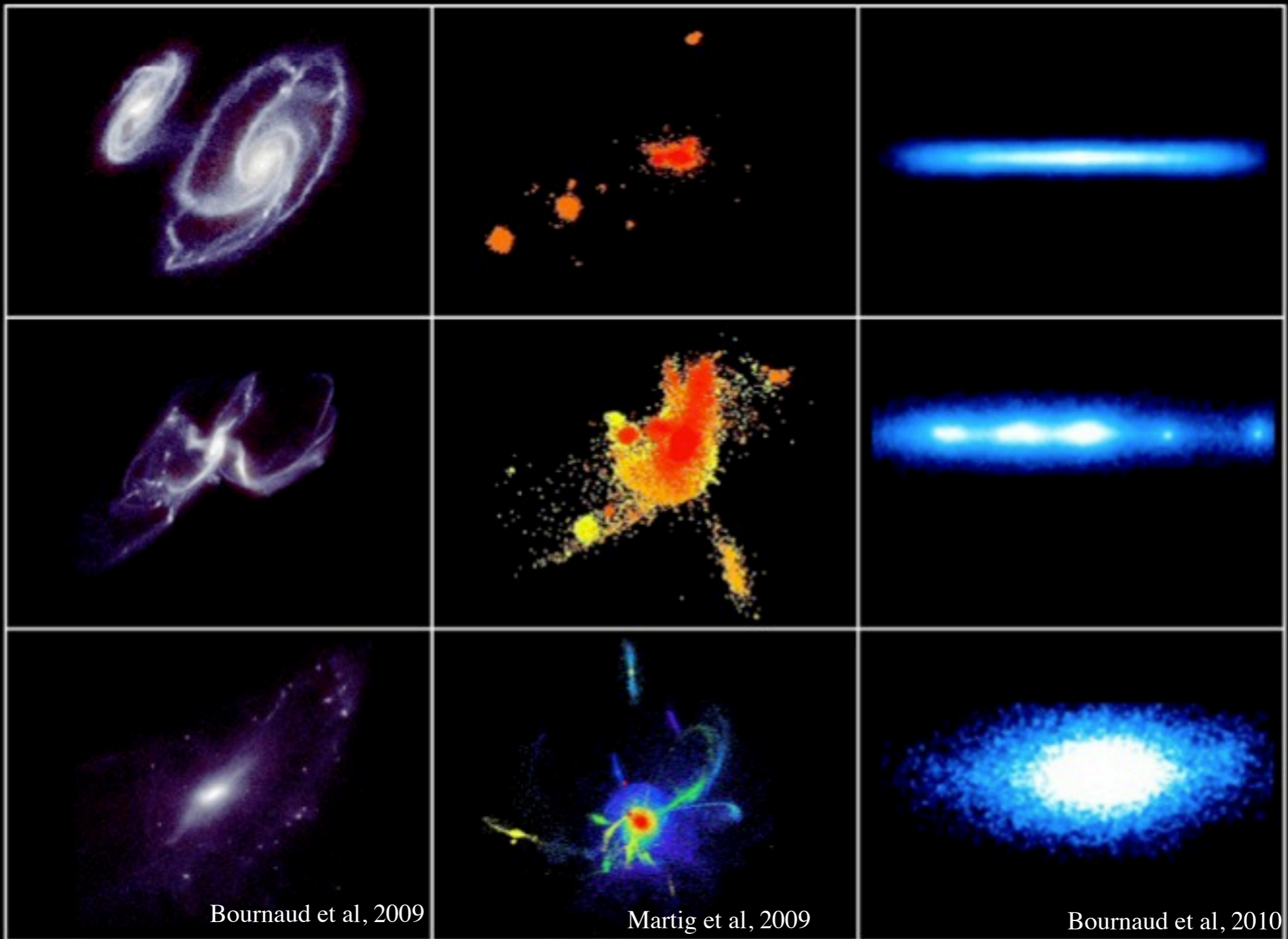


Atlas3D Collaboration
NGVS Collaboration

Pierre-Alain Duc, AIM, Paris-Saclay

Various scenarios to form massive galaxies



Bournaud et al, 2009

Martig et al, 2009

Bournaud et al, 2010

Recent major merger

Merger history

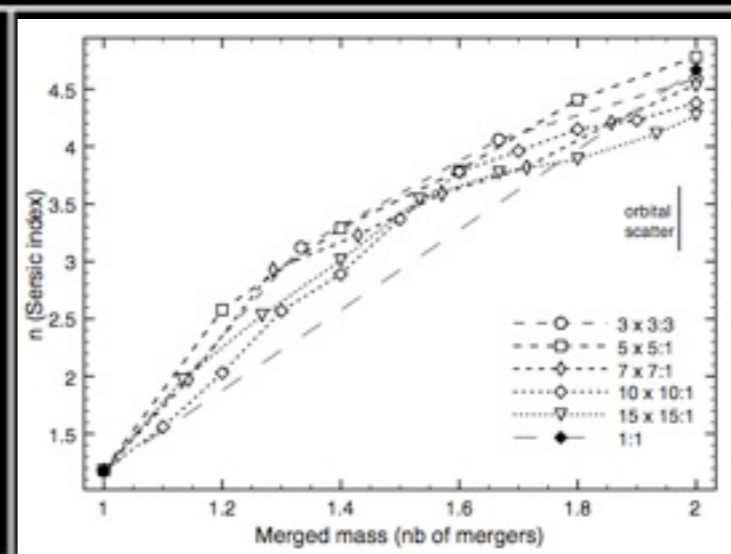
Secular evolution

Various scenarios to form massive galaxies

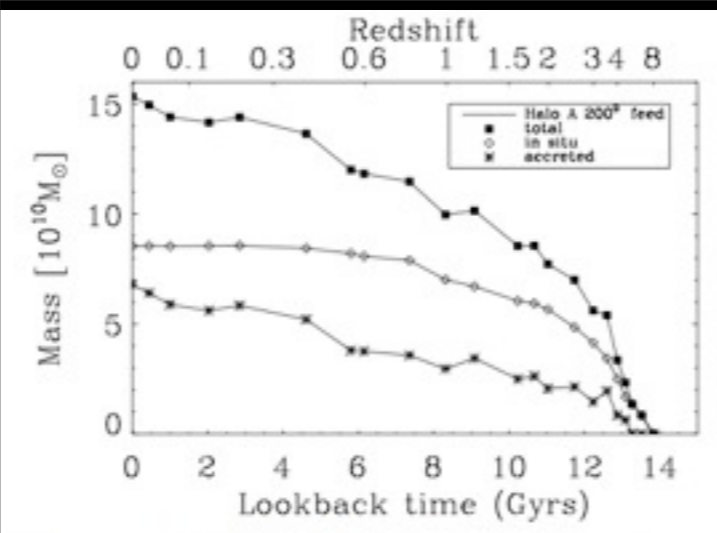


Multiple minor mergers have the same ability as major mergers to increase the Sersic index

Bournaud, Jog & Combes, 2007

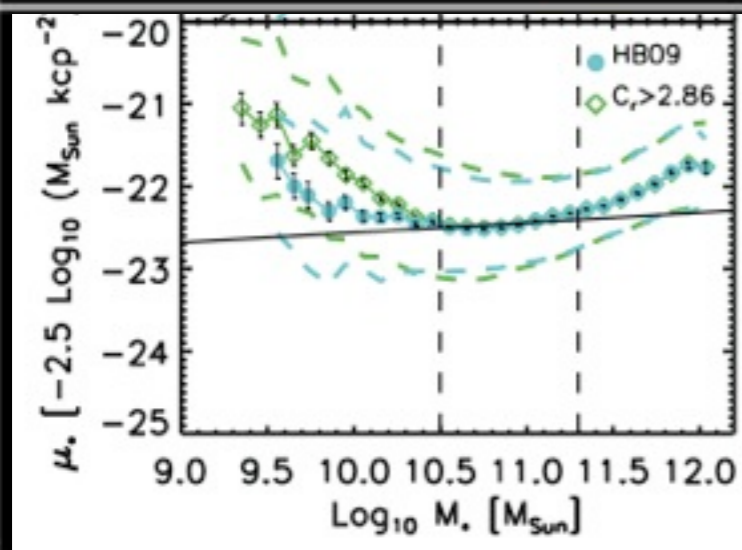


- Below $z < 1$, **mass growth** primary due to mass accretion (growth of size through minor mergers)



- At high z , primary role of in situ star formation fueled by gas accretion and cooling

Naab et al., 2009



Minor vs major merger
Dry vs wet mergers

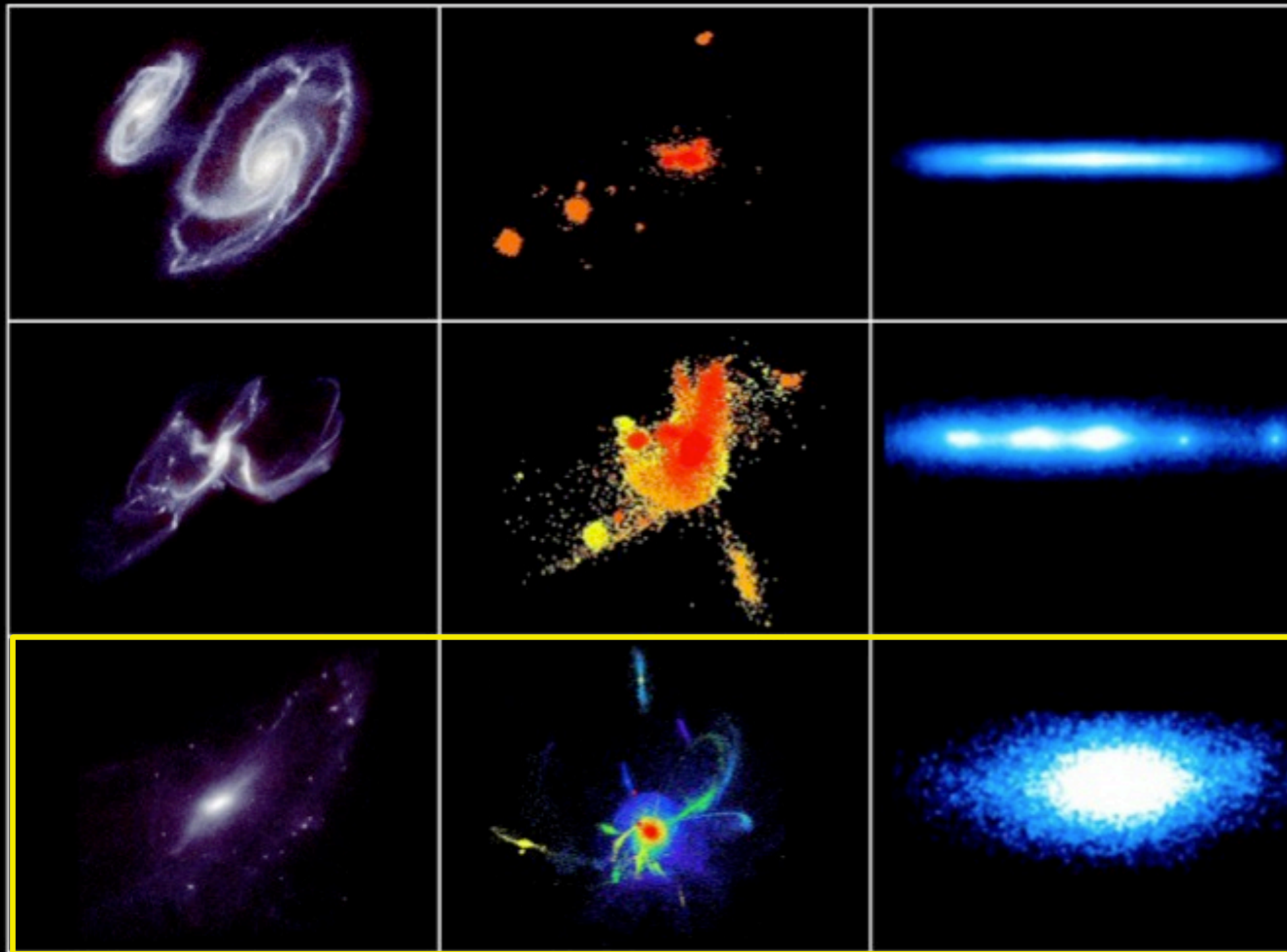
????????????????????

Hopkins et al., 2008
Bernardi et al., 2010



de Ravel et al., 2009
Lopez-Sanjuan et al., 2010

Various scenarios to form massive galaxies

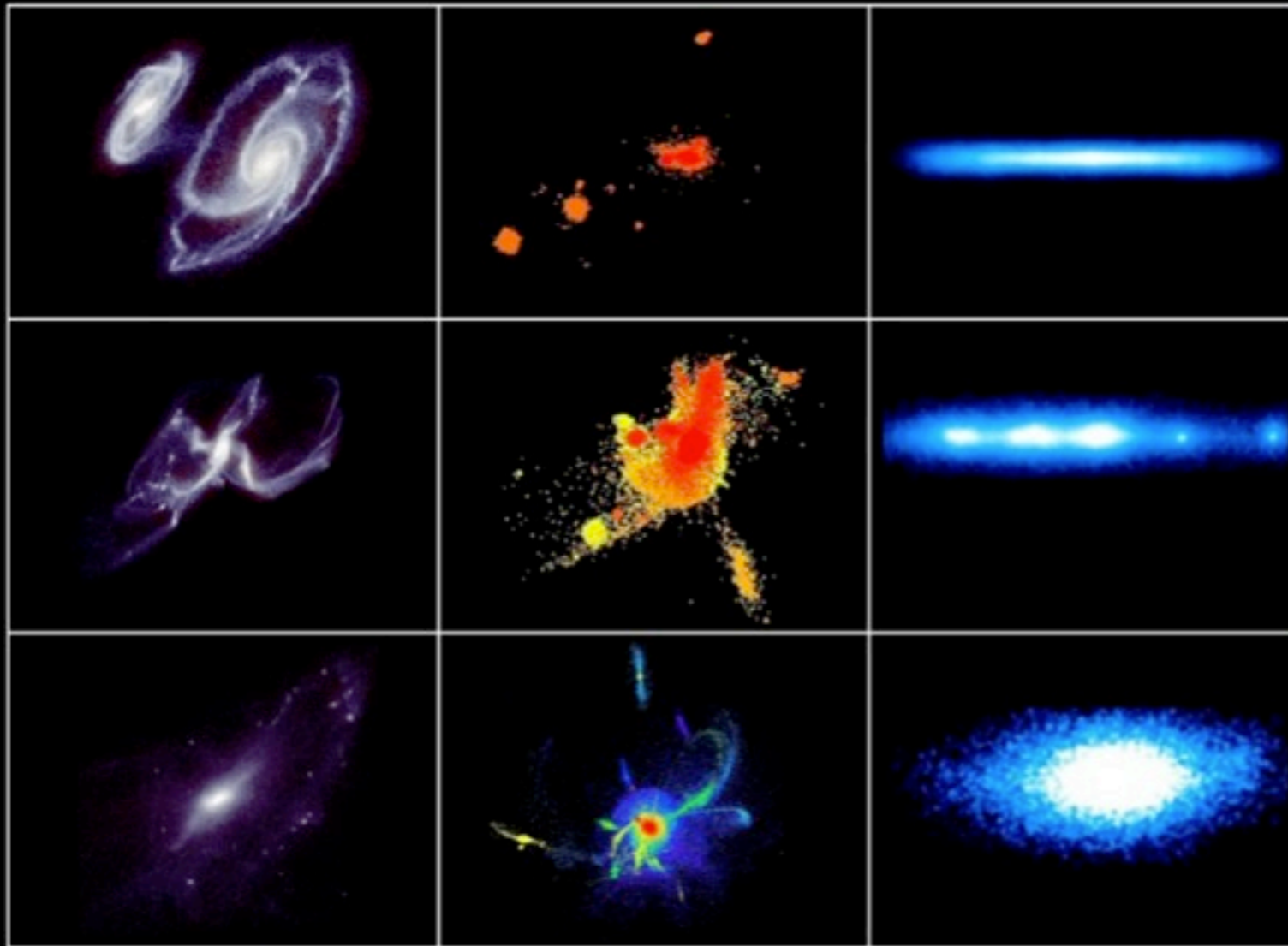


Recent major merger

Merger history

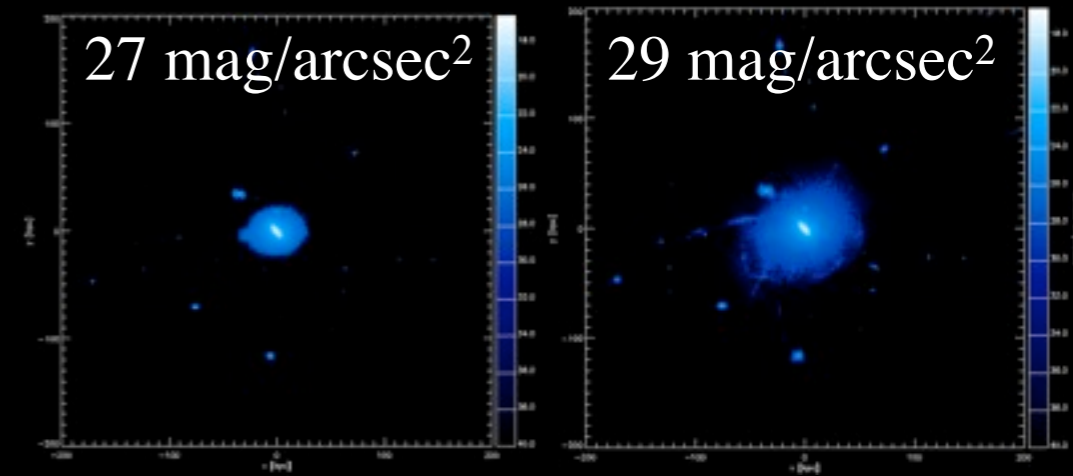
Secular evolution

... that produce various types of fine structures: tails, plumes, streams, shells, etc...

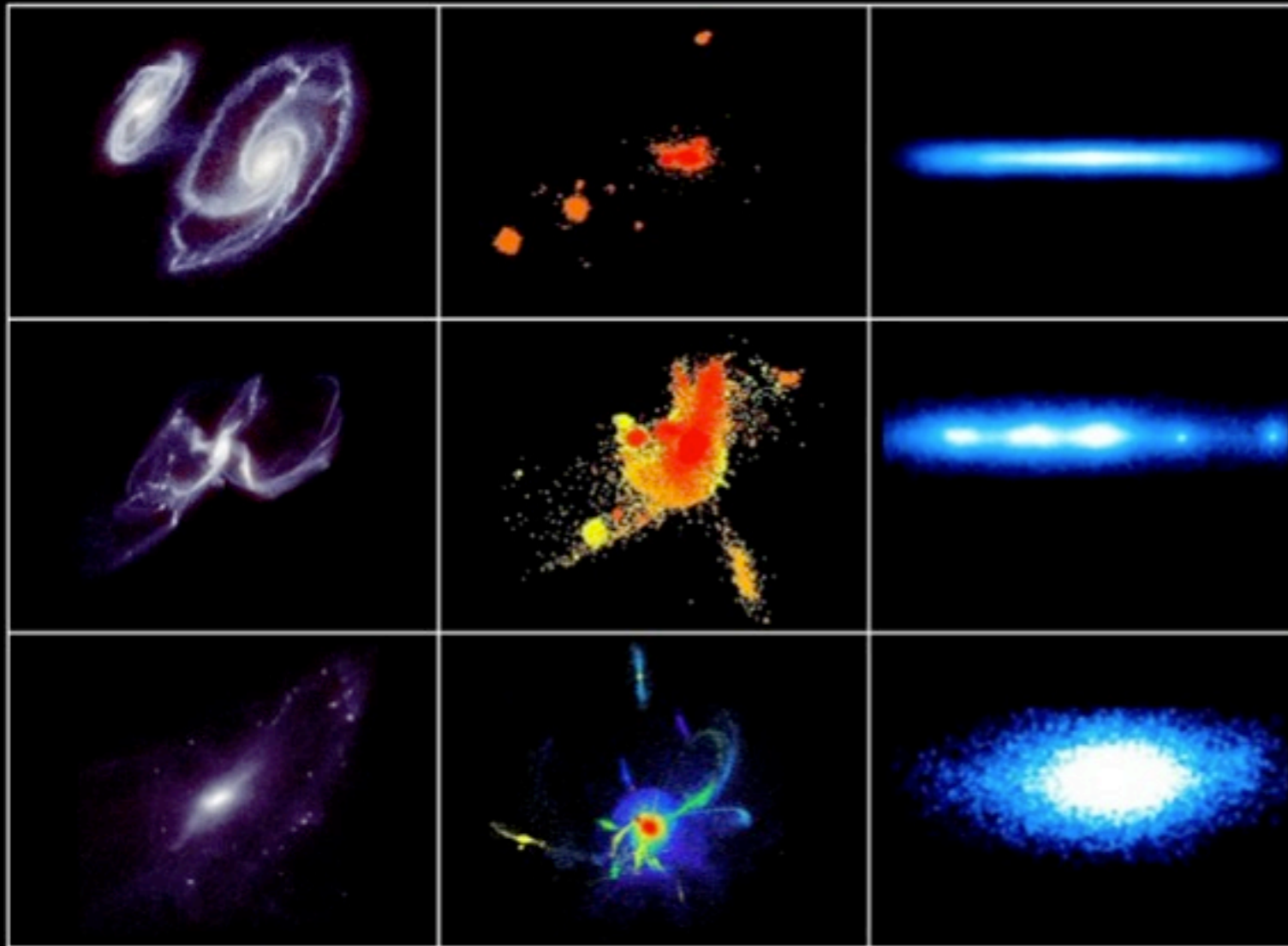


Tracing the origin of ETGs with fine structures

- Issues:
 - how to detect the fine structures?



Using specific observing methods, and dedicated pipeline (Elixir-LSB), MegaCam can now do it!



Tracing the origin of ETGs with fine structures

- Issues:

- how to detect the fine structures?

- the memory of past accretion might be lost:

 - ✓ with time

addressed by numerical simulations

 - ✓ with the environment (e.g. in clusters)

two MegaCam surveys of nearby ETGs

 - ✓ field, groups: Atlas-3D - 80 objects

 - ✓ cluster: NGVS - 60 objects

The Next Generation Virgo Cluster Survey

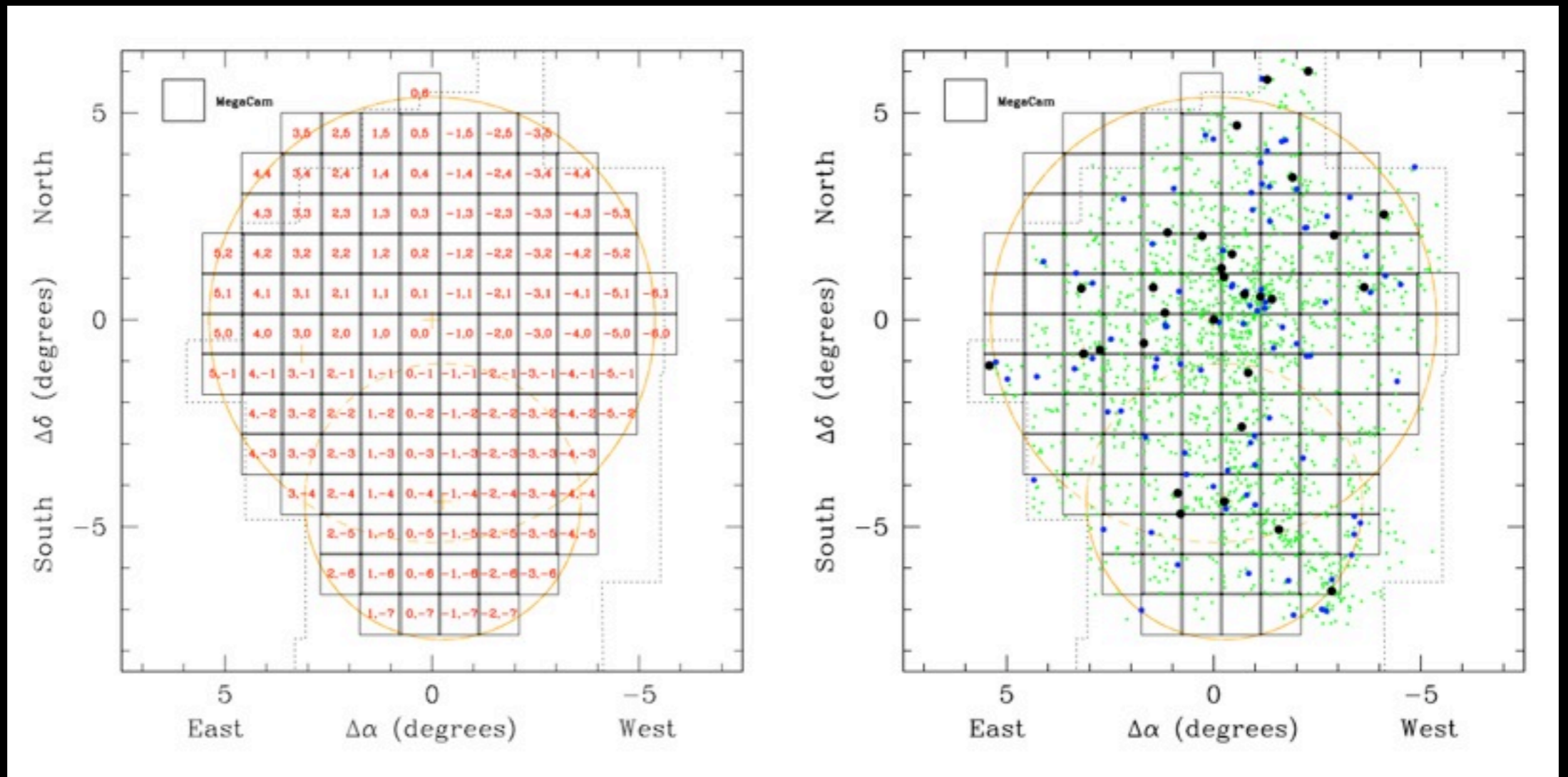


A Large Programme with CFHT / MegaCam
(771 hours over semesters 2009A-2012A)

- 104 square degrees in 5 bands (u,g,r,i,z)

- seeing(i) < 0.6''
- $g \sim 25.7$ AB mag
- SB (g) < 29 mag arcsec⁻²

u=6400 s
g=3200 s
r=4800 s
i=2050 s
z=4400 s



Ferrarese et al, 2011

Trouver ses petits...

Stellar streams



Galactic cirrus

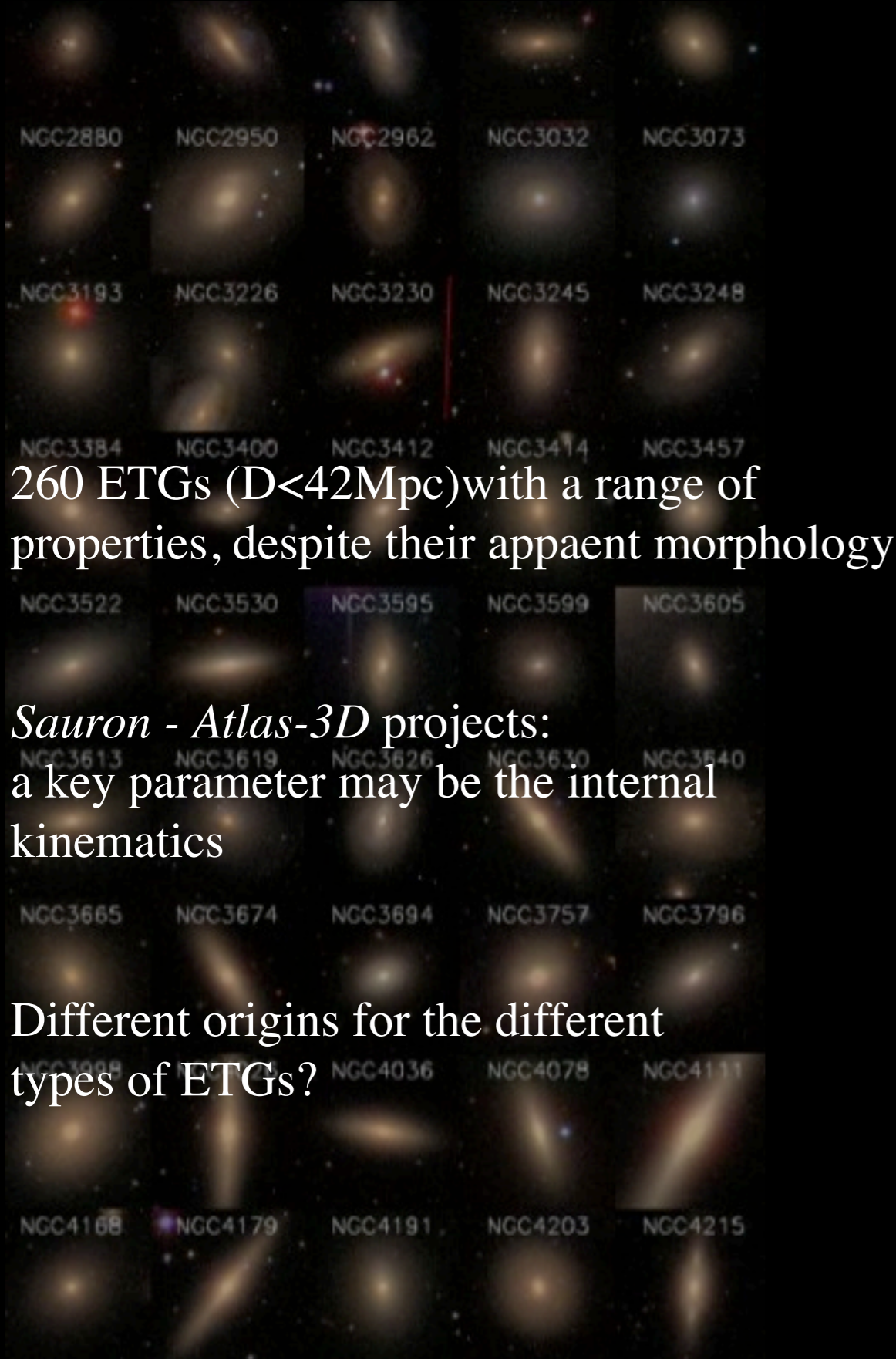
Faint foreground stars

Instrumental artifacts

Halos of bright stars

Plus galaxies

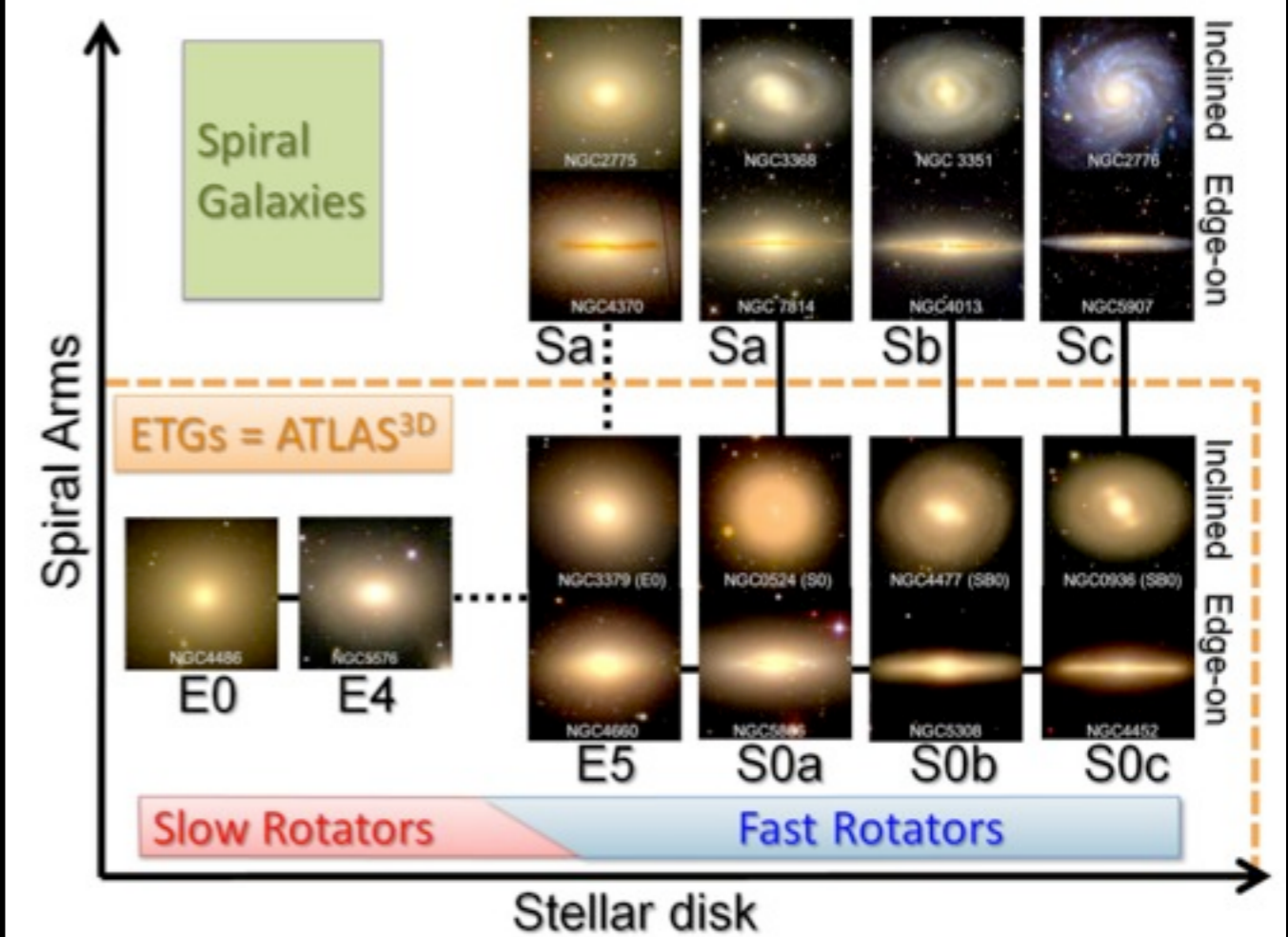
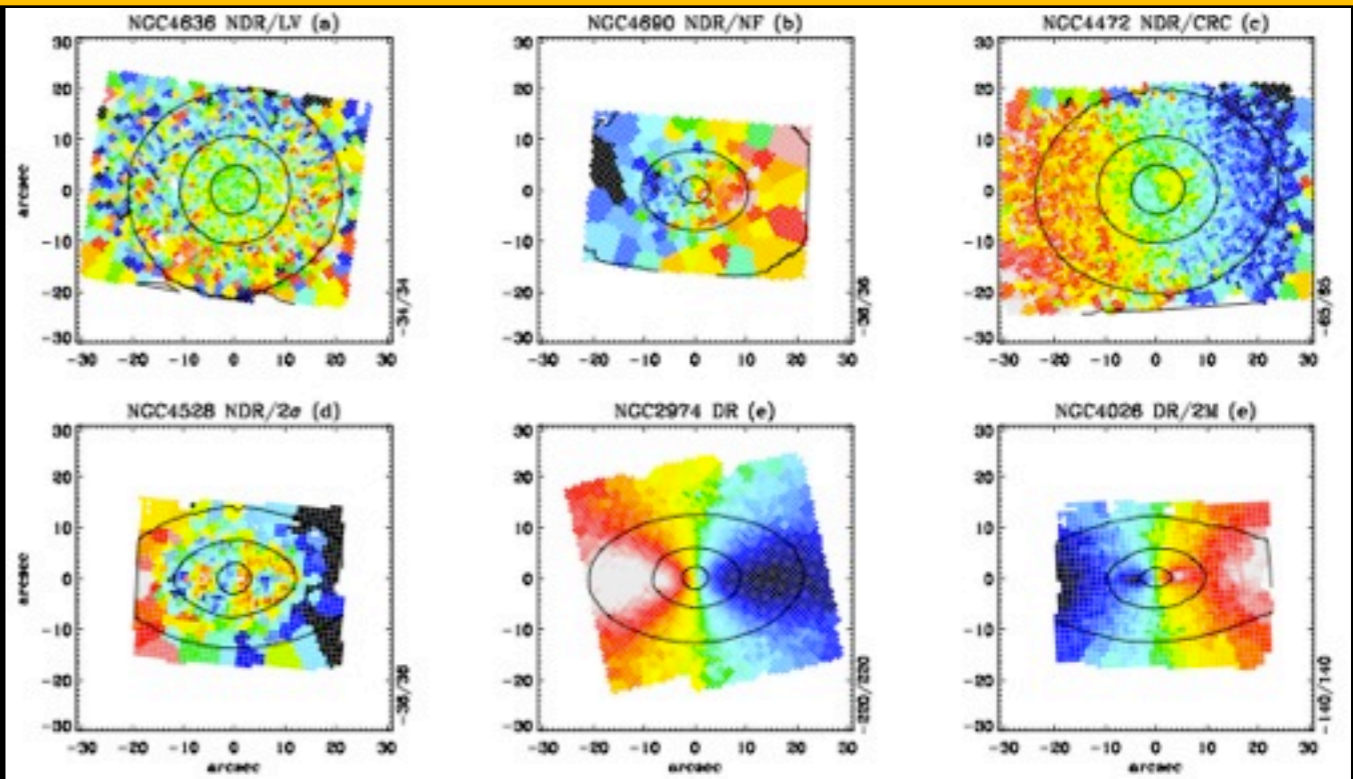
Atlas-3D sample of nearby early-type galaxies



260 ETGs ($D < 42 \text{ Mpc}$) with a range of properties, despite their apparent morphology

Sauron - *Atlas-3D* projects: a key parameter may be the internal kinematics

Different origins for the different types of ETGs?



Capellari et al, 2010



Tidally interacting systems

ATLAS 3D



Tidally interacting systems

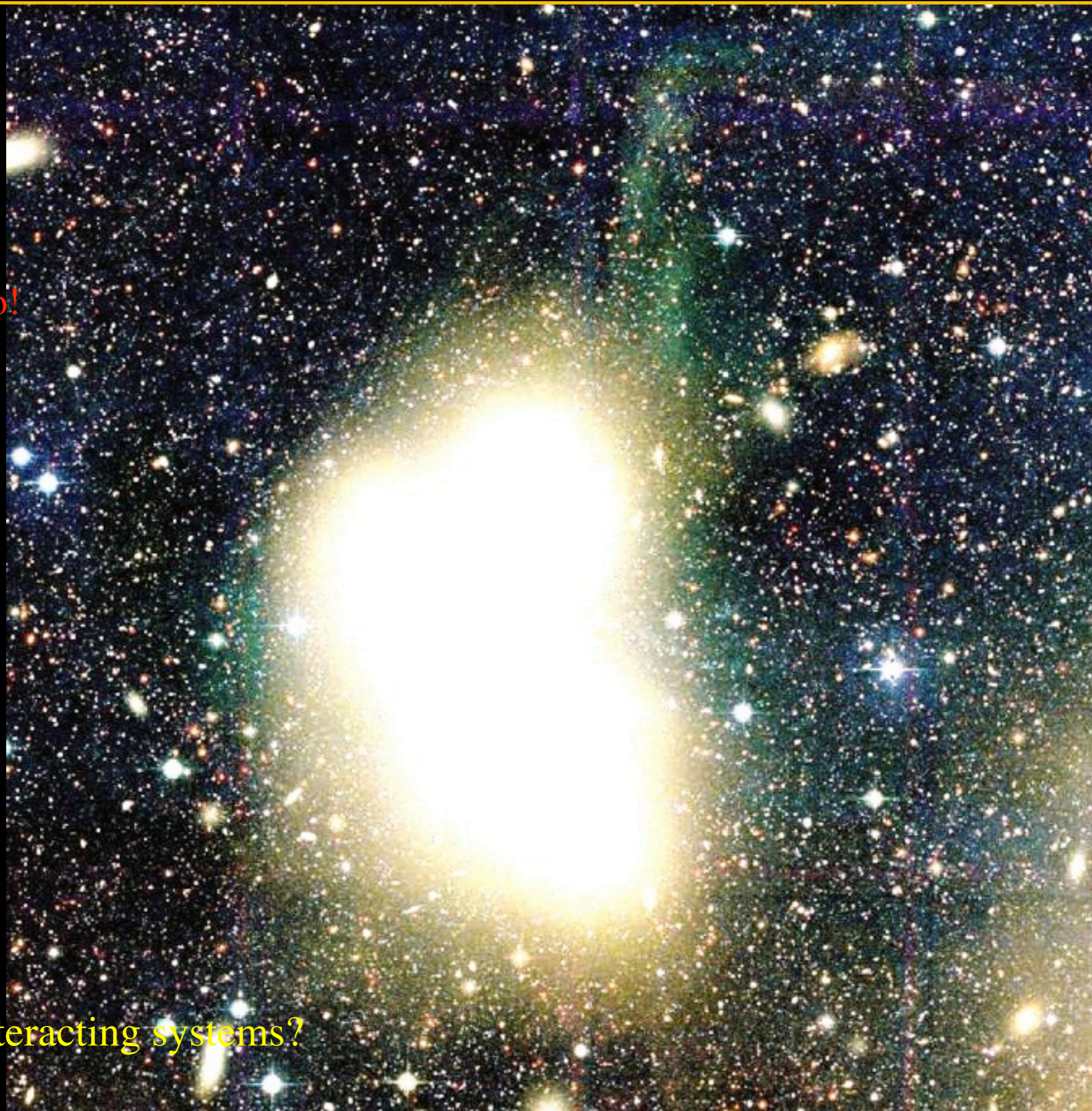
ATLAS 3D



Tidally interacting systems

NGVS

In Virgo!



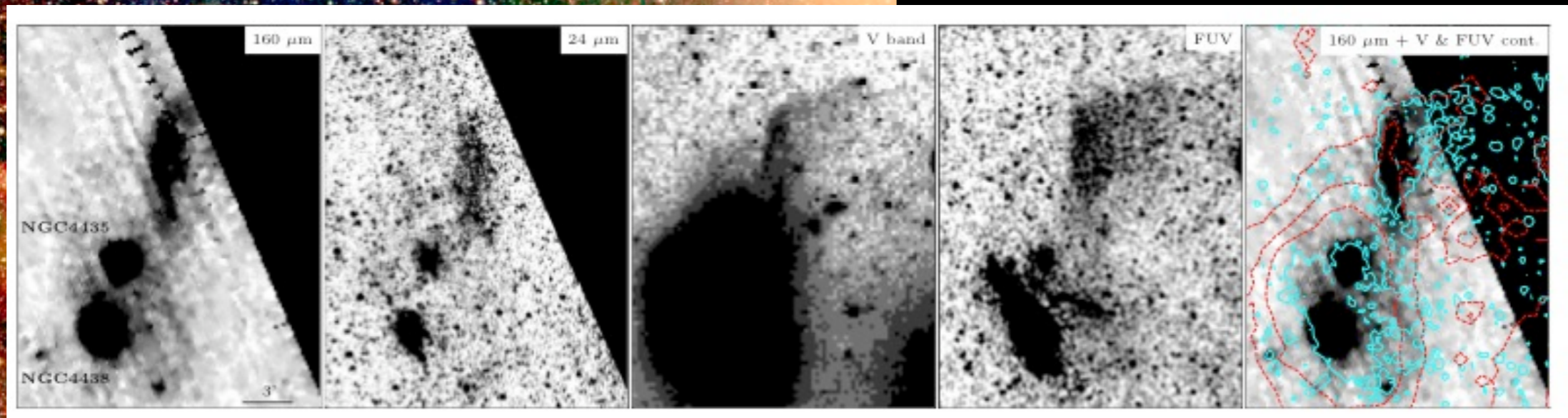
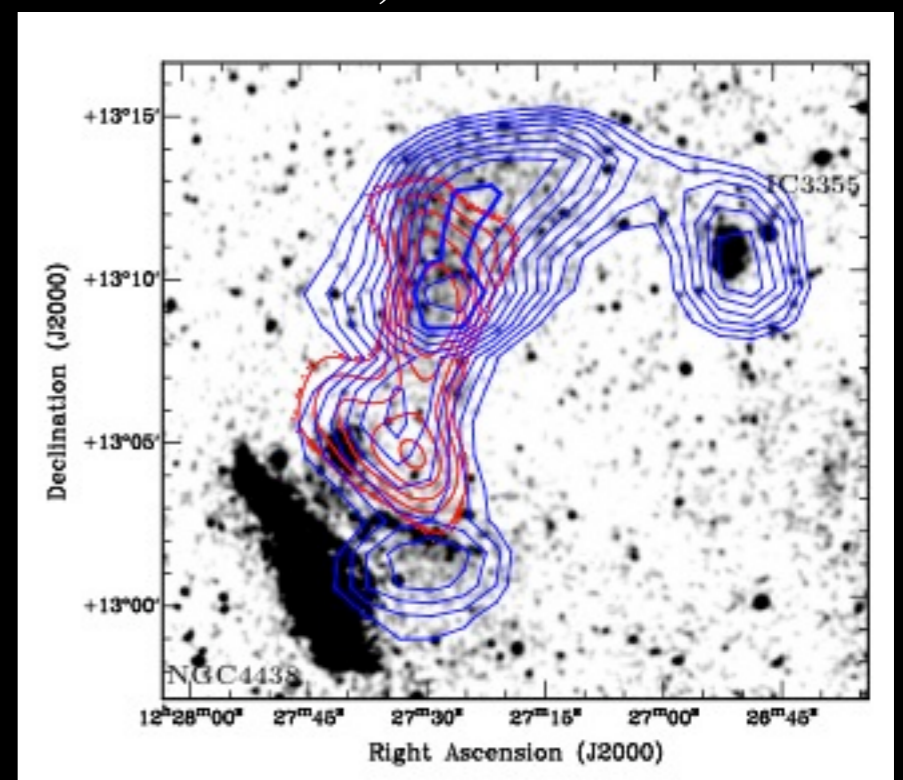
Tidally interacting systems?

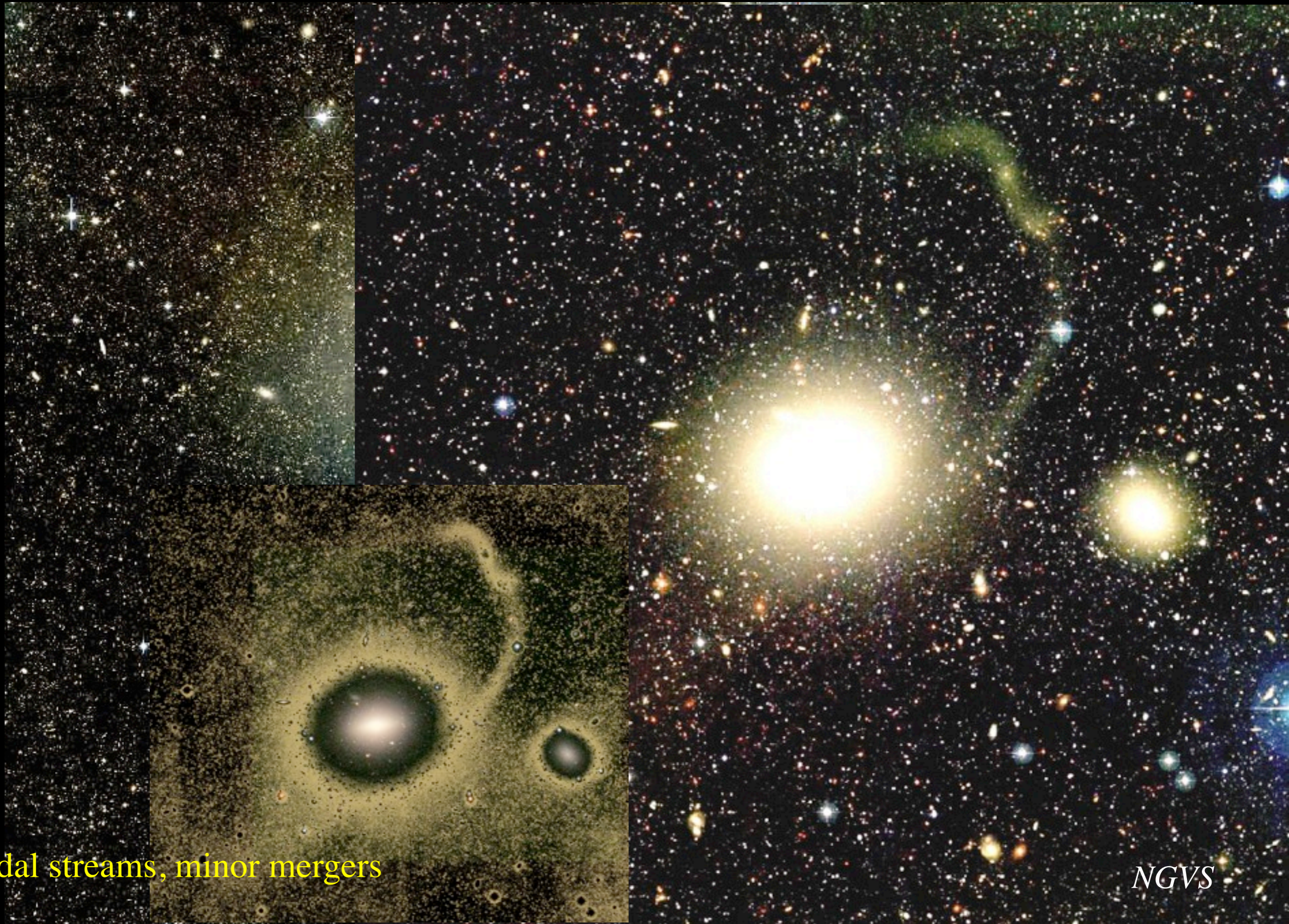
NGVS



Not a star-forming tidal tail

Cortese et al., 2010





Tidal streams, minor mergers

NGVS



Shells, minor/major mergers

ATLAS 3D



Major mergers

ATLAS 3D

Major mergers

ATLAS 3D



Major mergers

ATLAS 3D



Major mergers

ATLAS 3D



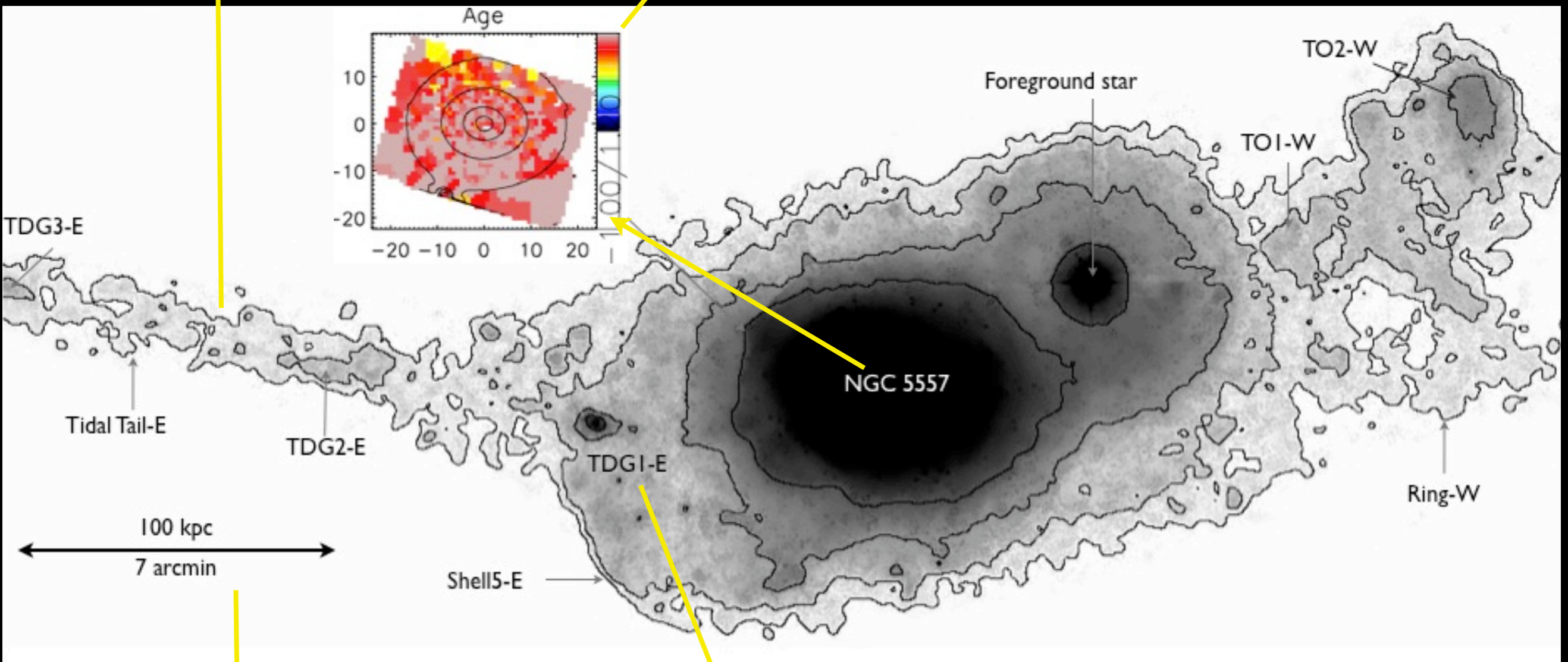
Major mergers

Duc et al., 2011

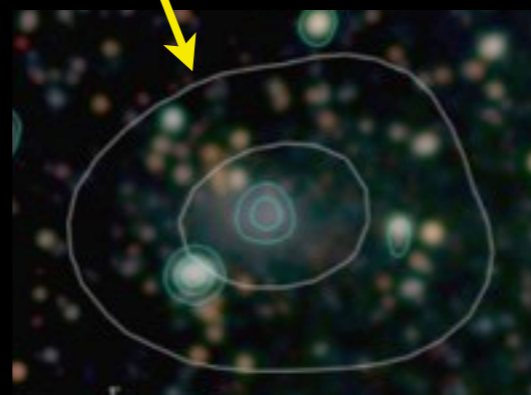
NGC 5557: an old major merger

the tidal tails reveal a wet relatively recent major merger at the origin of the ETG

the absence of young stars / gas in the remnant tell that the merger is at least 1-2 Gyr old



one of the largest stellar structure known in the nearby Universe



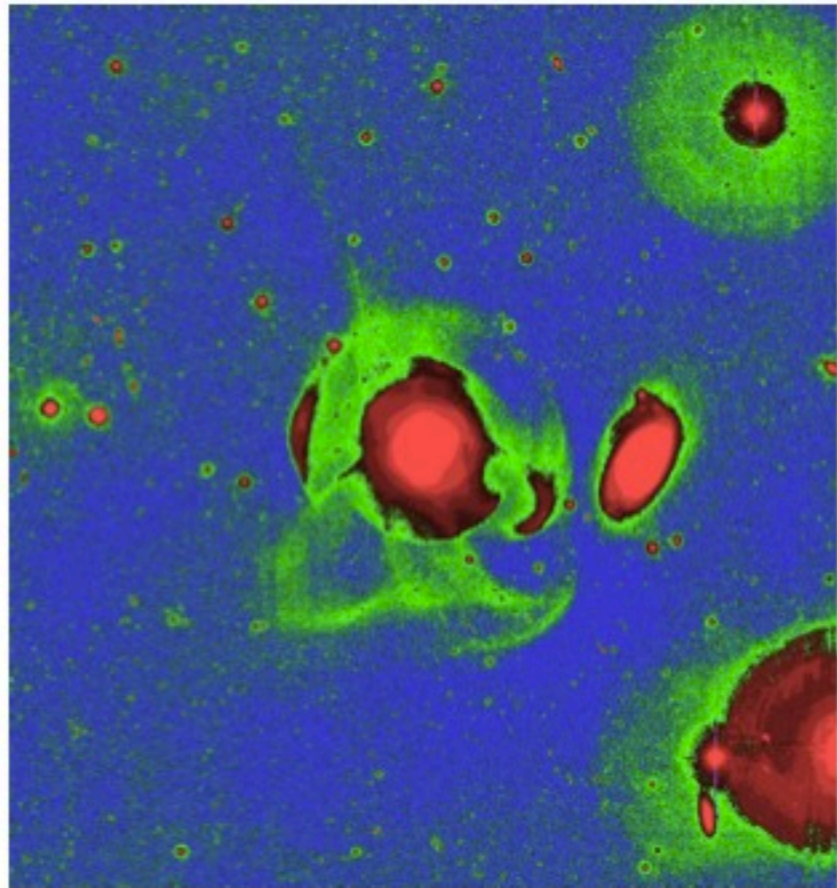
one of the oldest surviving Tidal Dwarf Galaxy so far know



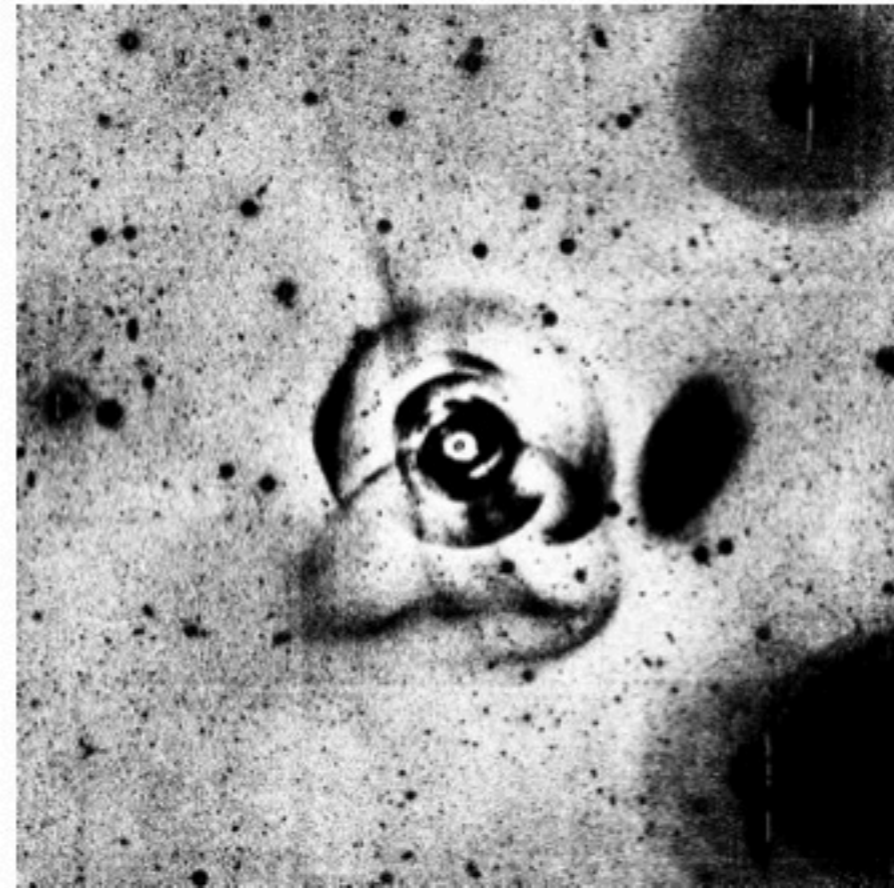
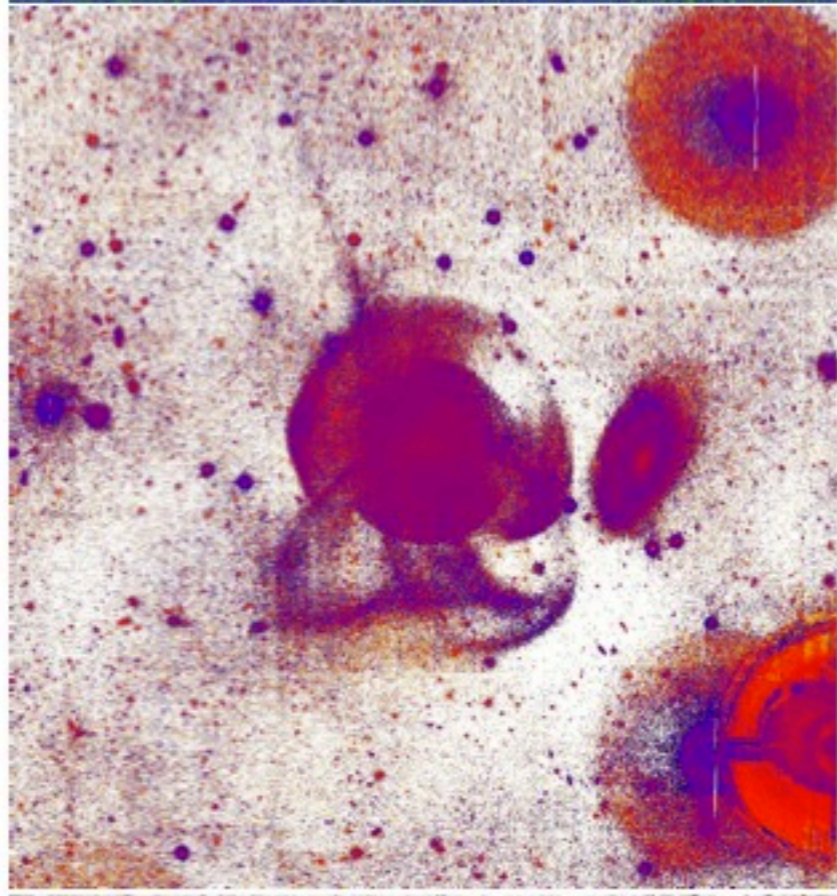
Boring, relaxed...

NGVS

Surface
brightness map



g-r color map

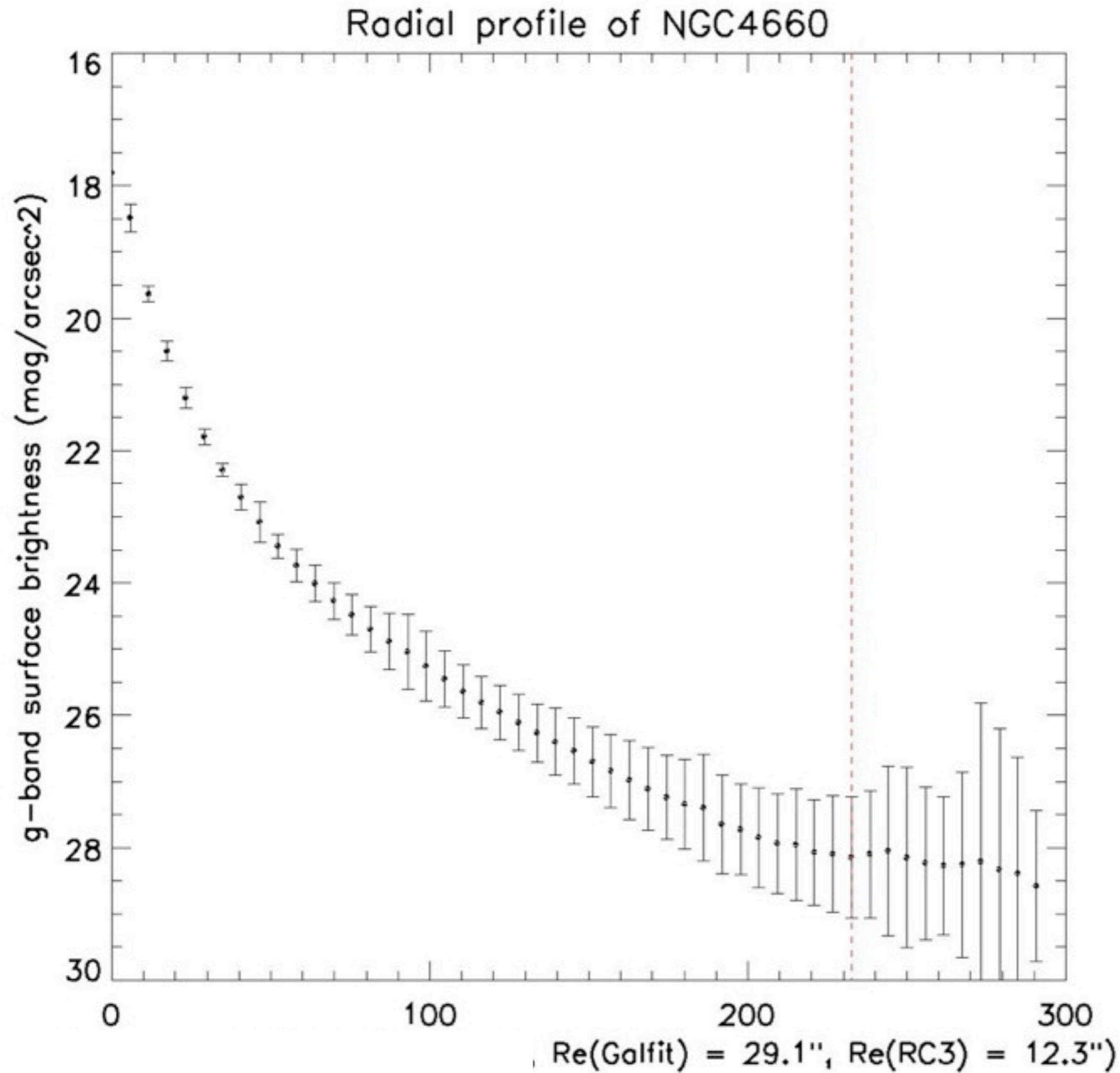


Galfit model
subtraction



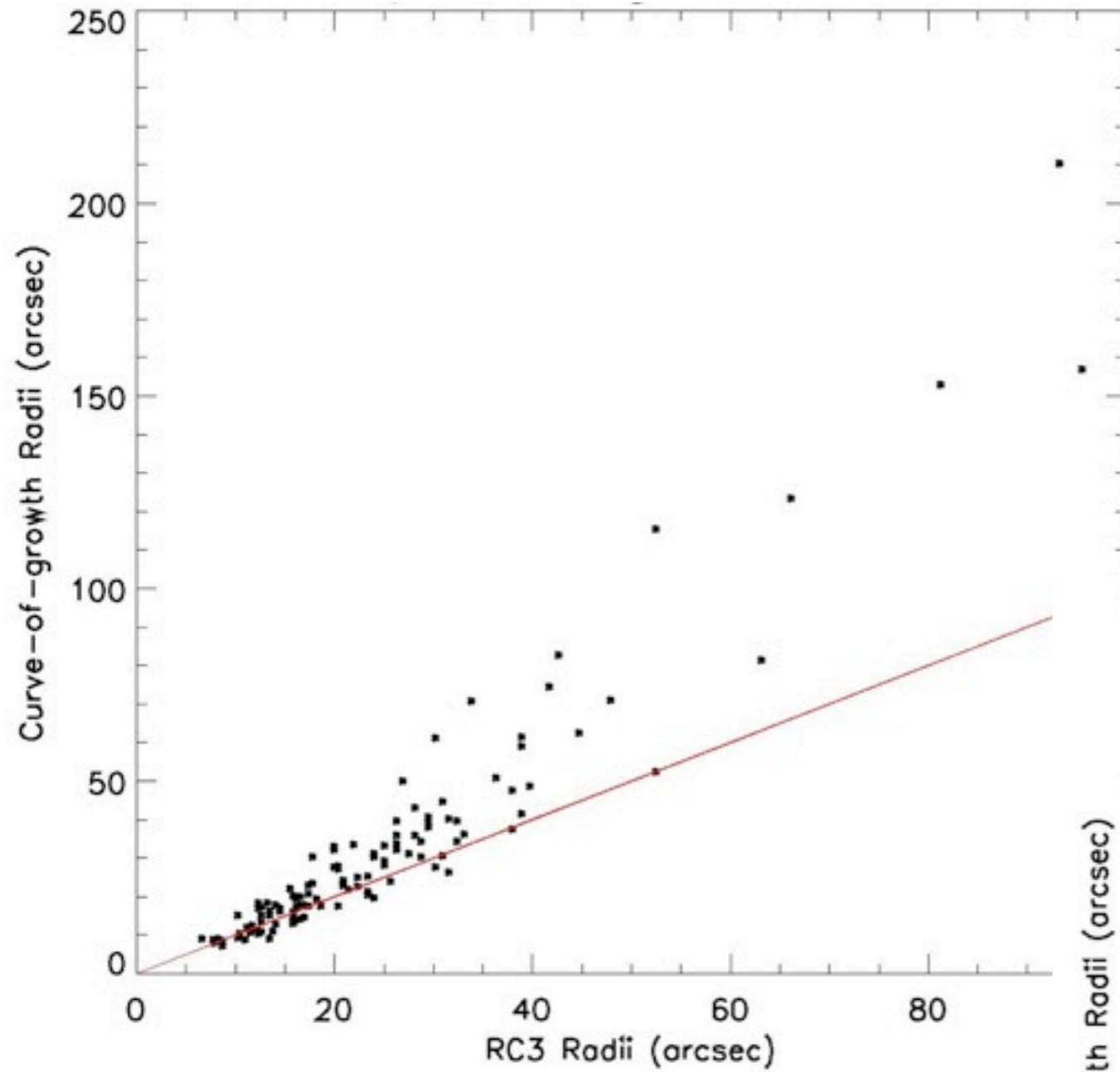
Unsharp
masking

Structural parameters



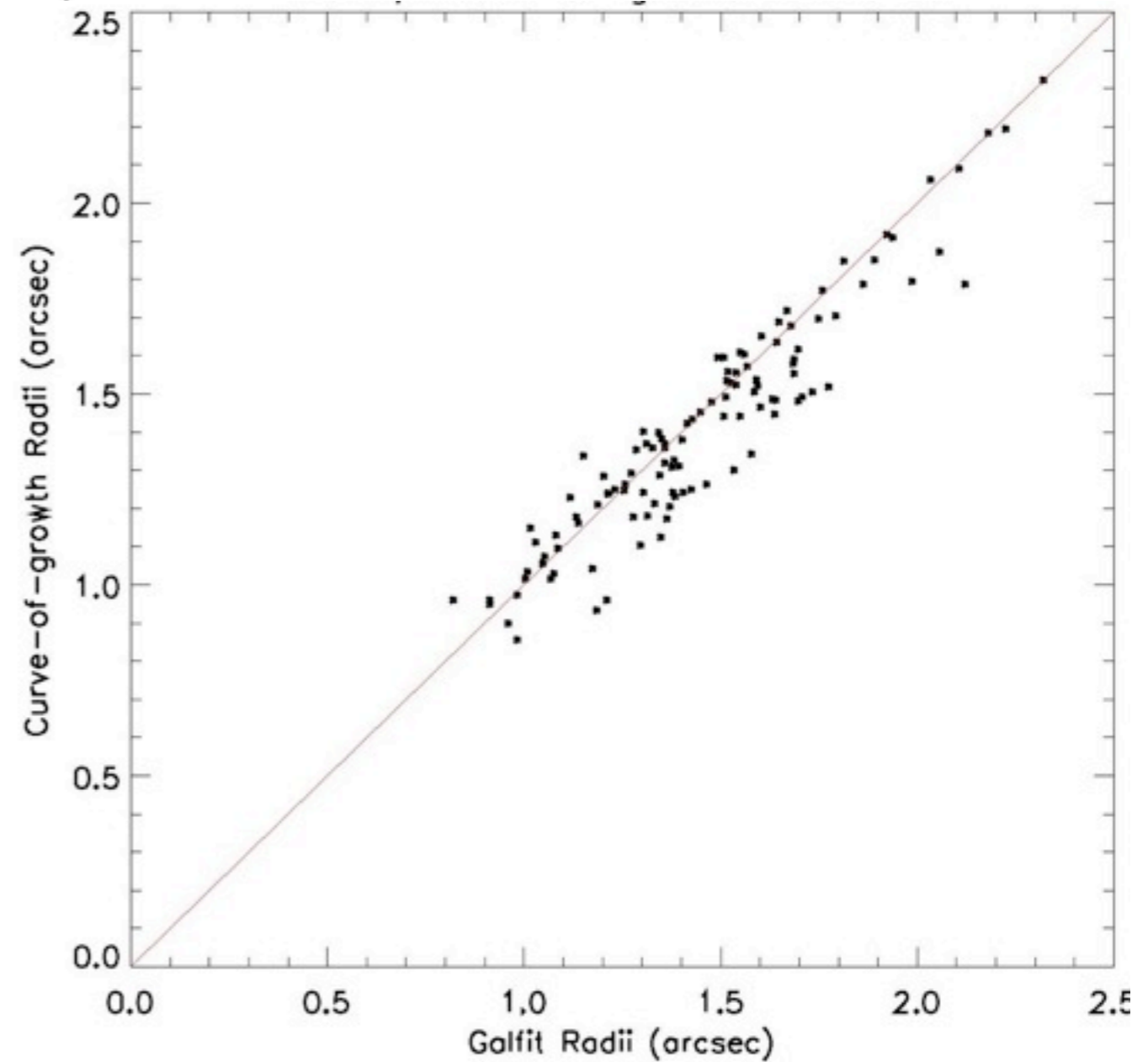
New measure of the effective radius with curve growth and galfit modeling

Structural parameters



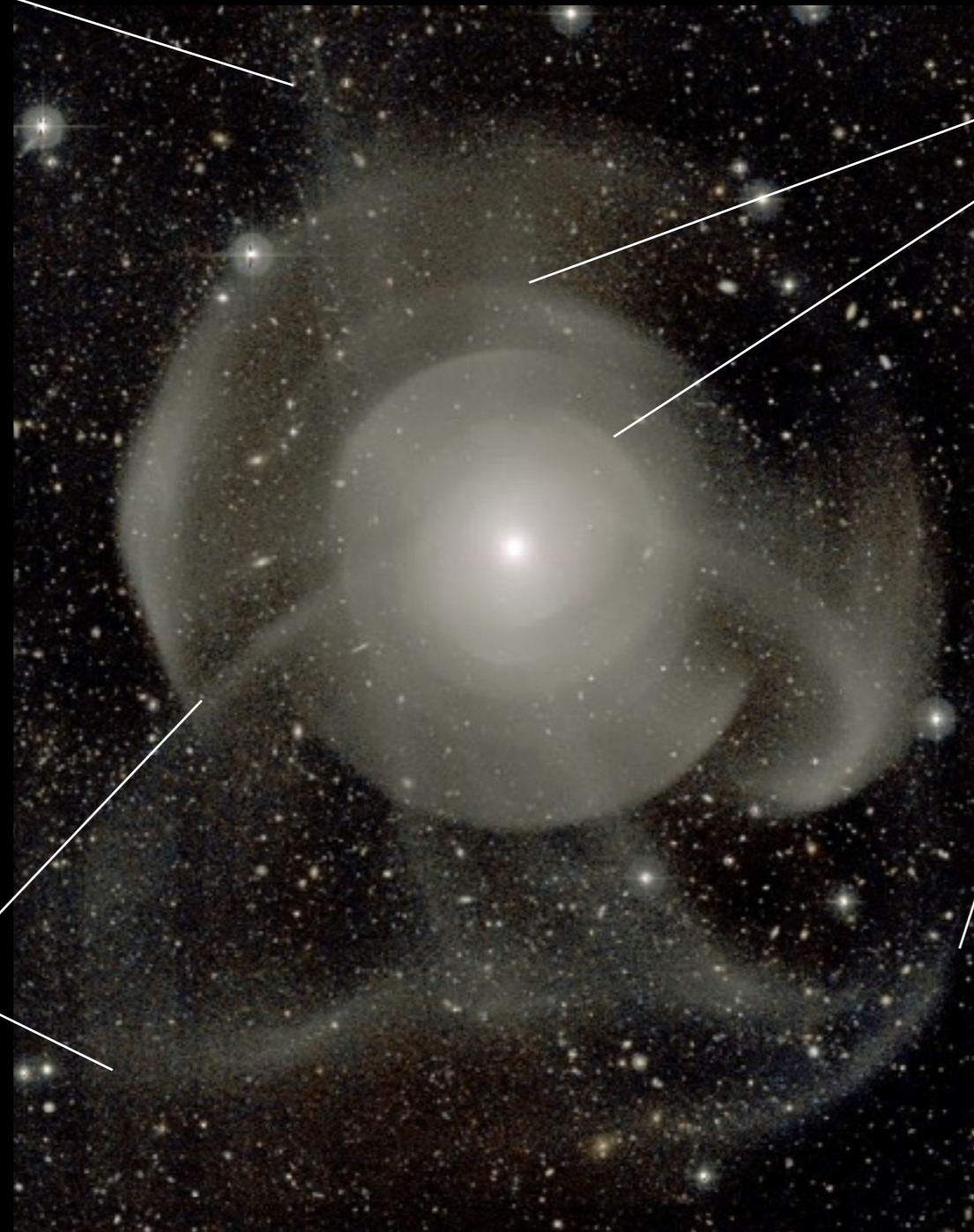
Extra component for the most massive galaxies

New measure of the effective radius with curve growth and galfit modeling



Number of tidal tails

Number of shells

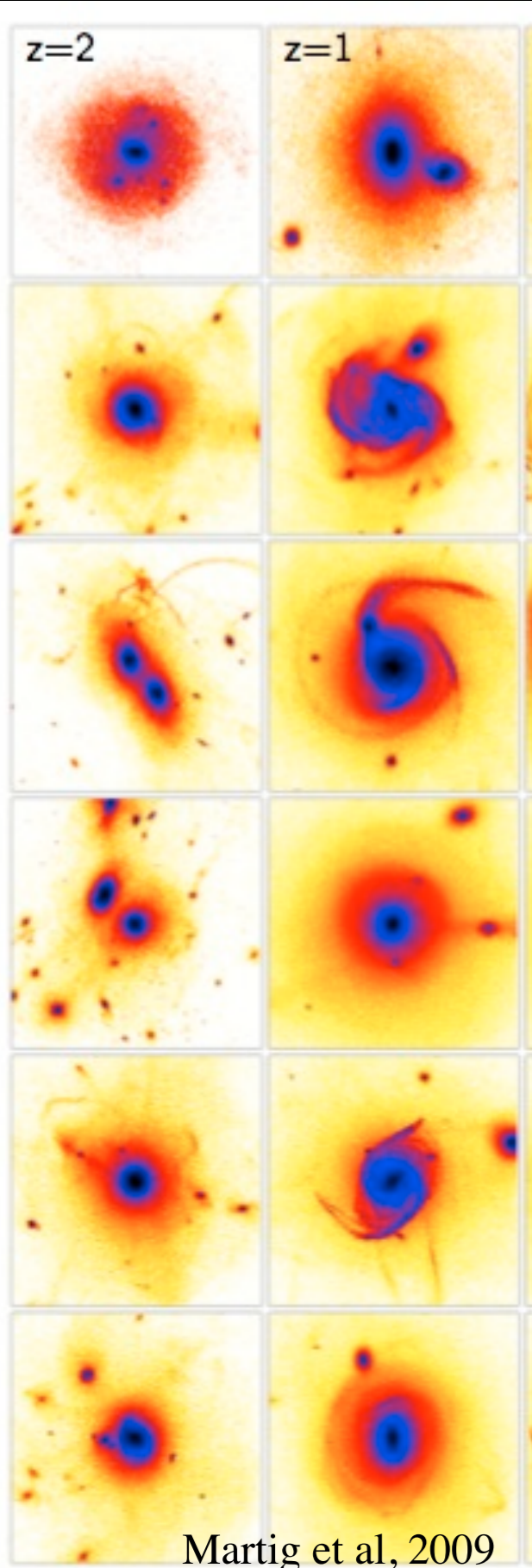


Number of streams

+ presence of diffuse halos,
bars, asymmetries, etc..

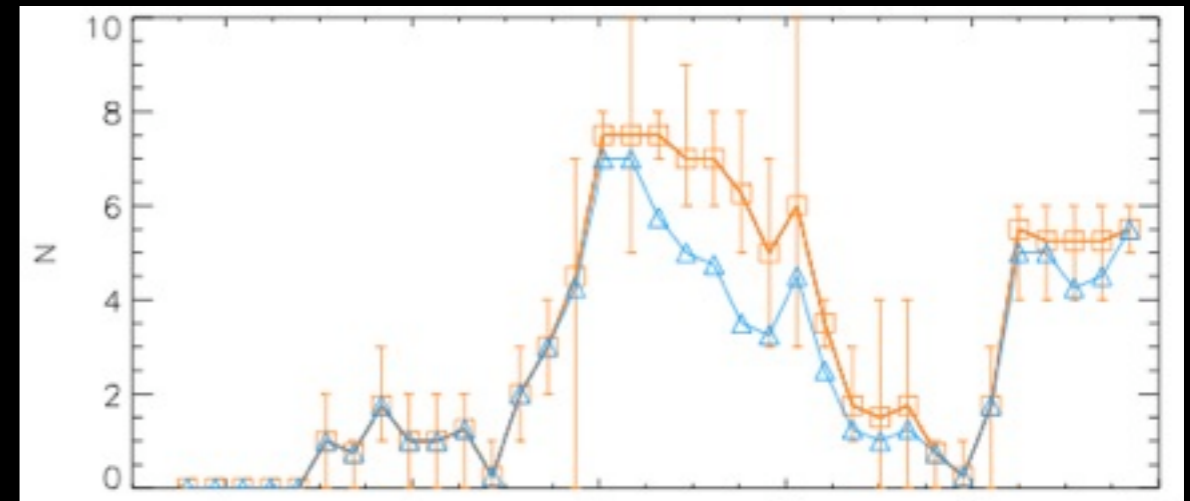
Statistics made on 115 ETGs, with a group of 4 people

Survival of fine structures (simulations)

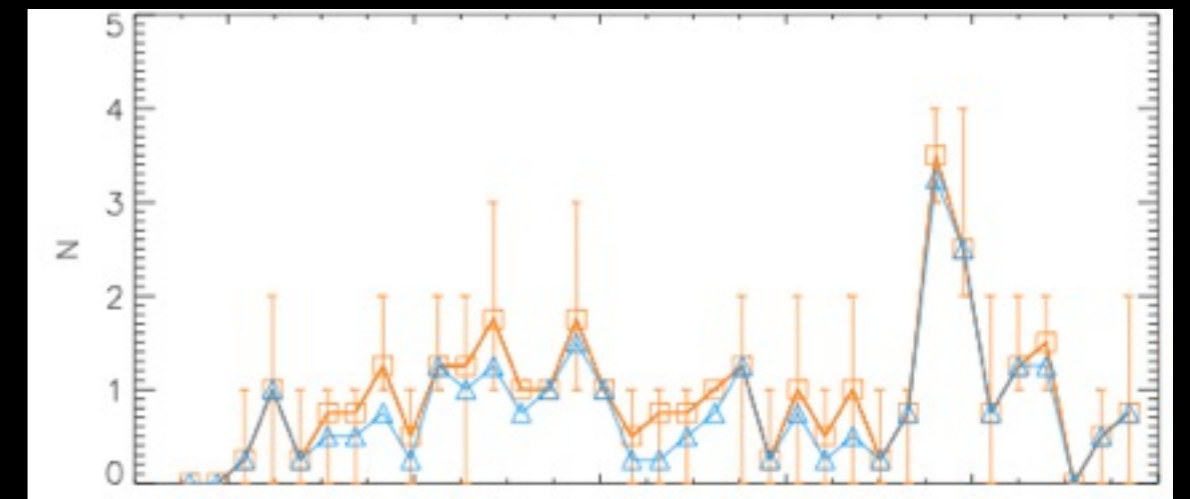


Martig et al, 2009

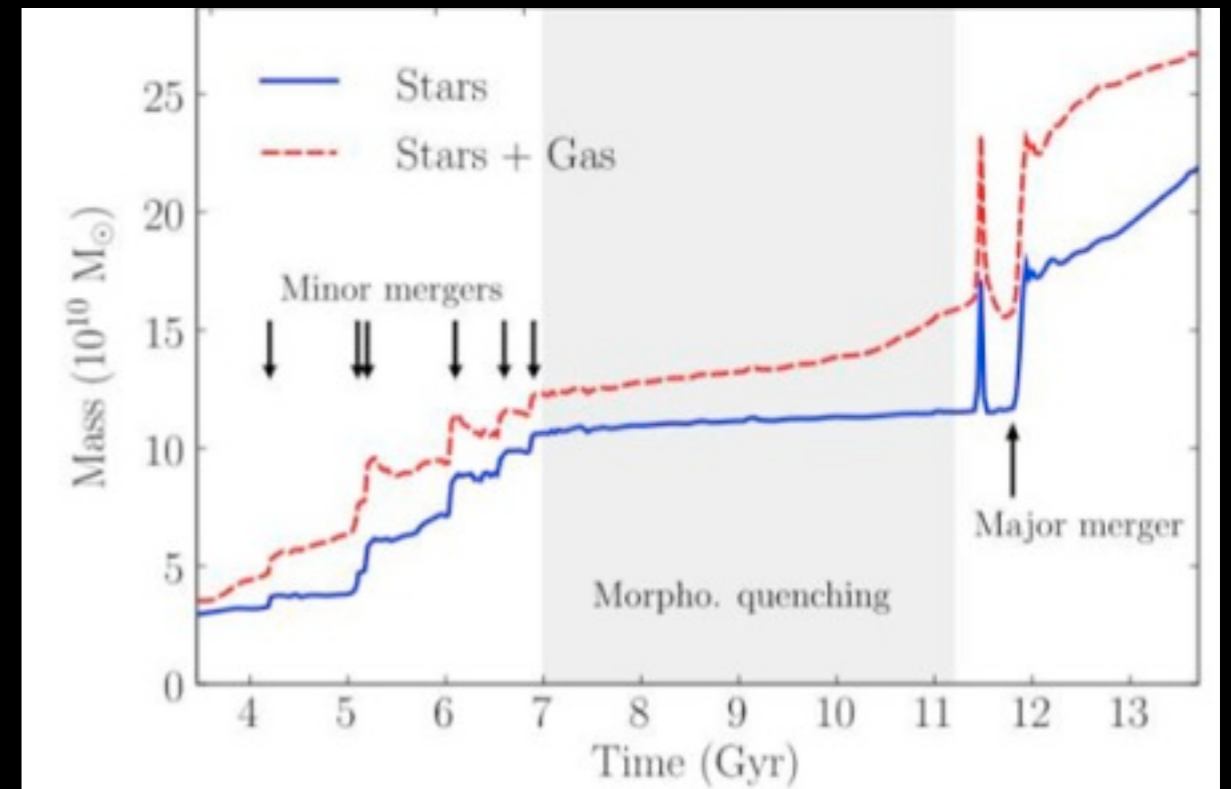
Number of shells



Number of tidal tails



Mass assembly

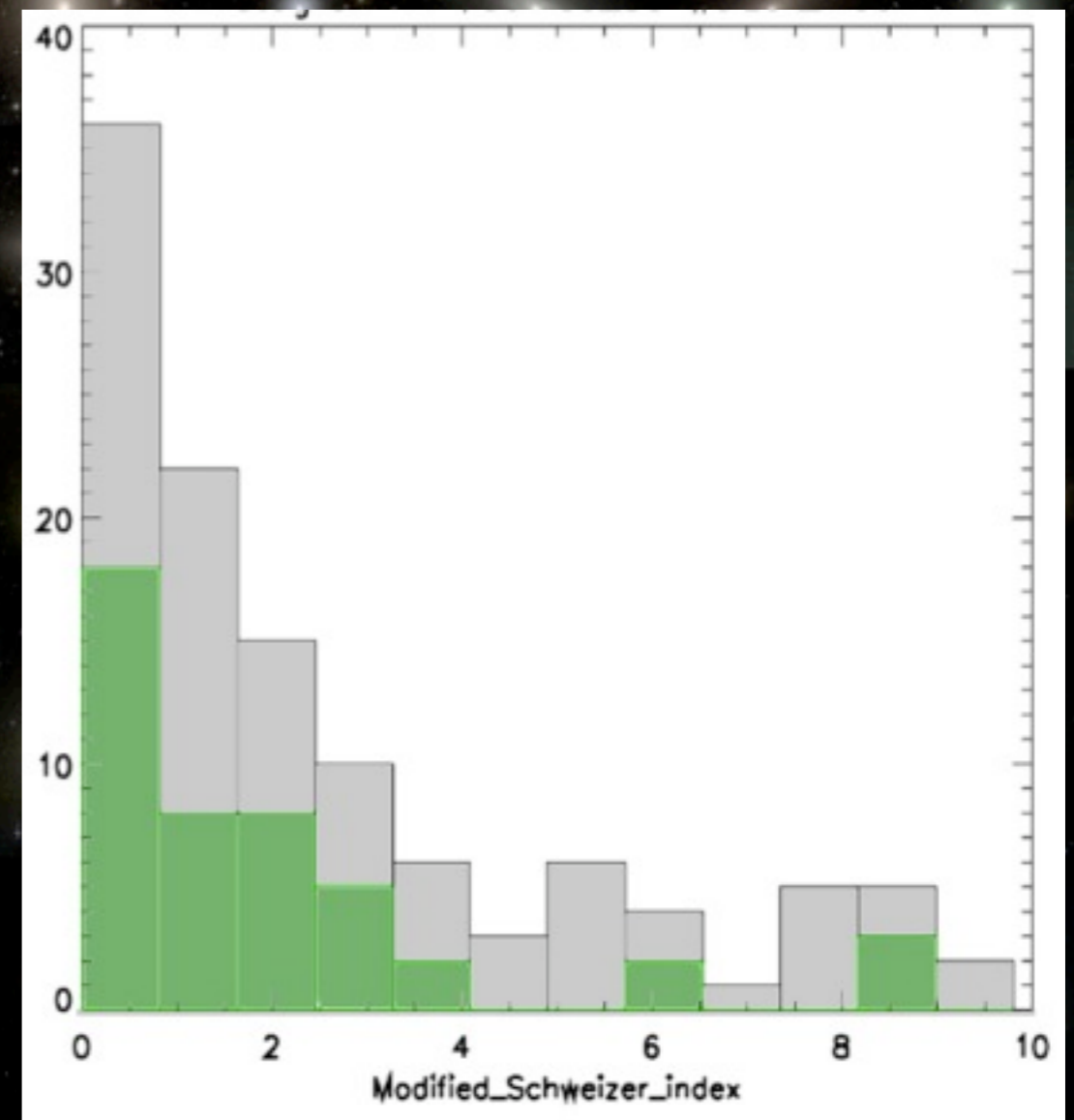


Michel-Dansac et al, 2011

Systematic differences

- Fraction of fully relaxed ETGs slightly higher among Virgo ETGs
- Fraction of highly perturbed ETGs higher in the «field»
- ✓ Age effect: cluster ETGs are older, and the memory of their past mass accretion has been lost
- ✓ History effect: the mass assembly is different in the field or clusters
- ✓ Local environment effect: tails and fine structures are destroyed in clusters (contributing to the ICL)

Statistical significance of these results?
Rather look at local density





Complete observations, analysis as a function of local density

Determining a less subjective index of the fine structure index (observations/simulations)

Stellar properties of the outskirts (minor vs major mergers predict different age/Z)