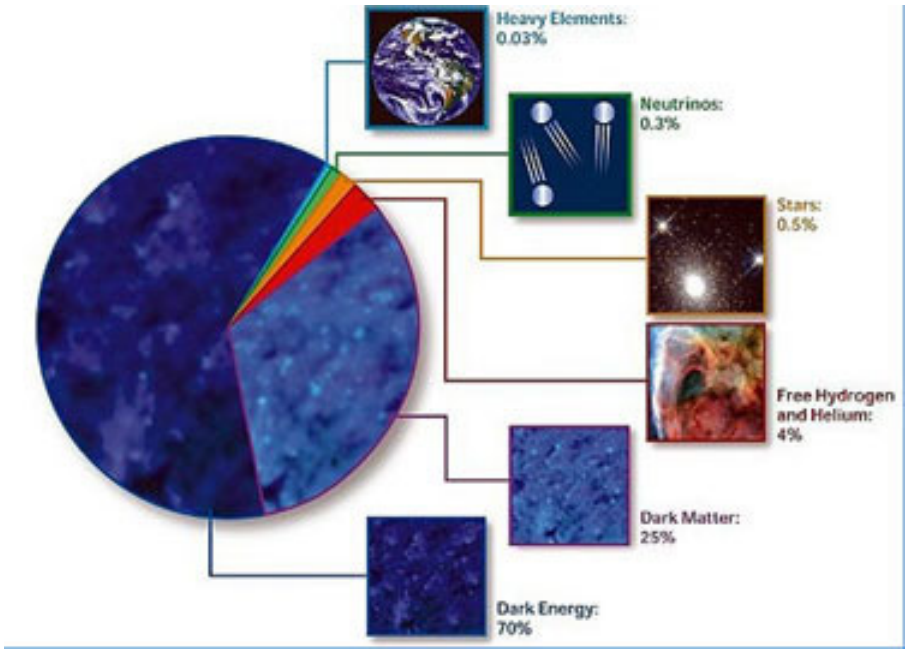
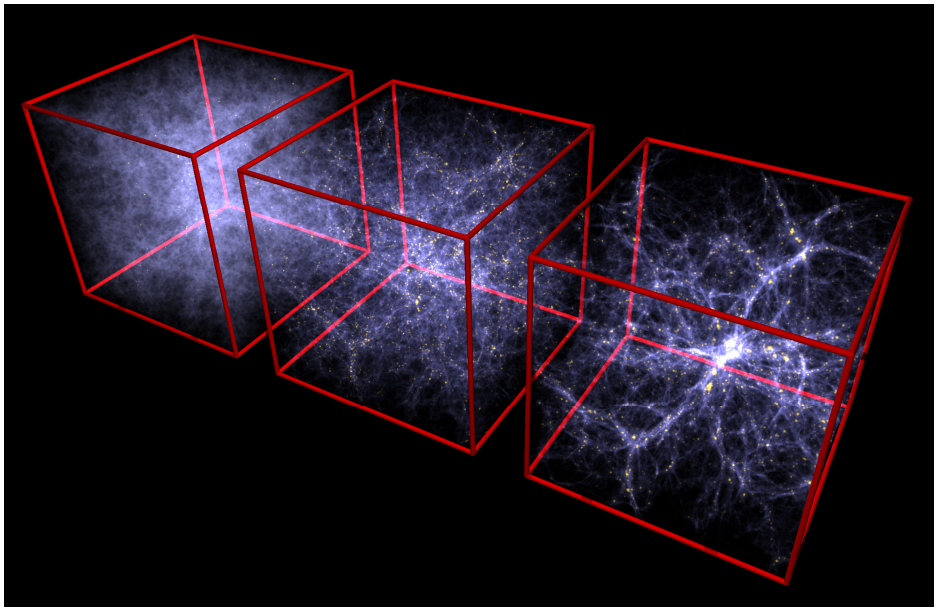
The influence of the environment in galactic structures: discs and bars

J. Alfonso L. Aguerri (IAC)

Structure formation in the Universe

$$(\Omega_\Lambda, \Omega_{DM}, \Omega_b) = (0.7, 0.25, 0.05)$$





- Hierarchical formation
- Galaxy clusters are the more massive and virialized structures
- Cosmological laboratories: determination of cosmological parameters
- Influence of the environment in galaxy evolution.

Different parts of a galaxy cluster

Bullet cluster (Markevitch et al. 2004; Clowe et al. 2004)

- Galaxy clusters are systems formed by different component evolving at the same time:
  - Dark matter: about 80% of the matter; they show universal mass density profiles; abundant substructure
  - Intracluster medium: hot gas (T~10^6-10^8 K) in htdrostatic equilibrium; stars of very low surface brightness forming the intracluster light; dominates the barionic mass of the cluster.
  - Galaxies: 5-15% of the mass of the cluster; from tens to hundreds galaxies depending of the mass; different properties as galaxy clusters.

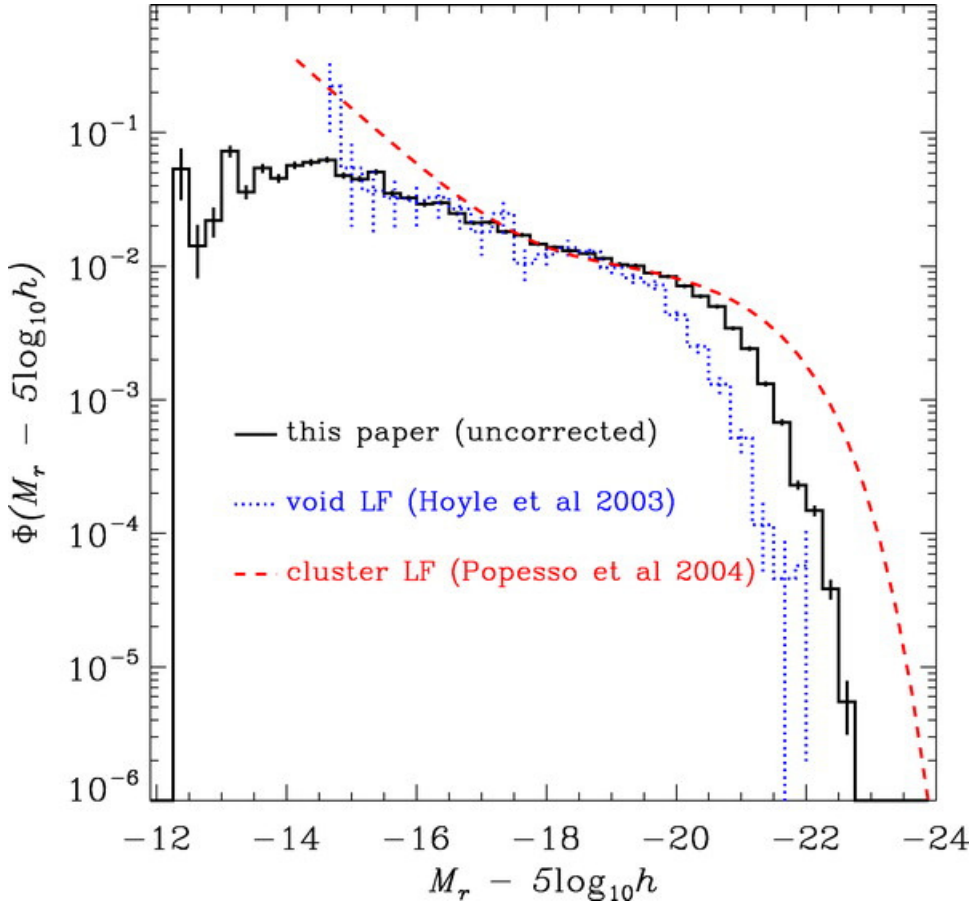
Observational Properties of galaxies in clusters

Properties at z=0

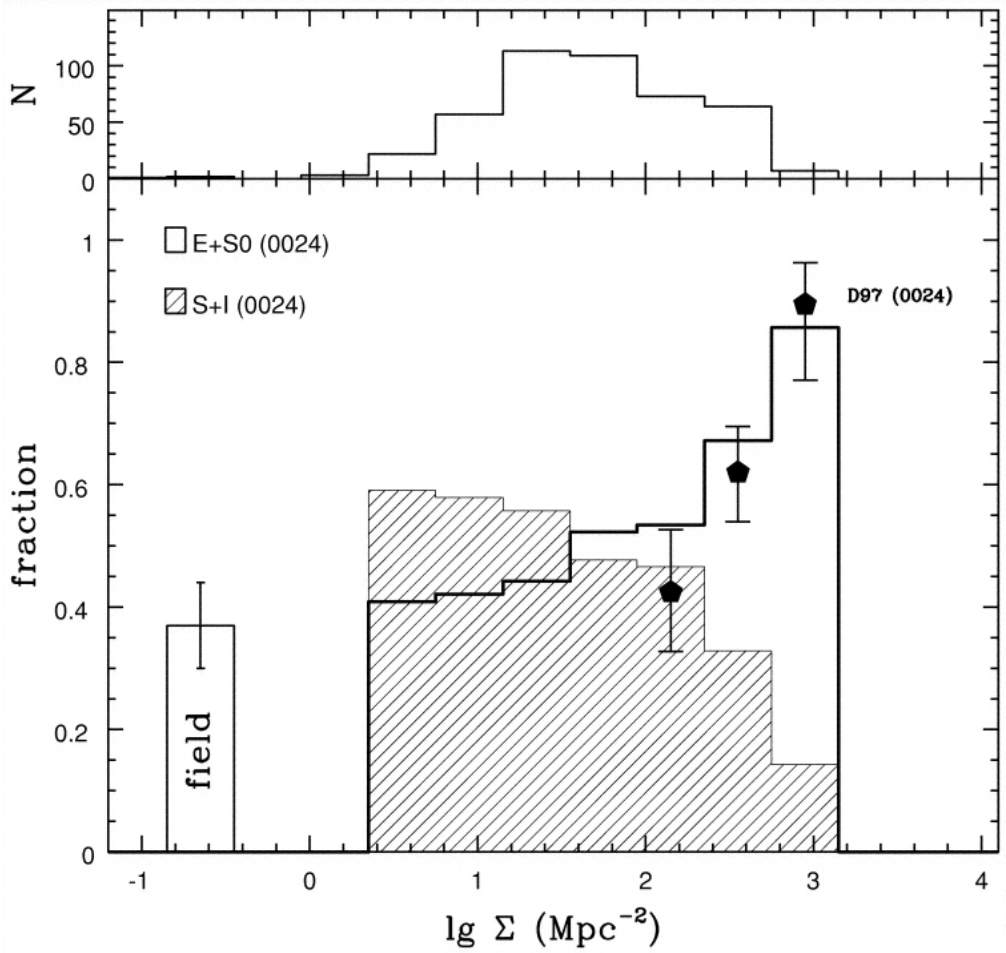
- Galaxy clusters are the "house" of E/S0 (Oemler 1974)
- Different population of galaxies (see LF of clusters Poppeso et al. 2004; Blanton et al. 2005)
- Hierarchical position and kinematics of galaxies (Dressler 1984; Adami et al. 1998; Biviano & Katgert 2003; Treu et al. 2003)
- Stop of the star formation (Lewis et al. 2002; Balogh et al. 2004) and anemic HI discs (Kenney et al. 2008)

Propiedades a z>0

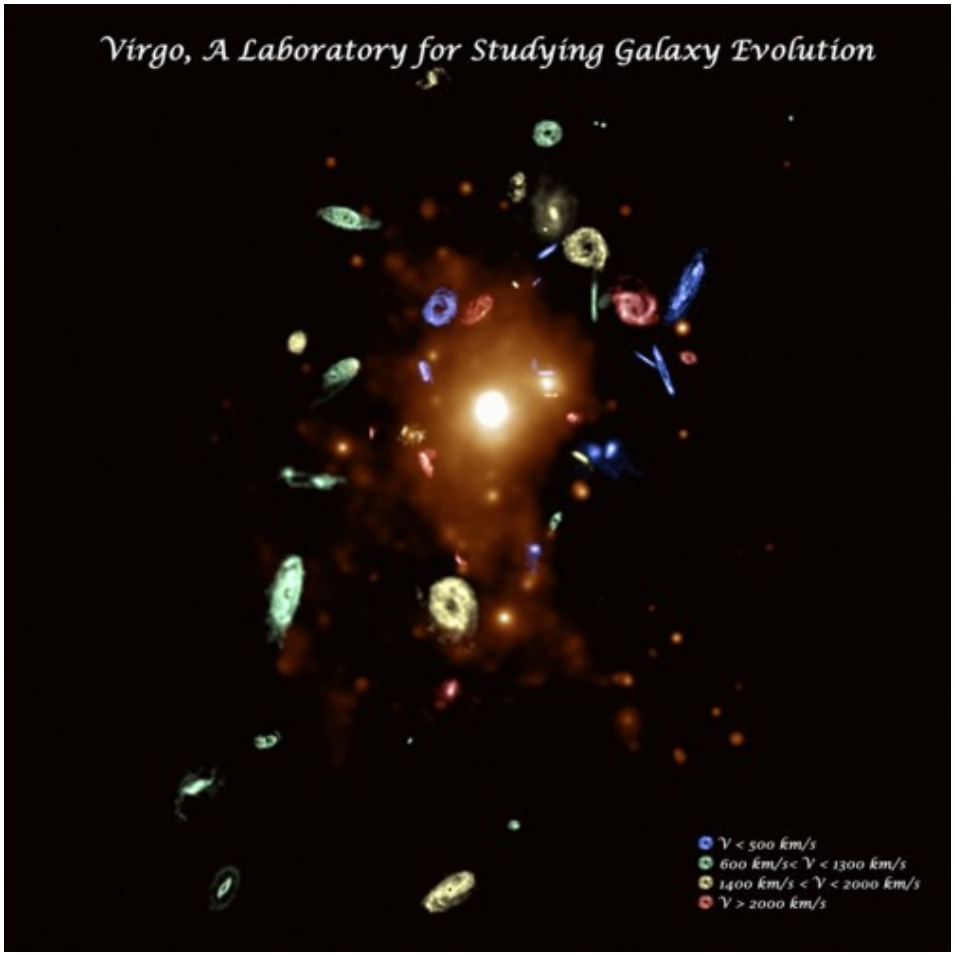
- Evolution: more blue galaxies at intermidiate redshift (Butcher & Oemler 1985; Margoriner & de Carvalho 2000)



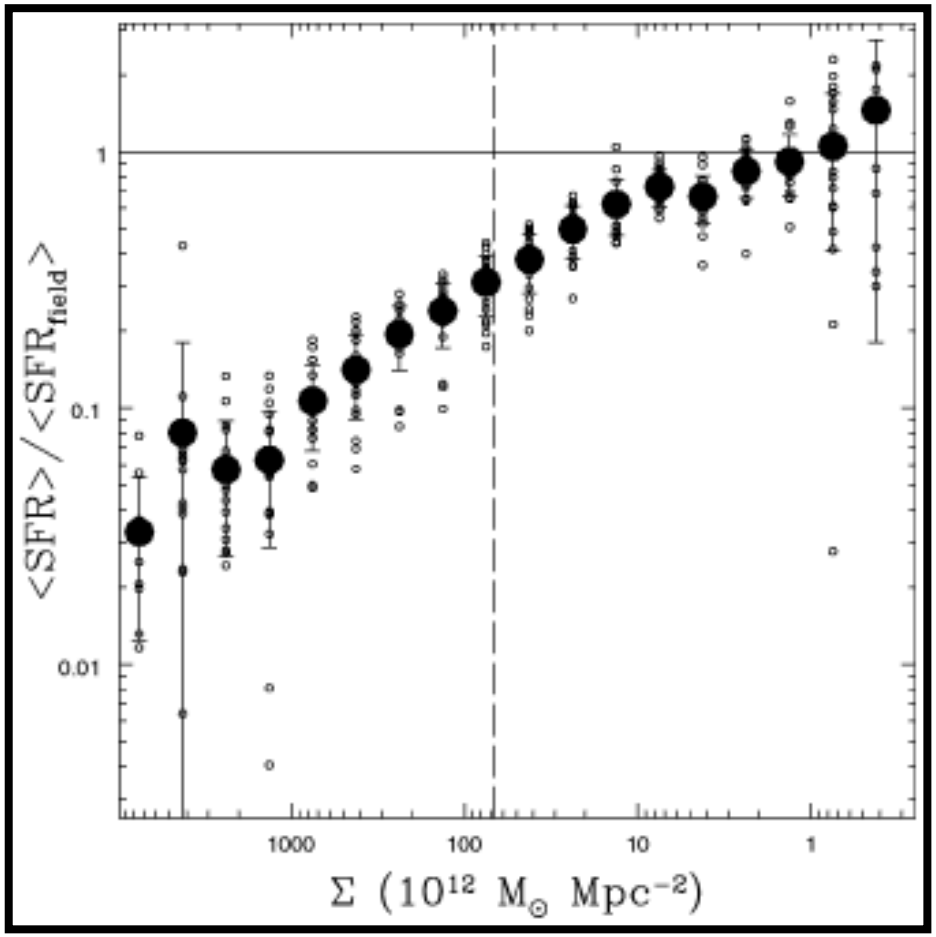
Popesso et al. 2004
Blanton et al. 2005



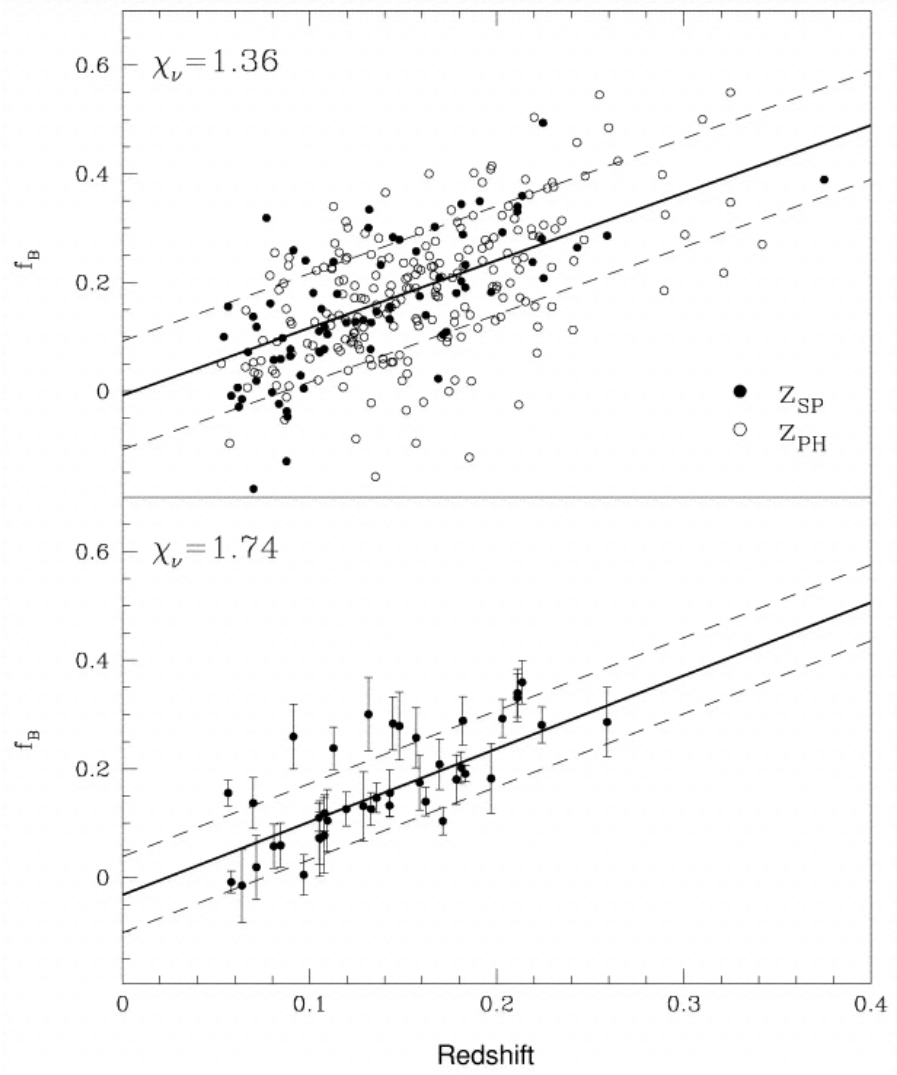
Treu et al. 2003



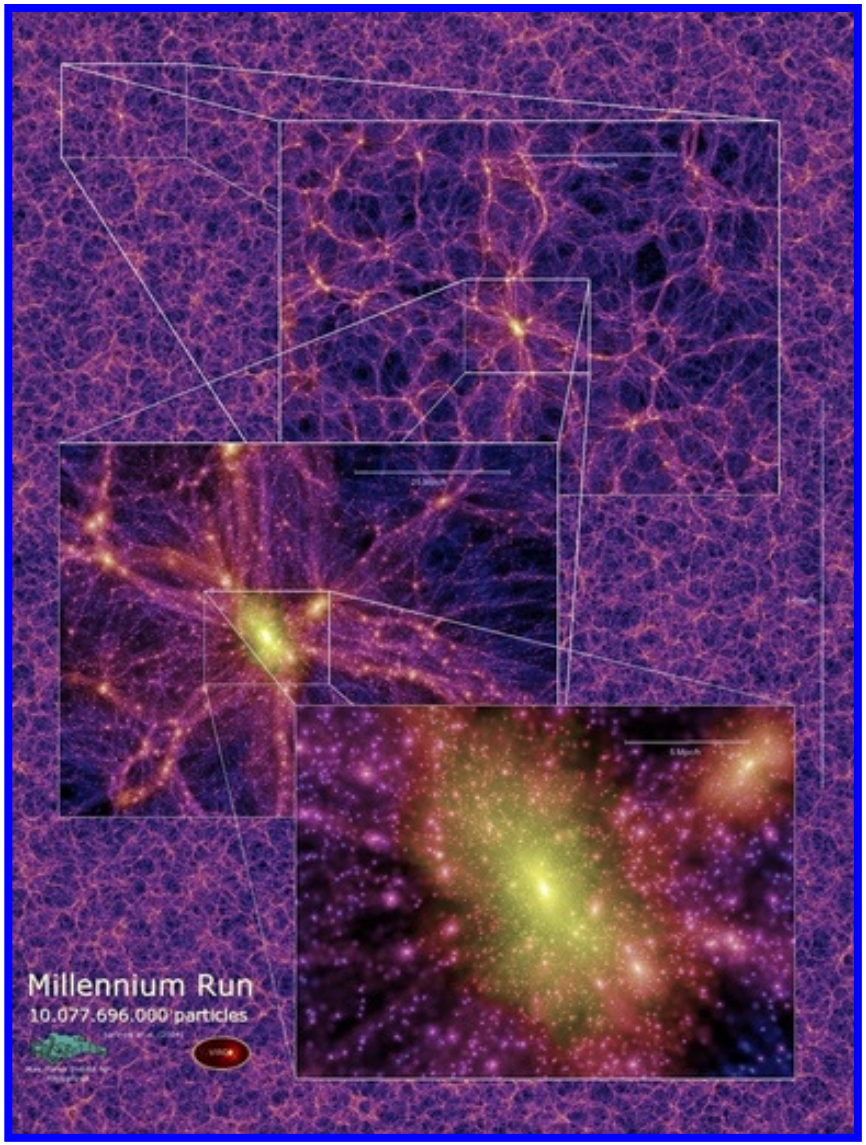
Kenney et al. 2008



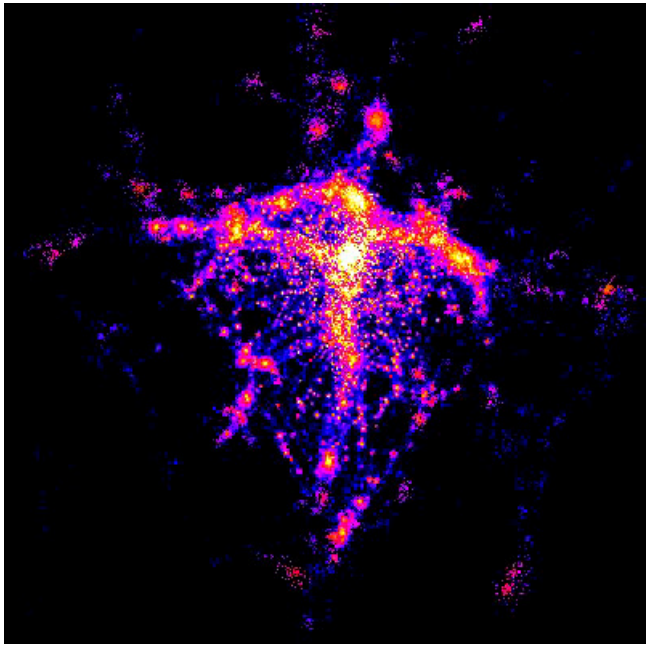
Lewis et al. 2002



Magorrian & de Carvalho 2000



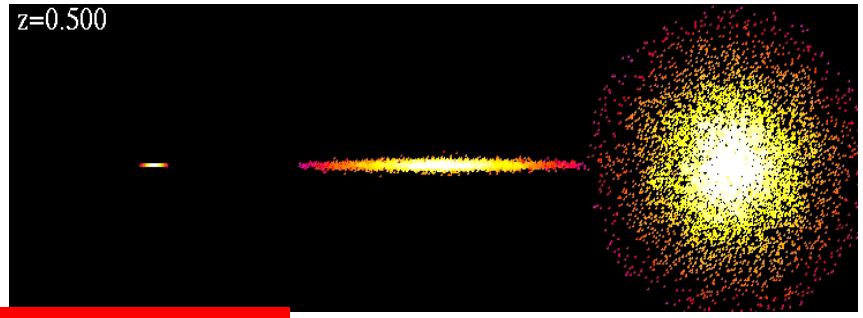
During last decade: big step forward
in numerical models of galaxy clusters.



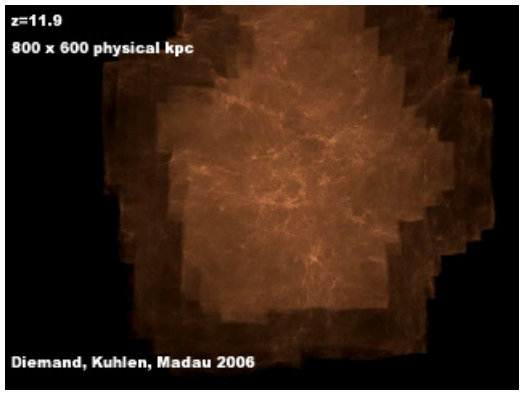
B. Moore et al.:

http://krone.physic.unizh/moore/movies.html

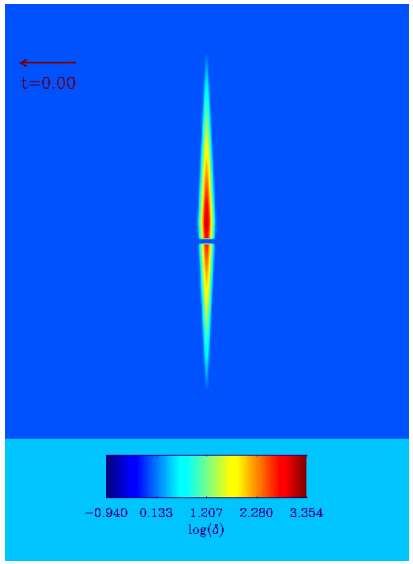
Cluster formation models



Moore et al 1996



Diemand et al. 2006



Quilis et al 2000

Galaxy transformation driven by different physical mechanisms on gas and stars:

Stars+gas: Fast galaxy interactions (Harassment; Moore et al 1996).

Mergers:more frecuent in some special places with high galaxy density.

Gas: Swept of the clod gas due to the galaxy interaction and the hot gas: "gas striping" (Quilis et al 2000)

Observational predictions

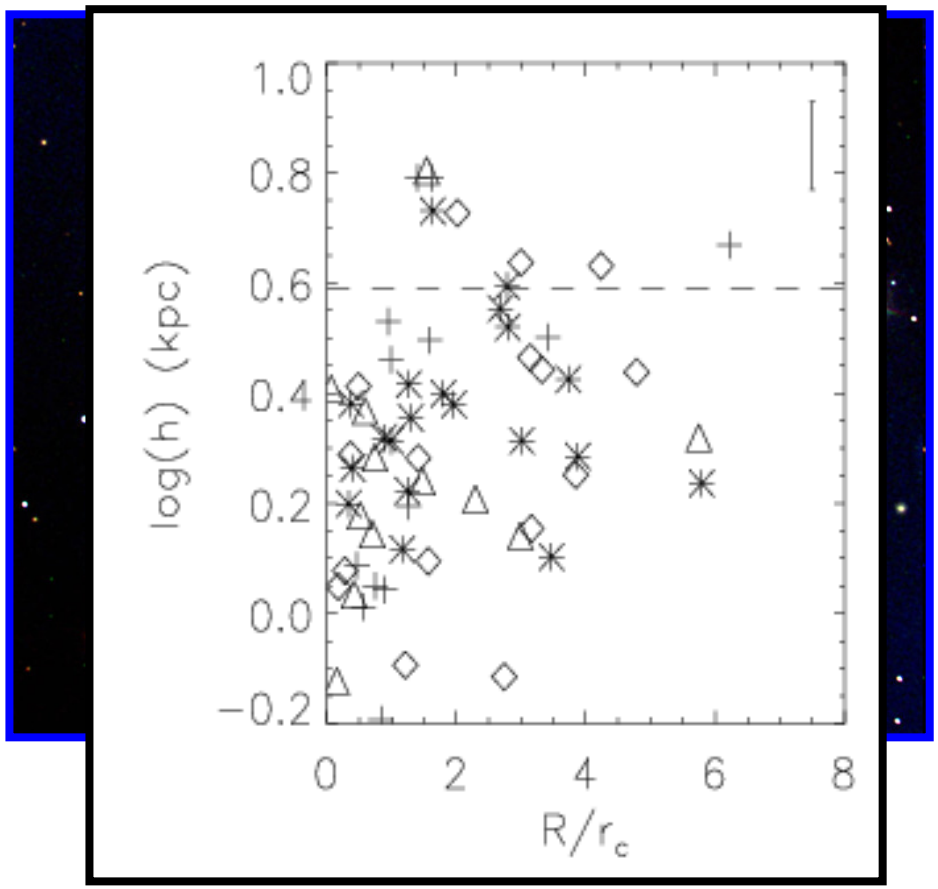
- Distribution of stars in galaxies in cluster different than similar galaxies in field.

→Galaxy structural parameters: Aguerri et al. 2004; 2005 Aguerri et al. 2009; Sánchez-Janssen 2009 PhD Thesis

- Part of the barions (stars) are out from the galaxies forming the so-called intracluster light. Low surface brightness component detected in some nearby galaxy clusters (Virgo, Fornax, Coma…).

→Diffuse light in Virgo cluster: Arnaboldi et al. 2002, 2004 Castro-Rodriguez et al. 2003, 2009; Aguerri et al. 2005

Structural parameters of galaxies in clusters: scale length of discs



No large discs in the central regions of the cluster!

- Stars in galaxy discs have small binding energy and can be easily disrrupted. Fast interactions with other galaxies can change the scale length of the discs.
- We started analysing the discs of bright galaxies in the Coma cluster (Aguerri et al. 2004).
- We fitted the surface brightness profile of discs galaxies by two components: bulge and disc.

$$I_{bulge}(r) = I_0 10^{-b_n (r/r_e)^{1/n}}$$

$$I_{disc}(r) = I_0 e^{-r/h}$$

Structural parameters of galaxies in clusters: scale length of discs

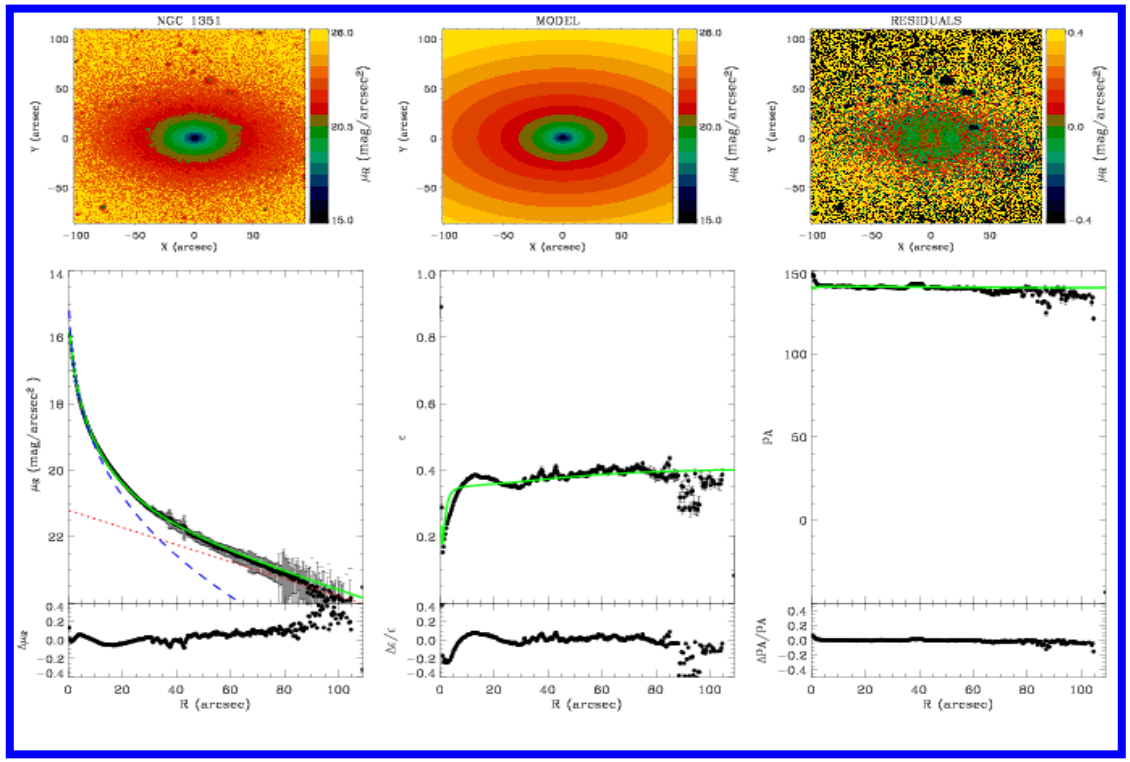
We analysed the structural parameters of galaxies in Wide-field Nearby Galaxy Cluster Survey (WINGS; Fasano et al. 2006)

Wide field photometric (B and V bands; Varela et al. 2006) and spectroscopic survey (Cava et al. 2009)

The survey reach V~24 mag with a spatial Coverage of ~2.5Mpc^2 and typical FWHM~1 kpc

Analysis of the structural parameters of 45 clusters. This results a total of ~7000 galaxies.

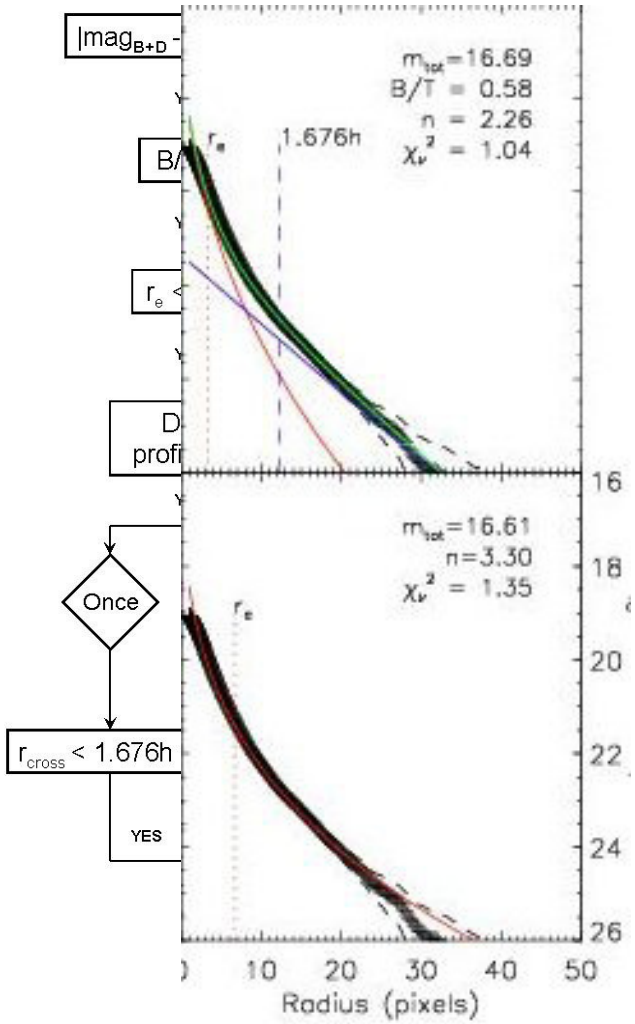
Structural parameters of galaxies in clusters: scale length of discs



- 2D fit of the surface brigtness galaxies using GASP2D (Méndez-Abreu et al. 2008)
- Automatical selection of initial conditions
- Two models per galaxy: Bulge and bulge+disc

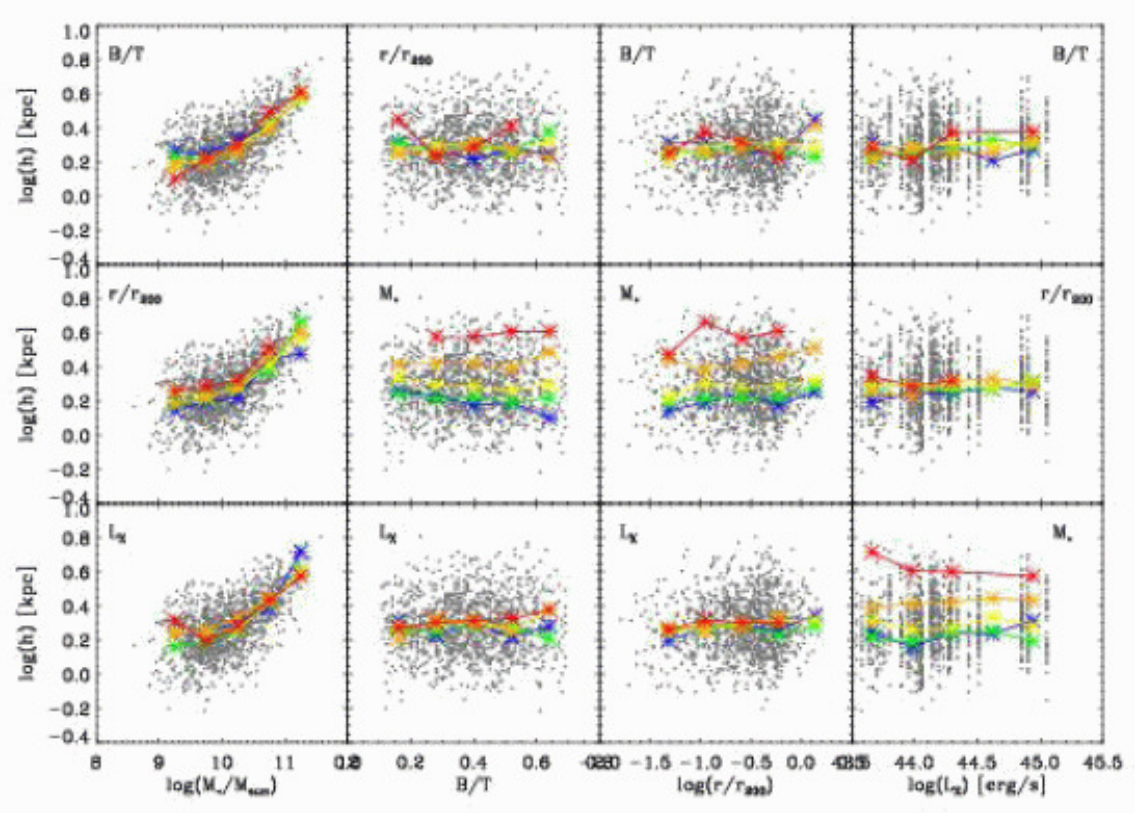
The results were tested with extensive galaxy simulations of similar galaxies with one and two components. Simulations tells that structural parameters of galaxies brighter than V~19 mag can be obtained without systematics tendencies.

Structural parameters of galaxies in clusters: scale length of discs



- The best fitted model was obtained using a decision tree
- Our aim is to classify B+D galaxies as those with a bulge dominating the light in the internal regions and a discs in the external ones.
- 95.3% of good fits
- 45% turned to be B+D systems.

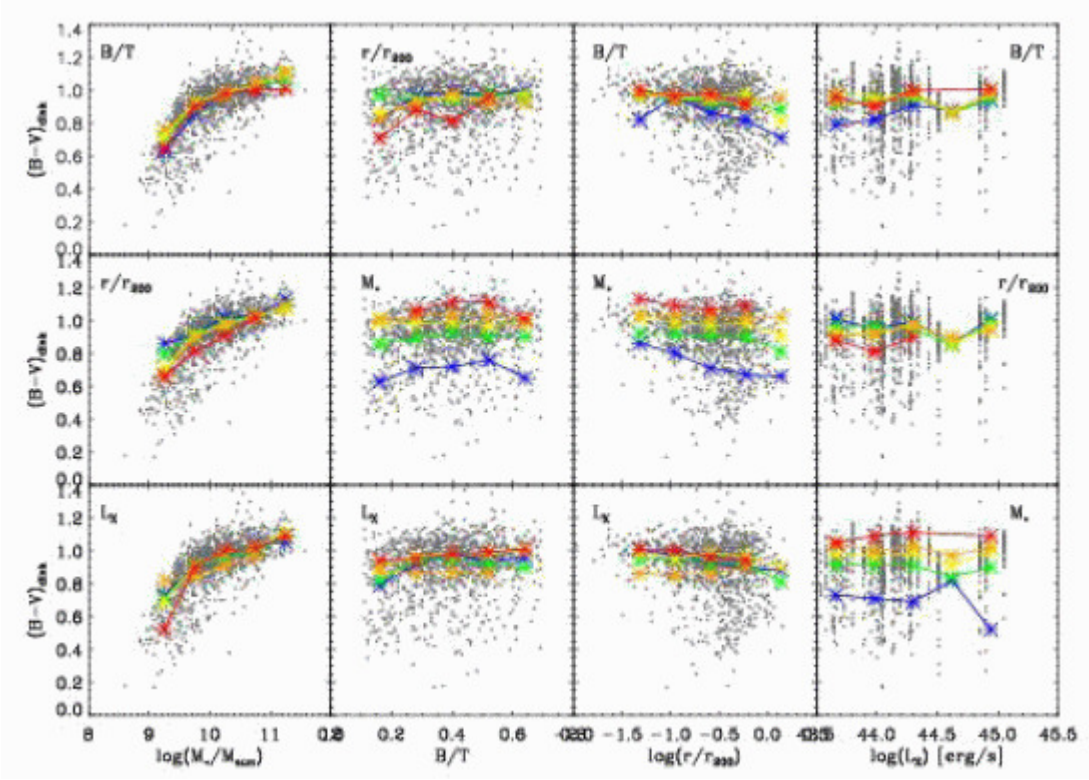
Structural parameters of galaxies in clusters: scale length of discs



- Which parameters determine the scale length of galactic discs?
- Internal (B/T and Mass) vs external (cluster position and Lx).
- The environment is important in second order.

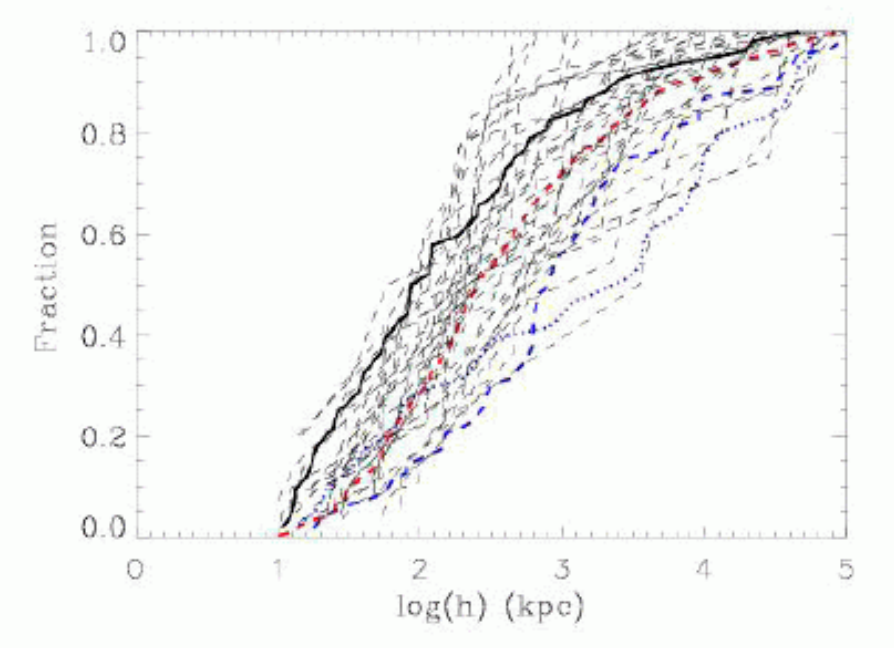
Sánchez-Janssen et al., 2010, in prep.

Structural parameters of galaxies in clusters: scale length of discs



- The color of the disc is also mainly determined by the stellar mass of the galaxy
- Nevertheless, for dwarf galaxies the environment can influence the color of the disc → hydro proceses.

Structural parameters of galaxies in clusters: scale length of discs



- There is a large dispersion in the scales of the discs of galaxies: from Coma discs to field galaxies.
- KS-test show that clusters with velocity dispersion larger than 800 km/s have scales distributions different than field.
- Cluster with large dispersion velocity have not large discs.

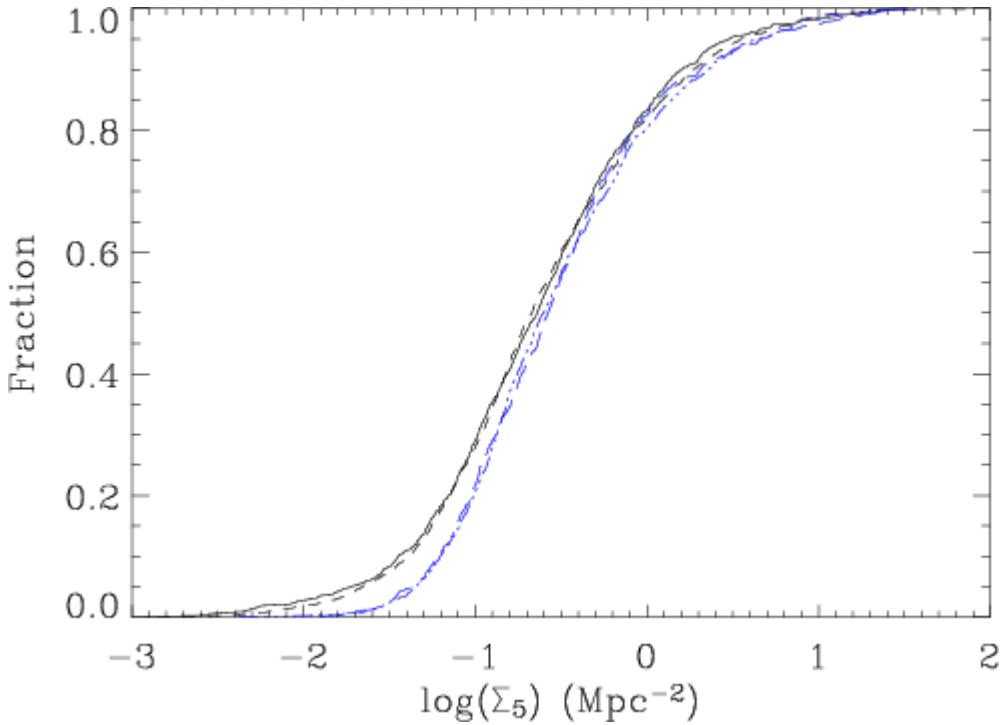
Structural parameters of galaxies in clusters: bars

- Bars are ellipsoidal structures presented in a large fraction of discs (Barazza et al. 2008; Aguerri et al. 2009).
- Why are they important? Modify the dynamics of the disc; They could have information about the mass distribution in galaxies.
- How are bars formed? Internal vs external proceses.
- If external processes form bars: are there more bars in galaxy high density environments than in field?

Structural parameters of galaxies in clusters: bars

- We selected a large sample (~3000 galaxies) of galaxies from SDSS-DR5
- Galaxies were selected in the redshift interval $0.01<z<0.04$ and brighter than Mr=-20.0. No aditional cuts in the selection.
- Bars were detected by the presence of a maximun in the ellipticity profile of galaxy isophotes or in the m=2 Fourier mode. The ellipticity method turned to be more efficient in the search of bars.
- 45% of discs host a bar structure. Larger fraction of barred galaxies in late-type discs.

Structural parameters of galaxies in clusters: bars



Aguerri et al. 2009

- The projected galaxy density was determined by measuring the distance to the 5th closer galaxy
- We do not observed statistical diferences in the fraction of bars in discs inside and outside high density environments.
- The formation of bars in bright galaxies is mainly driven by internal processes

Conclusions

- We have analysed the influence of the environment in the scale length of discs of spiral galaxies for a large statistical sample of nearby galaxy clusters
- The stellar mass of the galaxy is the most important parameter which determines the scale length of the disc.
- Nevertheless, clusters with large velocity dispersion (>800 km/s) show absent of large discs as detected in field galaxies.
- We have also analyzed the influence of the environment in the formation of barred galaxies. The sample consisted in ~3000 local and bright galaxies from SDSS-DR5.
- The fraction of barred galaxies in discs does not depend on the local galaxy density.
- Bar formation can be induced by internal galaxy properties.