WINGS

WIde-field Nearby Galaxy-cluster Survey

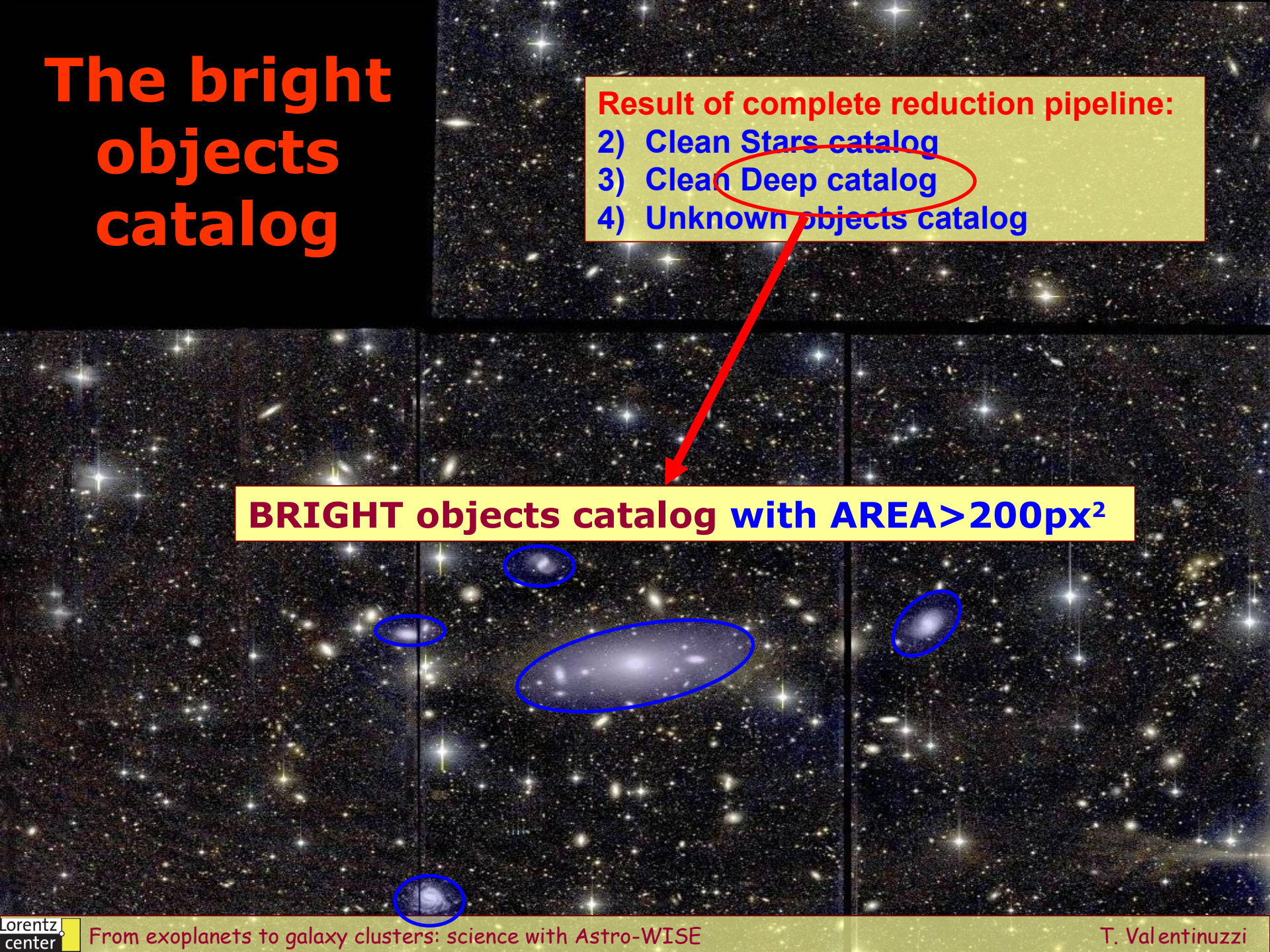
Preliminary Results

The bright objects catalog

Result of complete reduction pipeline:

2) Clean Stars catalog
3) Clean Deep catalog
4) Unknown objects catalog

BRIGHT objects catalog with AREA>200px²



GASPHOT Tool

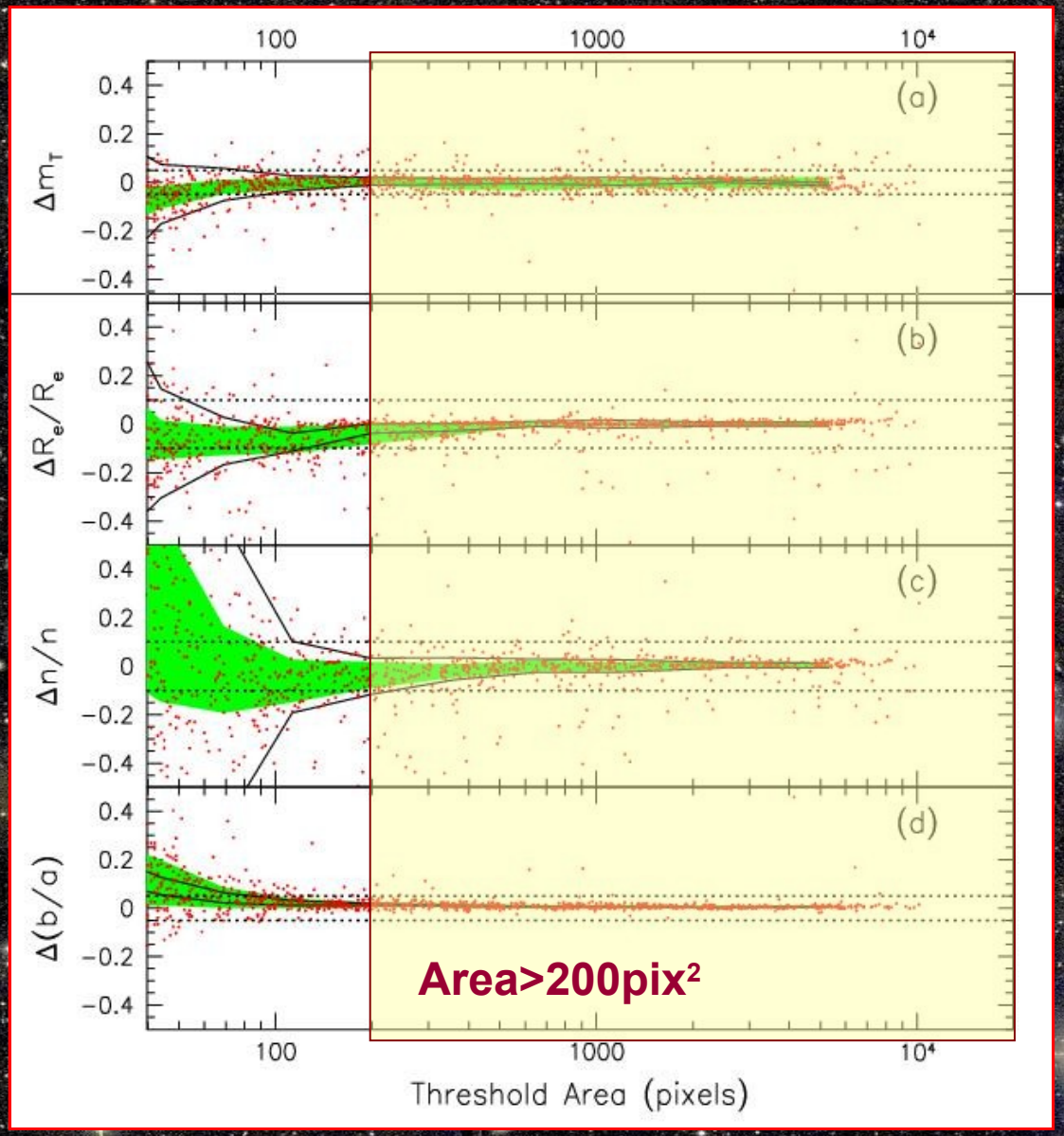
Pignatelli and Fasano, 2006

Tested on 15000 simulated and real galaxies, gives robust results...

Multiple SExtractor runs slicing the mosaic to produce all at once the whole set of isophotes for a given galaxy sample

PSF convolved Sersic law, fitting simultaneously the major and minor axis growth curves

R_e, μ_e, V_T, Sersic index n for ~45,000 WINGS galaxies with area>200 pixels

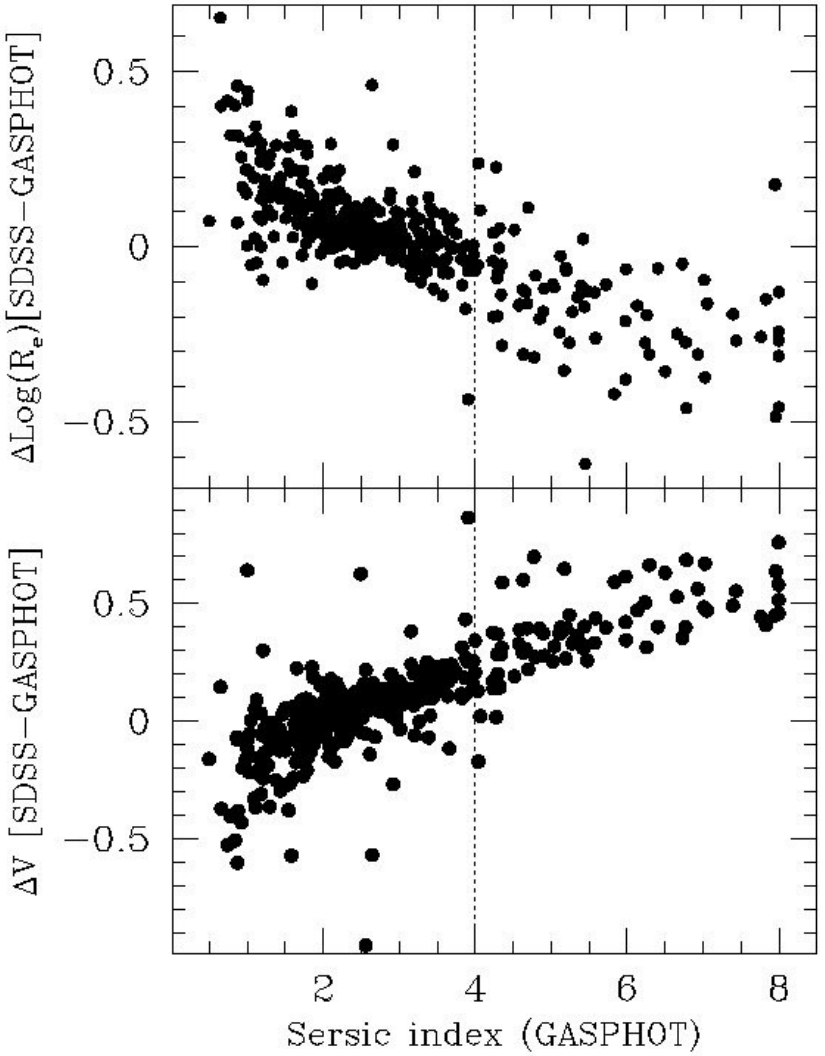


WINGS Fundamental Plane

D'Onofrio et al. 2008

Comparison between GASPHOT (sersic fit) and SLOAN (de Vaucouleurs fit) photometry

Cent
disper



WINGS Fundamental Plane

D'Onofrio et al. 2008

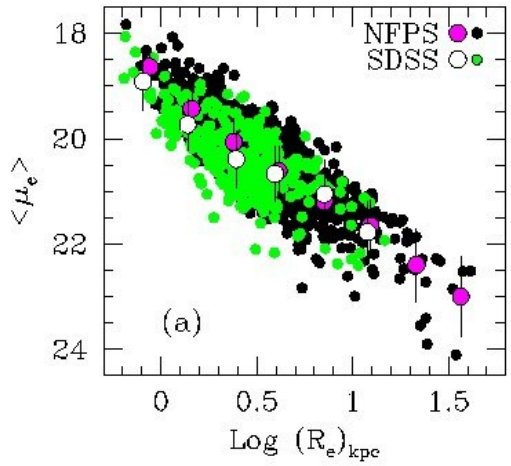
SLOAN: fainter magnitudes

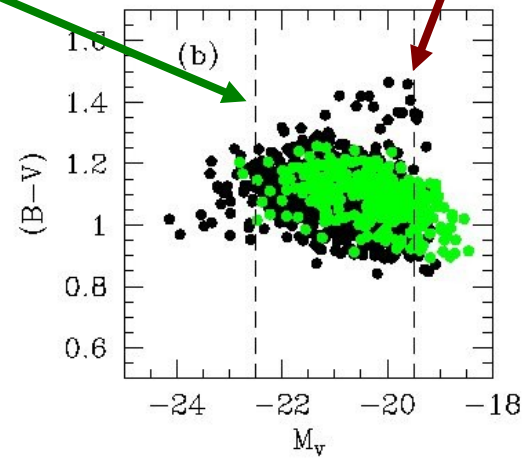
NFPS: brighter magnitudes

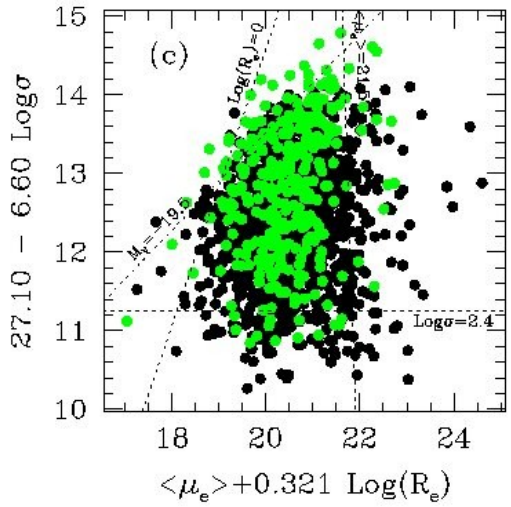
The Fundamental Plane relation

$$\mathrm{Log}(R_e) = a\ \mathrm{Log}(\sigma) + b\ \langle\mu\rangle_e + c$$

How the sample differences affect the FP coefficients???







The two samples have different selection criteria...

WINGS Fundamental Plane

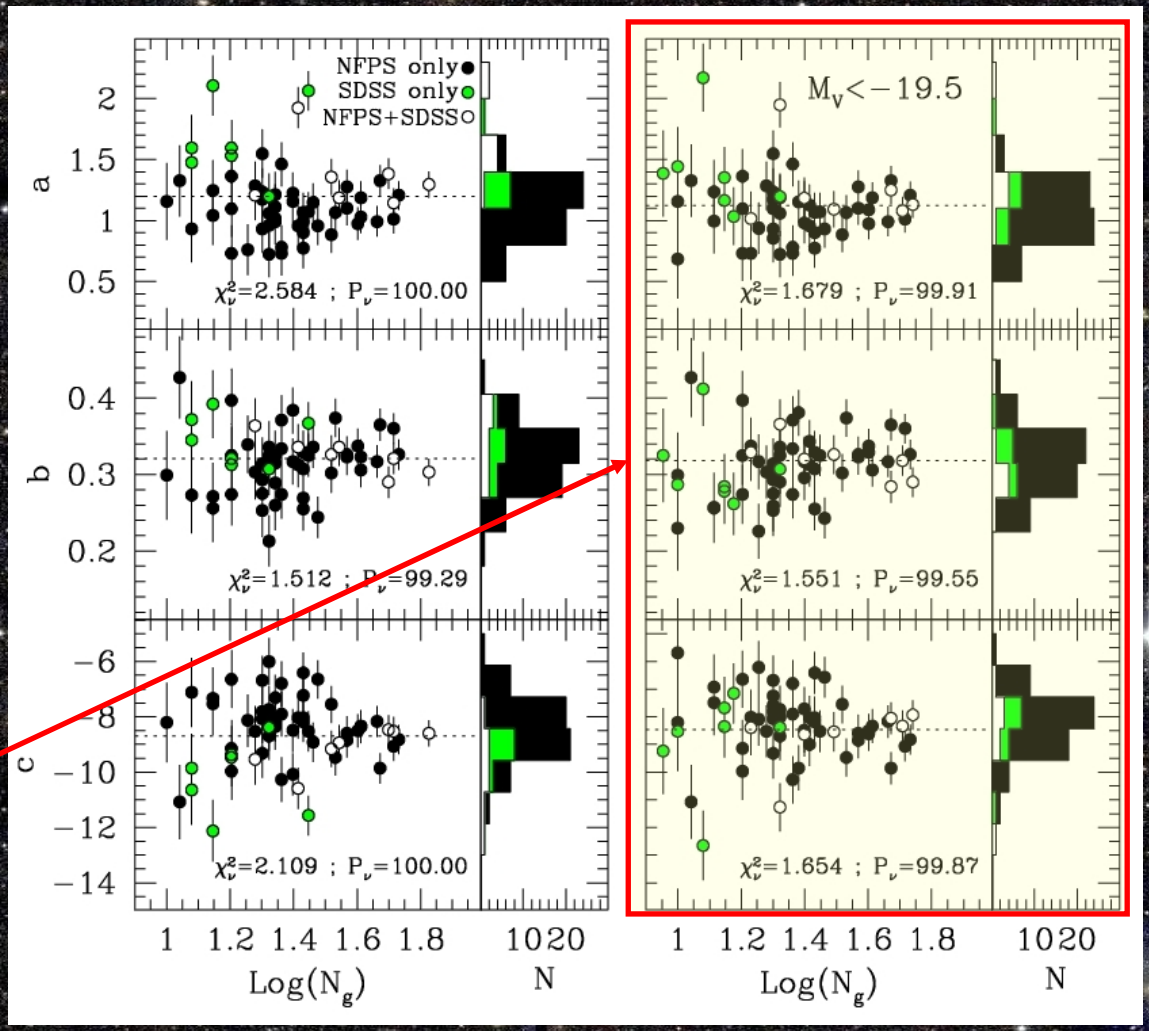
D'Onofrio et al. 2008

Different results of the FP coefficients for the two surveys, due to different galaxy sampling.

$$\mathrm{Log}(R_e) = a\ \mathrm{Log}(\sigma) + b\ \langle\mu\rangle_e + c$$

The Fundamental Plane (FP) of ETGs is not universal!!!

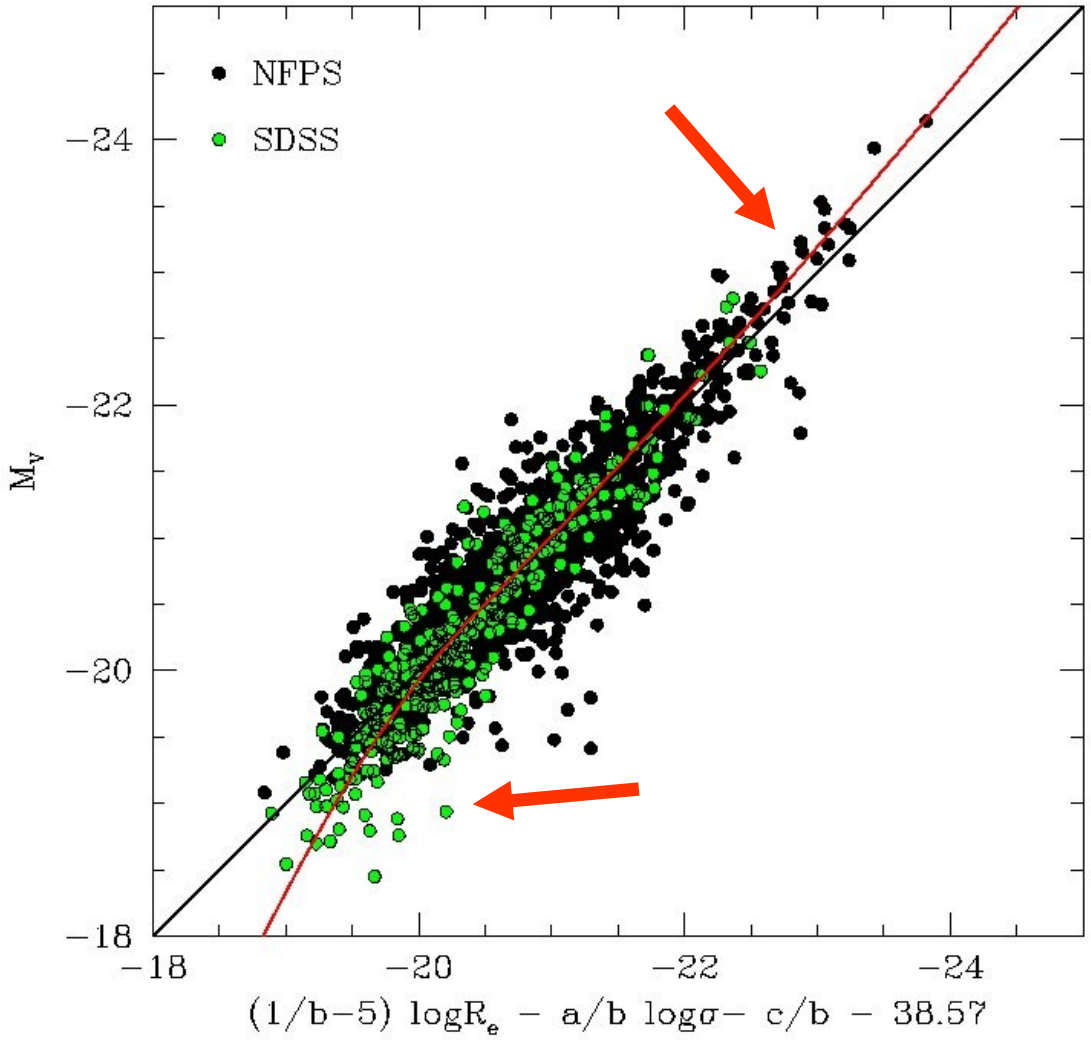
When the selection bias is *partially* removed, the scatter remains high ...



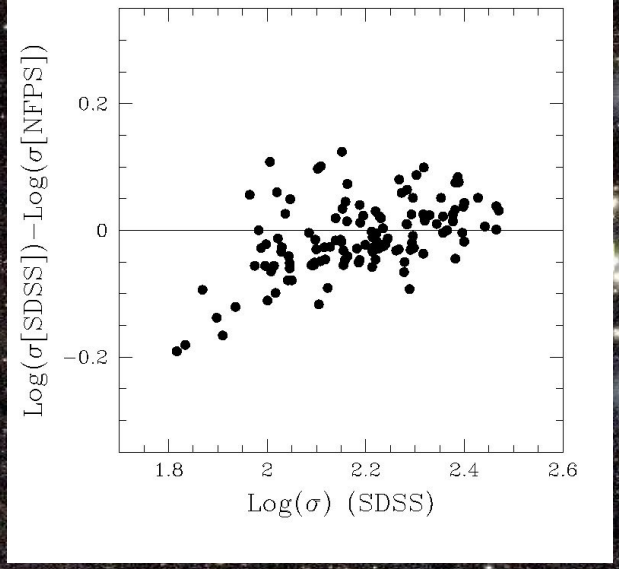
WINGS Fundamental Plane

D'Onofrio et al. 2008

The FP appears to be WARPED!!!



The WARP is not due to systematic differences in σ.

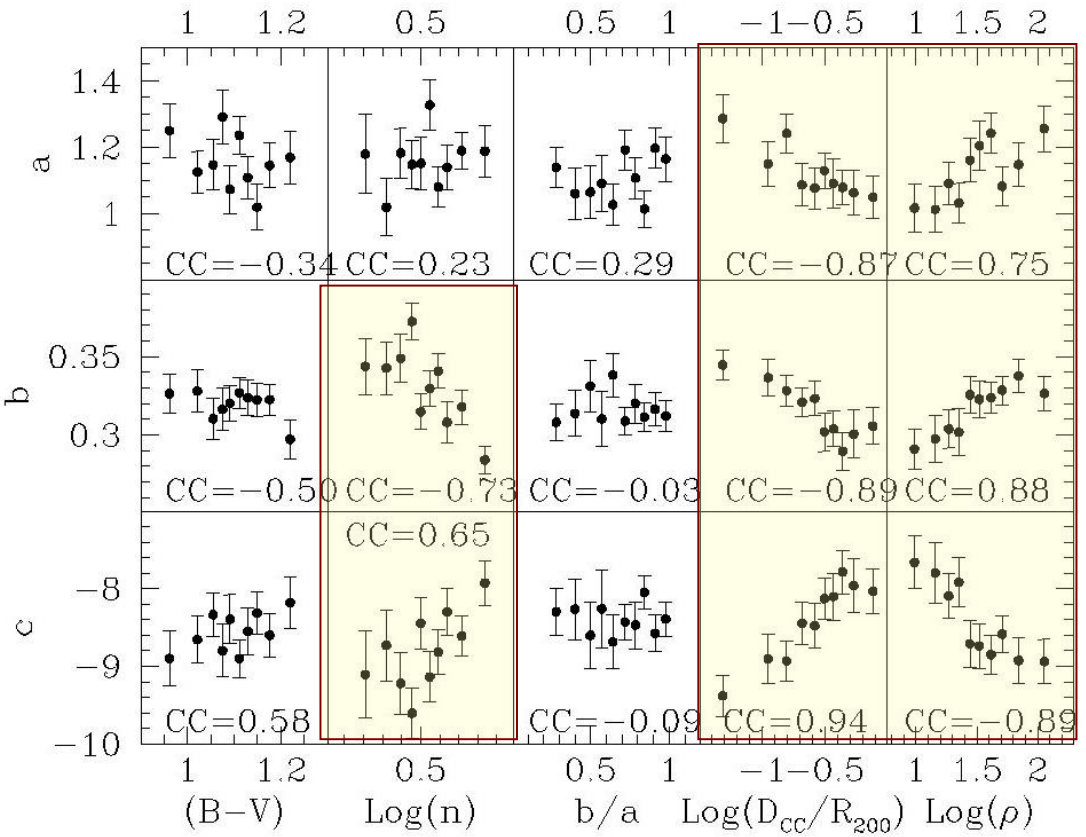


WINGS Fundamental Plane

D'Onofrio et al. 2008

The FP coefficients correlate weakly with galaxies properties, and significantly with environmental quantities

Correlation with local density and clustercentric distance

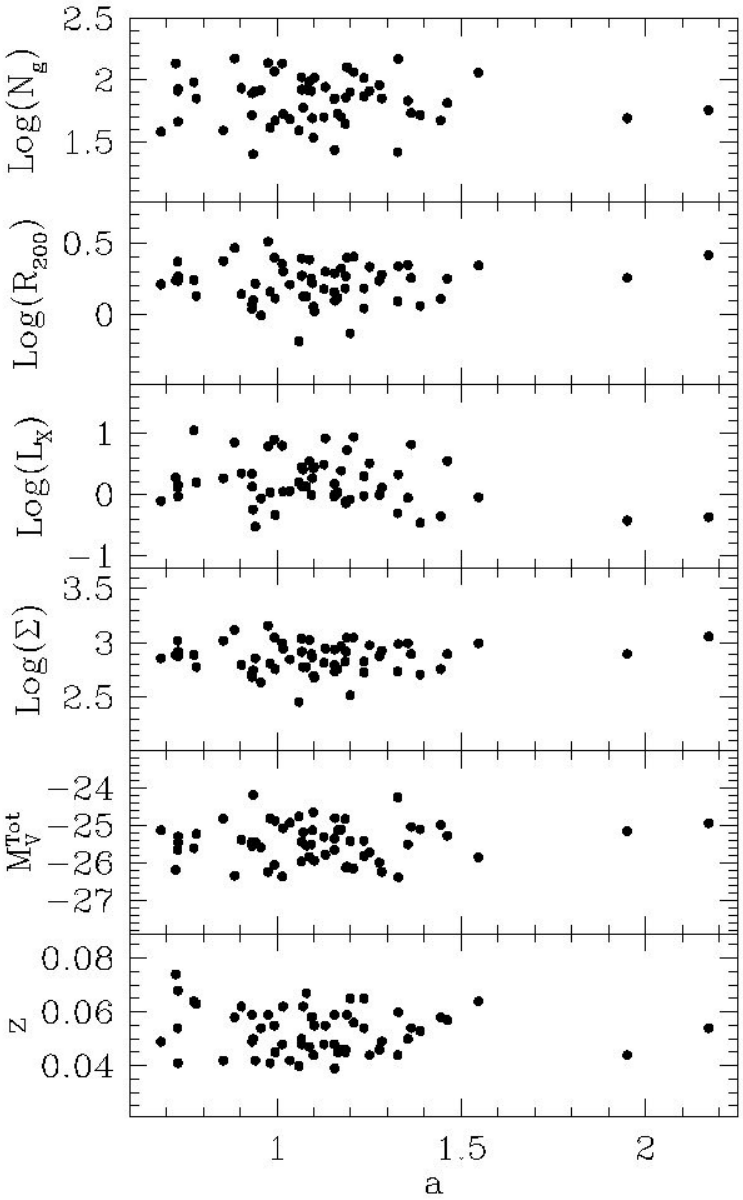


Binned parameters for the whole sample

WINGS Fundamental Plane

D'Onofrio et al. 2008

BUT, the FP coefficients do not correlate with cluster properties....



WINGS Fundamental Plane

D'Onofrio et al. 2008

THE FUNDAMENTAL PLANE OF EARLY–TYPE GALAXIES IN NEARBY CLUSTERS FROM THE WINGS DATABASE

M. D'Onofrio[1], G. Fasano[2], J. Varela[3], D. Bettoni[2], M. Moles[3], P. Kjærgaard[4], E. Pignatelli[5], B. Poggianti[2], A. Dressler[6], A. Cava[2], J. Fritz[2], W.J. Couch[7], A. Omizzolo[2,8]

[1] *Astronomy Department, Vicolo Osservatorio 3, I-35122 Padova, Italy*

SUMMARIZING

1) The systematic differences of the FP coefficients between SLOAN and NOAO surveys are primary due to different galaxy sampling

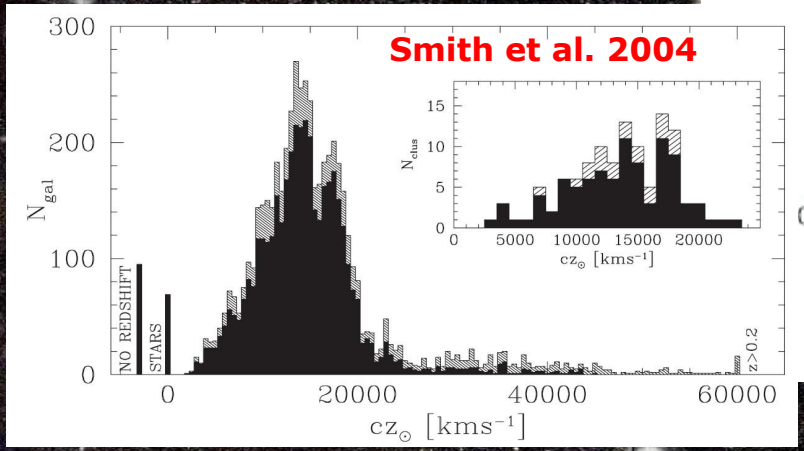
2) The FP coefficients scatter cannot be attributed only to random noise, even after removing the systematics of galaxy sampling

3) FP coefficients do depend on environmental properties and weakly on galaxies properties

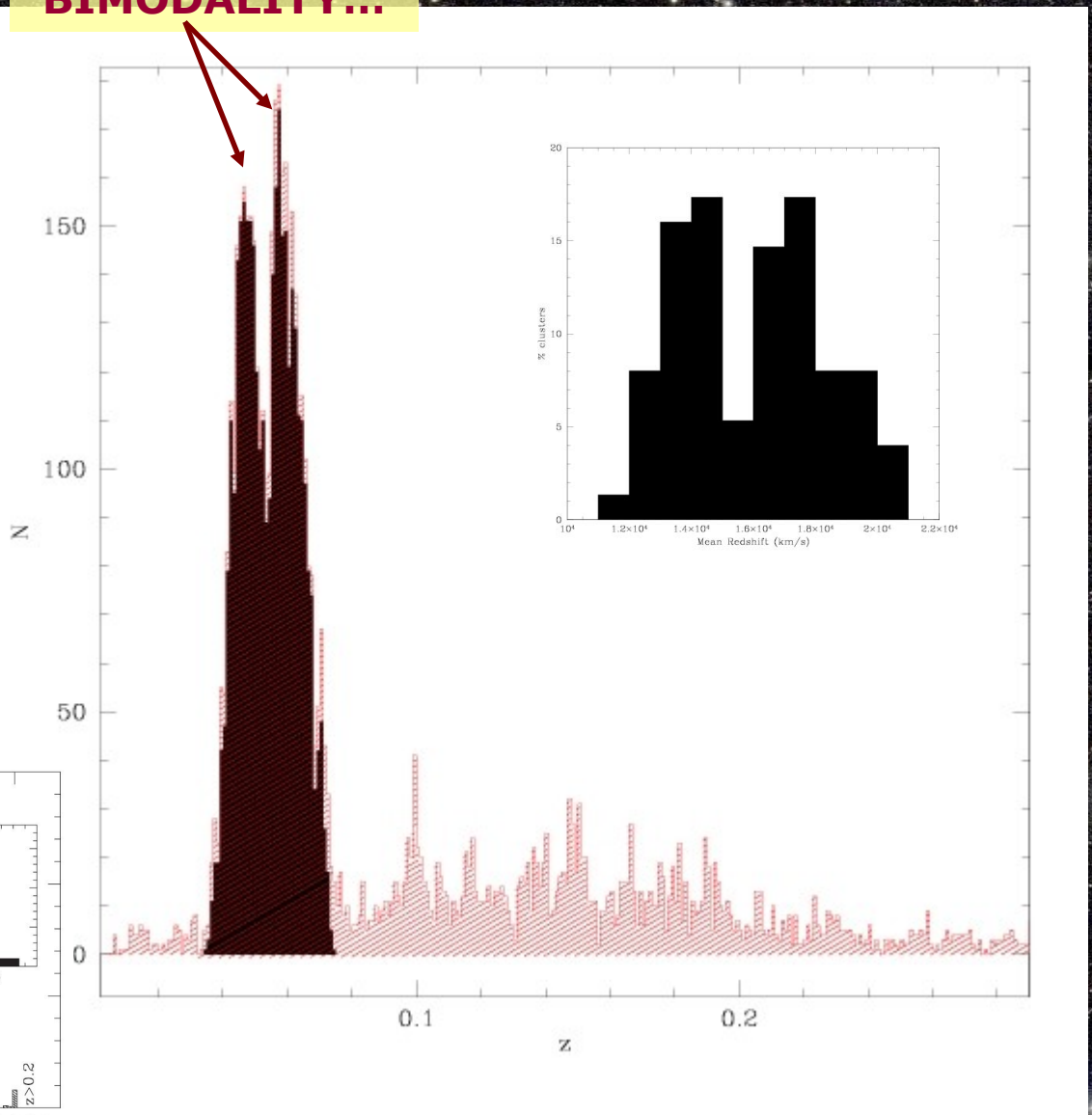
4) FP coefficients do not depend on global cluster properties

WINGS-SPE preliminary studies

About ~60% of the galaxies in the redshift catalogs have been classified as cluster members (black histogram)



BIMODALITY…



WINGS-SPE preliminary studies

6000 WINGS
4500 literature

~ 10500 galaxies with redshift

Analysis in two main directions:

Spectro-photometric modeling

...

(Fritz, Poggianti et al.)

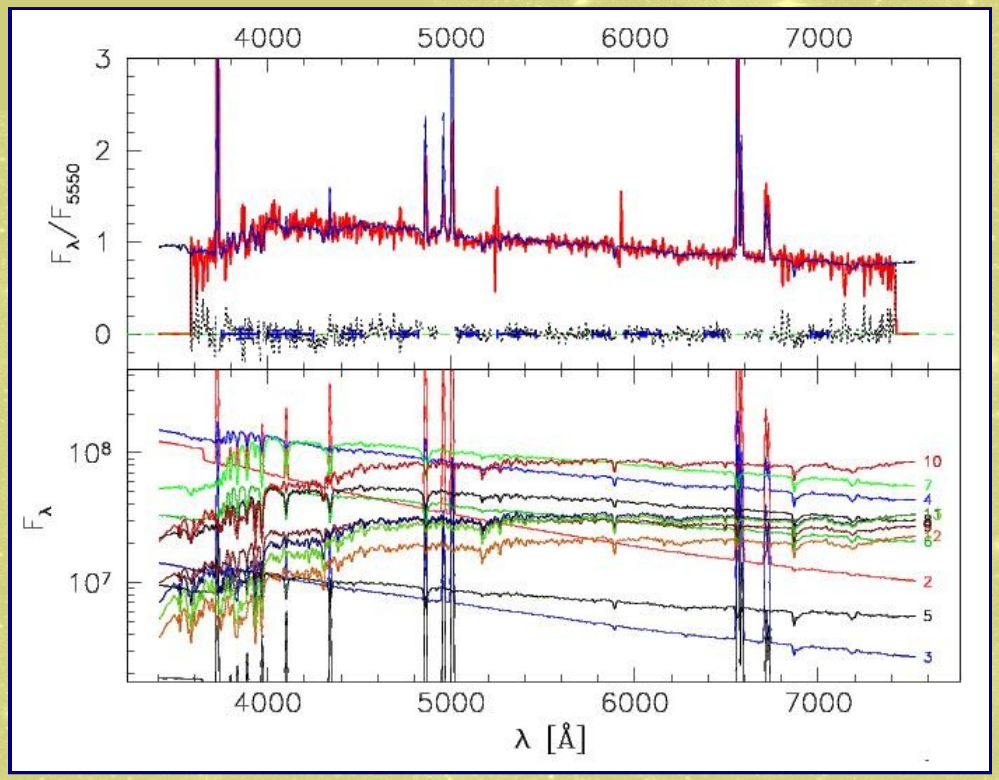
Kinematics and dynamics of clusters and substructures

(Cava, Ramella et al.)

Spectro Photometric tool

Purposely devised for automatic estimate of stellar populations and Star Formation Histories of large galaxy samples

(Fritz et al., 2007)



Technique:

automatic fitting of spectra (continuum and EWs) + broad-band photometry. Spectro-photometric models (4 main age bins) including selective extinction and emission from photoionized gas

Total mass, mass fraction and extinction for the 4 bins of stellar populations (old/interm-old/young-interm/young), Star Formation Rate, Star Formation History of galaxies in the WINGS clusters

Spectro Photometric modeling

(Fritz, Poggianti et al., 2007)

A Spectrophotometric Model Applied to Cluster Galaxies: the WINGS dataset

J. Fritz[1,2], B. M. Poggianti[1], D. Bettoni[1], A. Cava[1], W. J. Couch[3], M. D'Onofrio[2], A. Dressler[4], G. Fasano[1], P. Kjærgaard[5], M. Moles[6], and J. Varela[1].

A galaxy model spectrum is computed by adding the synthetic spectra of Single Stellar Populations (SSPs) of different ages built with a Salpeter initial mass function (IMF) with stellar masses in the range $0.15 \leq M \leq 120\ M_{sun}$

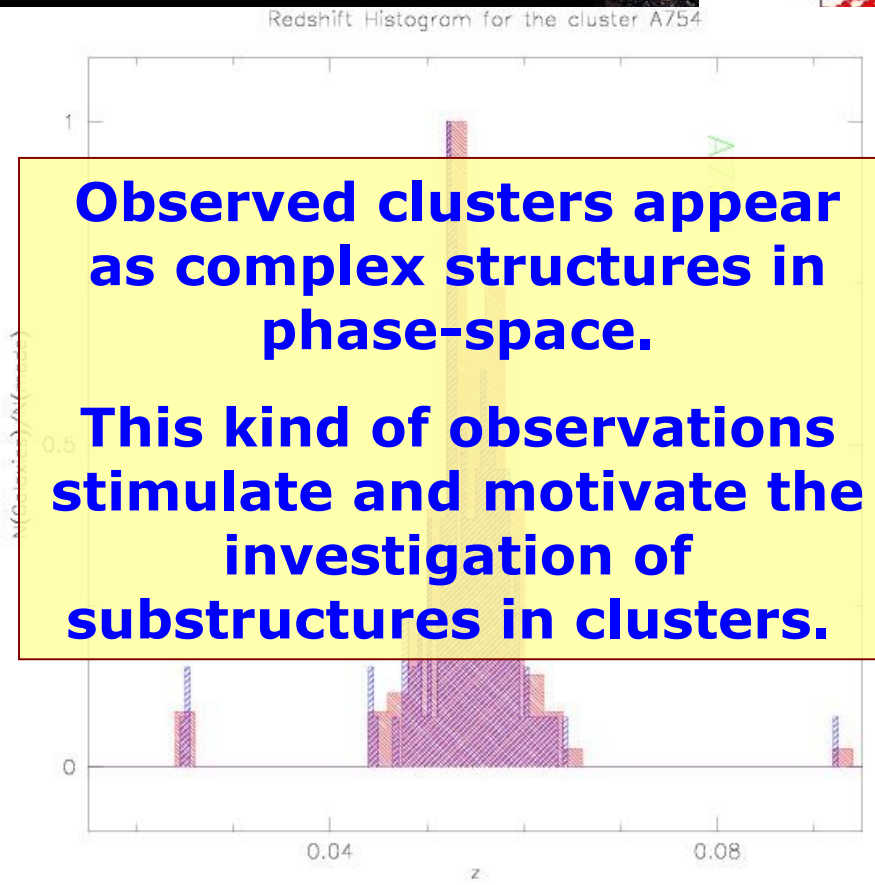
This will give us estimates for star formation rates and histories, as well as metallicity for the cluster galaxies from the line indices and equivalent widths measurements .

These data are used to explore the link between the spectral properties and the morphological evolution in different density environments.

Kinematics and Dynamics

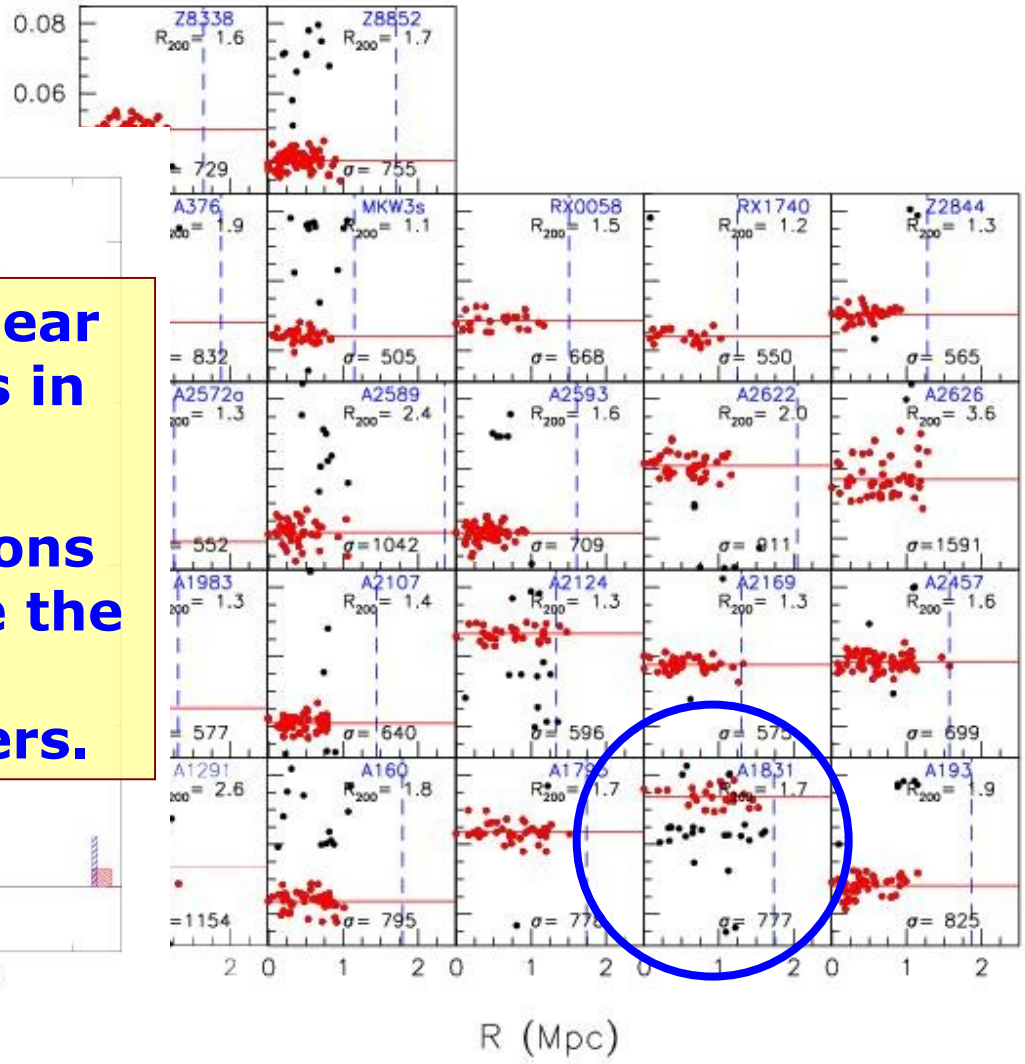
(Cava, Ramella et al., 2007+)

Membership and velocity dispersion determination



Observed clusters appear as complex structures in phase-space.

This kind of observations stimulate and motivate the investigation of substructures in clusters.



Cluster Substructures

(Cava, Ramella et al., 2007+)

DEDICA-2D

- **Spatial substructures (2D studies)**

Availability of large data sets, reaching thousand of positions for nearby clusters.

Contamination from fore/background objects

Modified Dressler-Shectman

- **Velocity substructures (2D+1 studies)**

Selection of cluster members with redshift

Unavailability of large data sets

ONGOING WORK

- **Spatial-velocity substructures (3D studies)**

"Objective" method, same weight to spatial coordinates and velocities

Arbitrary scale parameter

FoF

WINGS substructures

(Ramella, Biviano et al., 2007)

DEDICA

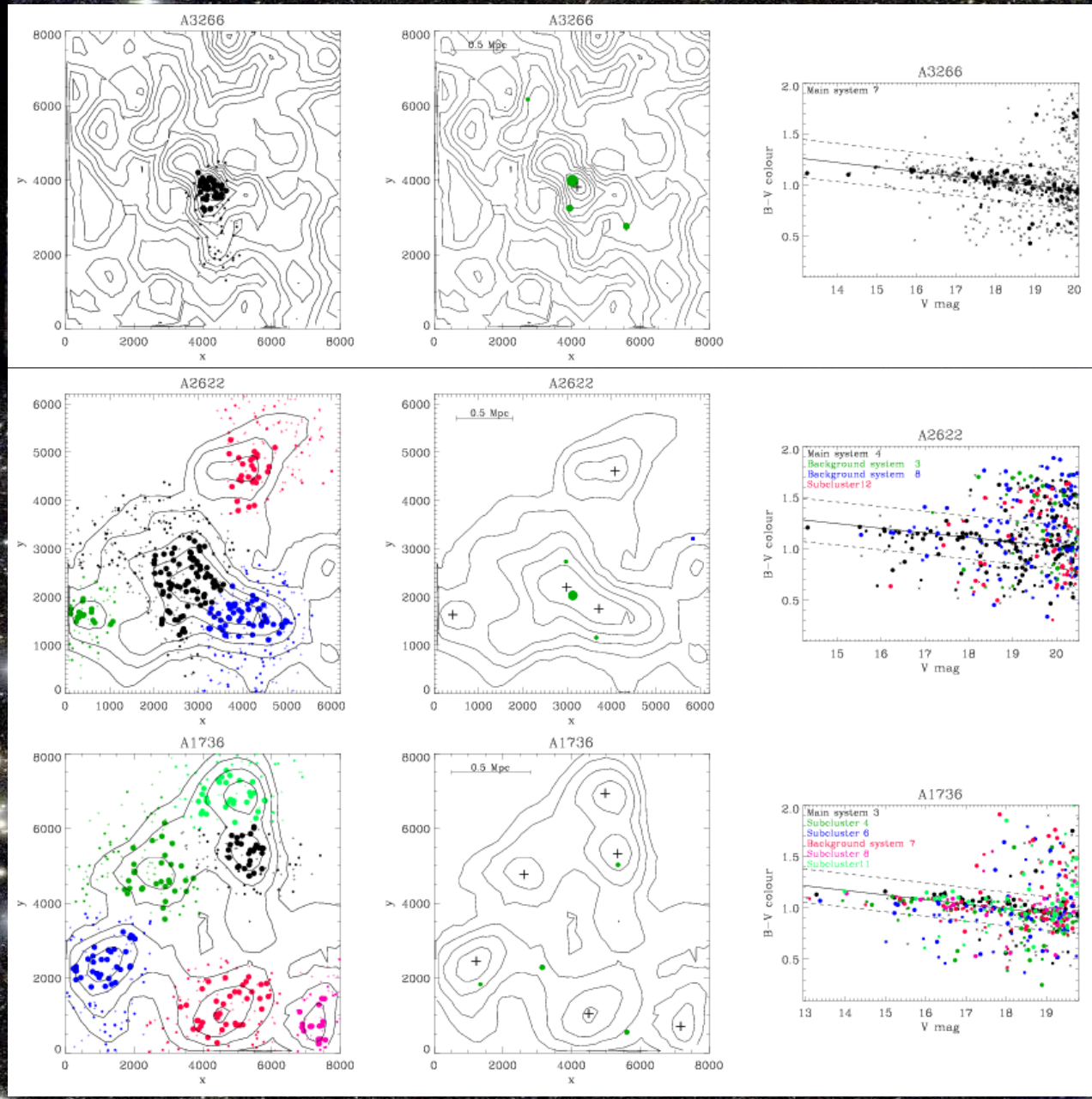
27 % with NO subs

40 % with Nsub=1

19 % with Nsub=2

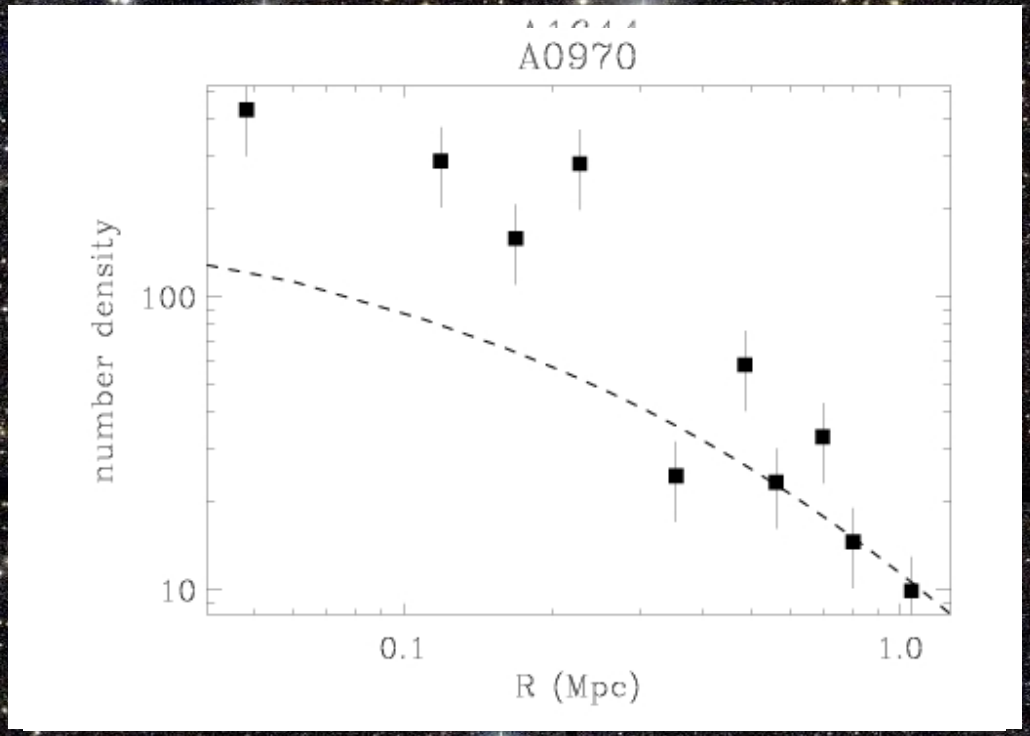
11 % with Nsub=3

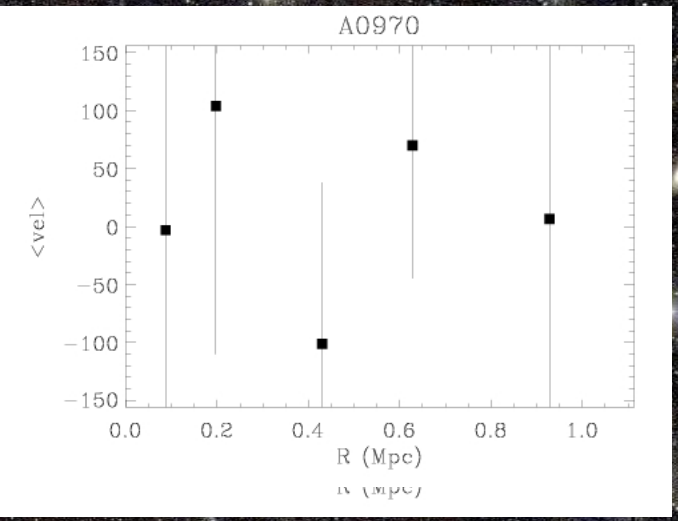
3 % with Nsub=4



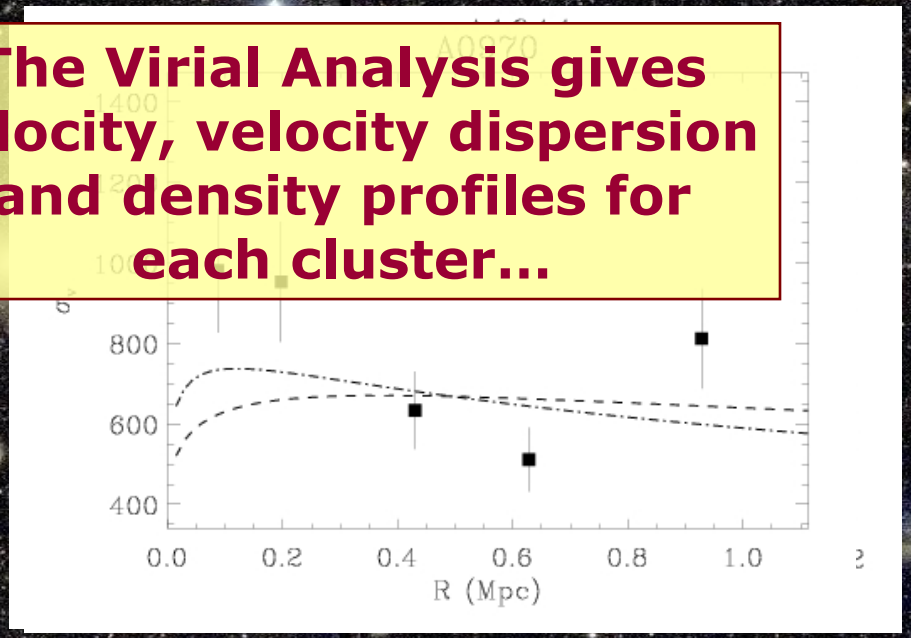
Kinematics and Dynamics

(Cava, Ramella et al., 2007+)





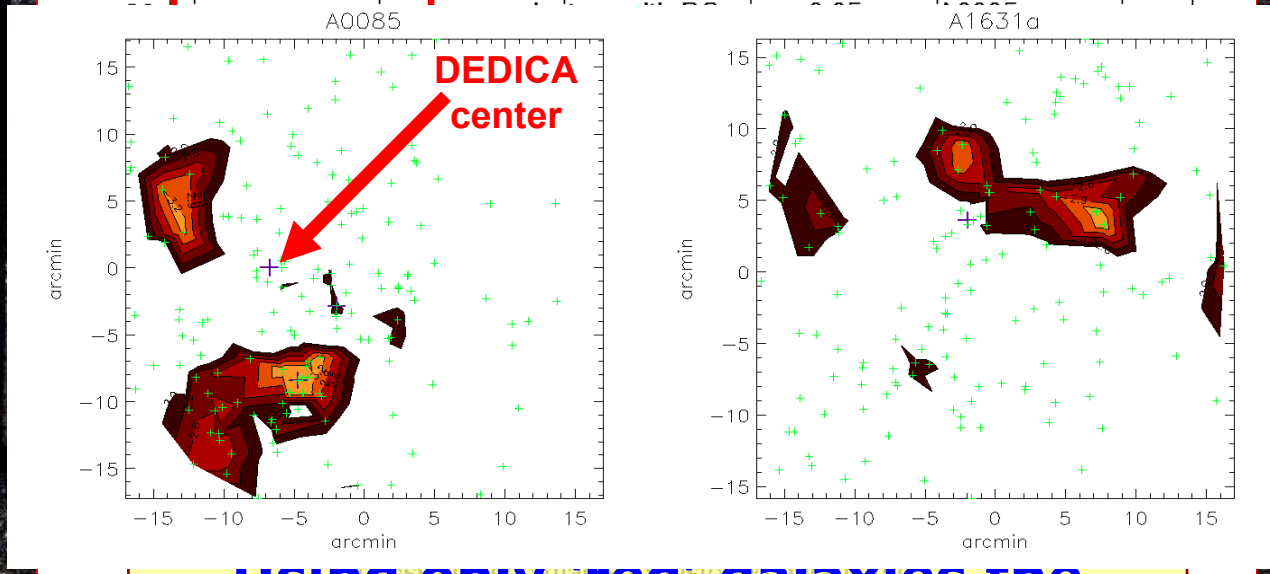
The Virial Analysis gives velocity, velocity dispersion and density profiles for each cluster…



About 65% of the clusters in the sample present deviations in the velocity, vdp and density profiles.

WINGS substructures

(Cava, Ramella et al., 2007+)



MODIFIED DRESSLER SHECTMAN

Use of redshift to decide cluster membership

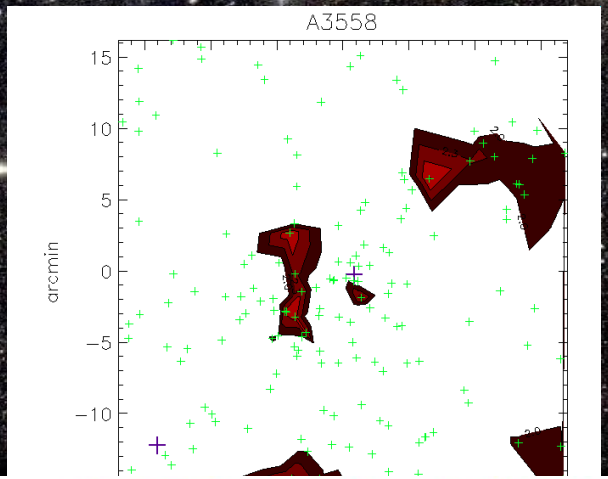
Using only red galaxies the number of substructured clusters falls to 28% as expected

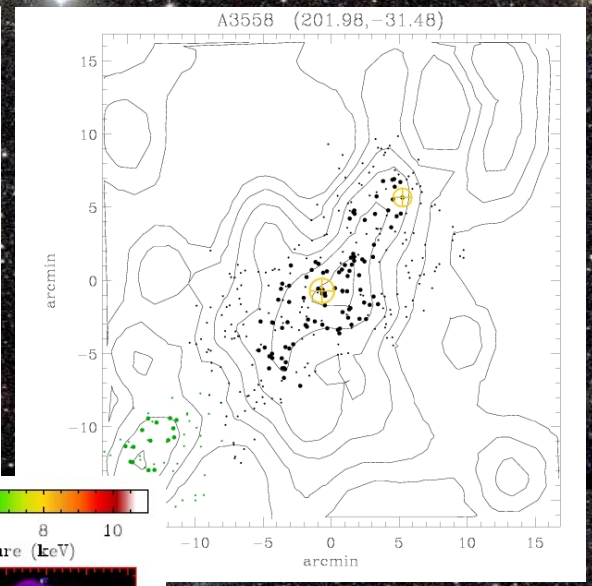
DS maps show the presence of substructures in velocity space...

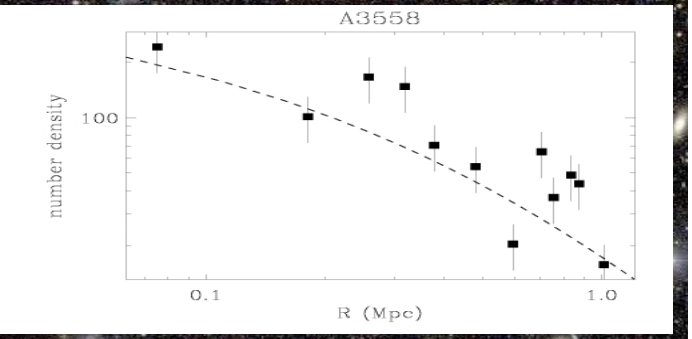
42% of clusters have a DS parameter that indicates presence of substructures
(Cava et al.,2008c)

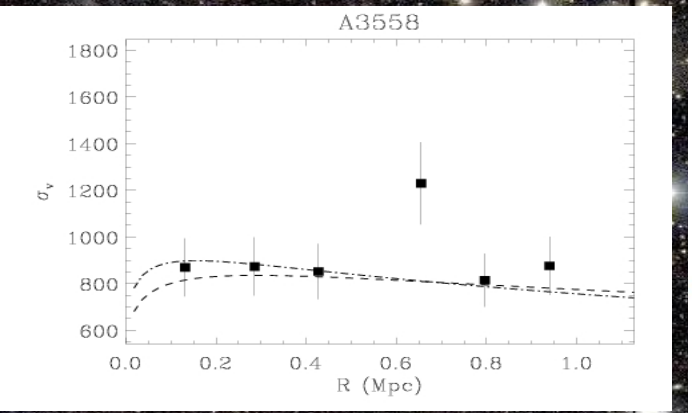
WINGS substructures

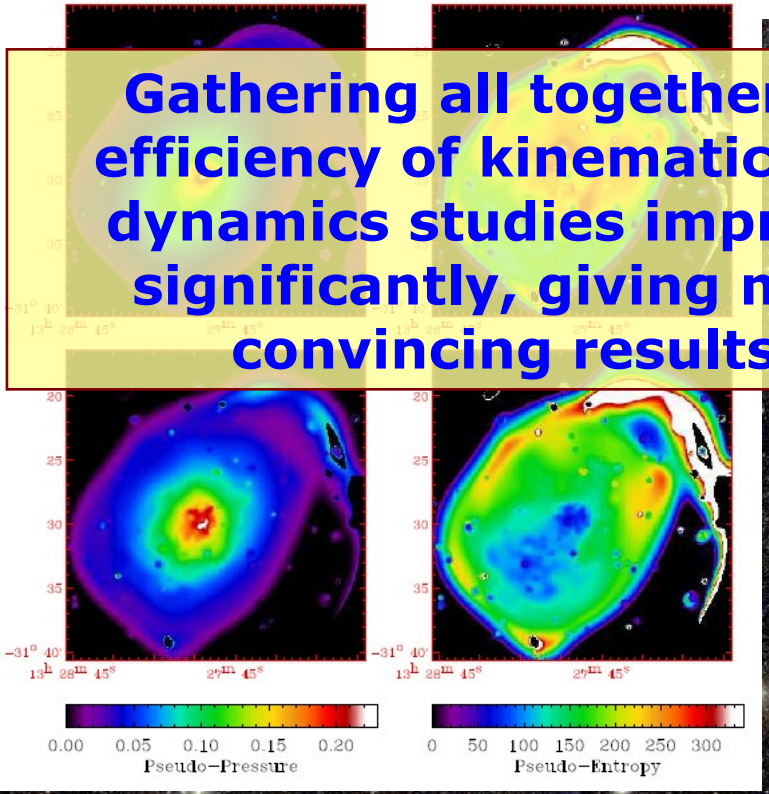
(Cava, Ramella et al., 2007+)









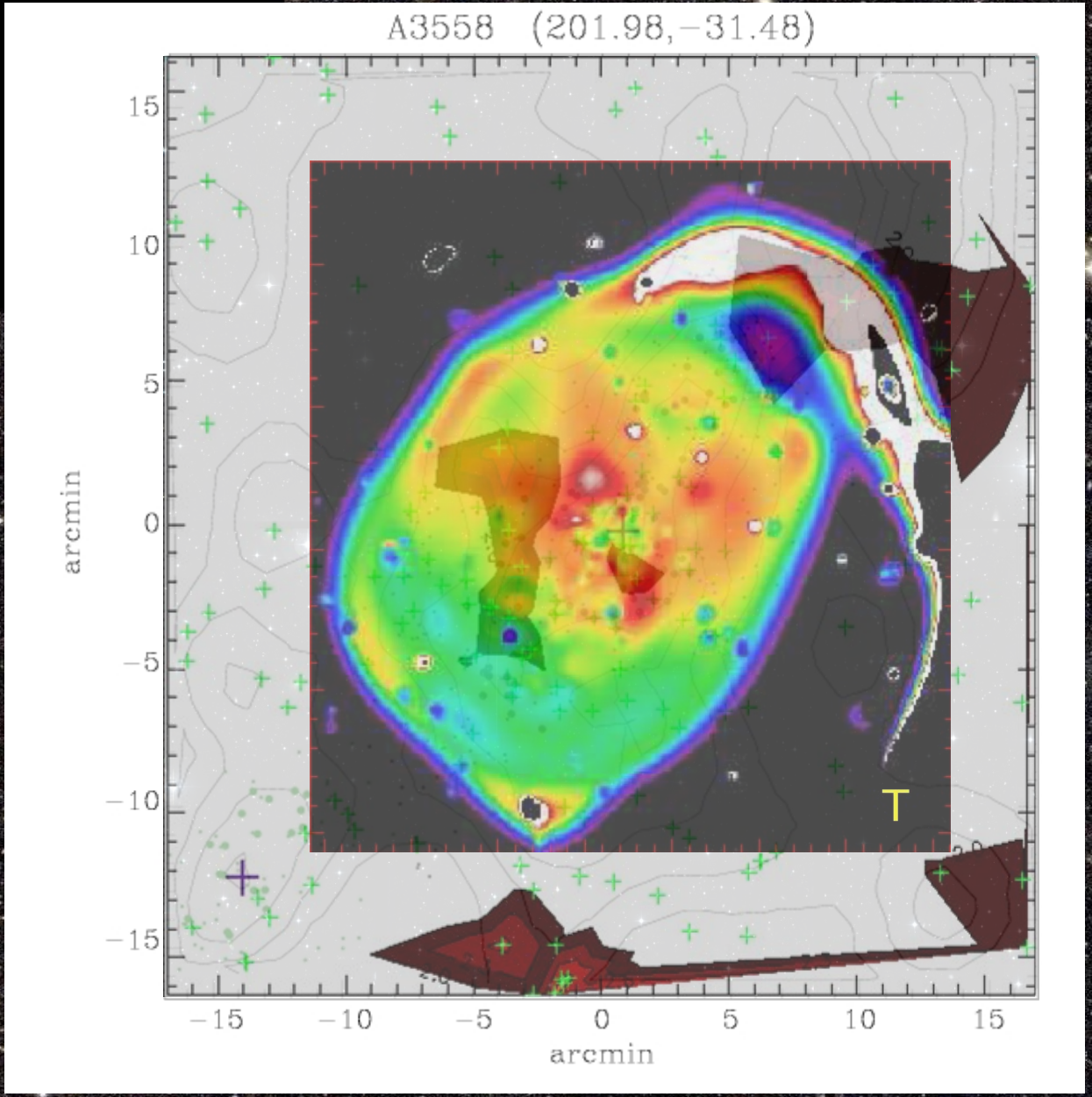


Gathering all together the efficiency of kinematics and dynamics studies improves significantly, giving more convincing results

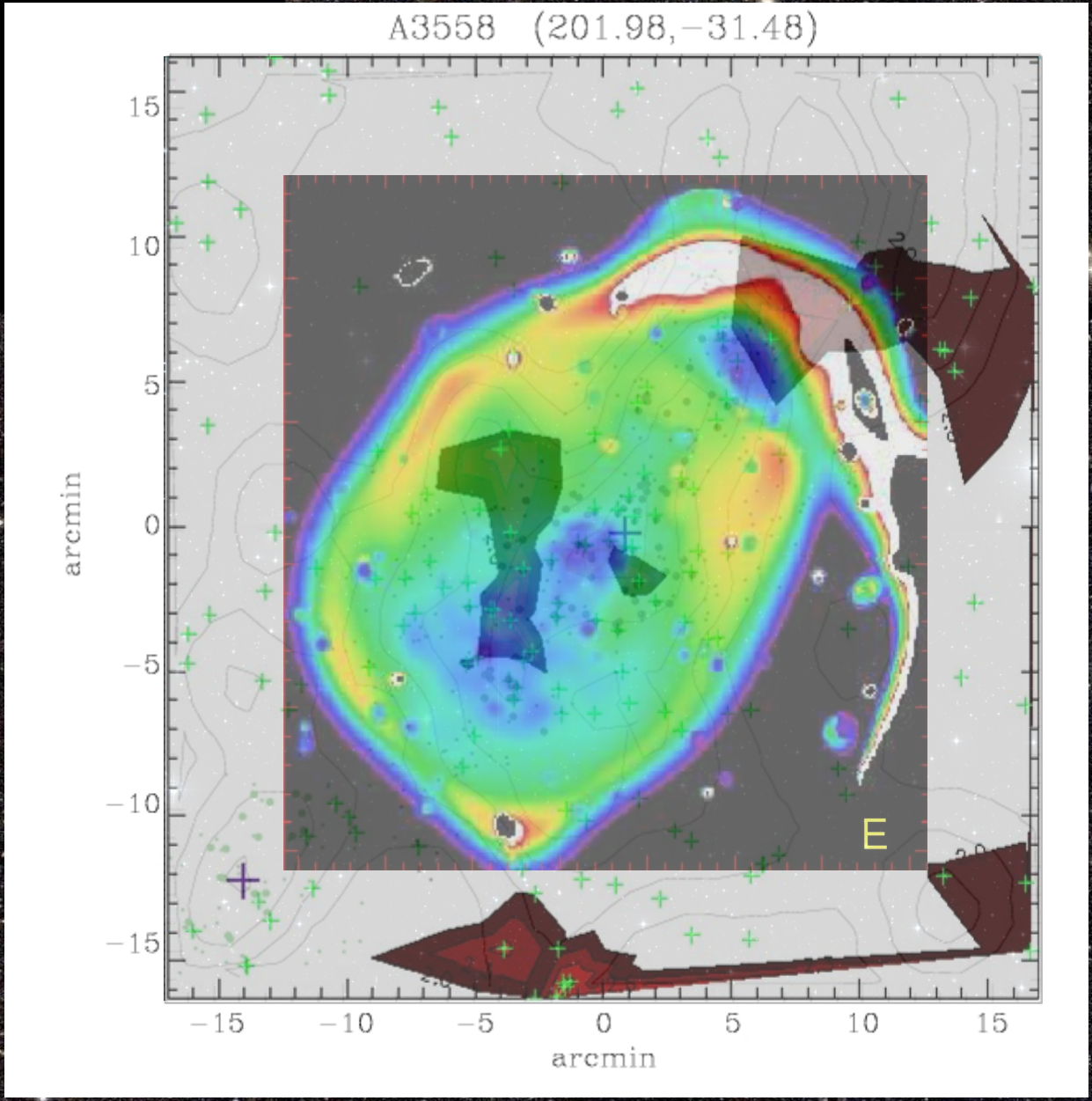
X-ray maps can give additional clues on cluster substructures

Courtesy of M.Rossetti

Gathering all together, the case of A3558



Gathering all together, the case of A3558



WINGS substructures

(Cava, Ramella et al., 2007+)

Substructures in WINGS clusters*

M. Ramella[1], A. Biviano[1], A. Pisani[2], J. Varela[3,8], D. Bettoni[3], W. J. Couch[4], M. D'Onofrio[5], A. Dressler[6], G. Fasano[3], P. Kjærgaard[7], M. Moles[8], E. Pignatelli[3], and B. M. Poggianti[3]

WINGS-SPE: Spectroscopy in the WIde-field Nearby Galaxy-clusters Survey.

A. Cava[1,2], D. Bettoni[1], B. M. Poggianti[1], W. J. Couch[3], M. D'Onofrio[4], A. Dressler[5], G. Fasano[1], P. Kjærgaard[6], M. Moles[7], and J. Varela[1]

2D-analysis with DEDICA (density maps)

Analysis of V, VD and density profiles

Study of sub-structural properties of the clusters in (2+1)D space (DS maps)

3D-analysis with FoF

Comparison with X-ray observations

Strong indications that galaxy clusters are very complex structures where subclustering assumes a relevant role.

Not relaxed????

The comparison of different methods reveals that in local universe the presence of subs is higher than found in earlier works (tipical values of 30%-50%, see, e.g., Girardi and Biviano 2002):

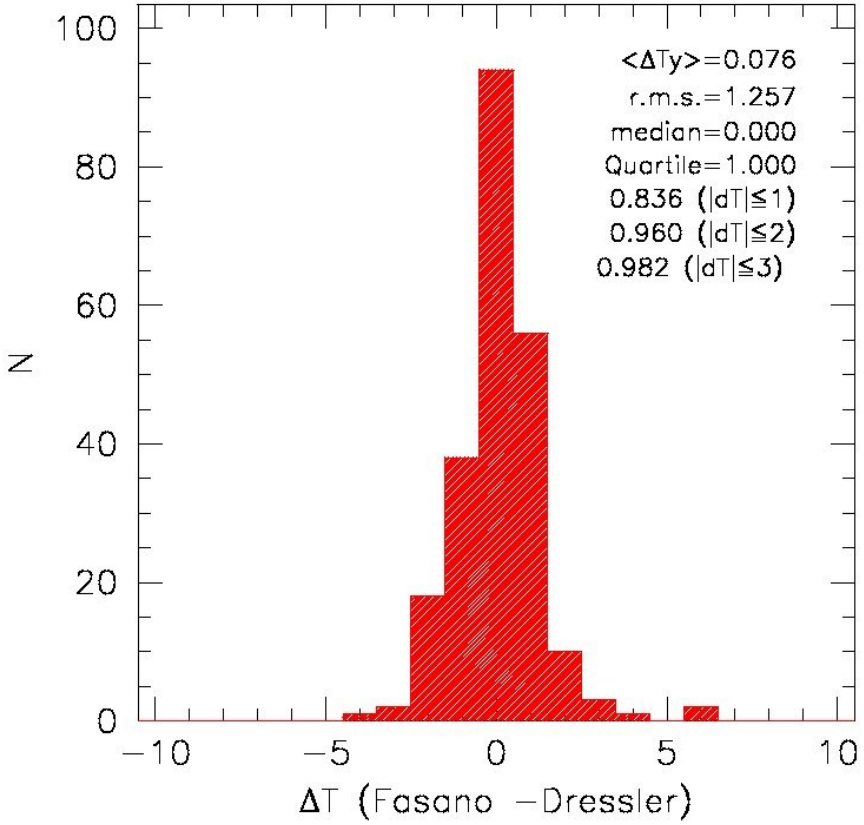
- **73% from 2D-DEDICA analysis**
- **65% investigating radial profiles**
- **42% from (2D+1)-DS analisys**
- **FoF ongoing**

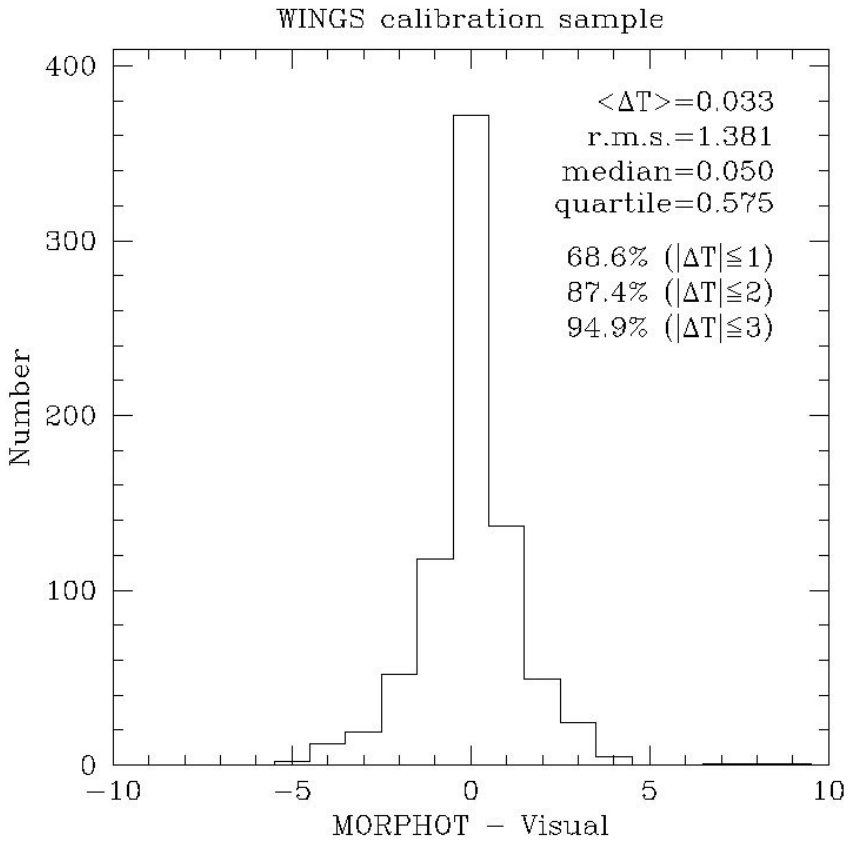
MORPHOT

Automated Morphology

Fasano et al. 2008

The idea is to have a fully automated tool to mimic the visual classification of galaxies morphology....





MORPHOT

Automated Morphology

Fasano et al. 2008

Technique:

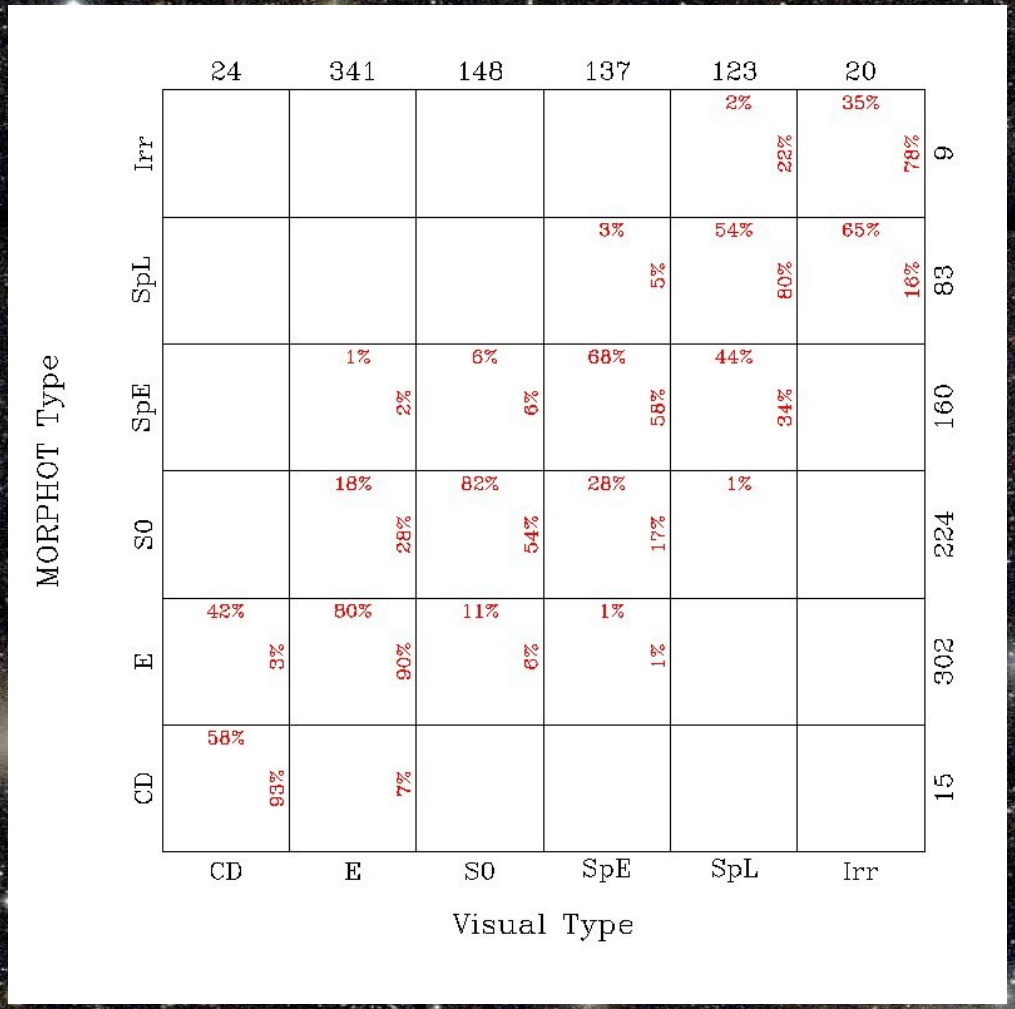
(i) extend the CAS (Concentration/Asymmetry/ Clumpiness) parameter set with several newly devised morphological indicators;

(ii) use a large sample of visually classified galaxies (SDSS and WINGS) to calibrate the whole set of indicators as a function of isophotal area and S/N ratio;

(iii) identify the minimum set of effective indicators

(iv) use both Maximum Likelihood (ML) and Neural Network (NN) techniques to combine them into a final indicator of morphological type

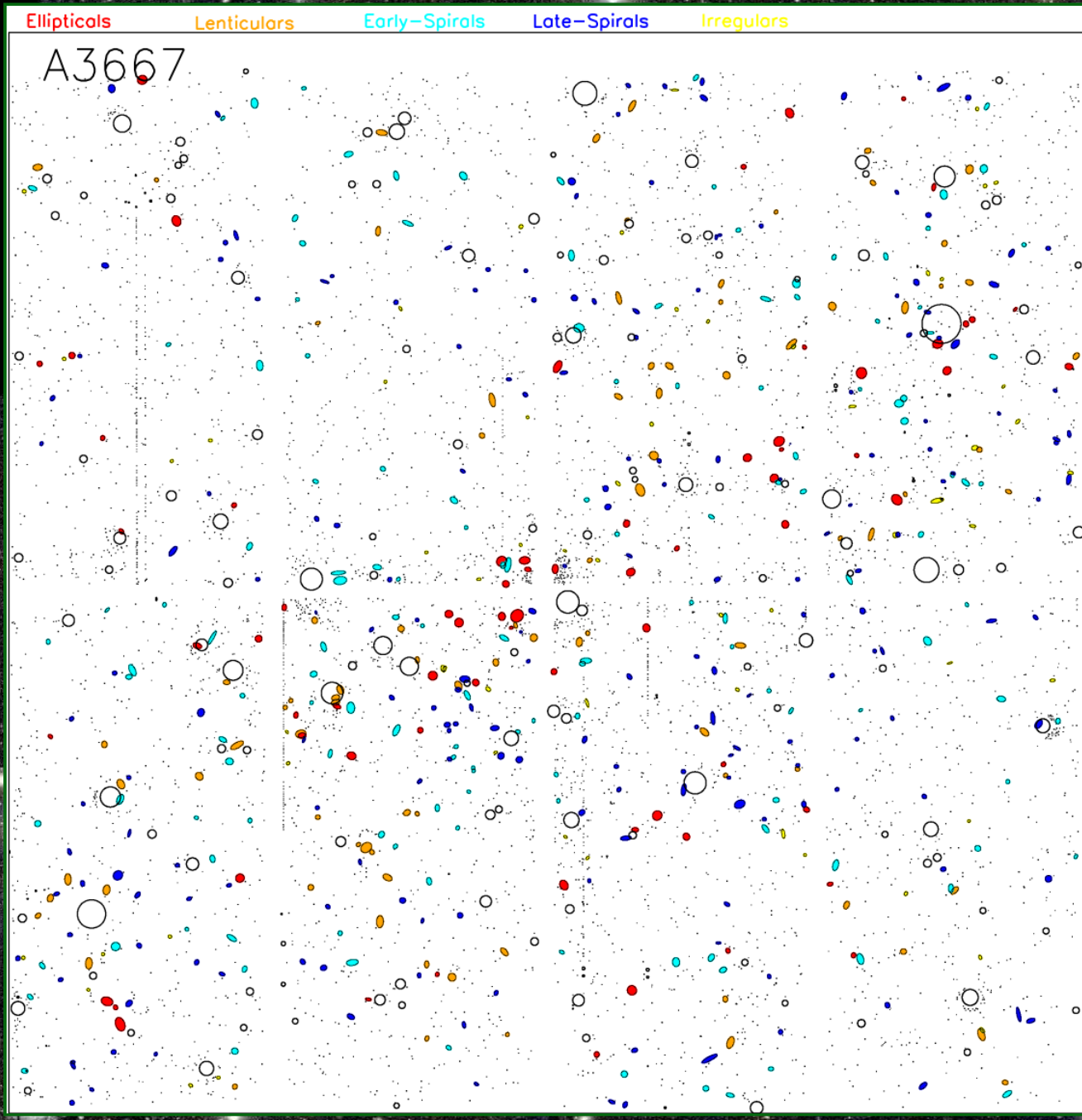
Performances of MORPHOT on SDSS galaxies



MORPHOT

Automated Morphology

Fasano et al. 2008



Morphological classification for ~40,000 WINGS galaxies (area>200 pix²)

FUTURE AND ONGOING WORK

MORPHOT = morphological classes (E/S0/S/Irr)

Distribution of morphological classes in clusters

- **Analysis of the variance of the morphological fractions**
- **Spectral type and Star Formation Histories**
- **Morphology-density relation**
- **Luminosity functions**
- **Color magnitude relations**

WINGS

A Wide-Field Multi-wavelength Survey of Cluster Galaxies in the Local Universe

Will use ASTROWISE for future work???

Hopefully…