

Is prolateness the (dominant) rule for BCGs ?



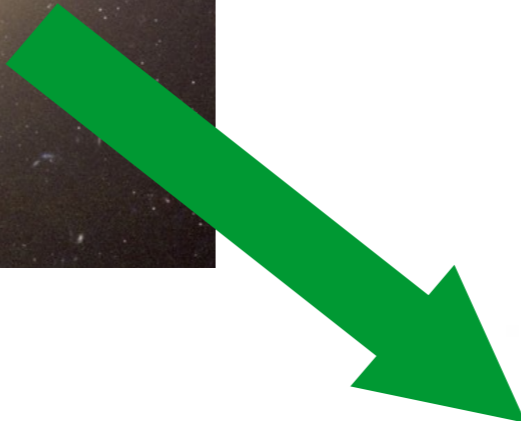
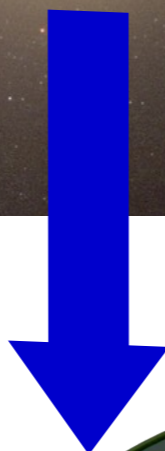
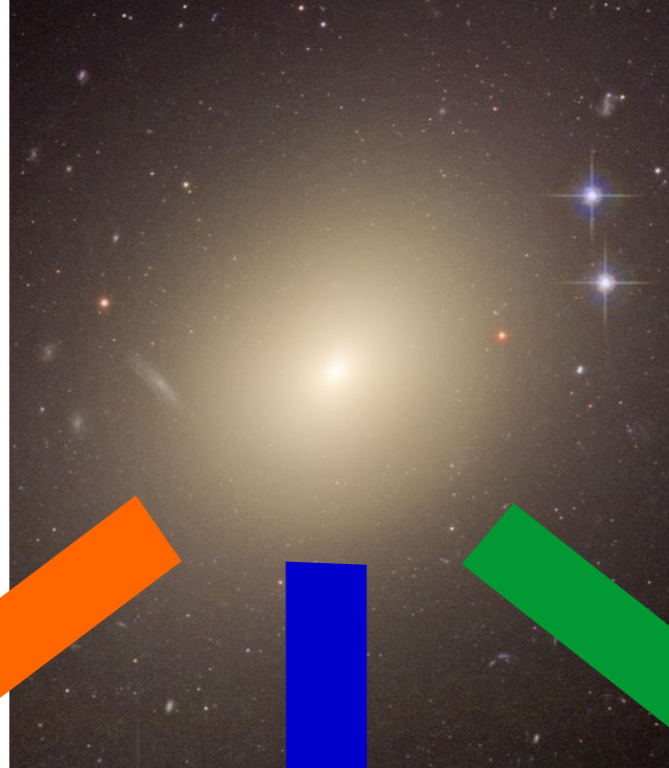
Eric Emsellem



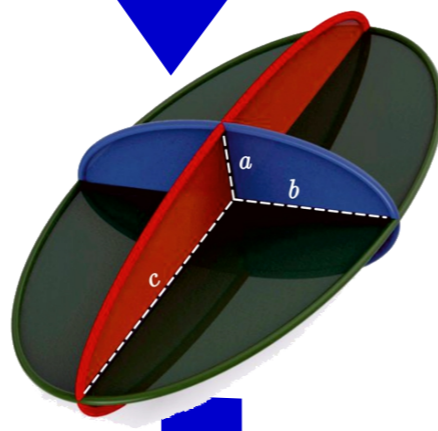
Davor Krajnović

Adrien Guérou

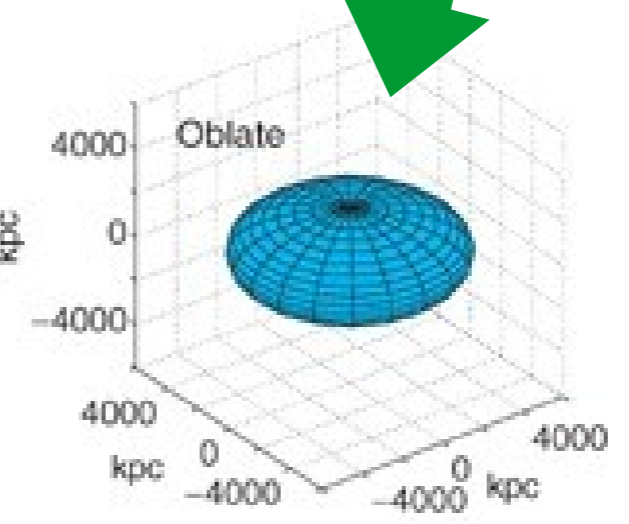
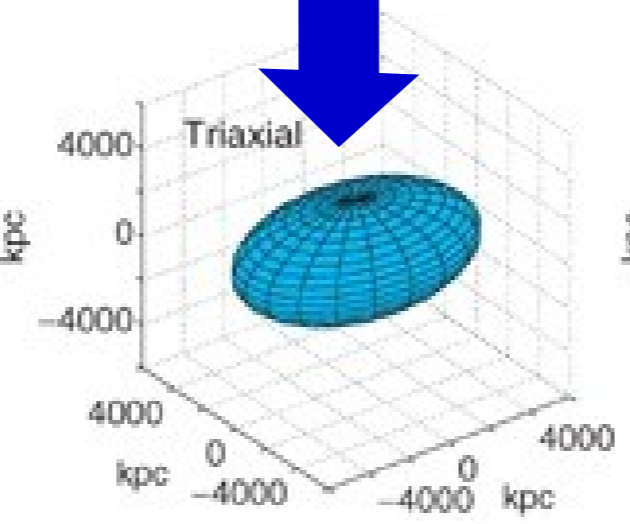
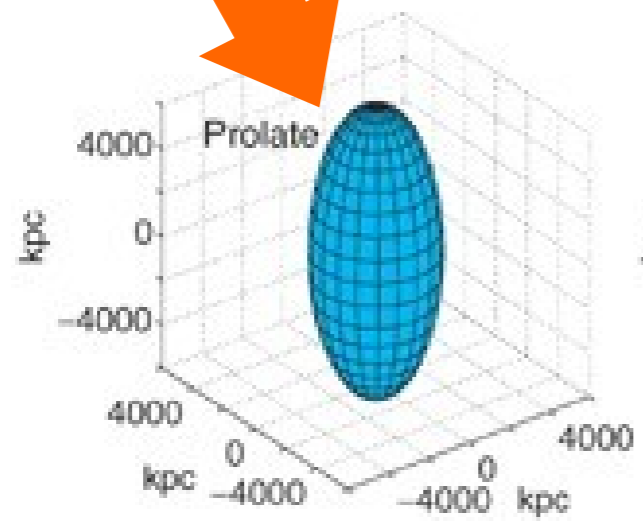


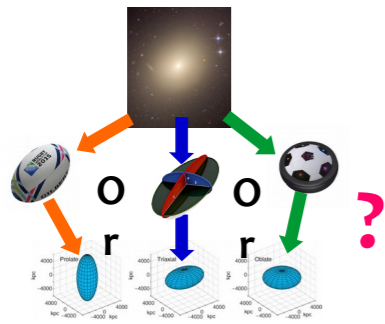


Or



Or





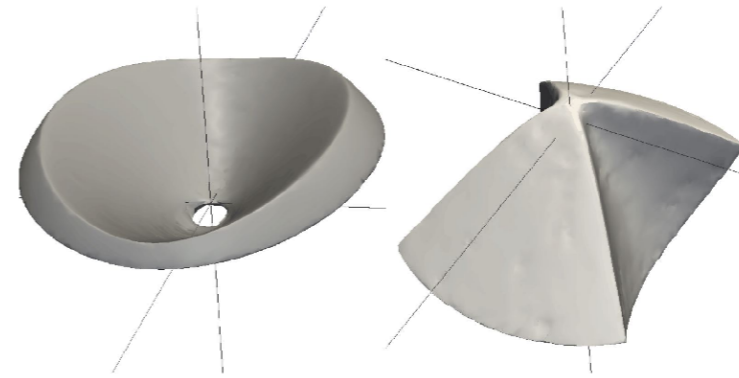
Why should we care ?

Orbital structure

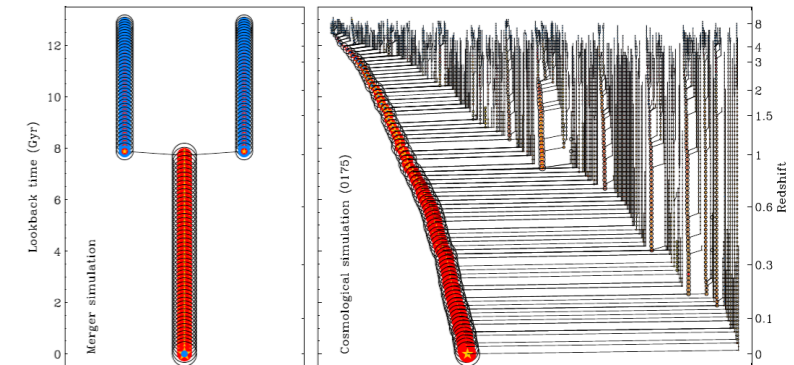
★ Morphology, Dynamics, Mass

Constraints on Formation / Evolution

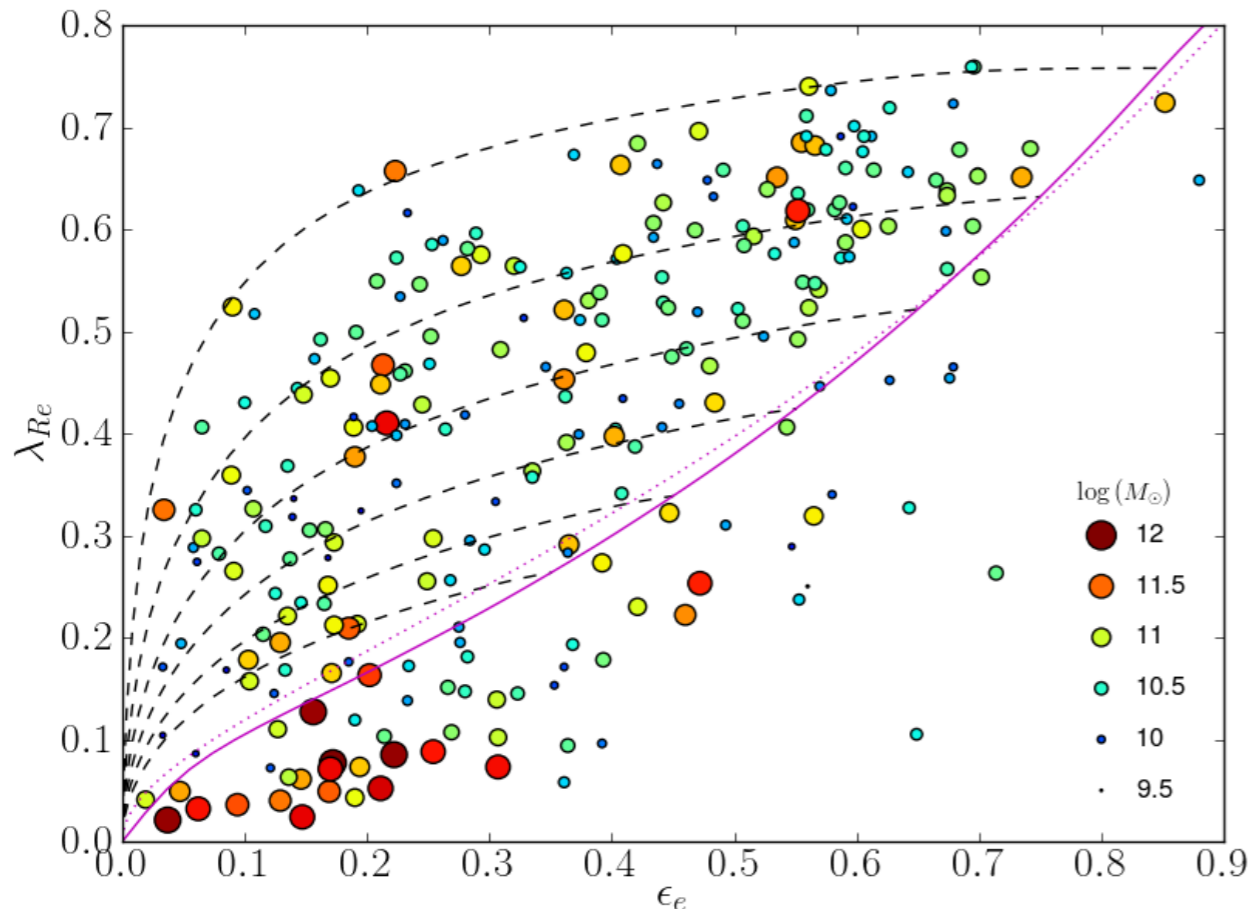
★ How are these formed / assembled ?



Merritt 2013



Naab, Oser, Emsellem et al. 2014

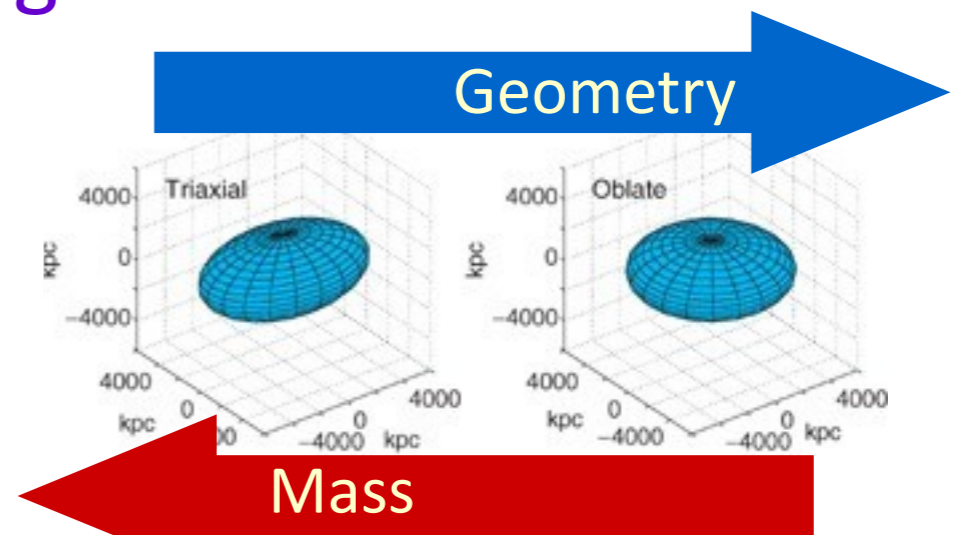


Emsellem, Cappellari, Krajnović et al. 2011

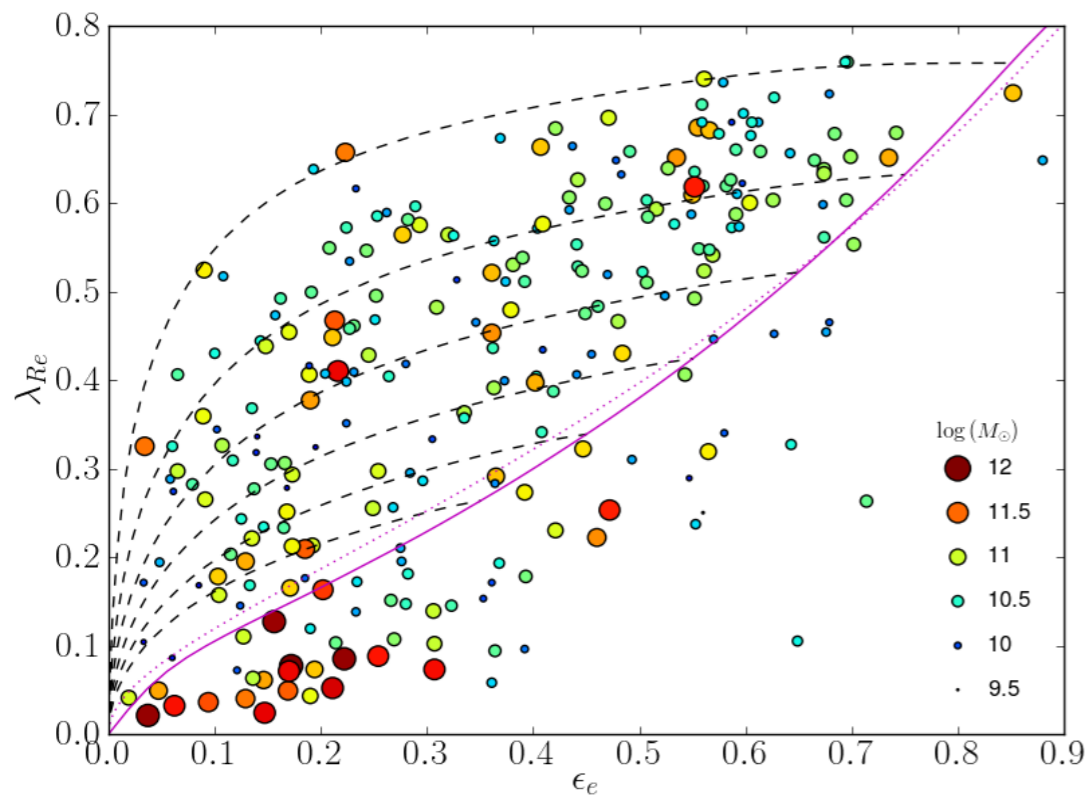


Things change with mass

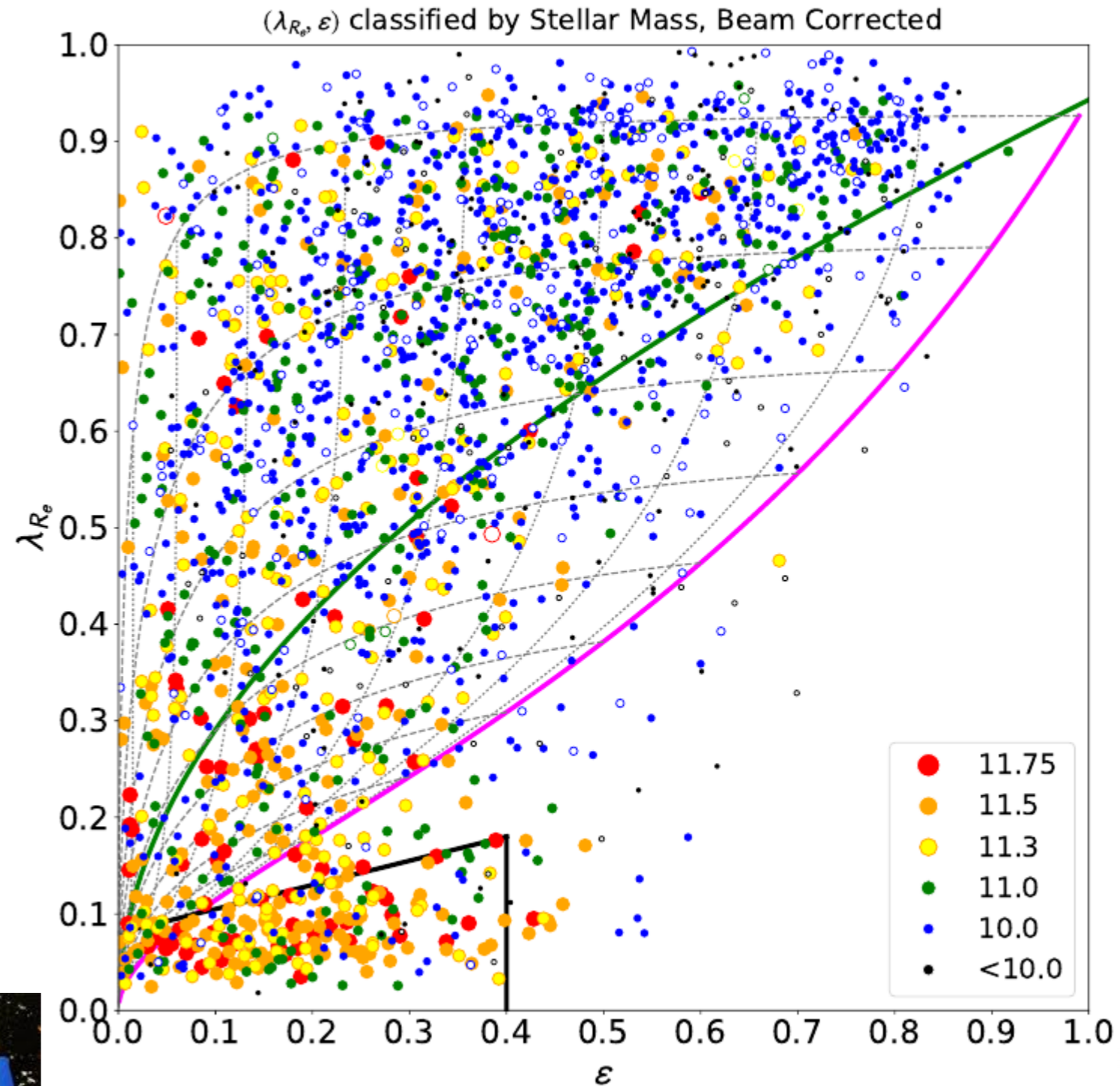
★ Angular momentum



Angular momentum



Emsellem et al. (2011)

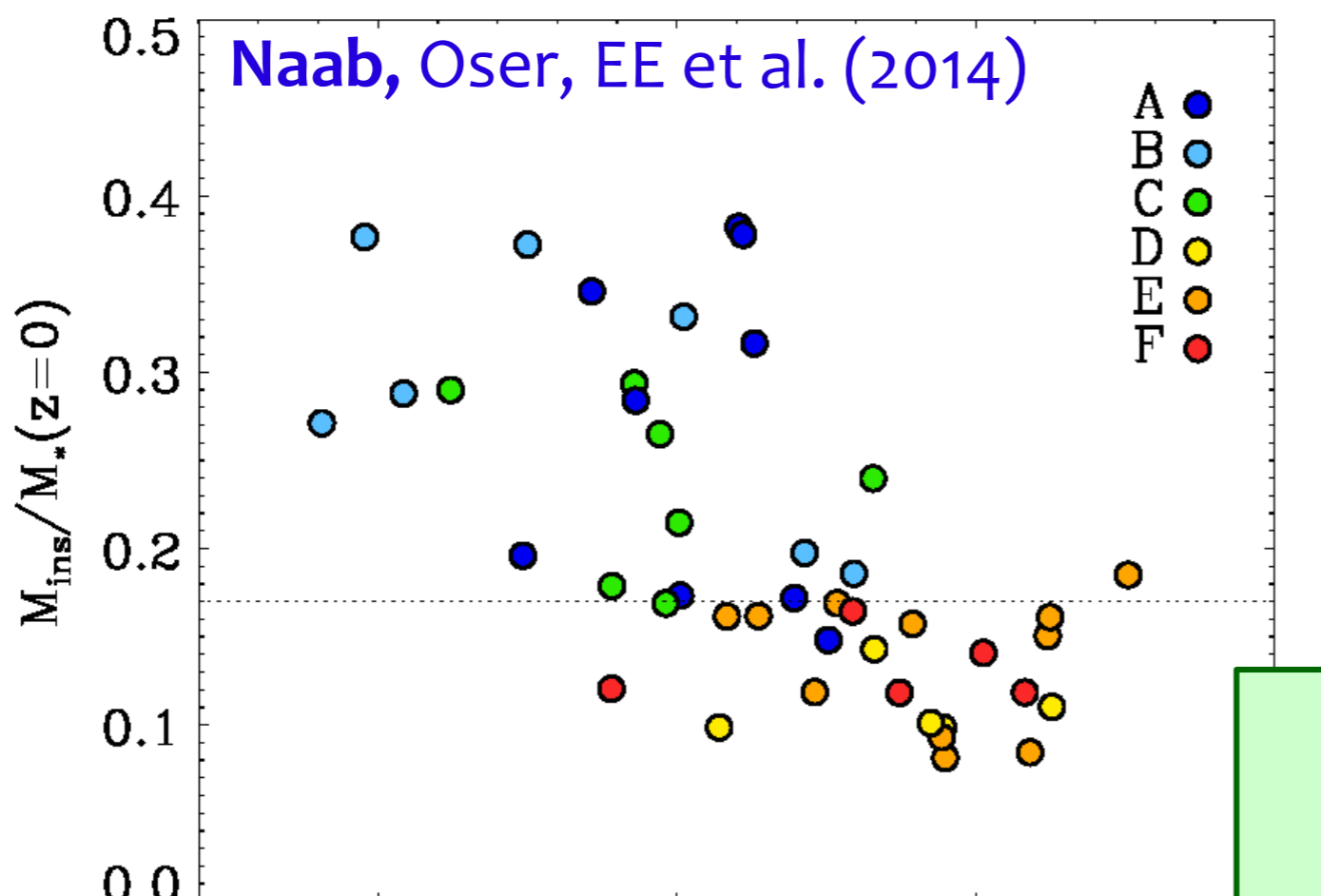


Graham et al. (2018)

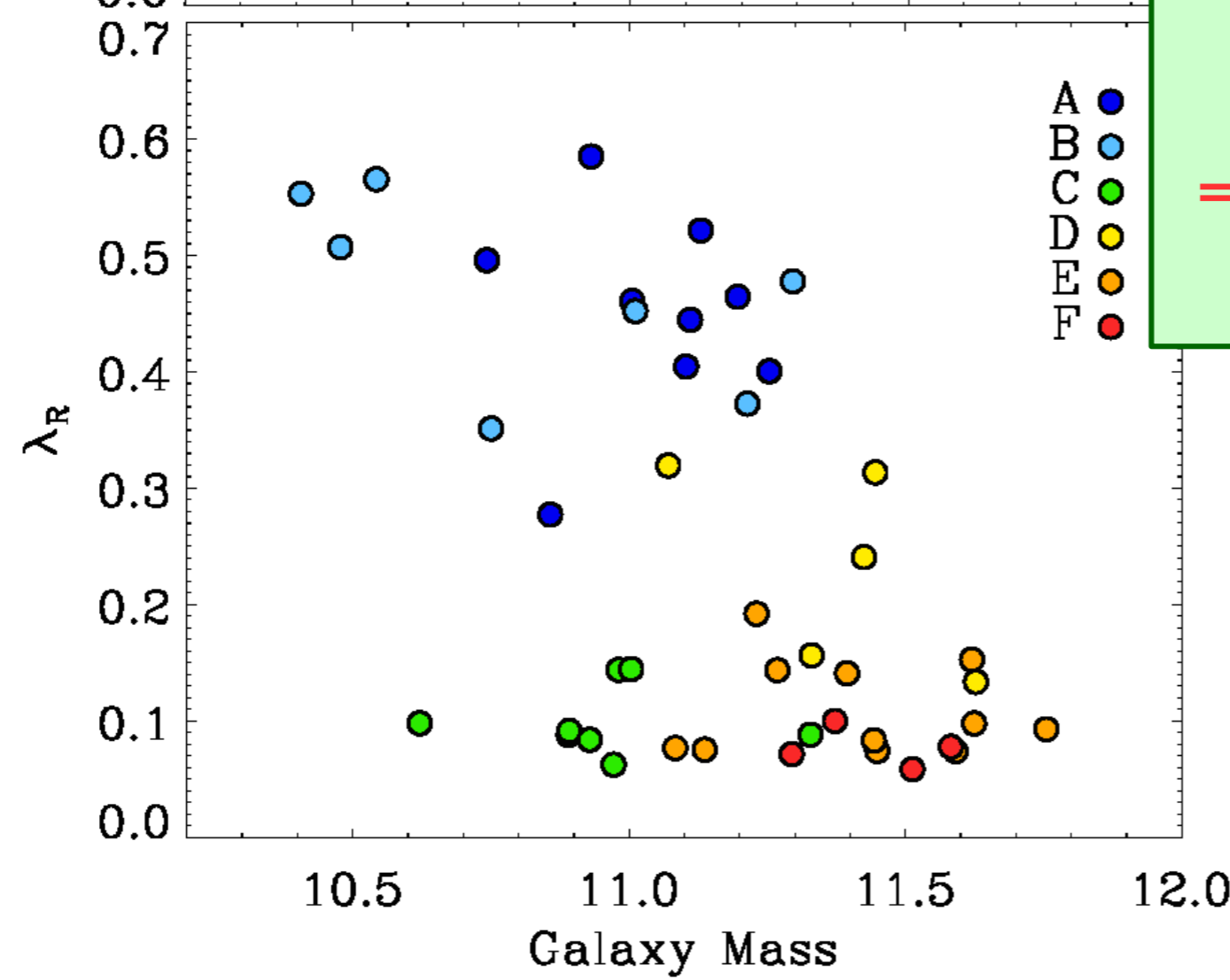


What's happening at **Masses $> 10^{11.5} M_{\odot}$?**

In situ -
Stellar Mass



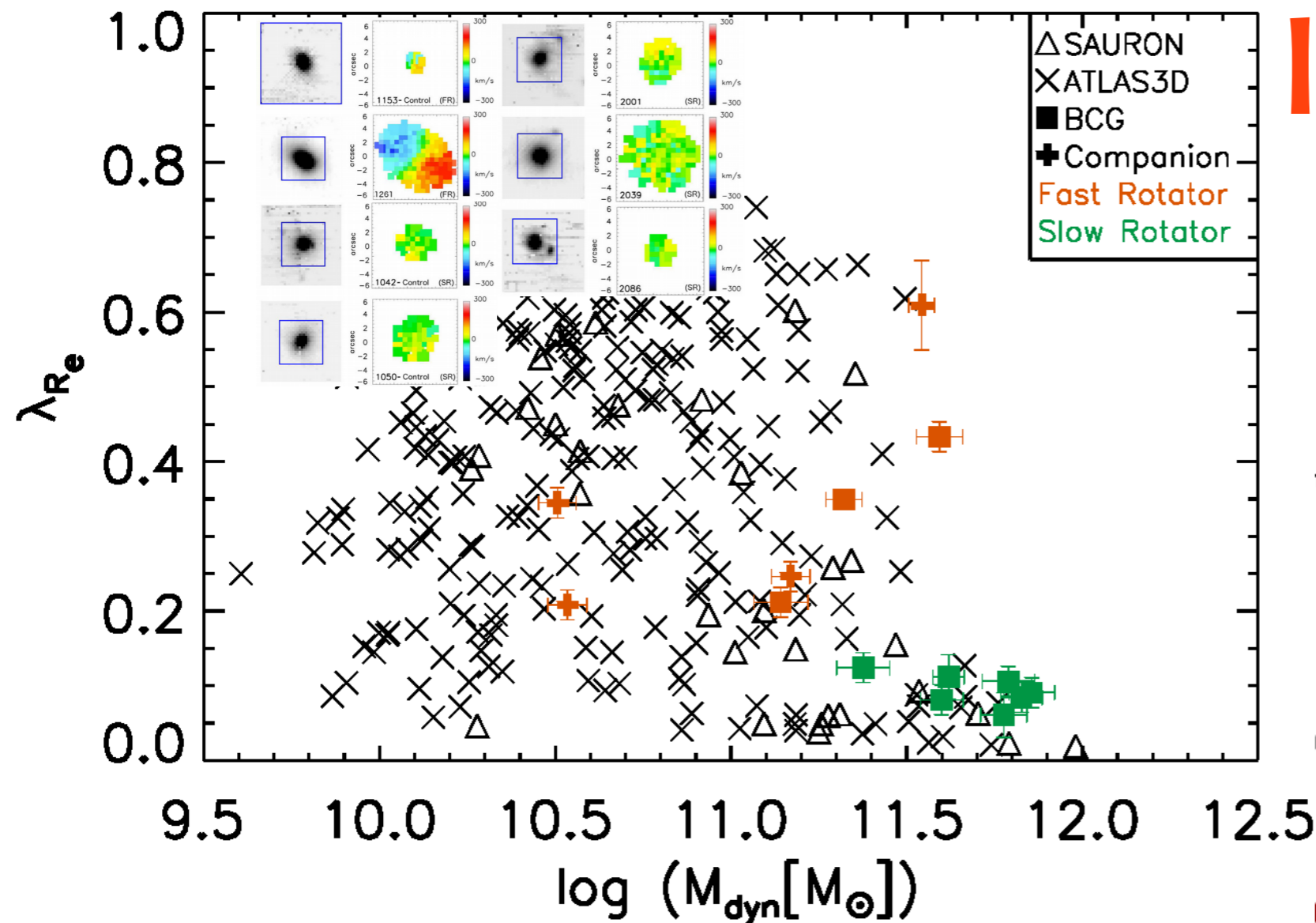
Angular
momentum



Various Mass
regimes

⇒ Most massive galaxies
In situ vs Ex situ

$\log_{10}[M] > 11.5$

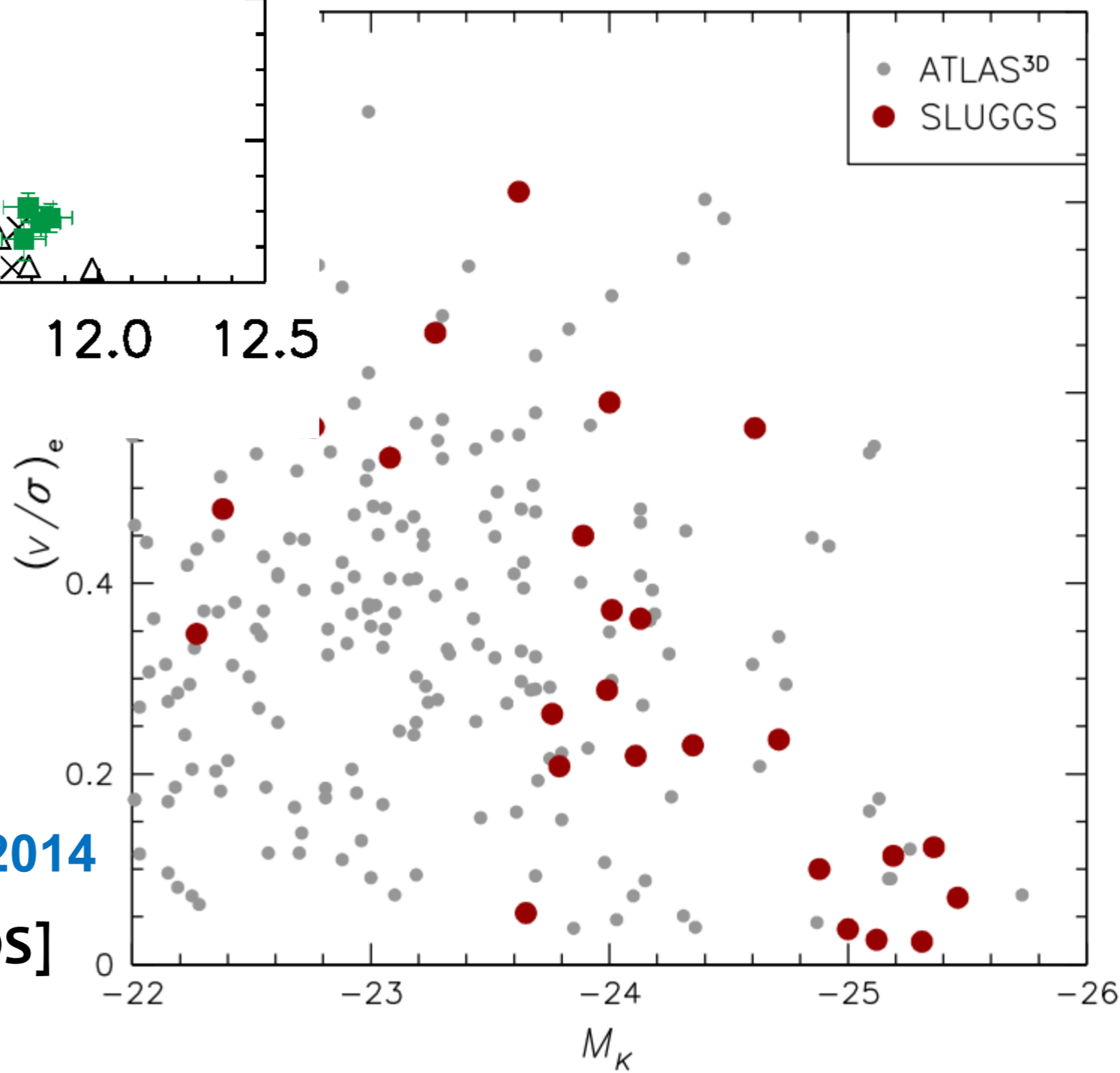


Jimmy, Brough et al. 2013

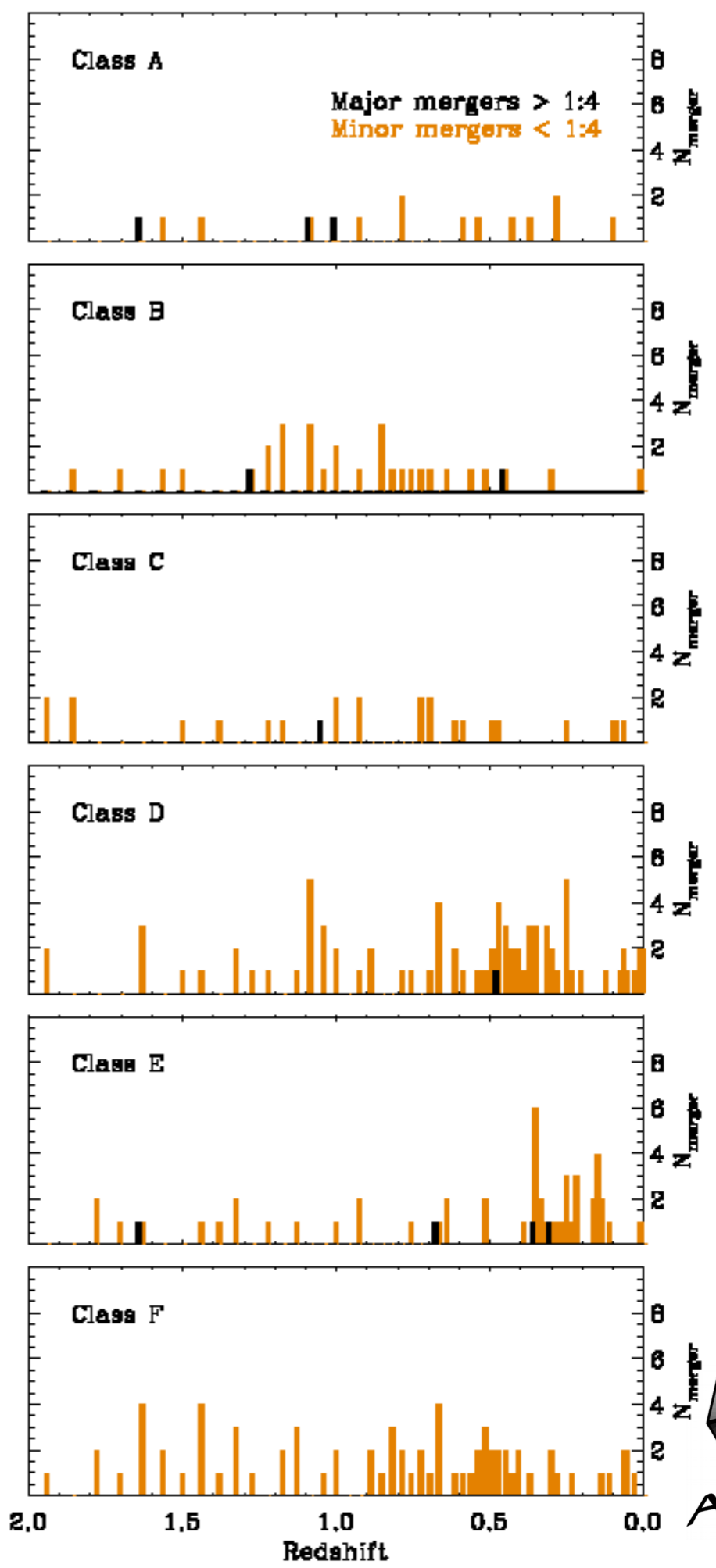
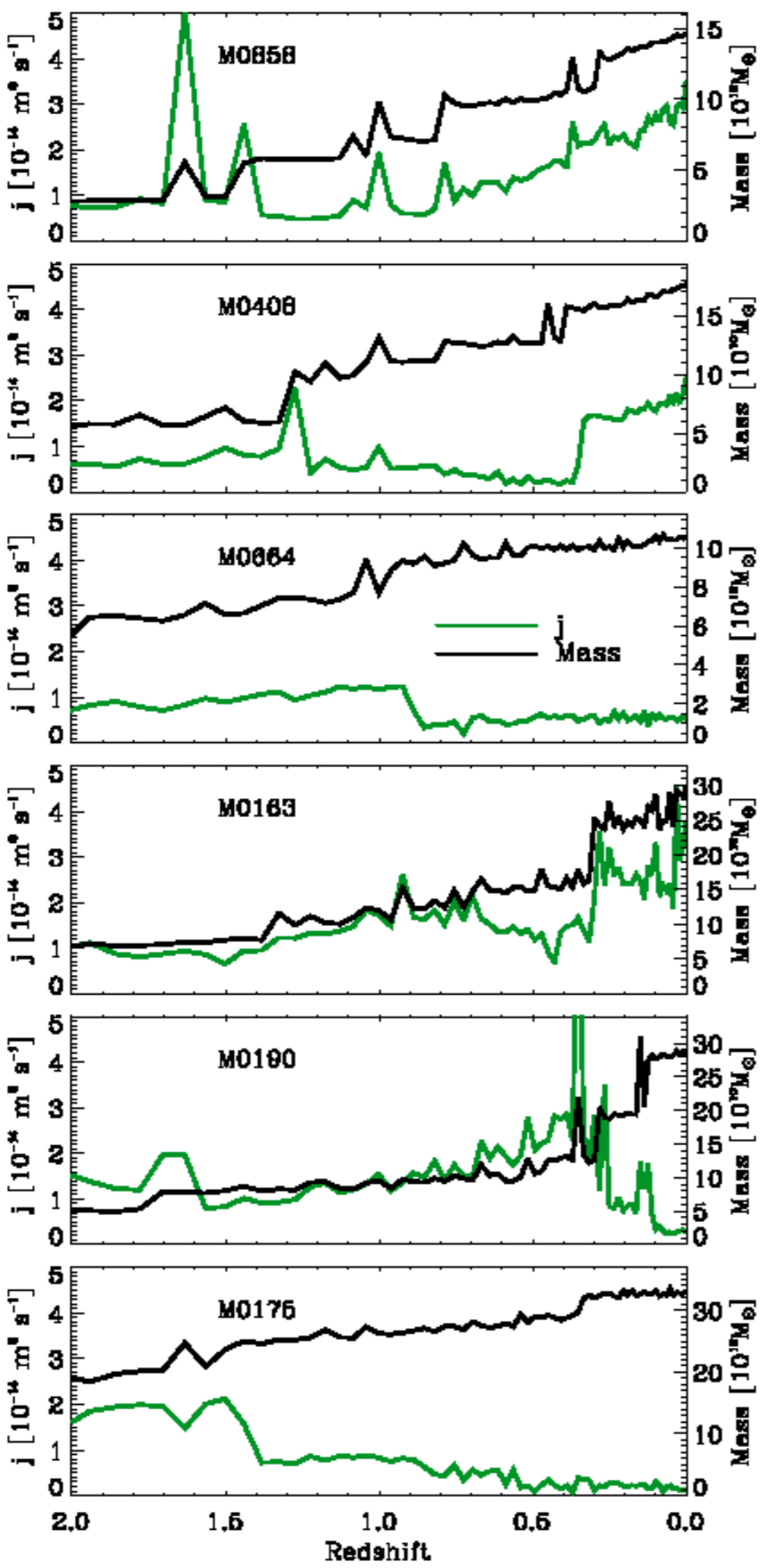
[VLT/VIMOS]

Brodie et al. 2014

[SLUGGS- Keck/DEIMOS]



Not just one Path!
Angular momentum



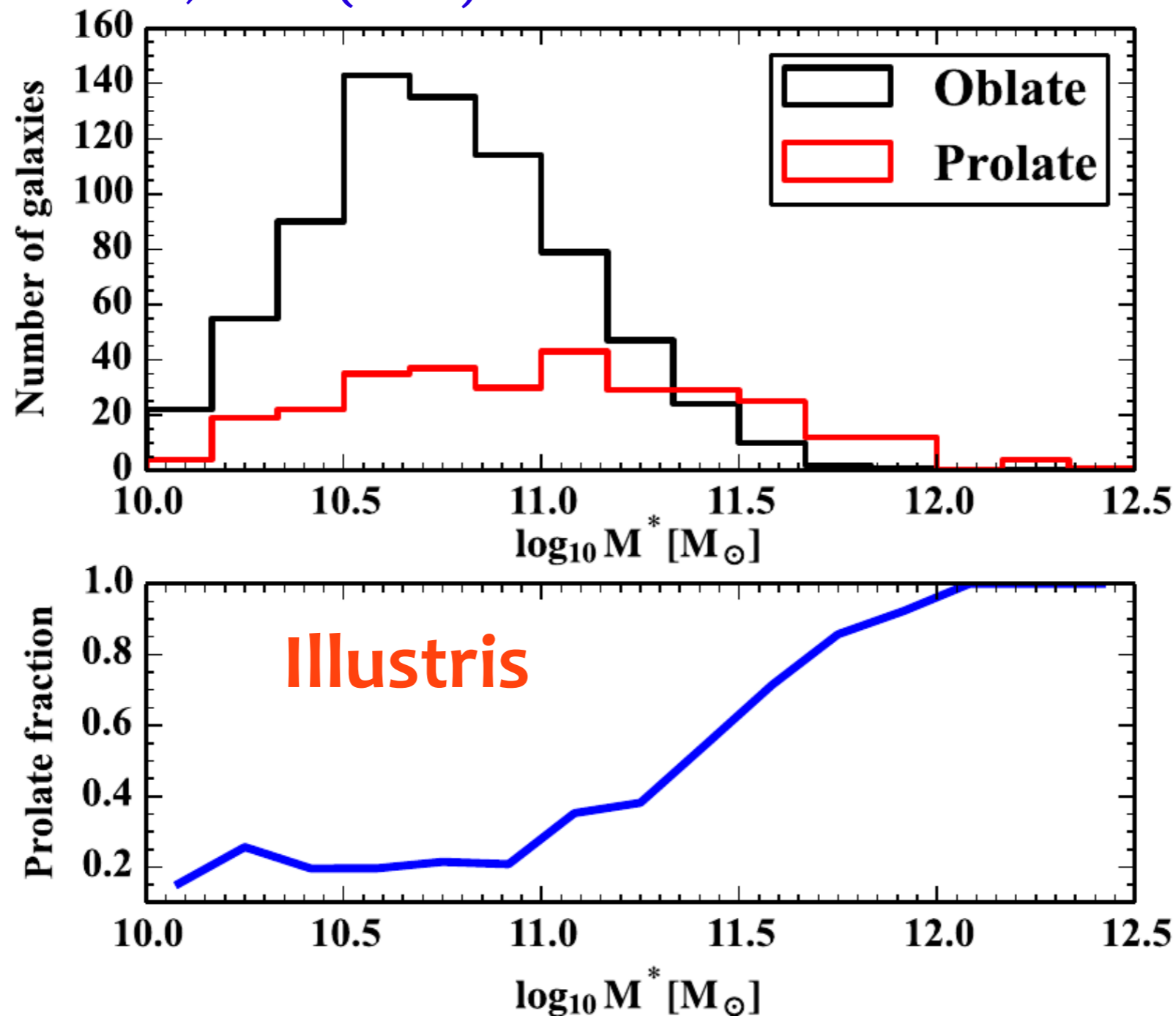
Naab, Oser, EE et al. (2014)



Predictions from Sims

- Above $10^{11.5} M_{\odot}$: fraction of *prolate systems* increases dramatically [see also Tsatsi et al. 2017, Weaver et al. 2018]

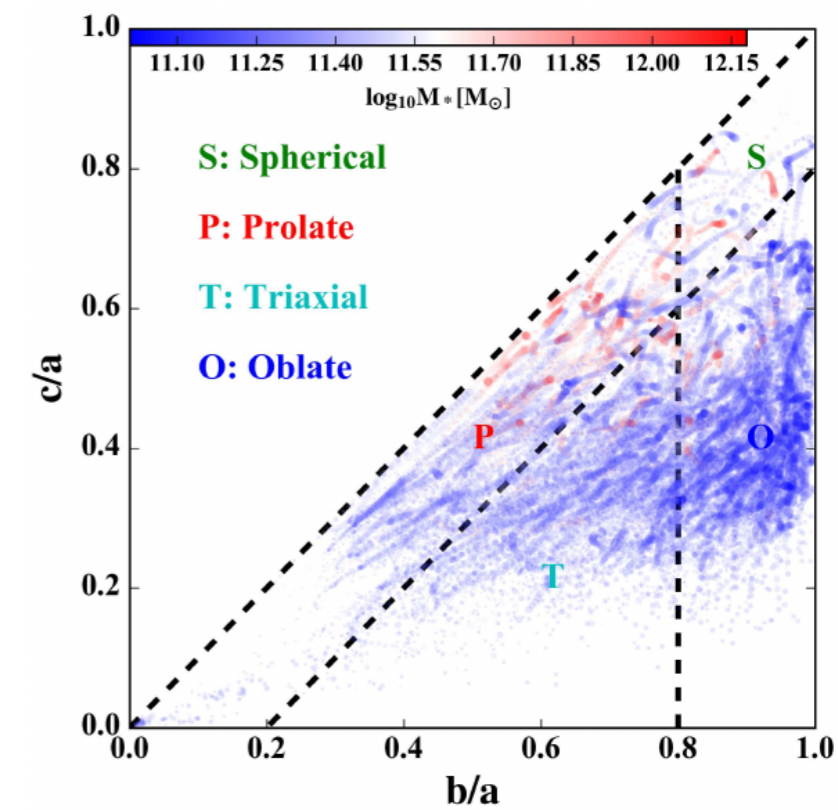
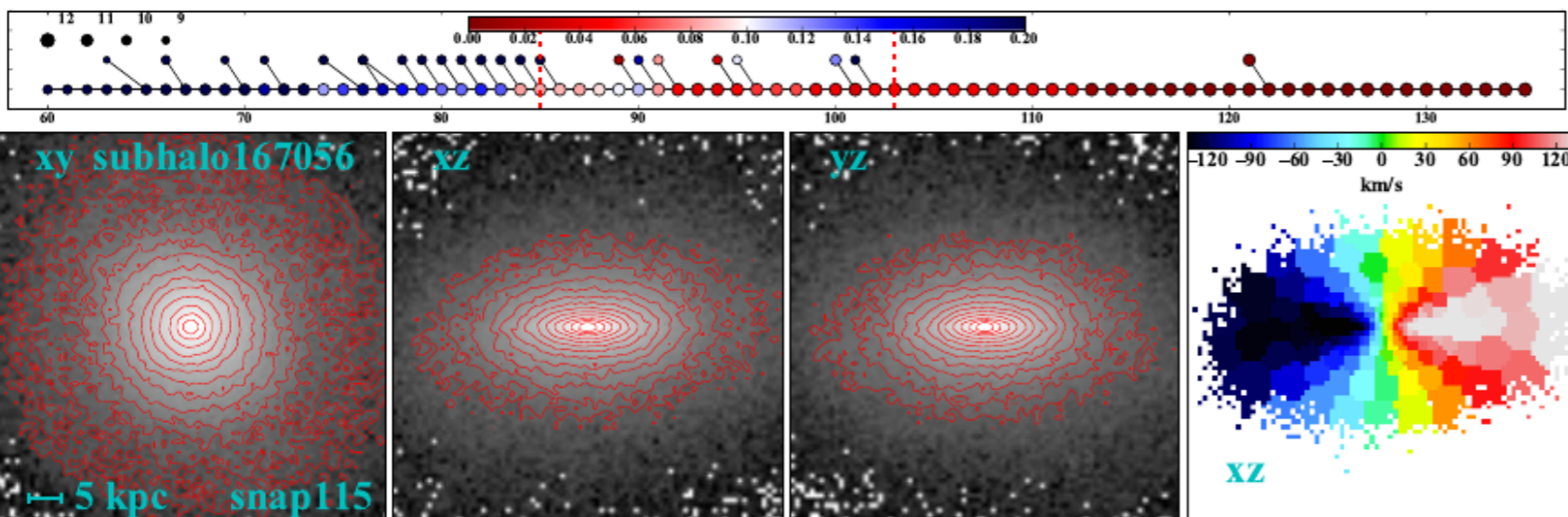
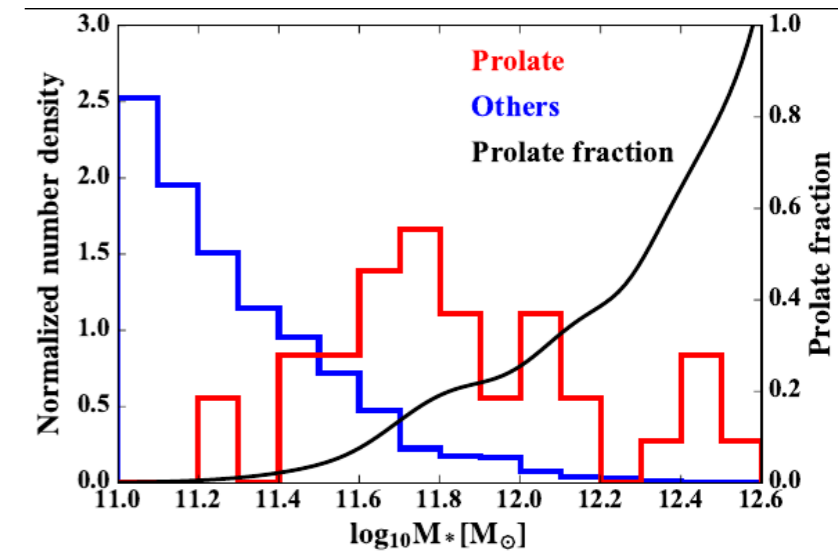
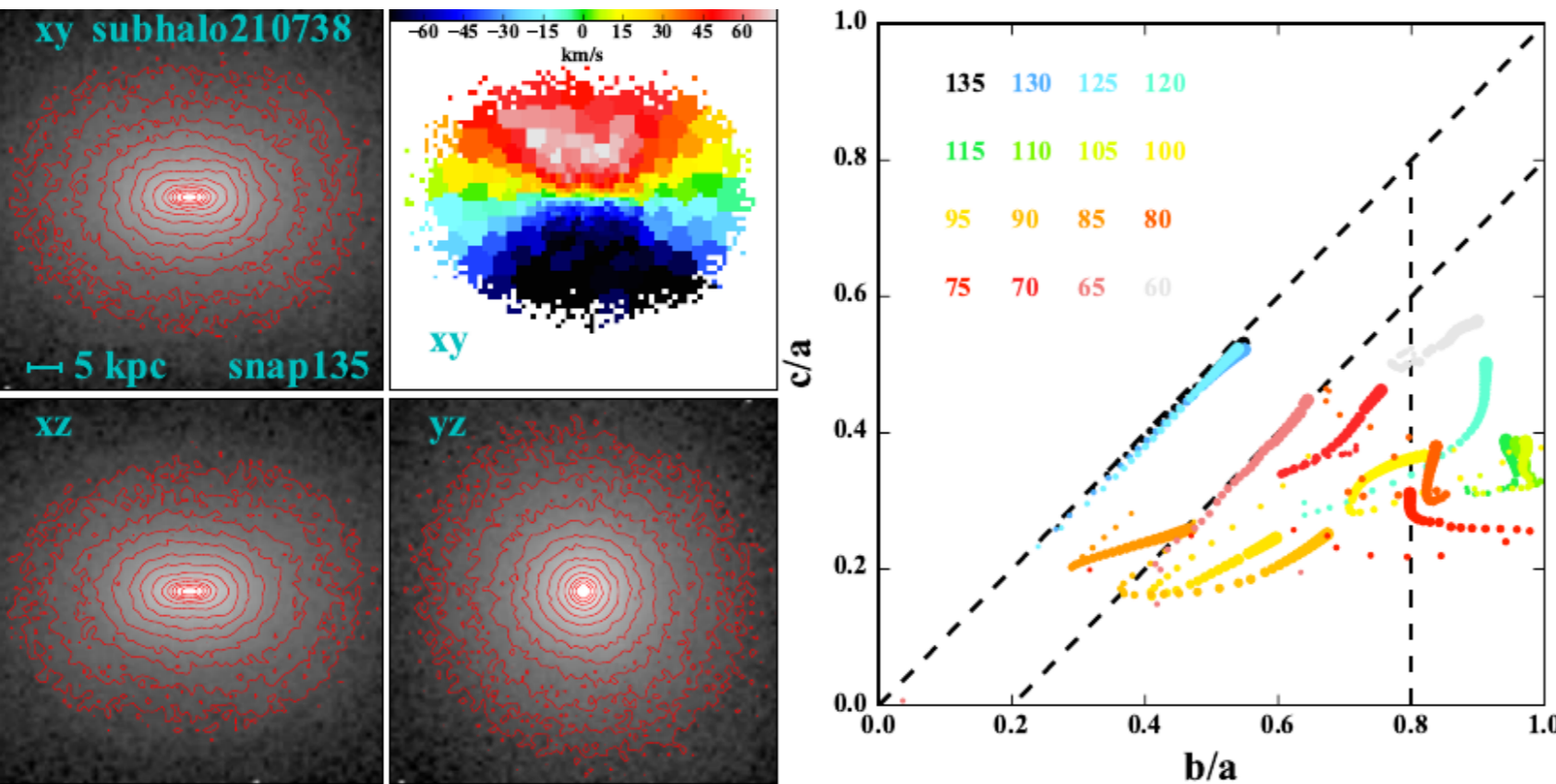
Li, et al. (2016)

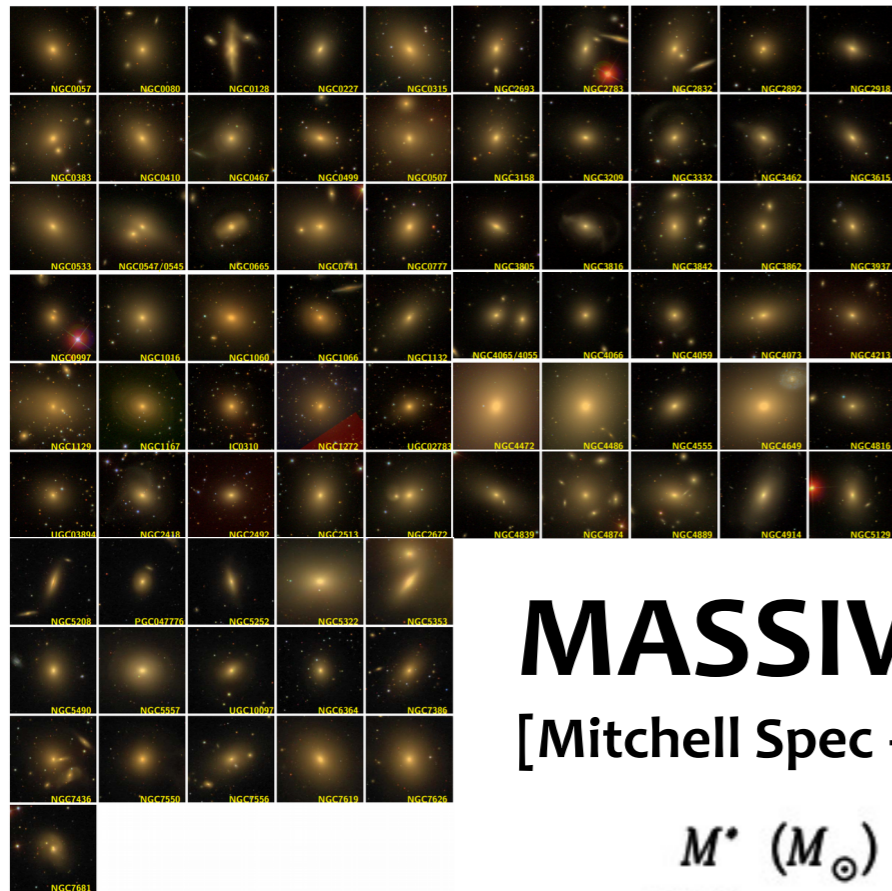


Predictions from Sims

- Above $10^{11} M_{\odot}$: fraction of prolate rotators increases dramatically
- Late ($z < 1$) Major dry merger is often the driver

Li, Shude, EE et al. (2018)

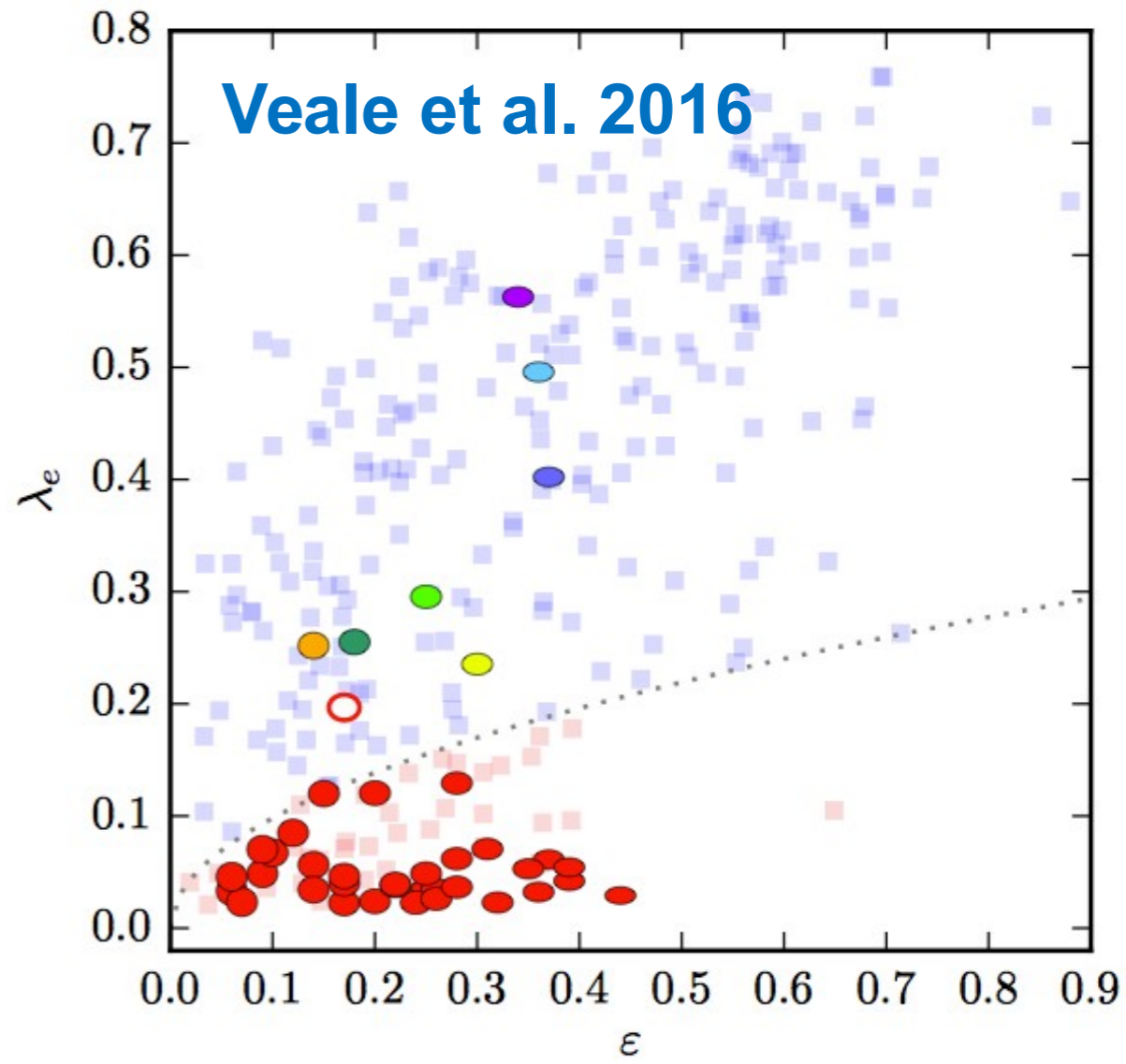
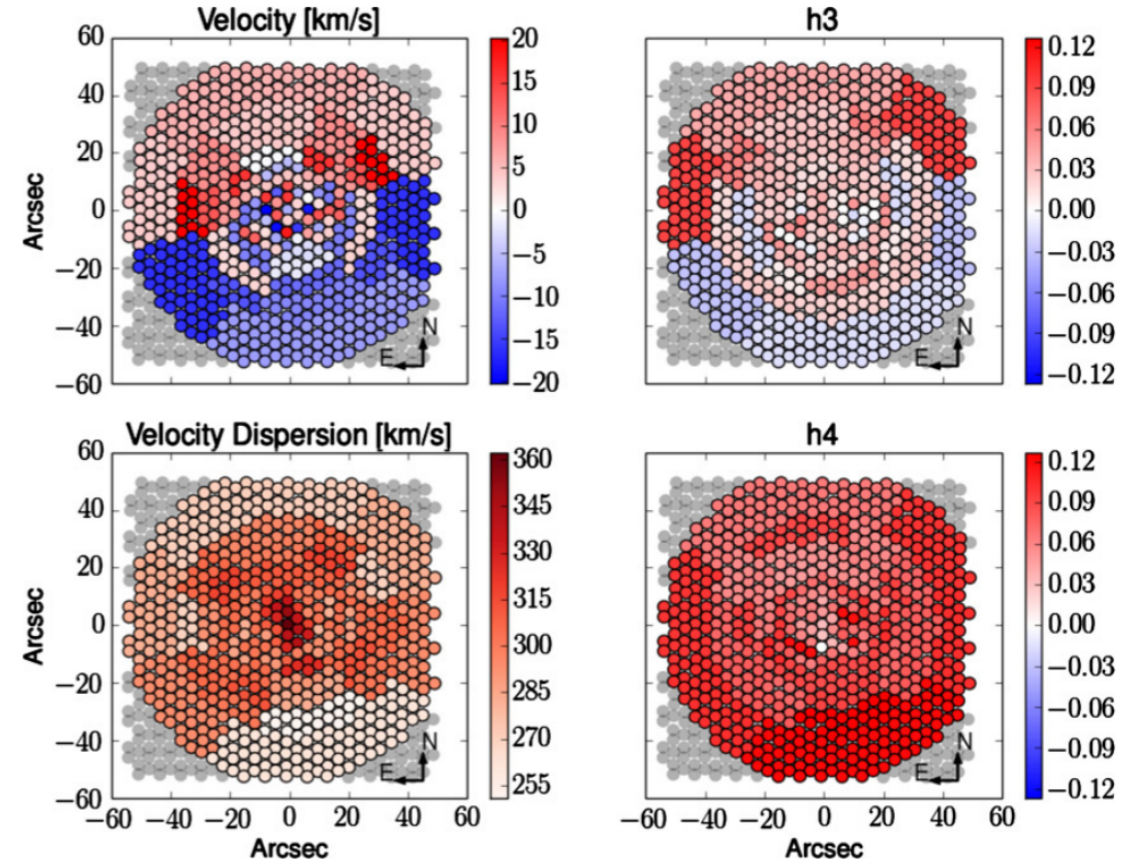
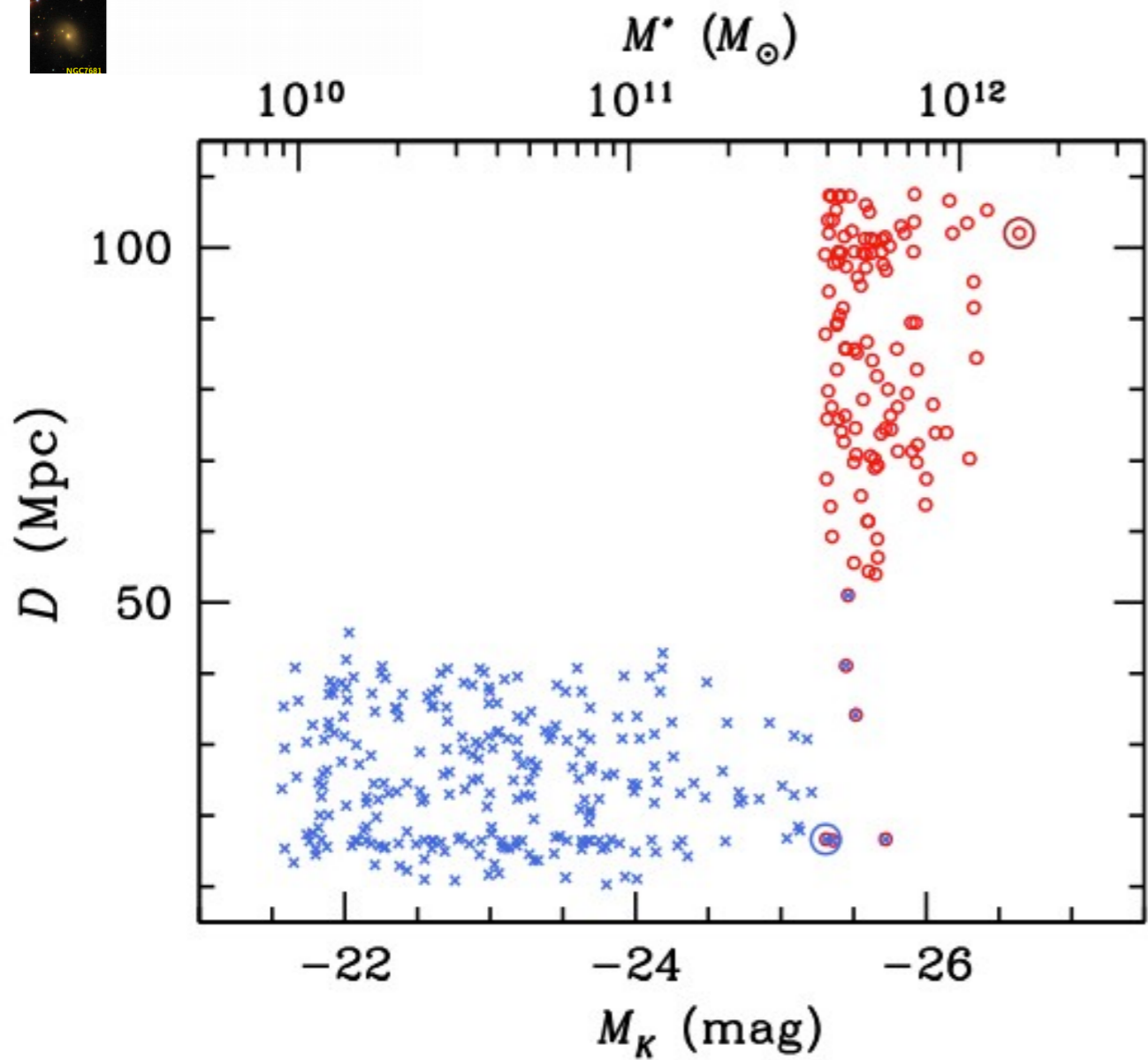




Ma et al. 2014

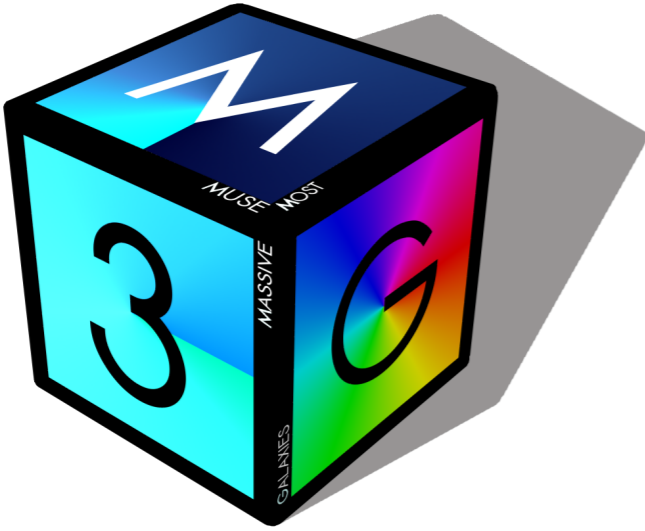
MASSIVE

[Mitchell Spec + AO-NIFS]



Veale et al. 2016

The Project



a **MUSE GTO programme**

PI Eric Emsellem

Goals:

Dynamical state, Dark matter content, SFH, IMF + Test predictions of numerical simulations

How:

Stellar content + dynamics (2 Re)
*of the most massive galaxies
in densest environments*

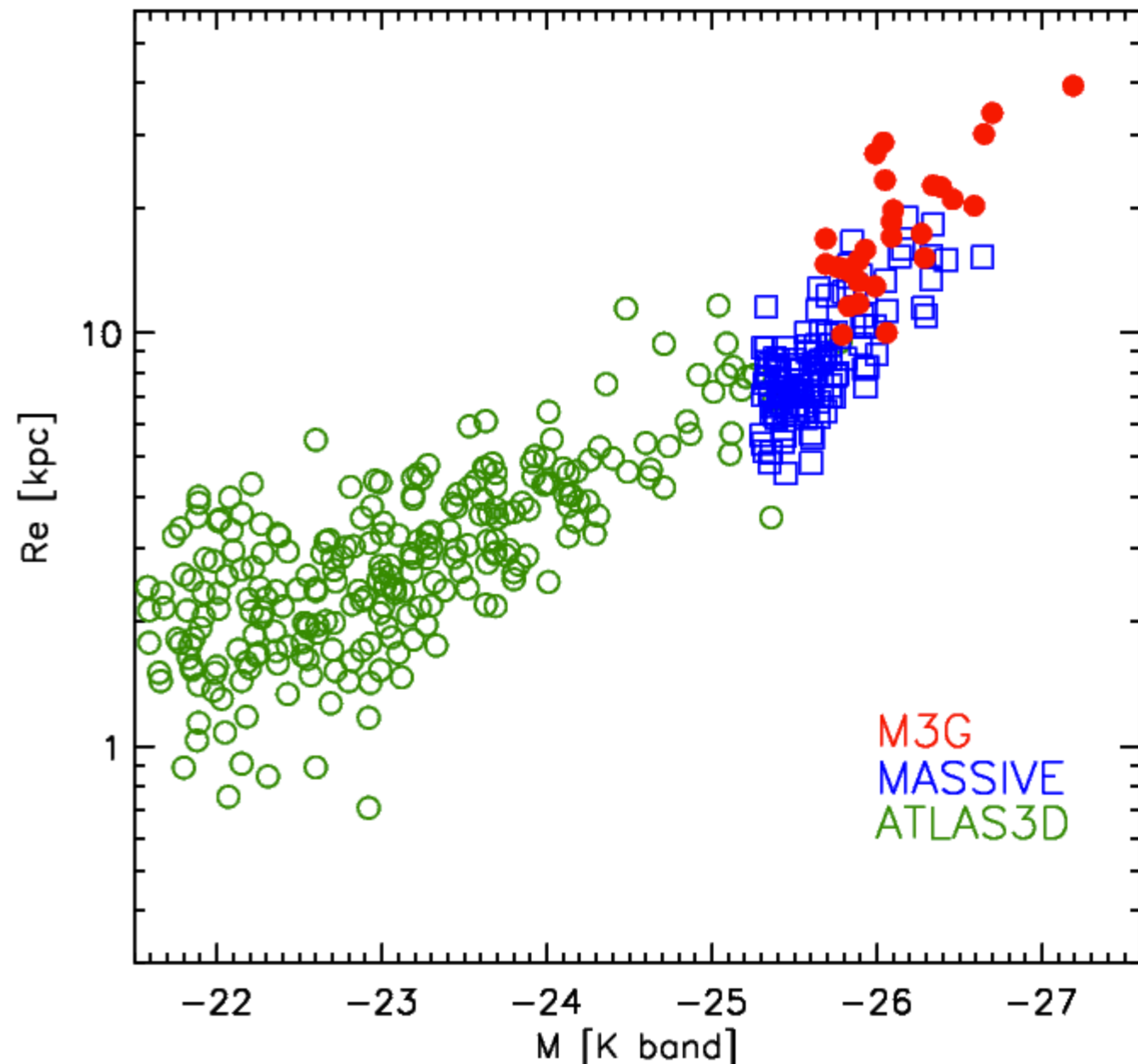
→ 2 sub-samples ($z \sim 0.04$)

I – Shapley Super Cluster

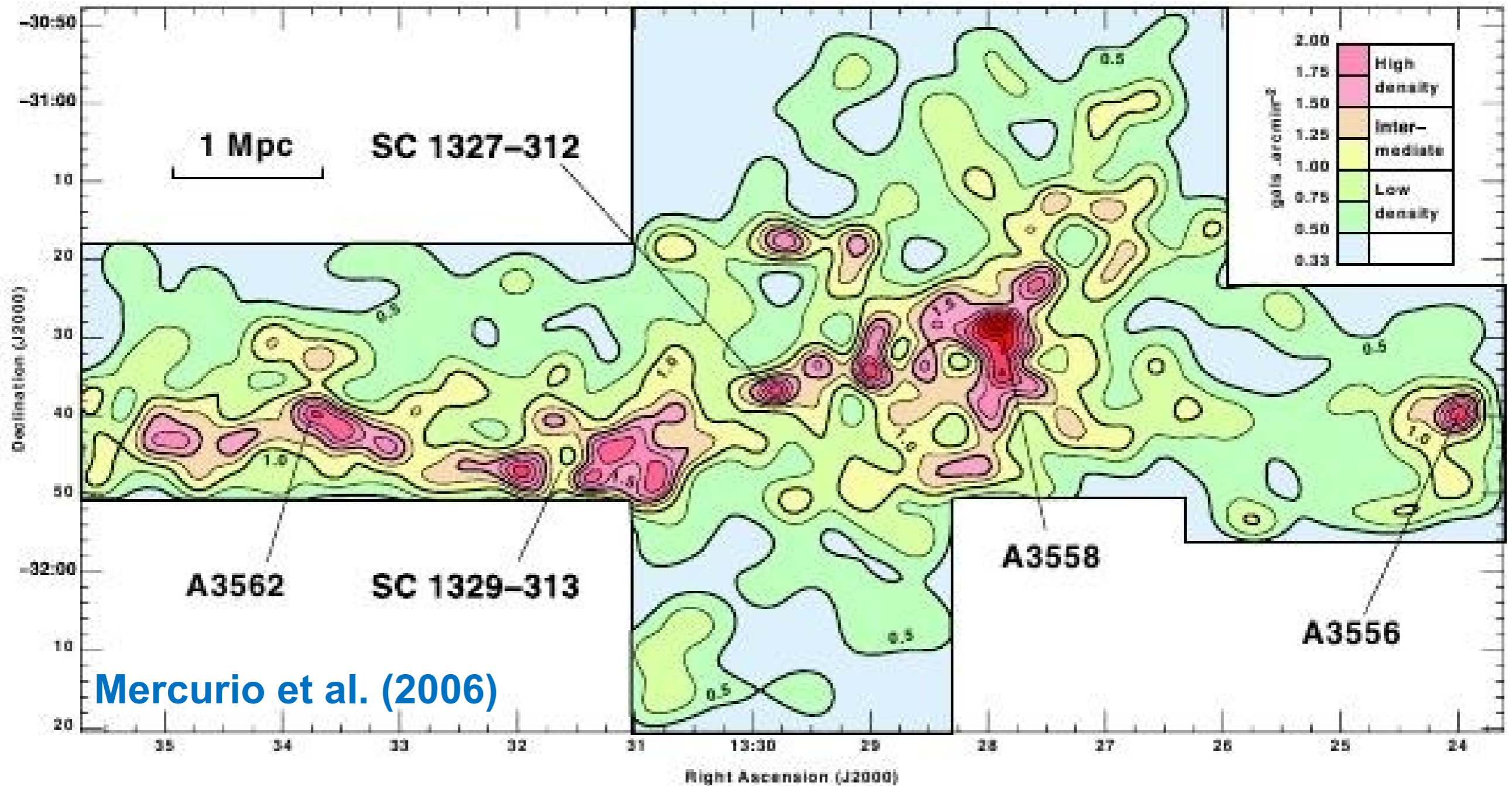
+

II – BCGs in rich clusters

brighter than -25.7 mag in K



Shapley Super Cluster

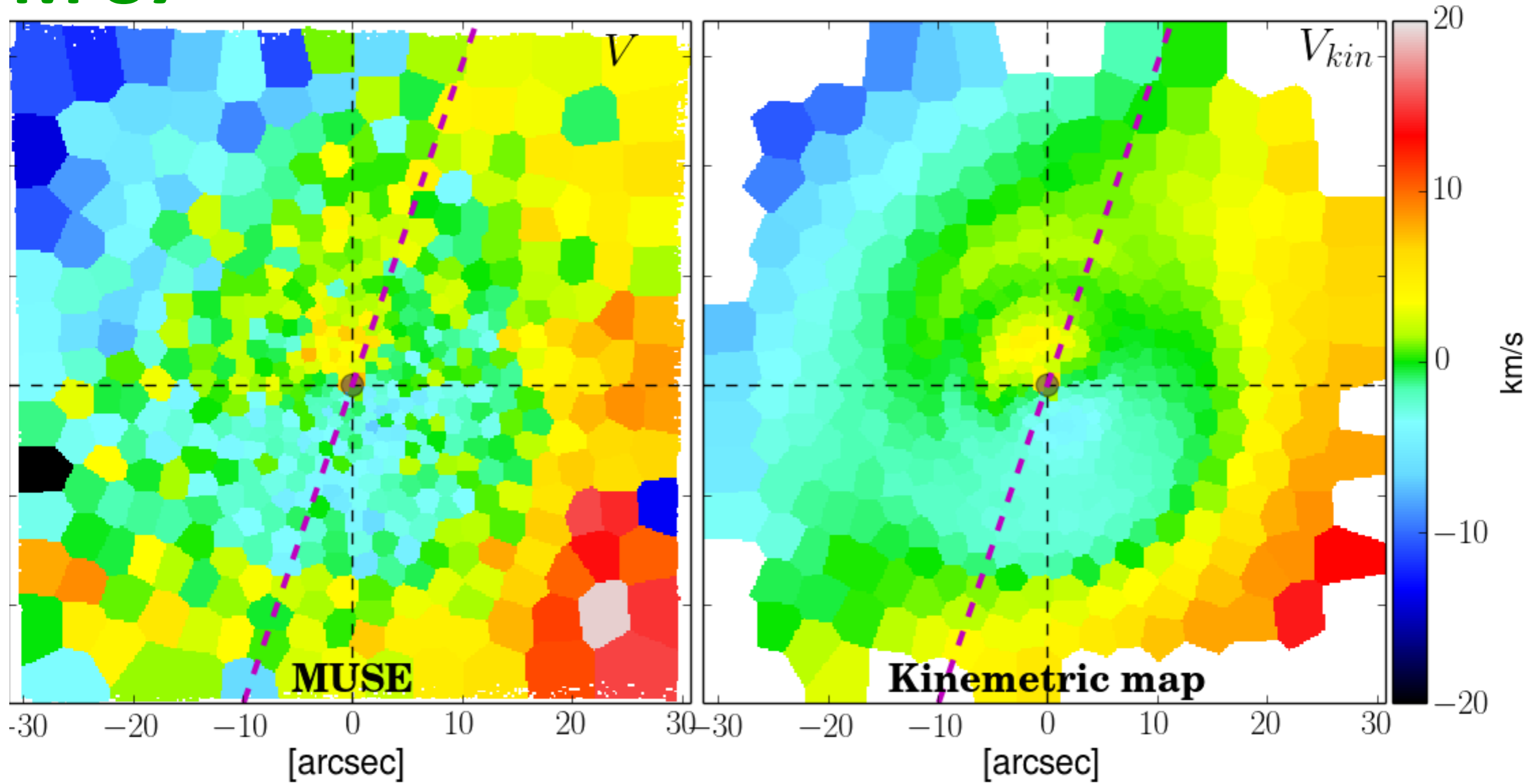


~200 Mpc [**~1kpc / arcsec**]



Why MUSE?

M 87



Emsellem, Krajnović, Sarzi 2014



PGC047202

The most massive galaxy in Shapley

2' x 2'

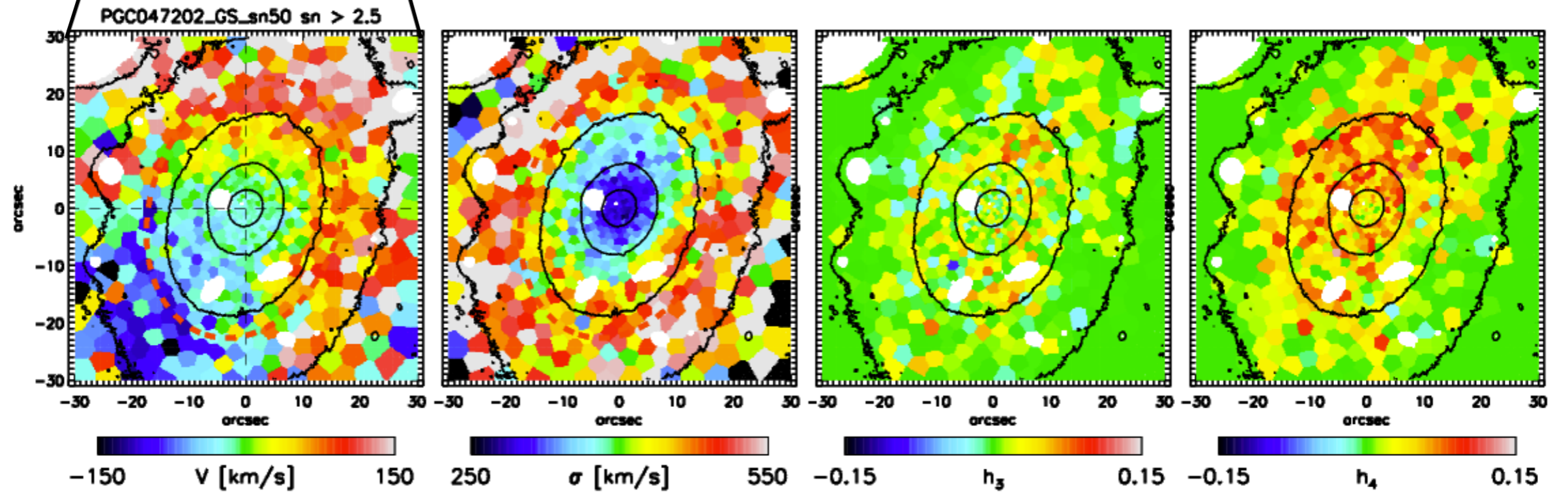
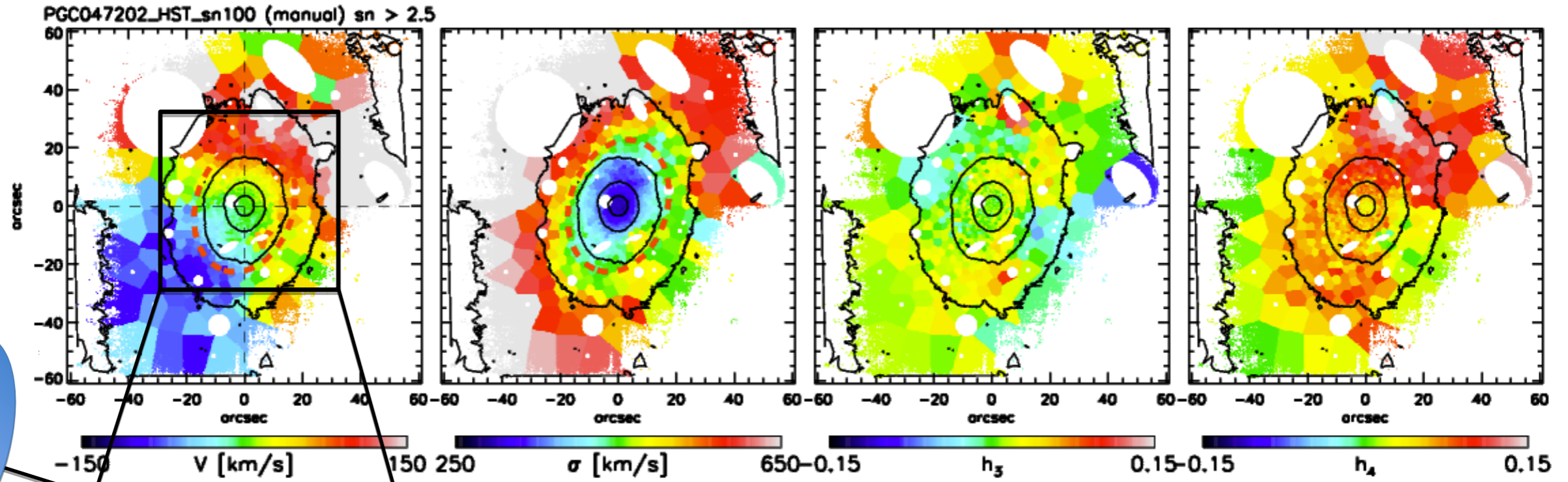
4 x 4h

101 merged data cubes...

374 544 spectra



PGC047202

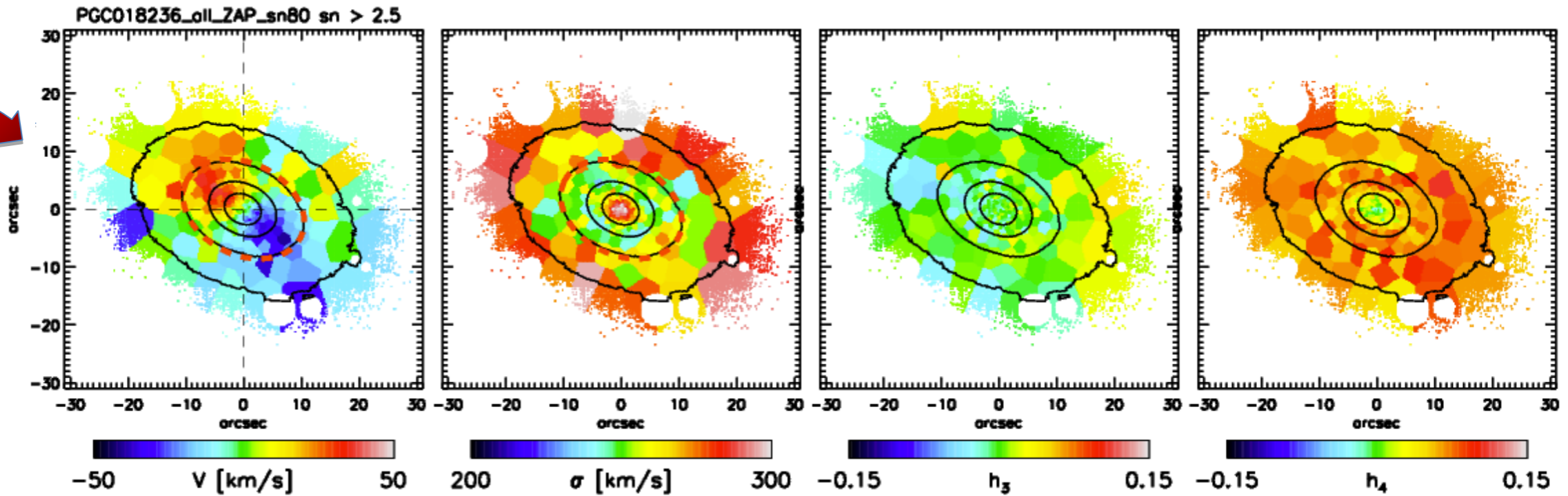
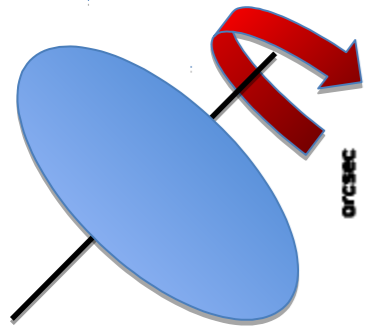


MUSE (V-R-I) “Snapshot” Images

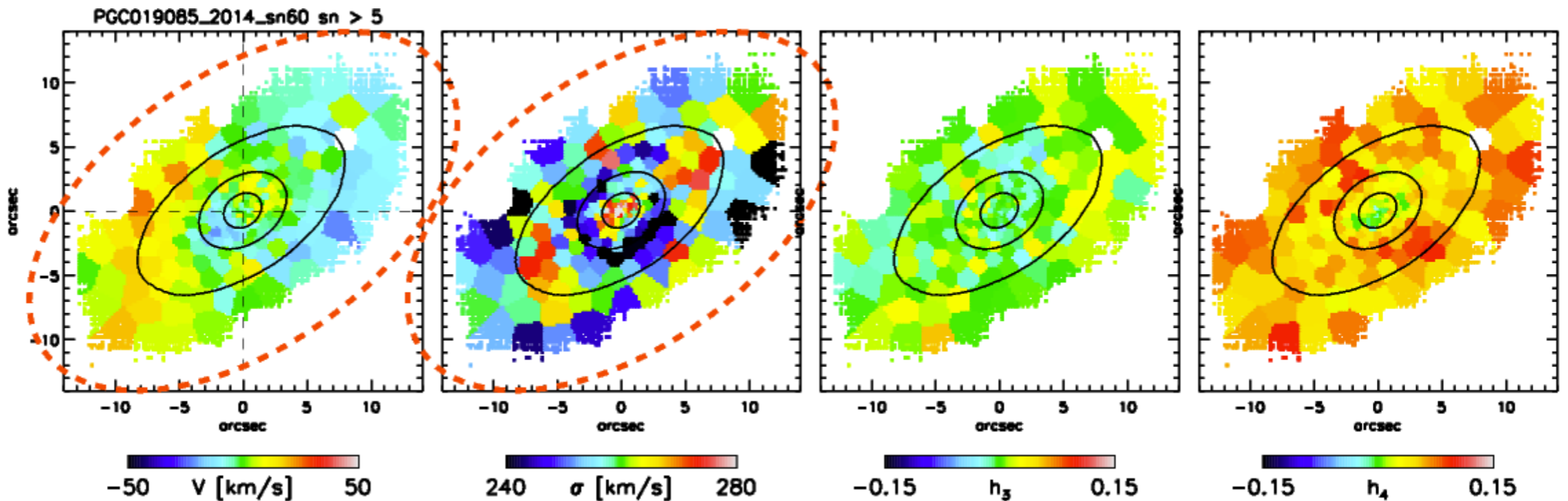
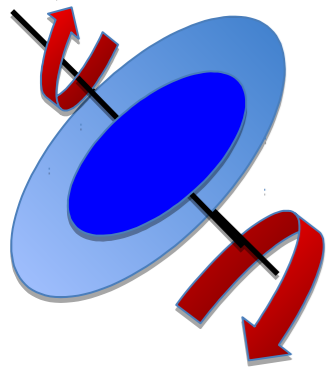


PGC018236 and PGC019085

Rotation around minor axis

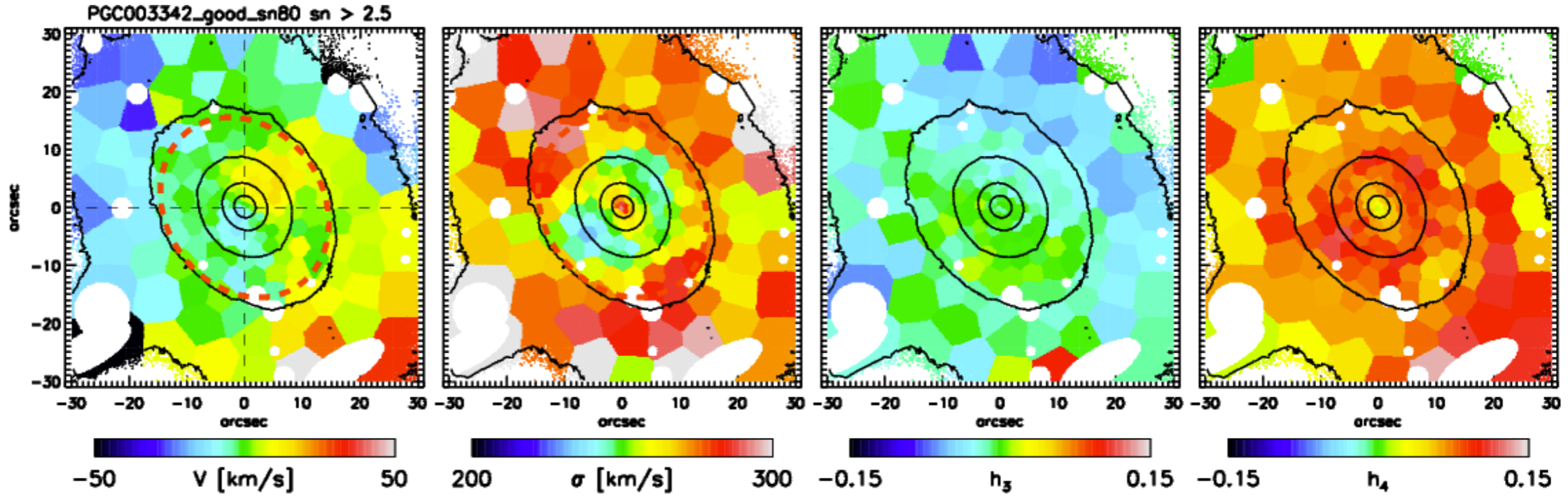


Rotation around minor axis – counter rotation

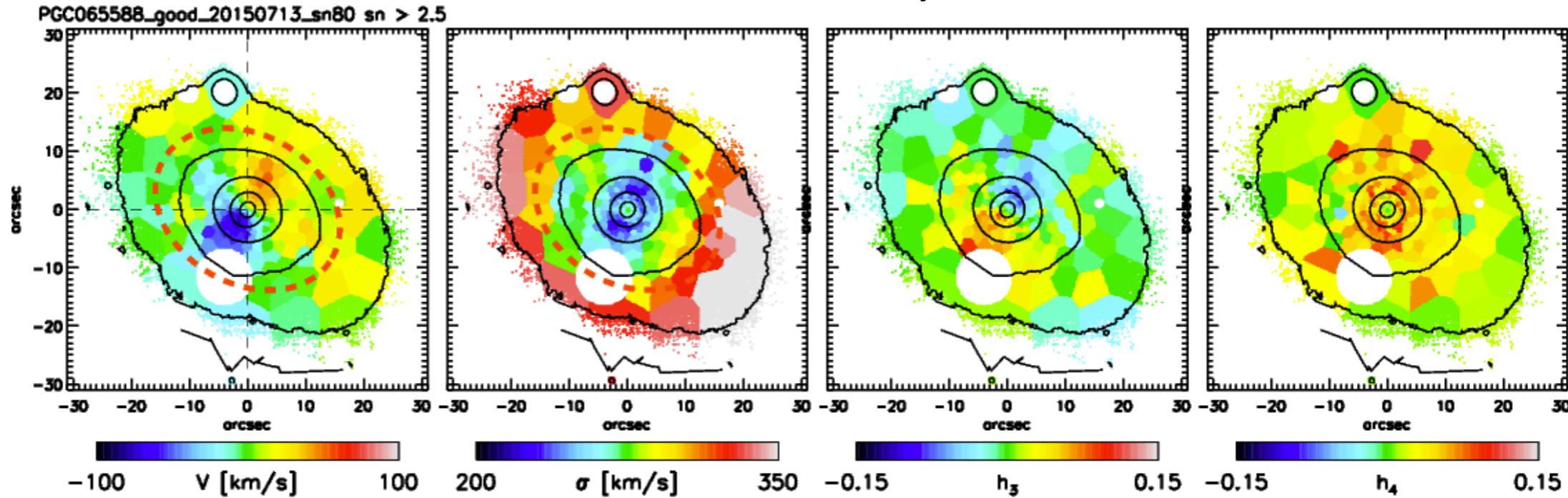


PGC003342 and PGC065588

Rotation around minor and major axis

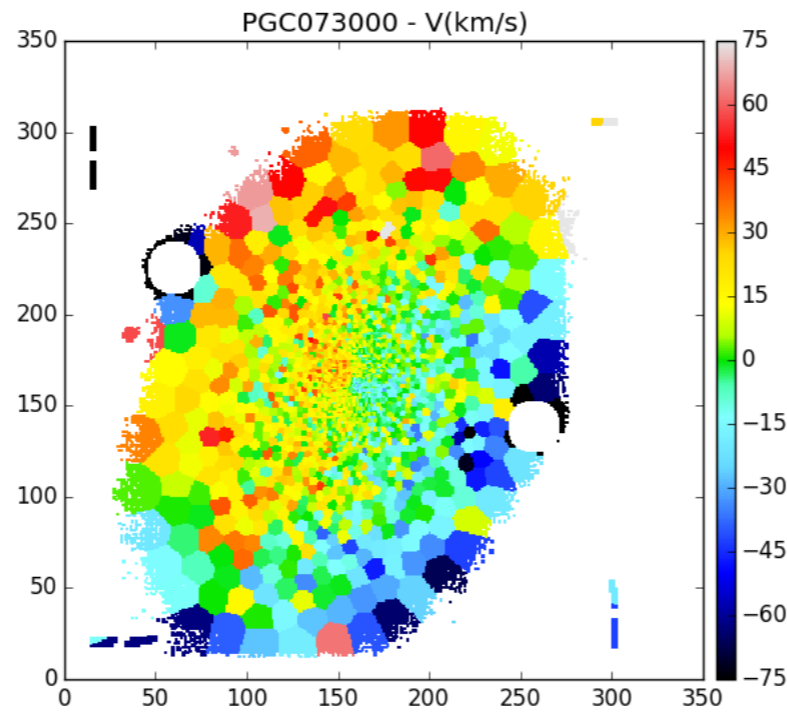


Rotation around major axis

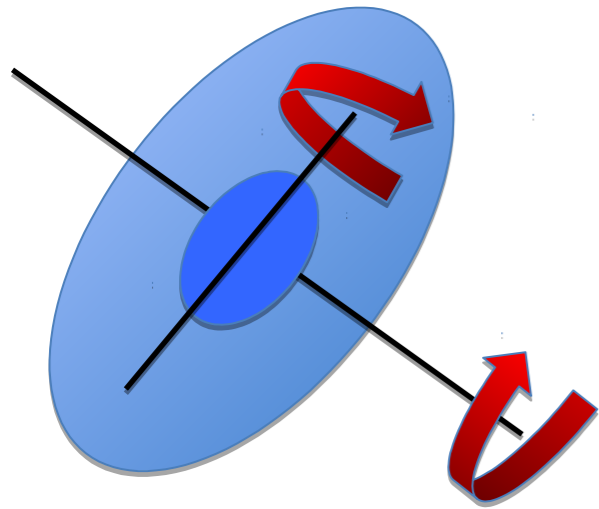
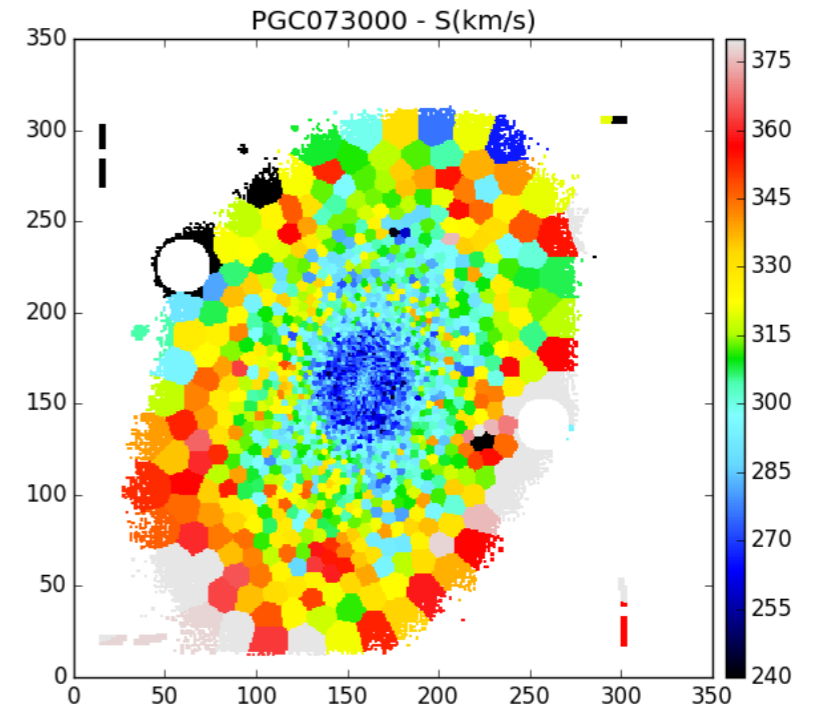


PGC007300

Velocity



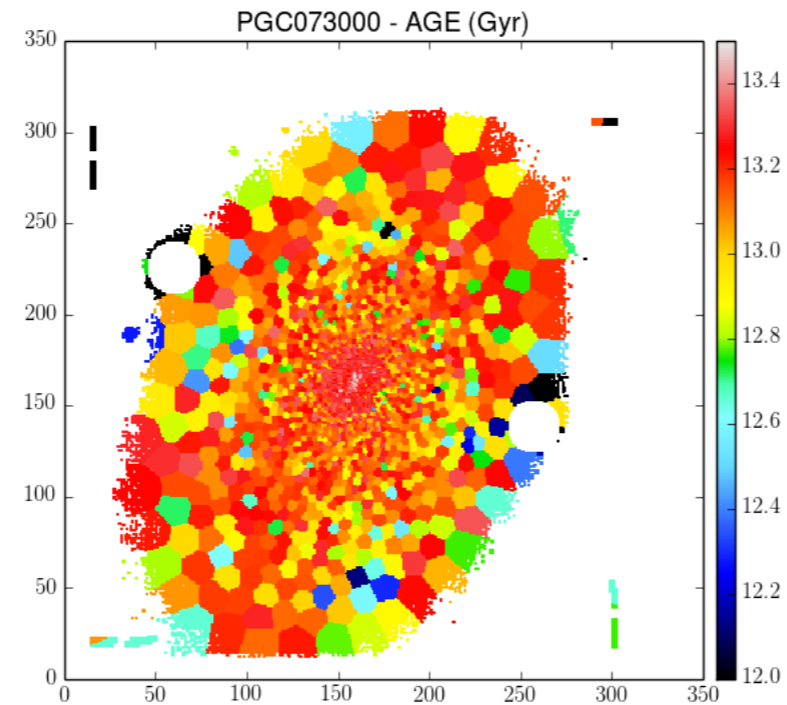
Dispersion



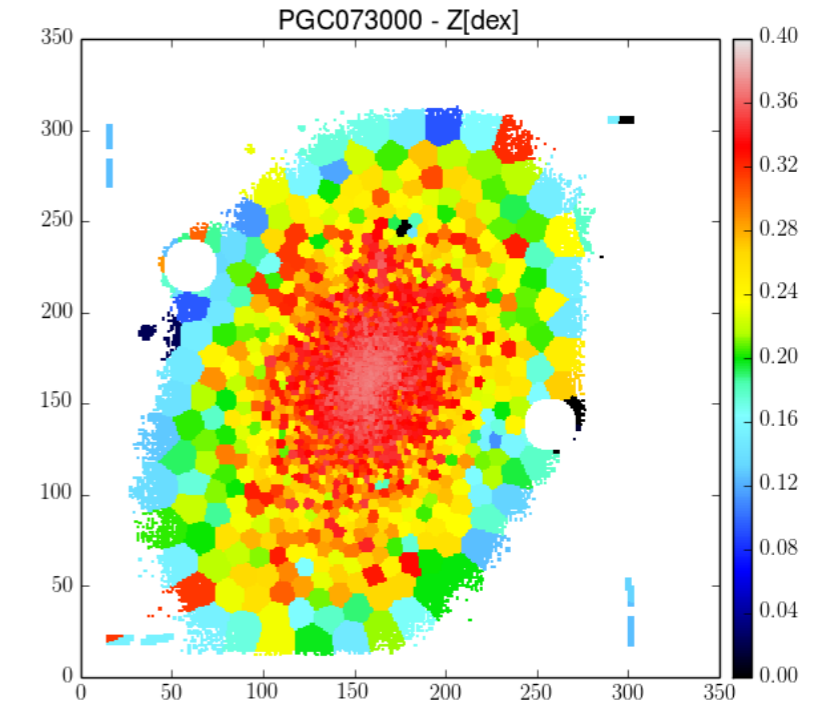
MUSE colour

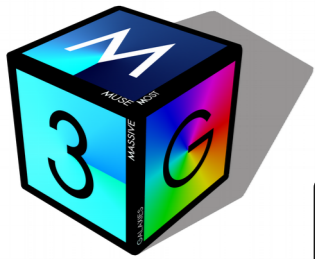


Age



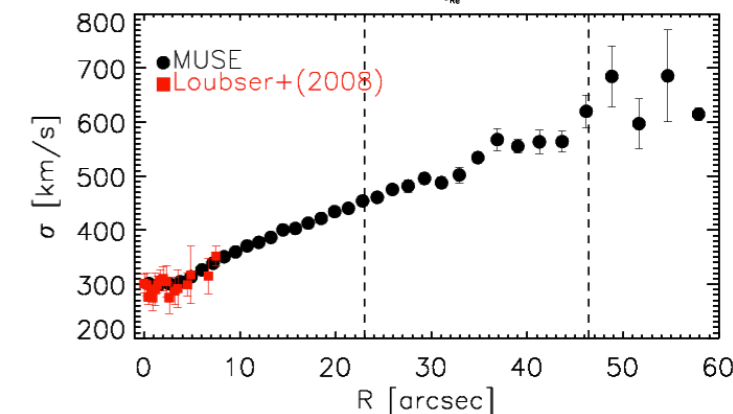
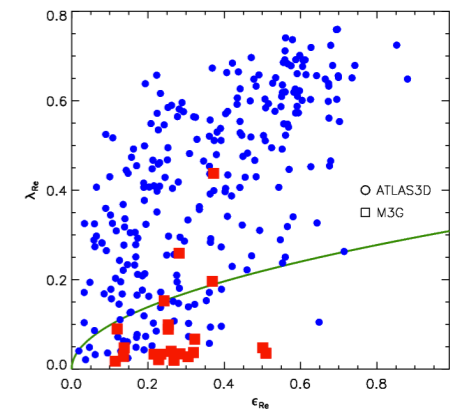
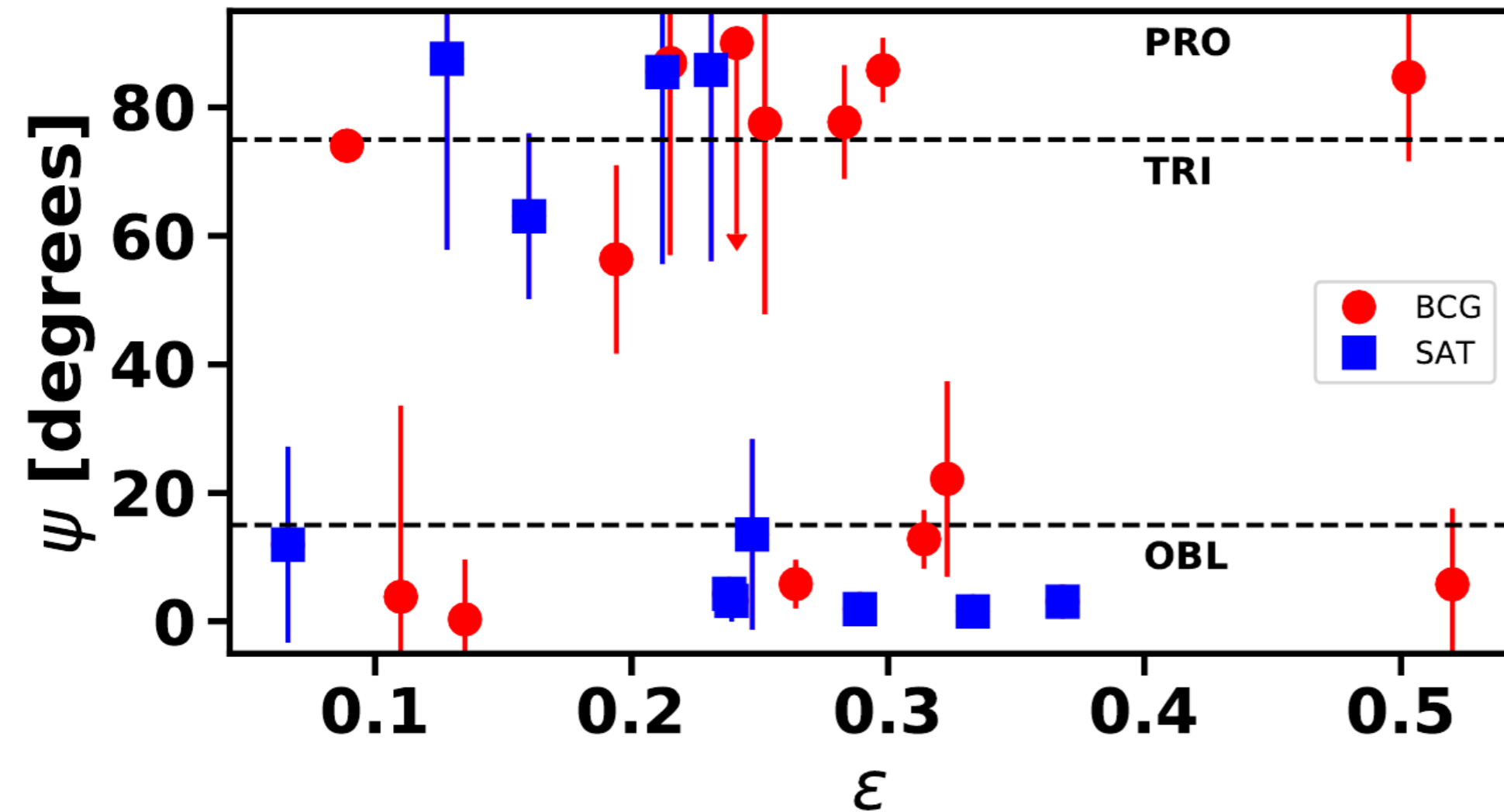
Metallicity





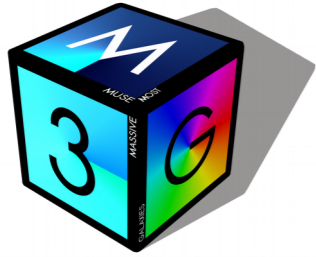
First Results

> 1/2 show prolate-like rotation for BCGs
(a bit less than 50 %, when including all)



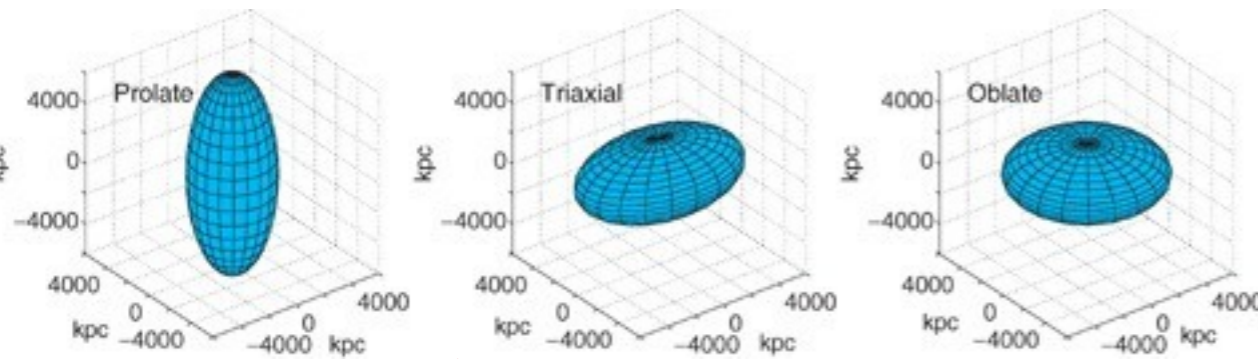
Krajnović, EE, et al. 2018

First Results

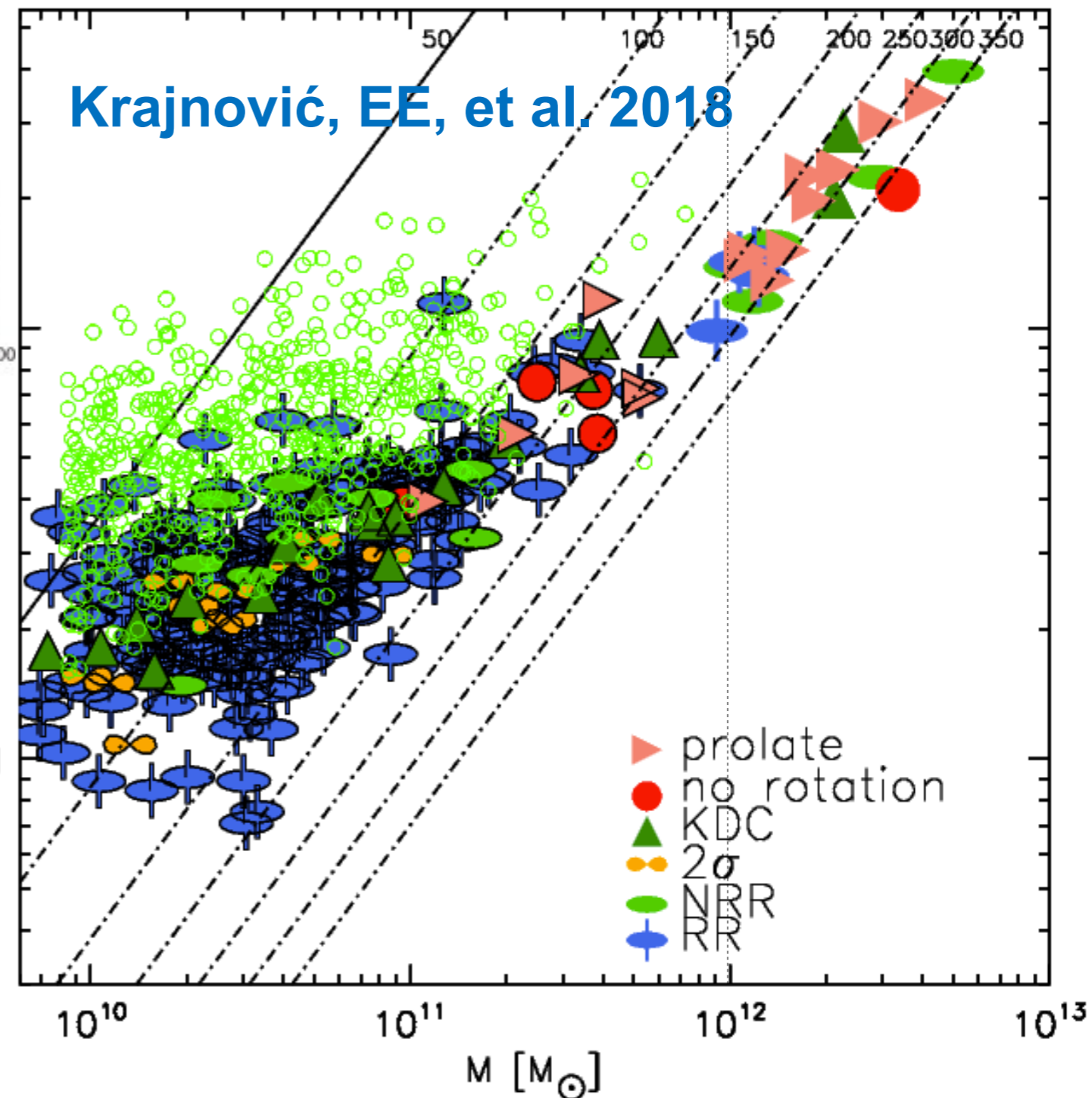


The morphology of galaxies change with mass
Oblate \Rightarrow Mildly Triaxial \Rightarrow Prolate ?

Geometry \rightarrow



Mass \leftarrow

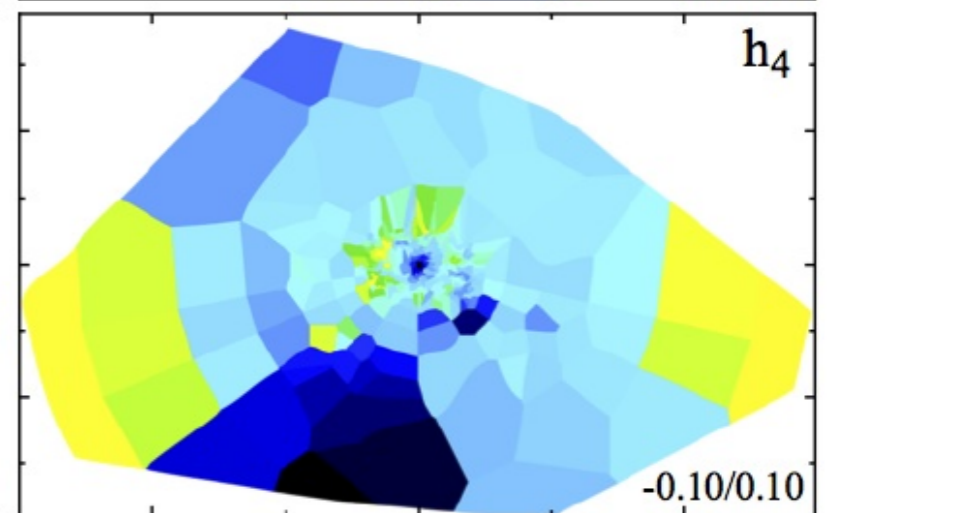
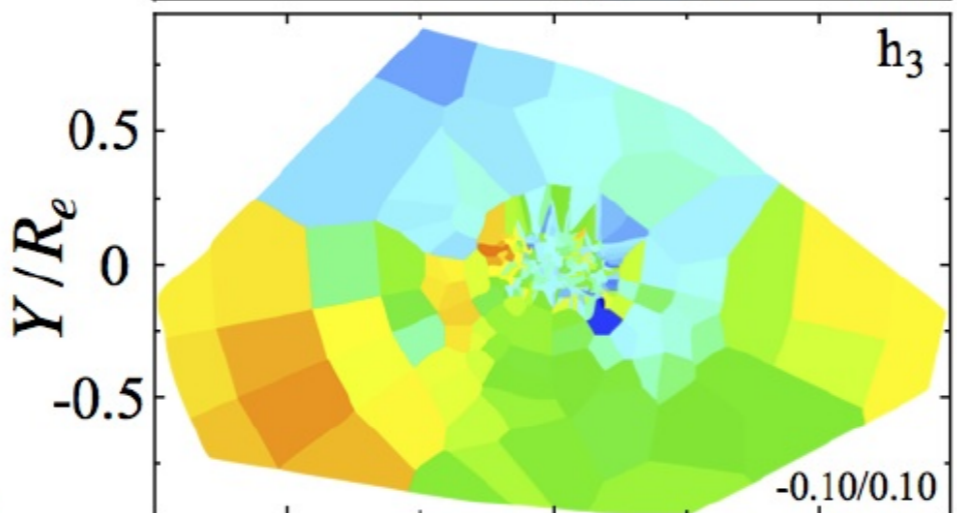
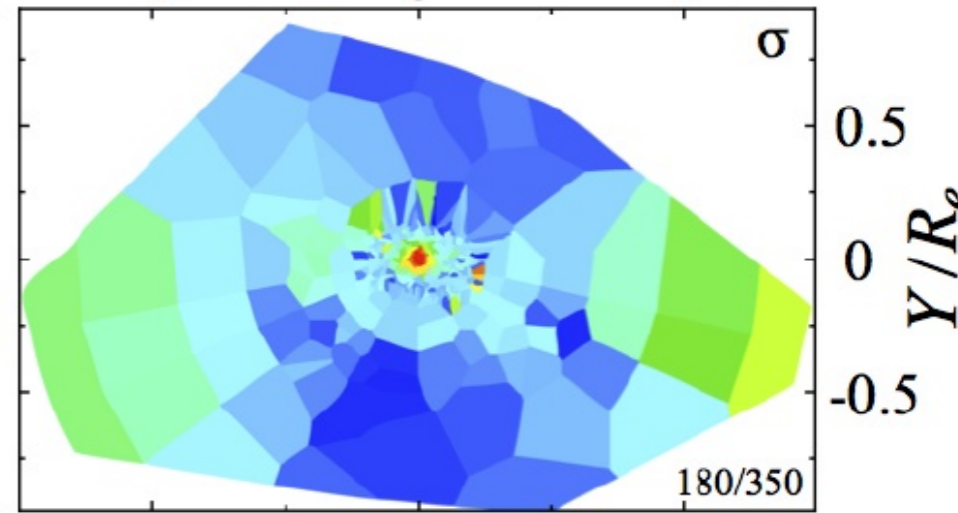
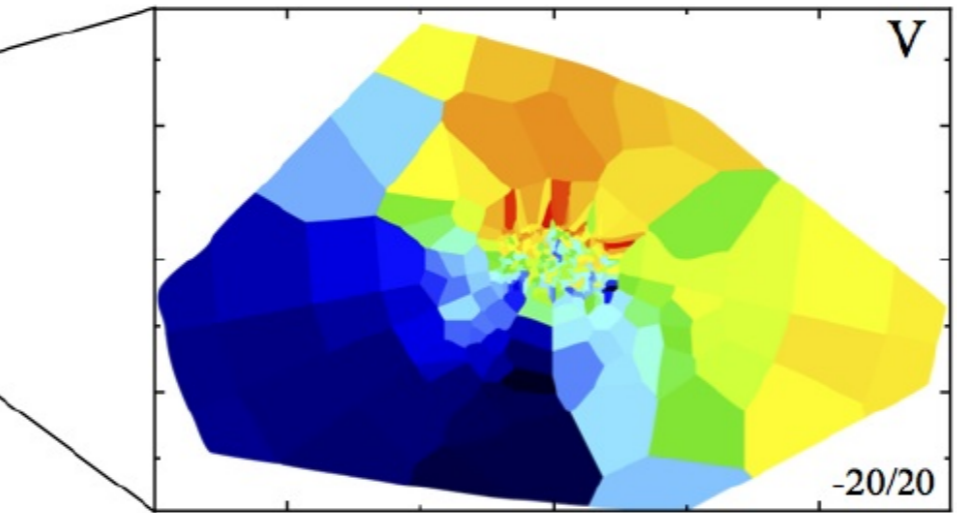
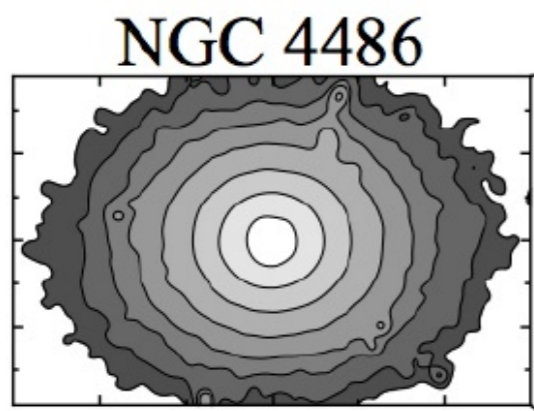
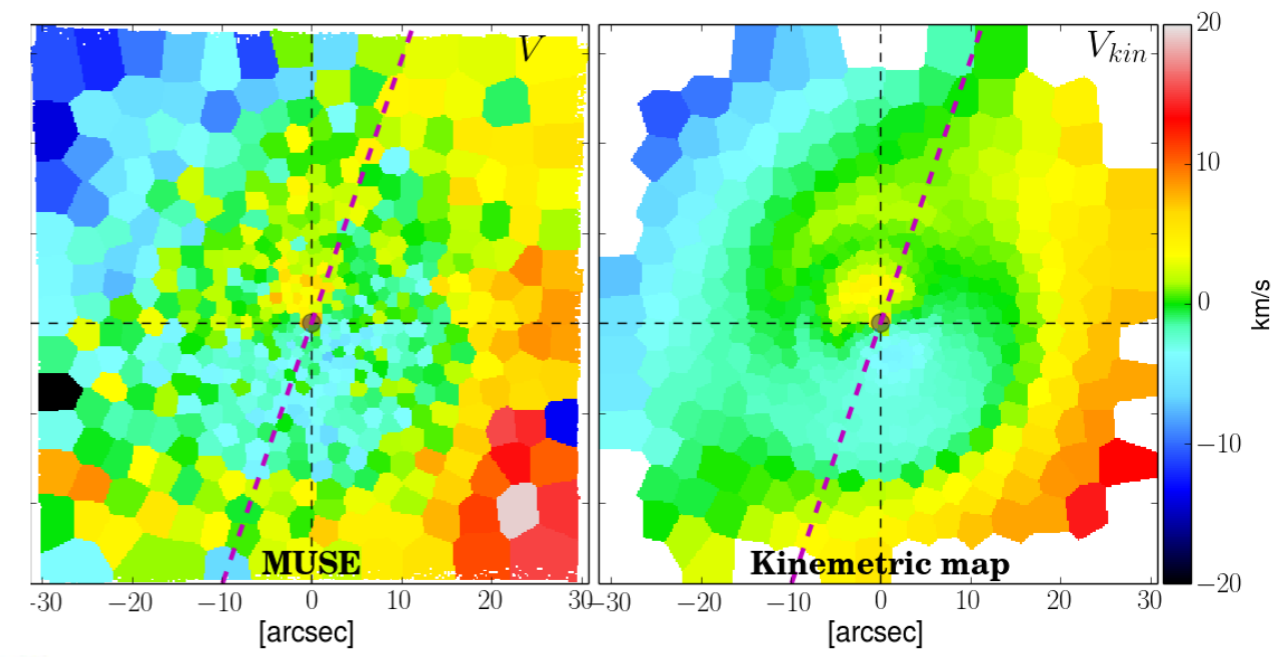


To Do

Dynamical models
Assembly history

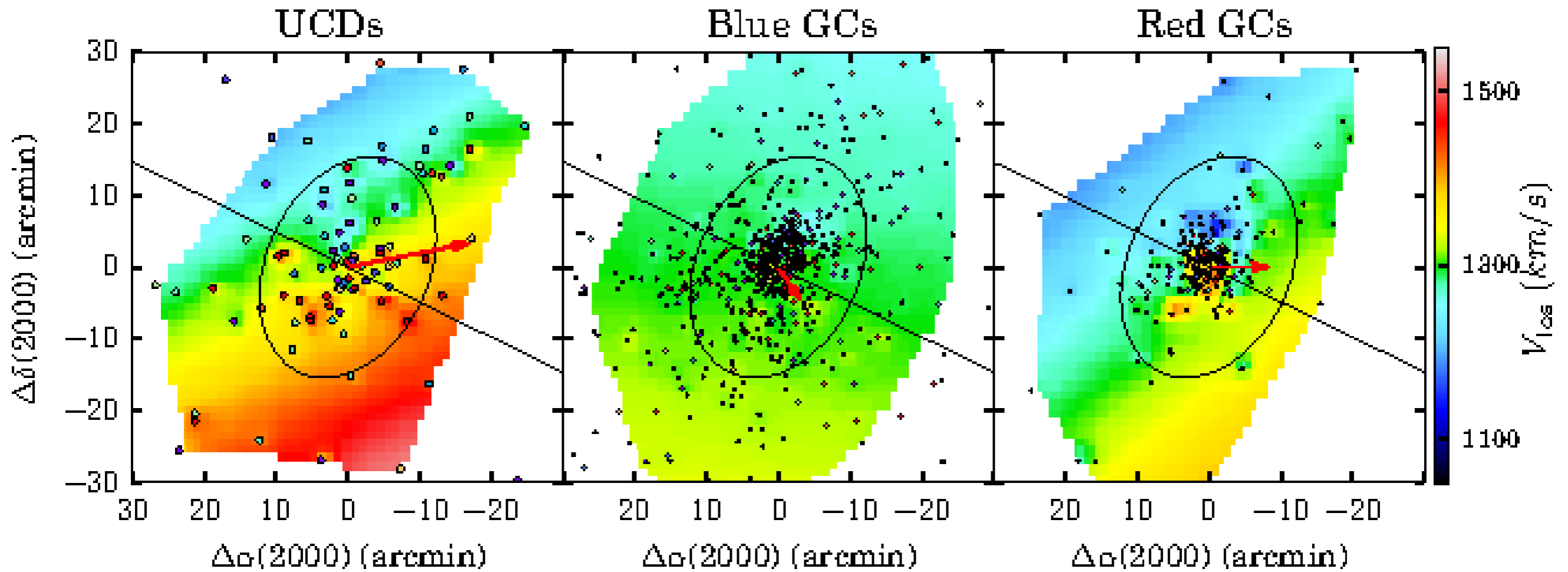
Reminder: M 87

See also Murphy et al. 2011,
Romanowsky et al. 2012,
Longobardi et al. 2013,
Agnello et al. 2014,
Zhu et al 2014, ...





M 87



Zhang et al. 2015 [AAT/AAOmega+MMT/Hectospec]

Constraining mass assembly

Krajnović, EE, et al. 2018

- Above $10^{11} M_{\odot}$: all BCGs have non-regular kinematics
- Up to $10^{12} M_{\odot}$: galaxies with regular kinematics exist, but not in BCGs
- Above $10^{12} M_{\odot}$: prolate-like rotation dominate \Rightarrow the only way to grow ?

[see also Tsatsi et al. 2017, Graham et al. 2018, Weaver et al. 2018]

Questions [climbing to the top of the mass ladder]

- How is prolate-like rotation produced ?
 - \Rightarrow Are major dry majors the key ?
 - \Rightarrow Are major **LATE** dry majors the key ?
 - \Rightarrow Bias from cluster vs large-scale alignments ?
(see e.g., West et al.)

\Rightarrow stellar populations, SFH

