



The dwarf galaxy content of present-day clusters: semi-analytic models vs. reality

Thorsten Lisker



Zentrum für Astronomie der Universität Heidelberg
Heidelberg Graduate School of Fundamental Physics

29.06.2011, Garching, “Fornax, Virgo, Coma et al.”



The dwarf galaxy content of present-day clusters: semi-analytic models vs. reality

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Simone Weinmann (Leiden)

Qi Guo (Beijing/Durham)

Hagen T. Meyer (Heidelberg)

Joachim Janz (Oulu/Heidelberg)

Weinmann, Lisker et al.
arXiv:1105.0674
2011 MNRAS in press



The dwarf galaxy content of present-day clusters: semi-analytic models vs. reality

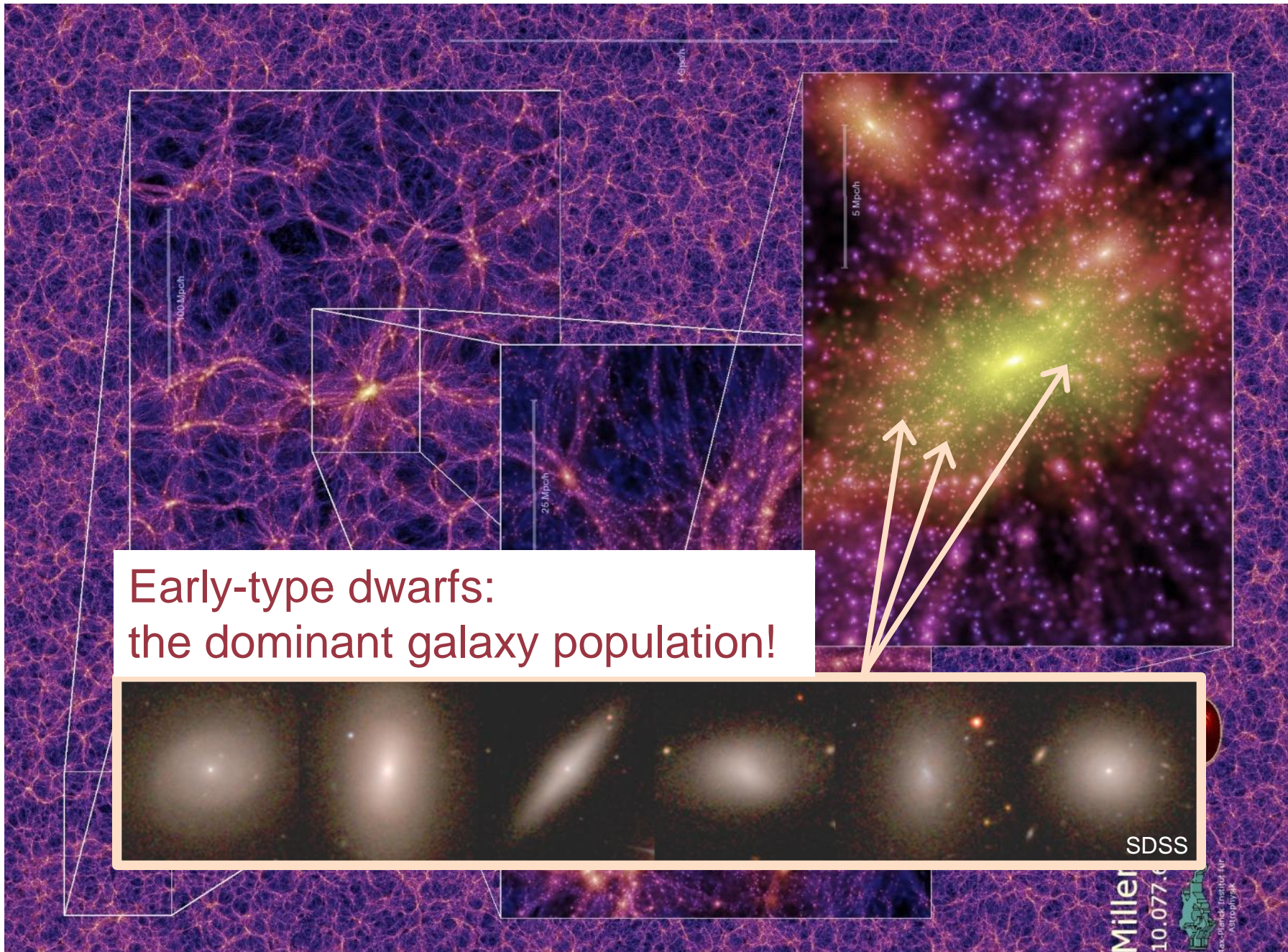
Thorsten Lisker



Hagen
Meyer

Sanjaya
Paudel

Stefan
Lieder



Early-type dwarfs:
the dominant galaxy population!

V. Springel
et al.

- Here we focus on luminosities of 10^8 to few times $10^9 L_{\odot}$
i.e. „bright dwarfs“

(At lower luminosity, observational samples are incomplete and simulations don't have the resolution)



- Fainter dwarfs: *Lieder, Lisker et al. 2011 (A&A subm.)*
~70 new dSphs in the Virgo core **PREVIOUS TALK**



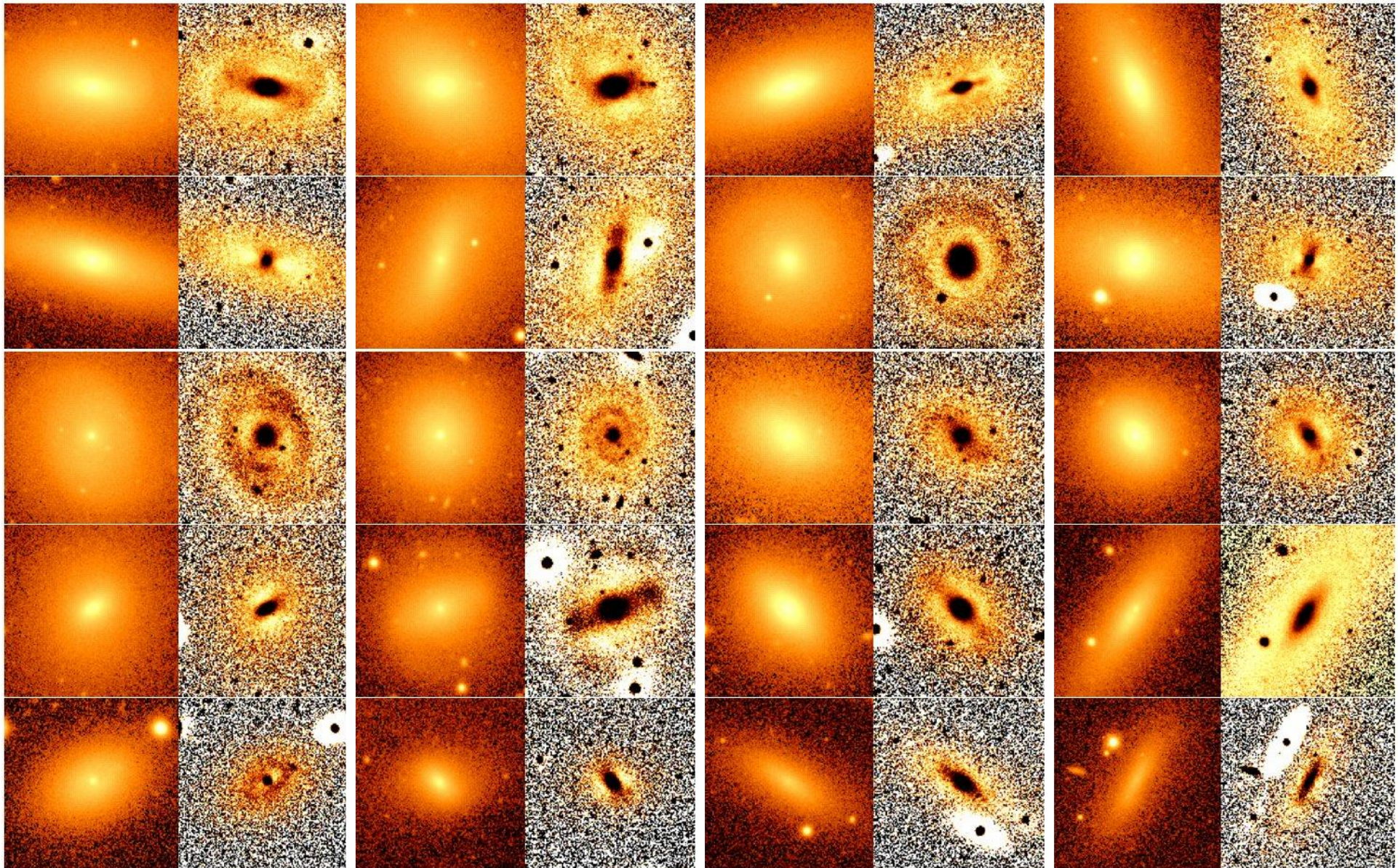
Stefan Lieder

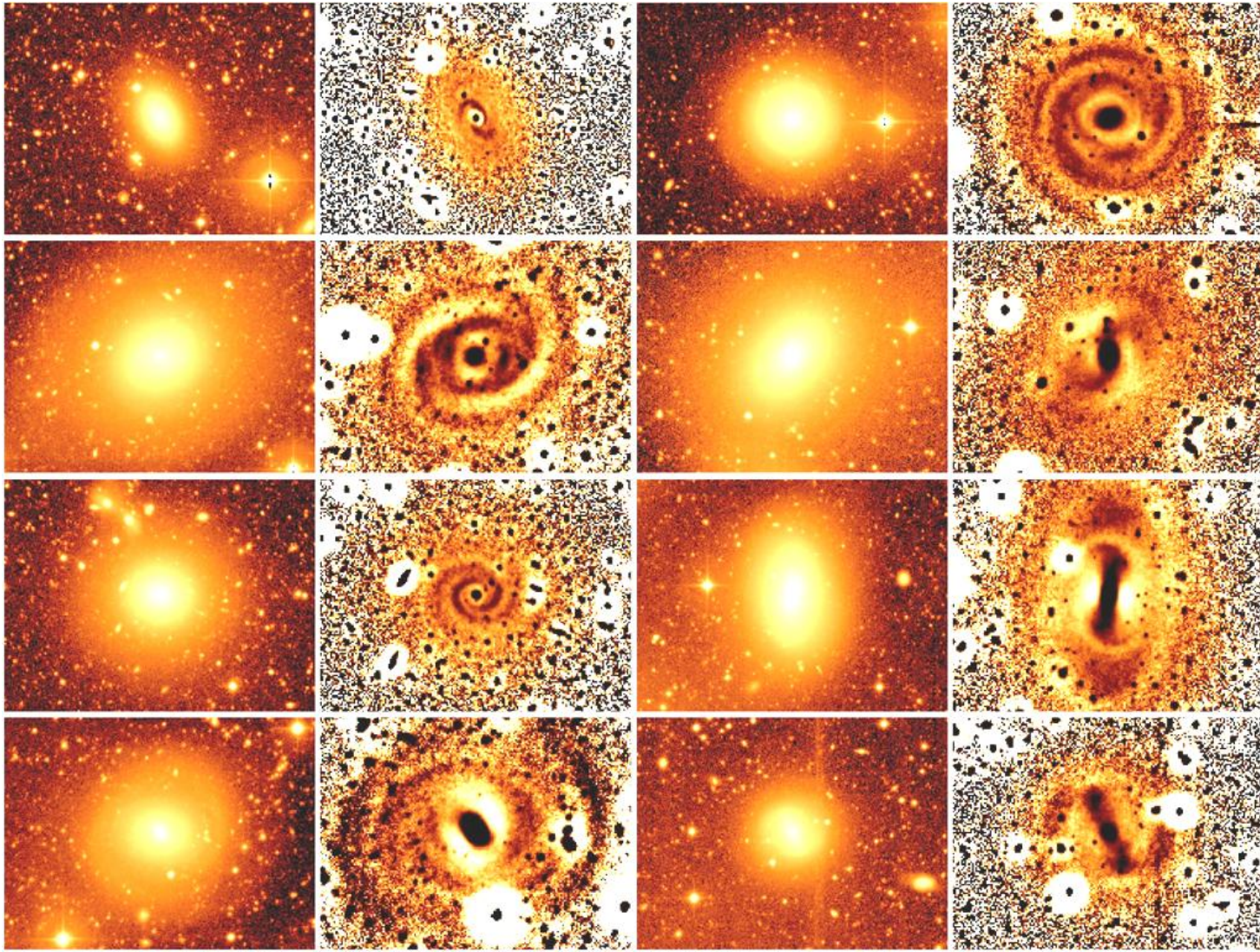
Normal
image ↓

Unsharp
↓ mask

Virgo cluster

Lisker et al. 2006a





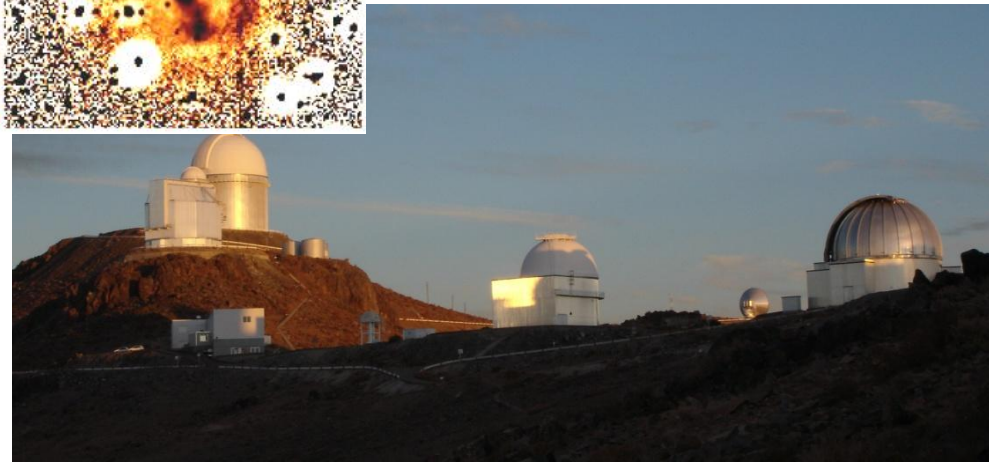
Lisker et al. in prep.

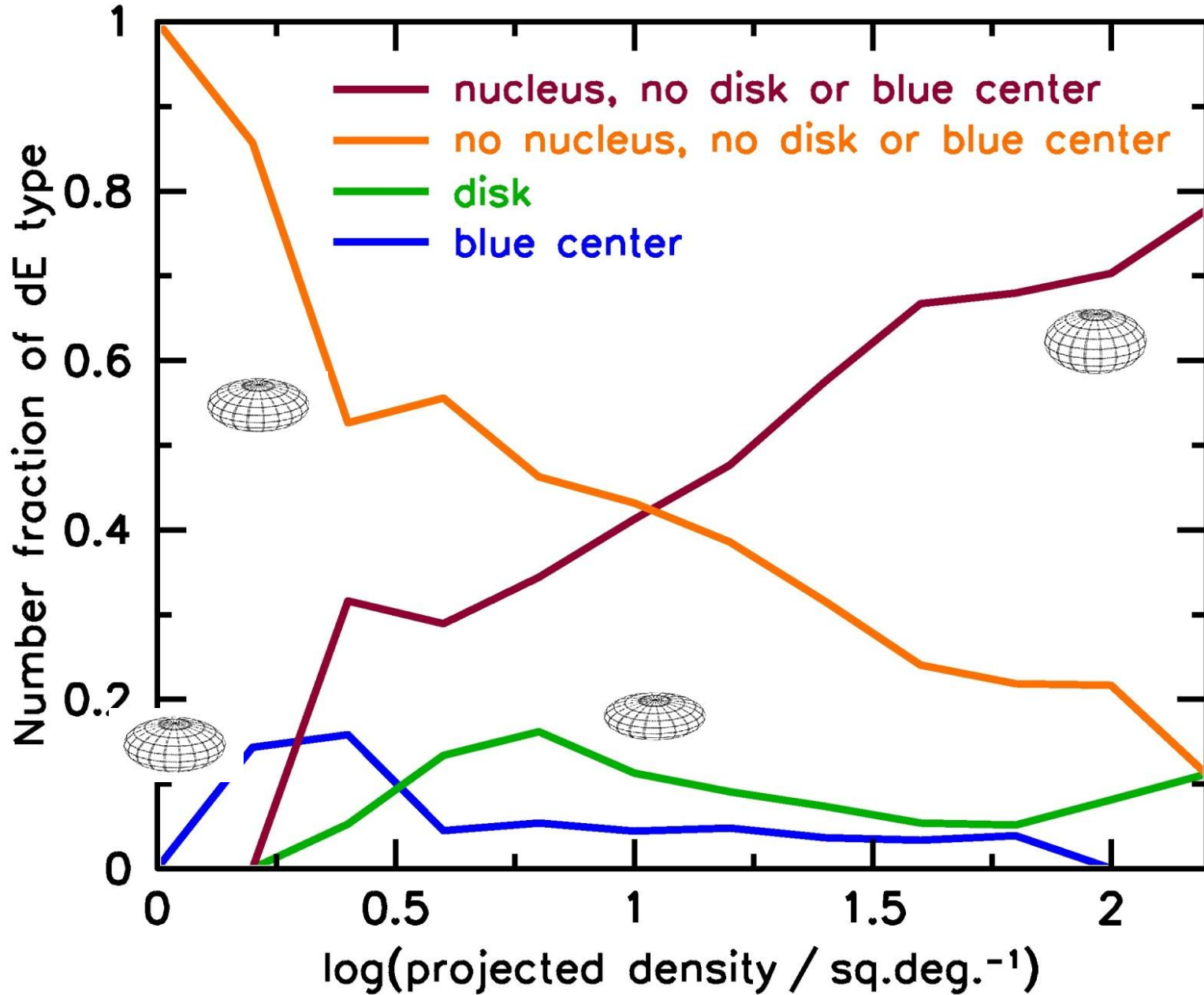
Virgo cluster

ESO 2.2m/WFI

Image

Unsharp
mask



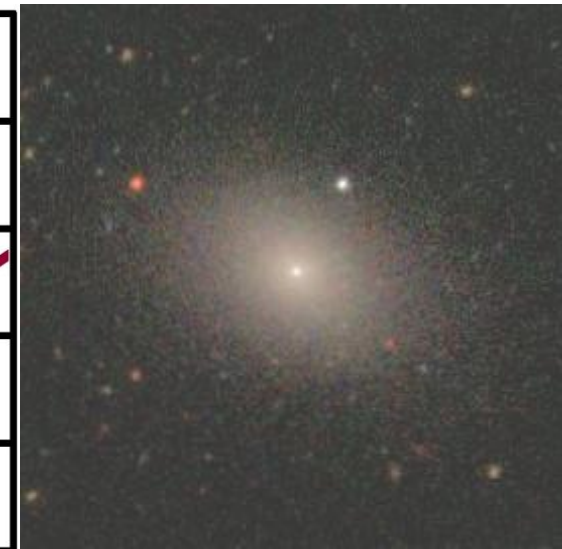
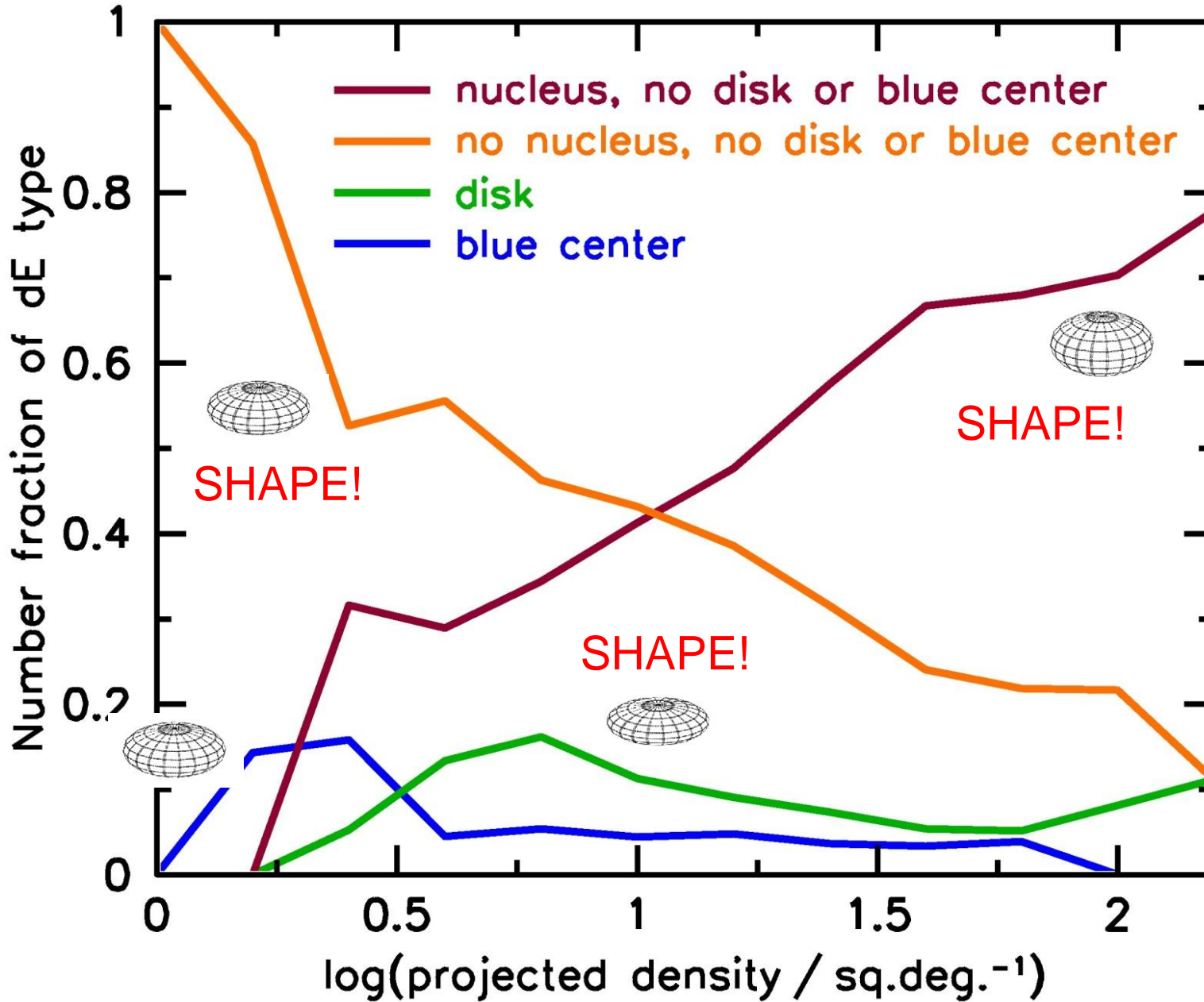


Virgo cluster

Lisker et al. 2007

Lisker 2009

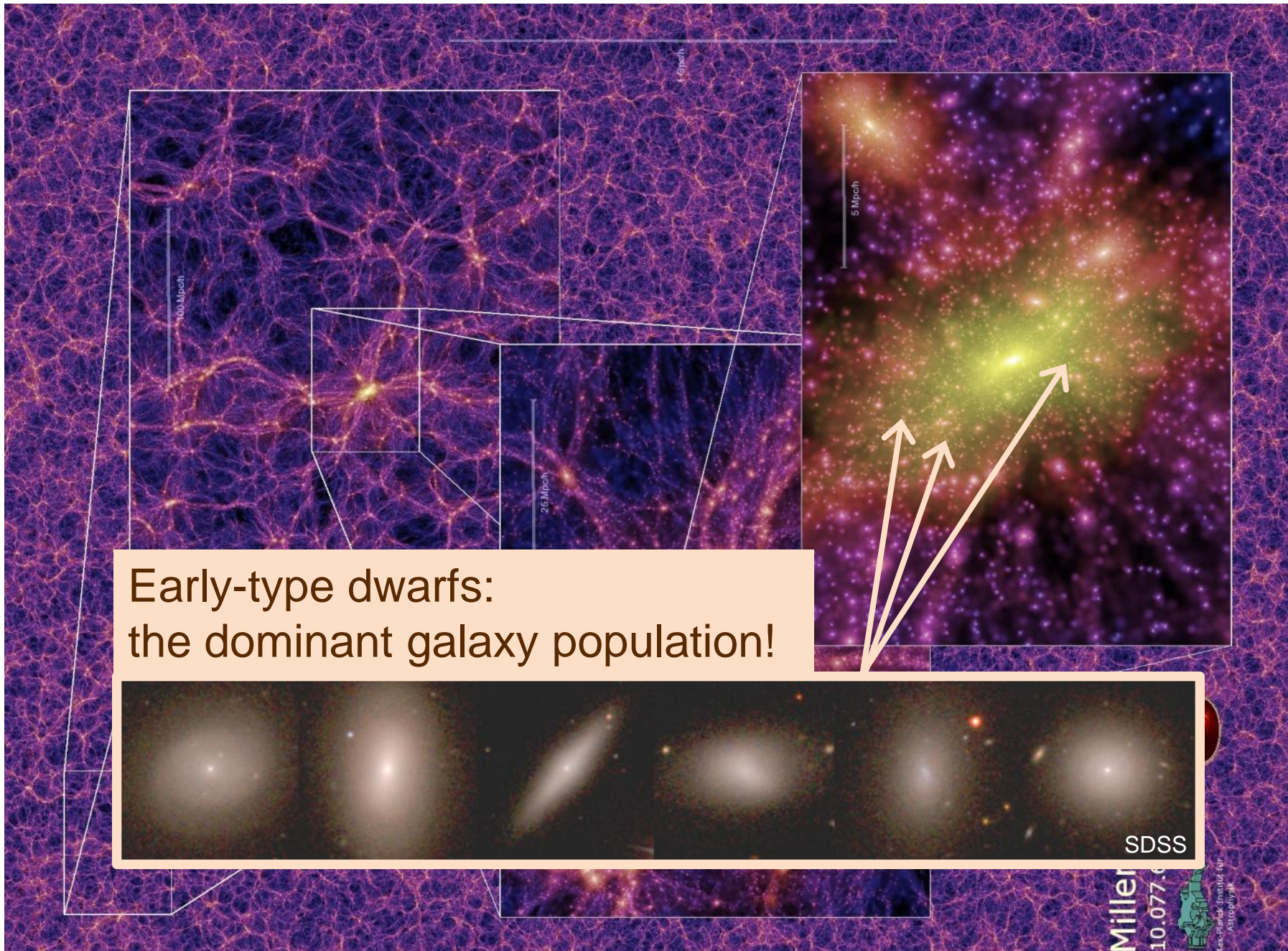
Morphology-density relation *within* this galaxy class!



Virgo cluster

Lisker et al. 2007

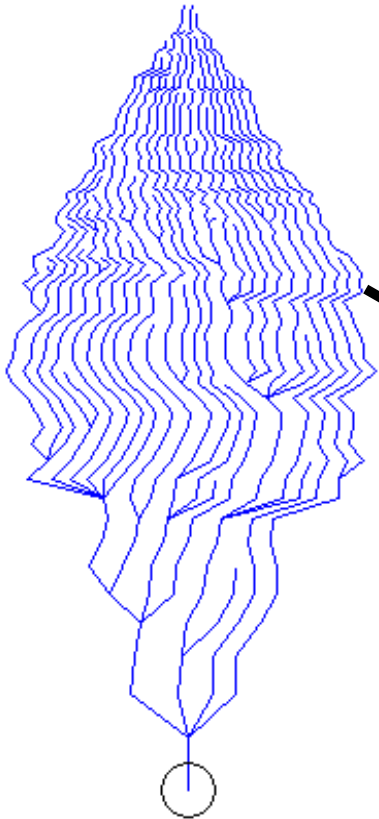
Lisker 2009



Early-type dwarfs:
the dominant galaxy population!

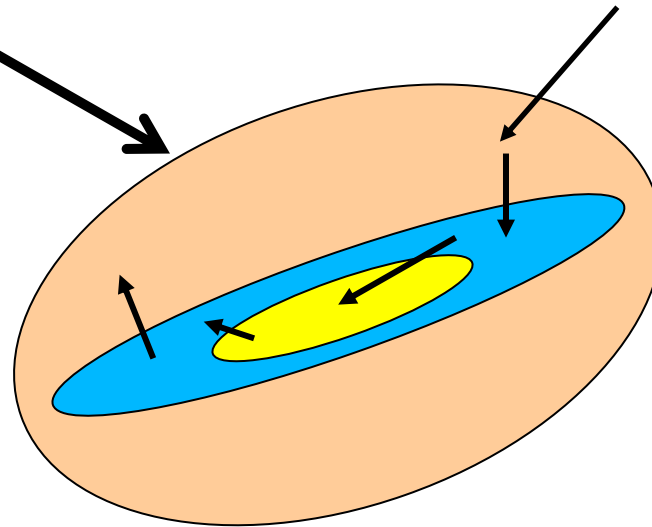
DM merger trees:

time



Galaxies:

- Stars
- Cold Gas
- Hot Gas
- ...

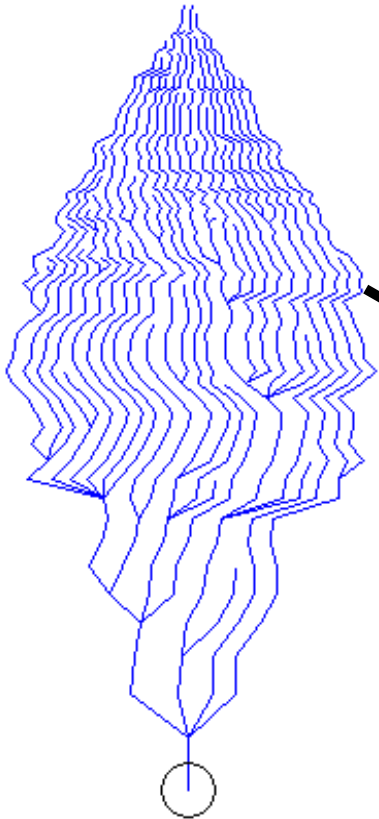


Physical processes:

- Accretion
- Cooling
- Star Formation
- SN feedback
- mergers
- treatment of satellites
- ...

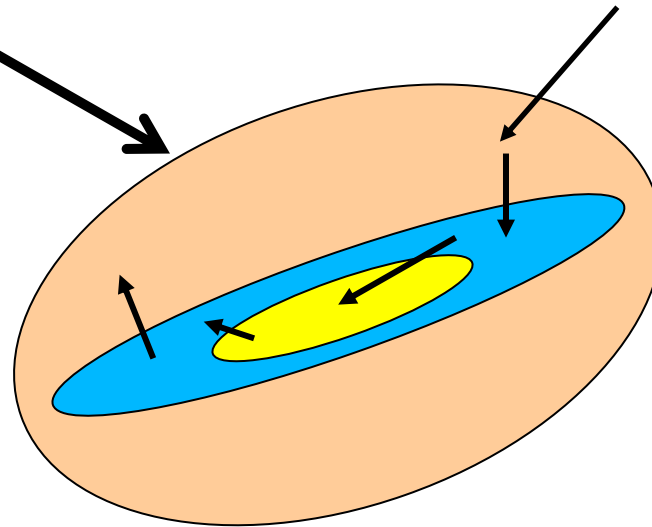
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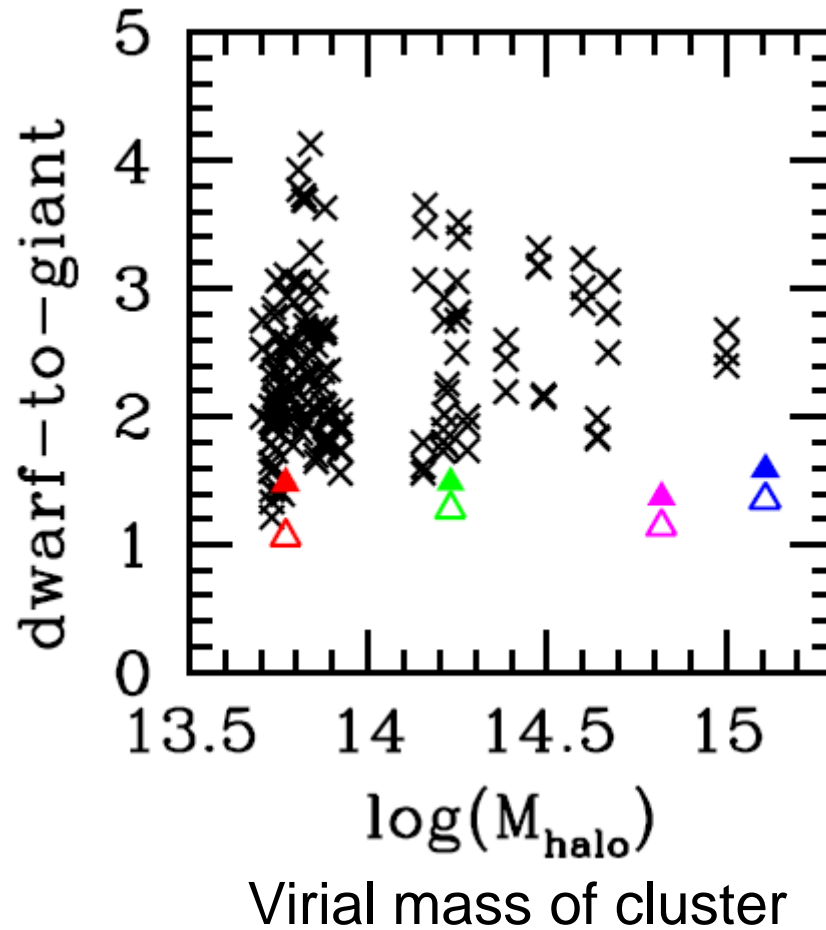
Physical processes:

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- mergers
- treatment of satellites
- ...

Guo et al. 2011:

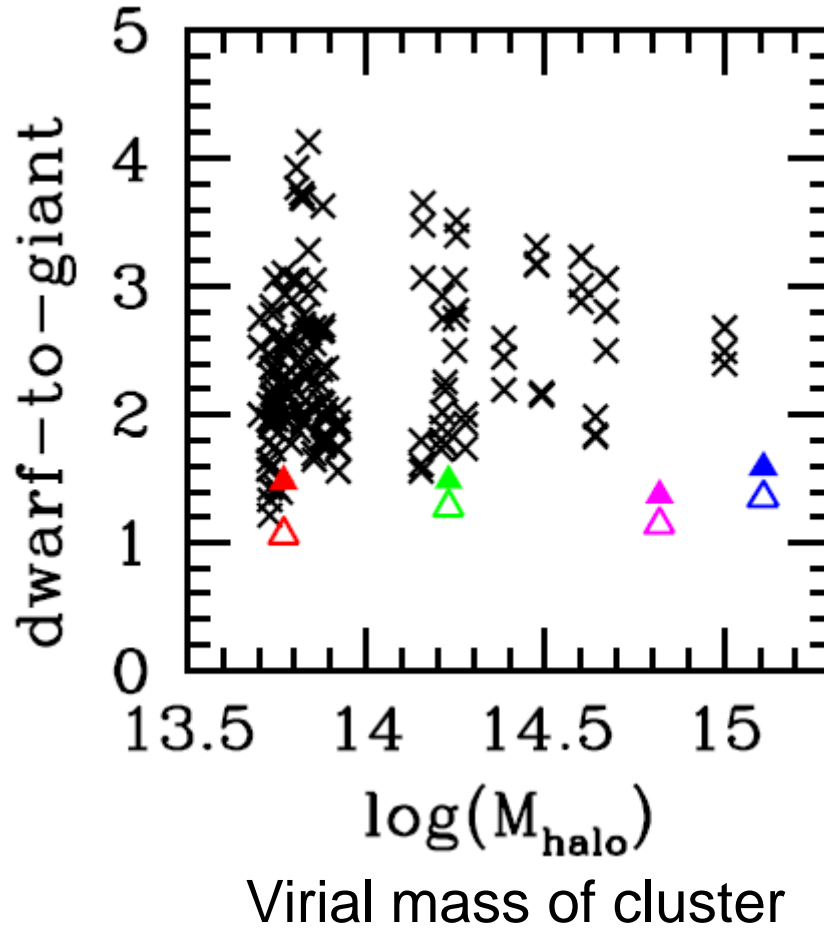
- First SAM based on Millennium-II simulation: particle mass $9.45 \cdot 10^6 M_{\odot}$
- Improved treatment of: disk sizes, bulge sizes, environmental effects...

MODEL CLUSTERS VS. REAL CLUSTERS: THE DWARF GALAXY CONTENT OF VIRGO, FORNAX, COMA, PERSEUS



Fornax Virgo Perseus Coma Model clusters (3 projections)

Giants / Dwarfs: Separated at $M_r = -19$ mag



Issue #1:
**Too many dwarfs
per giant
in the model**

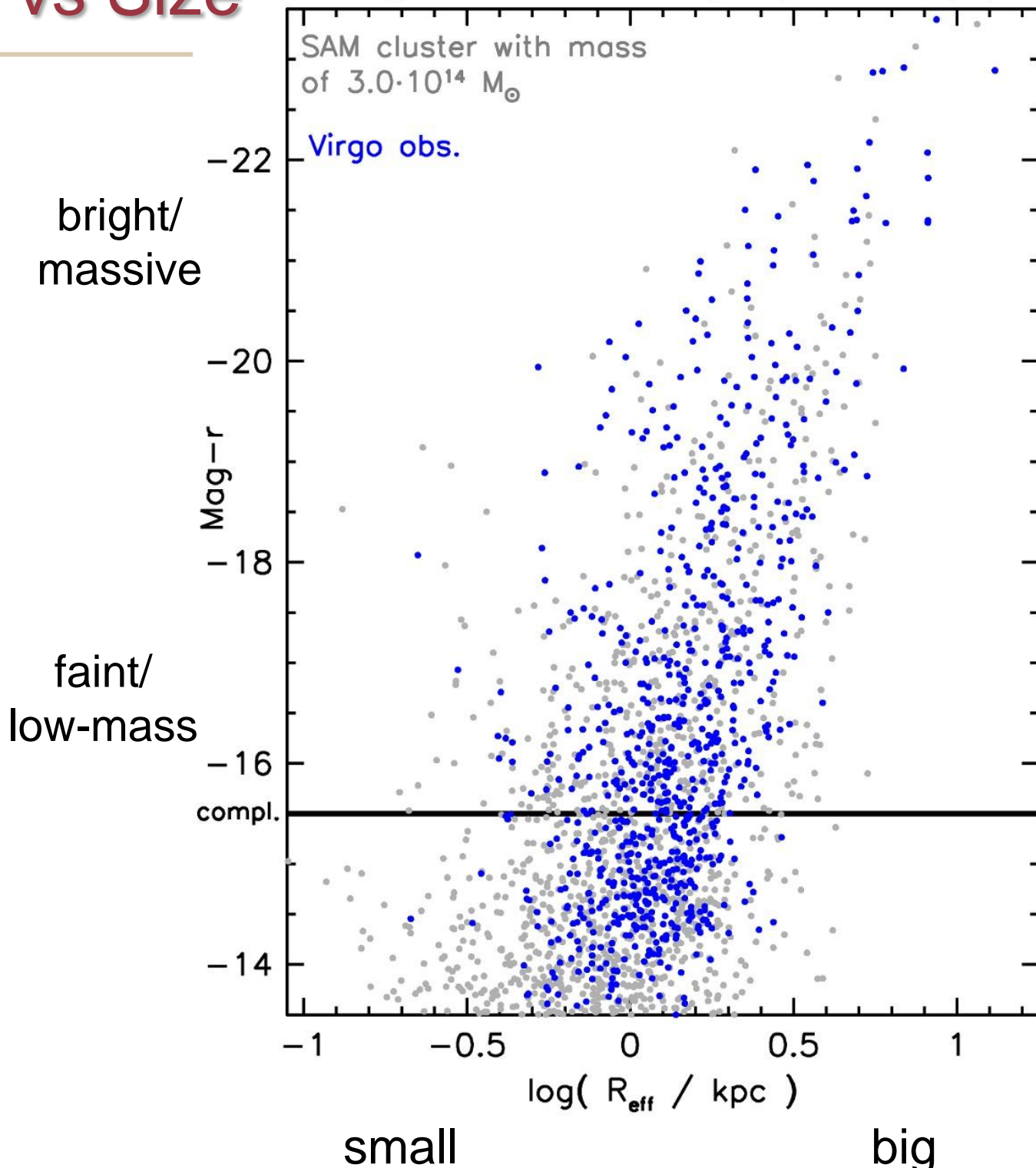
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Luminosity vs Size

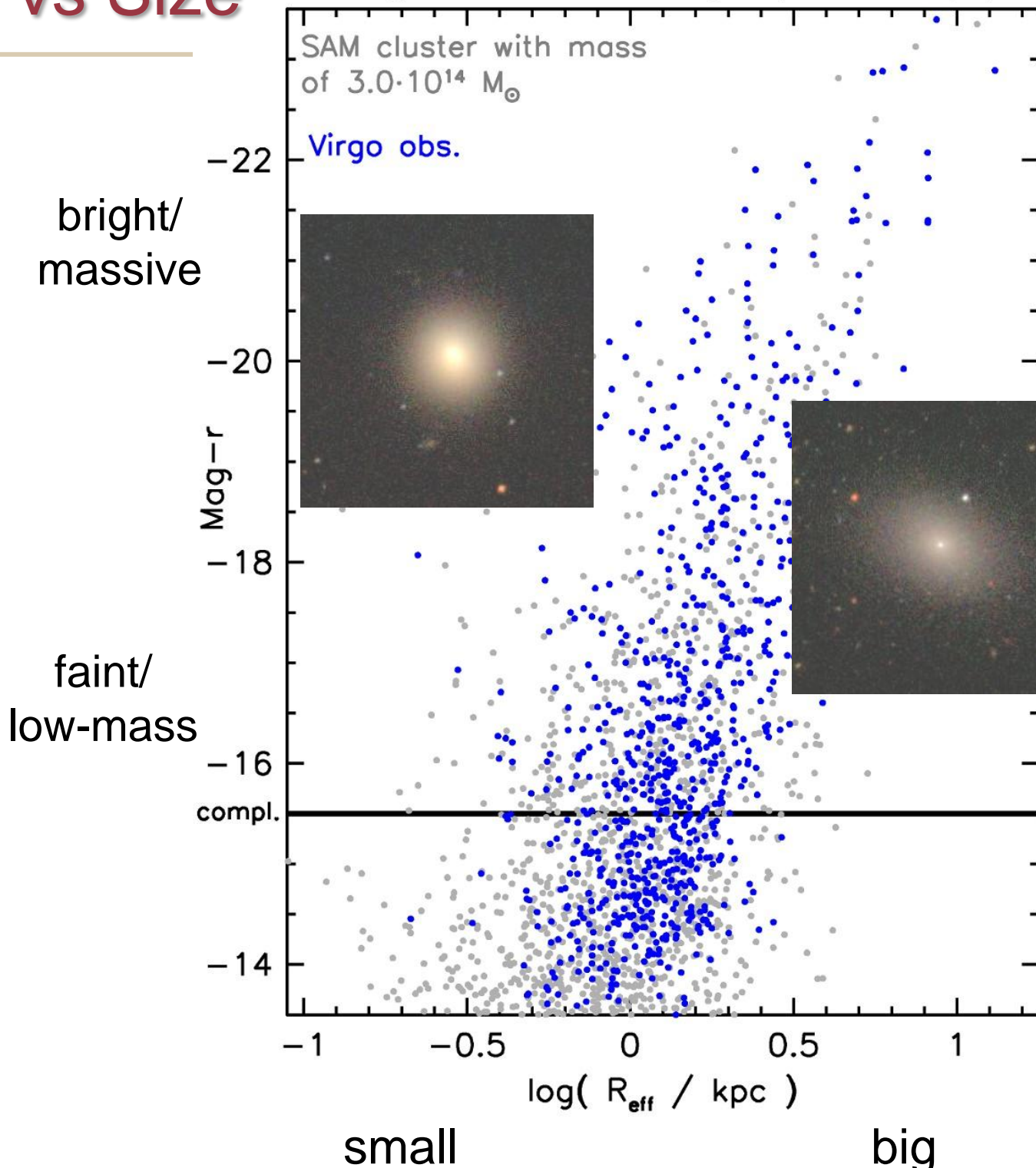
Half-light radii SAM vs Virgo ($d < 1.55$ Mpc)





Luminosity vs Size

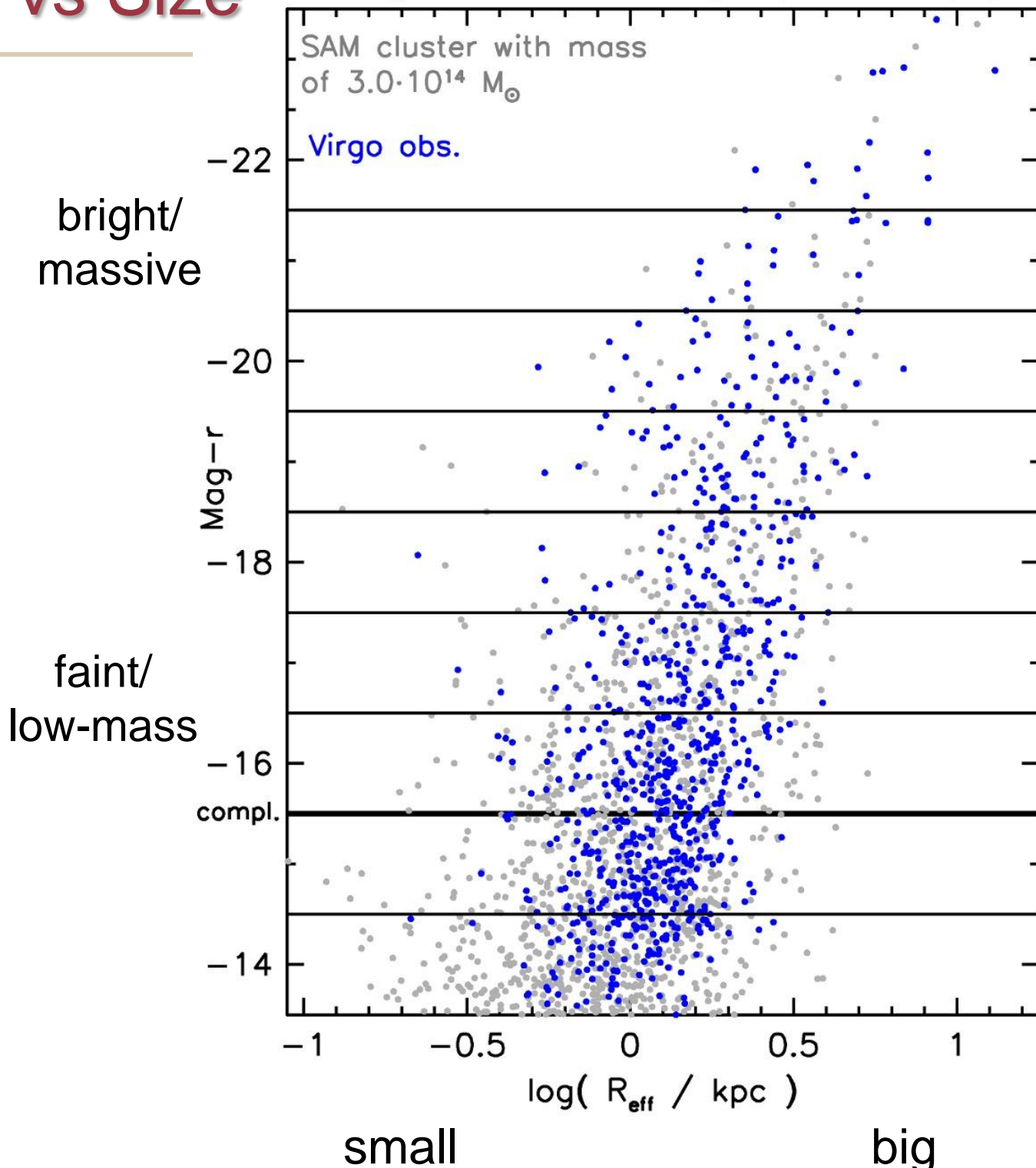
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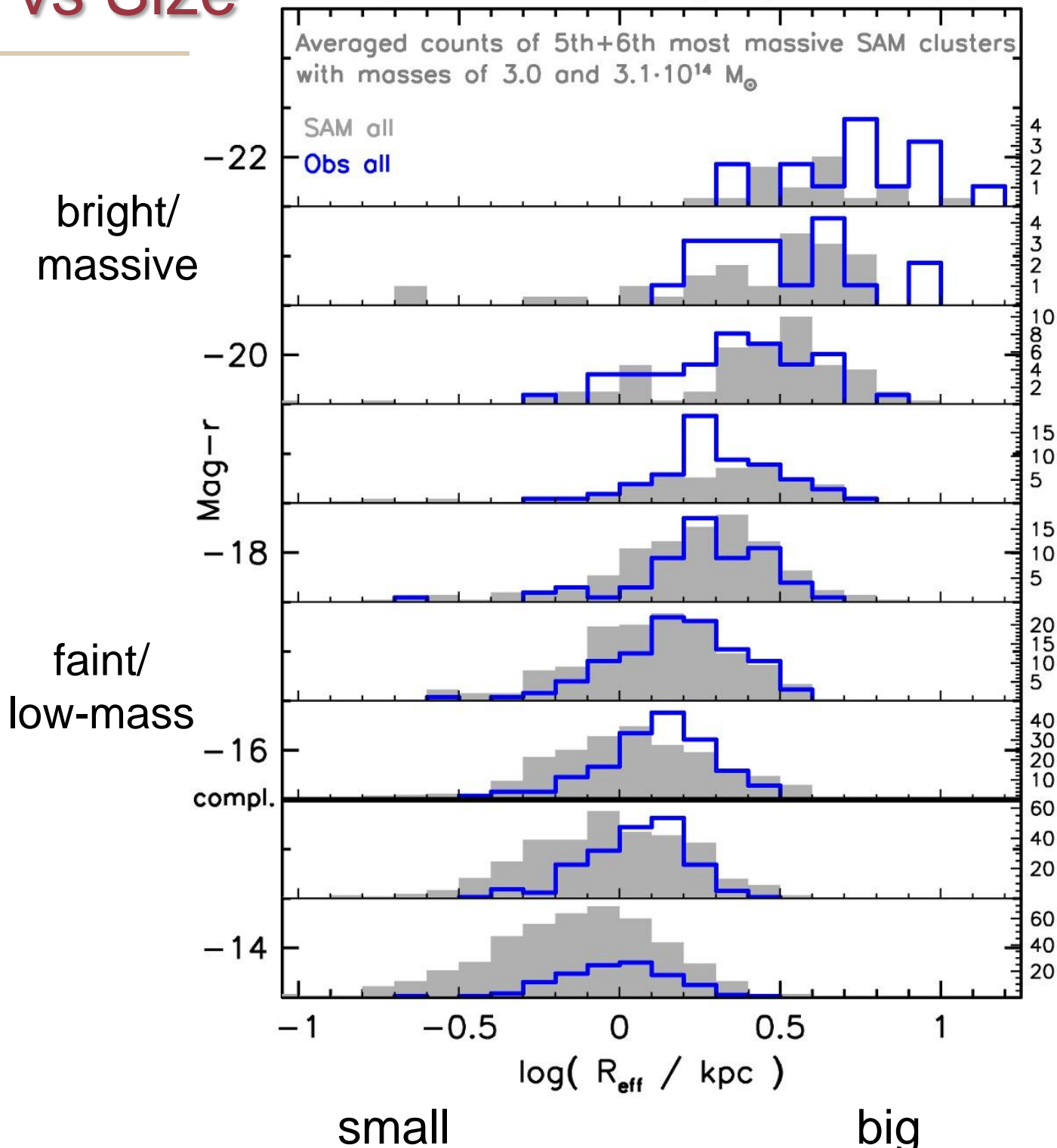
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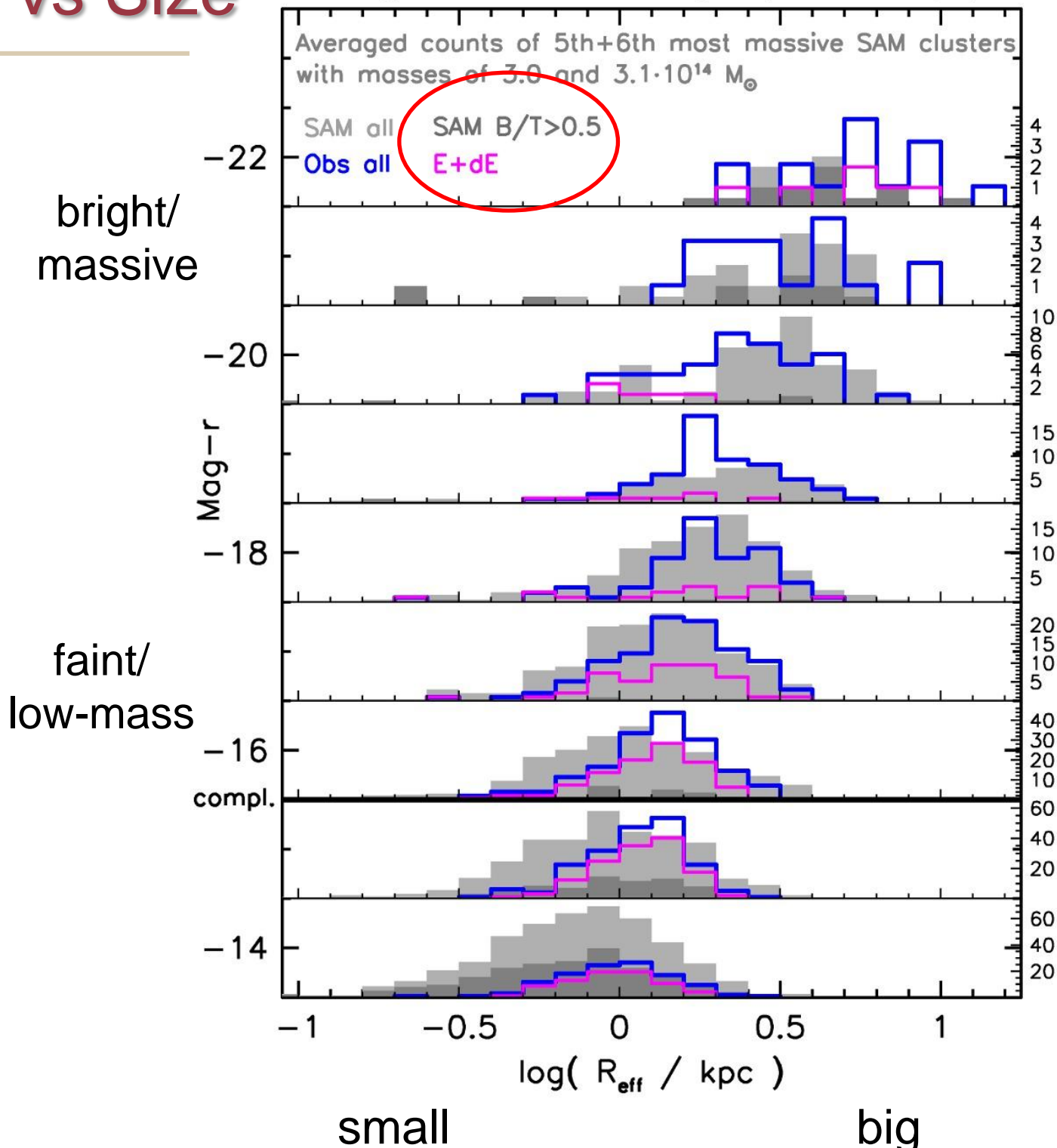
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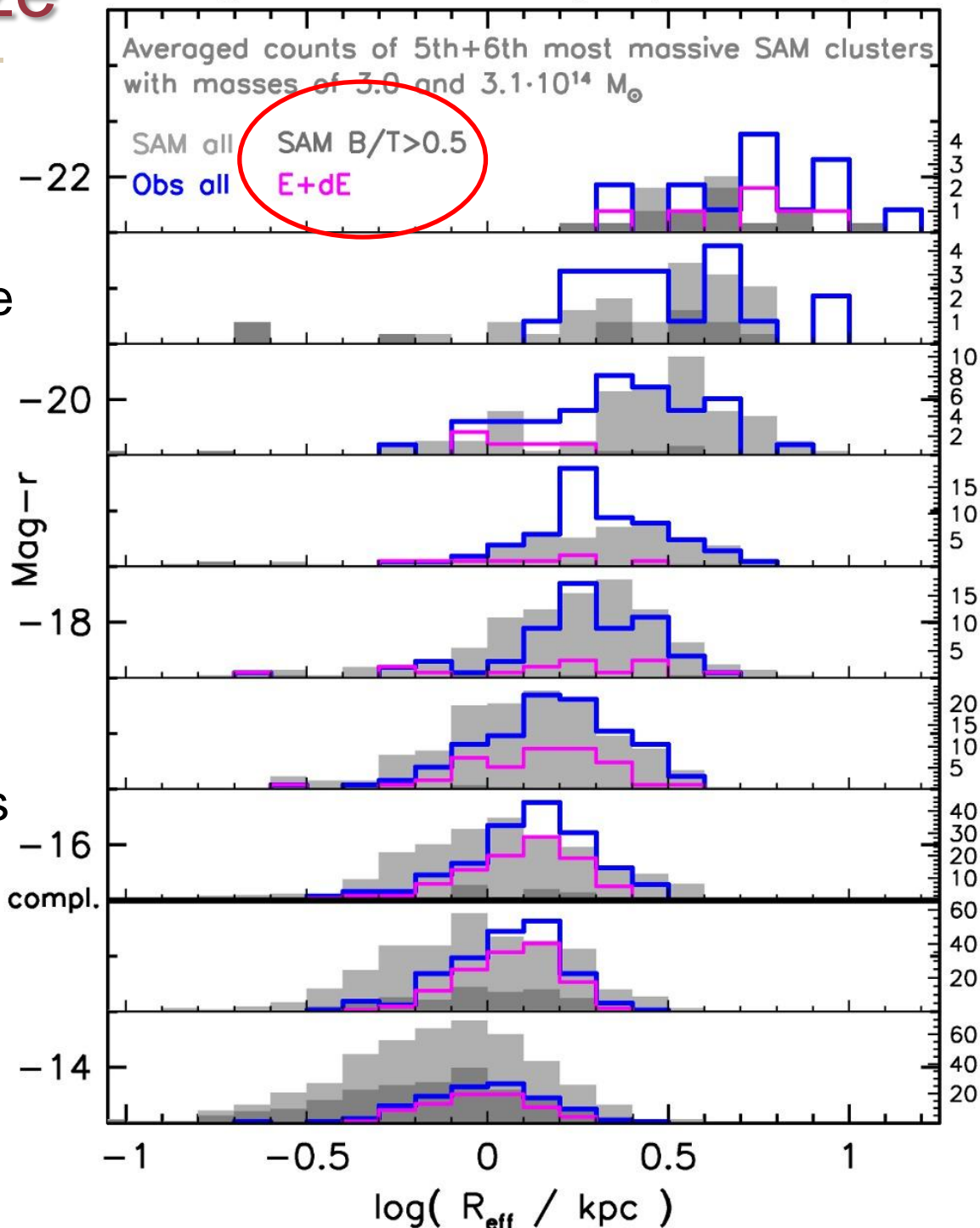
Half-light radii SAM vs Virgo (d < 1.55 Mpc)

Issue #2

Model dwarfs are disks, most real dwarfs look elliptical

bright/
massive

faint/
low-mass



small

big



Luminosity vs Size

Half-light radii SAM vs Virgo (d < 1.55 Mpc)

Issue #2

Model dwarfs are disks, most real dwarfs look elliptical

Spheroidal appearance of dwarfs

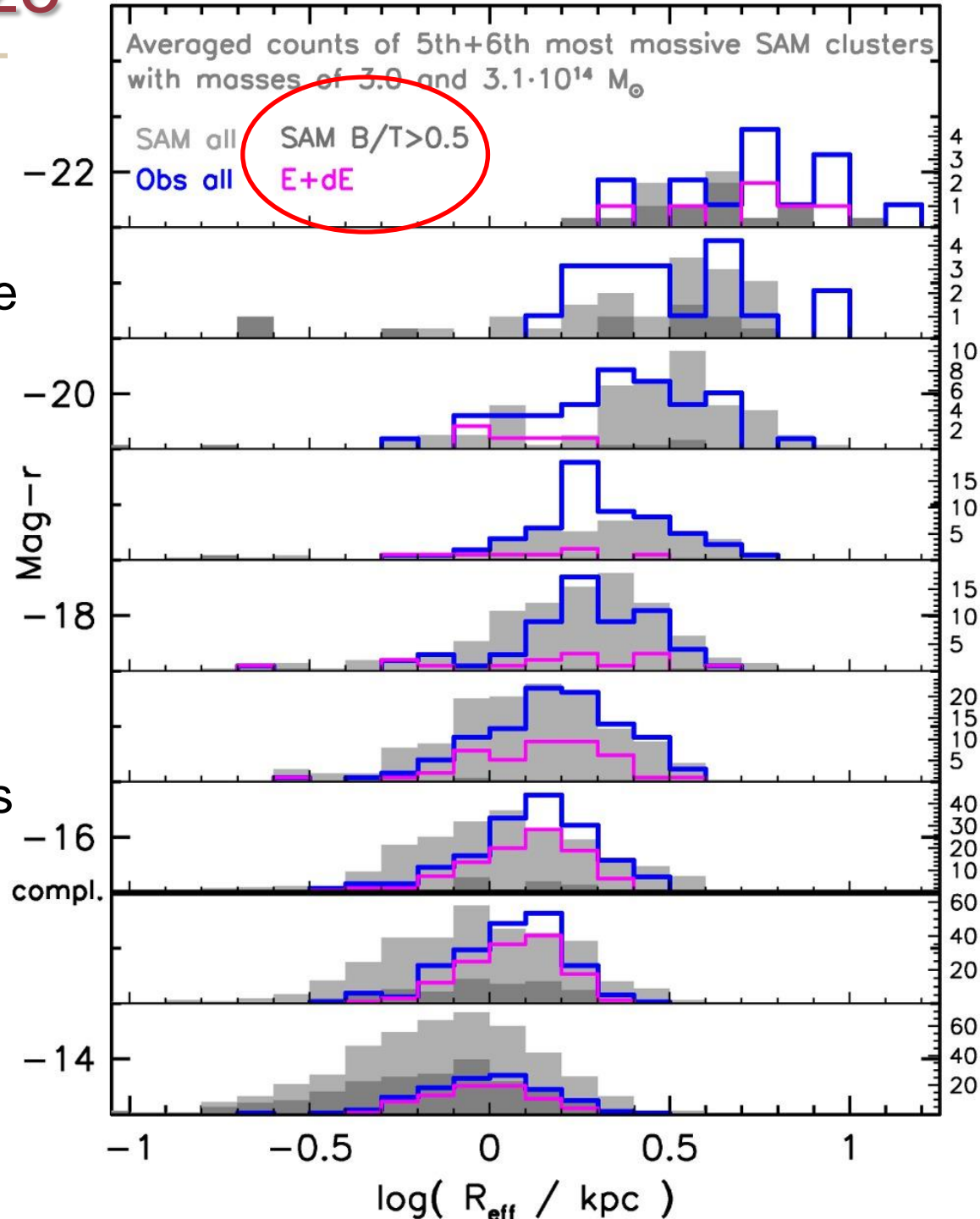
does not mean that they have/are classical bulges in the model-sense!

WE NEED MORE KINEMATICS!!

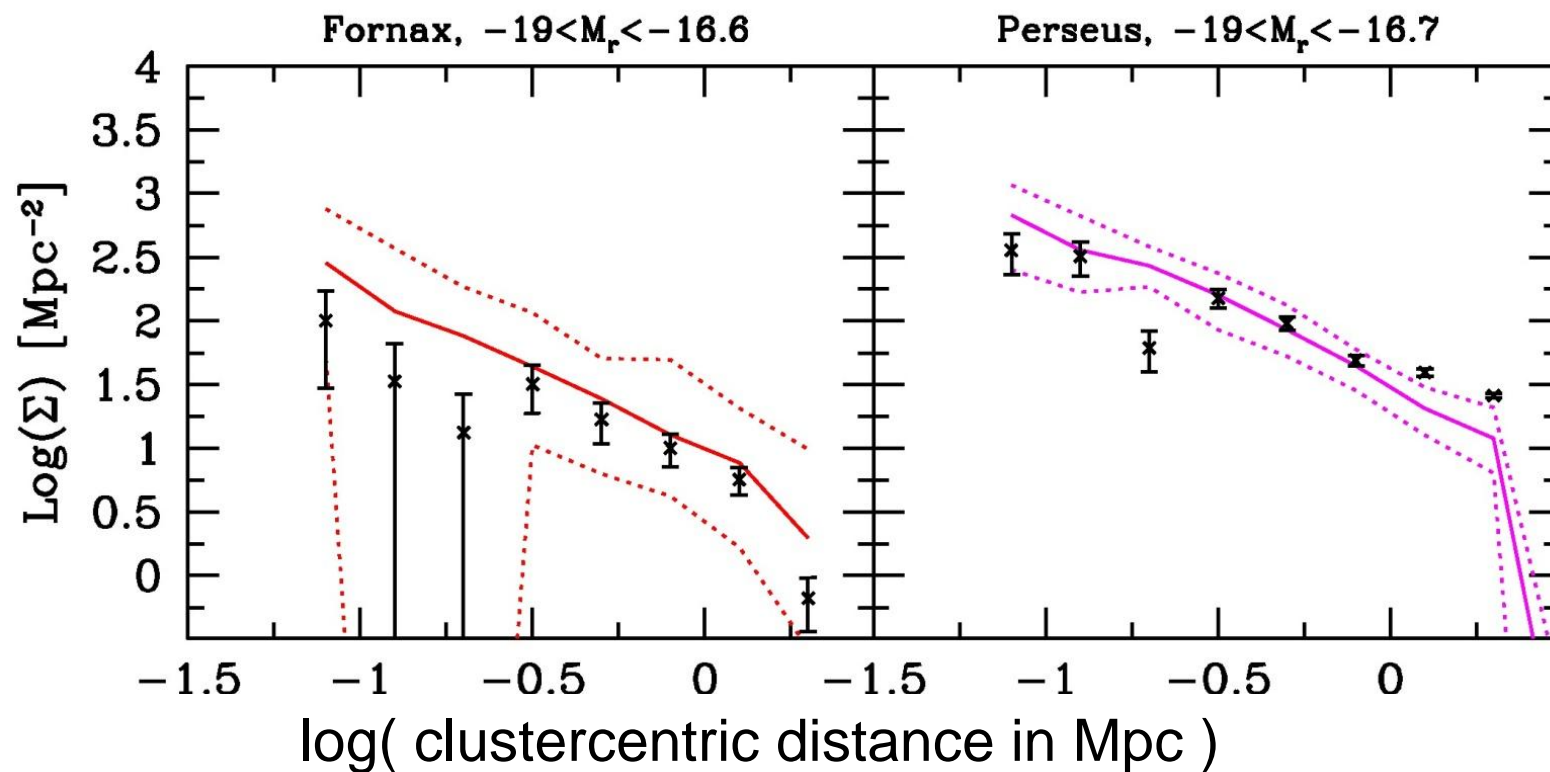
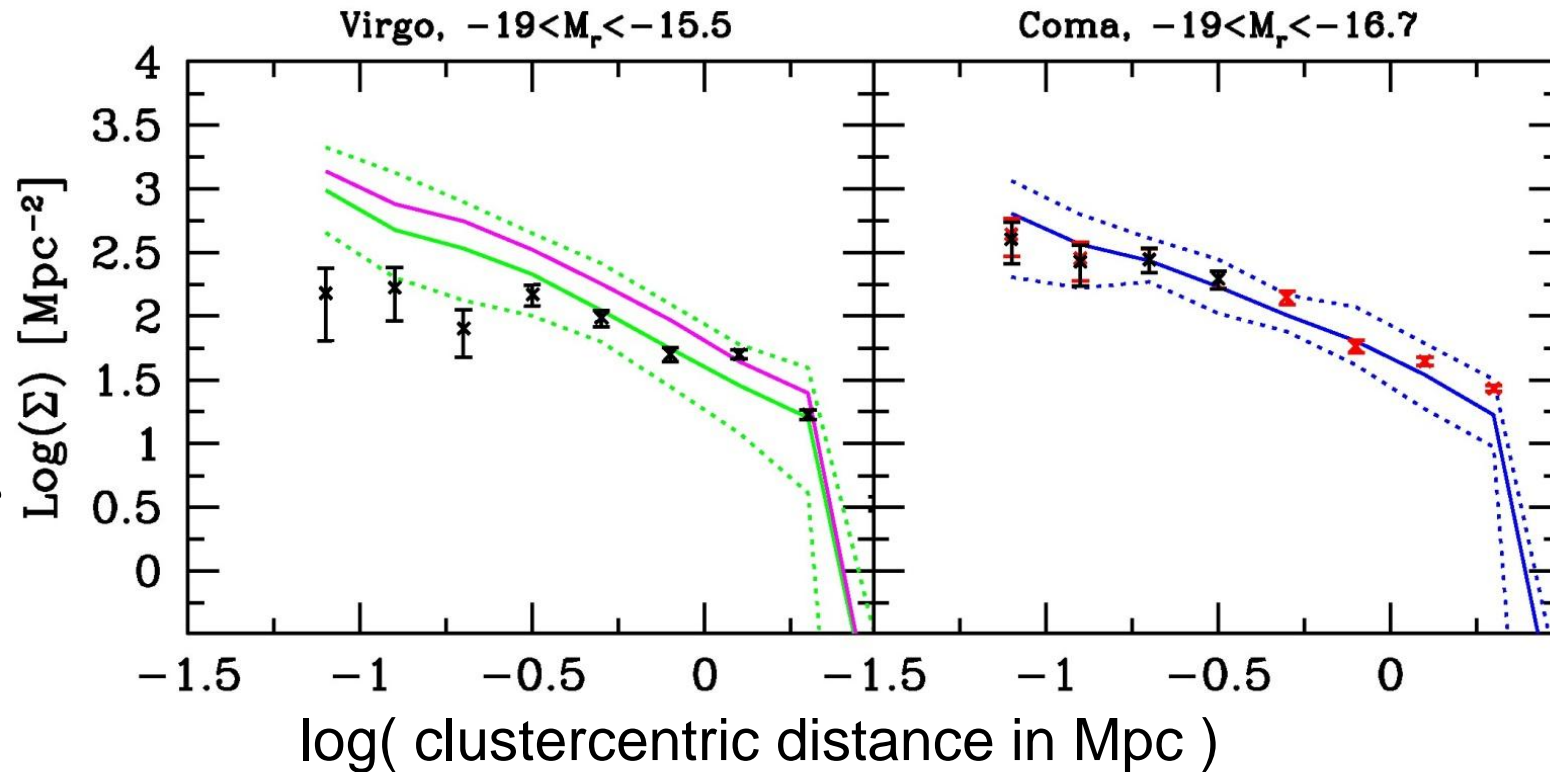
Model spheroids originate from major mergers!

bright/
massive

faint/
low-mass



Radial distribution



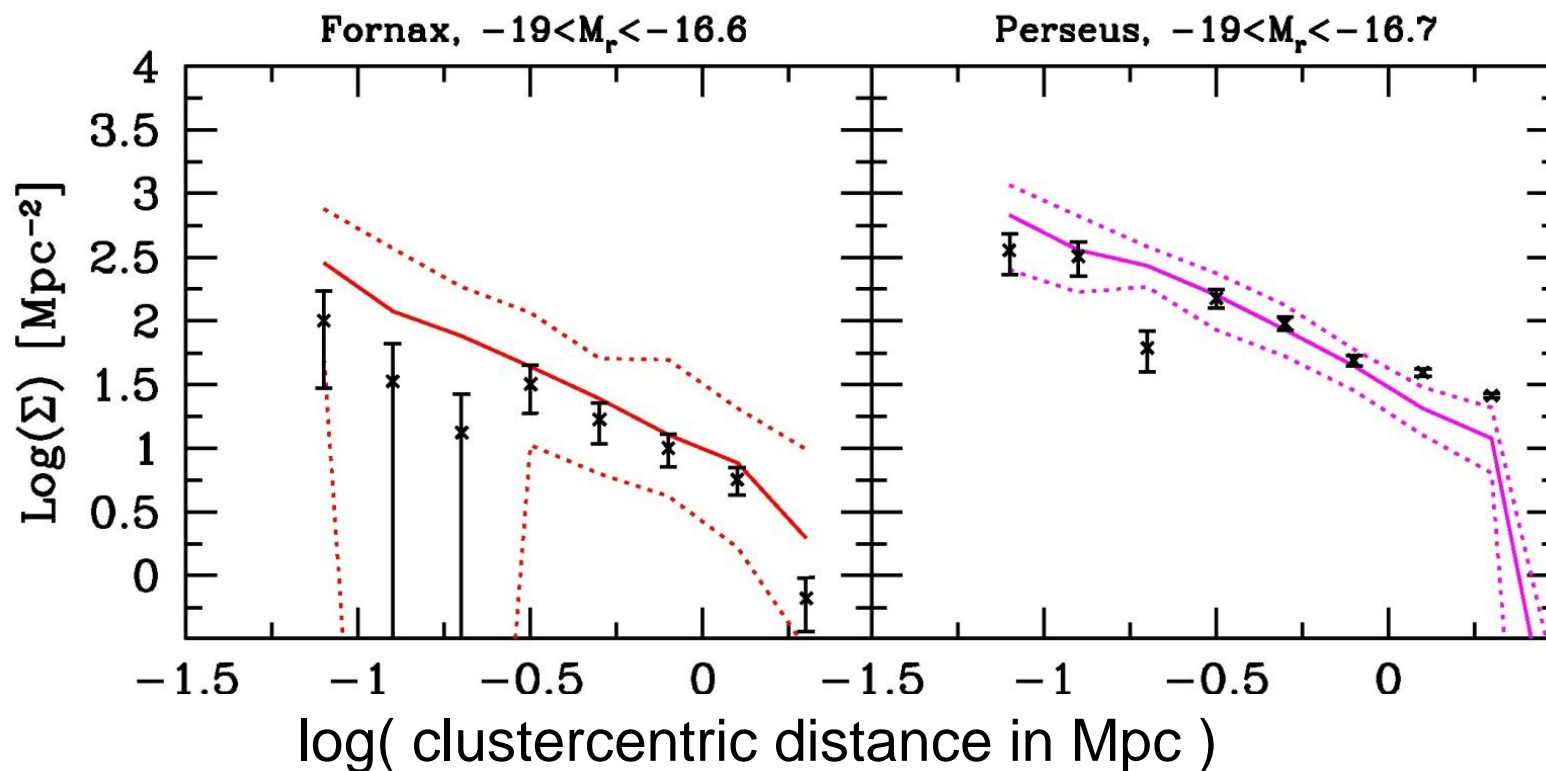
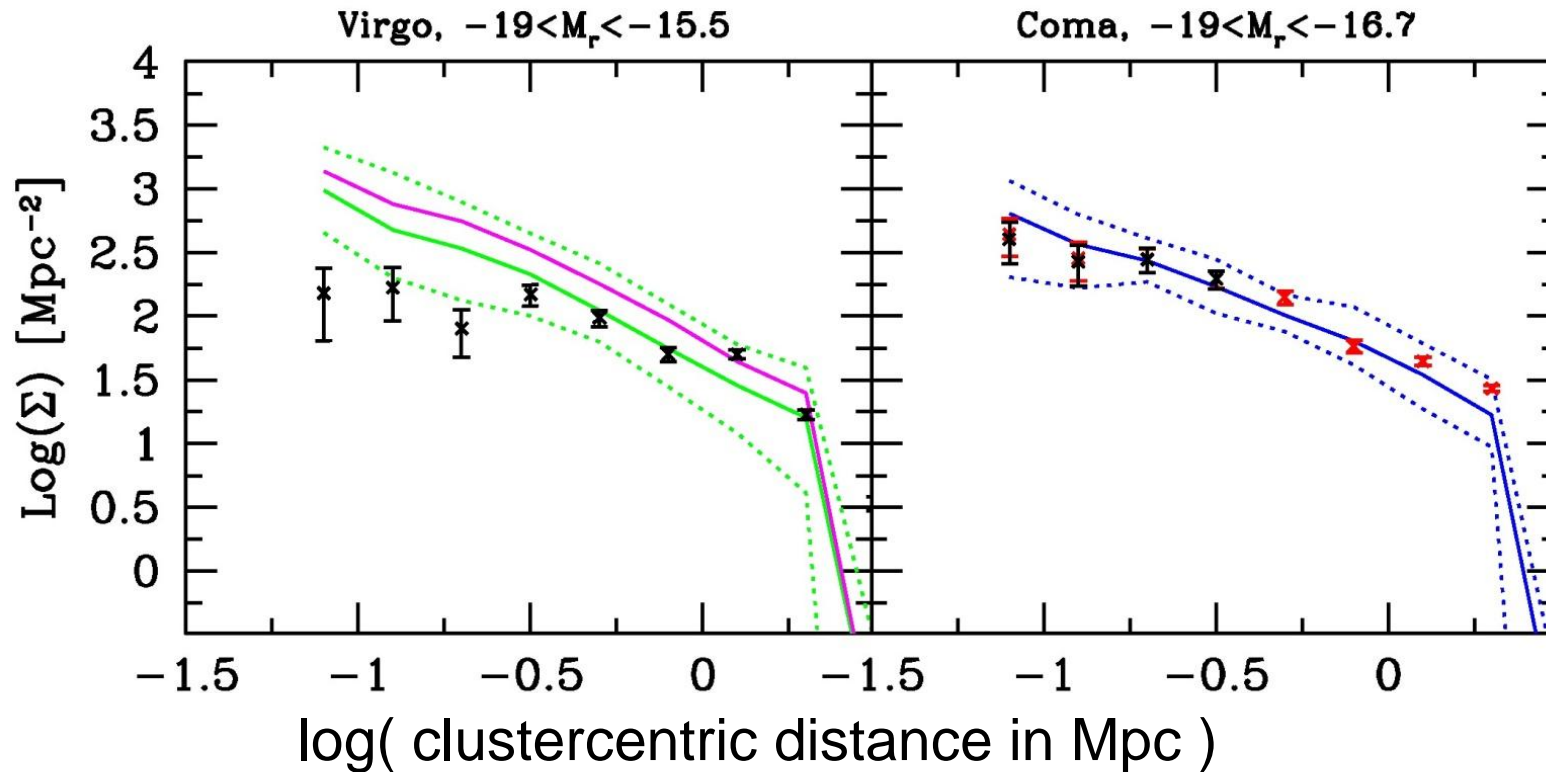
Radial distribution

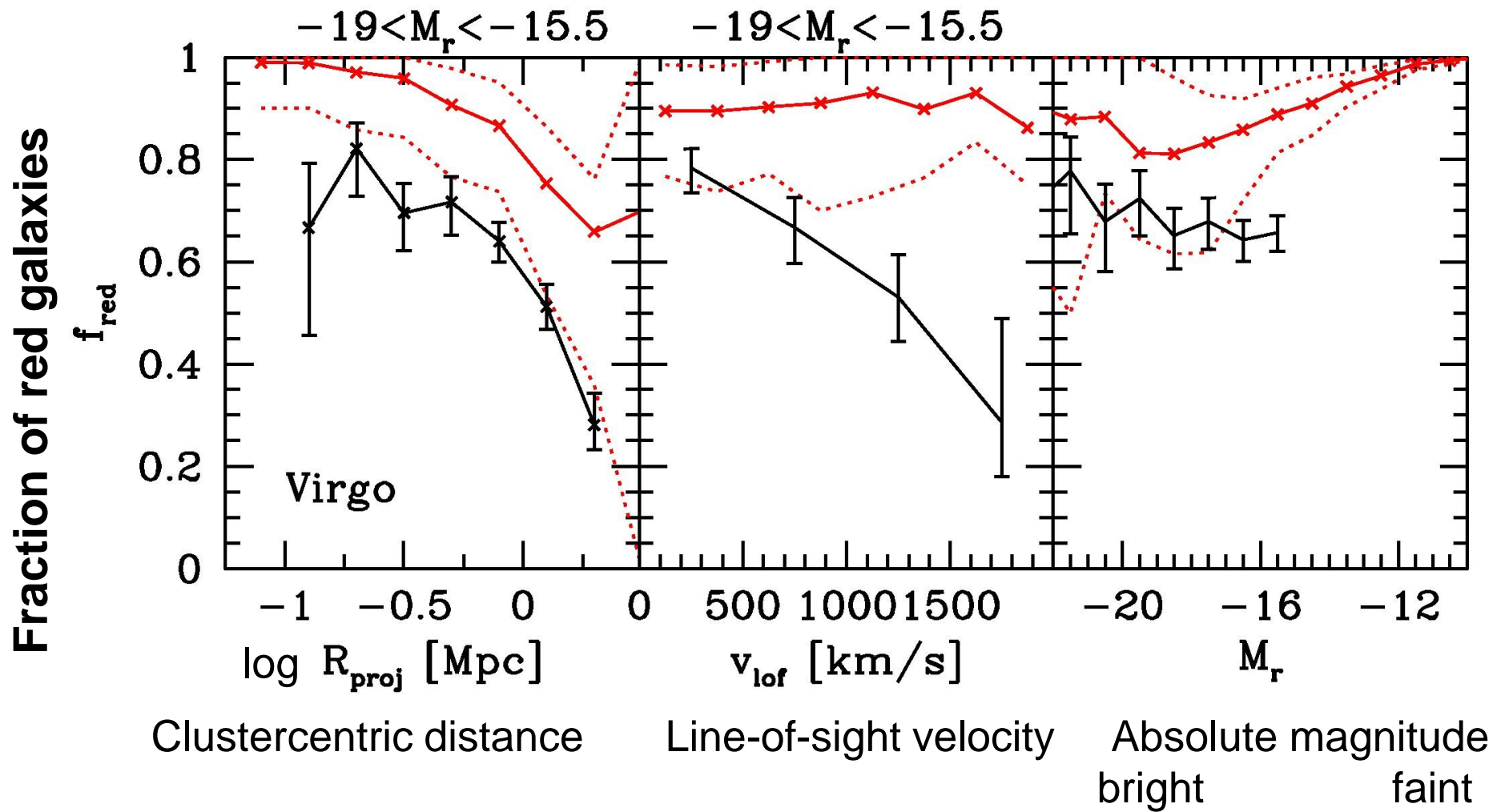
Coma+Perseus
more „evolved“
(but X-ray...!?)

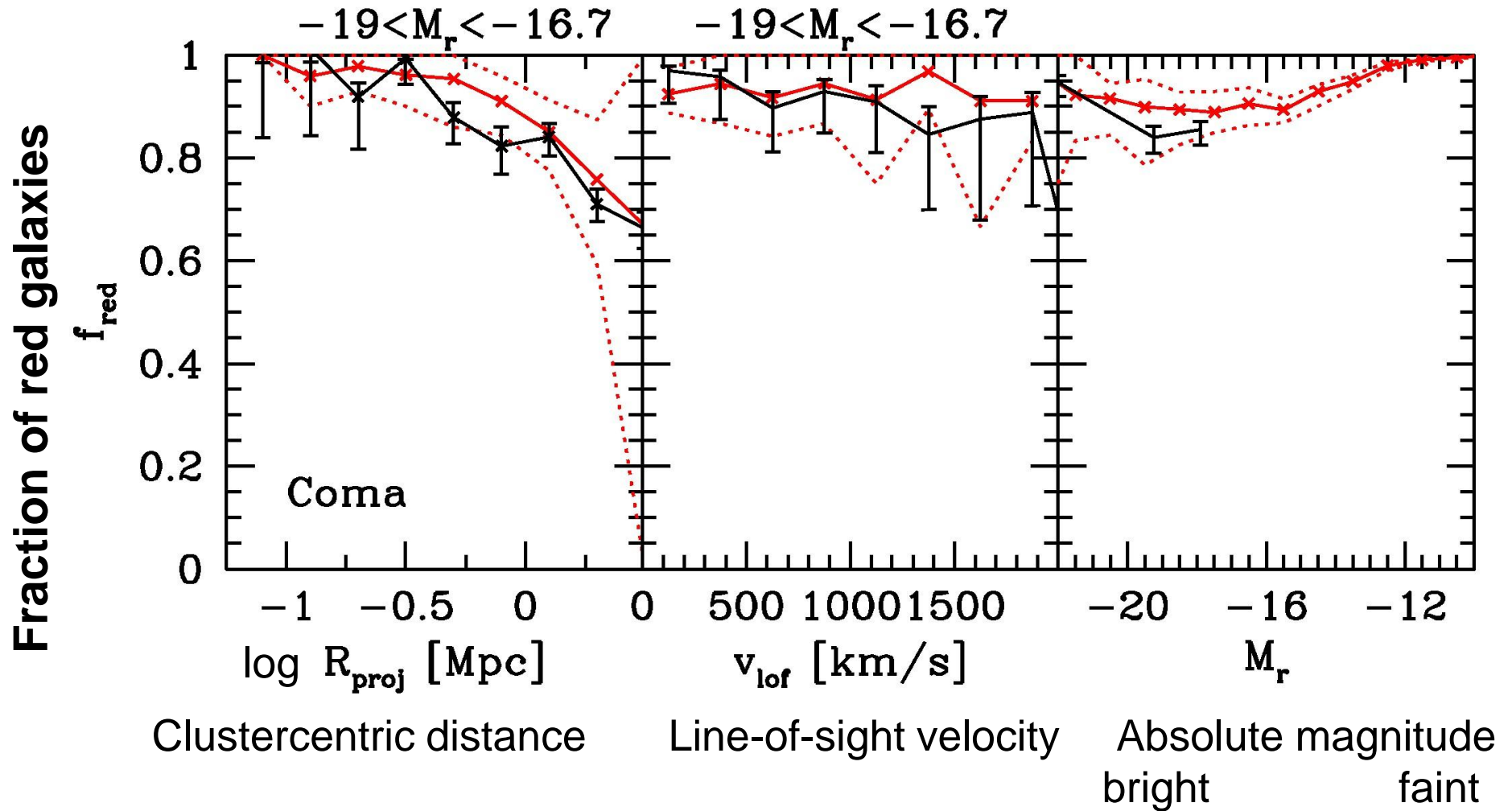
But why does
this mean a
higher central
dwarf density?

**Issue #4:
Is Virgo
peculiar?**

Surface number density







No model cluster like Virgo in Millennium-II + Guo et al. 2011 !

What made a dwarf red in the model?

How can you assign a size to your model galaxies?

Do your SAM clusters have the right number of total galaxies?

Is their motion comparable to real clusters?

How do you know that you found all cluster members?

How do you know the extent and mass of the cluster?

How can you claim that ram-pressure stripping of disk gas is relevant for many galaxies?



Observer



Theorist / Modeler

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Observer

Weinmann, Lisker et al. 2011
arXiv:1105.0674
(not all questions answered yet...)



Theorist / Modeler

- Physical properties of cluster dwarfs?

KINEMATICS! STRUCTURE!

e.g. fast vs. slow rotators like for giants? (\leftrightarrow SAURON)

Between 10^8 and $10^9 M_{\odot}$ stellar mass, only 25% of passive Virgo dwarfs have adequate kinematical data!

SMAKCED (Stellar content, Mass and Kinematics of Cluster Early-type Dwarfs) T. Lisker et al. POSTER

„Cosmological relevance“ ...!

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- Studying cluster surroundings;
comparing with regions of similar density in groups
cf. Extended Virgo Cluster Catalog, S. Kim et al. POSTER
- Develop/improve SAM-recipes for dynamical heating and partial tidal disruption of low-mass galaxies in clusters

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- Develop/improve SAM-recipes for dynamical heating and partial tidal disruption of low-mass galaxies in clusters
- Continue trying to link late and early-type galaxies by simulations & observations: *H. Meyer et al. POSTER*



- Basic galaxy cluster properties of the nearby universe are reproduced in the model of Guo et al. 2011: number, motion, and distribution of giant galaxies

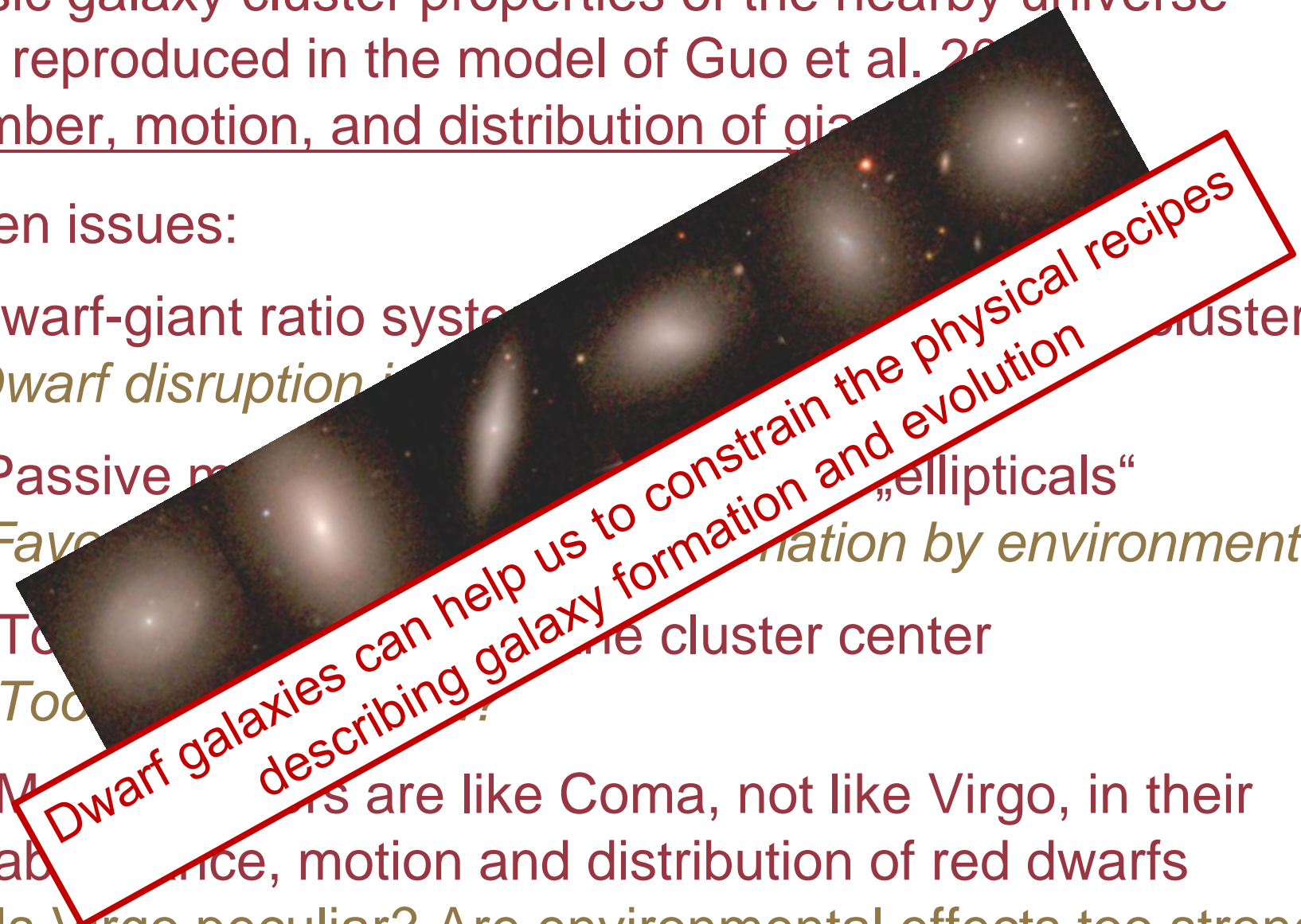
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 - I. Dwarf-giant ratio systematically lower for all real clusters
Dwarf disruption in the model too inefficient?

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Is Virgo peculiar? Are environmental effects too strong in the model in the „preprocessing“ phase?

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 - II. Passive members
Favorable conditions for "ellipticals" formation by environment
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