The dependence on environment of Cold Dark Matter Halo properties

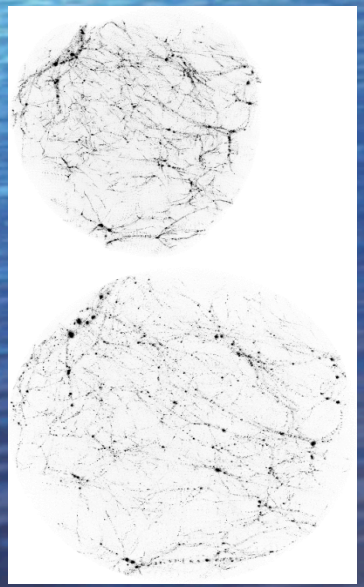
Regardless of they are parent (distinct) halos or subhalos

Trieste, 2005

Pedro Colin (CRyA, UNAM, Mexico)

collaborators

V. Avila-Reese (IA, UNAM)
C. Firmani (OAB, Merate)
S. Gottlöber & Ch. Maulbetsch (AIP)



void

cluster

Content

- Simulations and samples of halos
1. Concentration and inner density
2. Halo shape distribution
- Statistical properties
1. Spin parameter distribution
2. Internal angular momentum alignment
3. Alignment between halo shape and angular momentum
- Structural relations
1. Maximum circular velocity versus mass
2. Velocity dispersion versus mass
- Structural properties

Halos in clusters, voids, and in the field

Different environments

Cluster (hr)
M=2.1 x 10^{14} $M_{\odot}/h$
m_p= 4 x 10^{7} $M_{\odot}/h$
Resolution= 0.6 kpc/h

9 Clusters (lr)
M=[7.3x10^{13},2.4x10^{14}] $M_{\odot}/h$
m_p= 3.2 x 10^{8} $M_{\odot}/h$
Resolution= 2.4 kpc/h

5 Voids
m_p= 4 x 10^{7} $M_{\odot}/h$
Resolution= 1.2 kpc/h

Field
Box= 60 Mpc/h
Resolution=2.0 kpc/h
m_p= 1.1 x 10^{9} $M_{\odot}/h$

Void 50
m_p= 2.5 x 10^{7} $M_{\odot}/h$
Resolution= 0.8 kpc/h

Samples of Halos

Sample	$<M_h>(M_\odot/h)$	λ_{med}
Cl_{all}	5.3×10^{11}	0.024
$Cl_{6(hr)}$	1.0×10^{11}	0.024
V_{all}	4.9×10^{10}	0.030
$V_{50(hr)}$	2.2×10^{10}	0.033
FIELD[1]	1.2×10^{12}	0.032

1 Distinct galatic-size halos drawn from two 60 Mpc/h boxes

C versus Mass diagram

Solid line: linear regression of data from distinct halos of clusters.

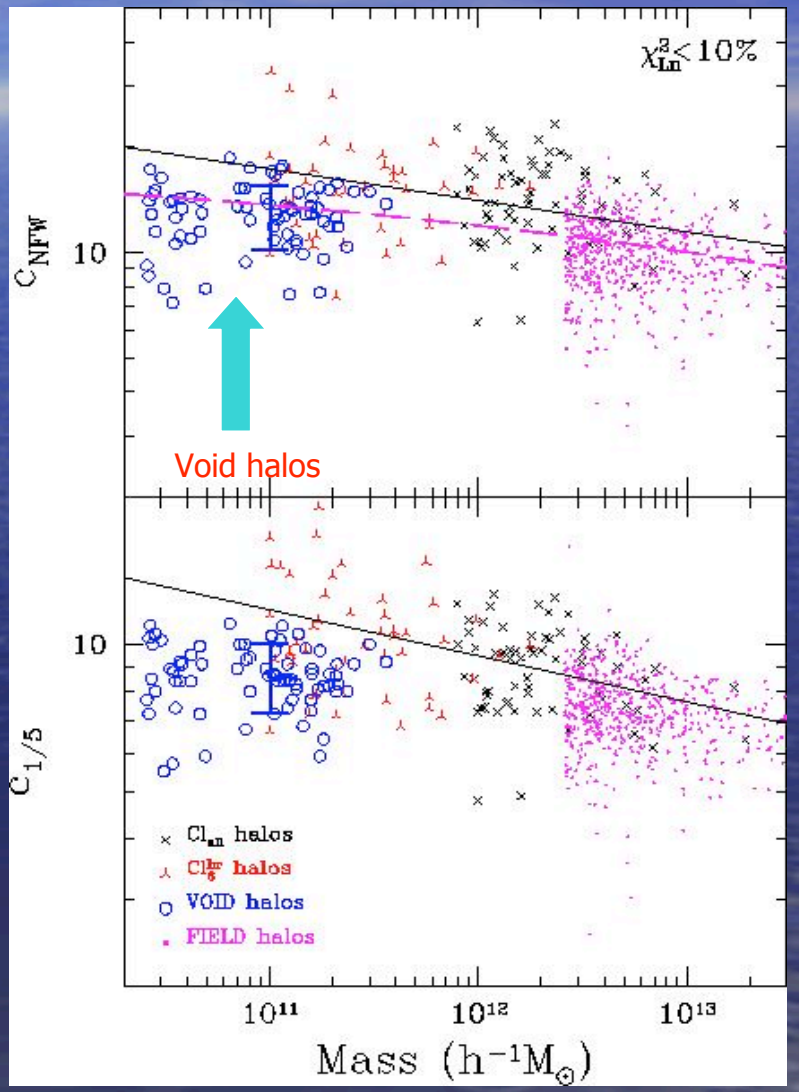
Dashed line: Eke, Navarro and Steinmetz model.

$c_{NFW\ or\ 1/5} = r_h/r_{s\ or\ r1/5}$

$r_{1/5}$ = the radius where 1/5 M_{vir} is contained.

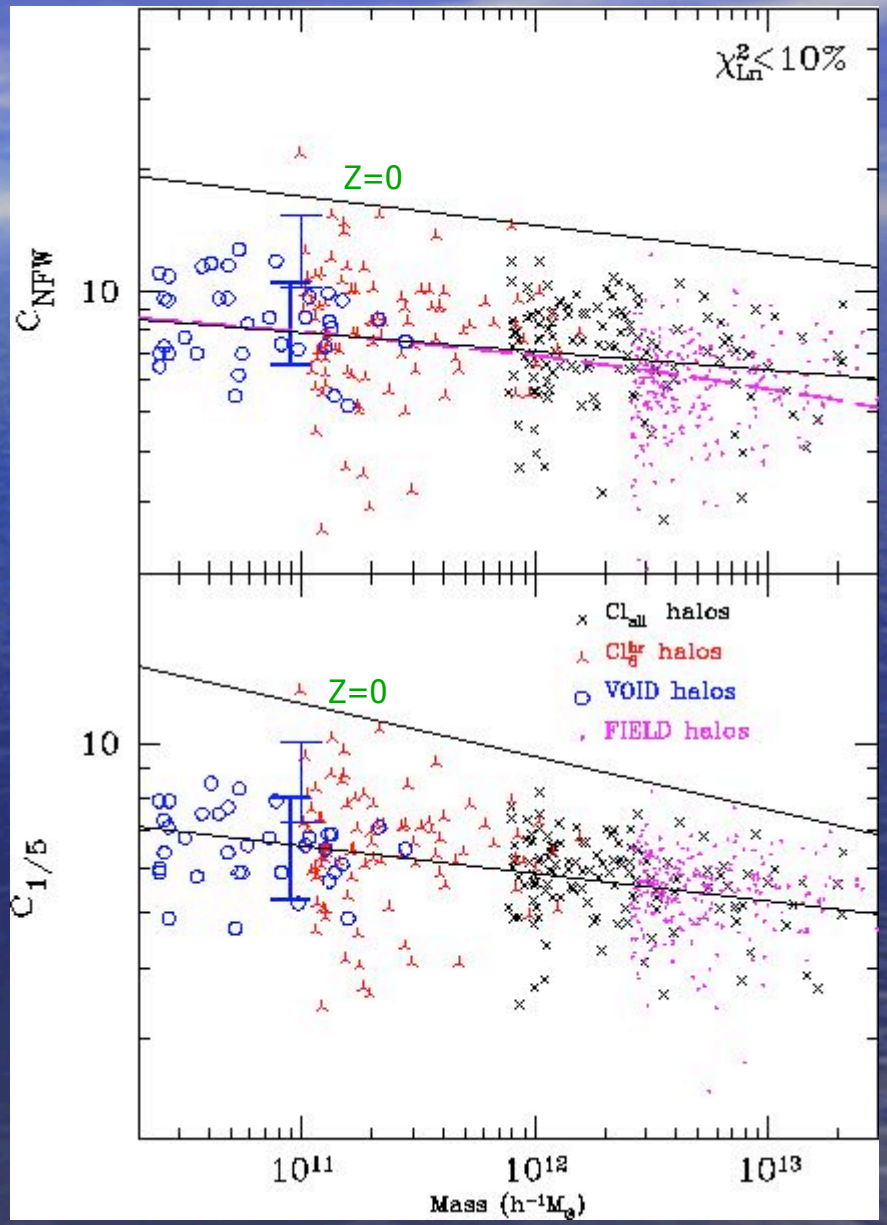
Halos have more than 2500 particles.

Void halos are 40% less concentrated than cluster halos



At z=1

Differences seen at z=0 disappear



Halo shape distribution

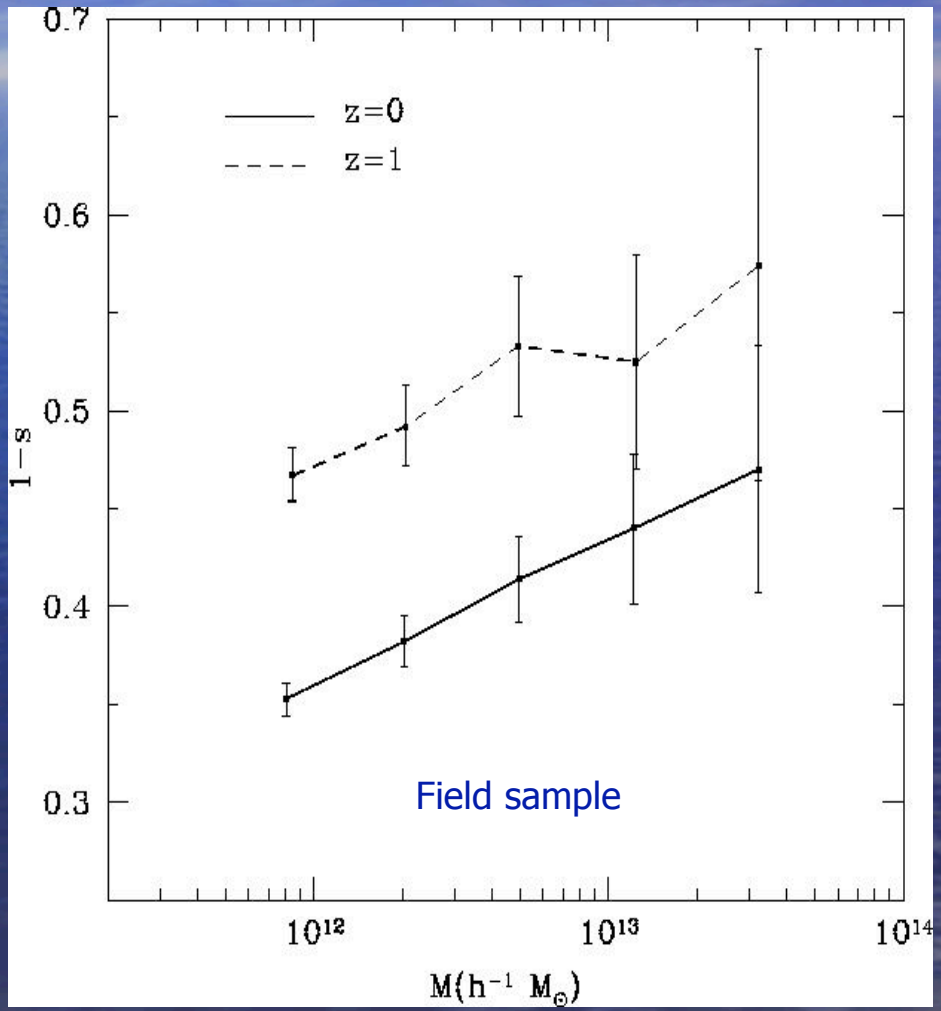
Halos with more than 500 particles and within R_h

The weighted inertia tensor

$$I_{ij} = \_x_i x_j / a^2,$$

Elliptical distance

$$a = (x^2 + y^2/q^2 + z^2/s^2)^{1/2}$$

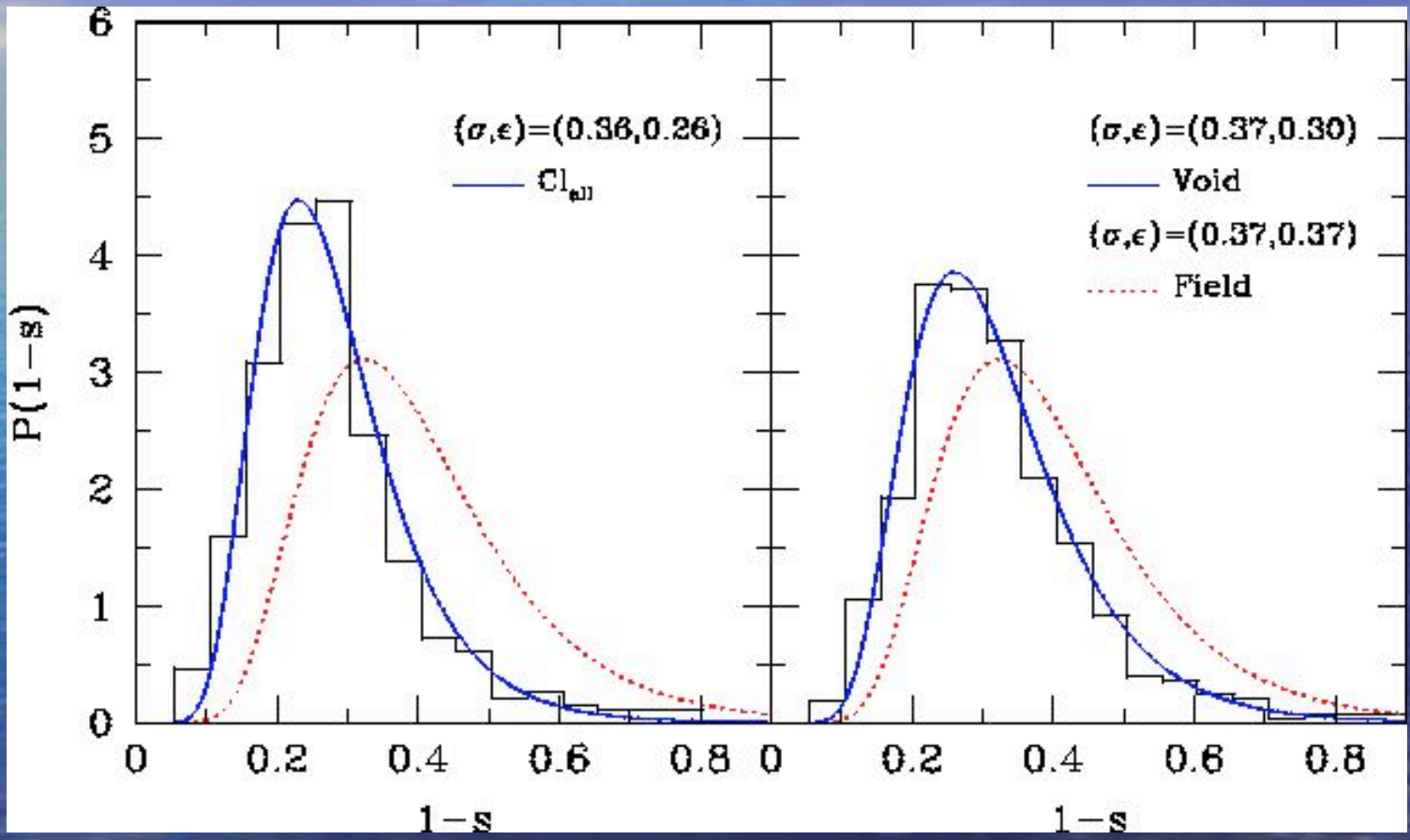


Statistical Properties: ellipticity distribution,

Halos with $n_p > 500$.

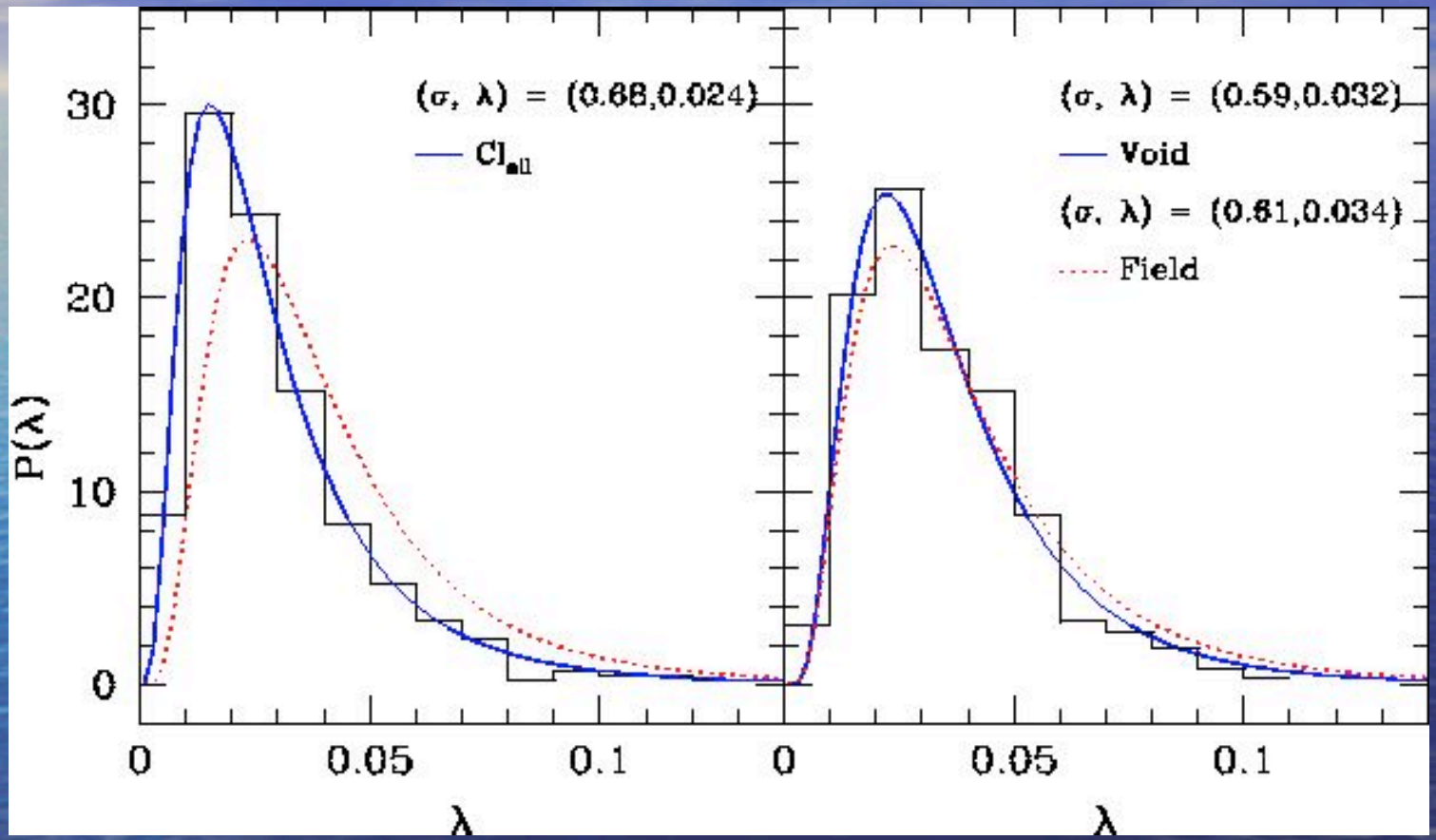
Subhalos are cut at the tidal or truncation radius.

Halos in the field are distinct halos with $R_{vir} < 300$ kpc/h.



$P(x) = [x(2\pi)^{1/2}\_]^{-1} \exp(-\ln^2(x/x_0) / 2\_^2)$ Halos in clusters are on average more spherical

Spin distribution



A KS test show that these two distributions are different

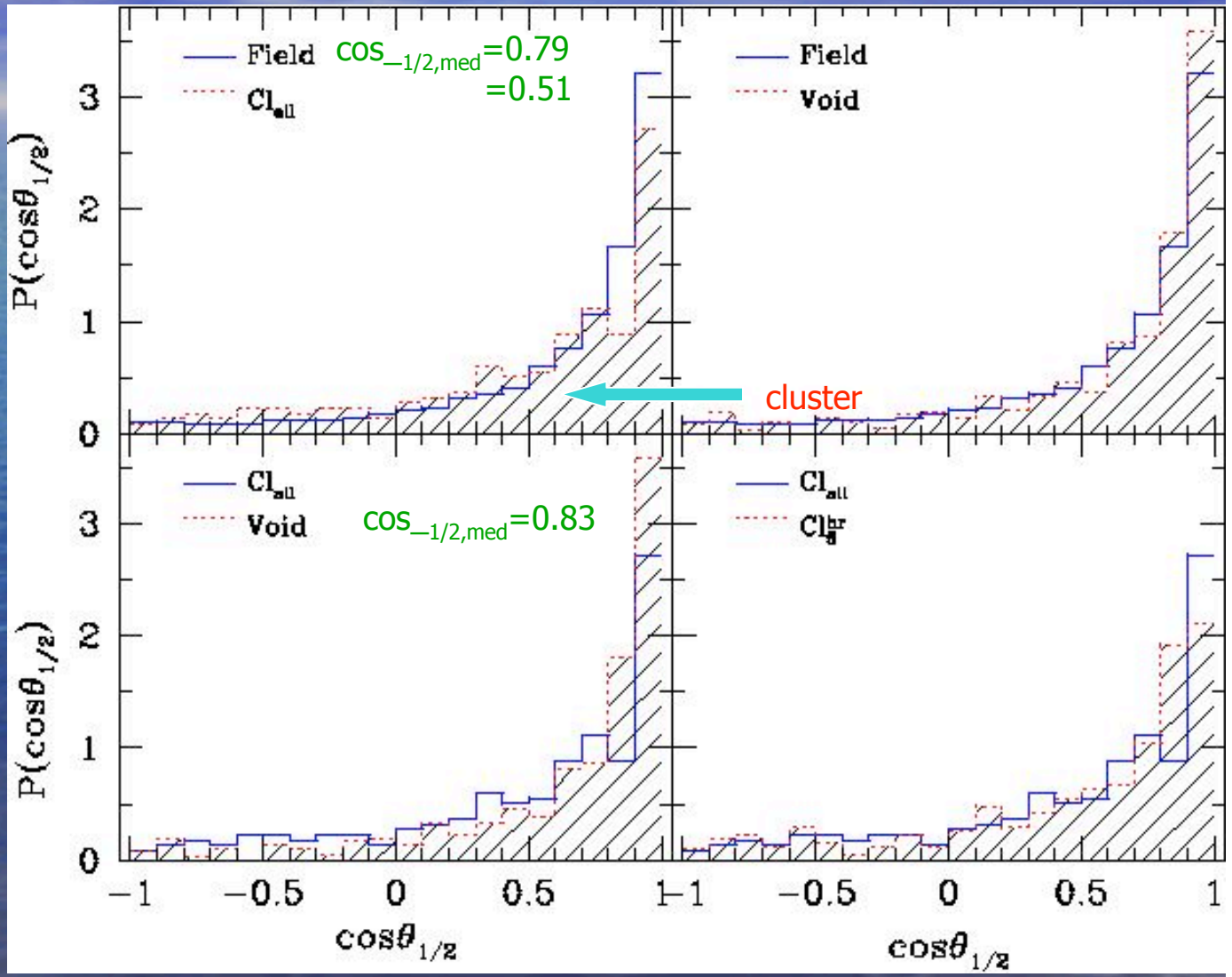
Halos, distinct or subhalos, in clusters have on average a lower spin

Internal angular momentum alignment

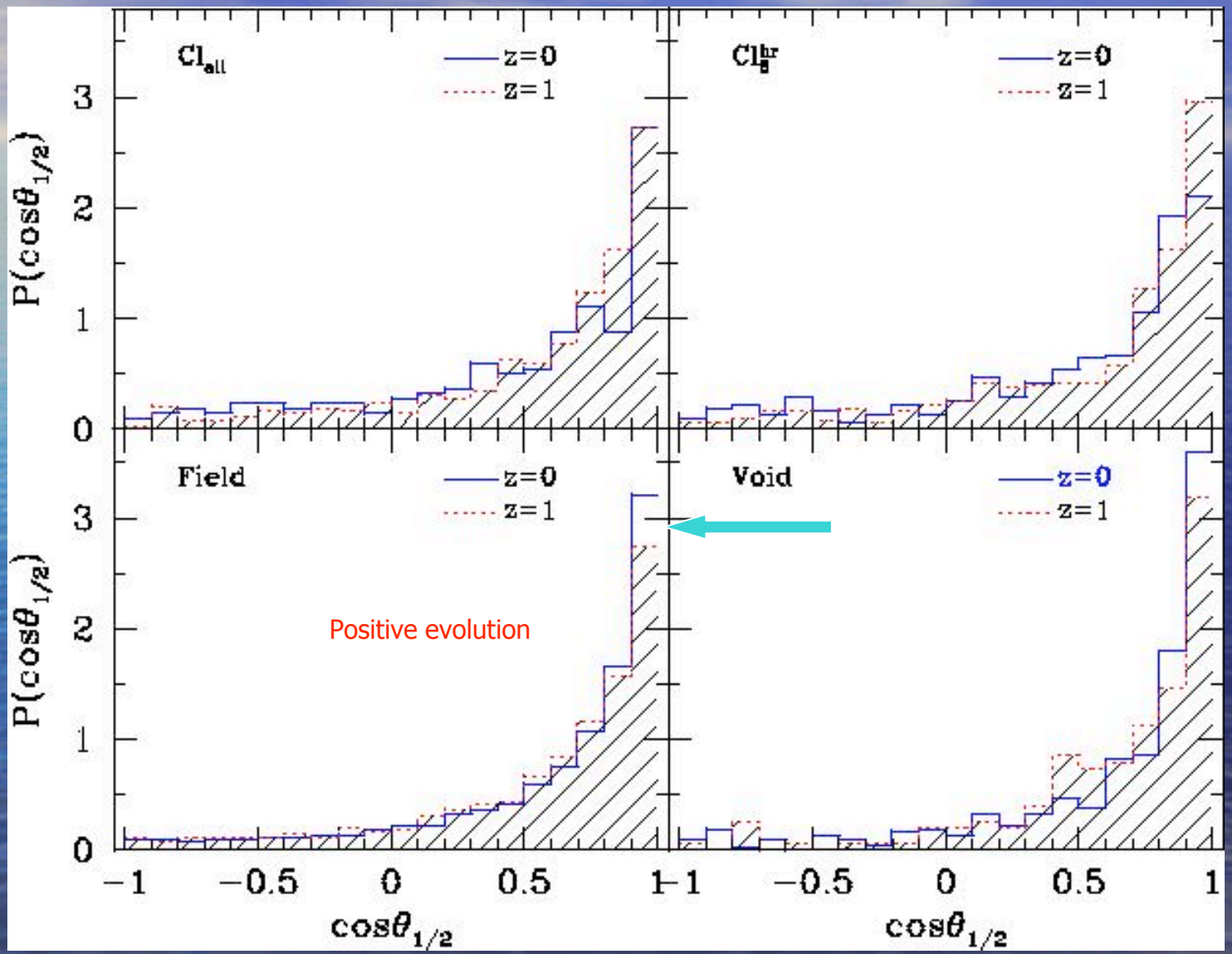
$\_{-1/2}$ angle between j_{int} and j_{out}.

Errors depend on N and _. They also seem to depend on intrinsic alignment.

Halos in clusters appear to be more disaligned on average, however the errors for 500 particles or so are high that this result needs to be confirmed in future works.

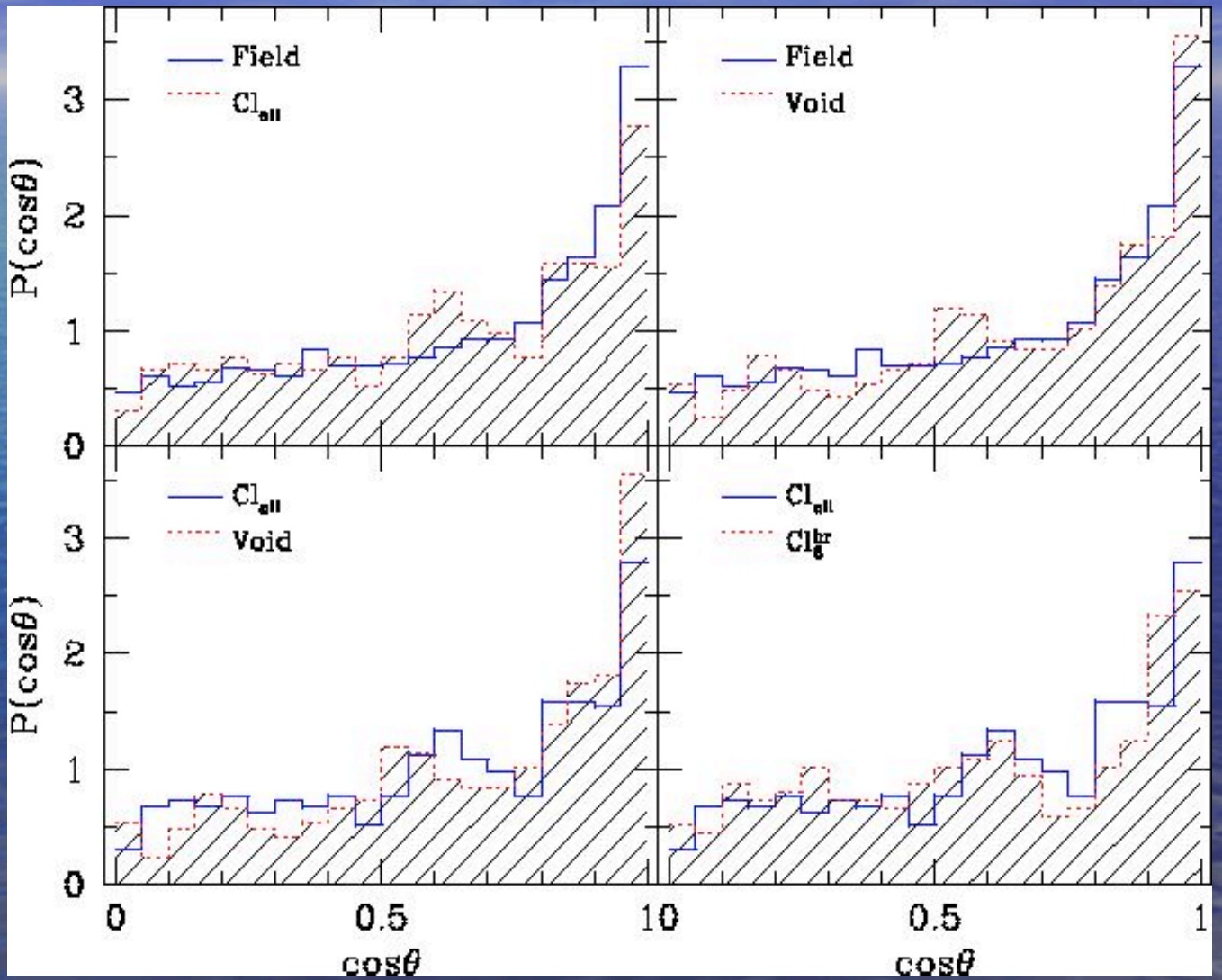


At z=0 and z=1


Cl_all
z=0
z=1
Cl^hr_s
Field
Void
P(cosθ_1/2)
cosθ_1/2
Positive evolution

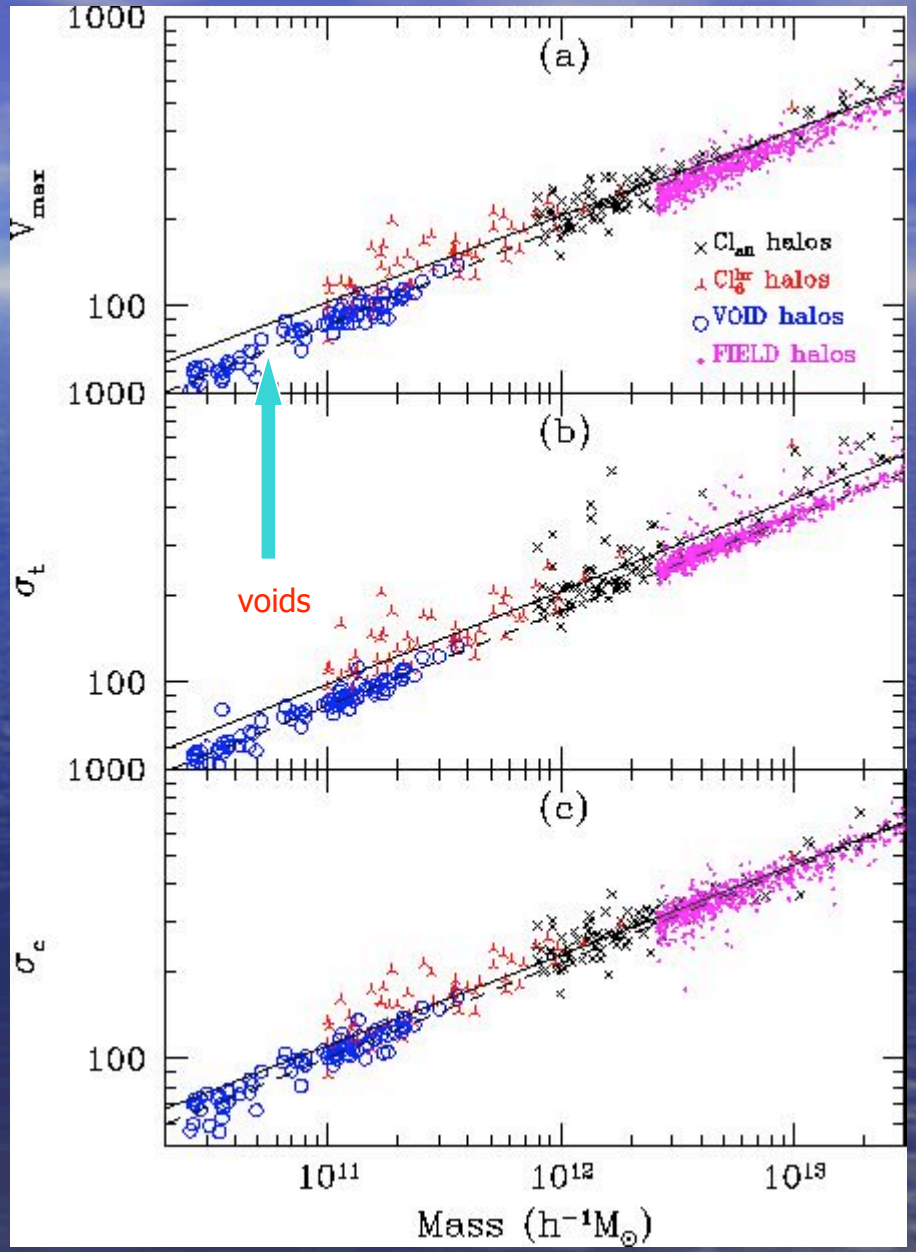
Alignment between halo shape and angular momentum

There is a trend for halos in the field (or voids) to have their angular momentum more aligned to minor principal axis.



Vmax versus mass relation

Halos in voids or in the field, for a given mass, have a smaller V_{max} than halos in clusters.



Conclusions

- Halos in voids or in the field are on average less concentrated than halos in clusters.
- In the V_{max} vs. M diagram, TF relation, or λ_v vs. M diagram void halos lie below cluster halos. Expressed the shift in magnitudes in the TF relation it amounts to 0.4 mag.
- Halos in clusters have on average a smaller spin parameter than those halos in voids and the field.
- Halos in voids are on average more flattened than halos in clusters.
- Cluster halos are on average less aligned than halos in voids or in the field, but this result needs to be confirmed by future works because of the high errors involved in the alignment calculation.

continue

- Present-day halos in voids or in the field are more aligned than halos at z=1.
- Seminumerical models of disk galaxy evolution by Firmani & Avila-Reese show that the use of these c's and _'s found here help to explain the observed differences in galaxy properties in the different environments.