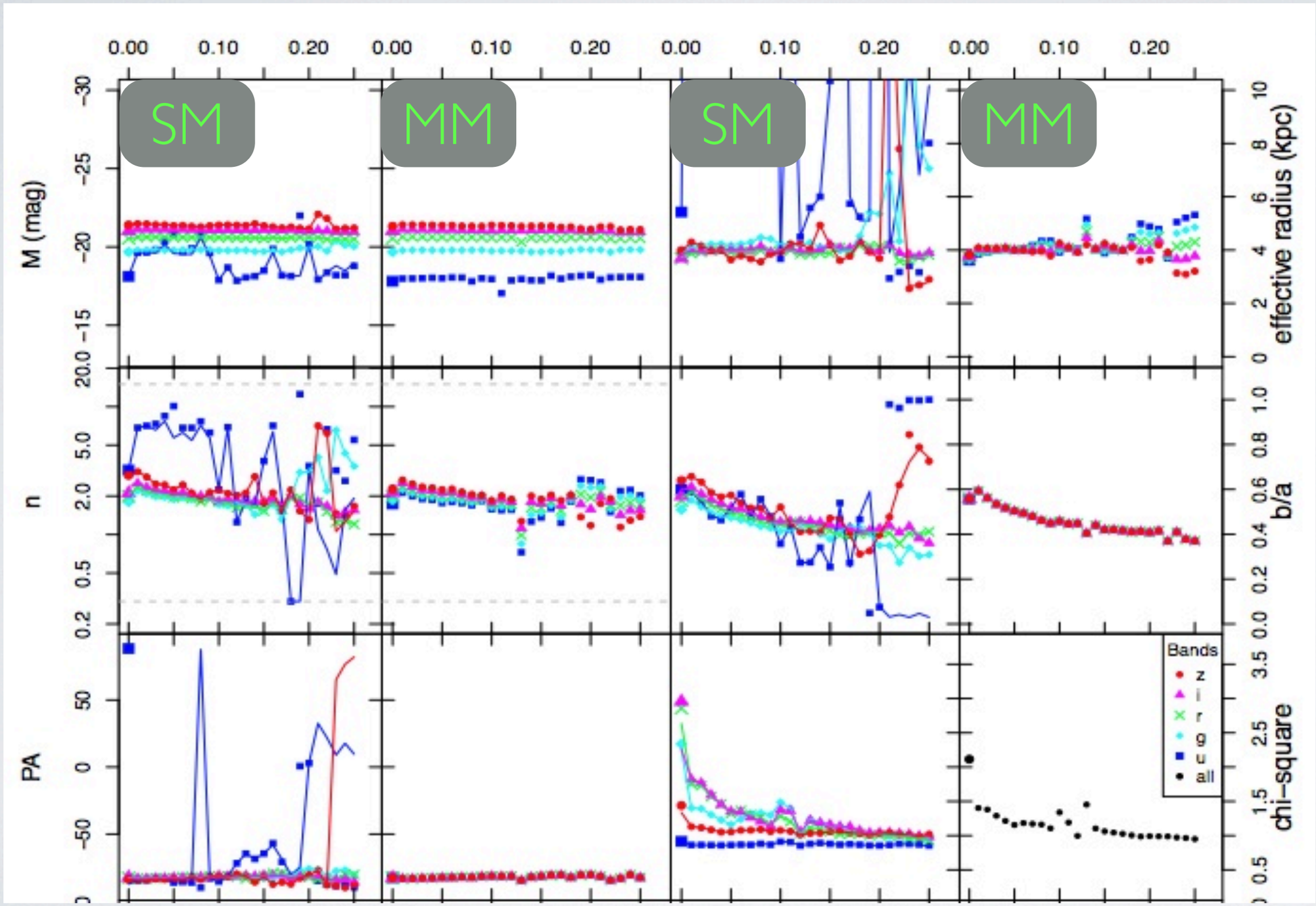
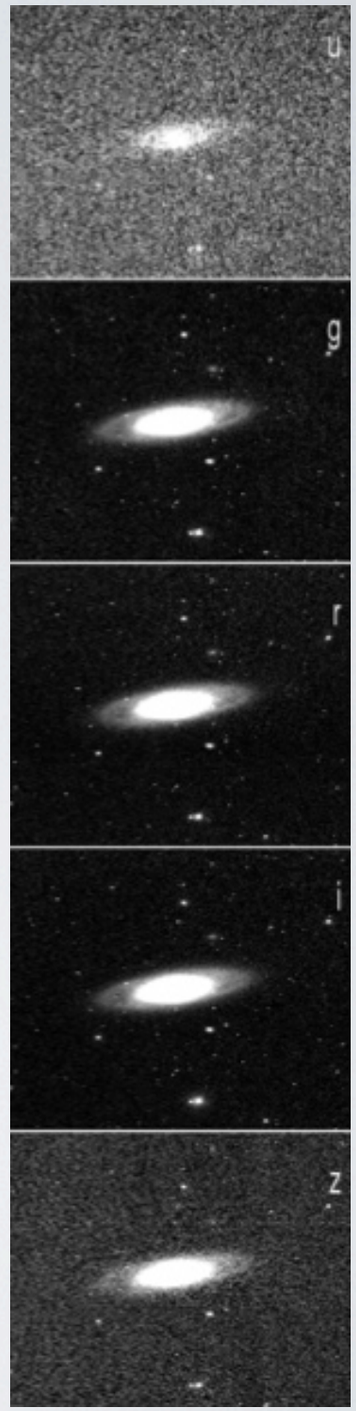
Multi-Wavelength (MM) vs Single- Wavelength (SM) Fitting





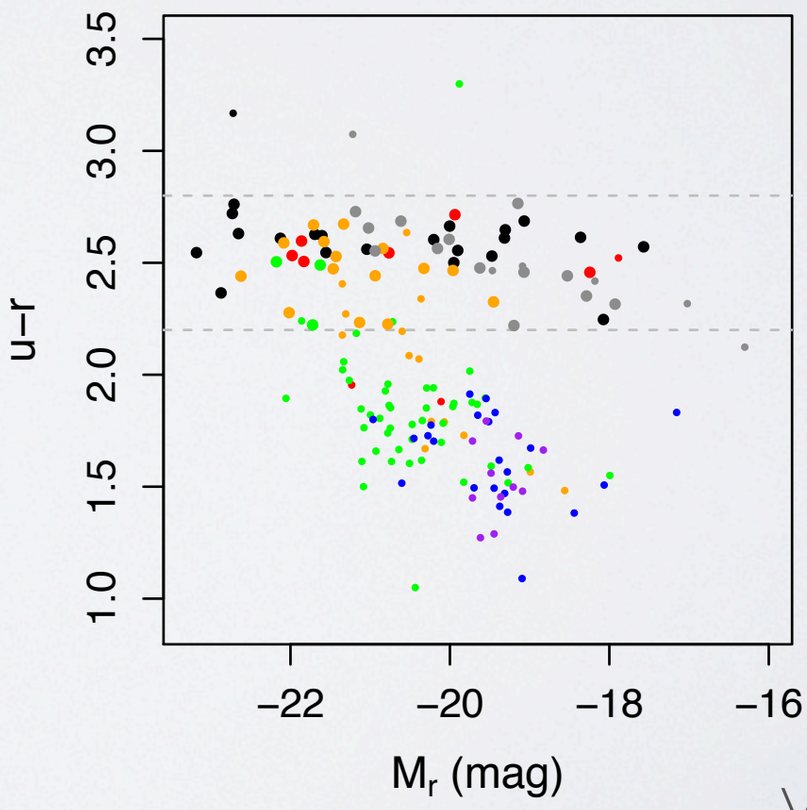
Multi-band fitting process by simultaneously using multiple images of the same galaxy to constrain a wavelength-dependent model.

Vika et al 2013

Structural parameters as classifiers

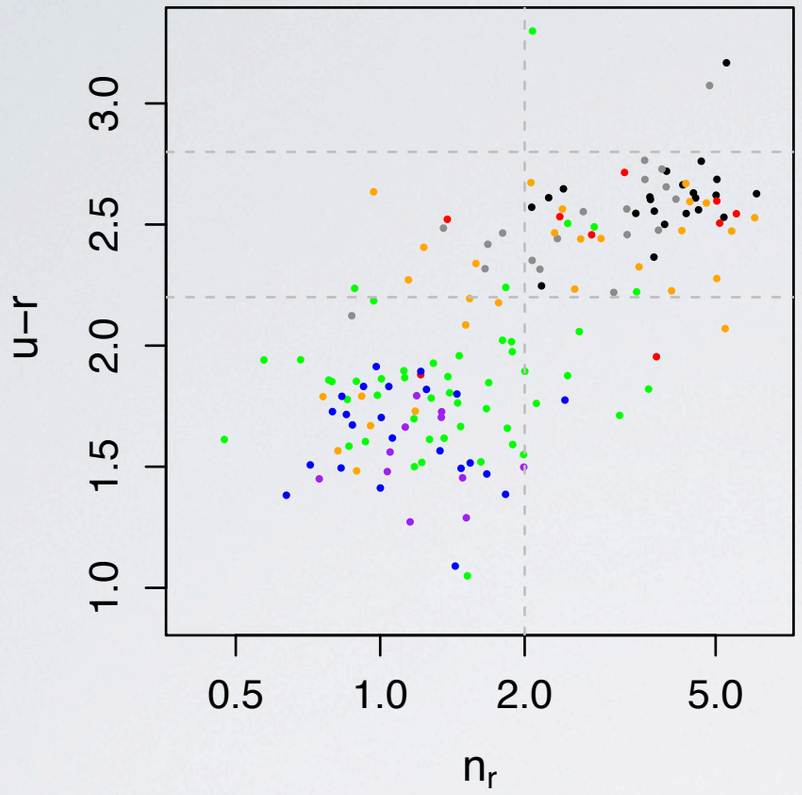
- E
- S0
- Sa/SBa
- Sab/Sb/SBb
- Sbc/Sc/SBc
- Scd/Sd
- Irr/Sm

Original Sample



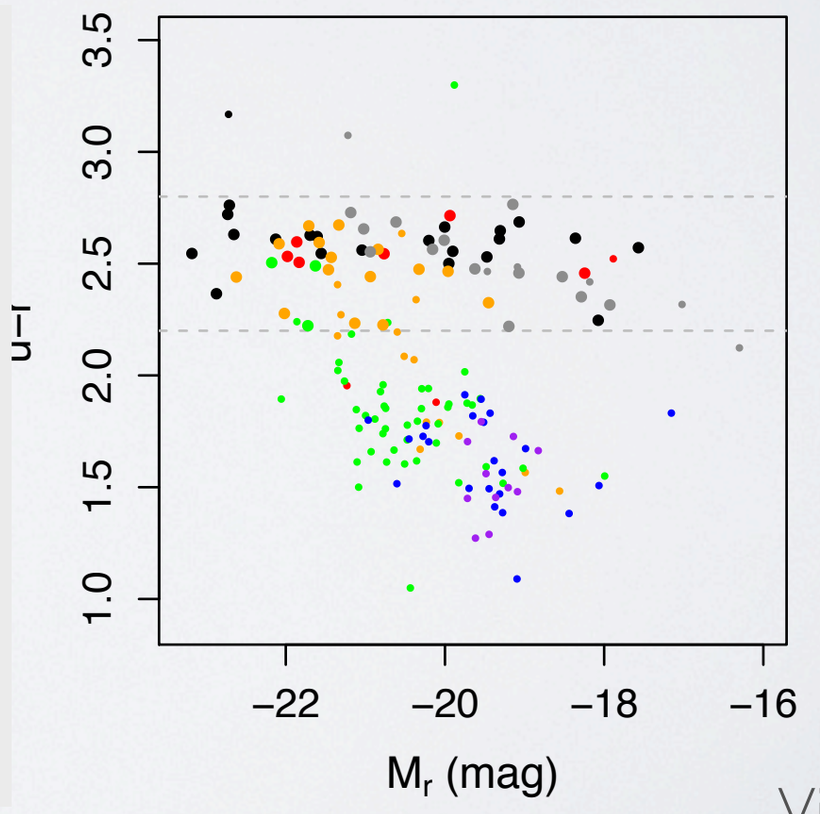
Vika et al in prep.

Structural parameters as classifiers



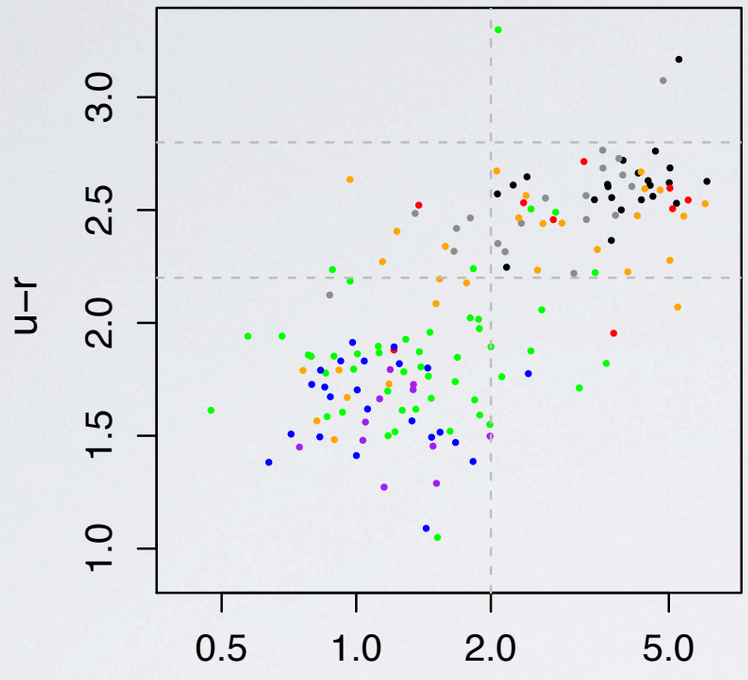
- E
- S0
- Sa/SBa
- Sab/Sb/SBb
- Sbc/Sc/SBc
- Scd/Sd
- Irr/Sm

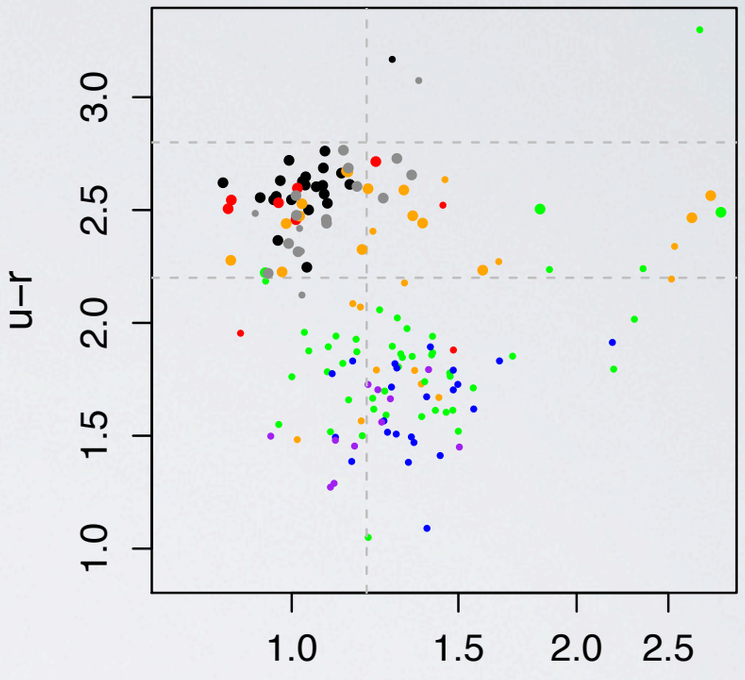
Original Sample



Vika et al in prep.

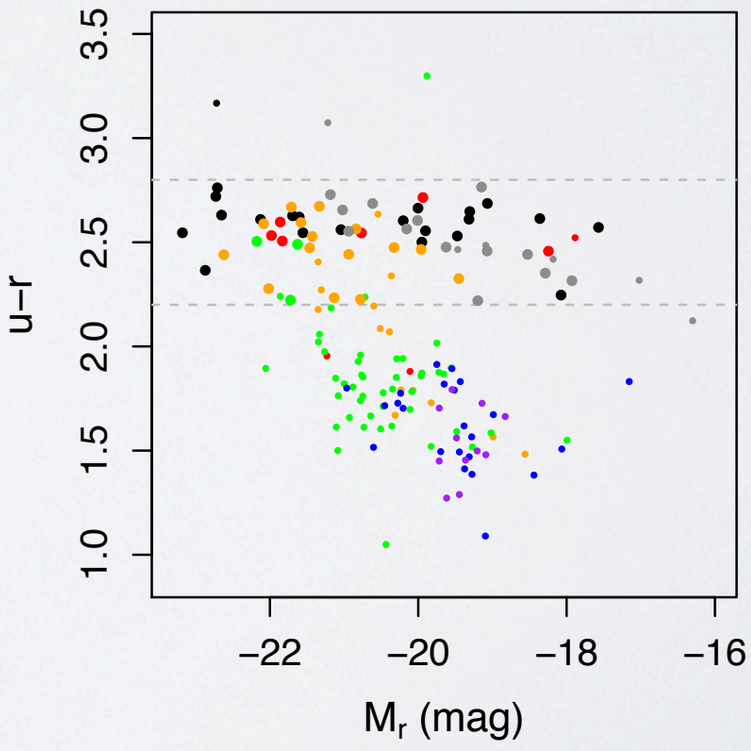
Structural parameters as classifiers





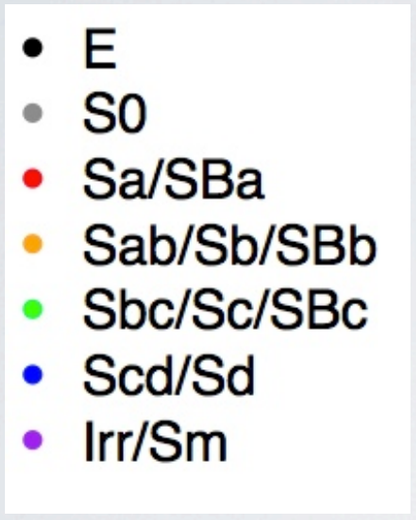
- E
- S0
- Sa/SBa
- Sab/Sb/SBb
- Sbc/Sc/SBc
- Scd/Sd
- Irr/Sm

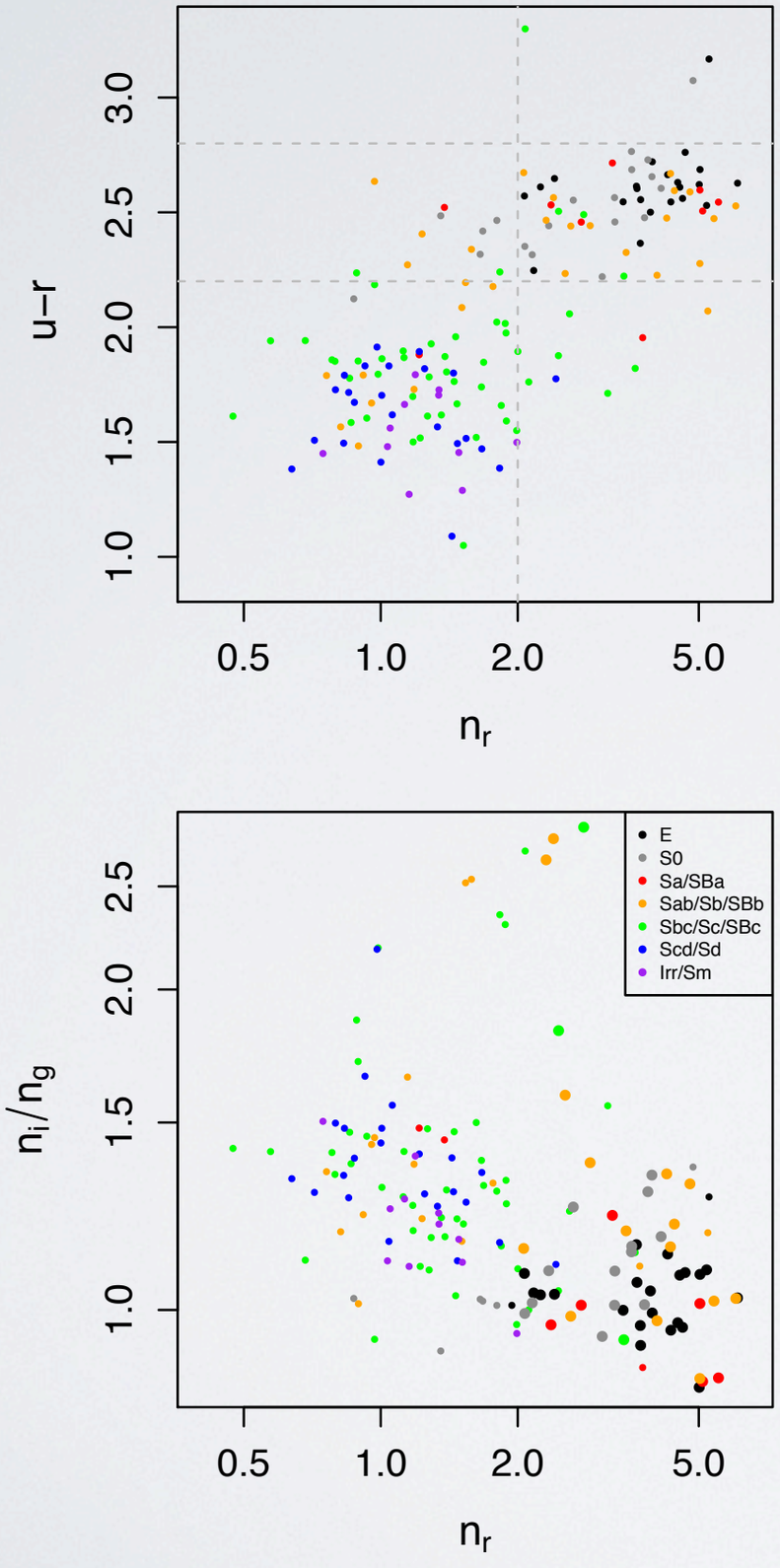
Original Sample

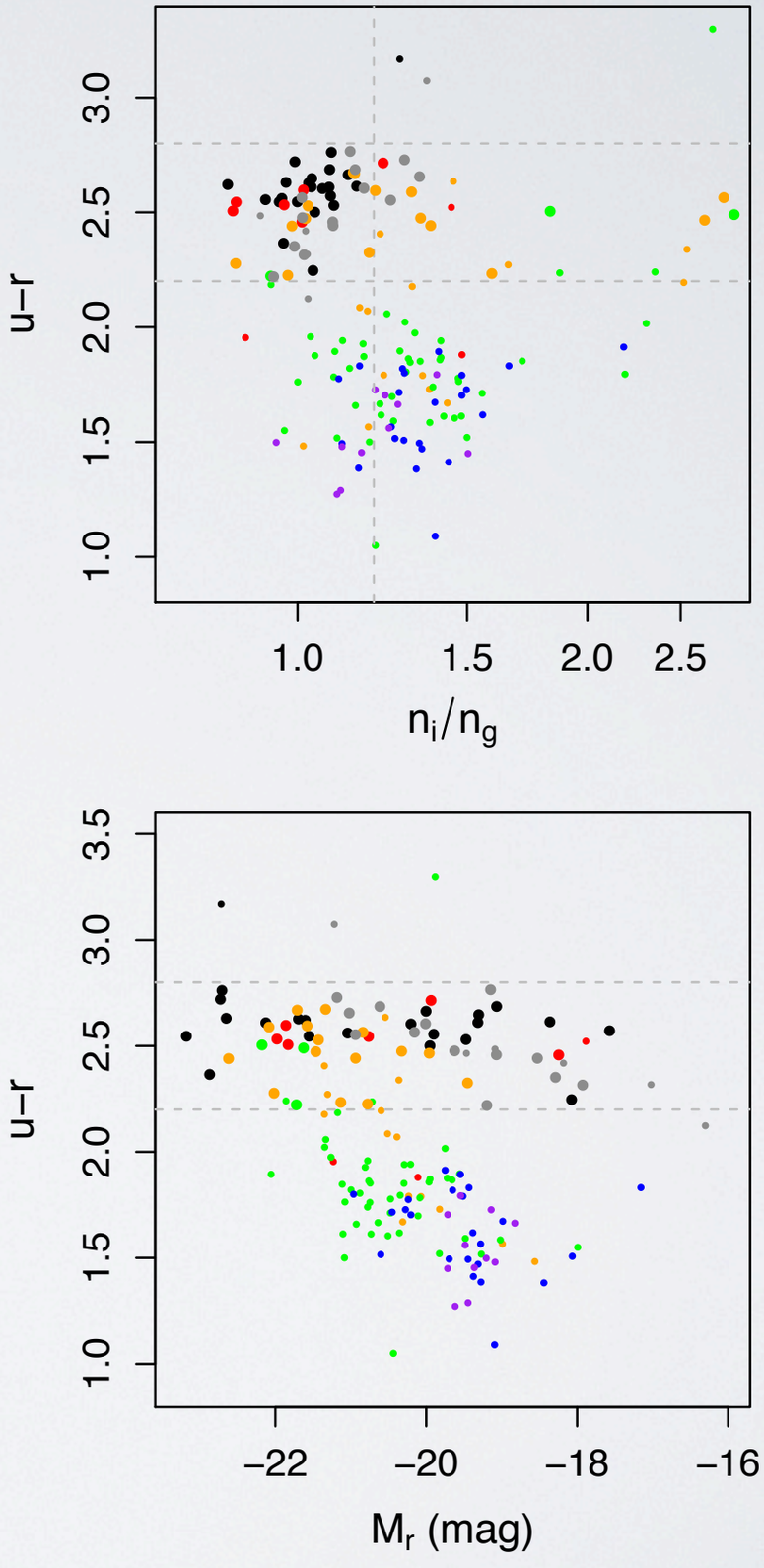


Vika et al in prep.

Structural parameters as classifiers



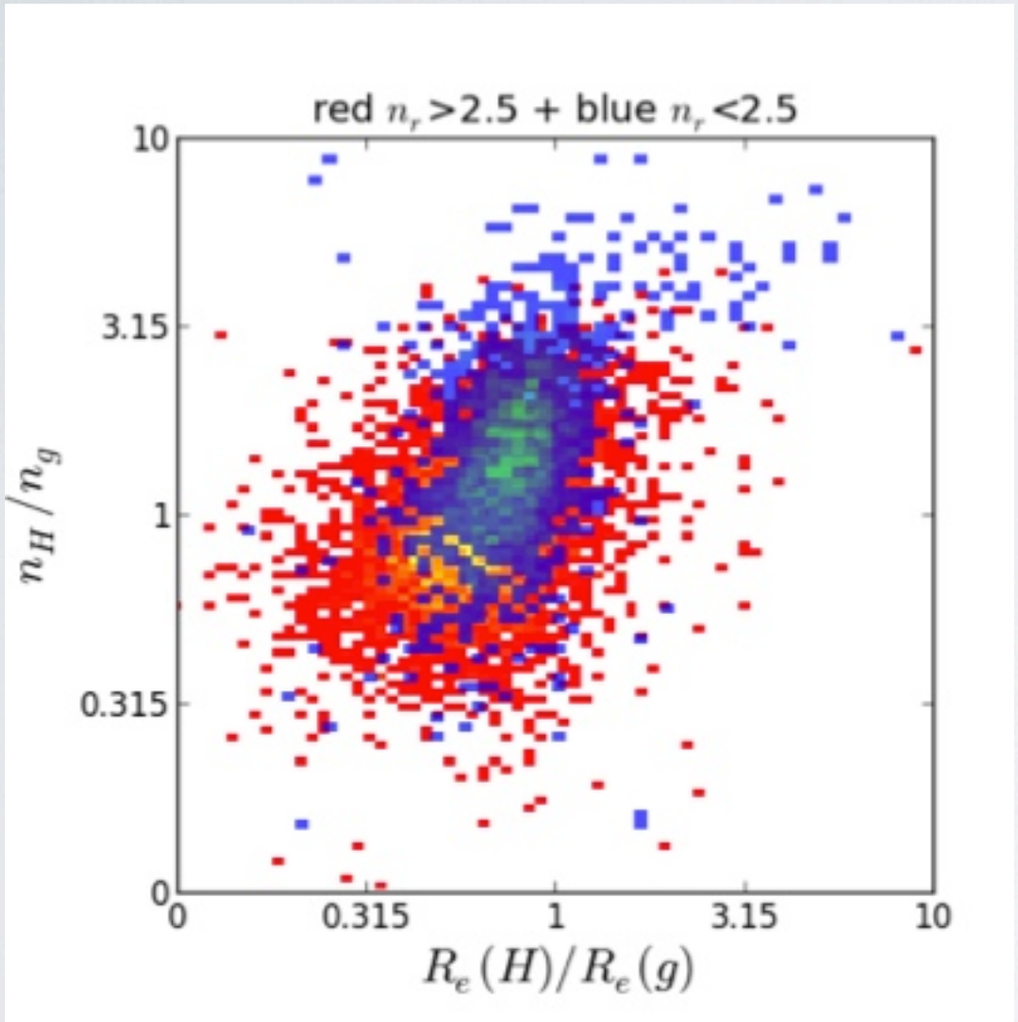


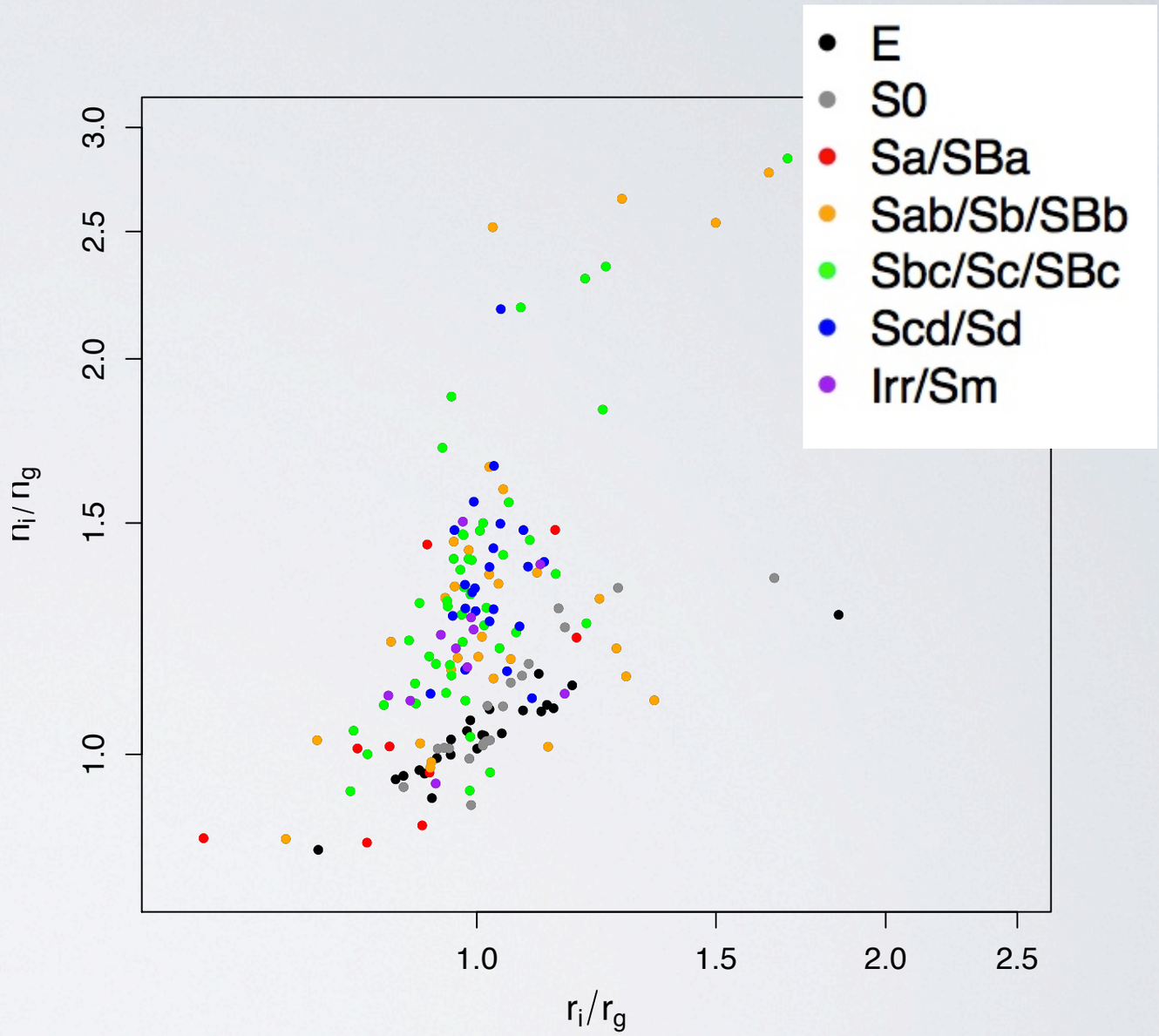


Original Sample

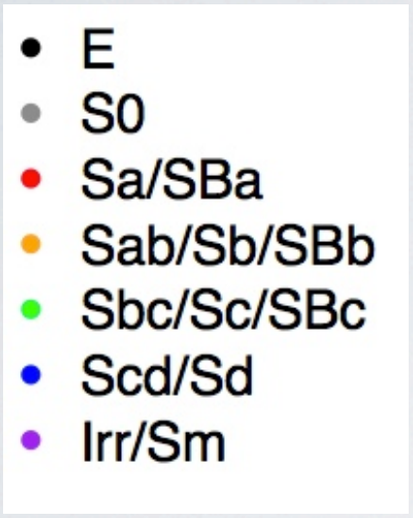
Vika et al in prep.

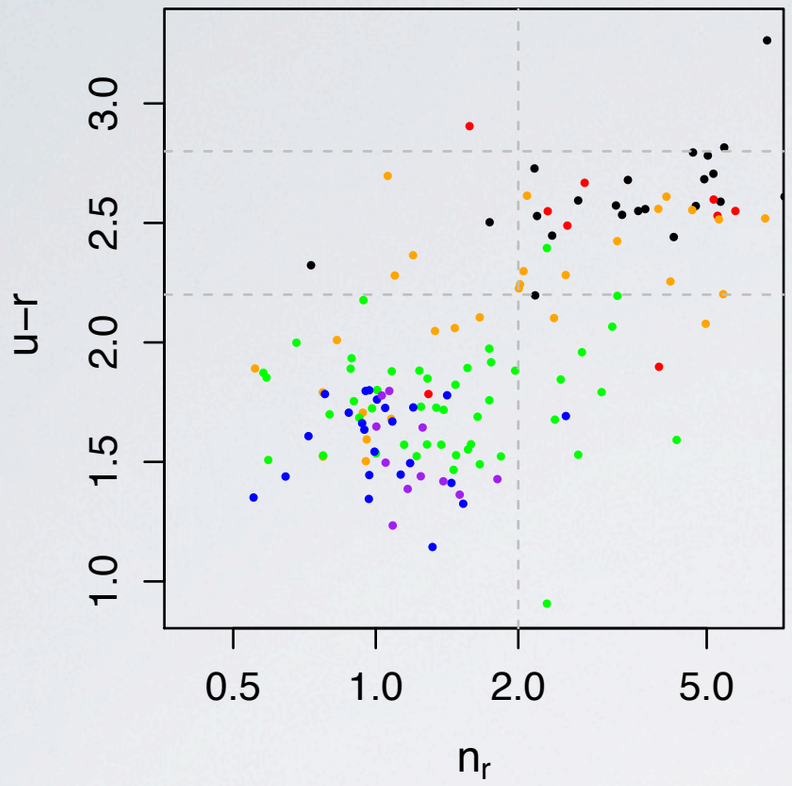
Structural parameters as classifiers

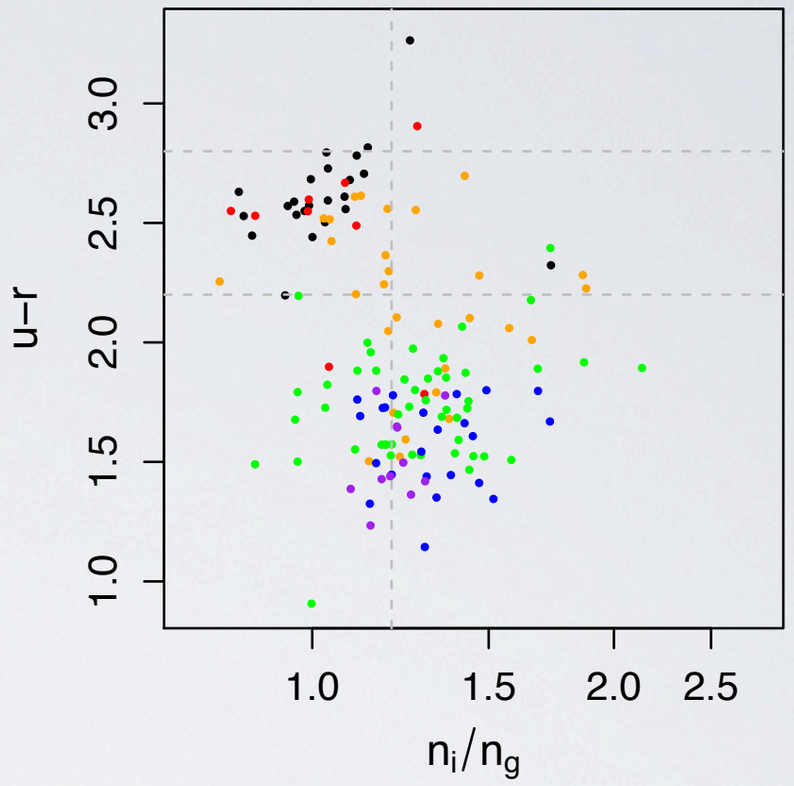




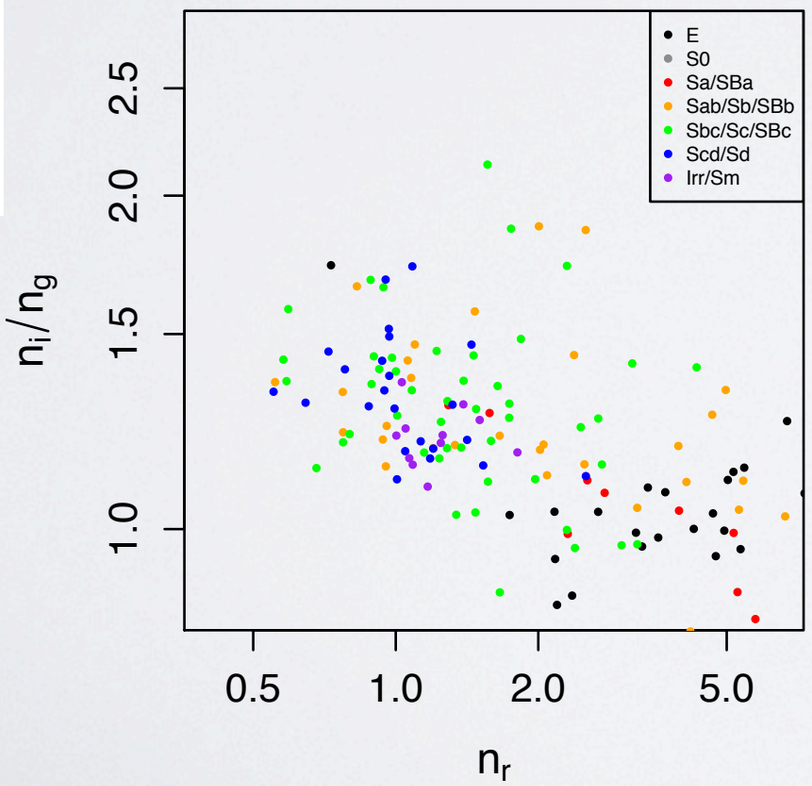
Structural parameters as classifiers (redshifted)

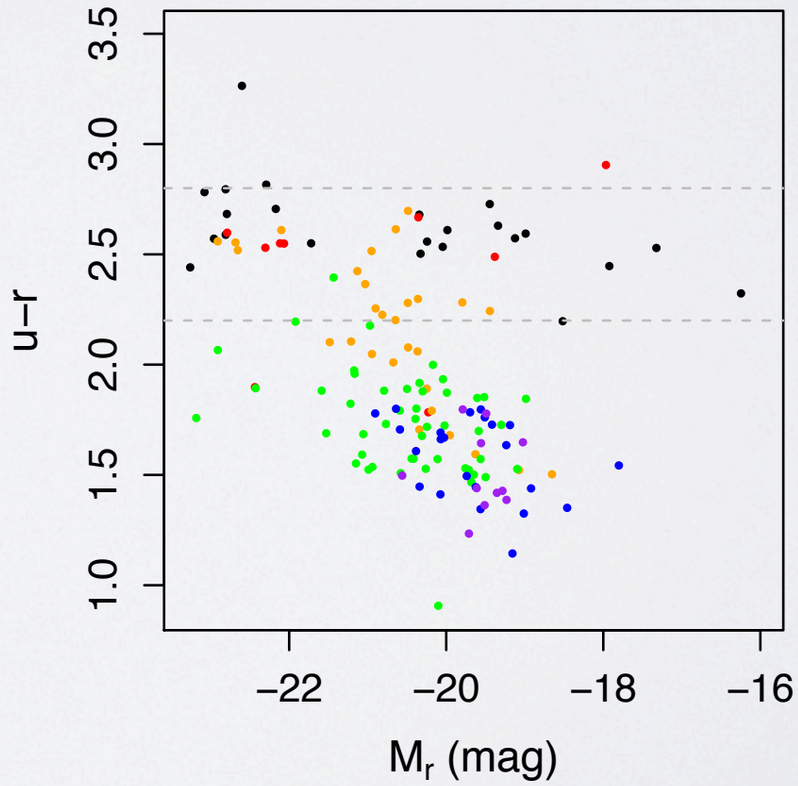




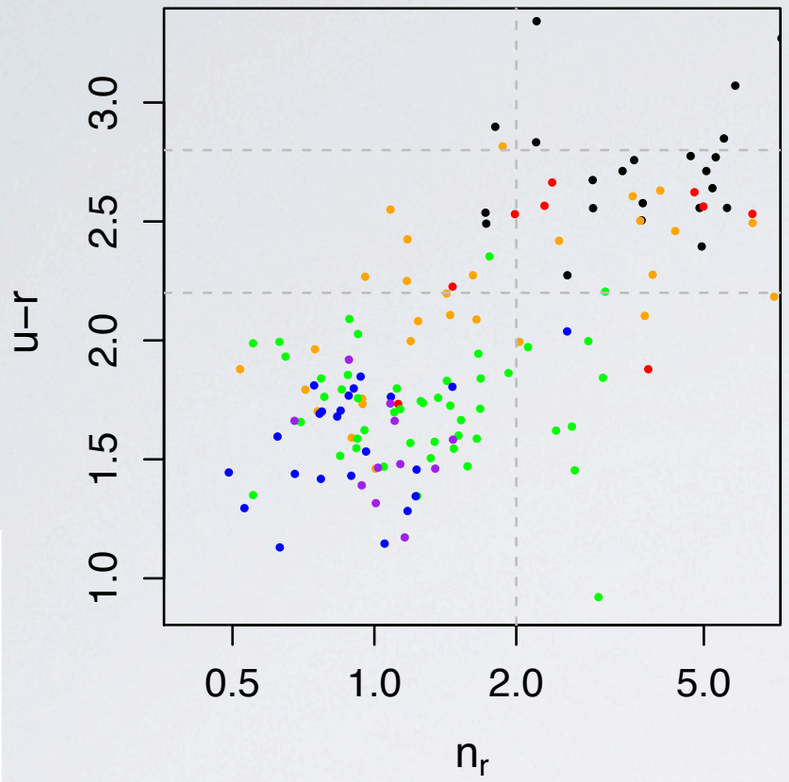


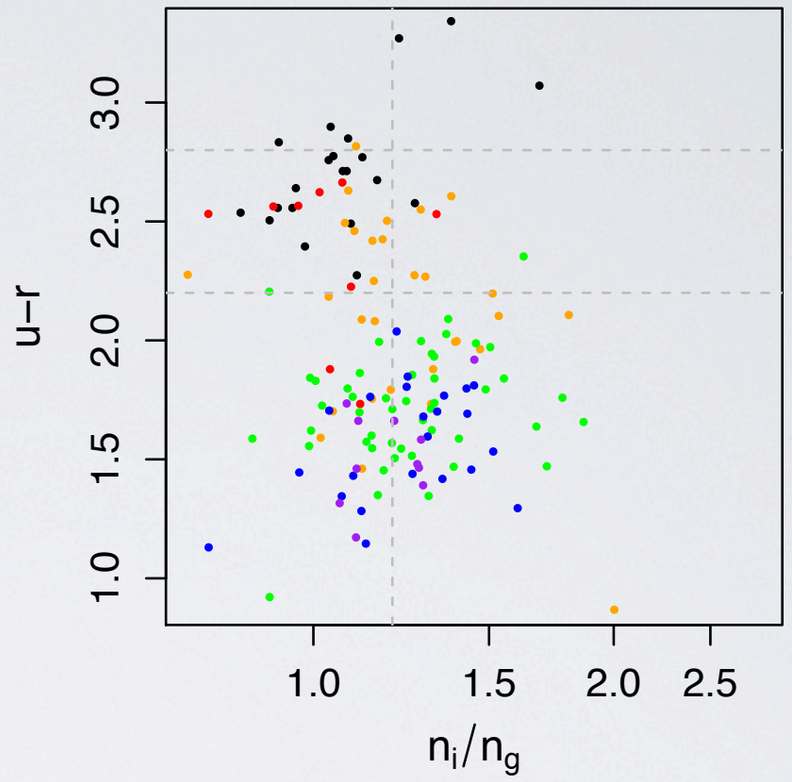
z =0.04





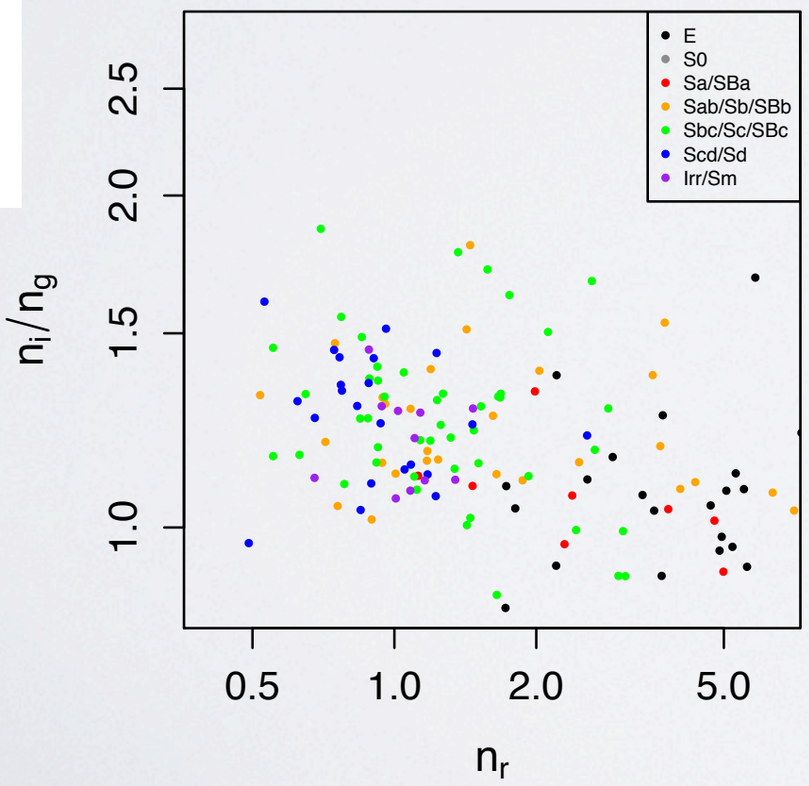
Structural parameters as classifiers (redshifted)

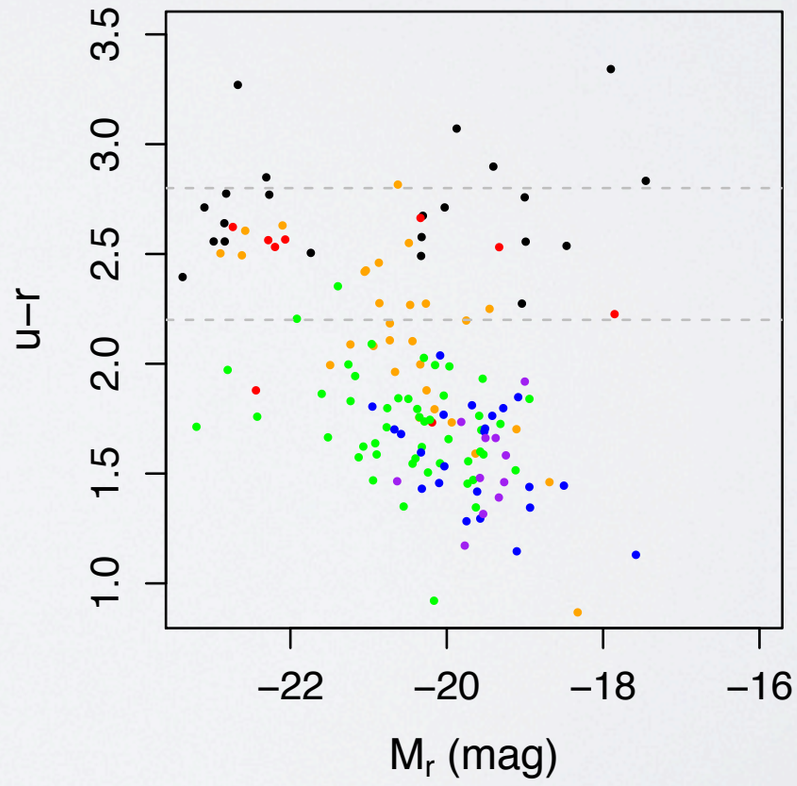




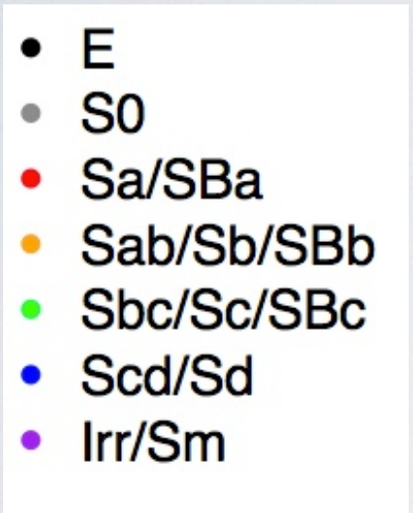
- E
- S0
- Sa/SBa
- Sab/Sb/SBb
- Sbc/Sc/SBc
- Scd/Sd
- Irr/Sm

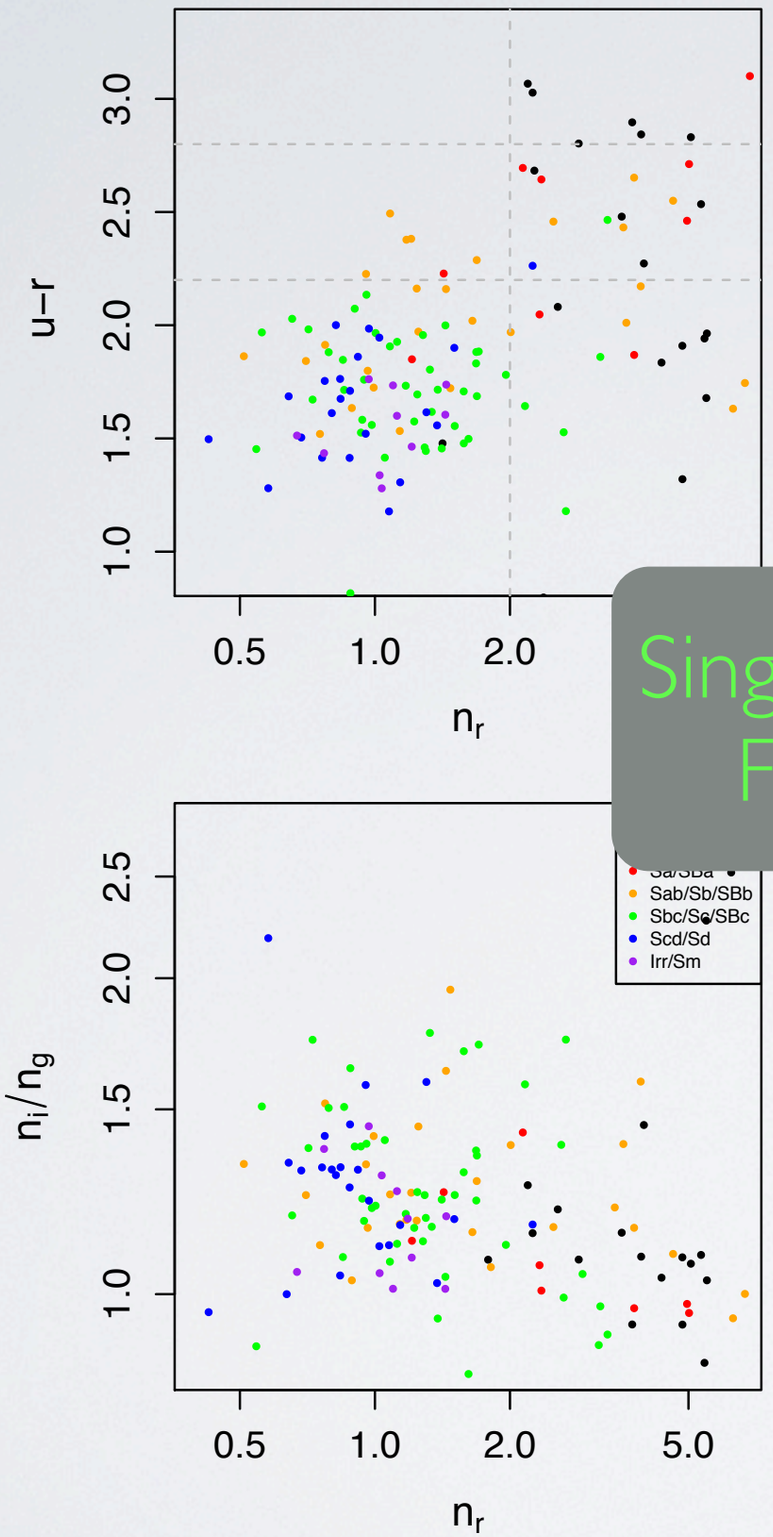
z =0.08

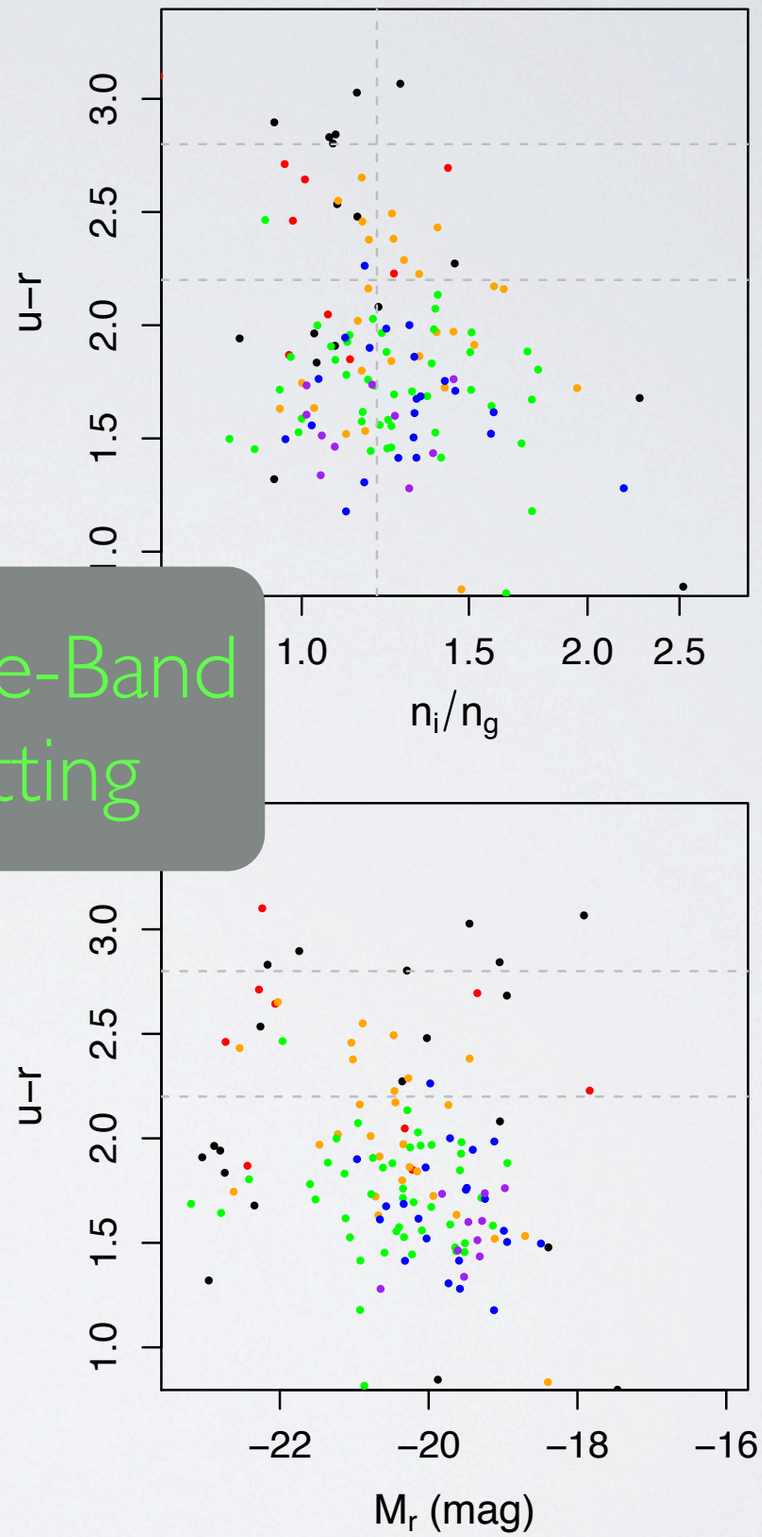




Structural parameters as classifiers (redshifted)







Single-Band Fitting

z =0.08

MULTI-WAVELENGTH MEASUREMENT OF GALAXY STRUCTURE:

BULGE-DISK DECOMPOSITION OF GALAXIES (GALFITM)

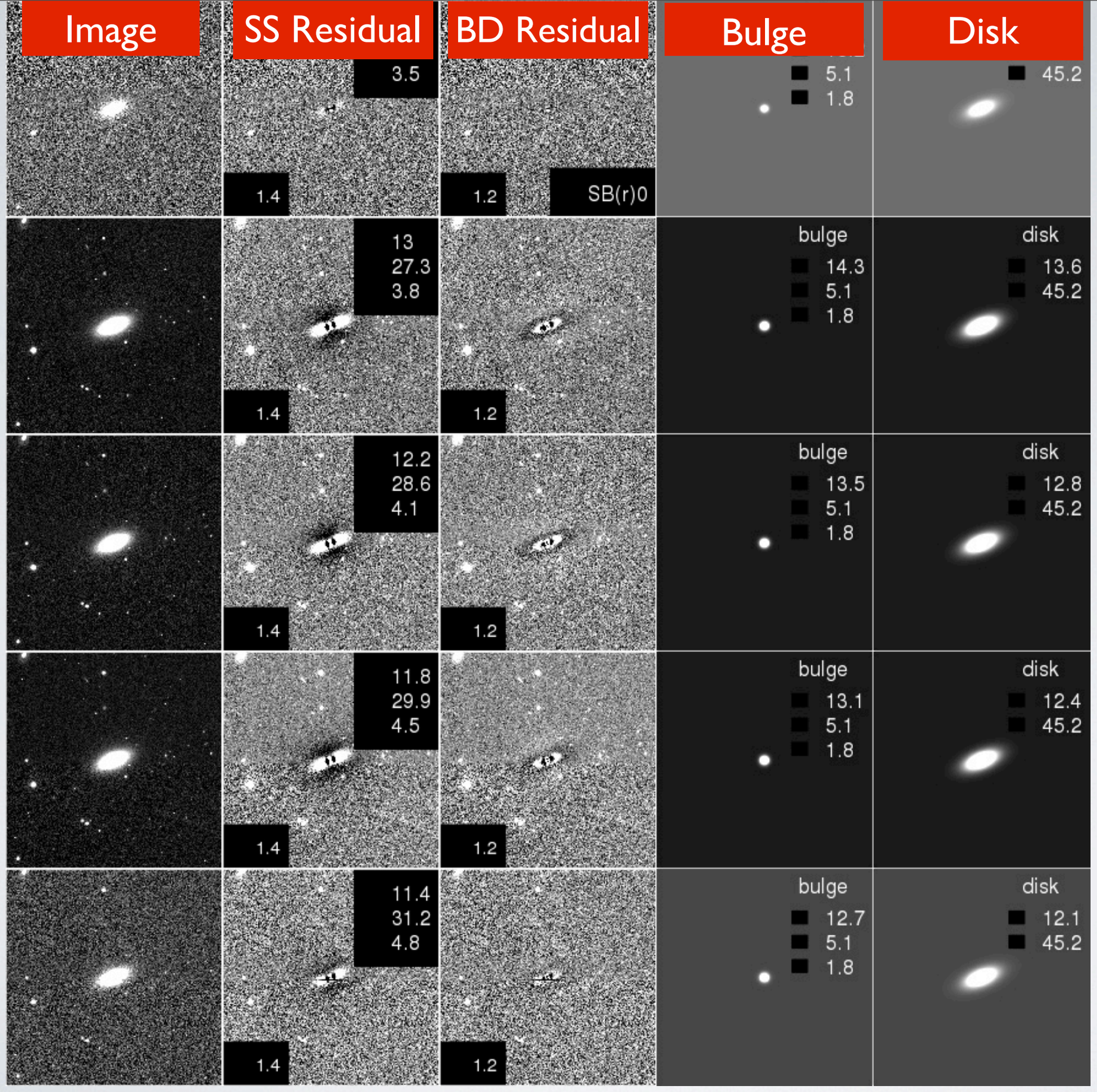
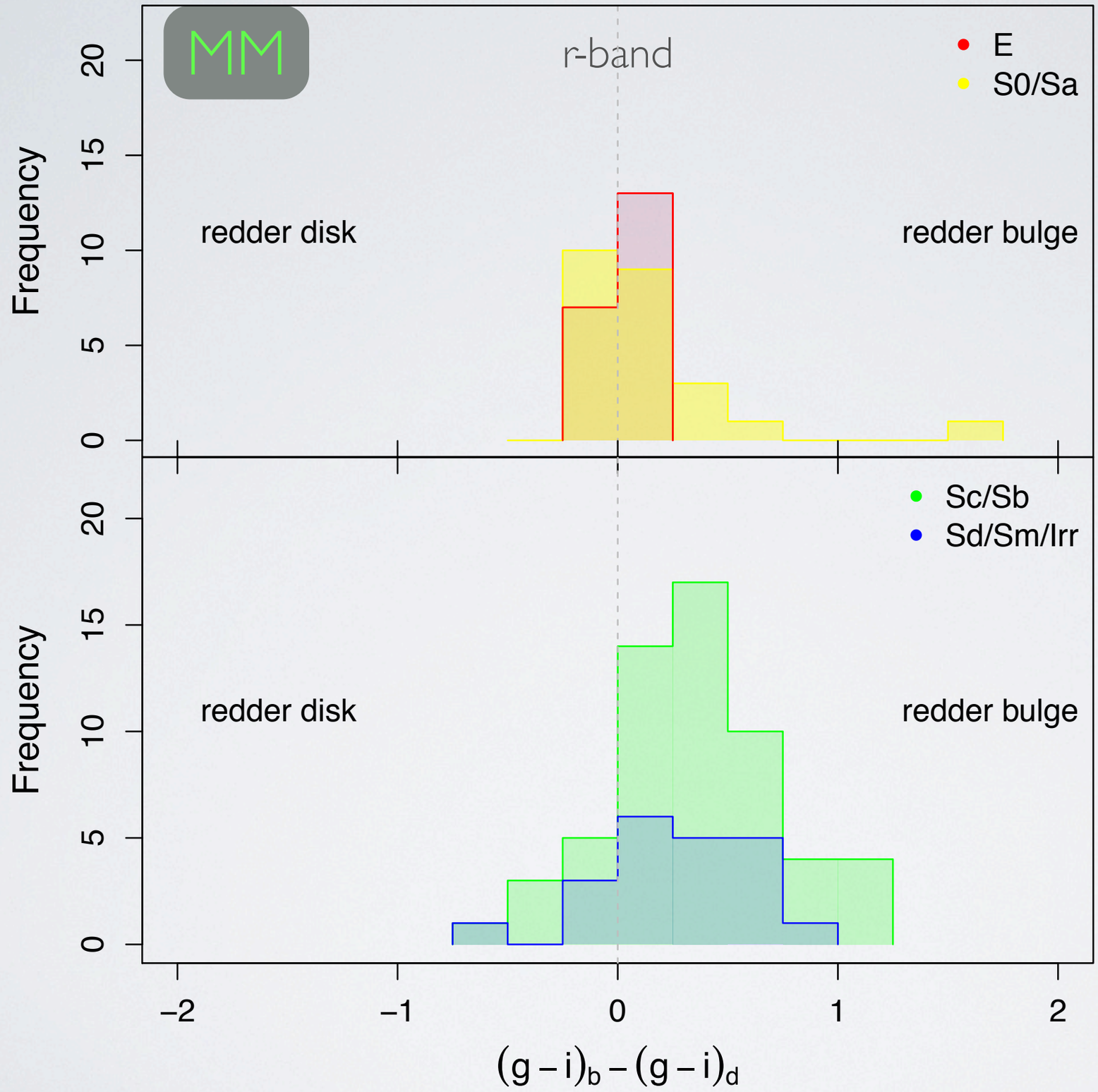


Image
SS Residual
BD Residual
Bulge
Disk
3.5
1.4
1.2
SB(r)0
5.1
1.8
45.2
13
27.3
3.8
bulge
14.3
5.1
1.8
disk
13.6
45.2
12.2
28.6
4.1
13.5
12.8
11.8
29.9
4.5
13.1
12.4
11.4
31.2
4.8
12.7
12.1

NGC 4255

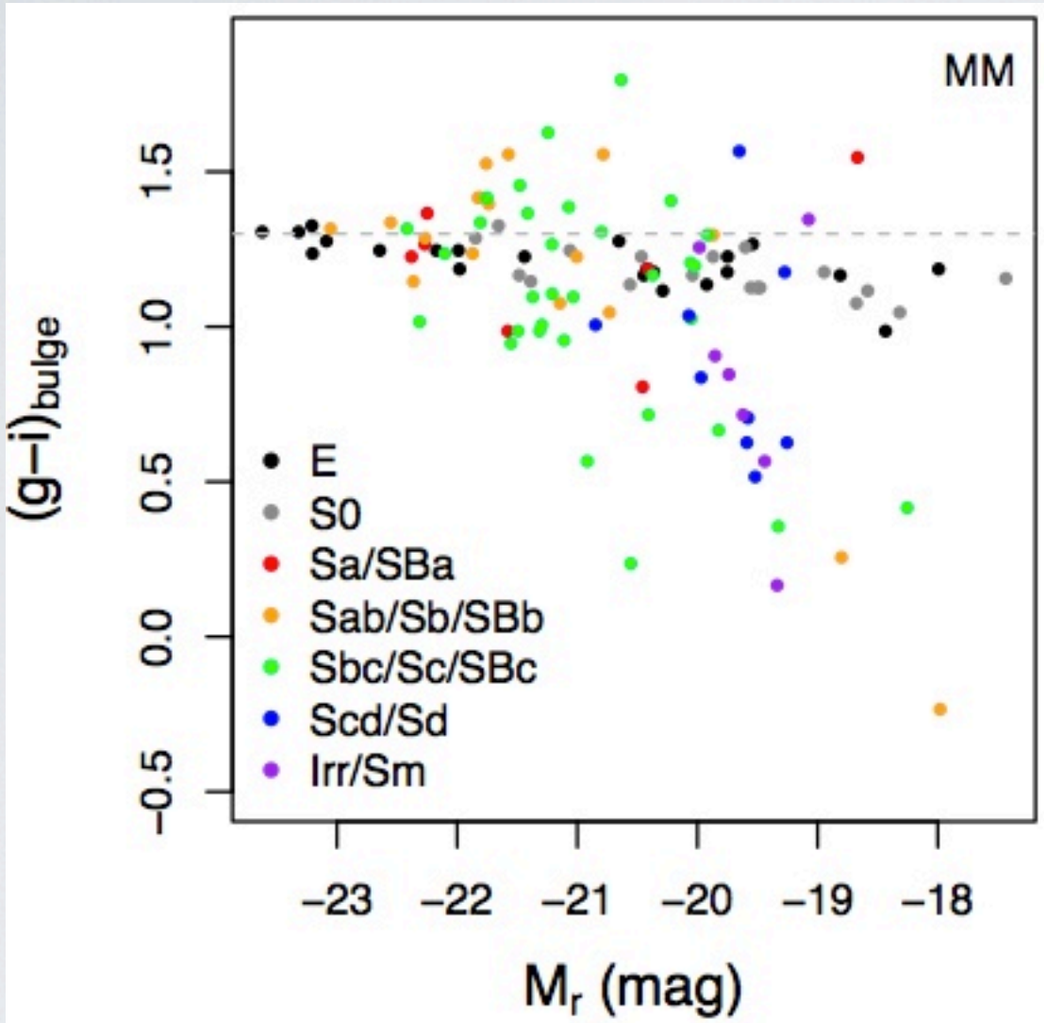
Bulge-Disk colour difference (Original images)

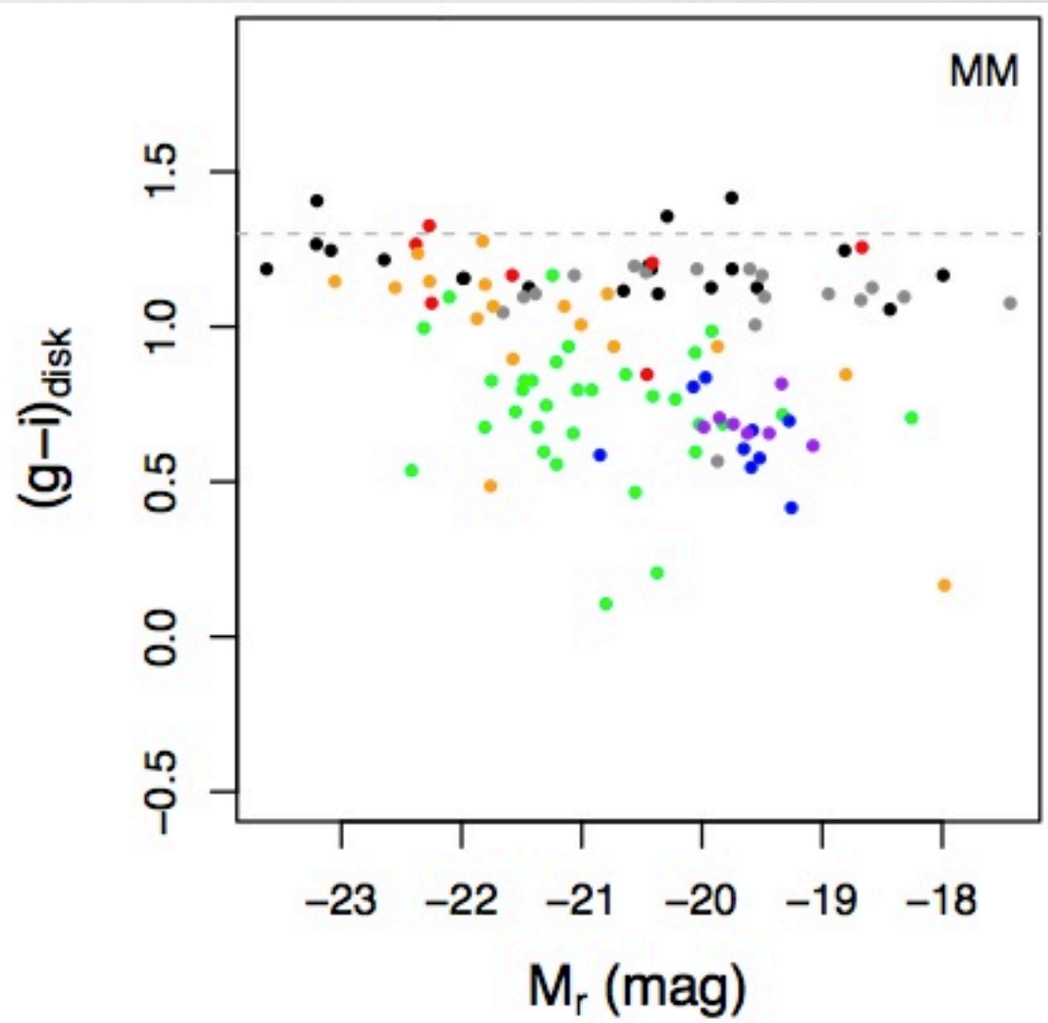


Average:
$(g\text{-}i)_b - (g\text{-}i)_d = 0.31 \pm 0.07$
in agreement with
Cameron et al 2009

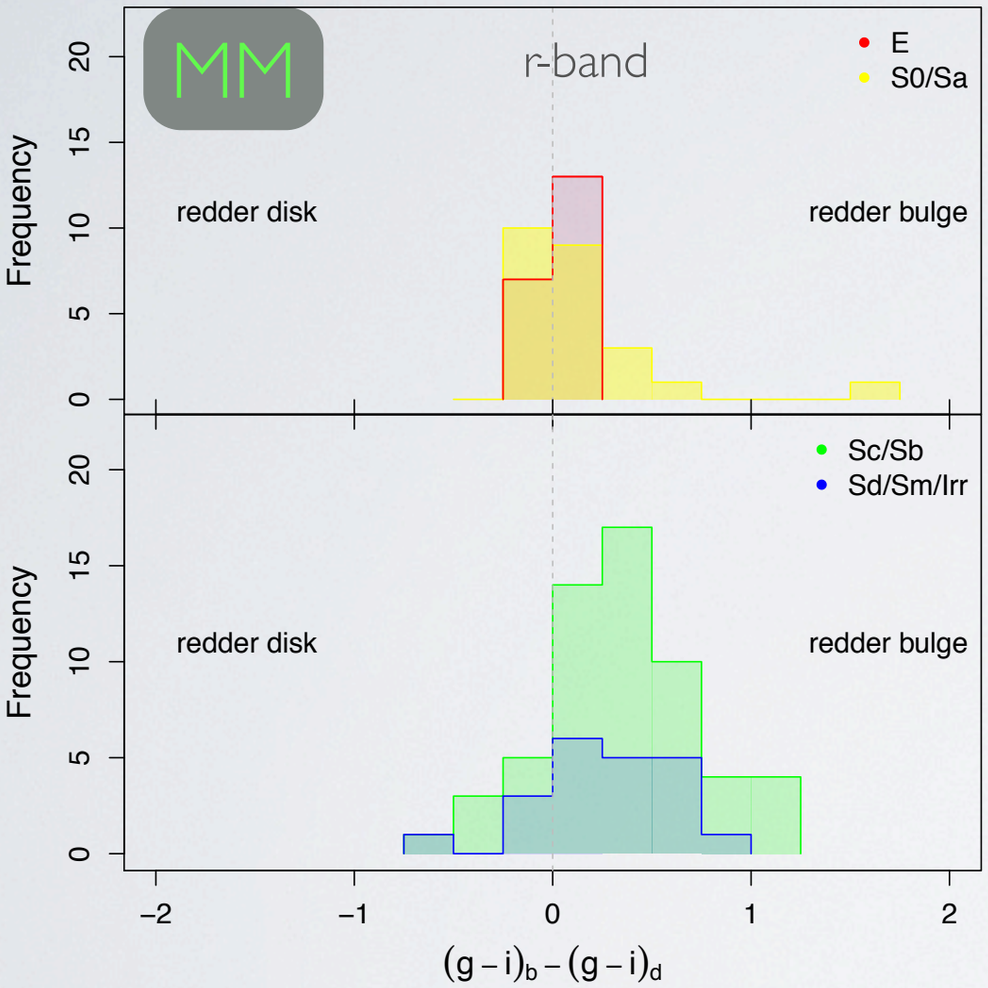
Vika et al in prep.

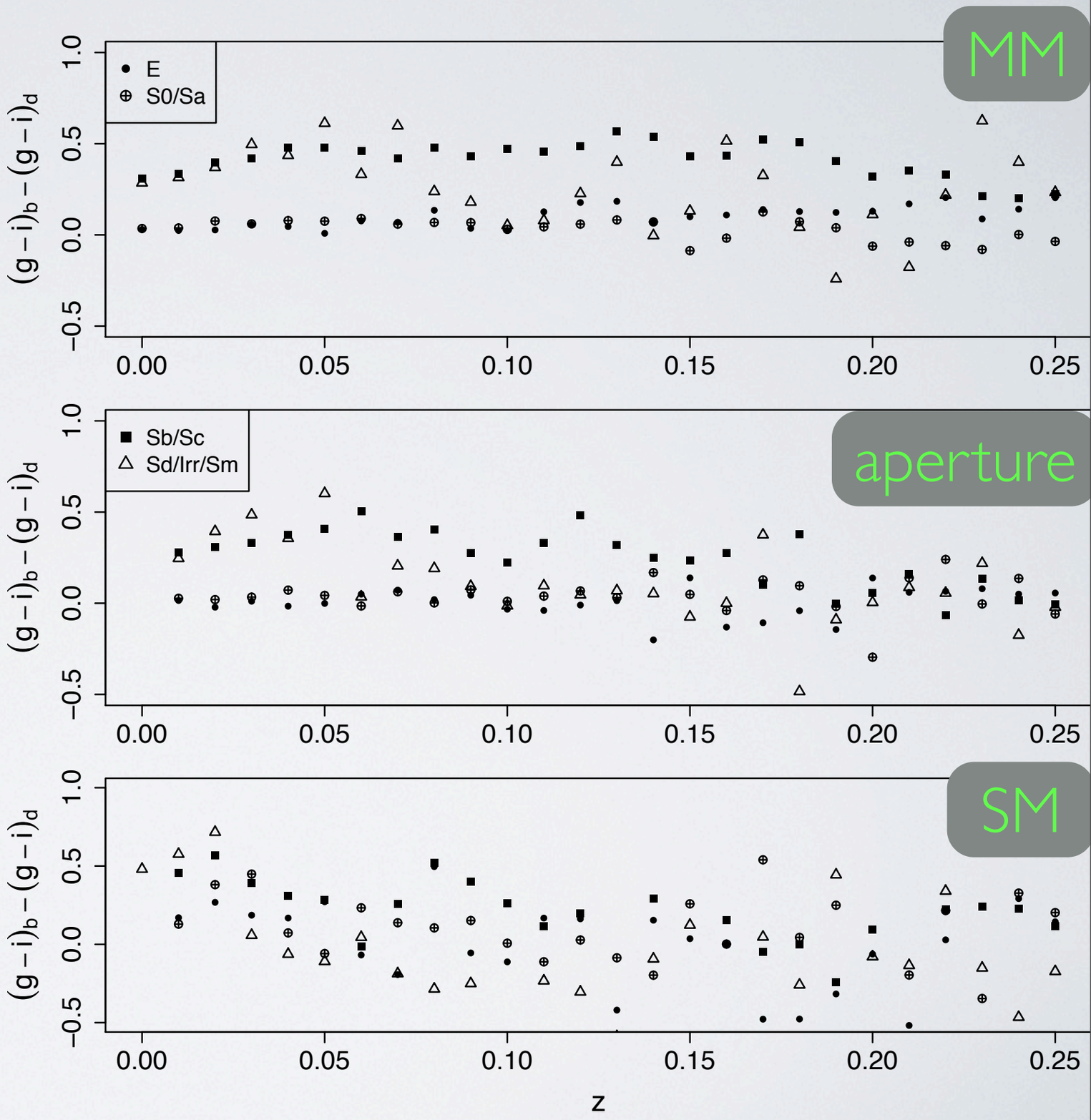
Bulge-Disk colour difference (Original images)





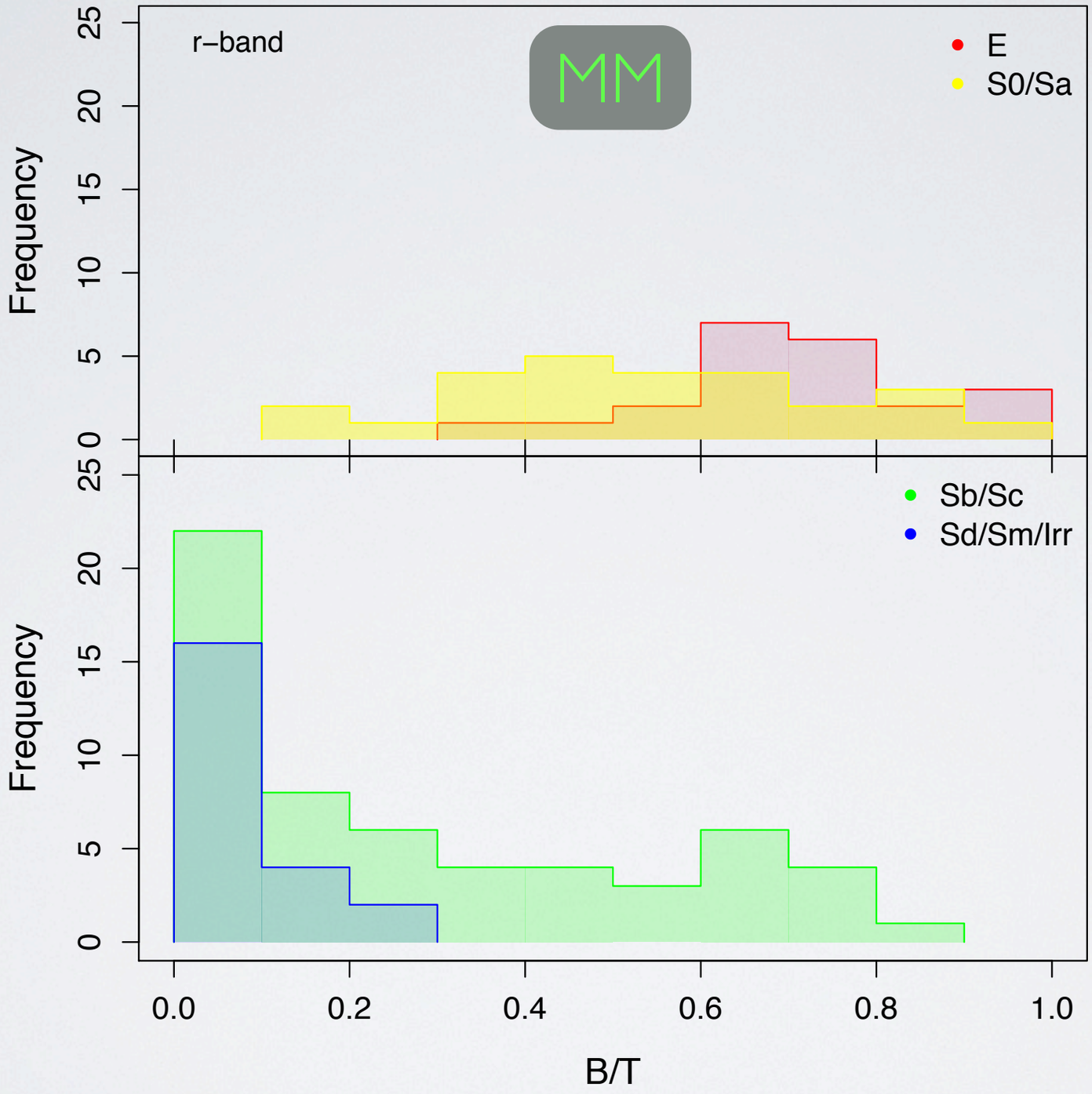
Bulge-Disk colour difference (Original & Ferengi images)



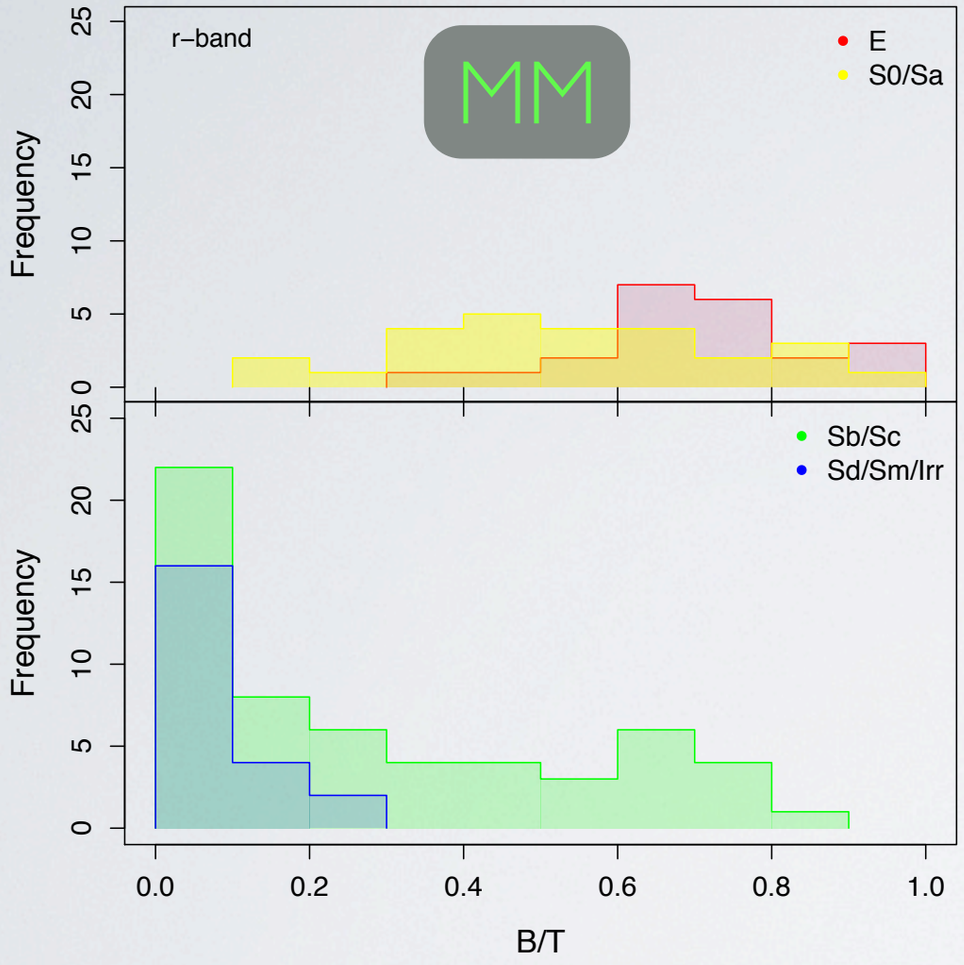


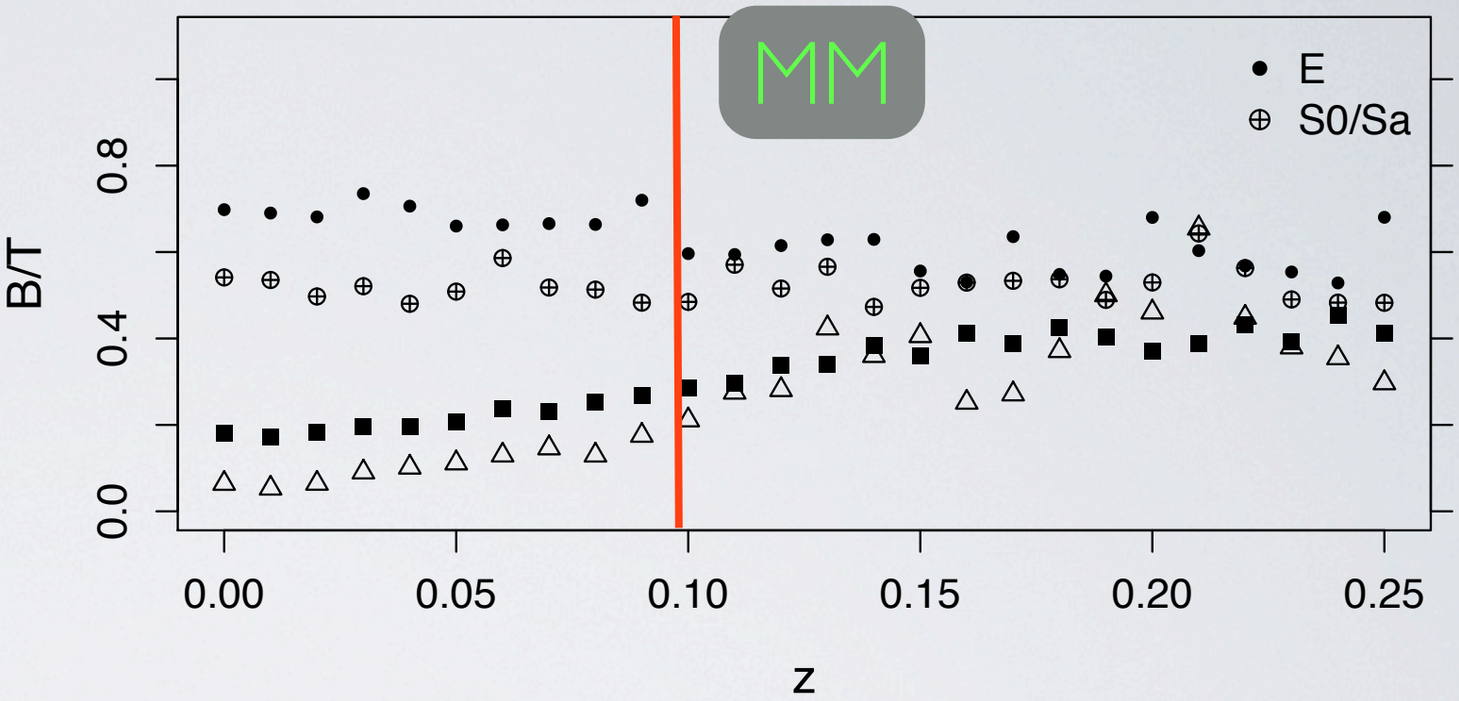
Vika et al in prep.

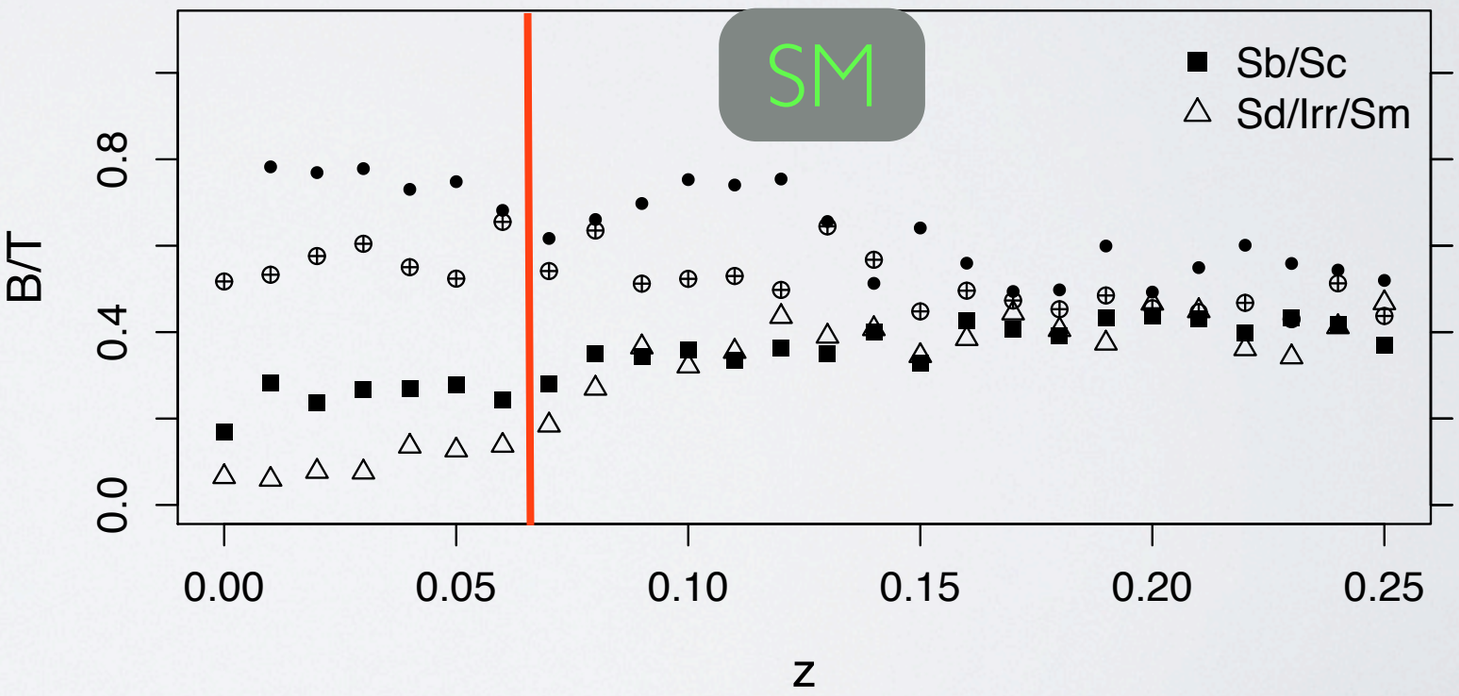
Bulge-to-total flux ratio (Original images)



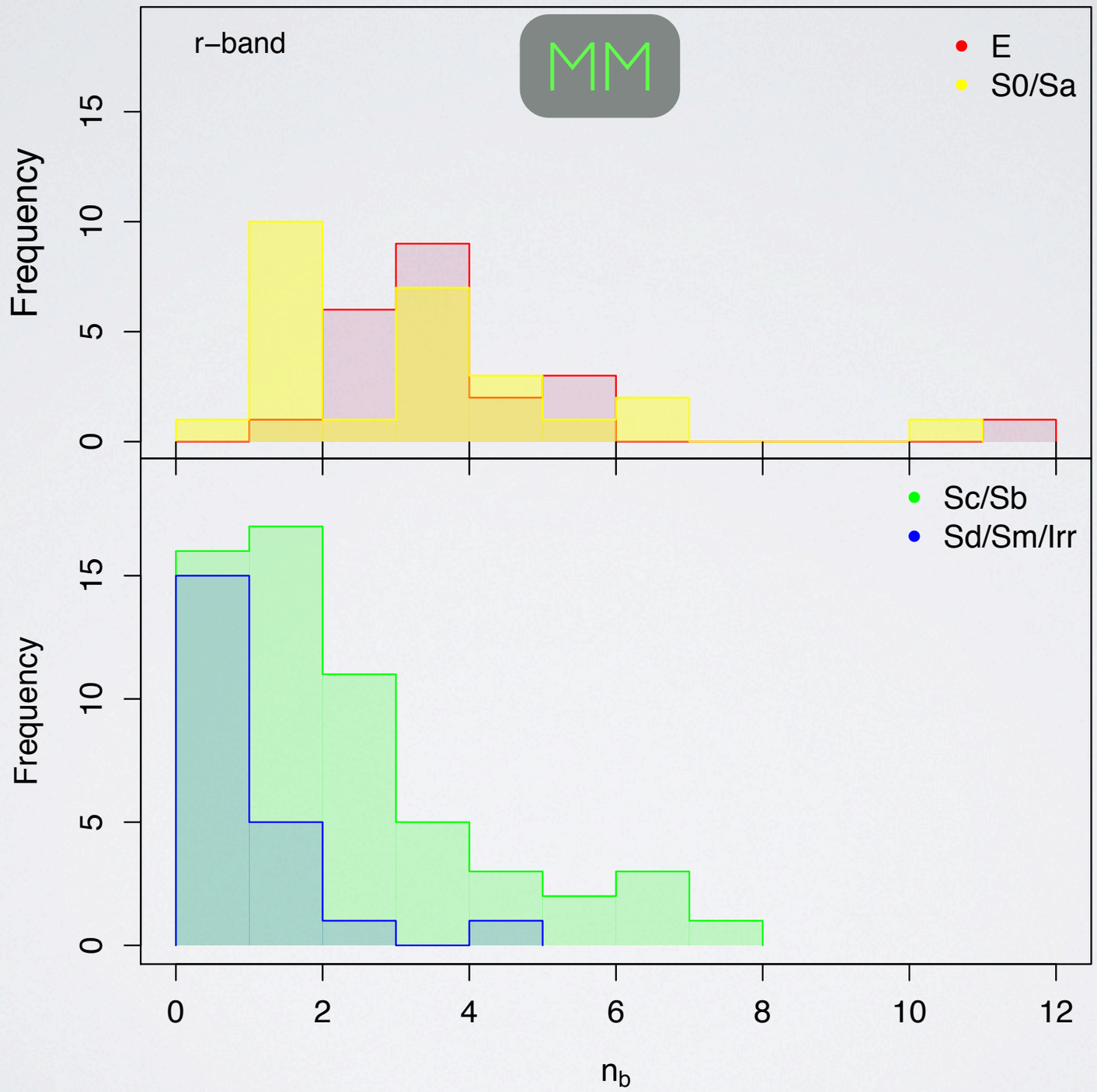
Bulge-to-total flux ratio (Original & Ferengi images)



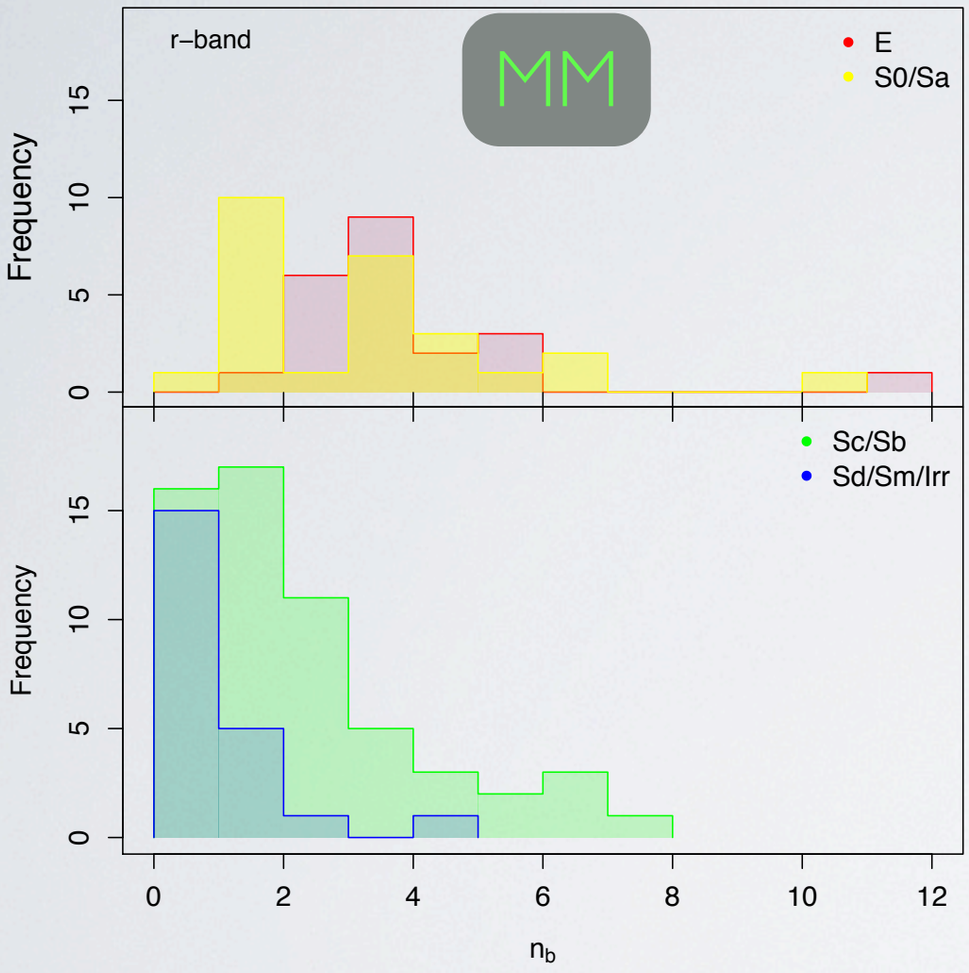


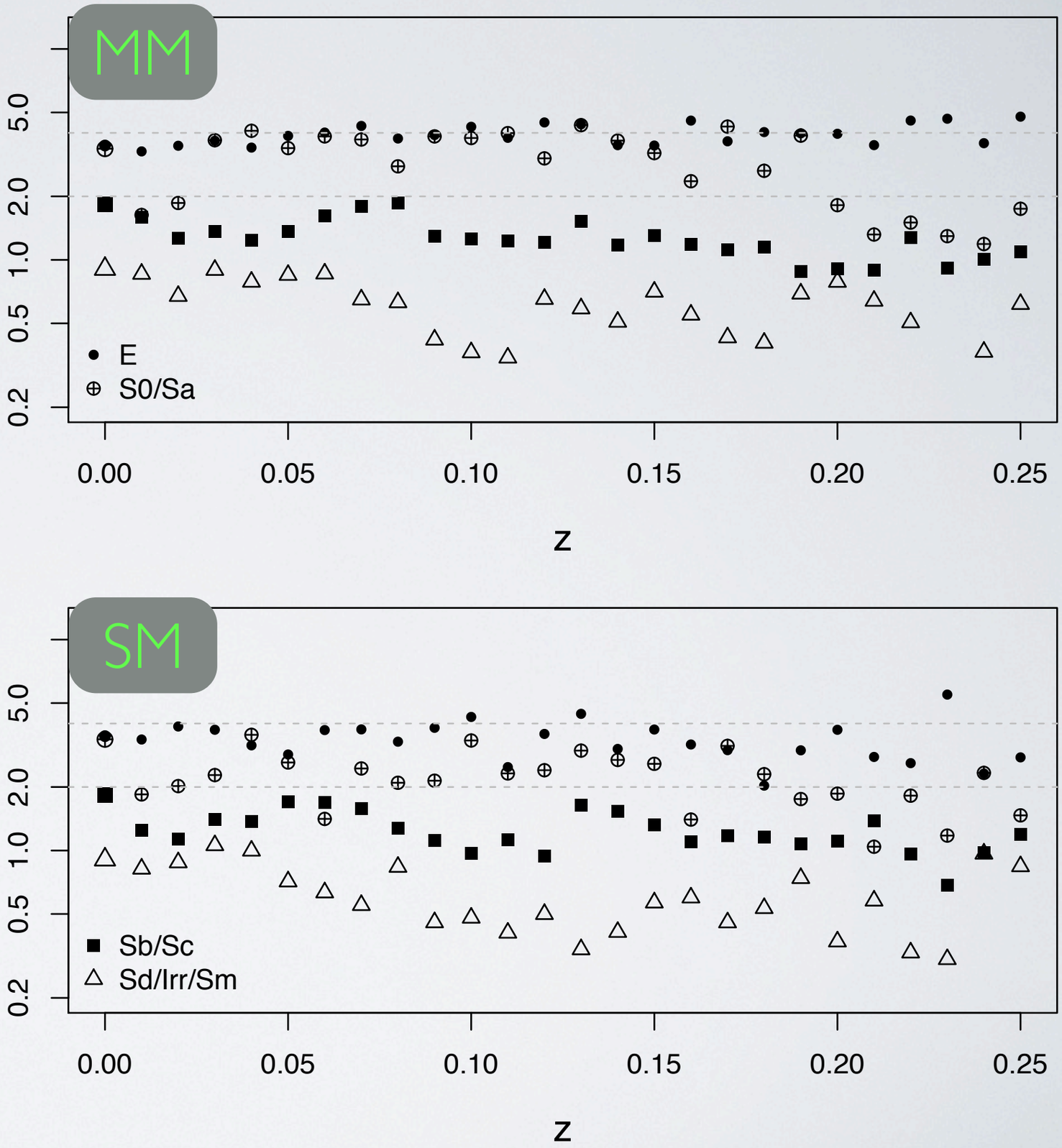


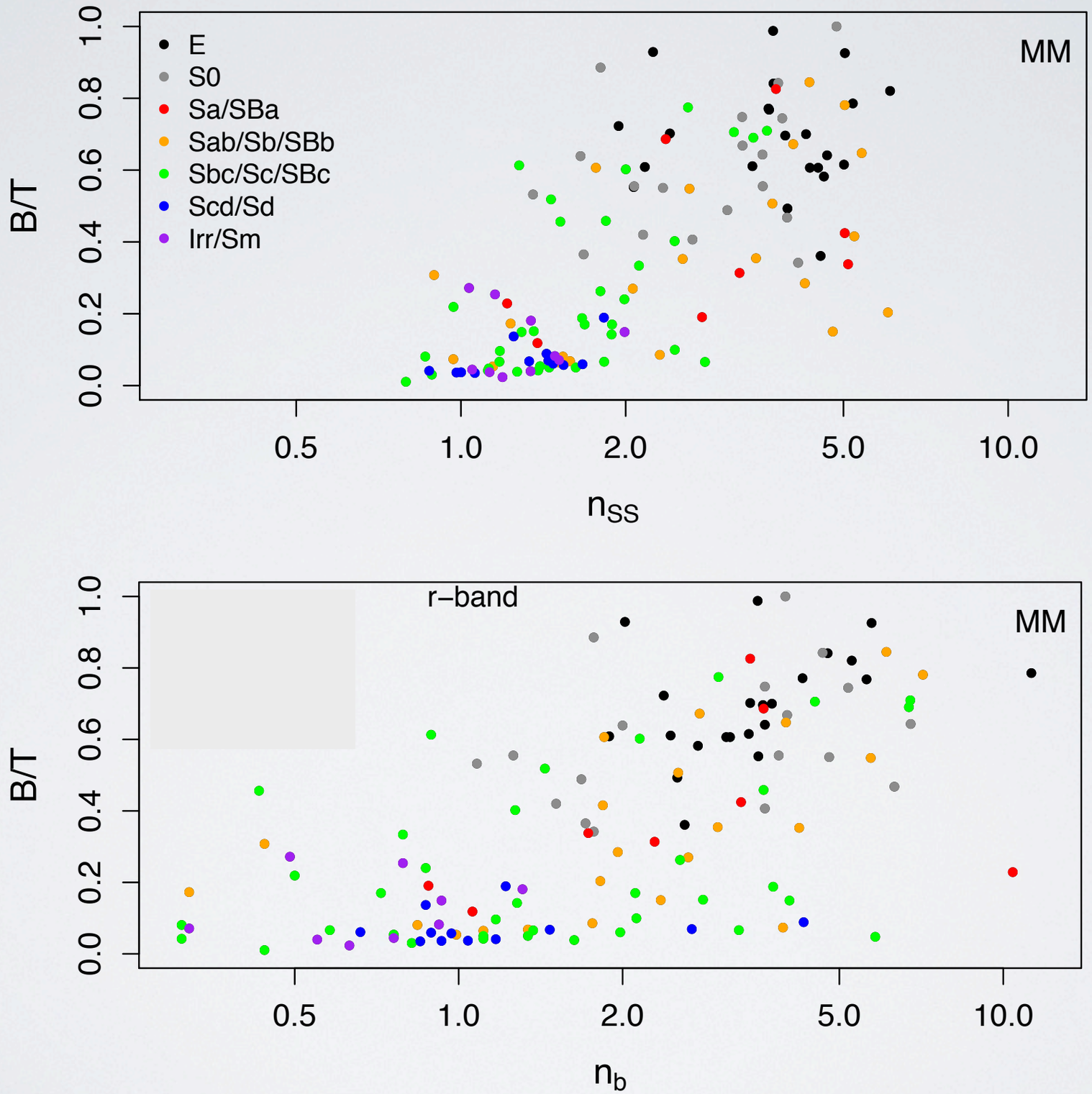
Bulge Sérsic index (Original images)



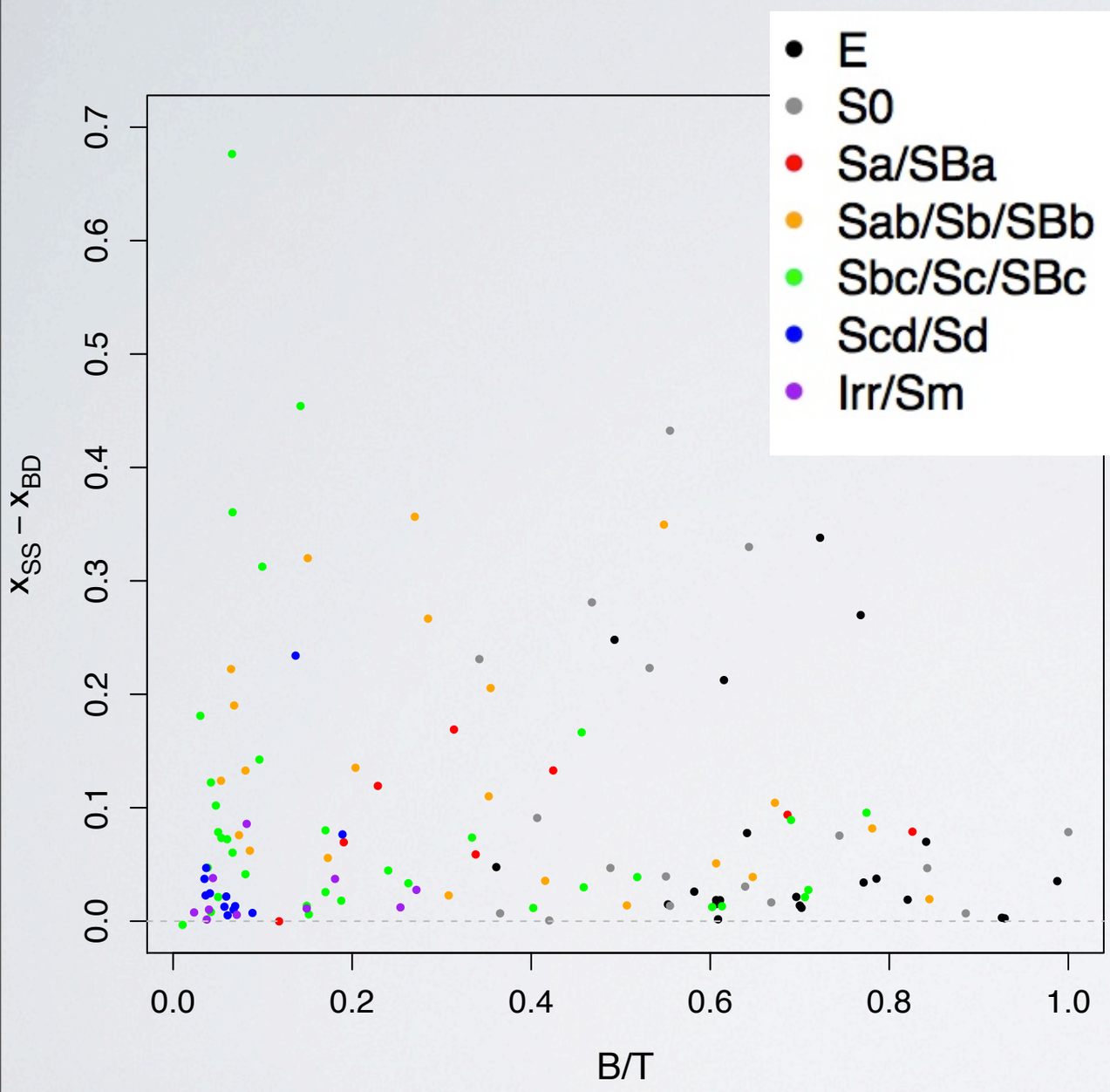
Bulge Sérsic index (Original & Ferengi images)

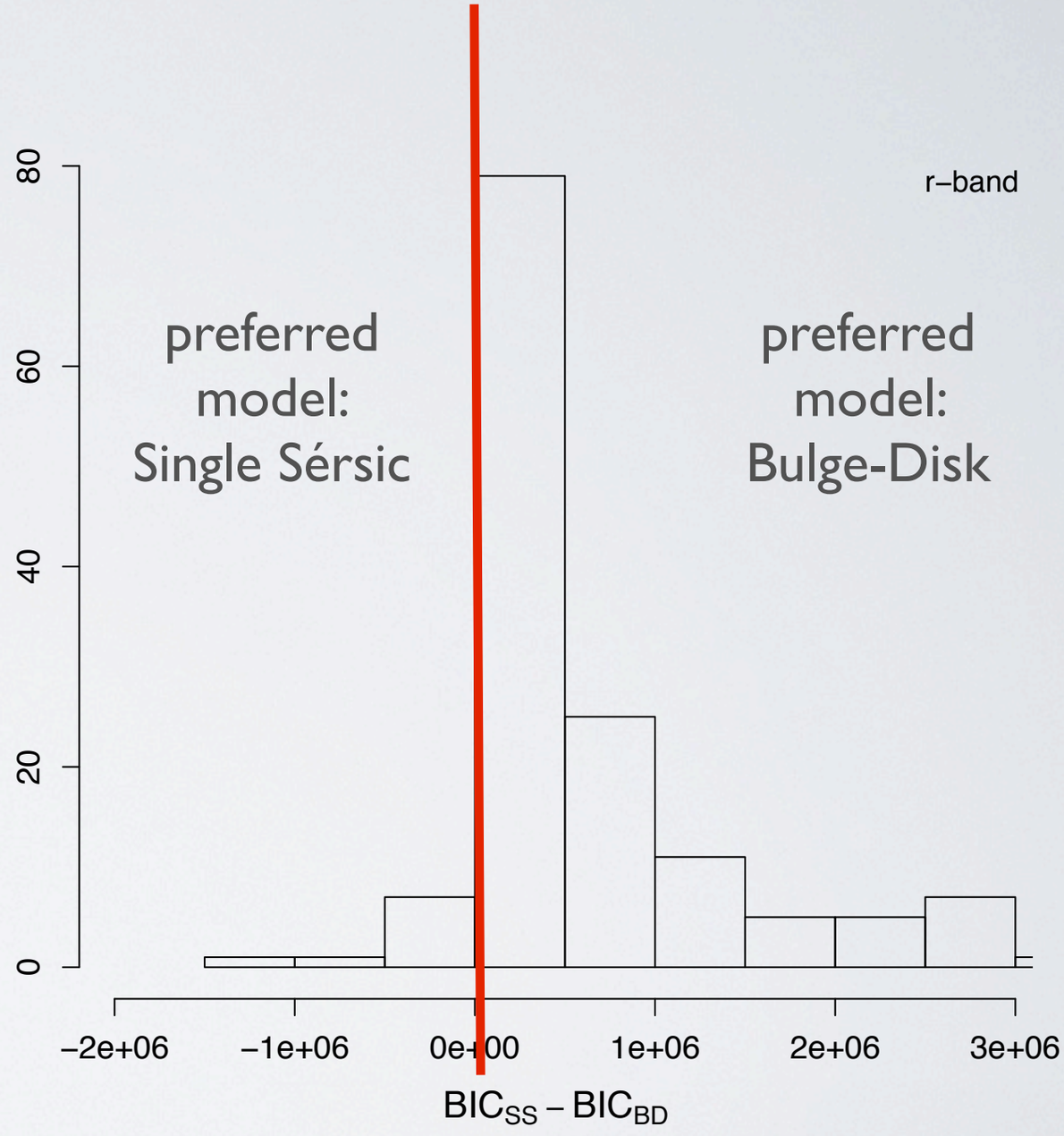





E
S0
Sa/SBa
Sab/Sb/SBb
Sbc/Sc/SBc
Scd/Sd
Irr/Sm
MM
B/T
0.0
0.2
0.4
0.6
0.8
1.0
0.5
1.0
2.0
5.0
10.0
n_{SS}
r−band
MM
B/T
n_b

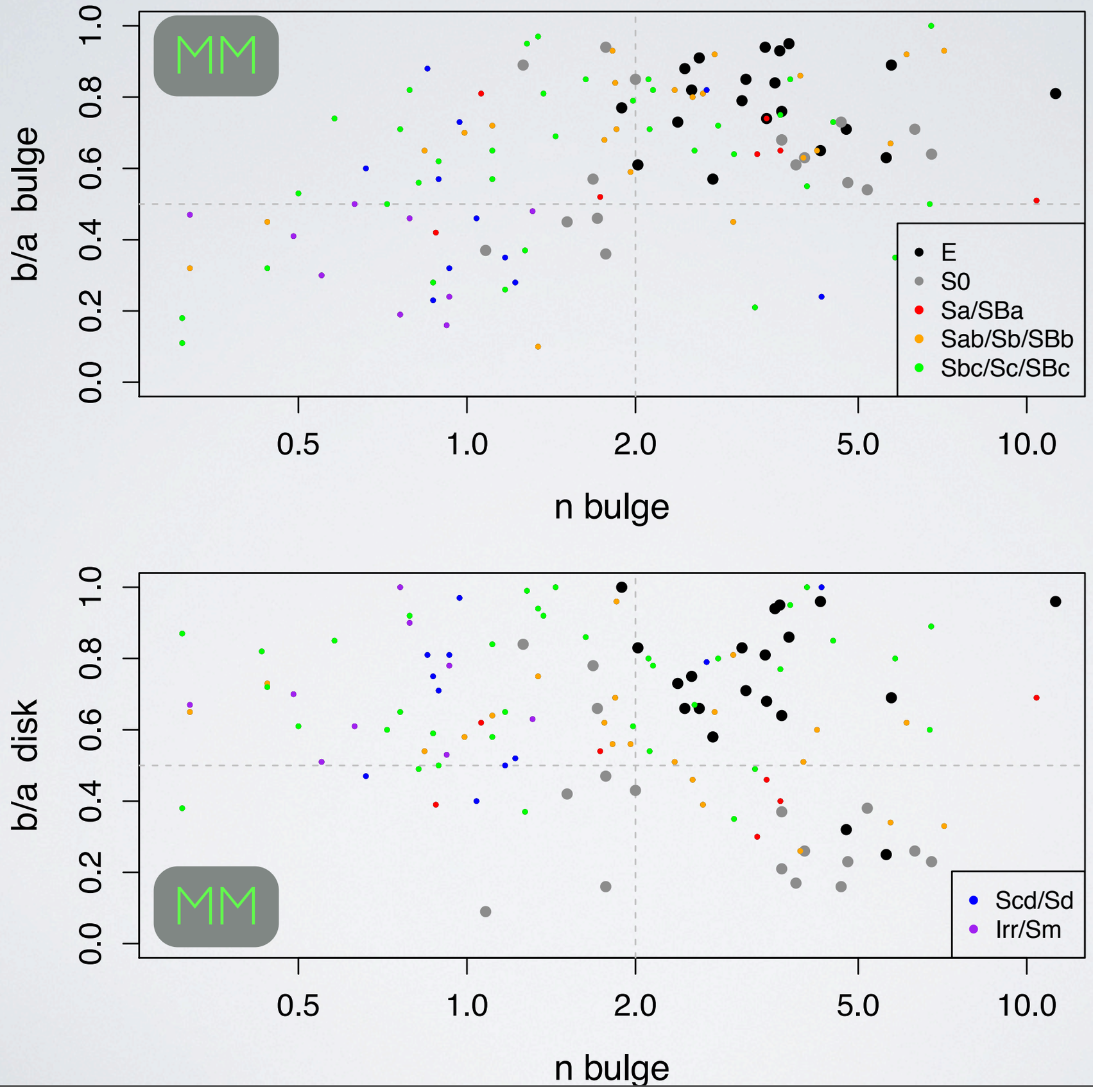
Model Selection Techniques



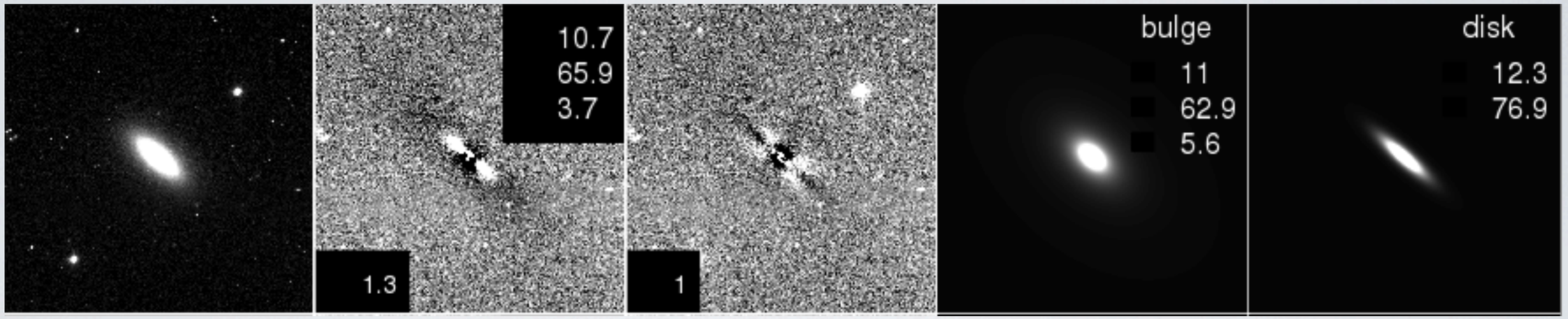


$BIC = x^2 + k*\ln(n)$

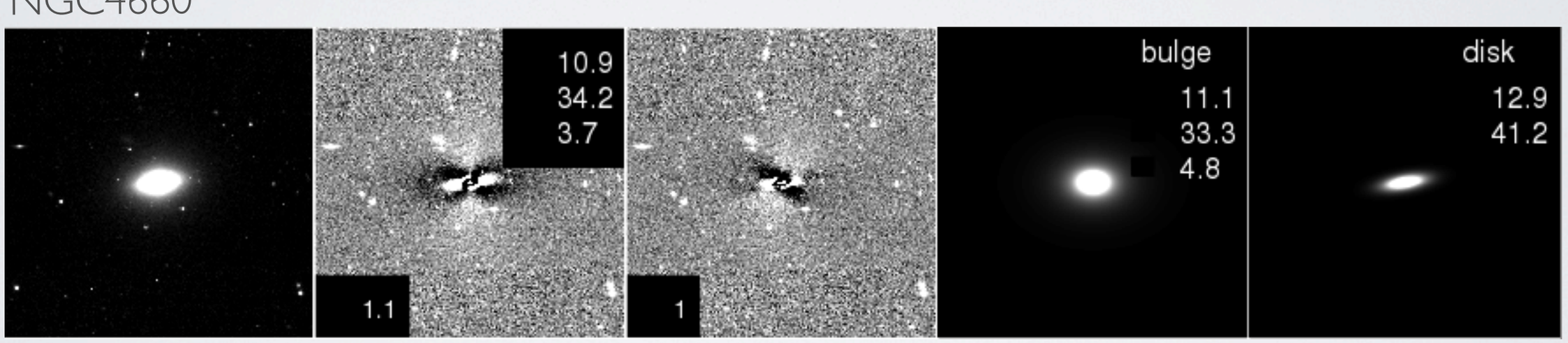
Axis ratio vs Bulge Sérsic index (Original images)



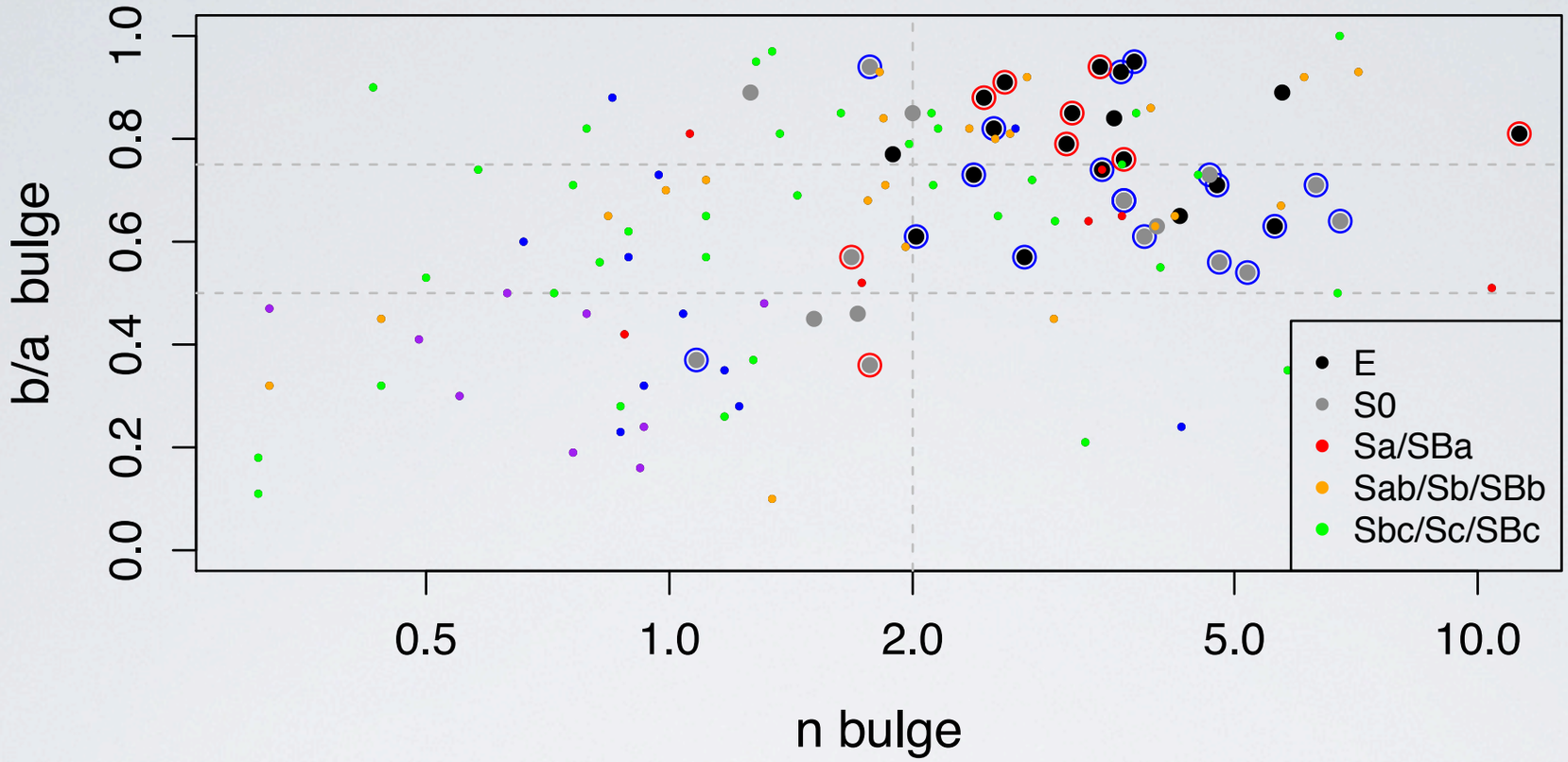
NGC4564

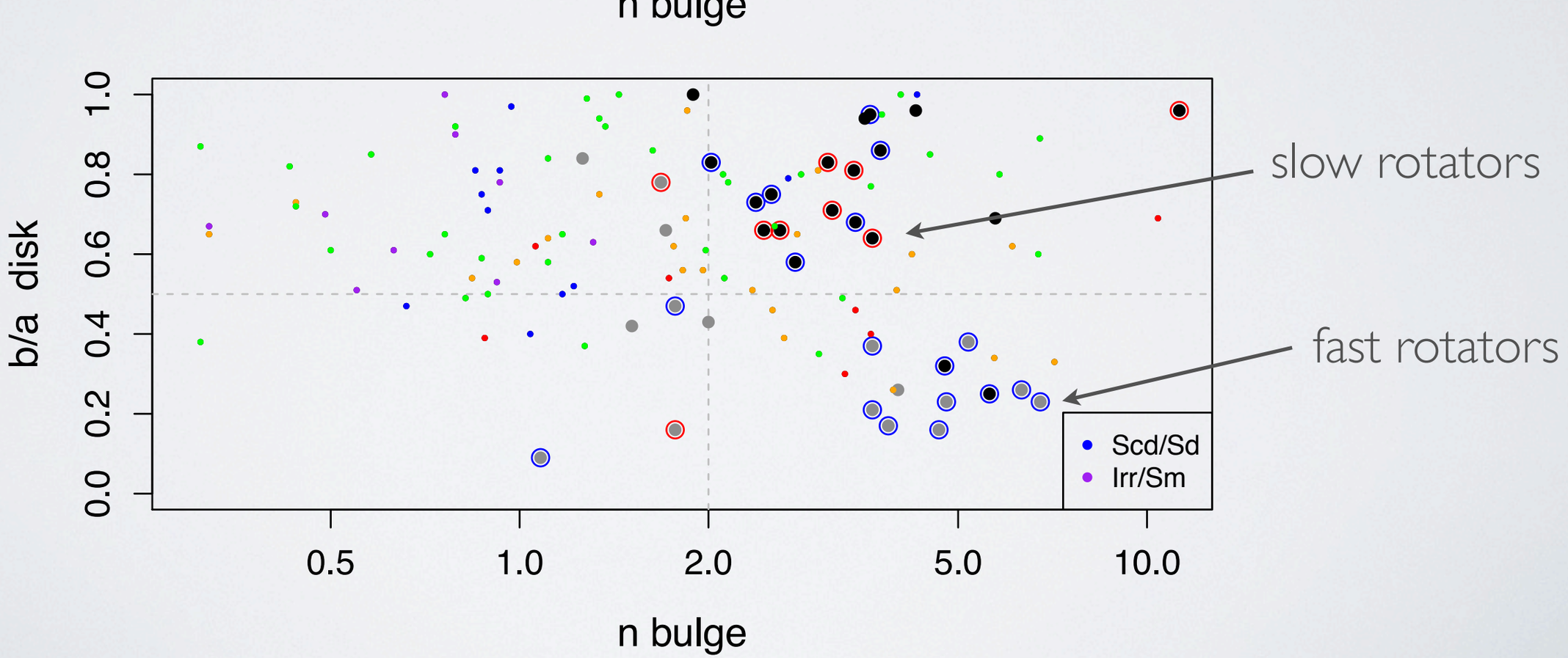


NGC4660

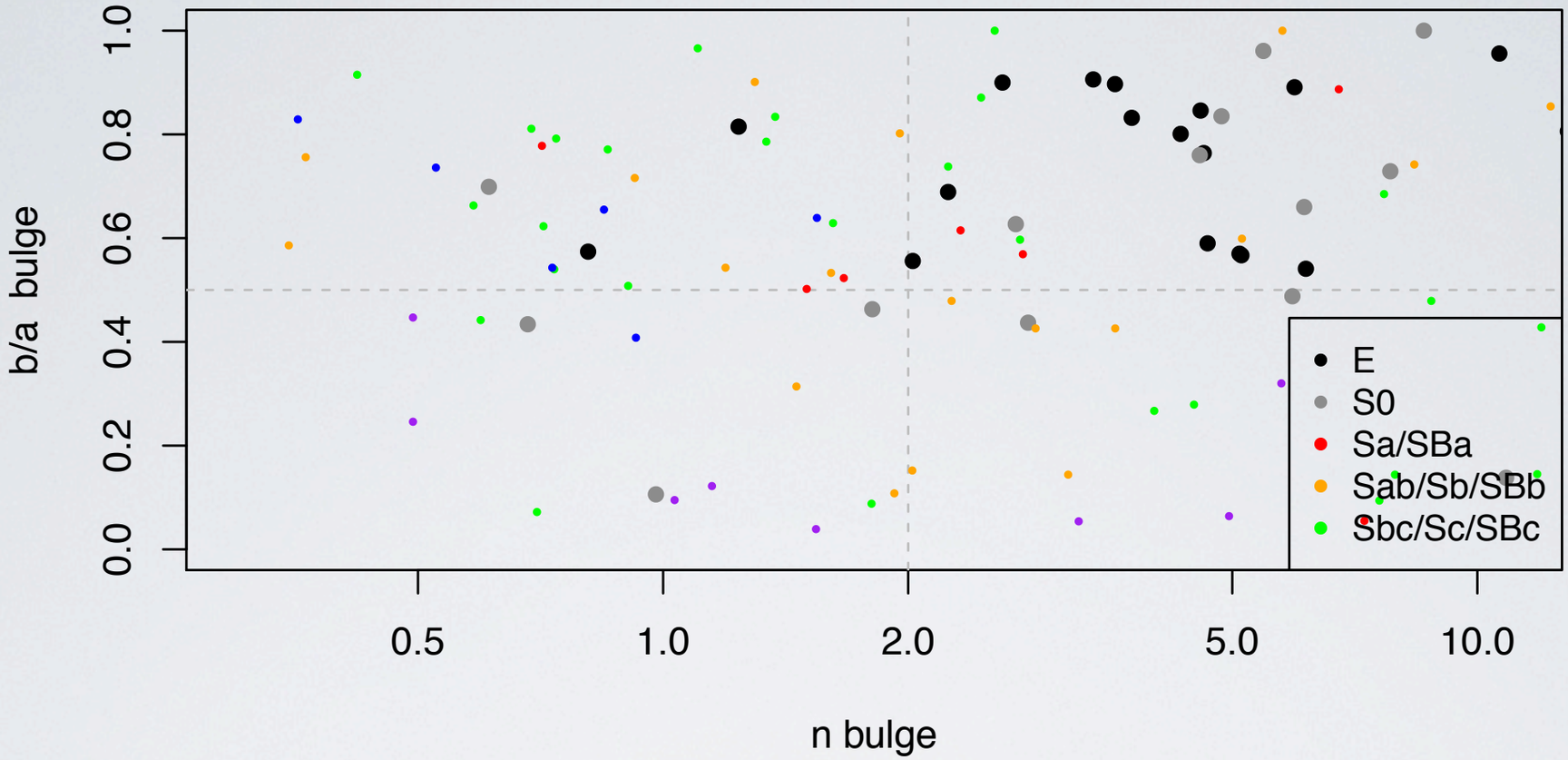


Axis ratio vs Bulge Sérsic index (Original images)

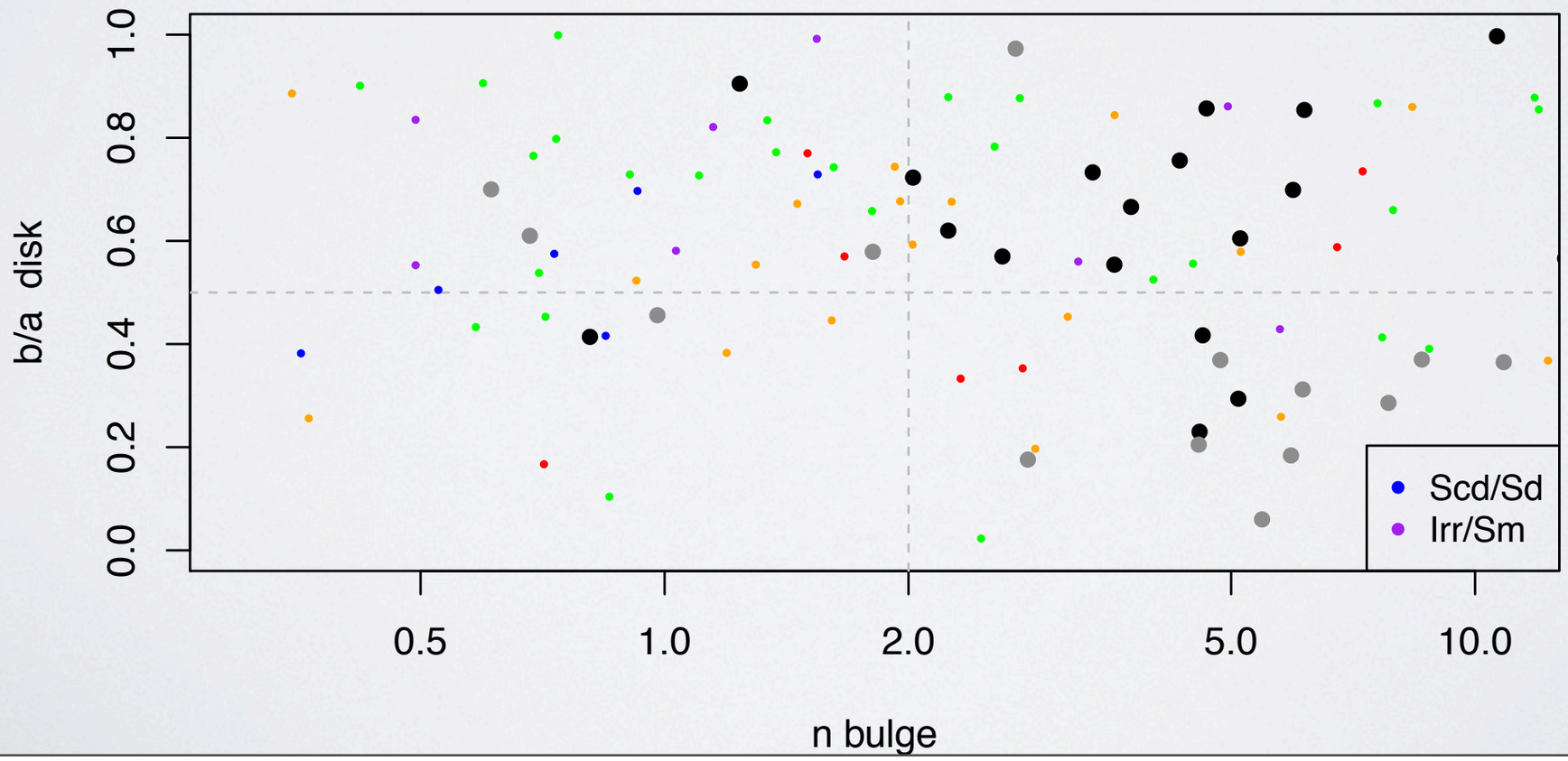




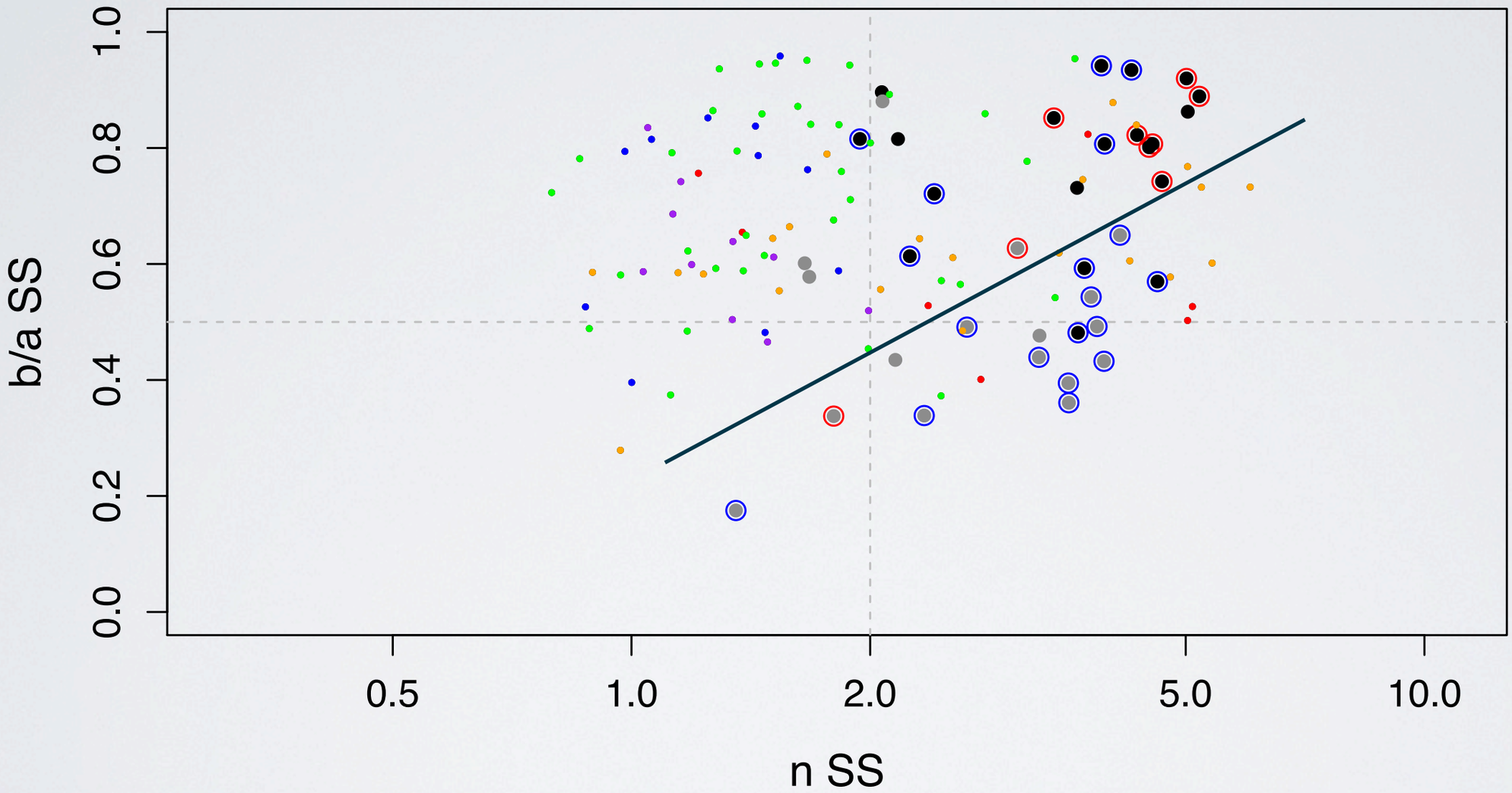
Axis ratio vs Bulge Sérsic index (Redshifted images)



z =0.08



Axis ratio vs single Sérsic index (Original images)



Summary

- Using single-Sérsic fits photometric structural parameters (Sérsic index, Sérsic index ratio (n_i/n_g) and colour) we can separate early type galaxies (E/S0/Sa) from late-type (Sb,Sc,Irr) galaxies.

- Using bulge-disk decomposition we find that early type (E/S0/Sa) galaxies have "components" with the same colour.

- Using bulge-disk decomposition results we showed that Sb-Sc and Sd-Irr galaxies have the same bulge-disk colour difference: $d(g-i) = 0.31 \pm 0.07$ and 0.34 ± 0.09.

- Fitting all galaxies with a Sérsic plus exponential function we find that the axial ratio of the exponential function distinguishes between visually classified E and S0.

- Multi-band fitting improves over single-band fitting for the extraction of structural parameters and reduces the scatter.

Thank you