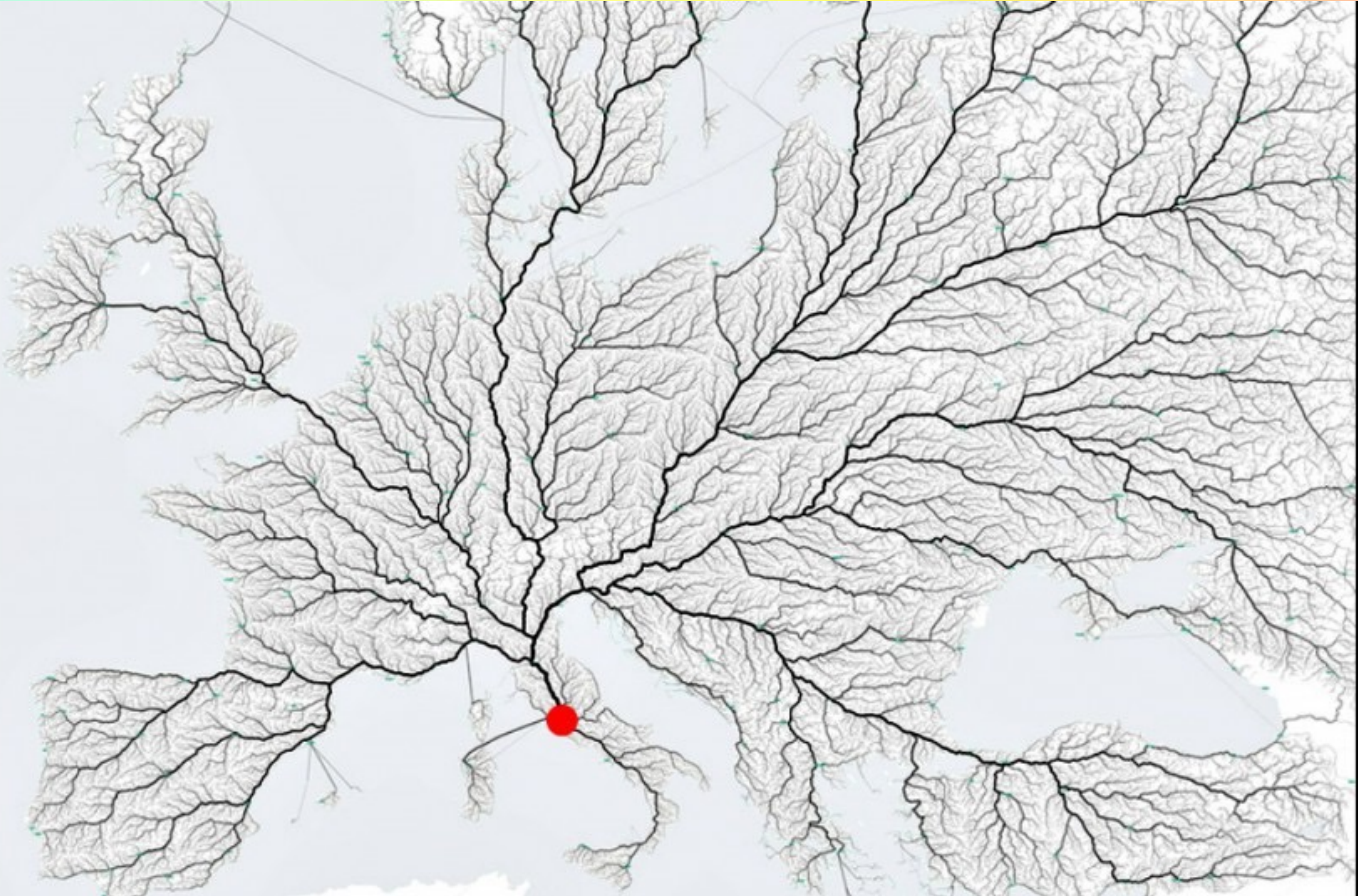


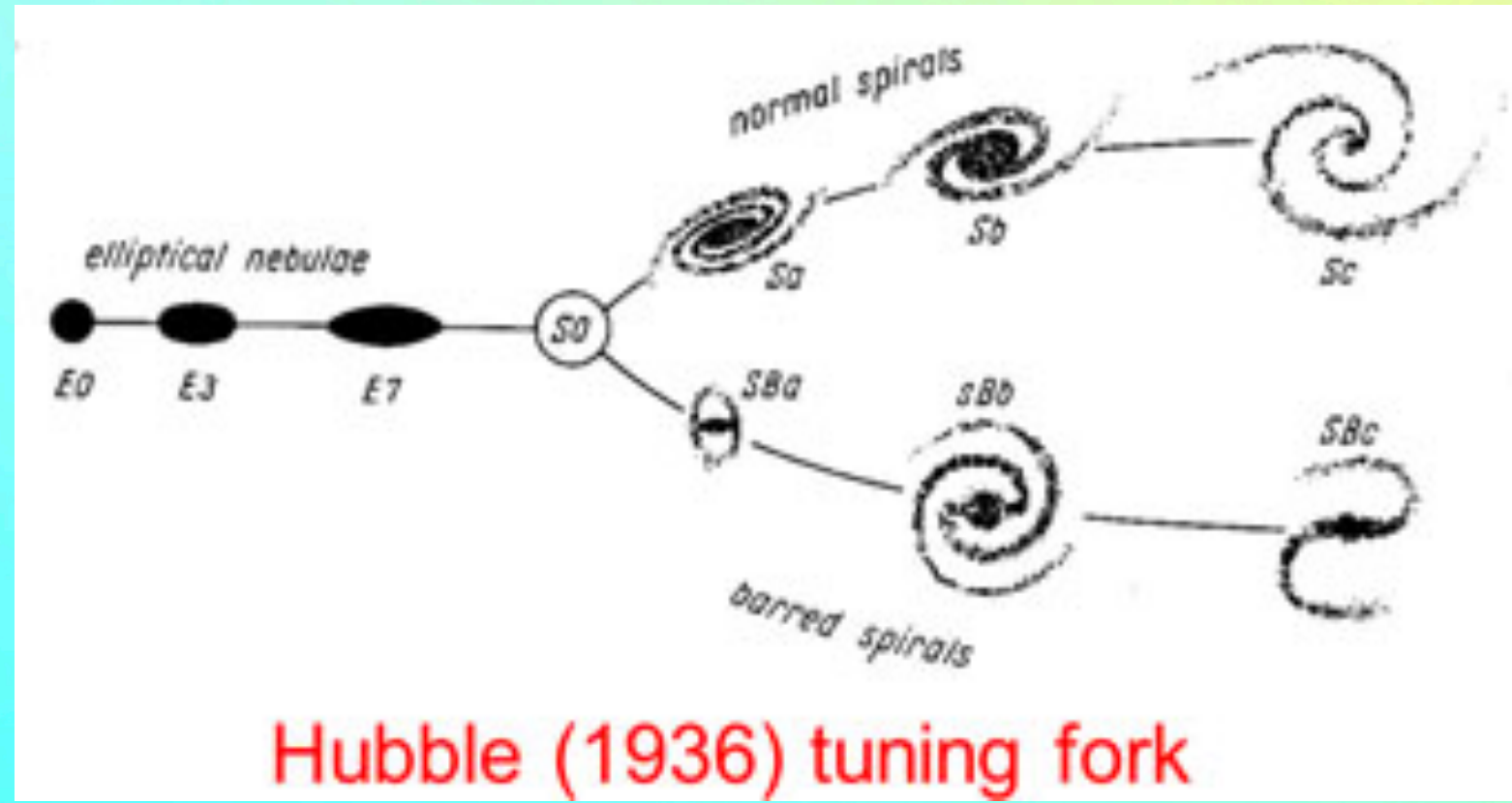
Recovering S0 galaxies formation routes using S-PLUS multiwavelengths data to find S0 analogues in the IllustrisTNG simulation

A. CORTESI, L. ZENOCRATTI, M.E. DE ROSSI, C. DE BOM, F. FERRARI, G. LUCATELLI, Y. JAFFE, D. PALLERO, L. COCCATO, K. SAHA, C. MENDES DE OLIVEIRA & THE S-PLUS COLLABORATION

All roads lead to SOs?



Galaxies classification schemes (some)

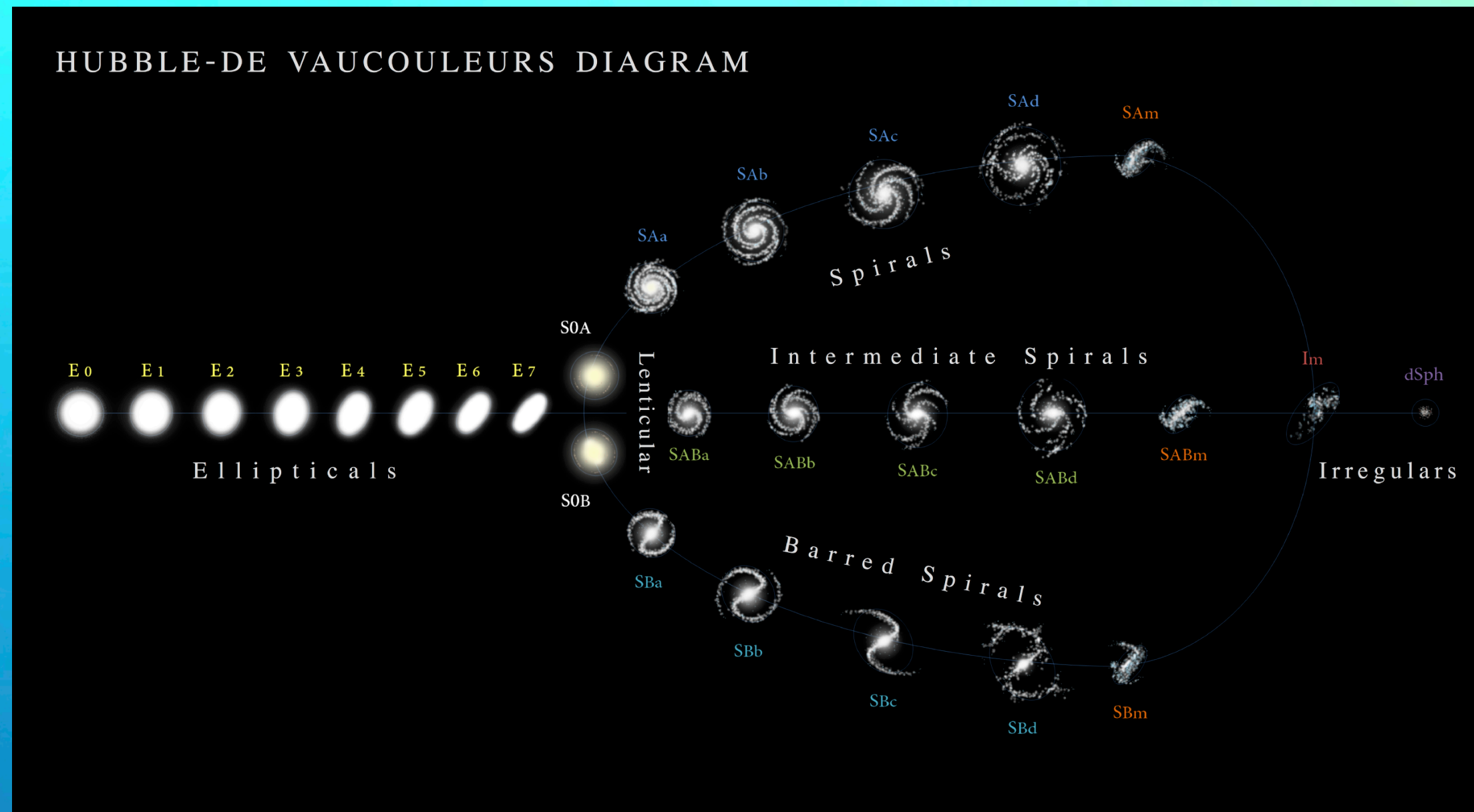


Morgan/Yerkes classification Scheme

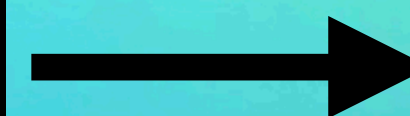
Galactic Shape	Explanation
B	Barred spiral
D	Rotational symmetry without pronounced spiral or elliptical structure
E	Elliptical
Ep	Elliptical with dust absorption
I	Irregular
L	Low surface brightness
N	Small bright nucleus
S	Spiral

Spectral Type	Explanation
a	Prominent A stars
af	Prominent A–F stars
f	Prominent F stars
fg	Prominent F–G stars
g	Prominent G stars
gk	Prominent G–K stars
k	Prominent K stars

Inclination	Explanation
1	Galaxy is "face-on"
2	
3	
4	
5	
6	
7	Galaxy is "edge-on"



r,s (rs)= ring/no ring
 Sm= irregular no bulge
 Sd = diffuse
 Im = highly irregular

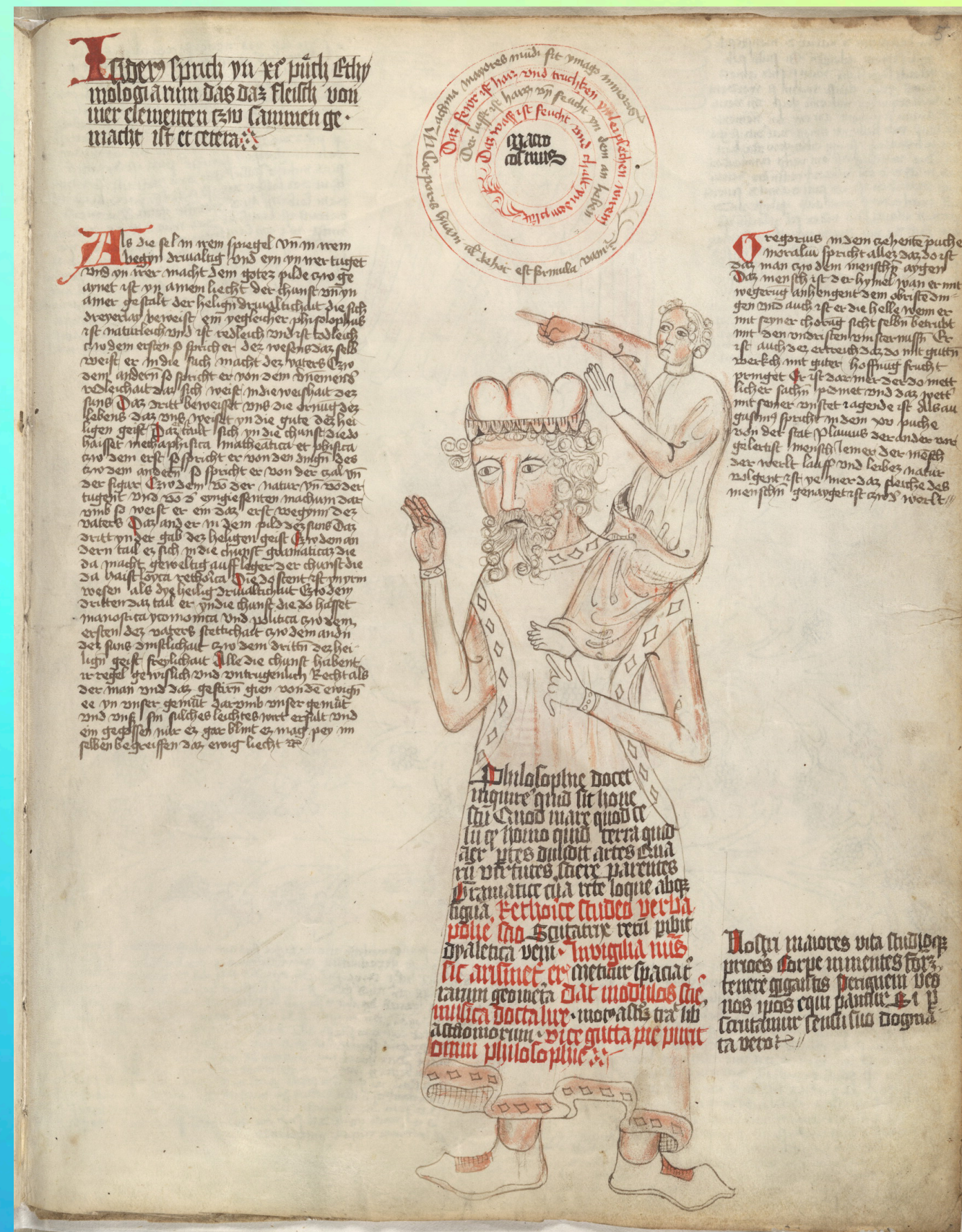


		Numerical Hubble stage																	
Hubble stage <i>T</i>		-6	-5	-4	-3	-2	-1	0	1	2	3	4	5	6	7	8	9	10	11
de Vaucouleurs class ^[16]		cE	E	E ⁺	S0 ⁻	S0 ⁰	S0 ⁺	S0/a	Sa	Sab	Sb	Sbc	Sc	Scd	Sd	Sdm	Sm	Im	
approximate Hubble class ^[19]		E		S0			S0/a	Sa	Sa-b	Sb	Sb-c	Sc		Sc-Irr		Irr I			

Some thoughts about SOs

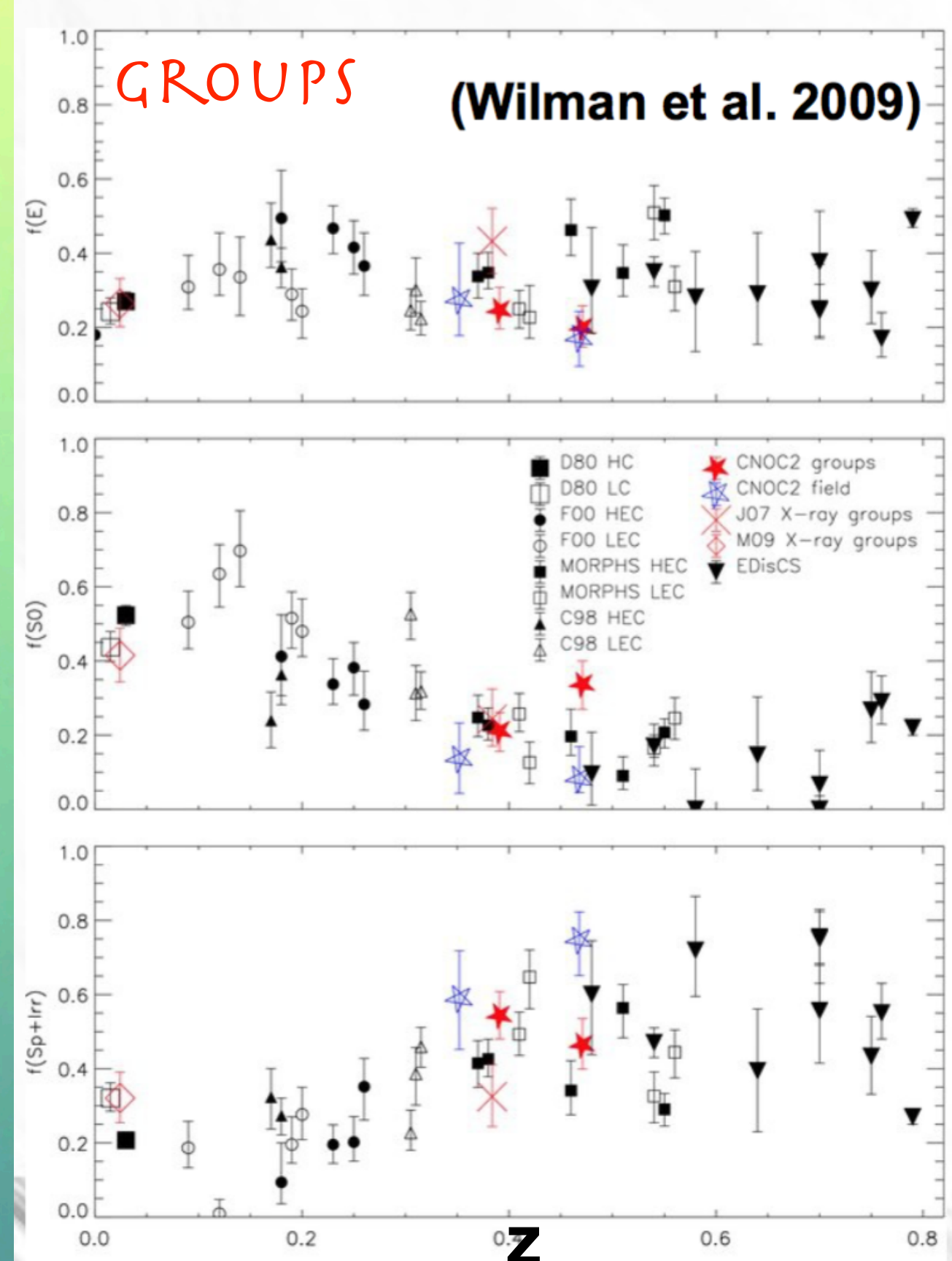
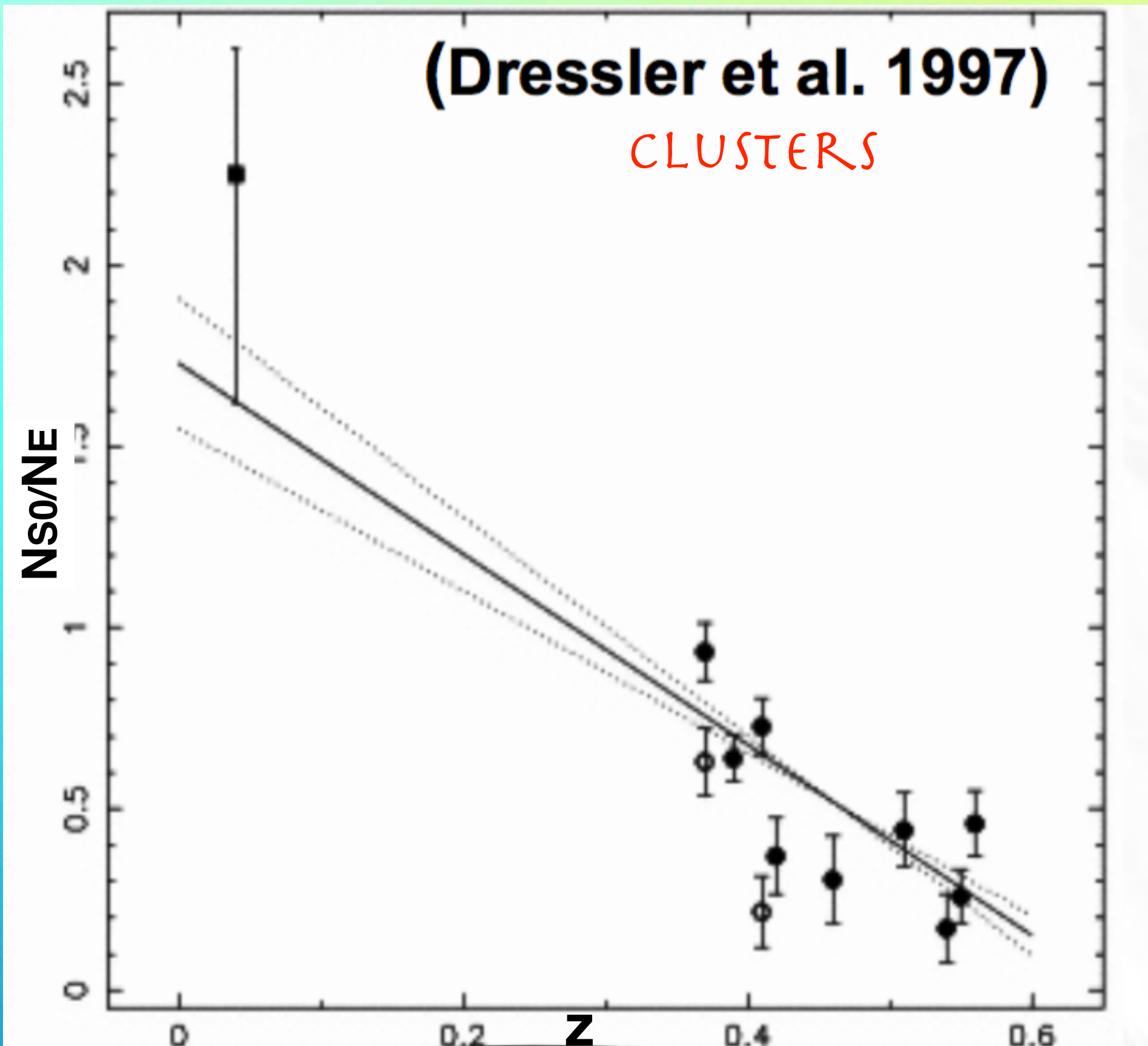
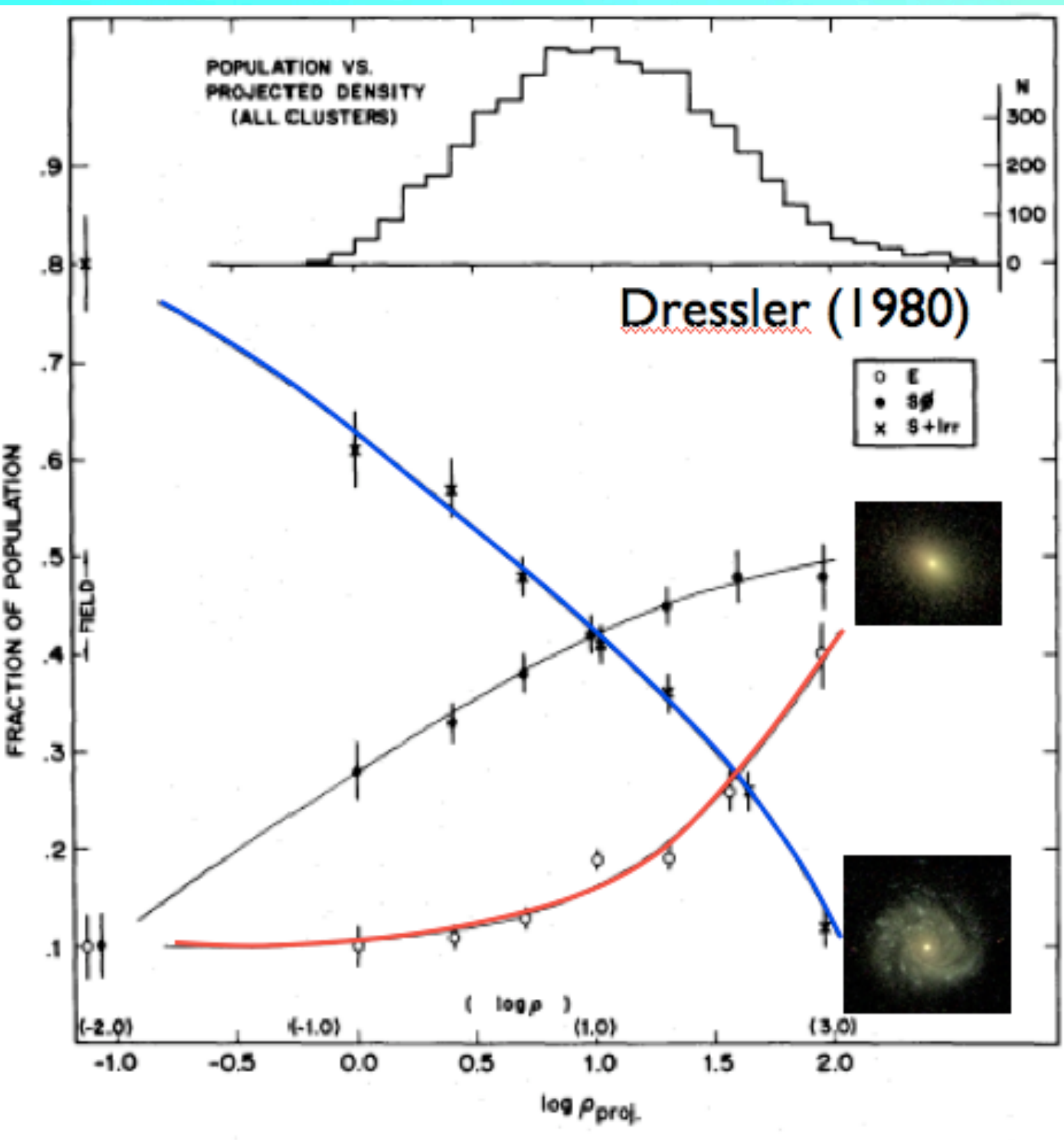
Van den Bergh 1990

... Morgan's suggestion that the *SO classification type is a repository of physically quite distinct sorts of objects* that exhibit only superficial similarities. This indicates that various kinds of SO galaxies might have arrived at their present morphological state along quite different evolutionary tracks.

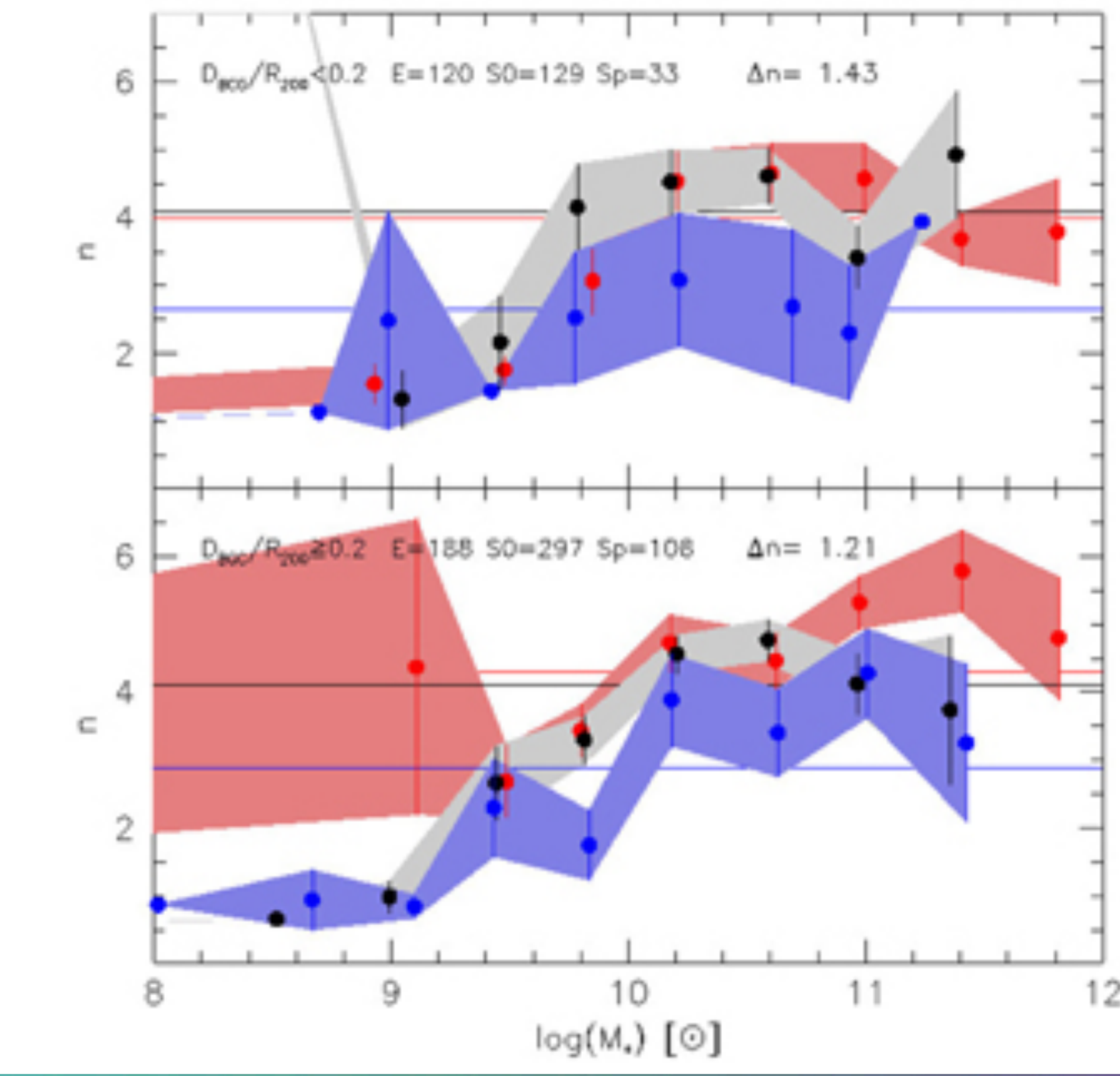
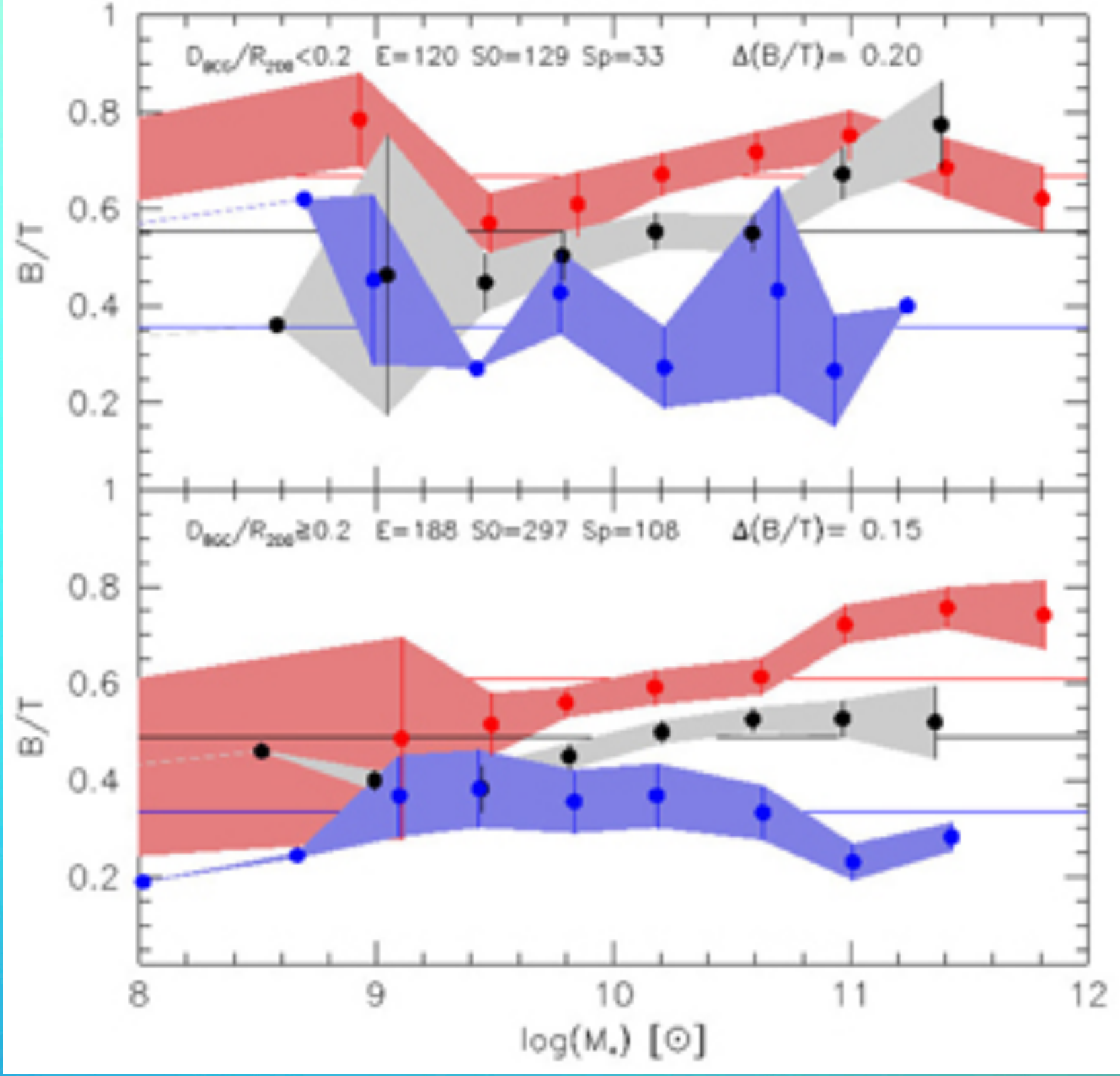
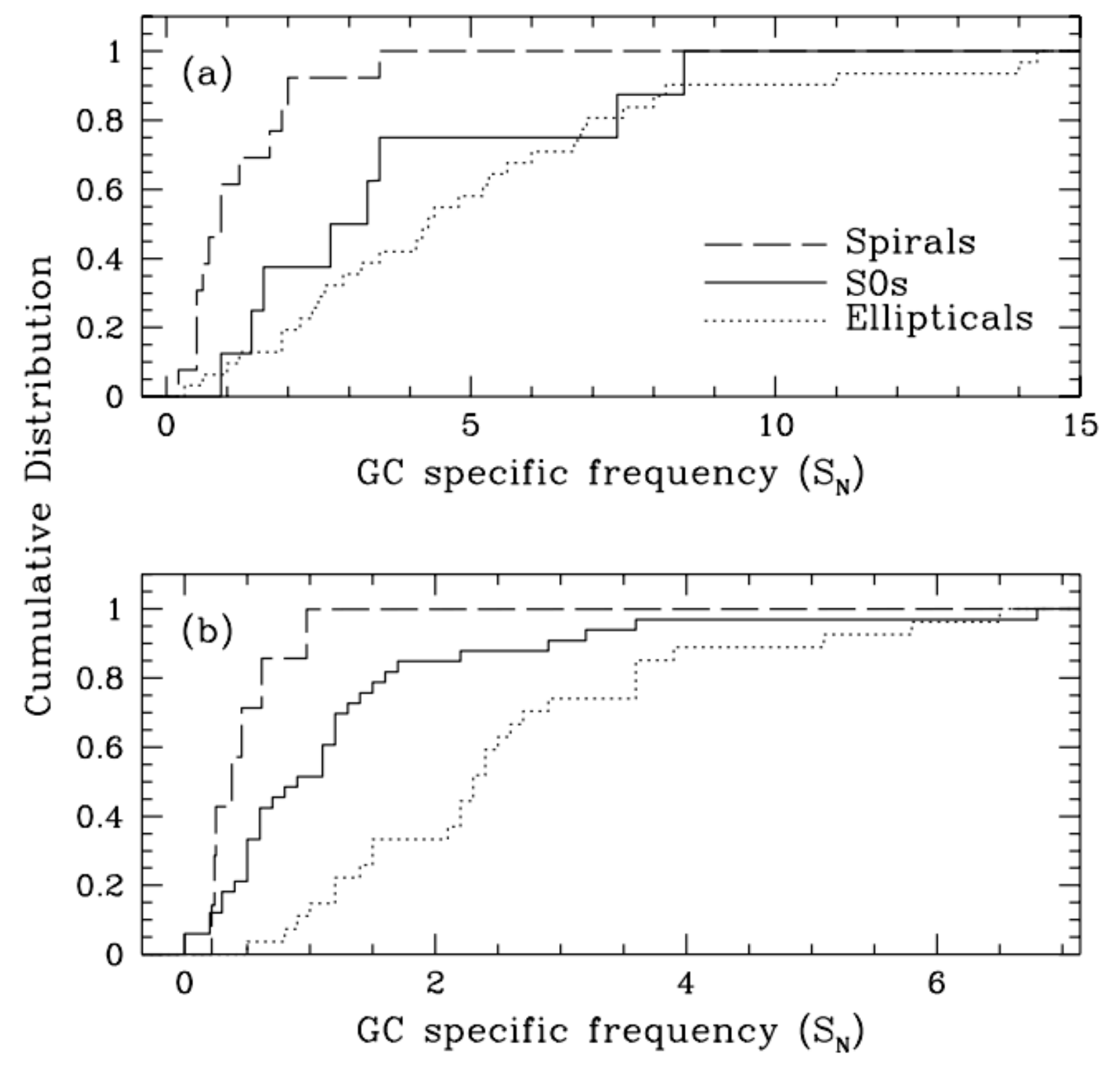
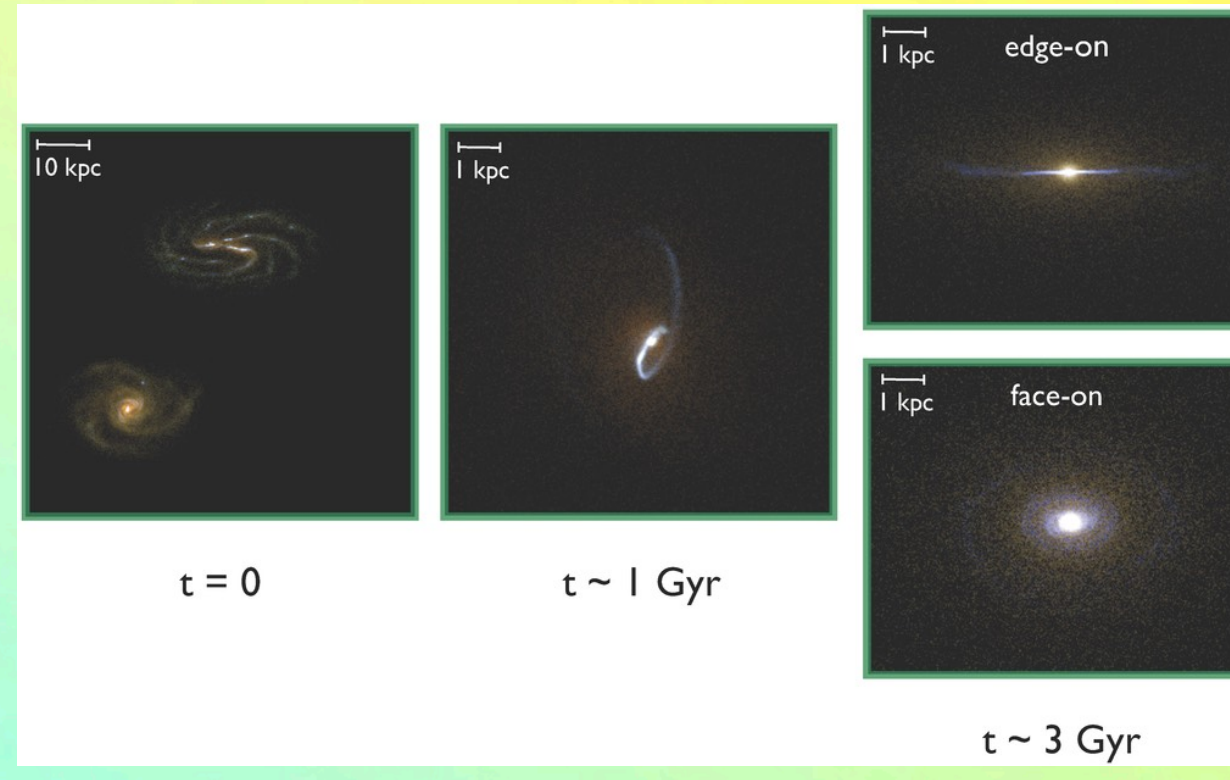


Bernard of Chartres(12th century), Isaac Newton 1675

Some thoughts about SOs



Some thoughts about SOs



Proposed scenarios of S0 galaxy formation

Fraser-McKelvie, Amelia 2018

high mass ($\log M/M_{\text{sun}} > 10.4$)

low mass ($\log M/M_{\text{sun}} < 10.4$)

Cocato et al 2020

low dens
merger or accretion

high dens
gently stripped

primordial galaxy

major
Eliche-Moral et al. 2018
Querejeta et al. 2015
Tapia et al. 2017
Borlaff et al. 2014

minor
Bekki 1998
Bournaud 2005

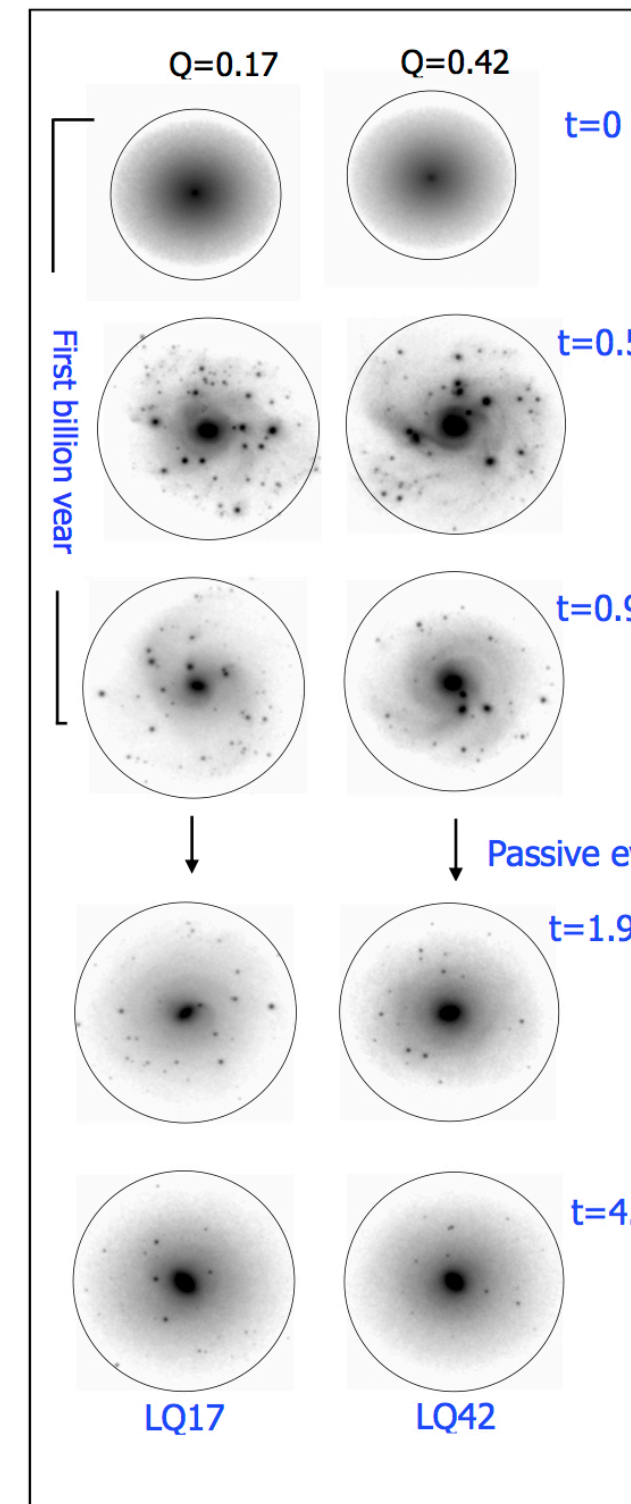
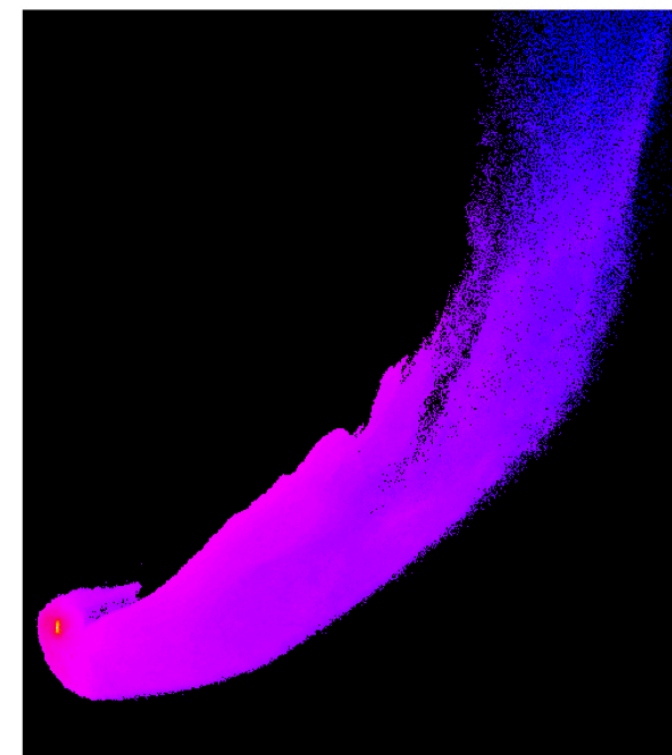
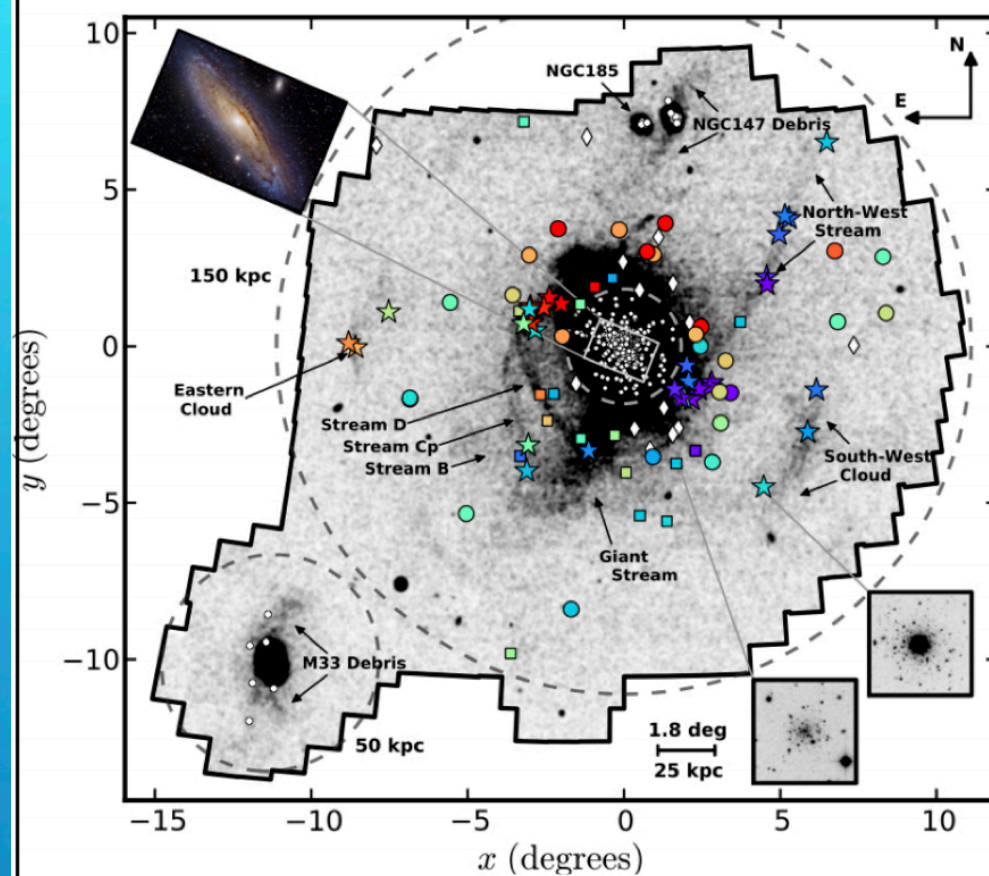
disk instability
Saha & Cortesi 2018
Romanowsky et al. in prep.

accretion
Diaz et al. 2018

tidal interactions
Bekki & Couch 2011

stripping
Larson et al. 1980
Bekki 2009

secular evolution
Mishra et al. 2018
Bassett et al. 2017
Osman & Bekki 2017



What can we do?

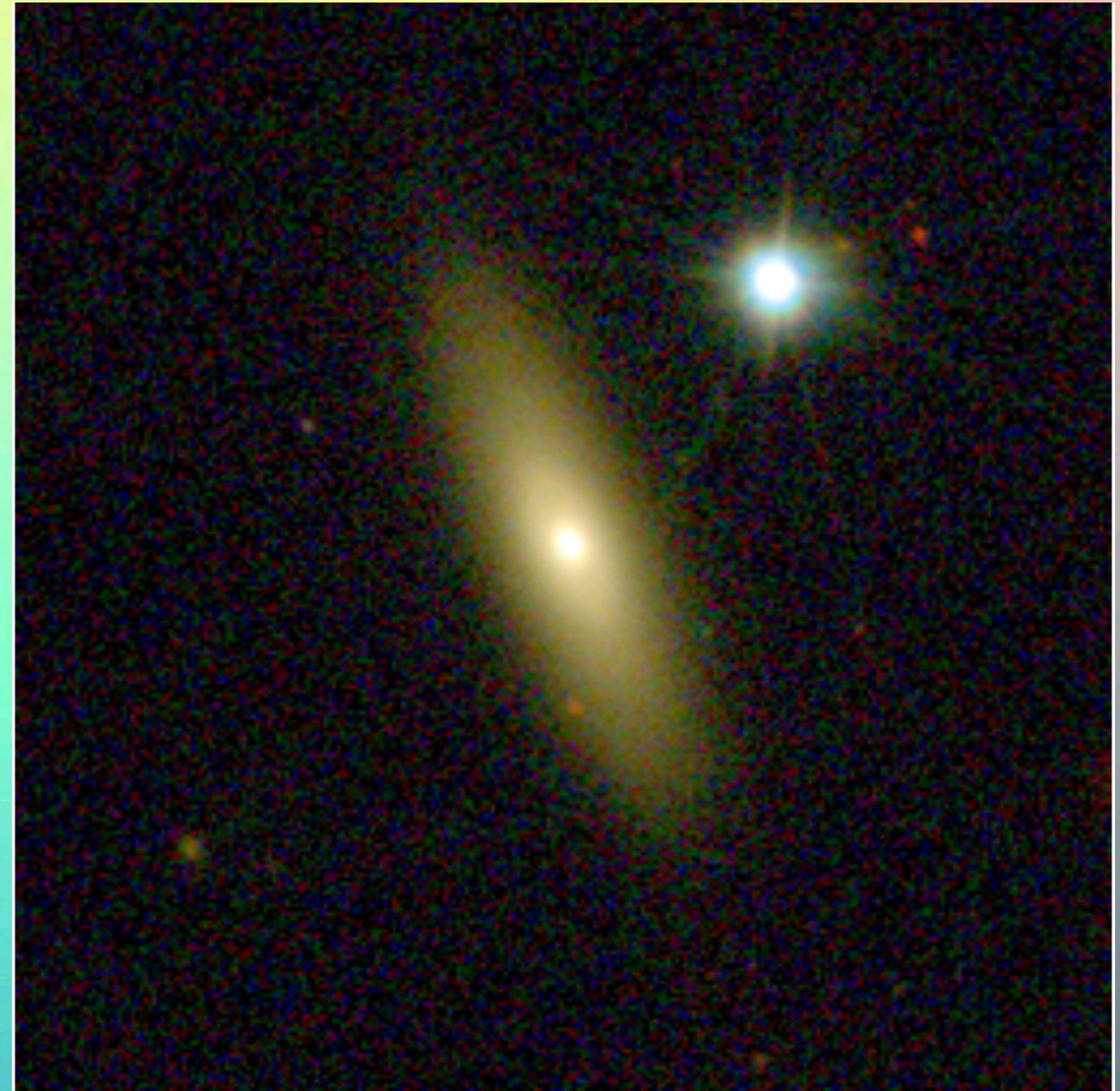
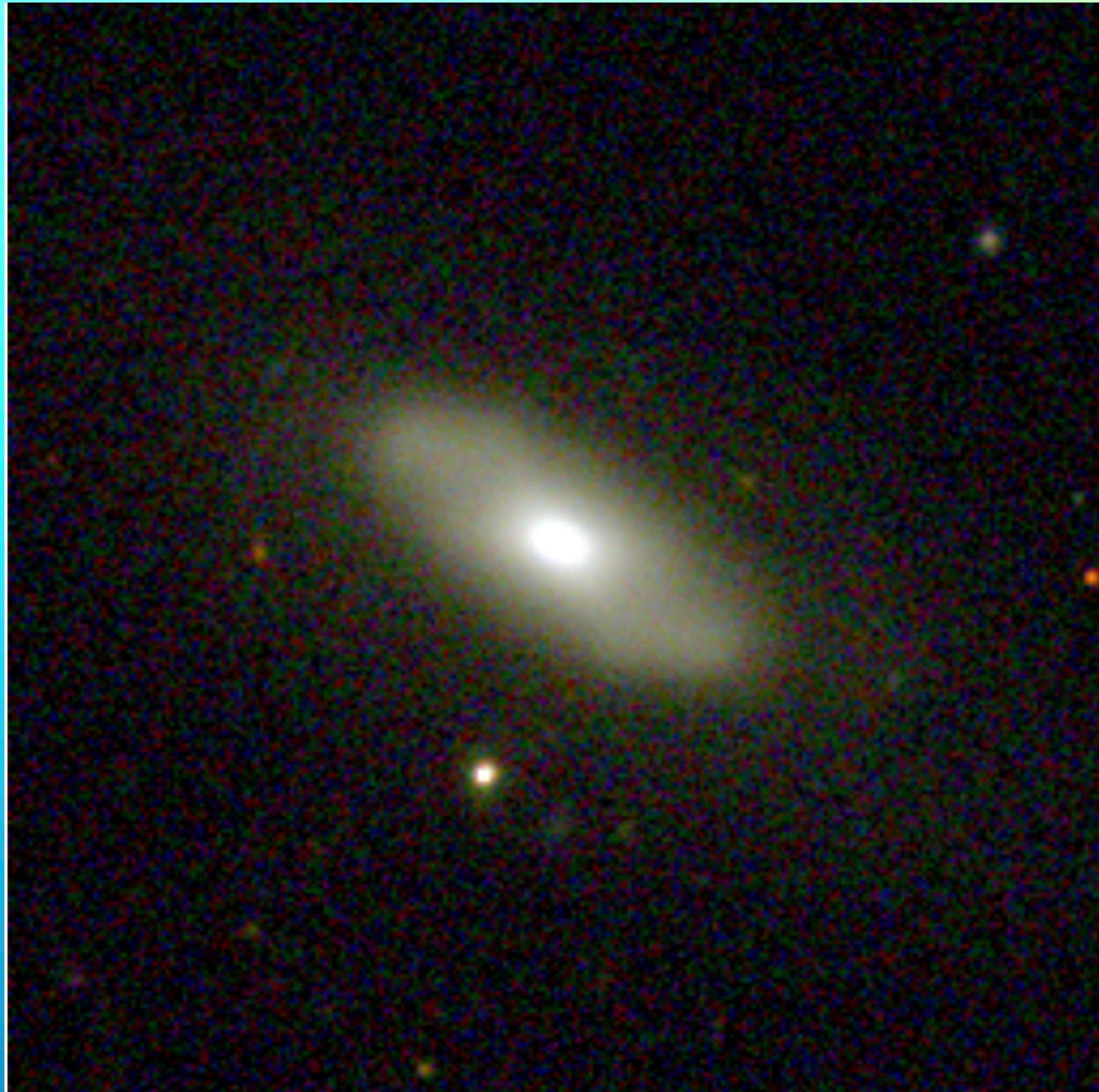
- 1) Propose unique definition of S0 galaxies based on morphometric (kinematics) parameters —-> see Geferson Lucatelli talk firday at 9:40
- 2) Looking for S0 galaxies in simulations

We are not the only one

- Deeley et al 2021: Follow the same visual classification scheme used for the SAMI survey, found 2 main routes of forming S0s
- Y. Jaffe & Diego Pallero: Using kinematics properties as determine by studies of S0s with Muse
- Us: using S-PLUS!

What did we do till now

- We chose 2 well studied lenticular galaxies as reference:



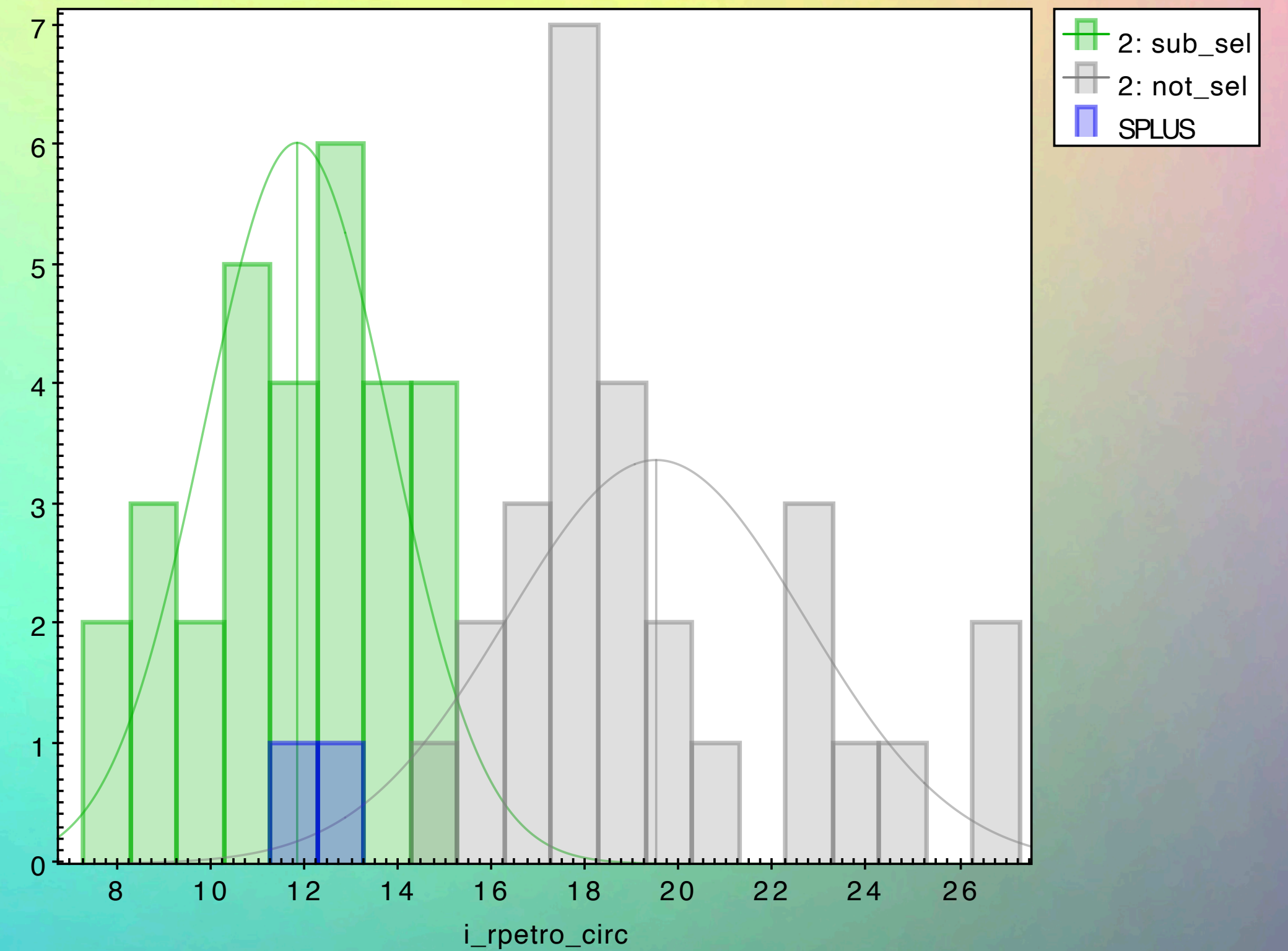
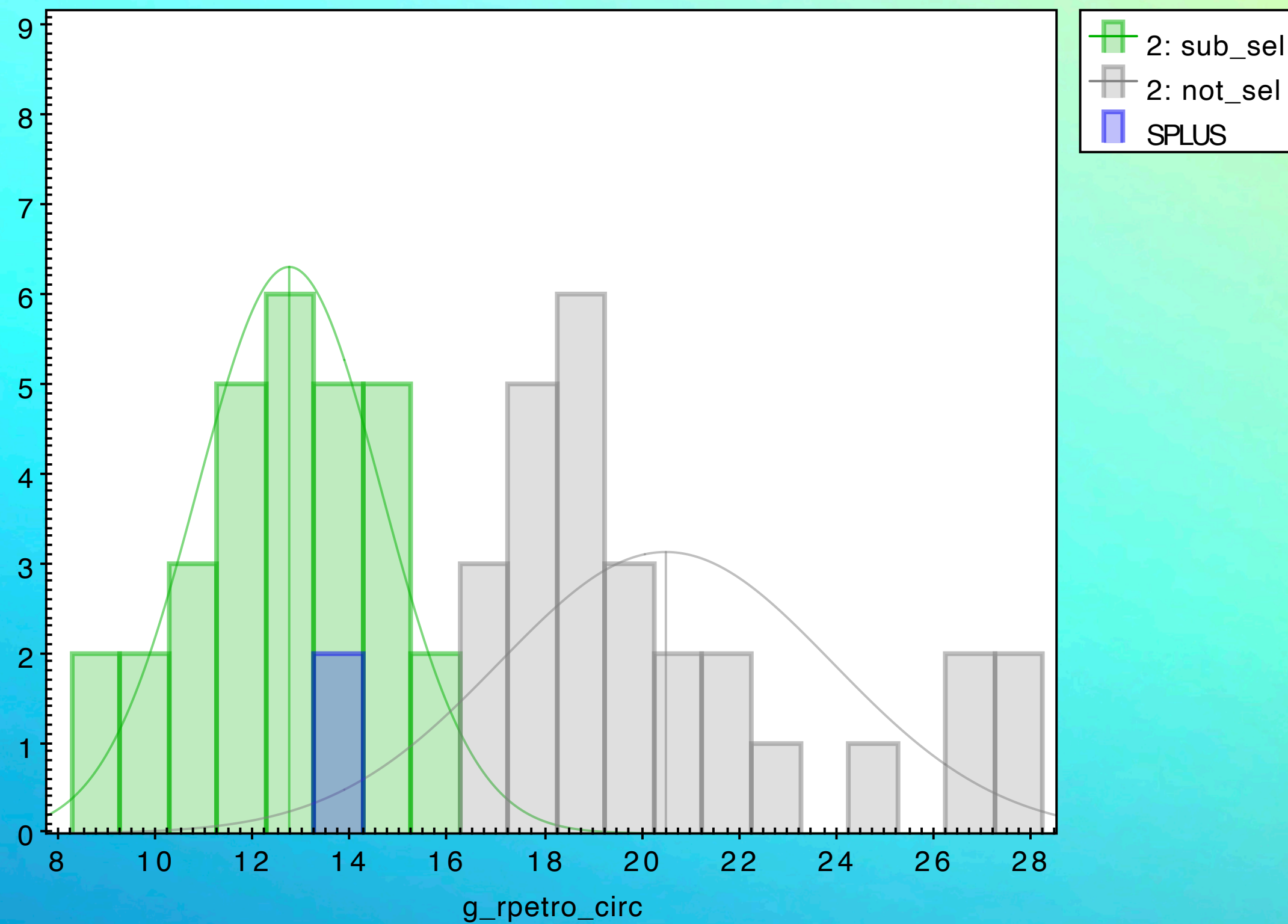
What did we do till now

- We used photometric parameters from MFMTK & S-PLUS pipeline to find their analog in Illustris simulation
- 2.2) Star-forming gas fraction ≤ 0.1
 - 2.3) sSFR $< 1e-11$
 - 2.4) $\log(M_{\text{star}}) > 10.75$
 - 2.5) Sersic index in g-band $1 < n < 4$
 - 2.6) Sersic index in i-band $1.5 < n < 5.5$
 - 2.7) Colour g-i > 1
 - 2.8) Colour u-r > 2
 - 2.9) Concentration index in g-band $0.5 < C < 0.8$
 - 2.10) Concentration index in i-band $0.7 < C < 0.9$
 - 2.11) In g-band, $G - 0.14 * M_{20} > 0.80$, where G is the Gini coefficient and M20 is the M_20 statistic.
 - 2.11) In g-band, $G + 0.14 * M_{20} < 0.33$, where G is the Gini coefficient and M20 is the M_20 statistic.

We find 51 SOs analogs

What did we do till now

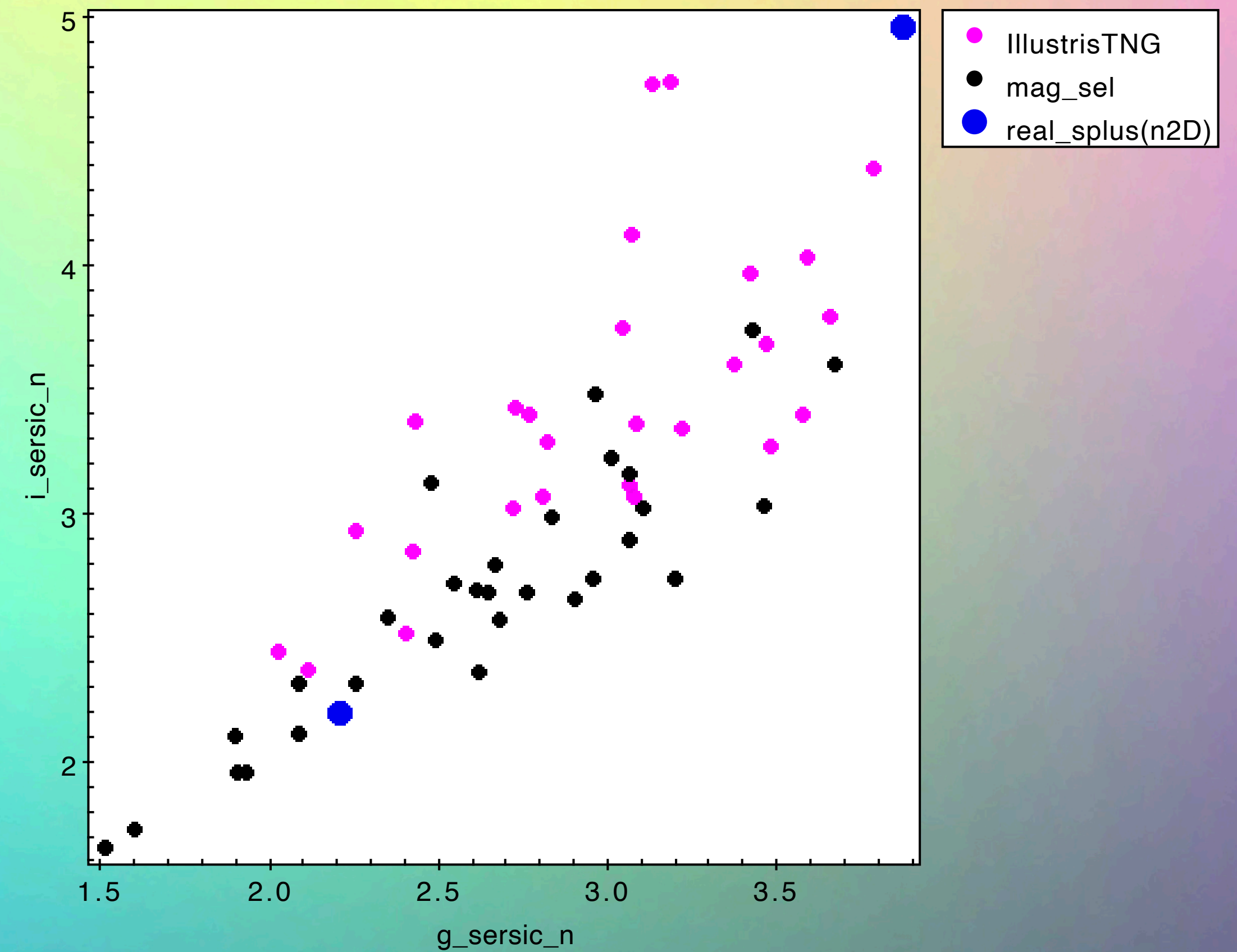
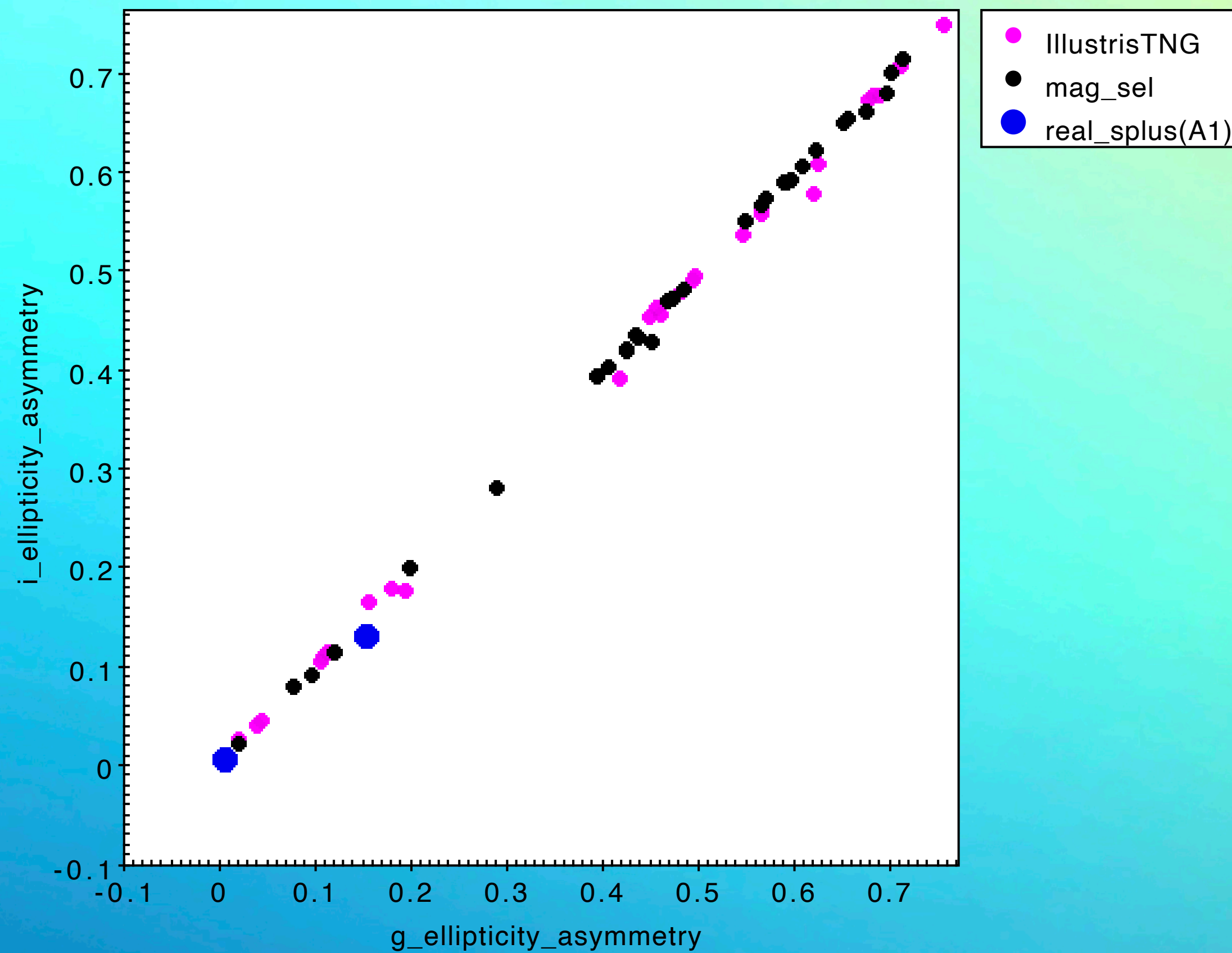
- We compared the properties of the S0 analogs and the real ones



We find 51 S0s analogs

What did we do till now

- We compared the properties of the S0 analogs and the real ones

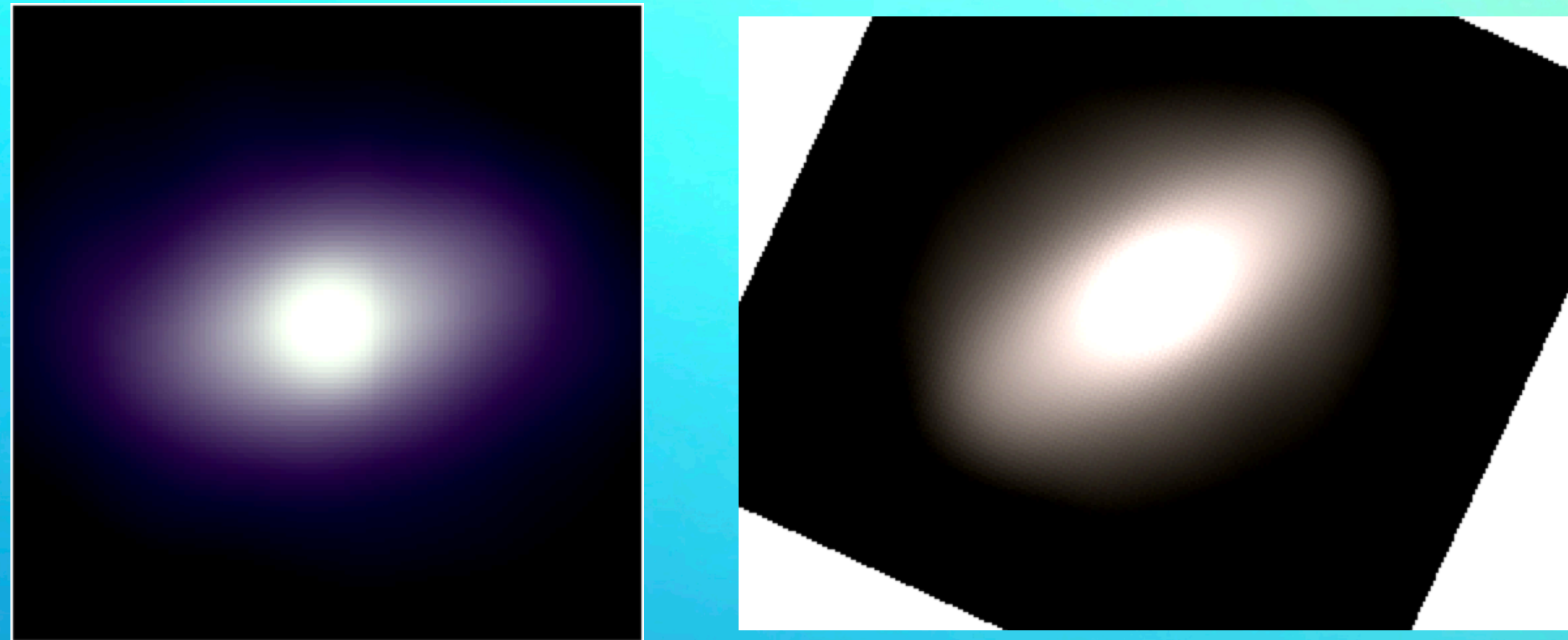


We find 51 S0s analogs

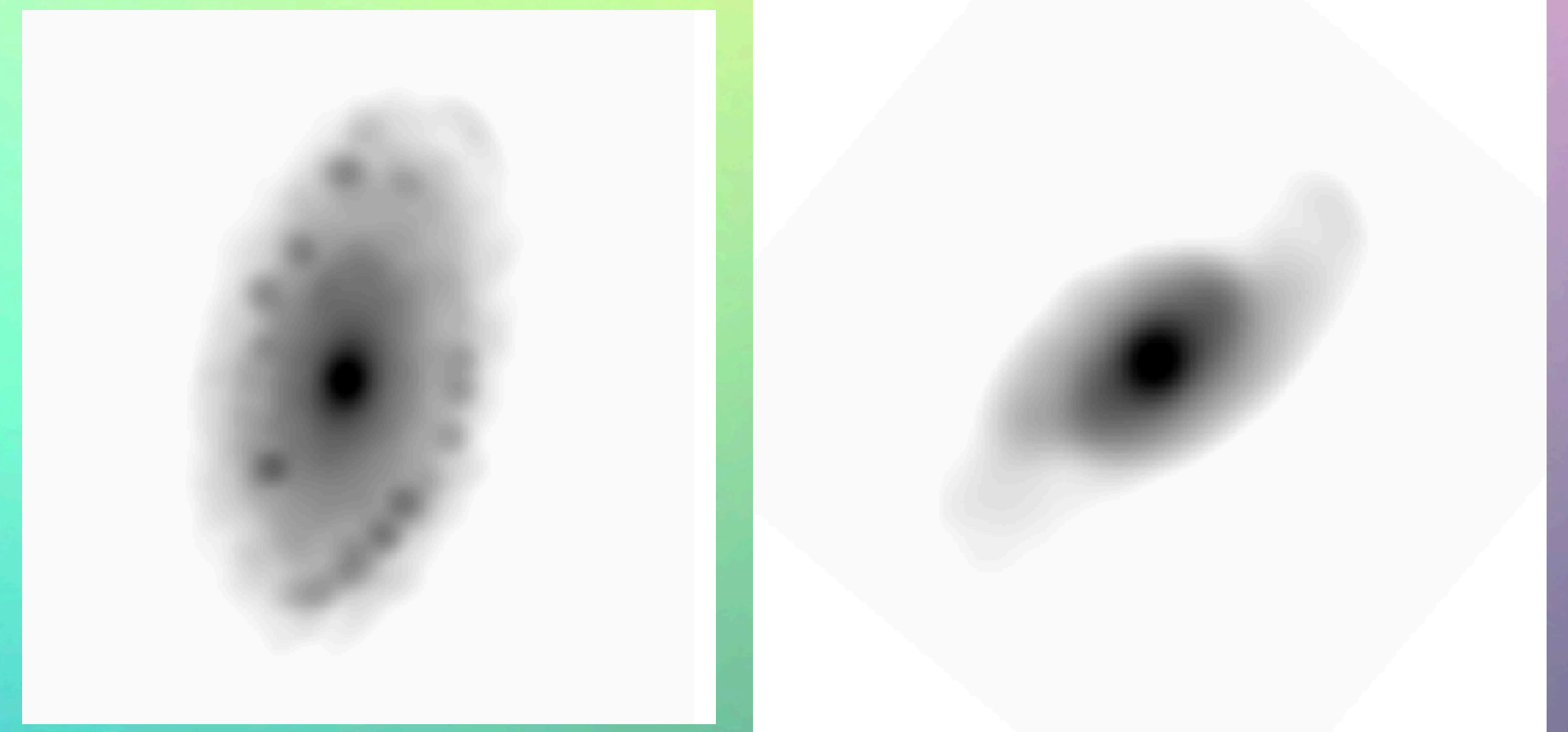
What did we do till now

- We inspect the psf convolved g/i band images of the galaxies

34 S0 like



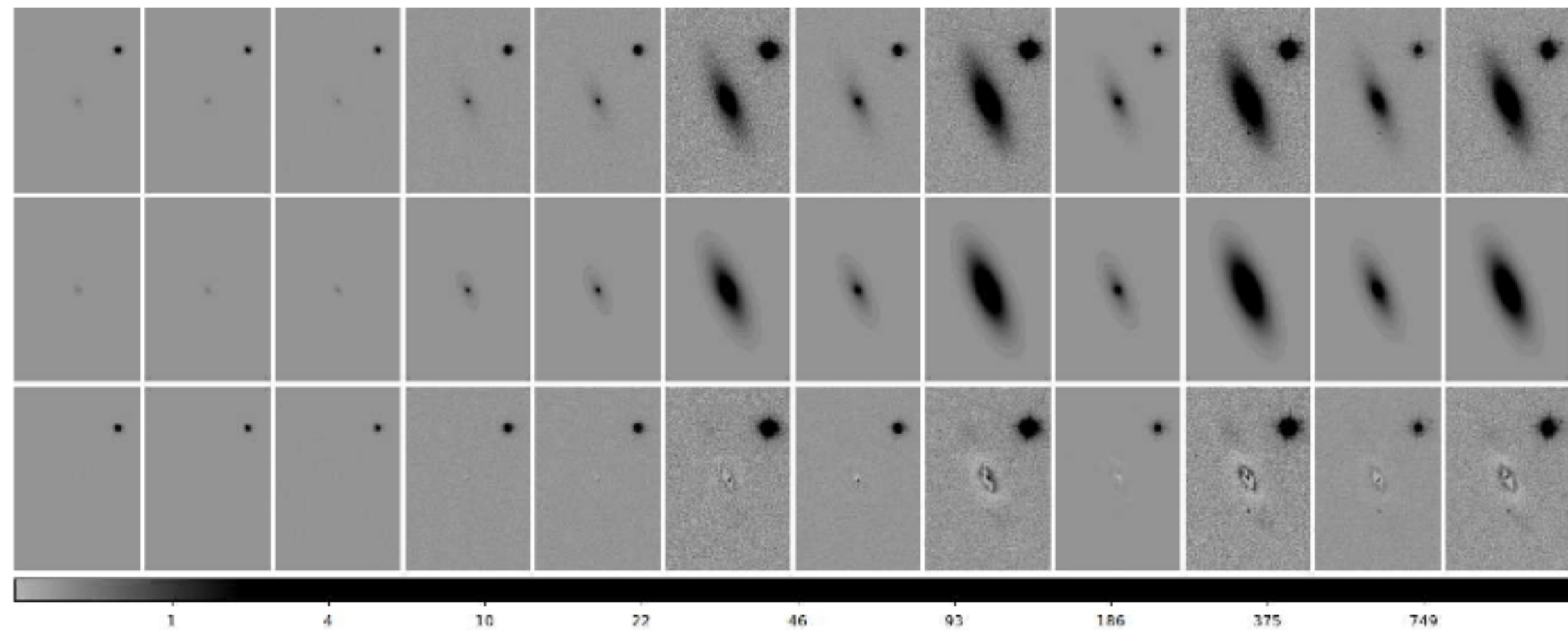
17 S like, interactions, blobs



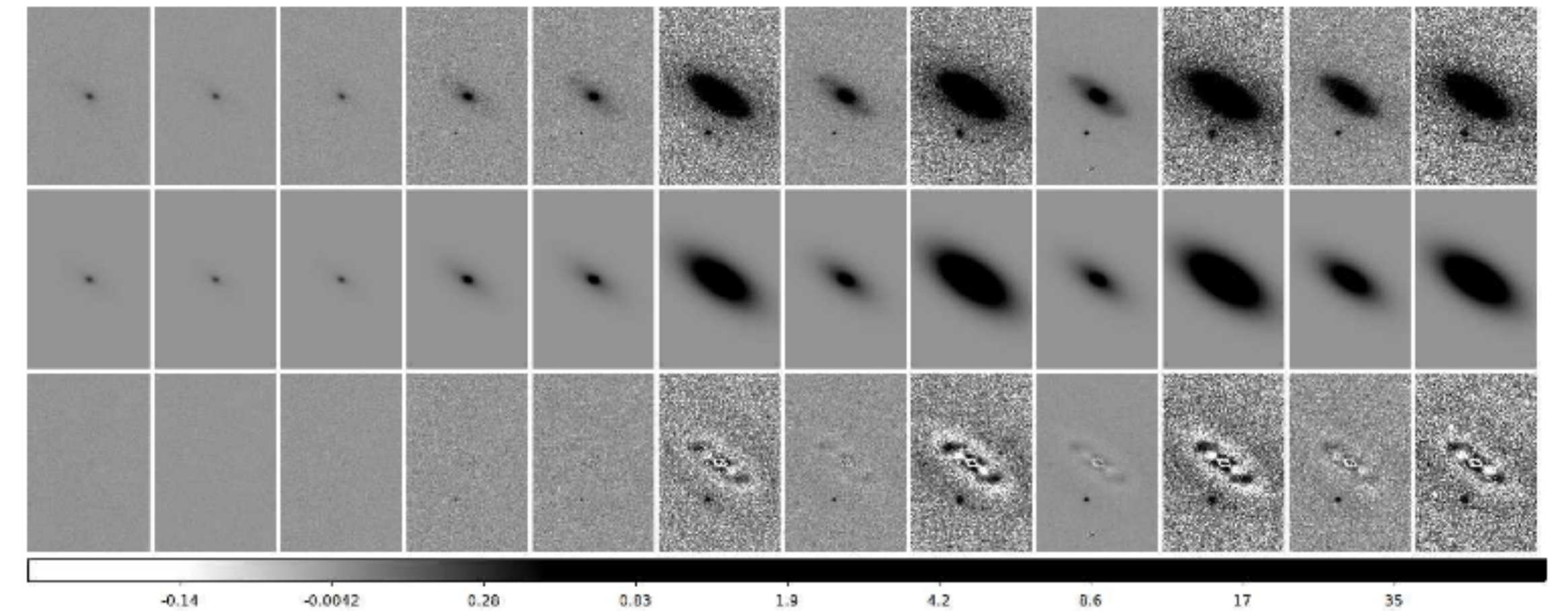
What did we do till now

- We decomposed the S0 galaxies images using GALFITM (Juliana Caffer)

NGC7684

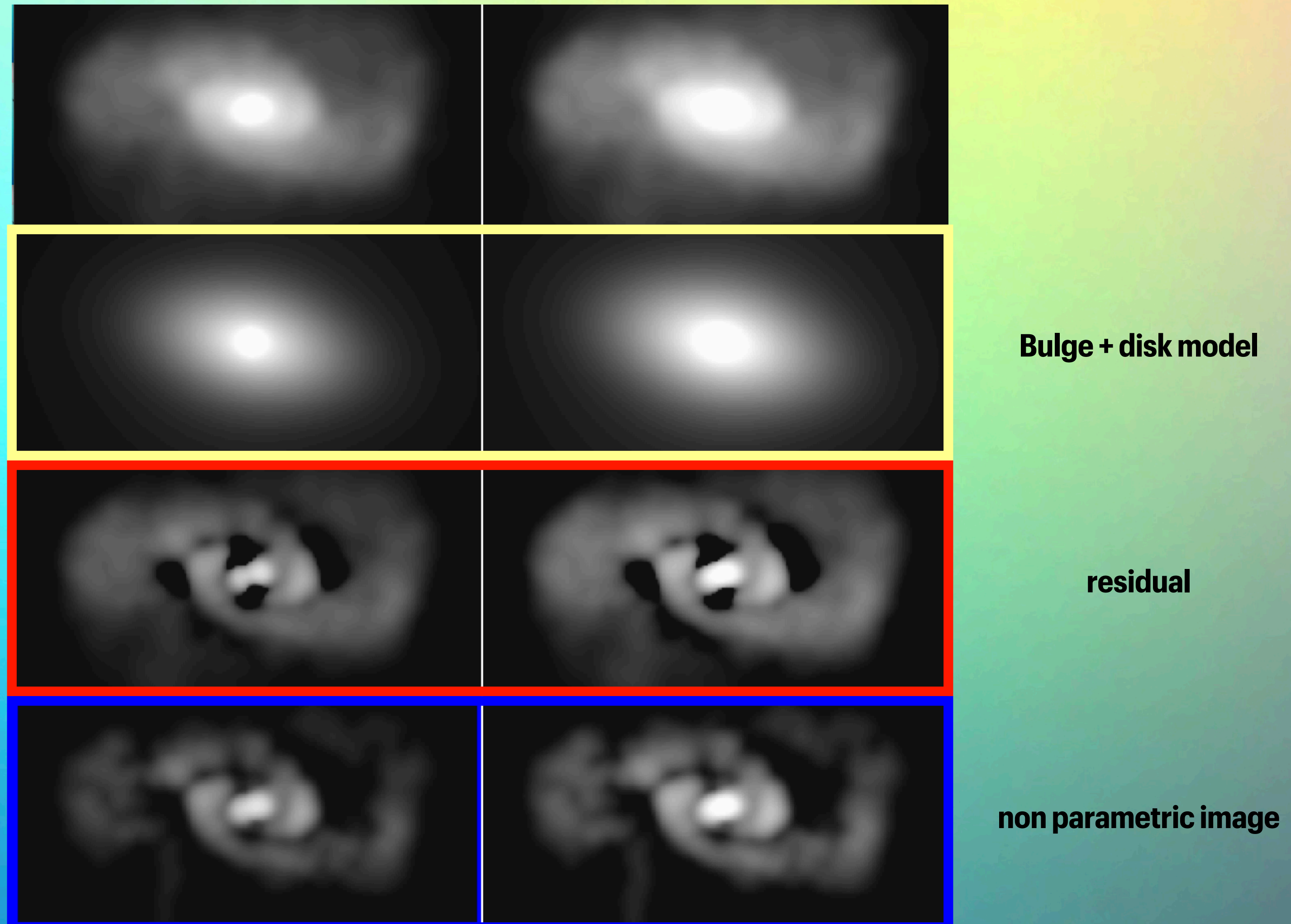


UGC01062



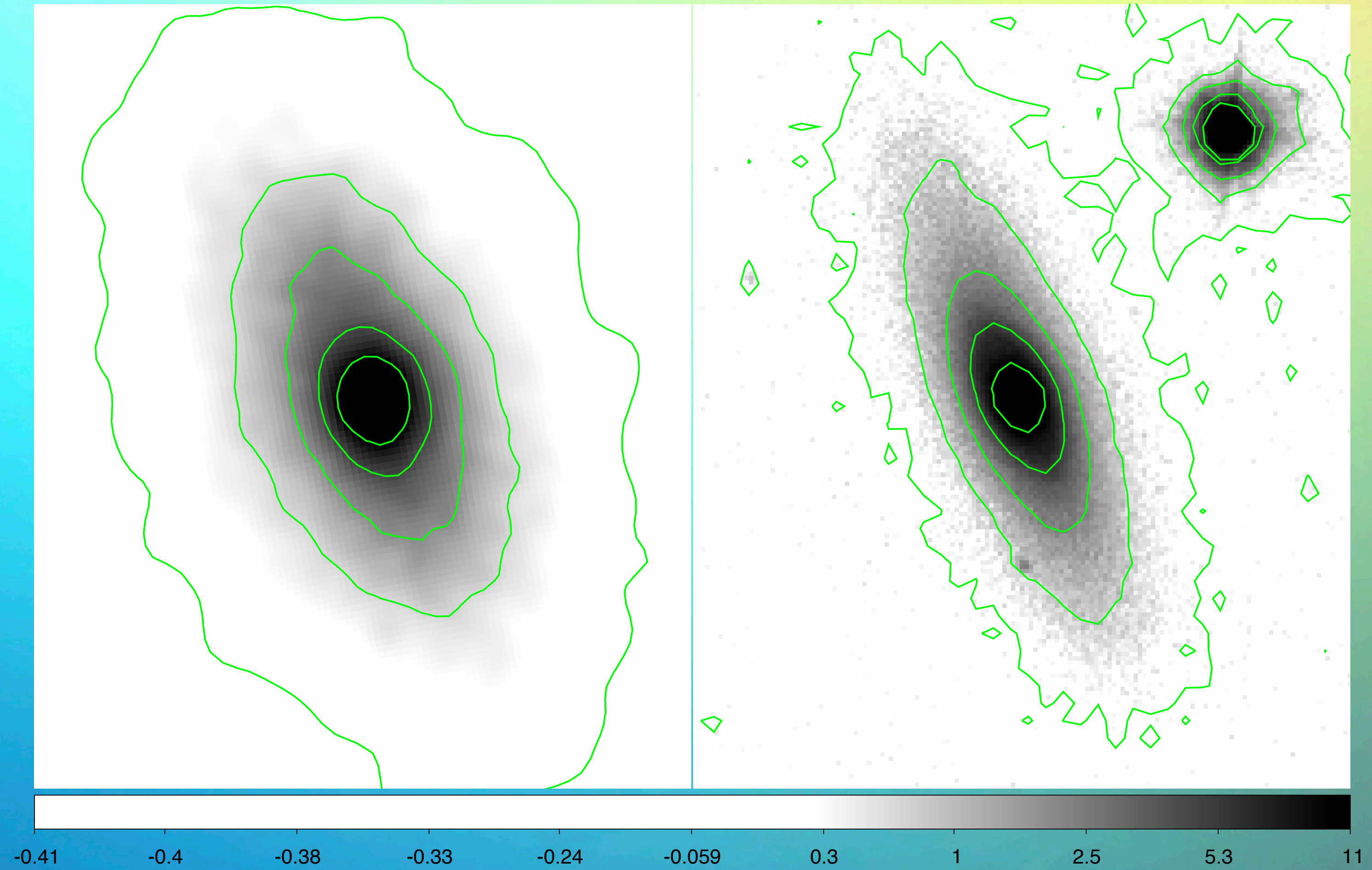
What did we do till now

- We started decomposing the S0 analog galaxies images using GALFITM



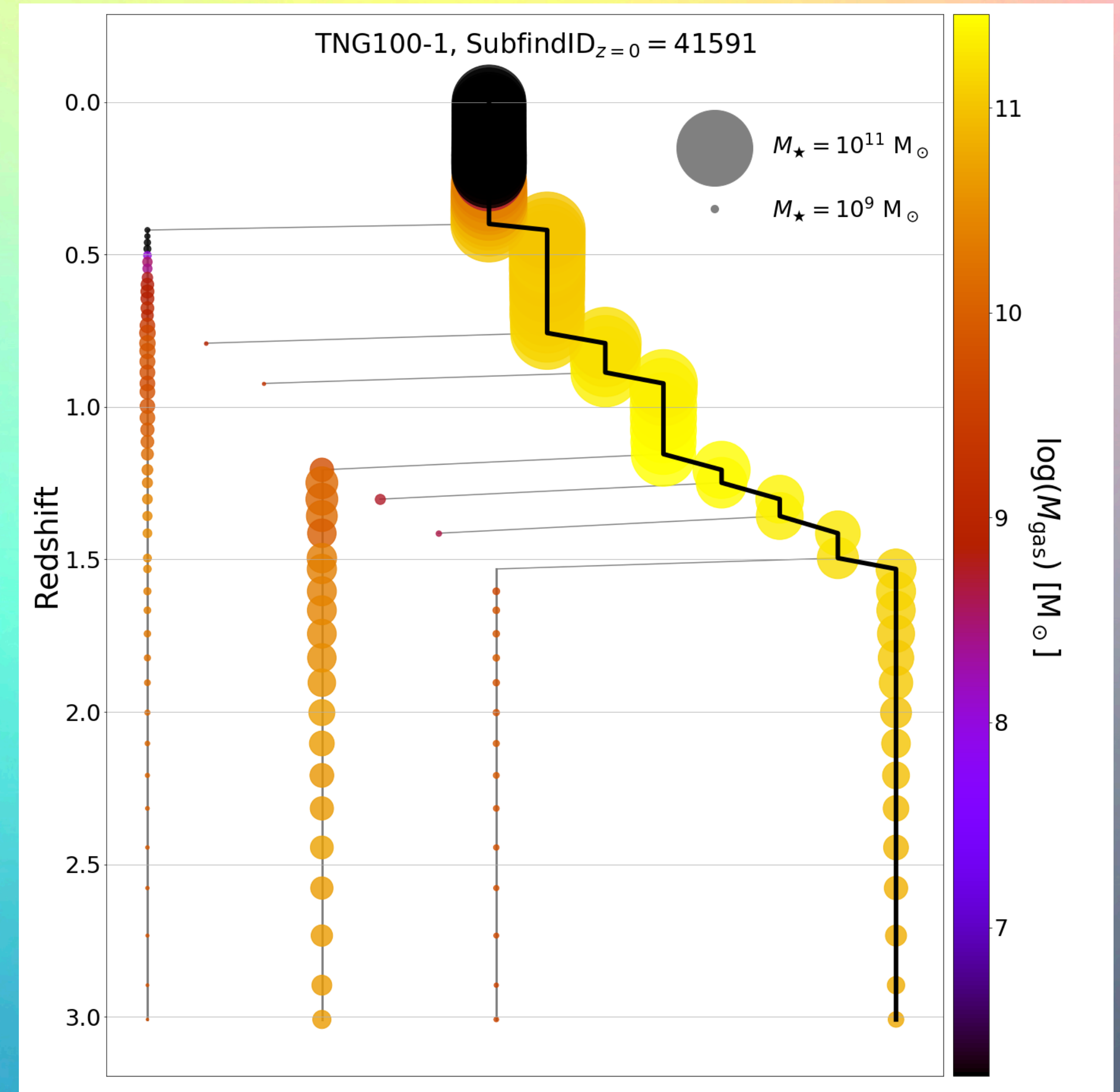
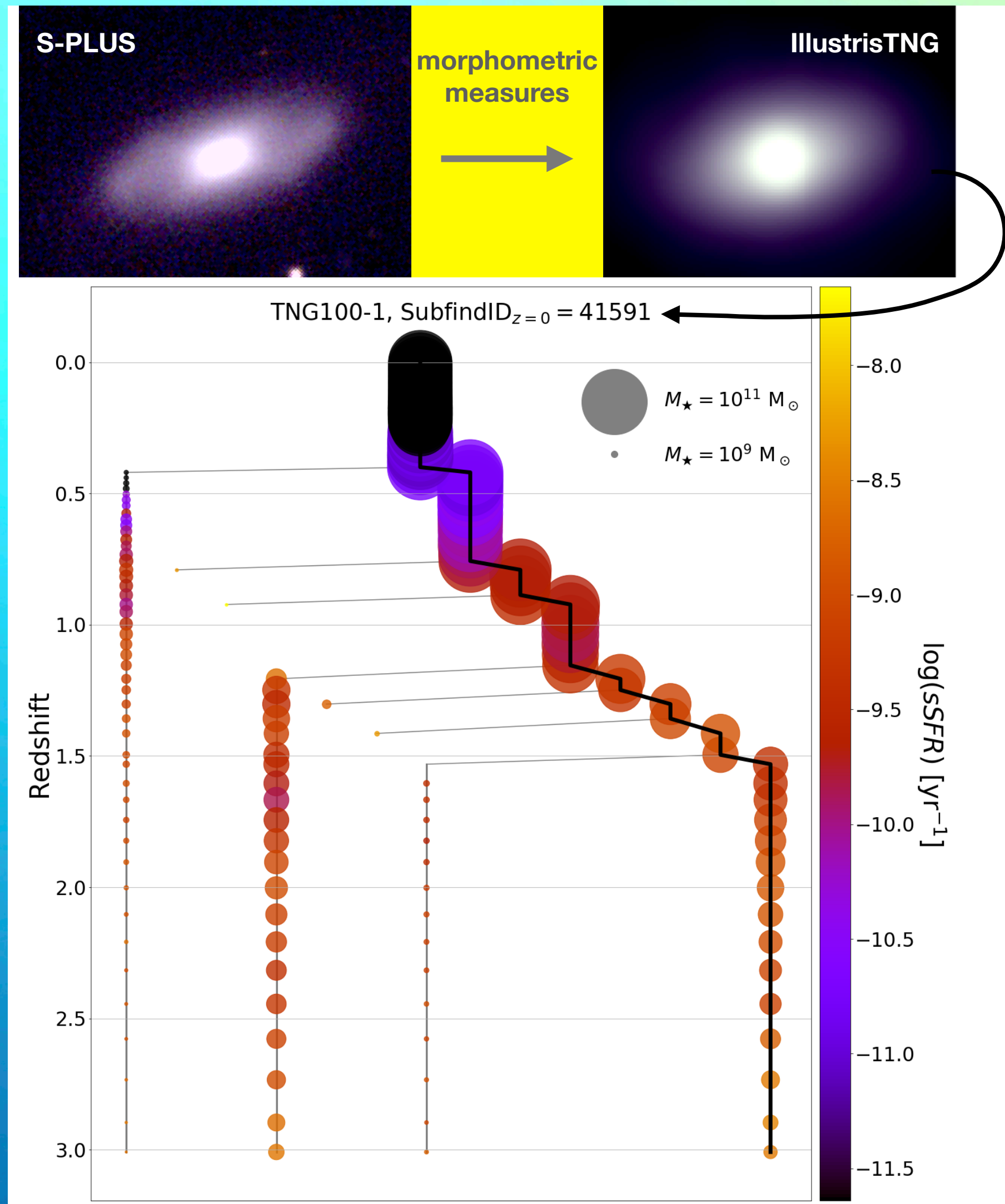
What did we do till now

- We took our favourite S0



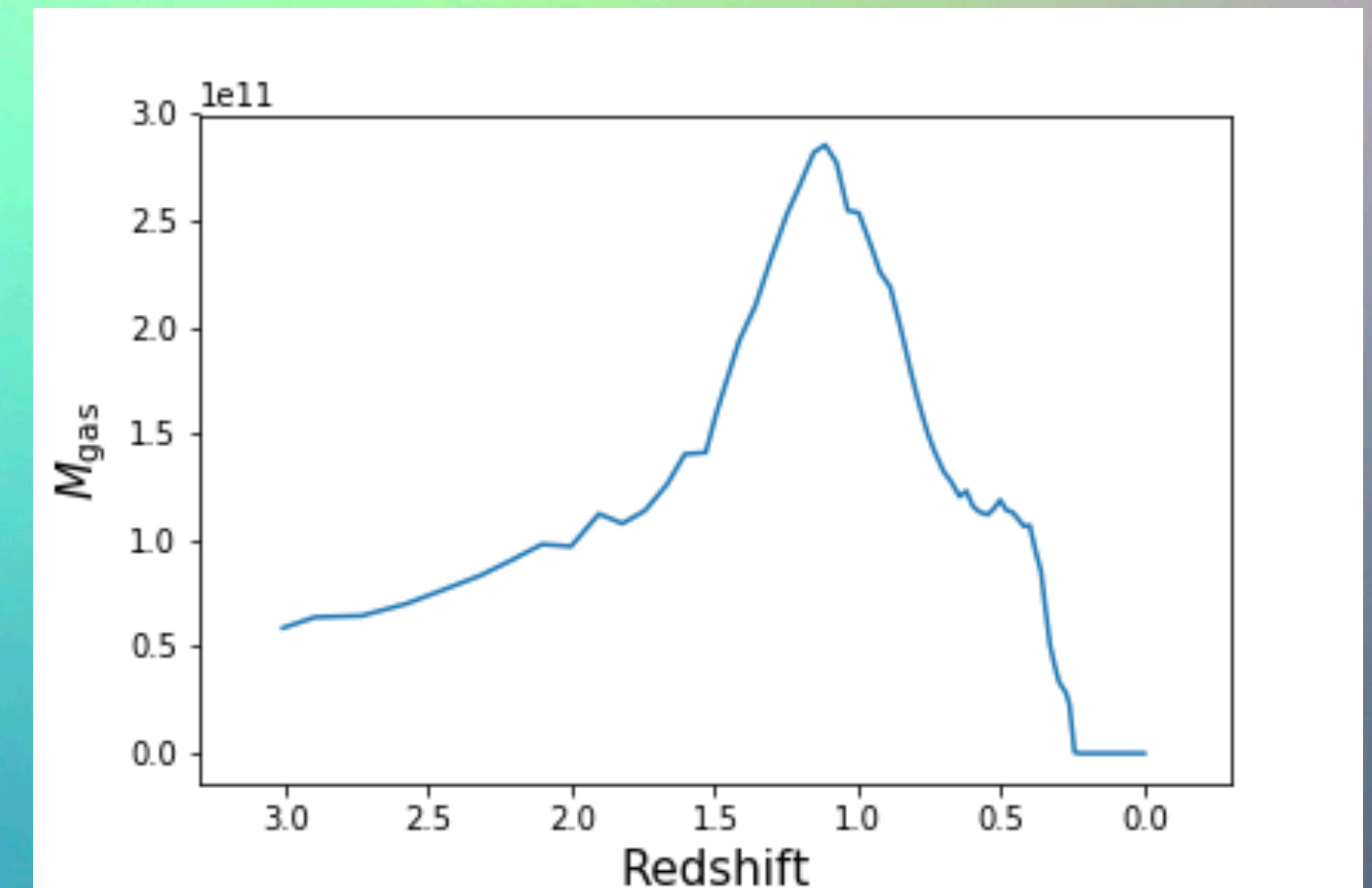
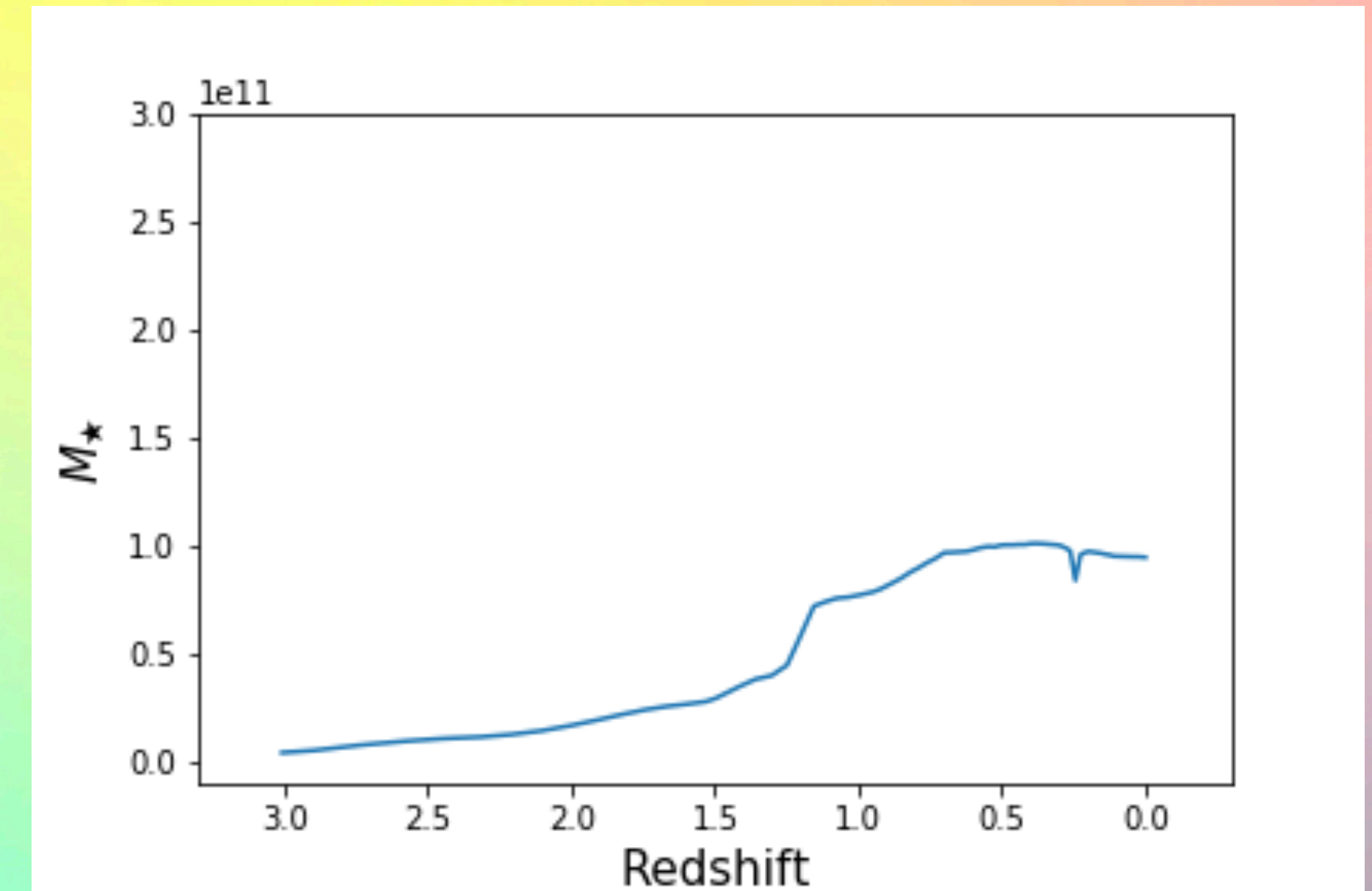
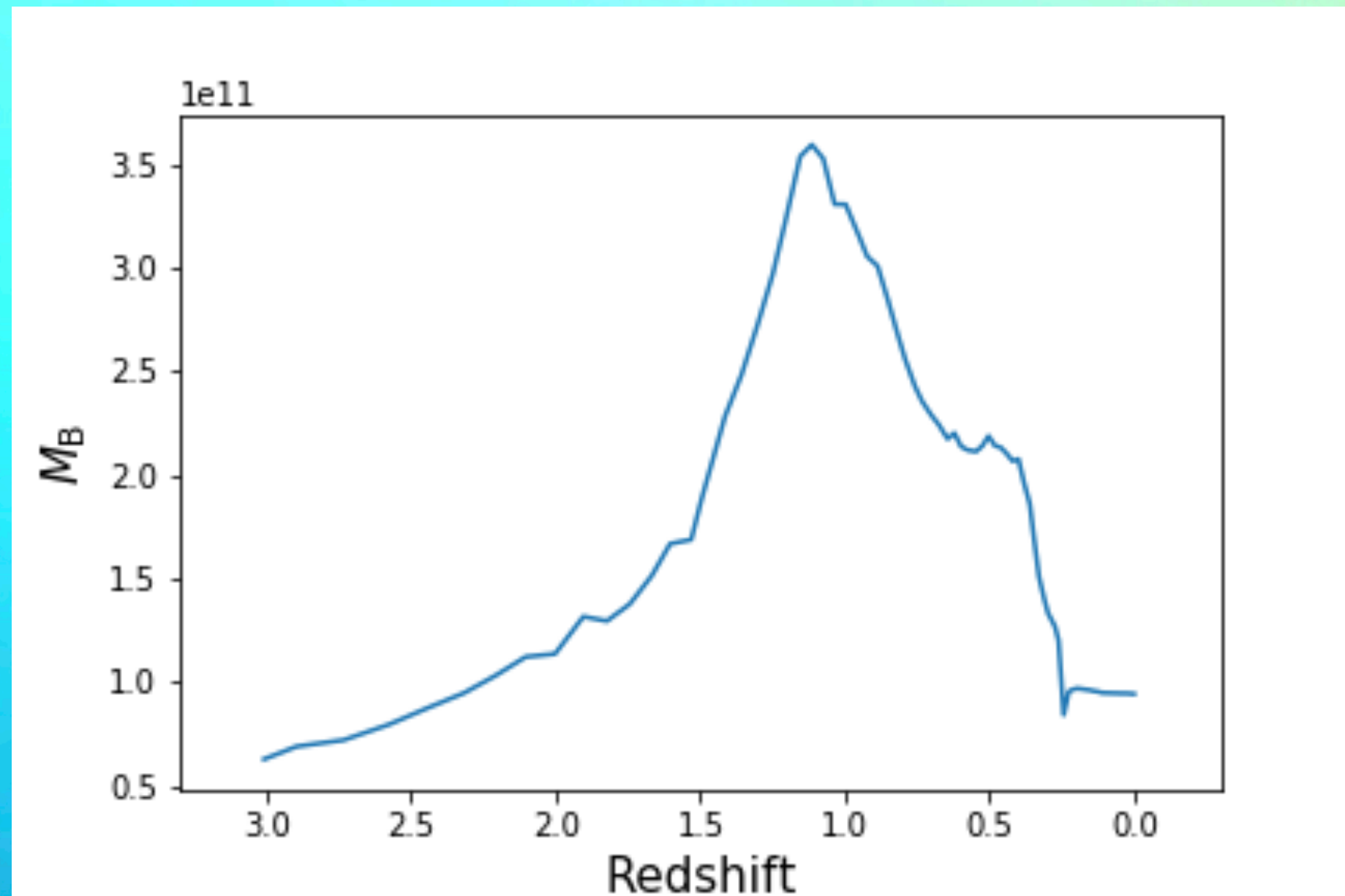
What did we do till now

- And we recover its merger tree



What did we do till now

- And we look at its properties



Where did the baryons go? —> environmental effects

ASSOCIAÇÃO
DE
MORADORES DO
CANTA GALO

"NÃO BATE
É

"BECOS E VIÉLAS
NOSSO NOME É
FAVELA"



THANK YOU