

Compact dwarf galaxies with the GMOS-IFU and NGVS

Testing the continuity hypothesis

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Satellites & Streams

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13 – 17 April 2015

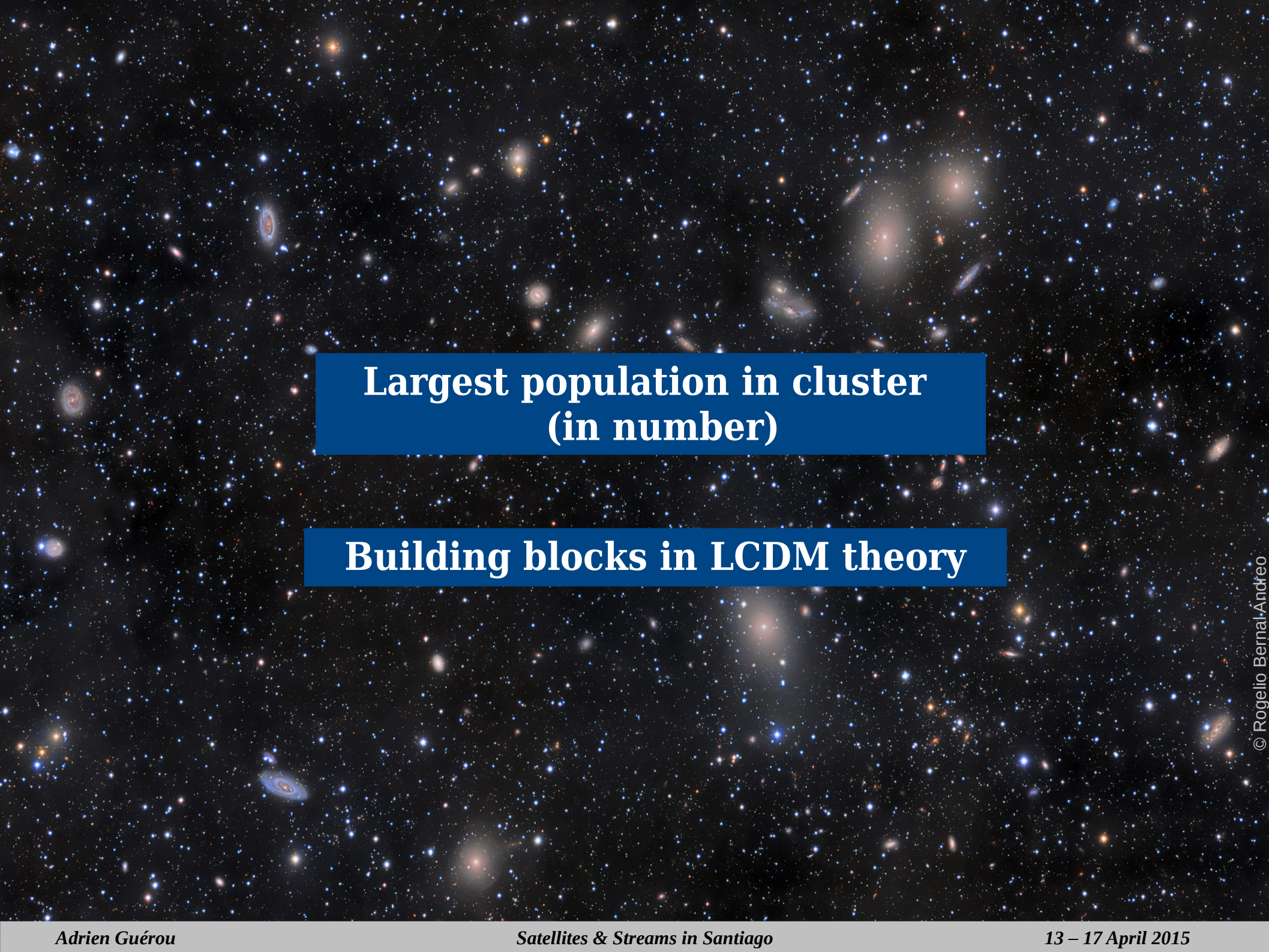
ESO-Santiago, Chile



Université
Paul Sabatier
TOULOUSE III



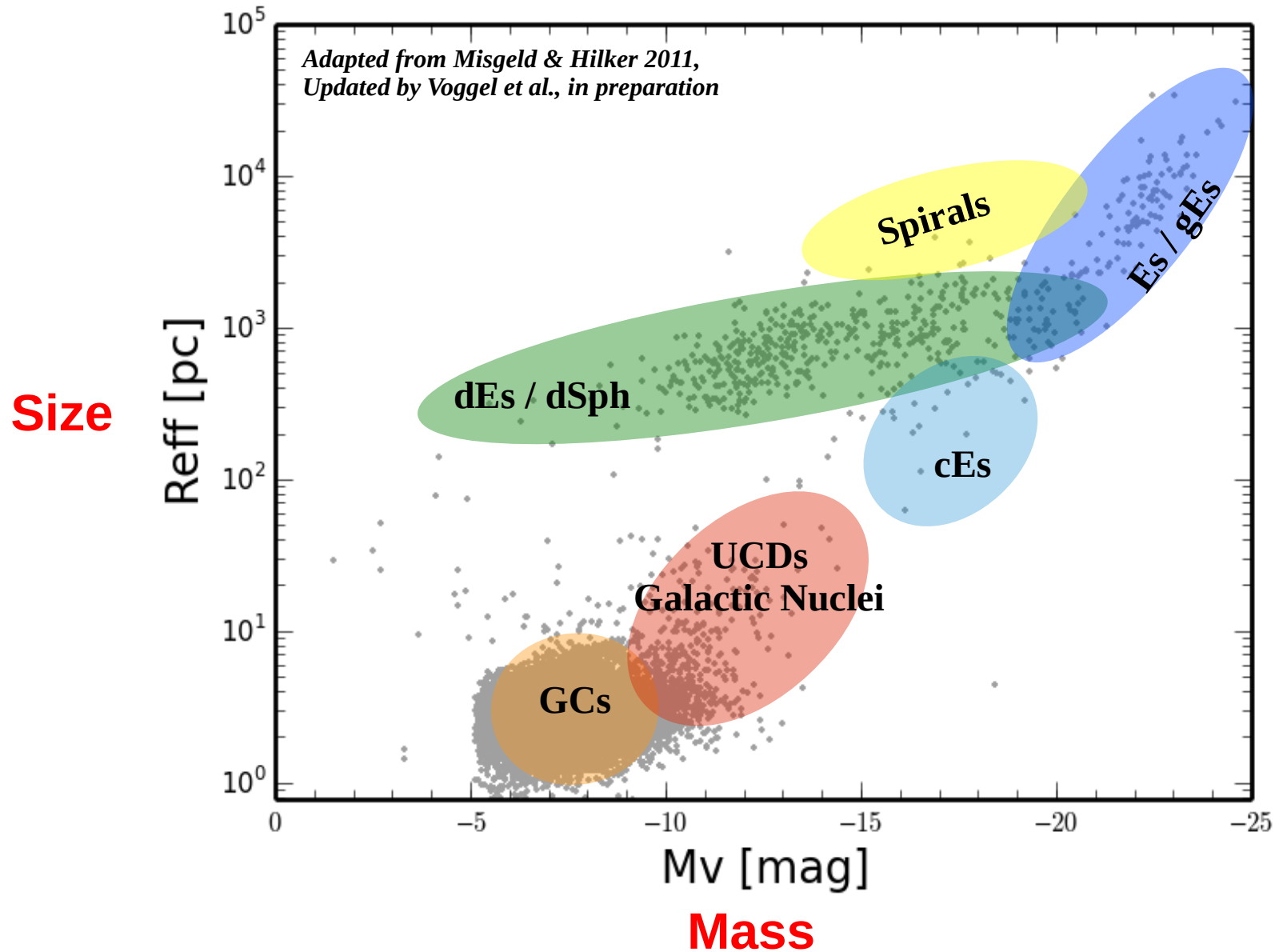
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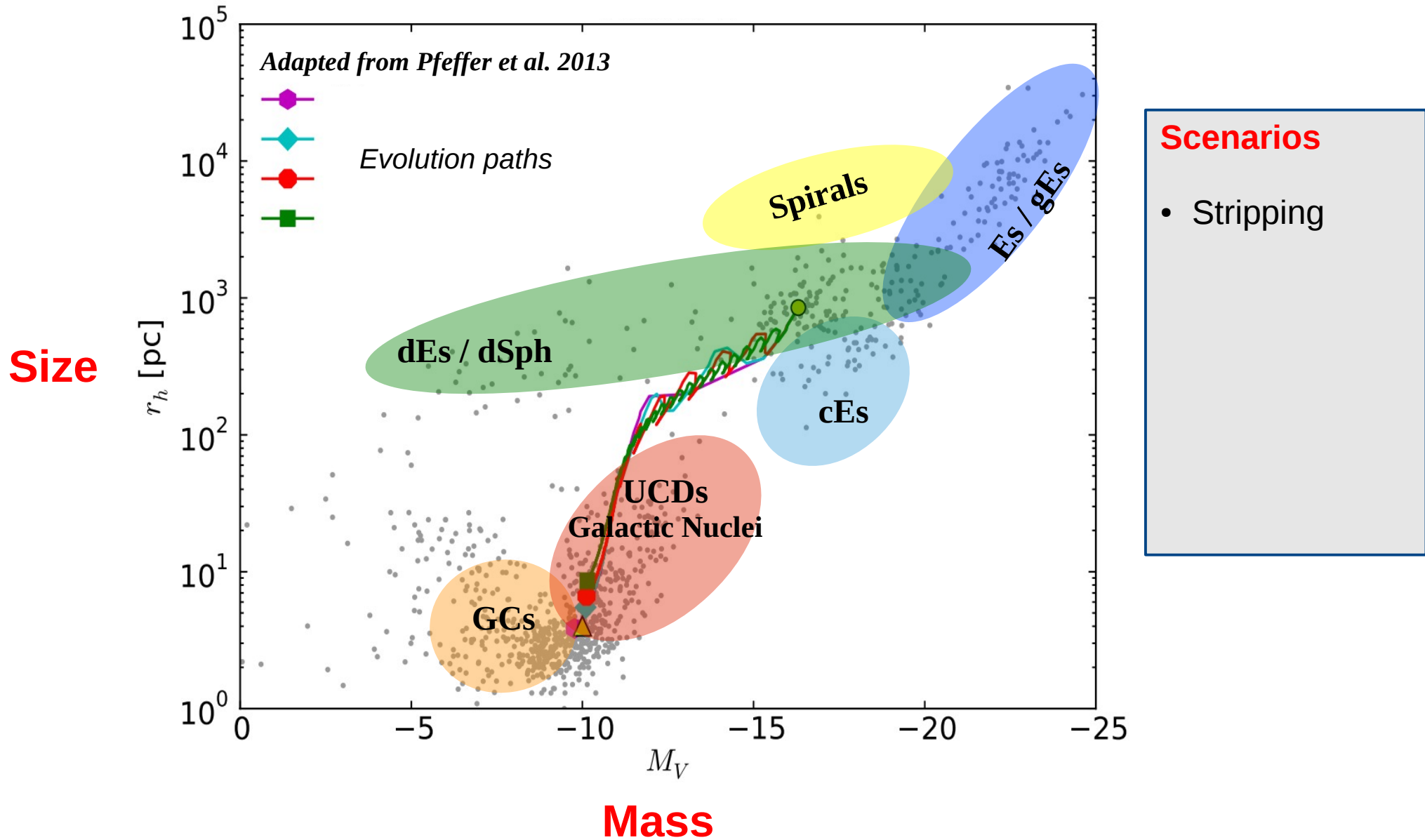
**Largest population in cluster
(in number)**

Building blocks in LCDM theory

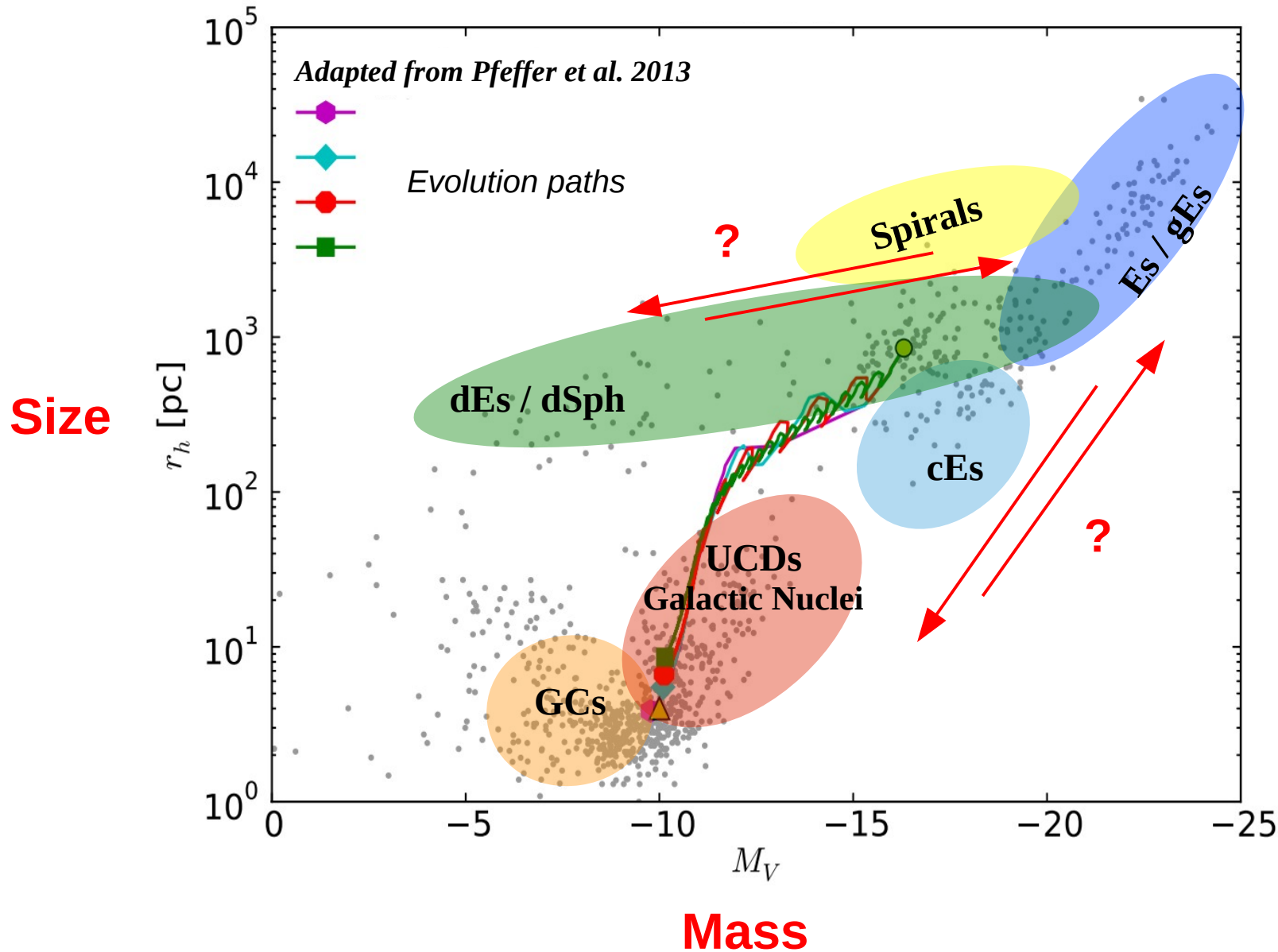
“Mass – size” plane of galaxies



“Mass – size” plane of galaxies



“Mass – size” plane of galaxies

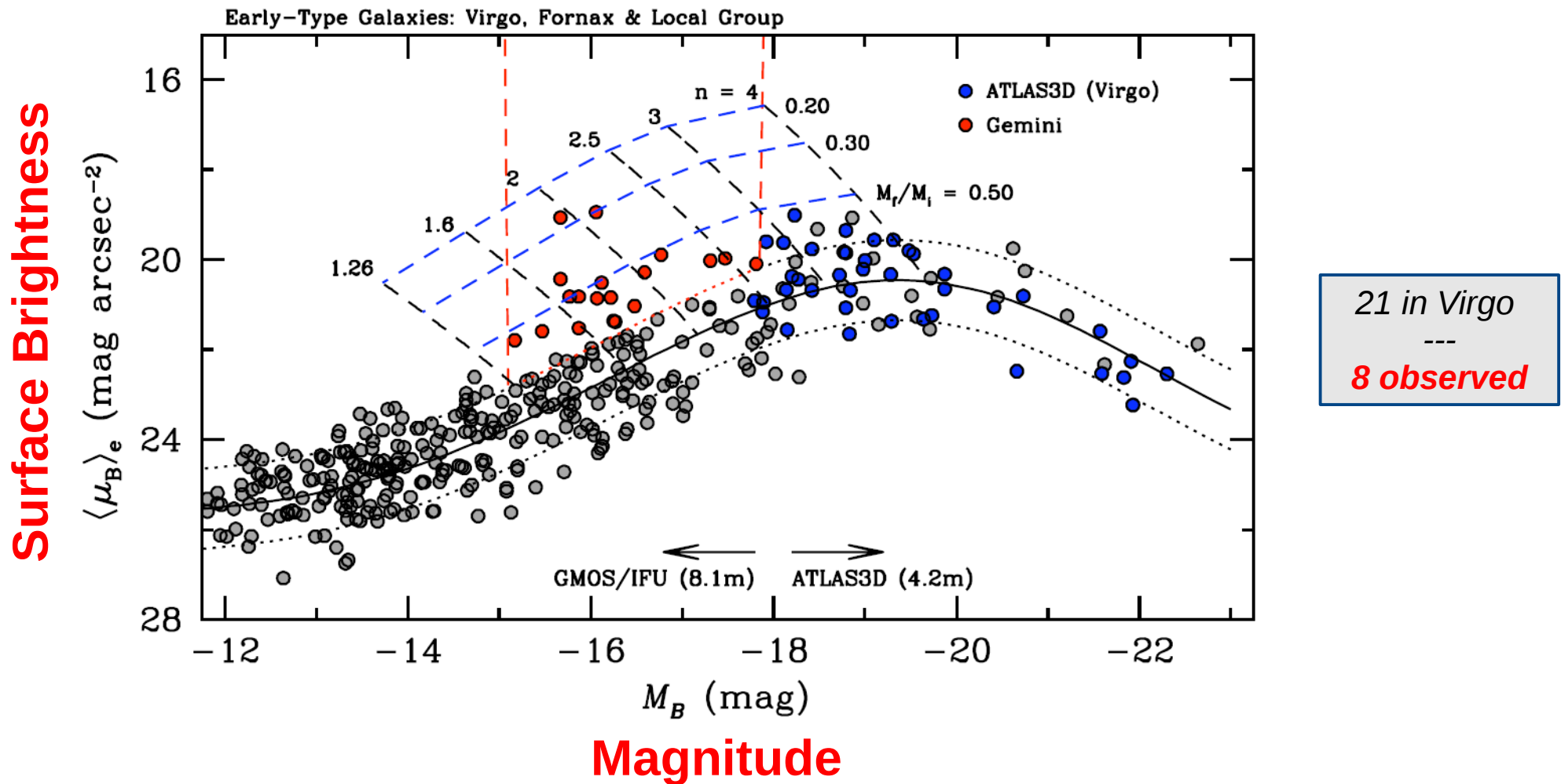


Scenarios

- Stripping
- Ram pressure
- Harassment
- Merging
- Gas accretion
- ...

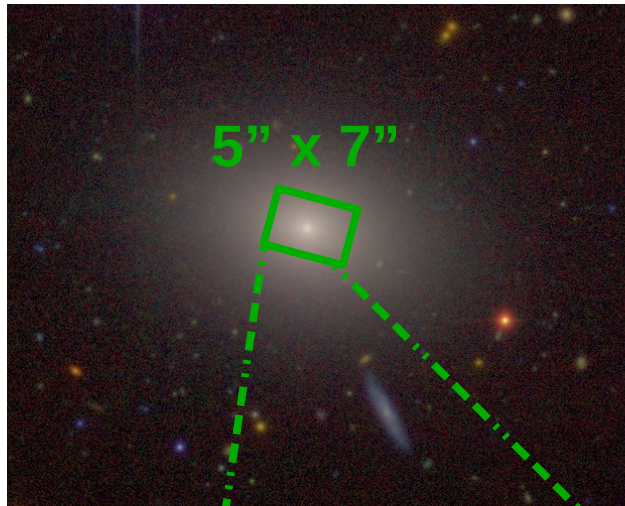
GMOS-IFU program

- “Compact, low-mass” ETGs

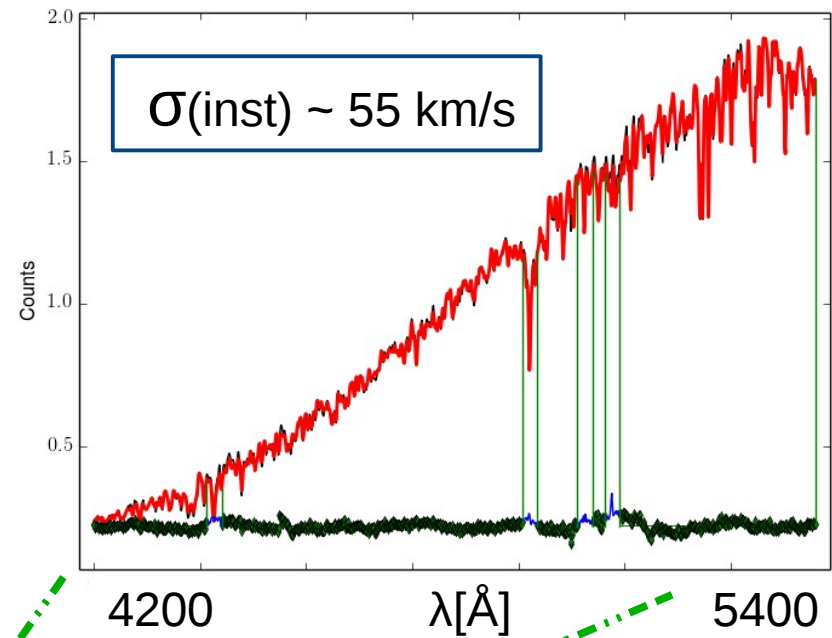
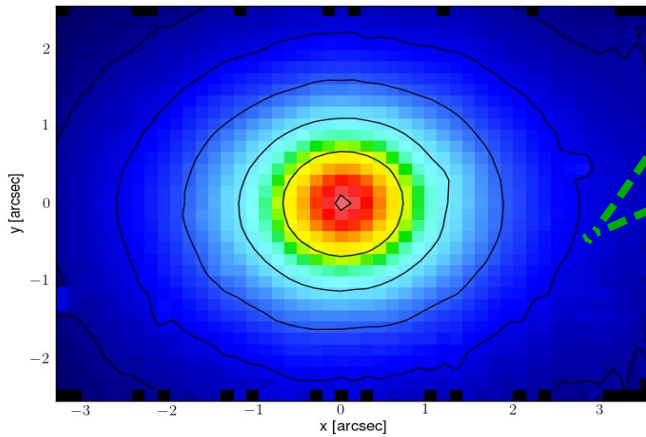


GMOS-IFU program

• NGVS - GIZ image

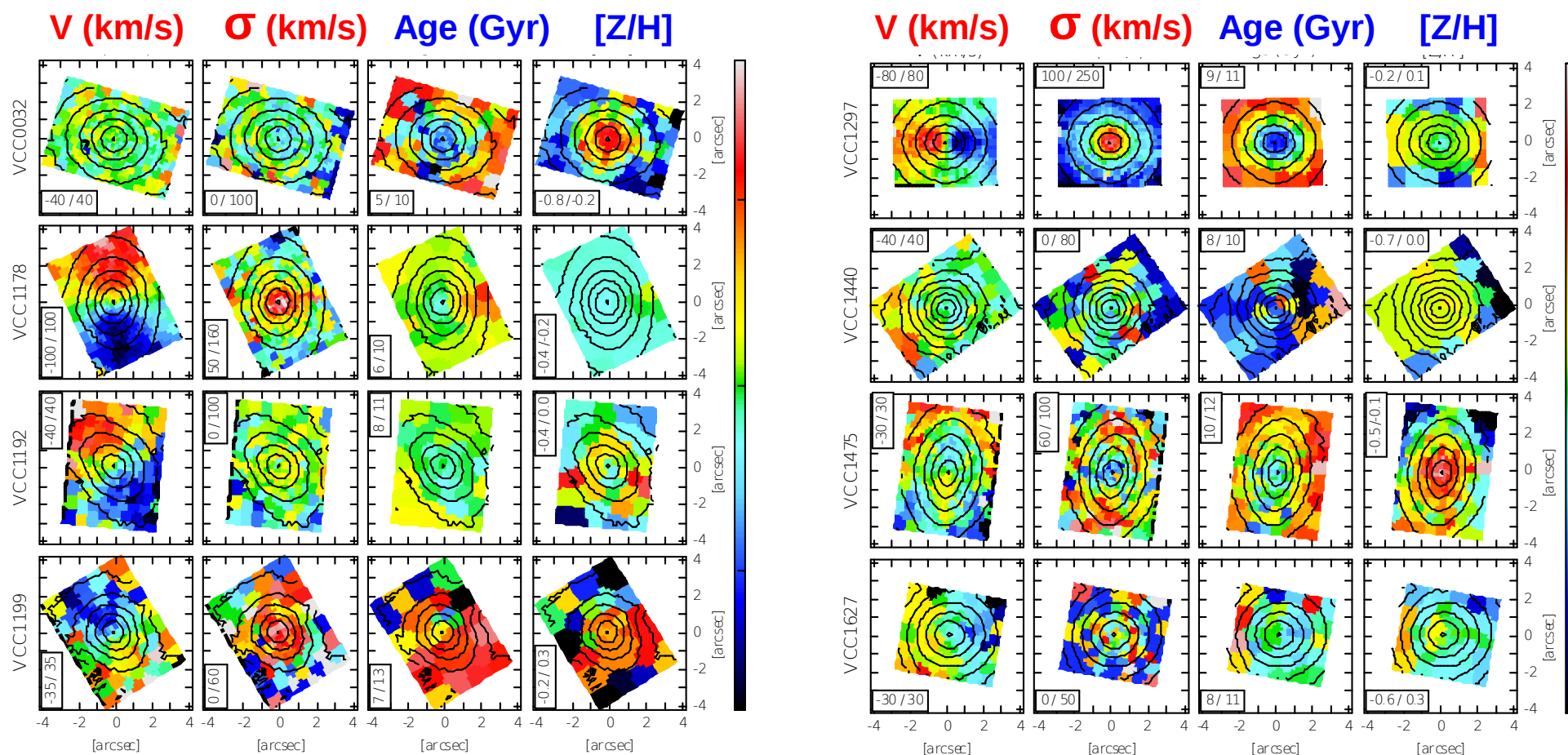


• GMOS-IFU cube



- **Full spectral fitting:** pPXF
(Cappellari & Emsellem, 2004)
- **Stellar kinematics:** MILES library
(Sanchez-Blasquez, 2006 ;
Flacón-Barroso, 2011)
- **Stellar population:** MIUSCAT library
(Vazdeskis, 2012)

Compact dwarfs: kinematics & stellar population



Guérou et al., 2015, ApJ
arXiv 1504.03714

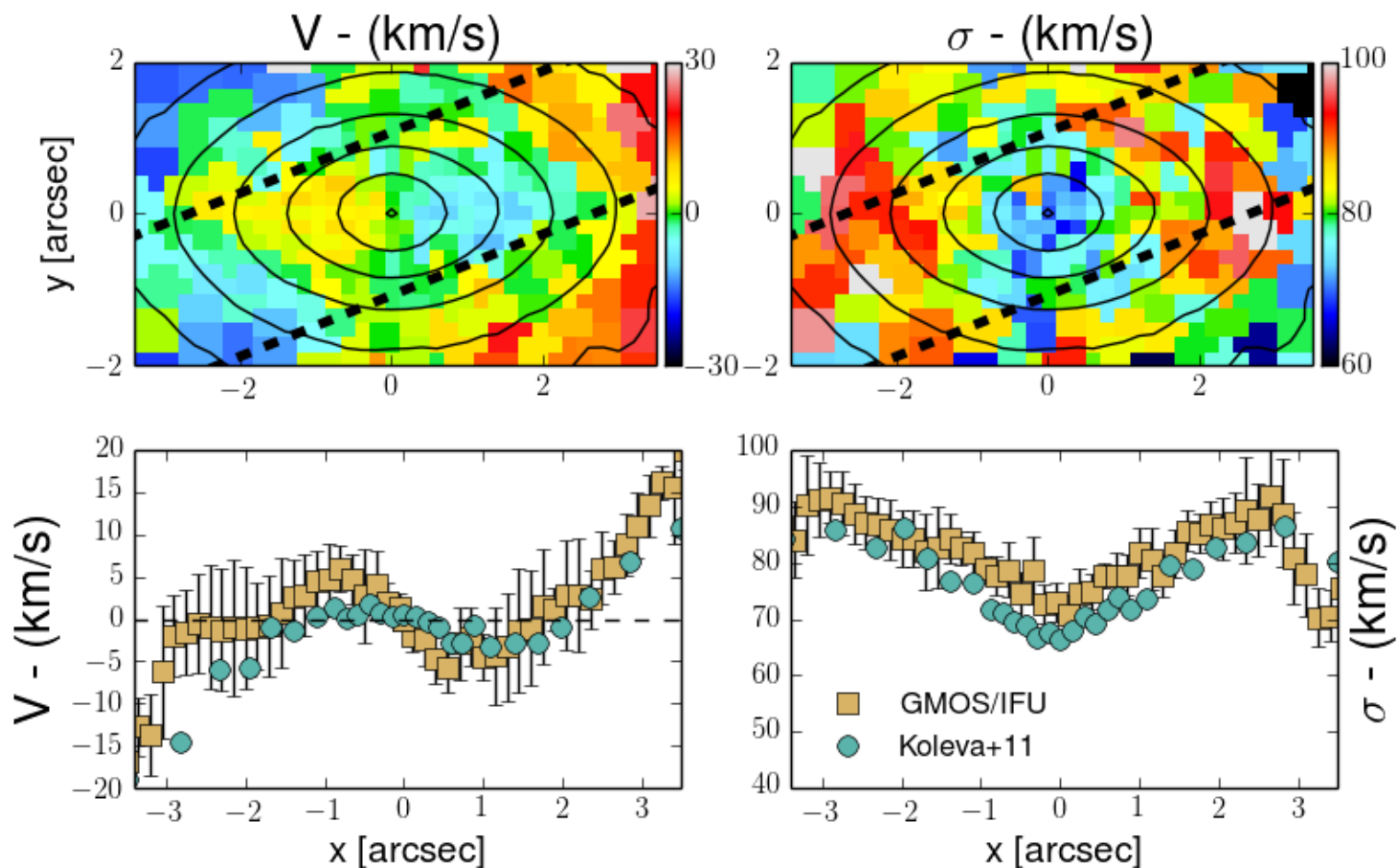
- Kinematics**

V : 30 – 40 km/s
 σ : 20 – 60 km/s

- Stellar population**

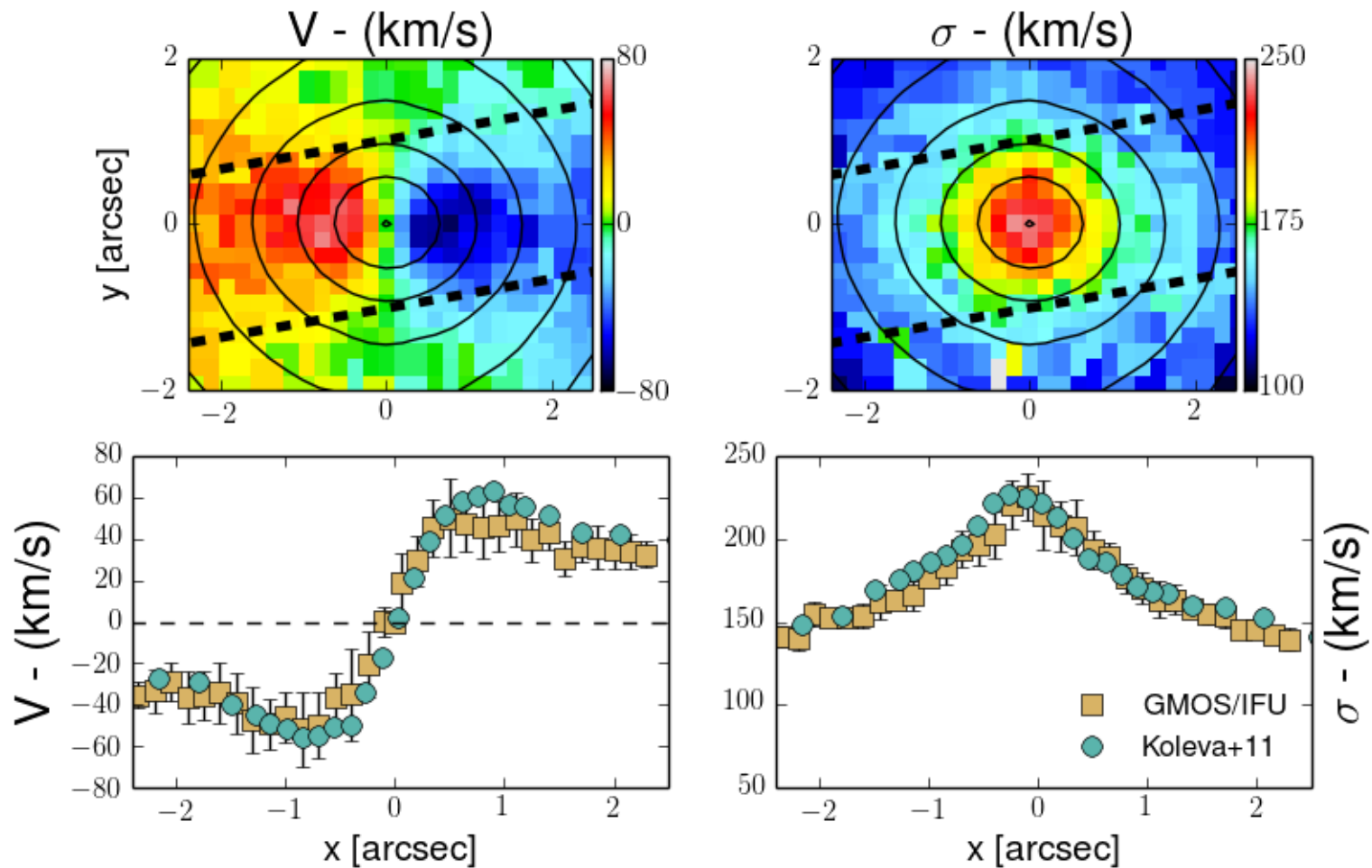
Age : 6 – 11.5 Gyr
[Z/H] : -0.8 – 0.2 dex

VCC 1475: a Kinematically decoupled core (KDC)



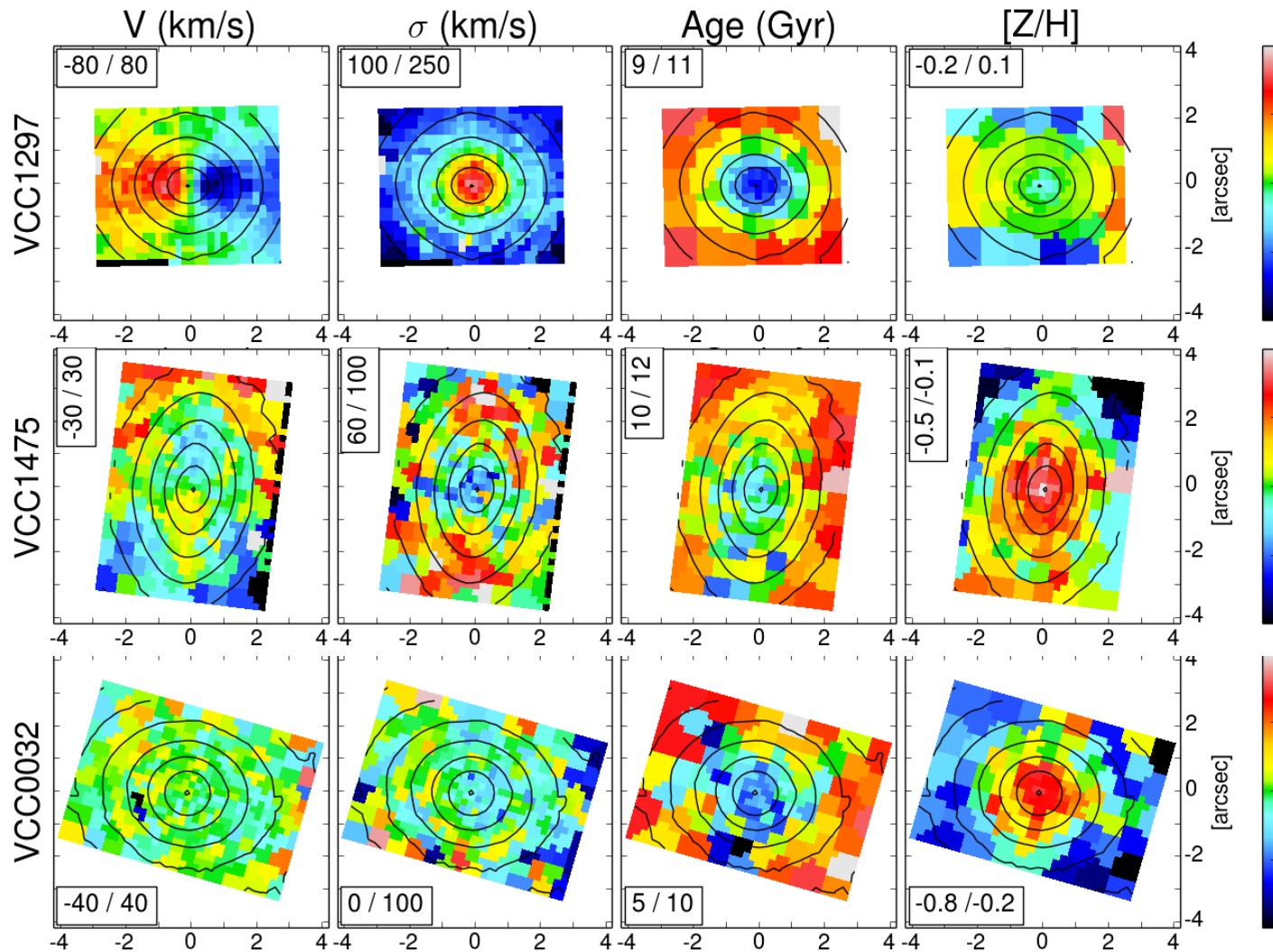
- 2 – σ galaxy (Krajnović, 2011)
- A few other found in dEs/dSph (Toloba, 2014 (a,b), Geha, 2005)

VCC1297 (NGC4486b): a central BH ... ?



- Central BH of $\sim 10^8 M_{\odot}$ (Kormendy & Bender, 1997)
- 5% of its dynamical mass ($\sim 1.1 \times 10^{10} M_{\odot}$)

Younger & more [Z/H] rich cores

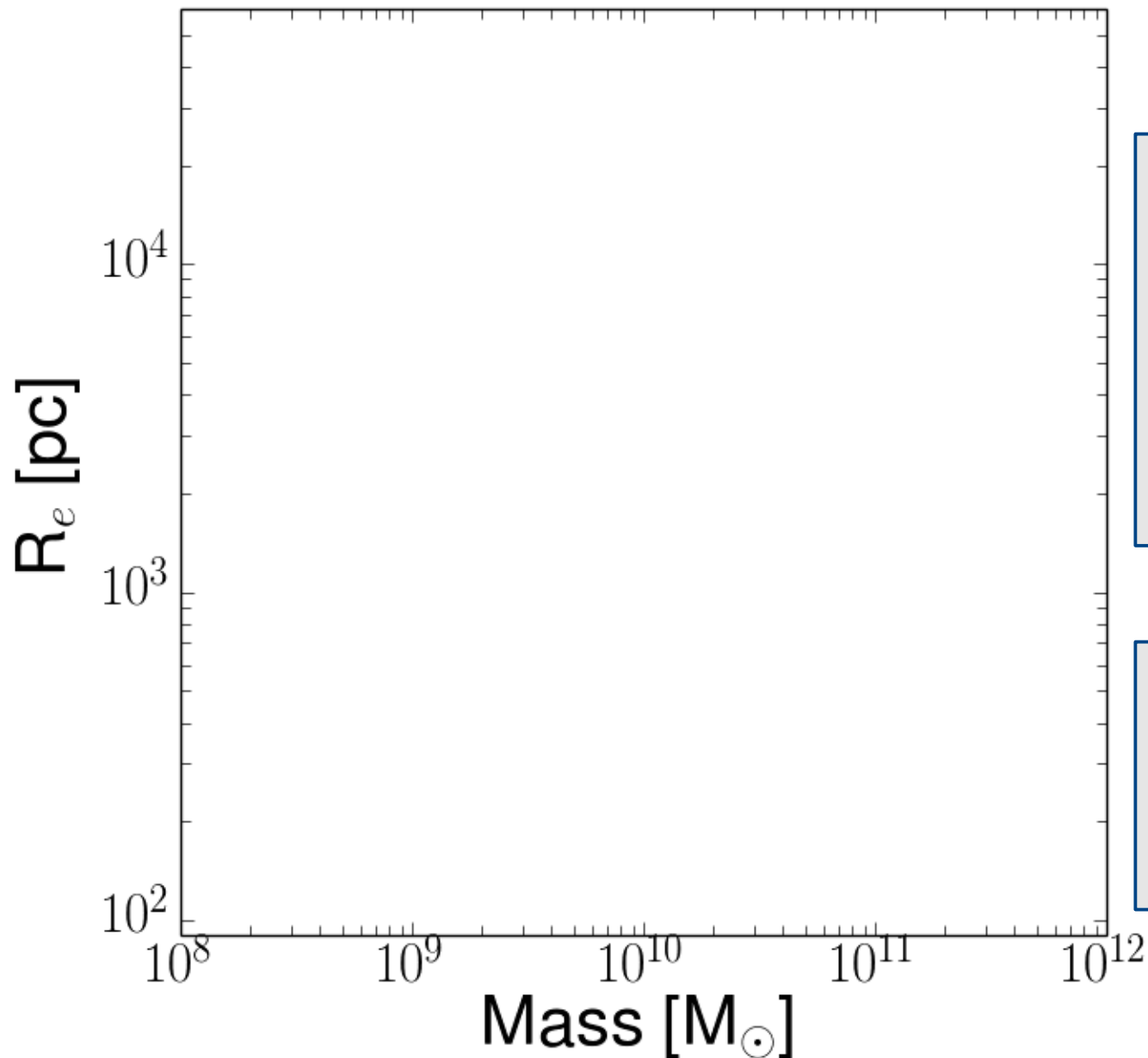


**SF episode
at the center**

Scenarios:

- Secular processes
- External processes:
 - Gas accretion
 - Grav. interaction

Low-mass, compact galaxies in the “Mass-size” plane



- **Dynamical mass**

JAM :

Anisotropic Jeans equation

Virial theorem :

$$M \equiv \beta(\mathbf{n}) \cdot \sigma(\text{Re})^2 \cdot \text{Re} / G$$

(equivalent, Cappellari et al. 2013)

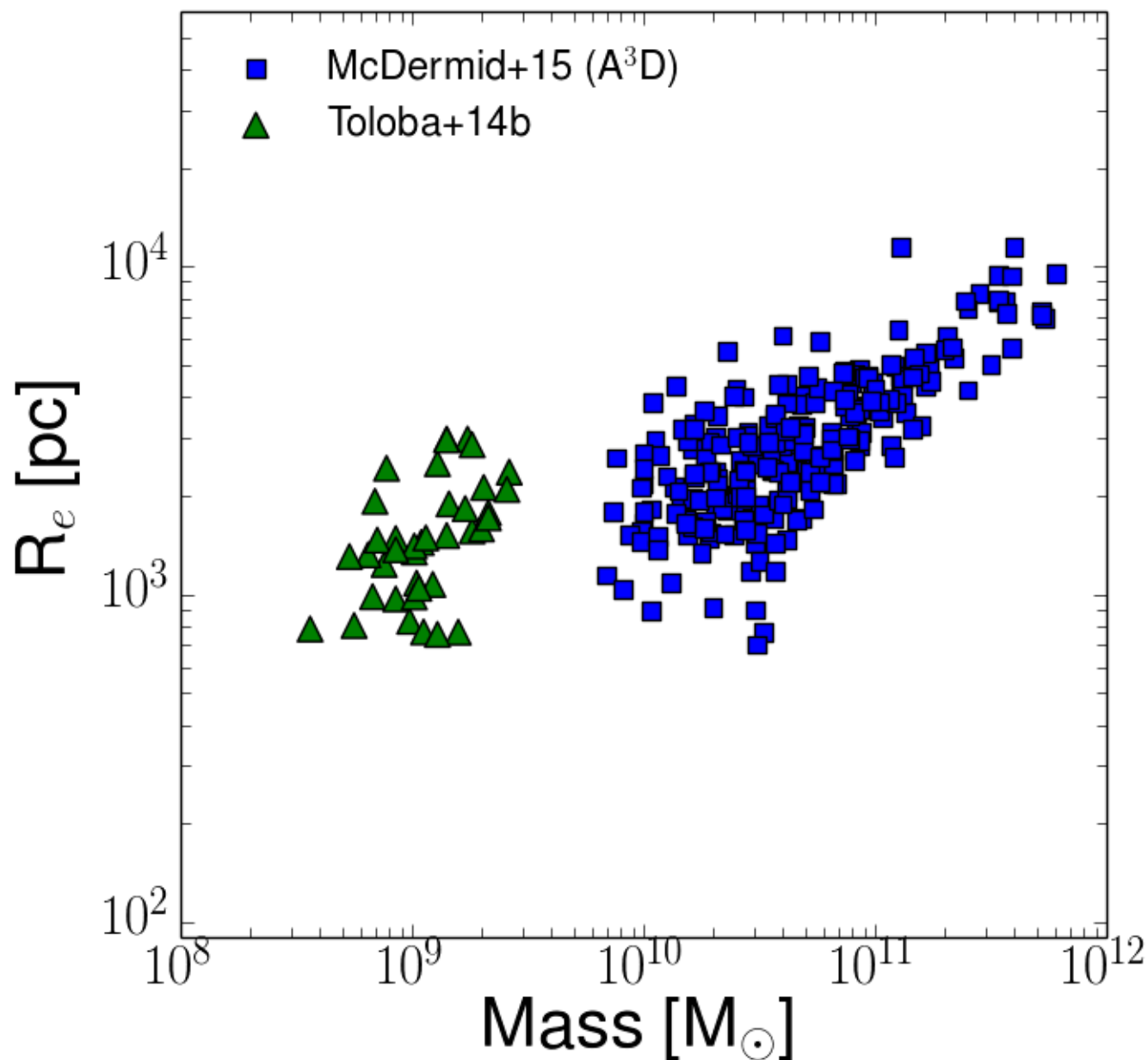
- **Effective Radius, R_e**

NGVS:

Photometry *i*-band images

(Ferrarese, L. et al. 2012)

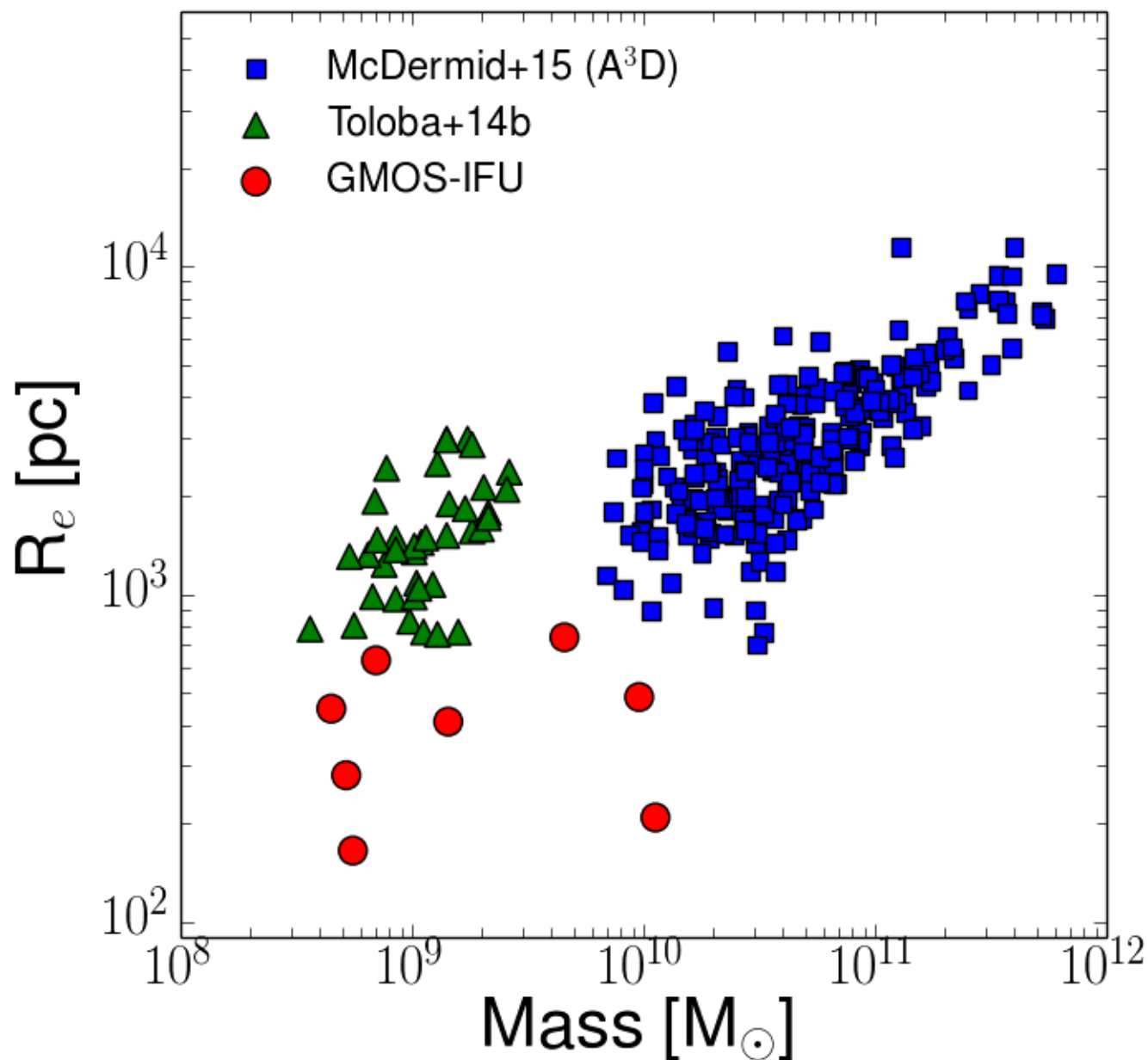
Low-mass, compact galaxies in the “Mass-size” plane



260 “massive” ETGs
(A3D, $M_k < -21.5$)

39 “low-mass” ETGs
(SMAKCED survey)

Low-mass, compact galaxies in the “Mass-size” plane

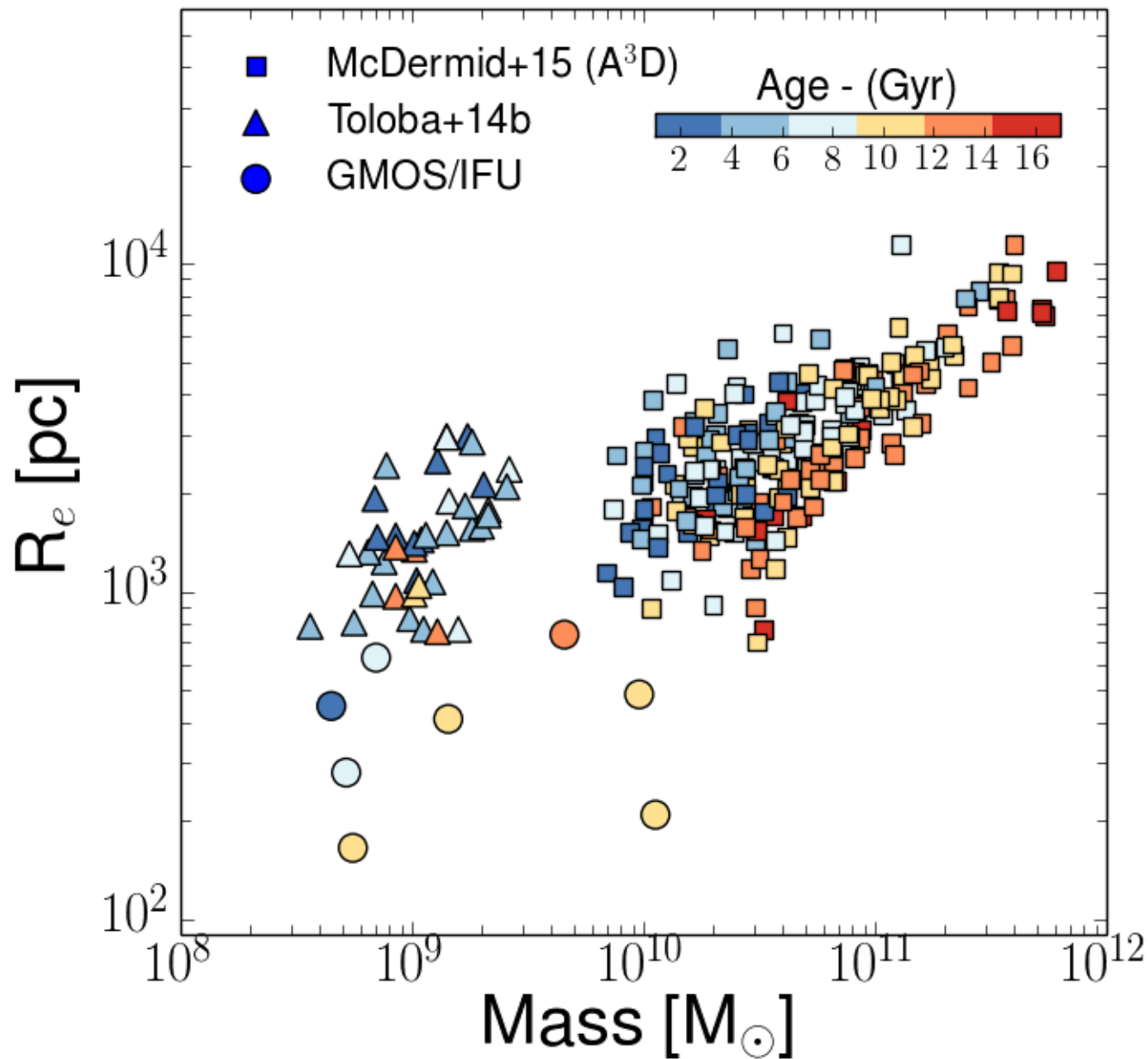


260 “massive” ETGs
(A³D, $M_k < -21.5$)

39 “low-mass” ETGs
(SMAKCED survey)

8 “low-mass, COMPACT”
ETGs (GMOS-IFU program)

GMOS-IFU program : results



AGE

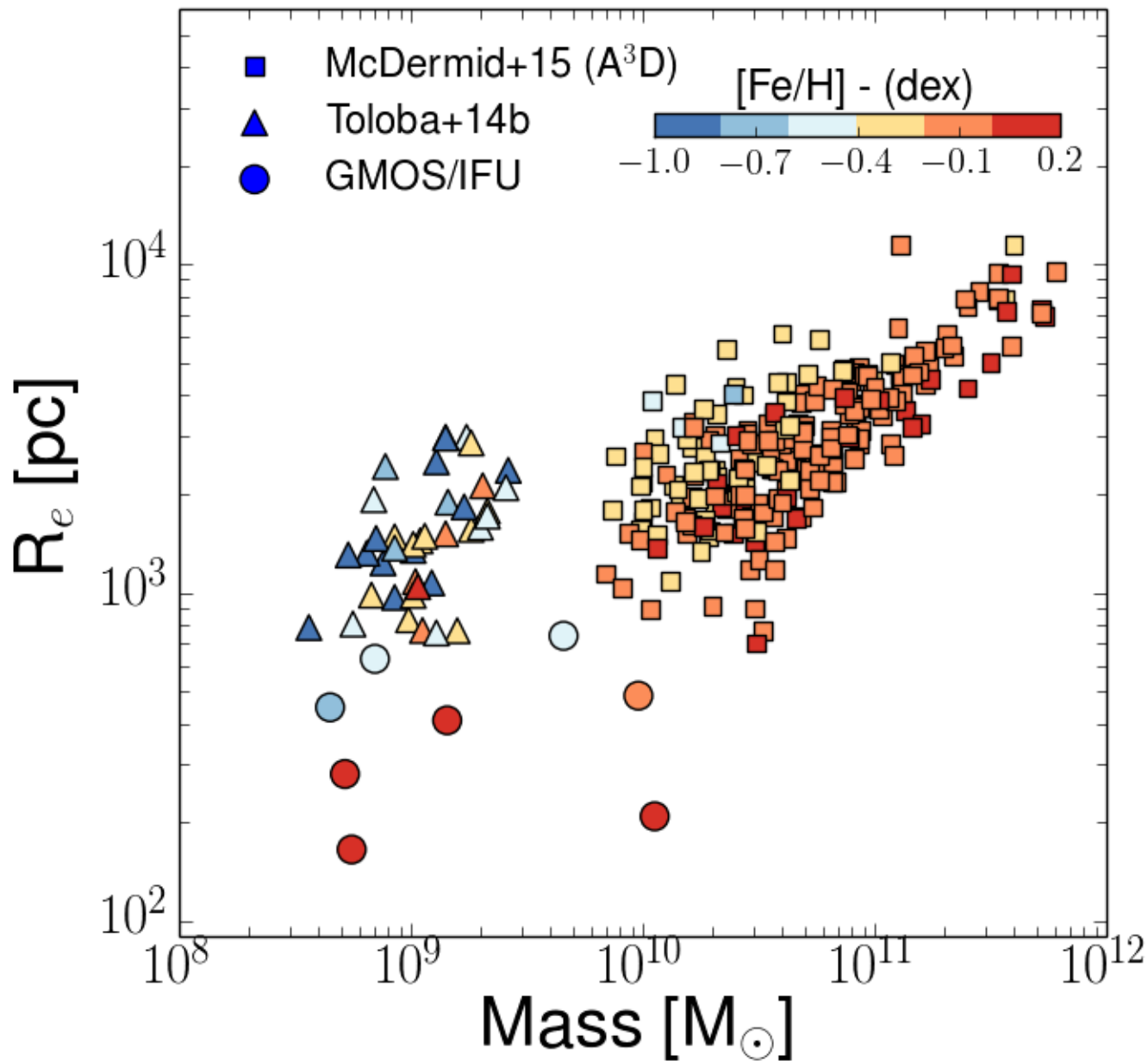
*Single Stellar Population
within R_e*

COMPACT = OLDER

**CONTINUITY
MASSIVE & LOW-MASS**

Guérou et al., 2015, ApJ
arXiv 1504.03714

GMOS-IFU program : results



[Fe/H]

*Single Stellar Population
within R_e*

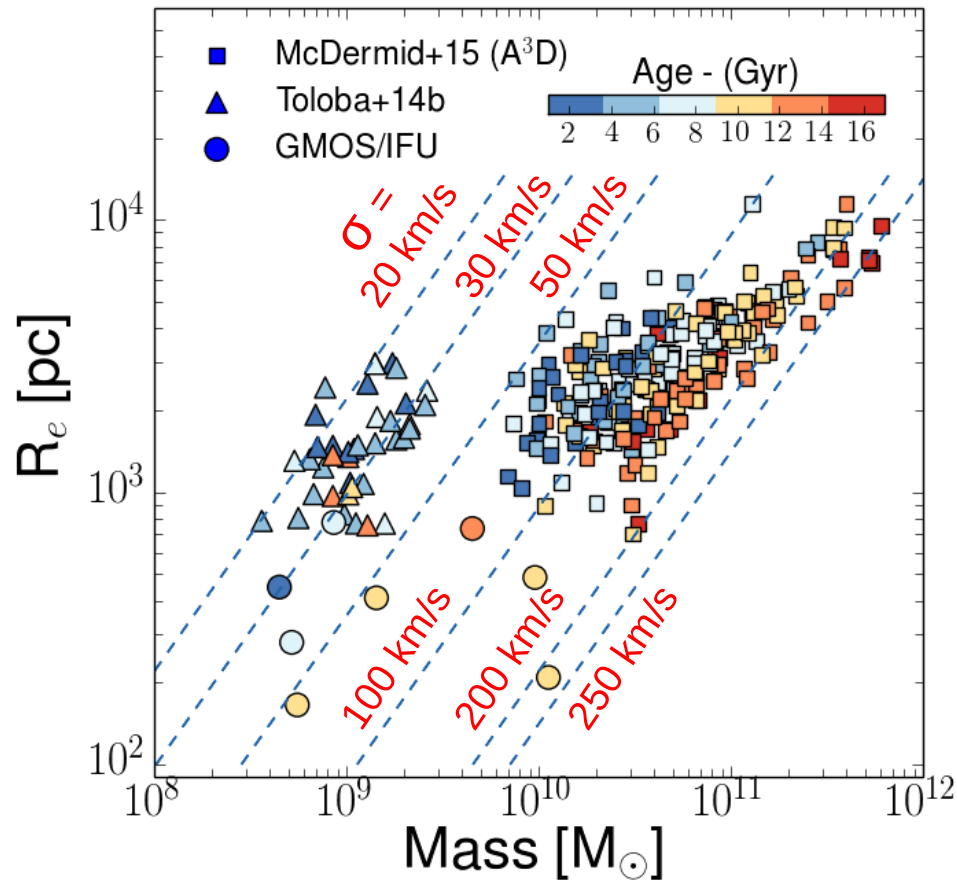
**COMPACT
MORE METAL-RICH

CONTINUITY
MASSIVE & LOW-MASS**

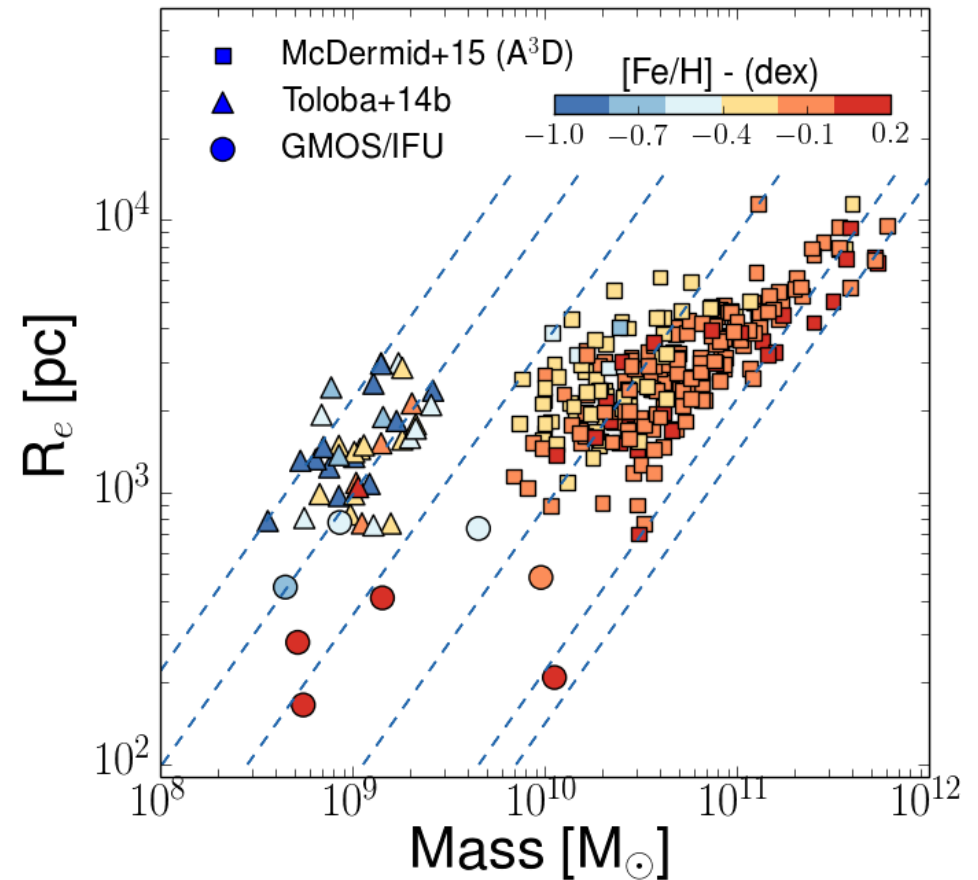
Guérou et al., 2015, ApJ
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GMOS-IFU program : results

AGE



[Fe/H]



Velocity dispersion
predictor of AGE and [Fe/H]

(Graves & Faber 2012 ; Wake et al. 2012 ; Cappellari et al. 2013, McDermid et al. 2015)

extended to **low-mass galaxies**

NGVS survey

- 900 hours in Virgo (CFHT-MegaCam) [Ferrarese, L. et al. 2012]
- u^* , g , i , z down to $\mu_g \sim 29 \text{ mag.arcsec}^2$

- Streams

[Talk of Duc, P.A.]

- GCs

[Durrell, P. et al, 2014]

- UCDs

[Zhang, H.-X., 2015]

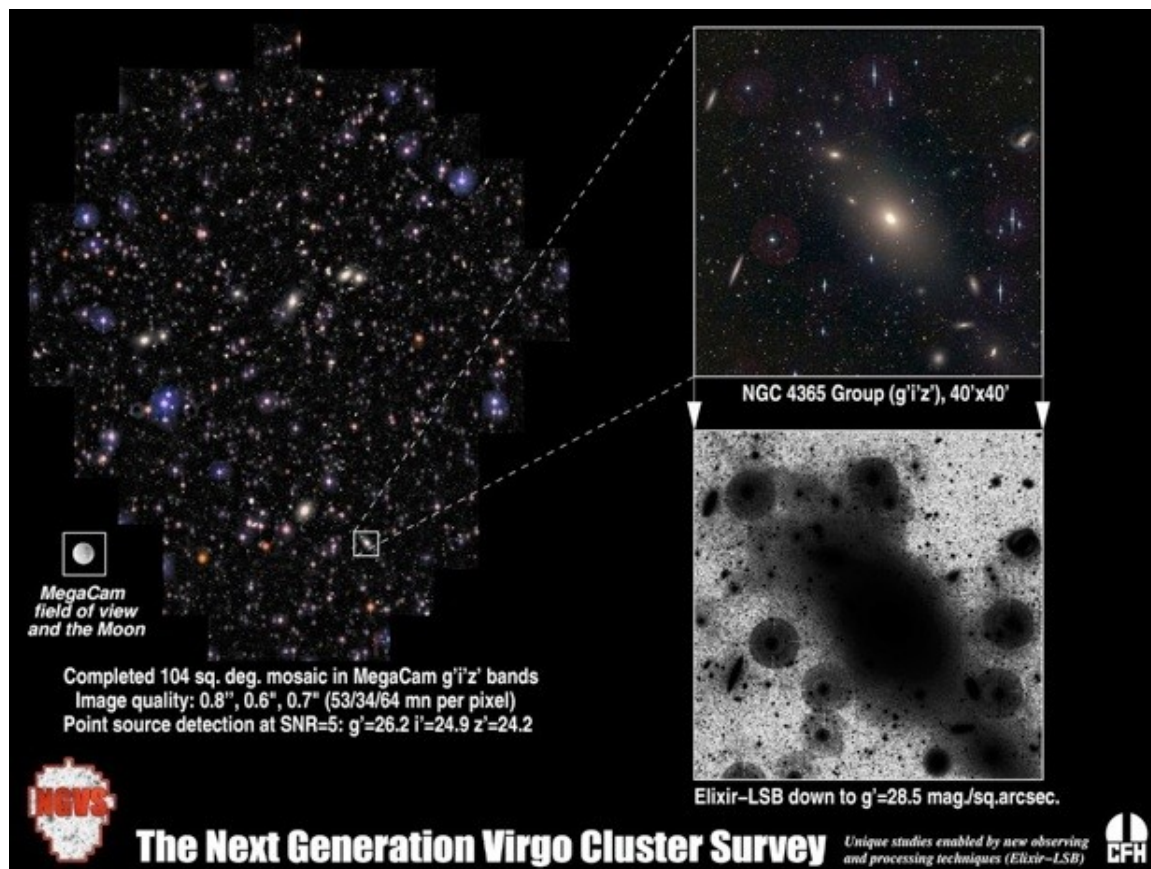
- Dwarfs

[Toloba (in prep.)]

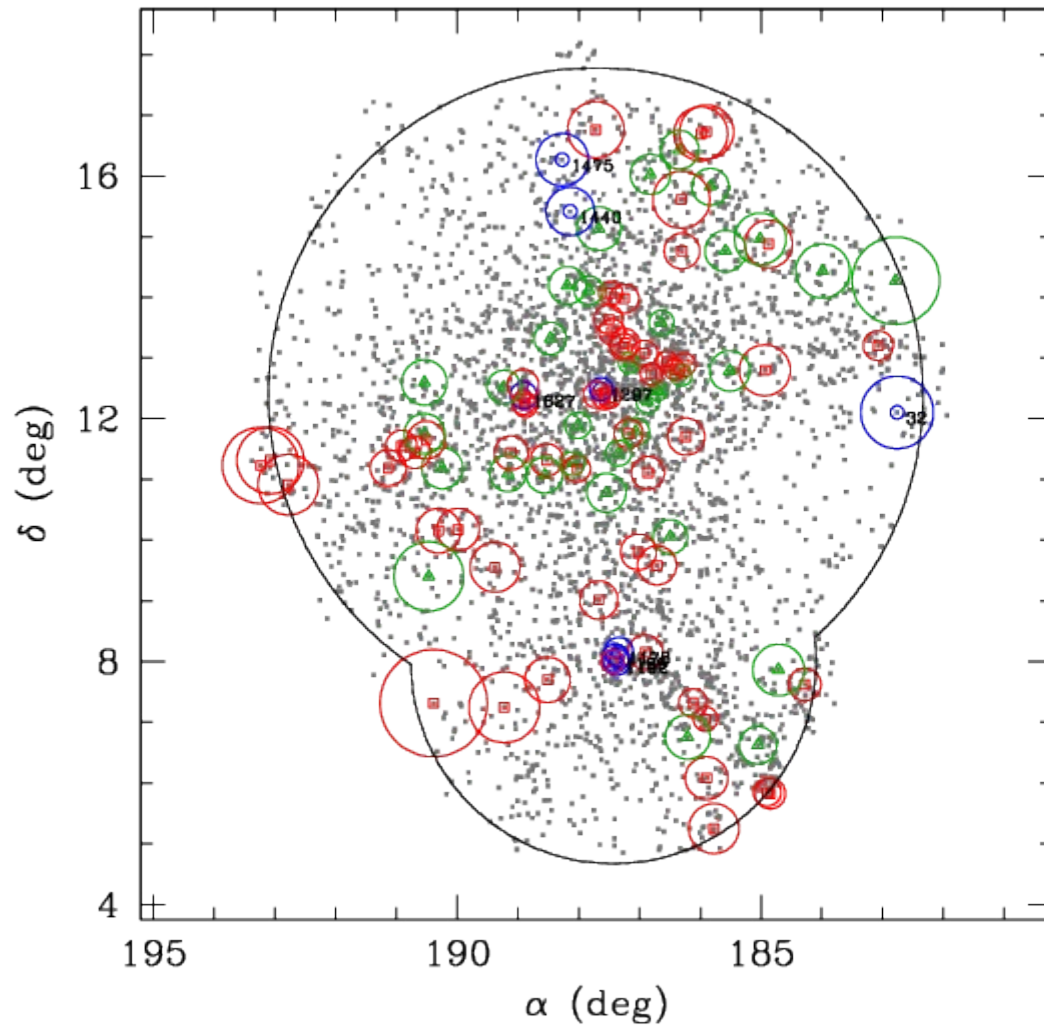
[Guerou et al. 2015
(NGVS XII, accepted in ApJ)
arXiv 1231463, yesterday]

Photometry

Probing environment



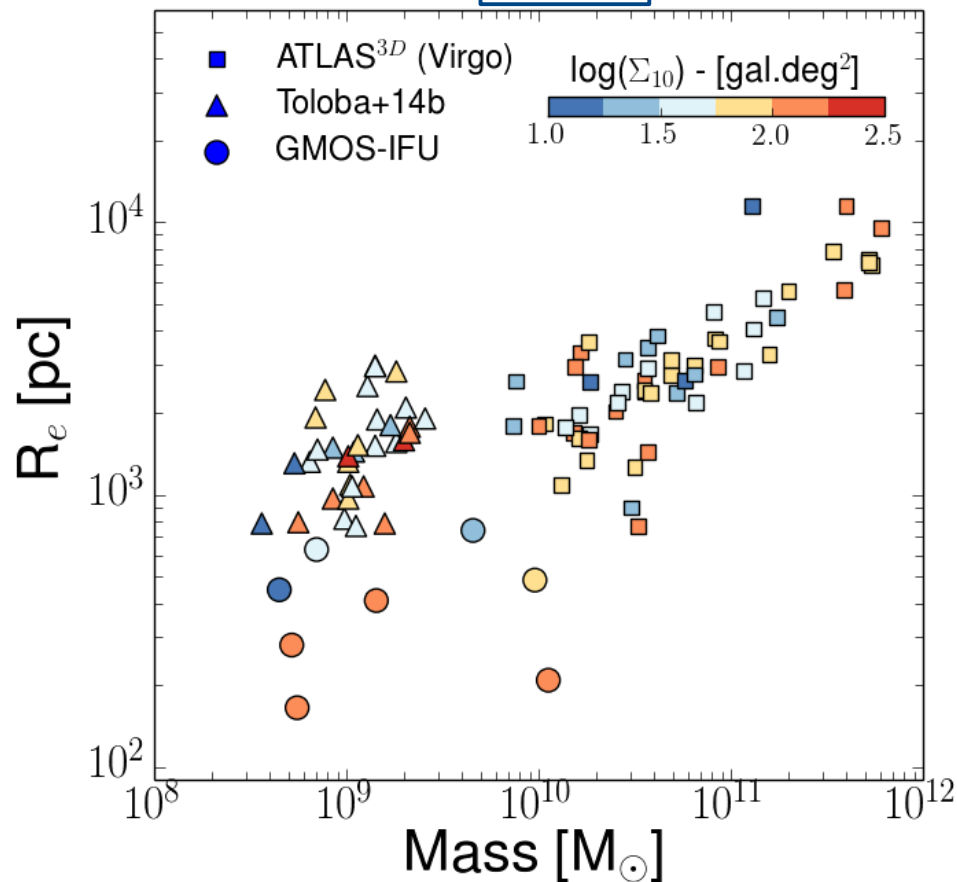
Probing the environment with NGVS



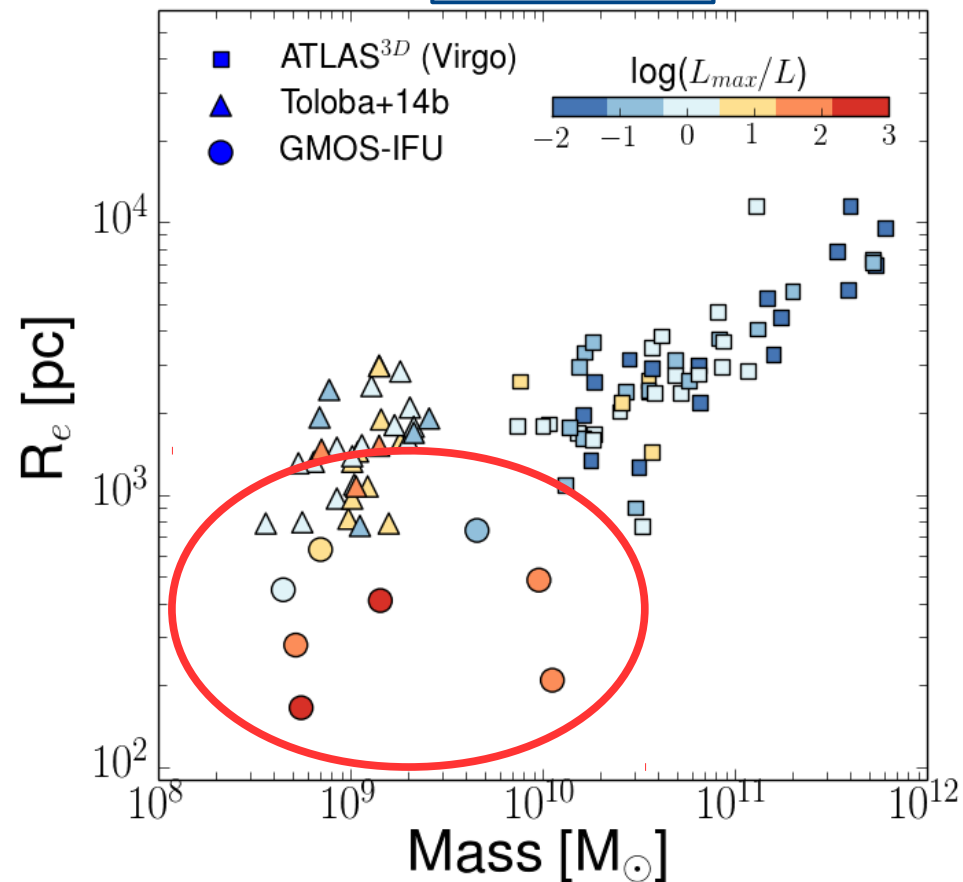
- $\Sigma_{10} = L_{\text{tot}}(R_{10}) / L_{\text{gal}}$
“Relative luminosity density”
- $L_{\text{max}} / L = L_{\text{max}}(R_{10}) / L_{\text{gal}}$
“Most luminous companion”

Probing the environment with NGVS

Σ_{10}



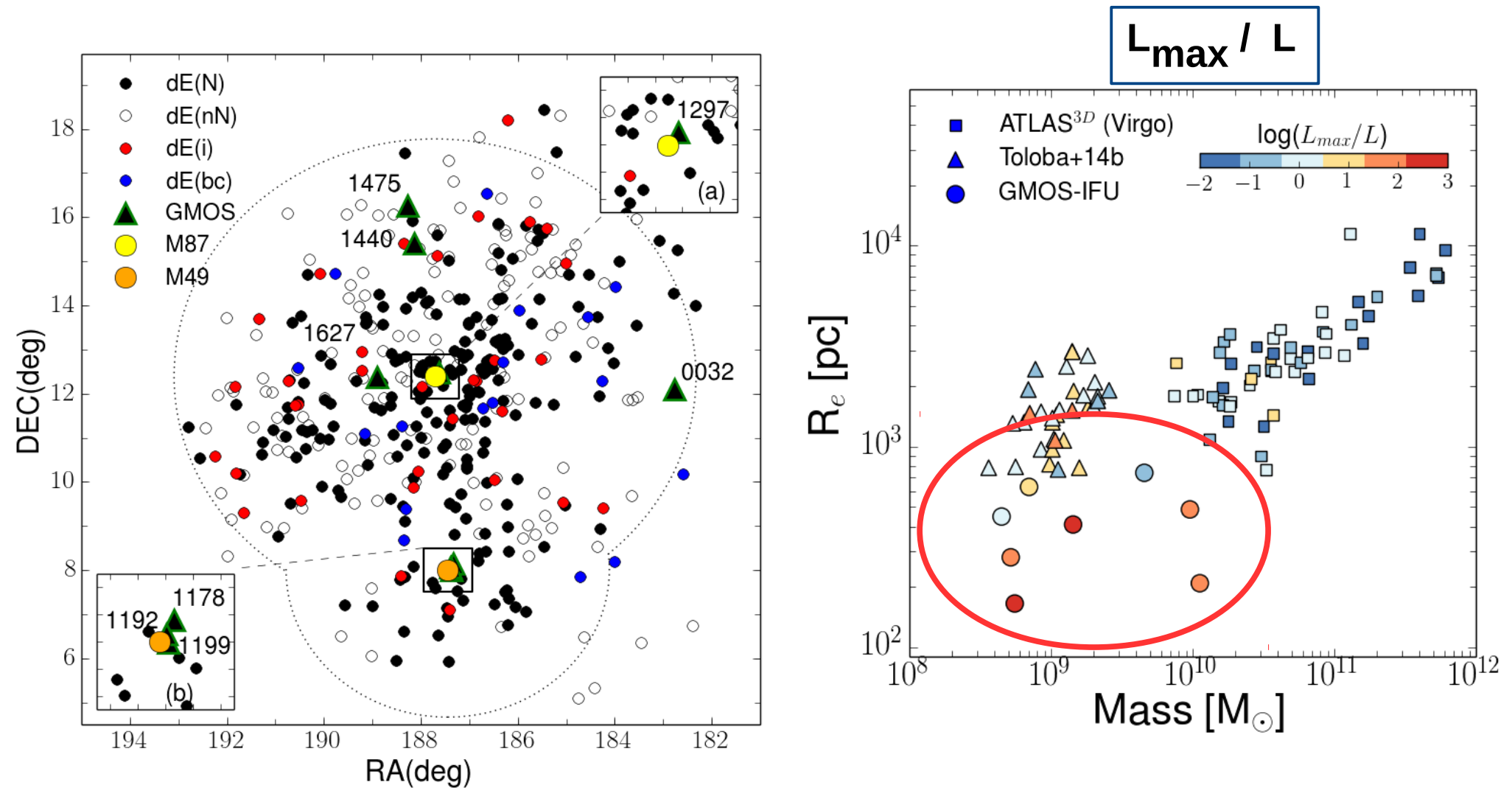
L_{max} / L



COMPACT : CLOSE TO MASSIVE GALAXIES

Guérou et al., 2015, ApJ
arXiv 1504.03714

Probing the environment with NGVS

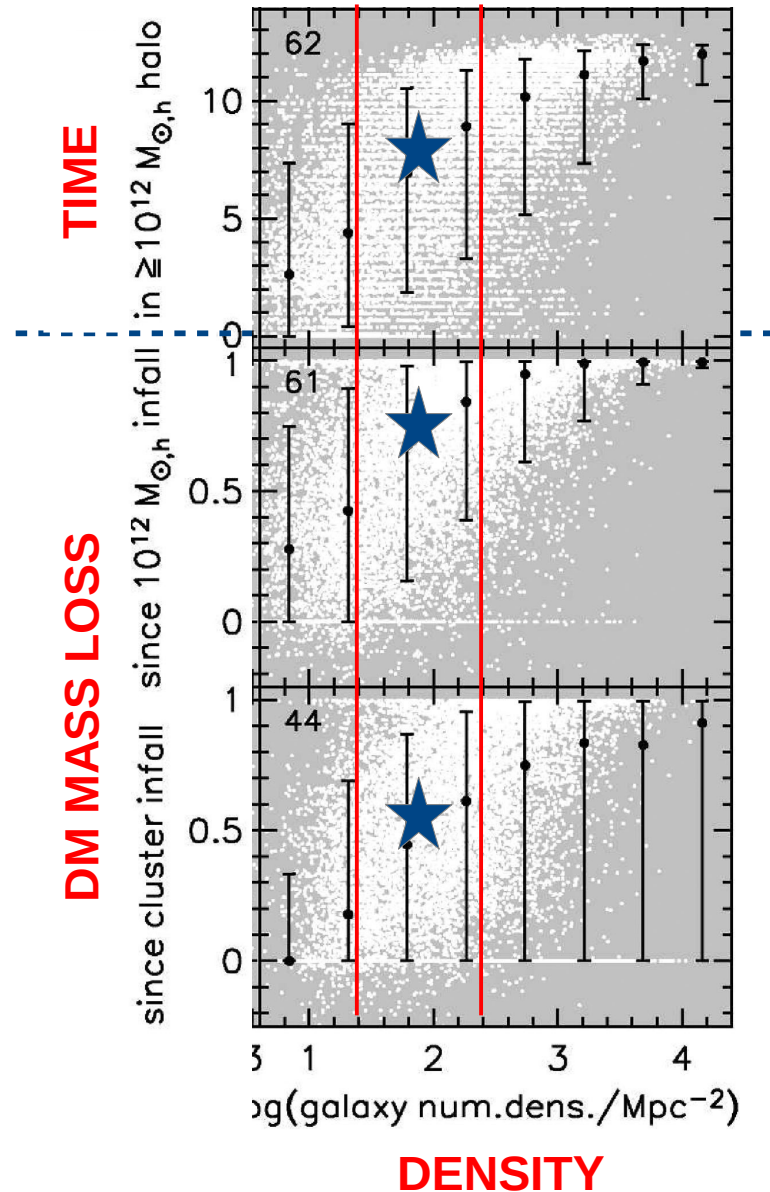


COMPACT : CLOSE TO MASSIVE GALAXIES

Guérou et al., 2015, ApJ
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Cluster environment from simulations

(Adapted from *Lisker et al., 2013*)



⇒ ~ **7 Gyr** spent in $M > 10^{12} M_{\odot}$

⇒ ~ **80%** of DM mass loss

COMPACT galaxies ~ 9 Gyr old

**Strong environmental
influence**

(companions, pair, cluster)

Conclusions

- **2D kinematics and stellar populations of 8 compact, low-mass ETGs in the Virgo Cluster ($10^8 - 10^{10} M_{\odot}$, 200 – 700 pc)**
- **Trend for a continuity of the stellar populations in the mass-size plane with massive ETGs**
- **Strong influence and variation of the environment (pairs, group, cluster)**