
Local and large-scale effects on the astrophysics of void galaxies

Agustín Rodríguez-Medrano
Dante Paz
Federico Stasyszyn
Facundo Rodríguez
Manuel Merchán
Andrés Ruiz

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contact: arodriguez@unc.edu.ar



I A T E

JOURNAL ARTICLE

Local and large-scale effects on the astrophysics of void galaxies

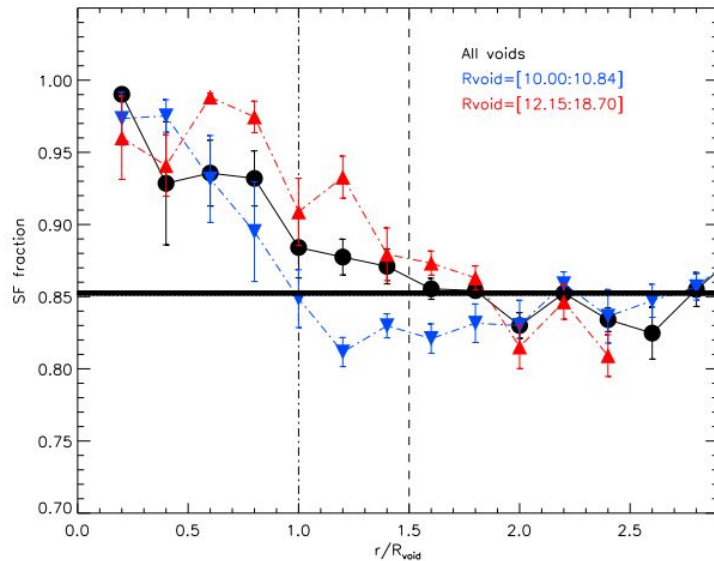
Agustín M Rodríguez-Medrano , Dante J Paz, Federico A Stasyszyn, Facundo Rodríguez, Andrés N Ruiz, Manuel Merchán

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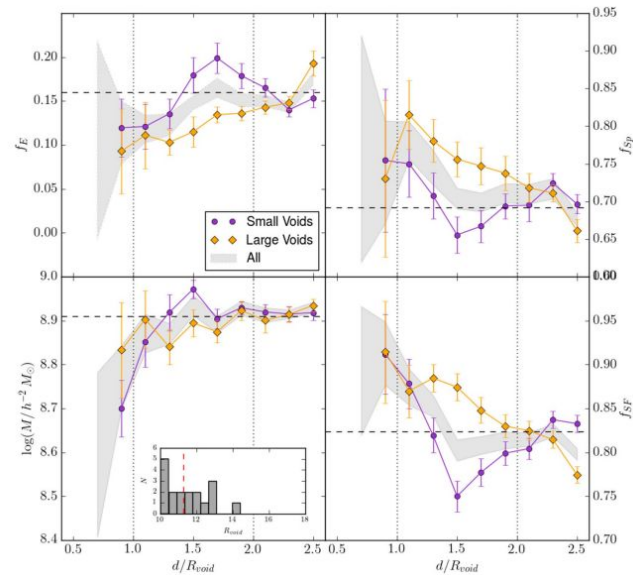
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Antecedentes

- Cosmic voids are the most subdense regions in the universe
- Void galaxies are blue, star-forming and late type, which suggest a different evolution rate
- The astrophysical characteristics seems to depend on the distance to the void center.



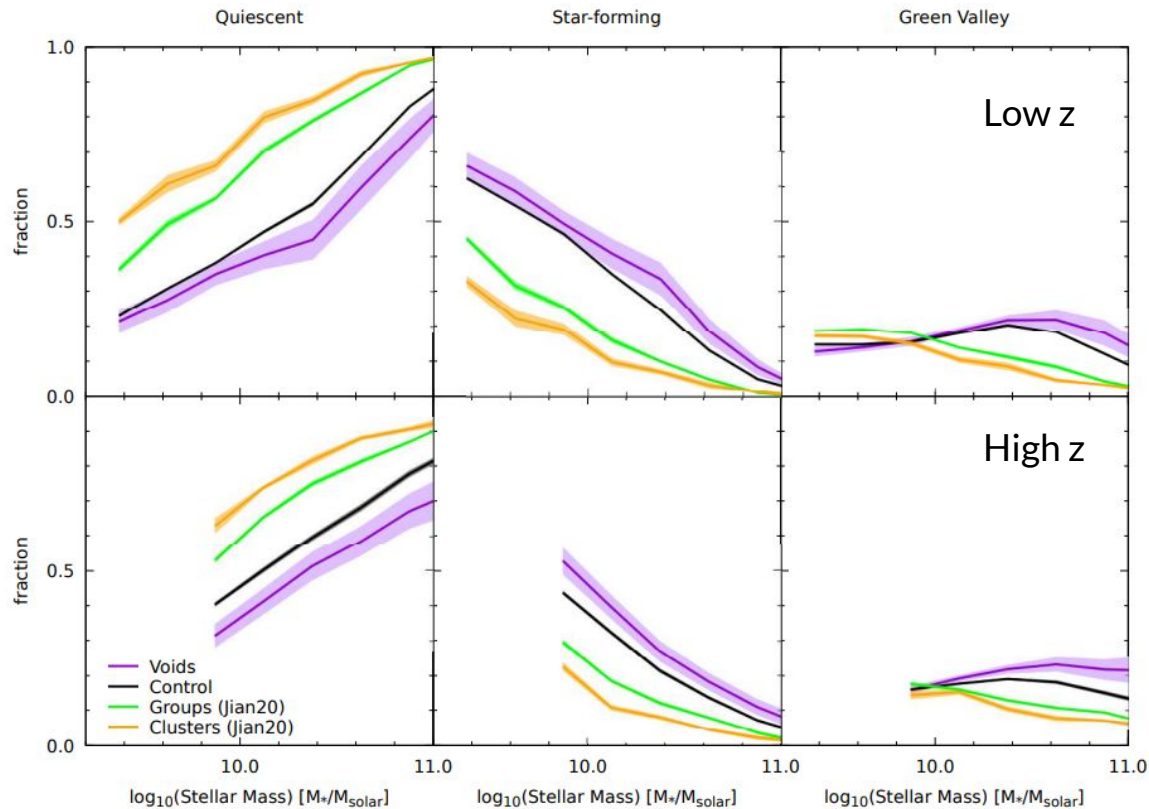
Ricciardelli et al. 2014



Ricciardelli et al. 2017

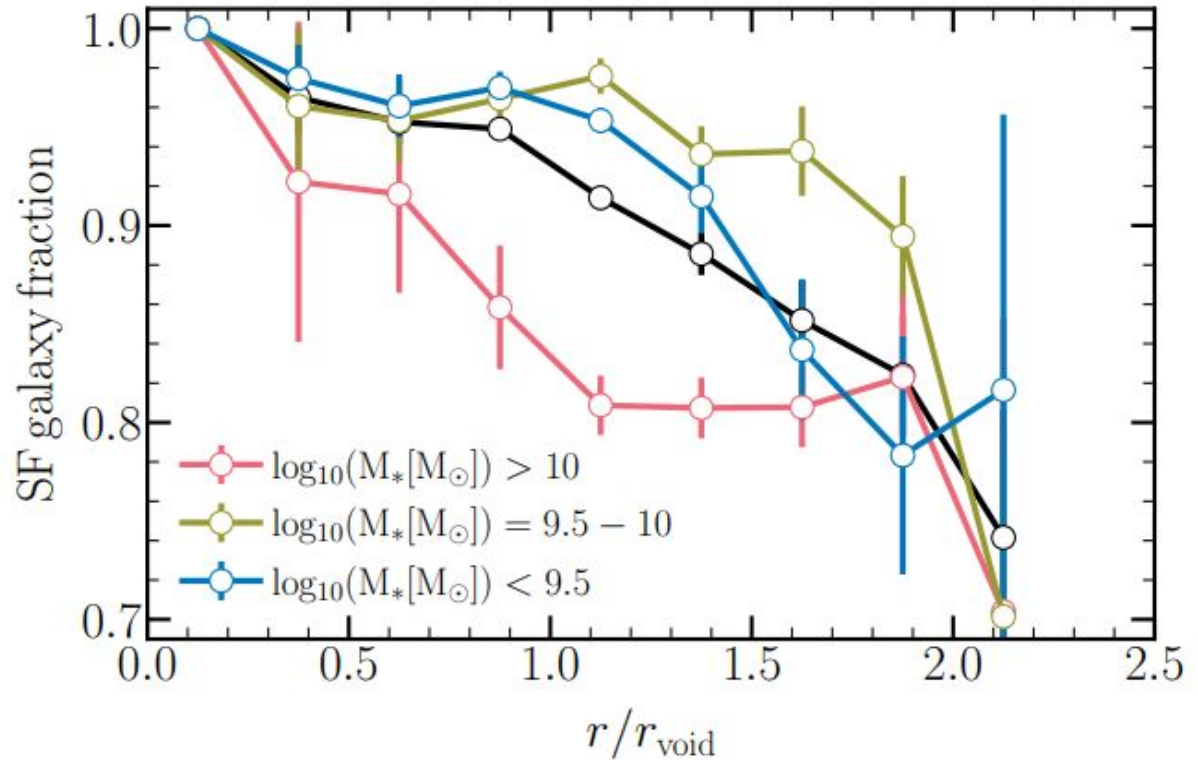
- Photometry (BOSS)

Differences in the SF, quiescent and green valley fraction with the environment.



- Simulaciones
(EAGLE)

The fraction of SF galaxies increase in the void center.



The impact of the large-scale environment on the properties of galaxies in voids remains an unresolved issue.

Effects on galaxy properties have been reported:

- Simulations: SFR - Mstar/Mhalo - Metallicity (Rosas-Guevara 2022, Alfaro 2020)

- Large-scale surveys: SFR - color (Rojas 2005, Ceccarelli 2011, Jian 2020)

No dependence of the properties on the void environment has been found:

- High-resolution spectroscopy: Morphology - SFR - Metallicity (VGS, CAVITY, Kreckler 2020, etc)

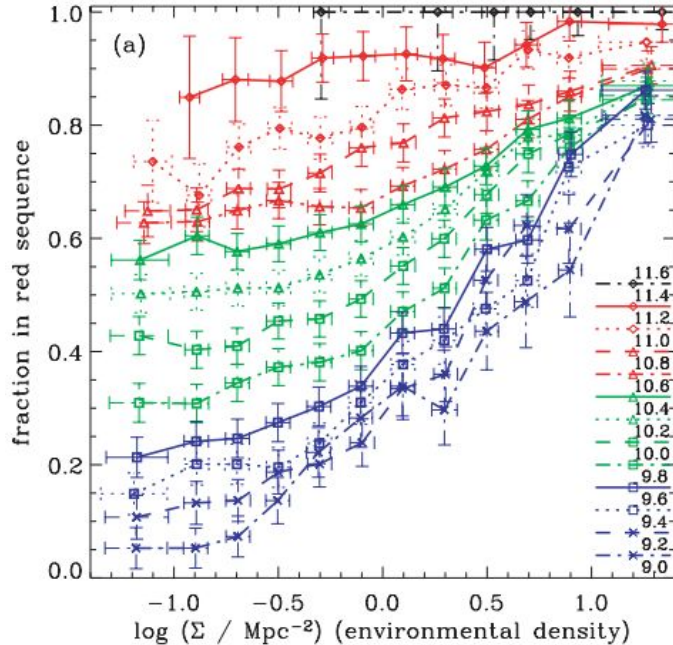
Local density effects in galaxies

It is expected to find that galaxies in voids have low local densities: i.e., distant neighboring galaxies.

-> It is important to control the local density.

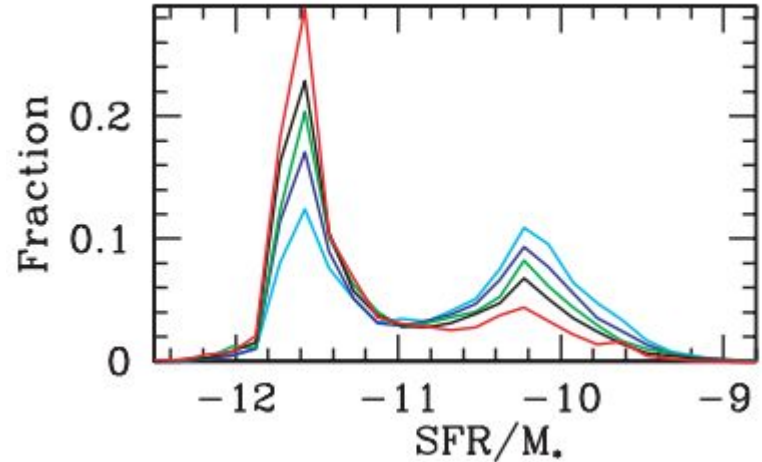
Local density effects in galaxies

RS fraction \rightarrow



local density \rightarrow

blue few neighbors
red many neighbors



Kauffmann et al. 2004

Our approach:

Analyze astrophysical (evolutionary) properties of galaxies (SDSS DR16) taking into account the local density of galaxies and their large-scale environment.

- Local density -> Halo host mass (groups: Rodríguez et al. 2020)
- Large scale -> Membership (or no) to voids (voids: Ruiz et al. 2019)

Properties to study:

- SFR (MPA-JHU)
 - color (g-r)
 - concentration index ($c = r_{90}/r_{50}$)
-

Void identification:

Ruiz, A. N. et al. 2019

- spherical voids
- identified in the contrast density profile ($\Delta < -0.9$)
- identified in a sample of galaxies with $M_r < -19.5$

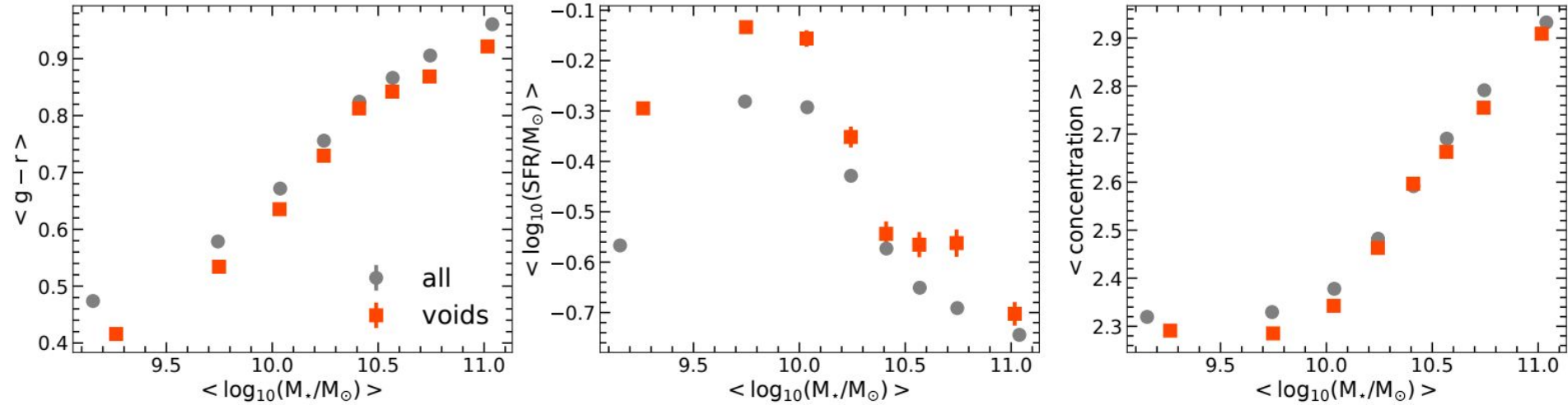
Galaxy group identification:

Rodríguez et al. 2020

FOF + halo based method

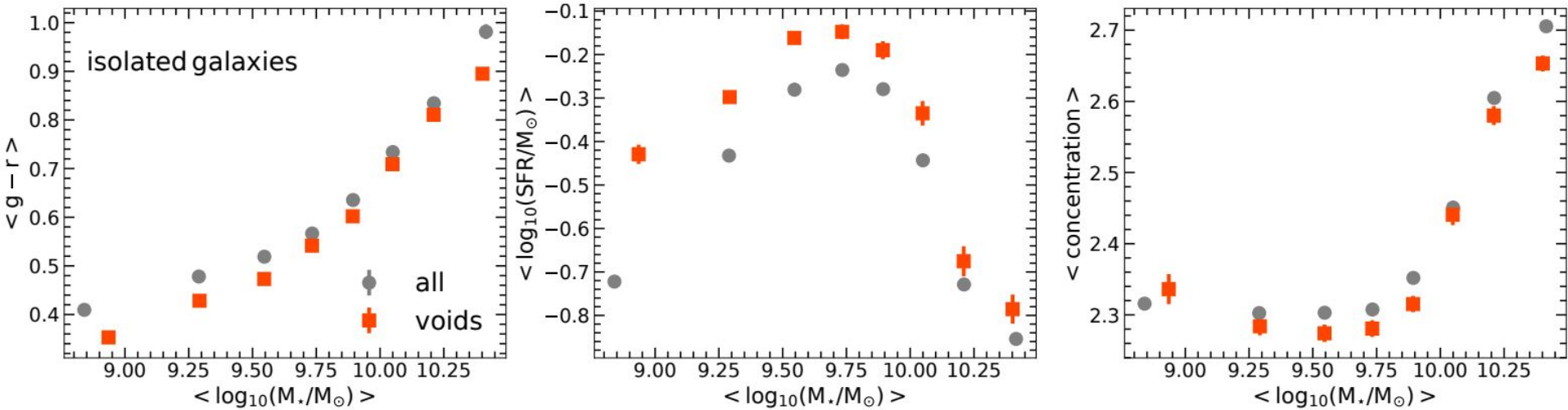
- FOF algorithm
 - mass assignment by abundance matching
-

Galaxy general population



Void galaxies tend to be bluer, more star-forming and have lower concentration. The trend is more noticeable at lower masses.

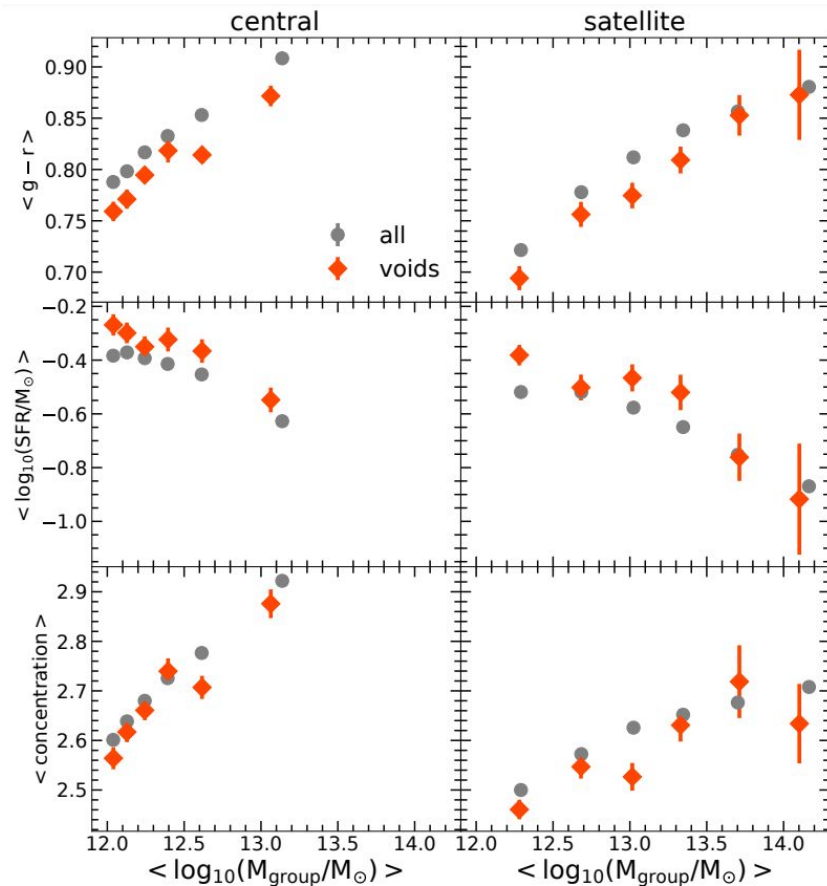
Isolated galaxies



Void galaxies tend to be bluer, more star-forming and have lower concentration.
The trend is more noticeable at lower masses.

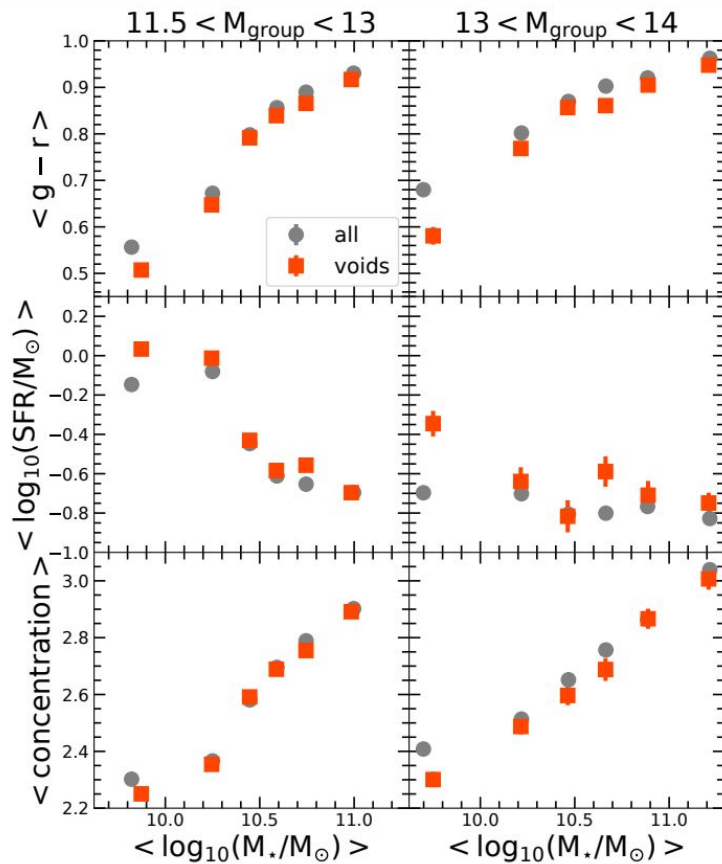
Central and satellite properties

-At a given halo mass, galaxies in voids are bluer, more star-forming and less concentrated.

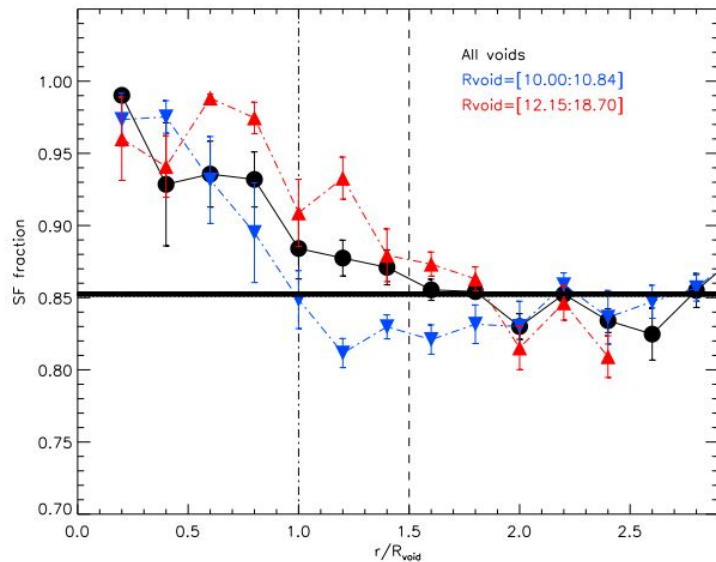


Central and satellite properties

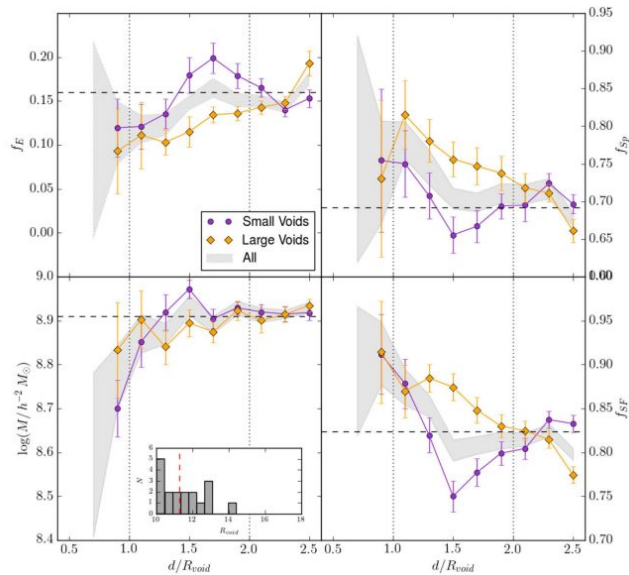
Separating galaxies according to halo mass, we find the same trends as a function of stellar mass.



- The properties of galaxies show dependence on whether or not they belong to voids.
- Do they also depend on their size and type (R-S)?



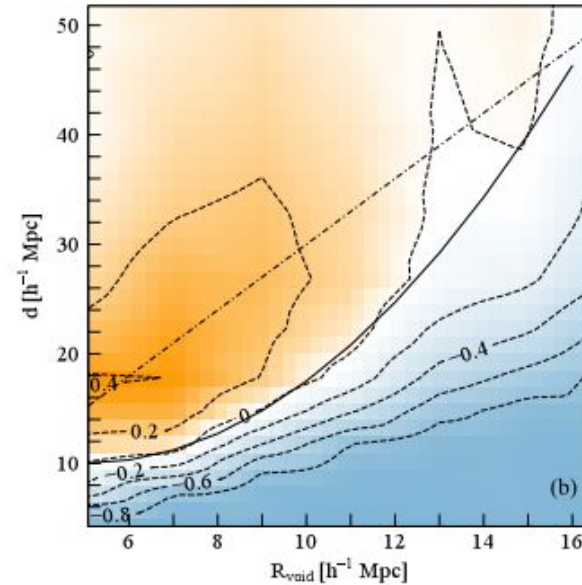
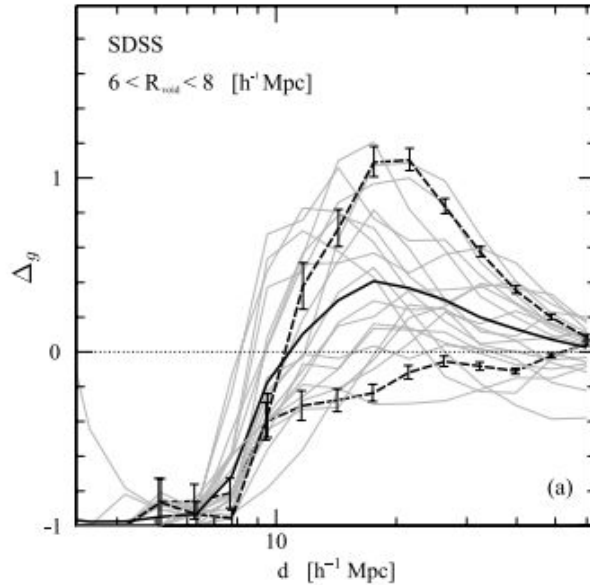
Ricciardelli et al. 2014



Ricciardelli et al. 2017

Background

- Ceccarelli et al. 2013 distinguishes two types of voids (type R - S) associated with evolutionary and density issues.
- These two types of voids show a dependence on voids size

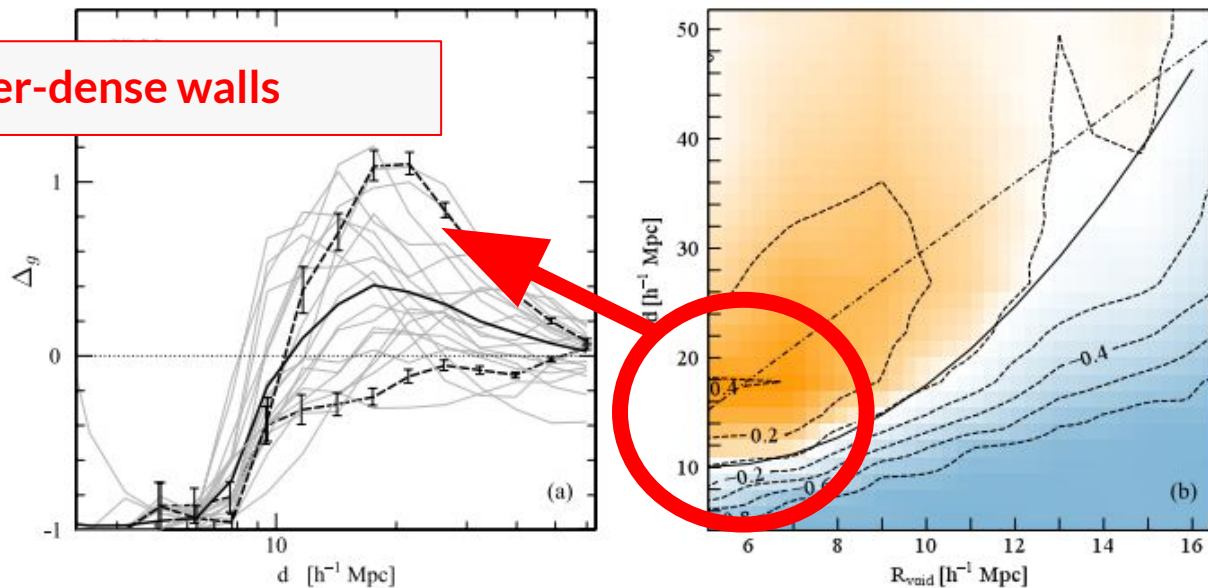


ColorMap - $\Delta(r)$

Antecedentes

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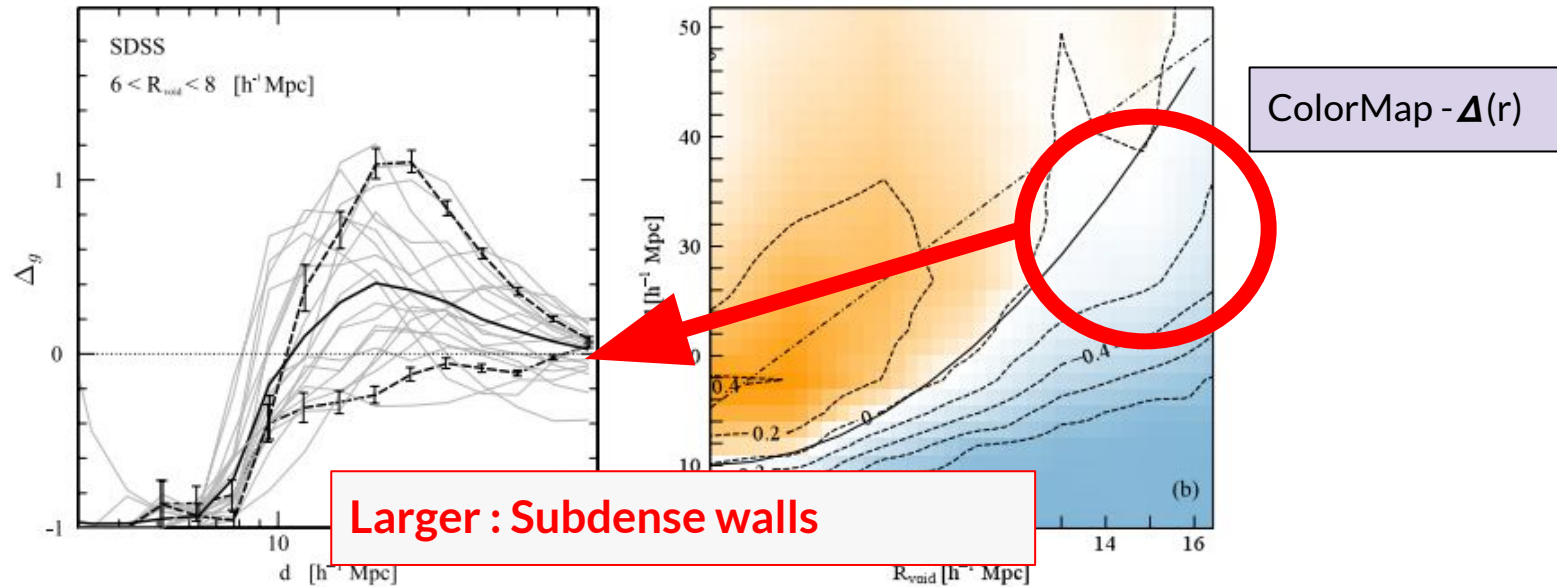
Smaller: Over-dense walls



ColorMap - $\Delta(r)$

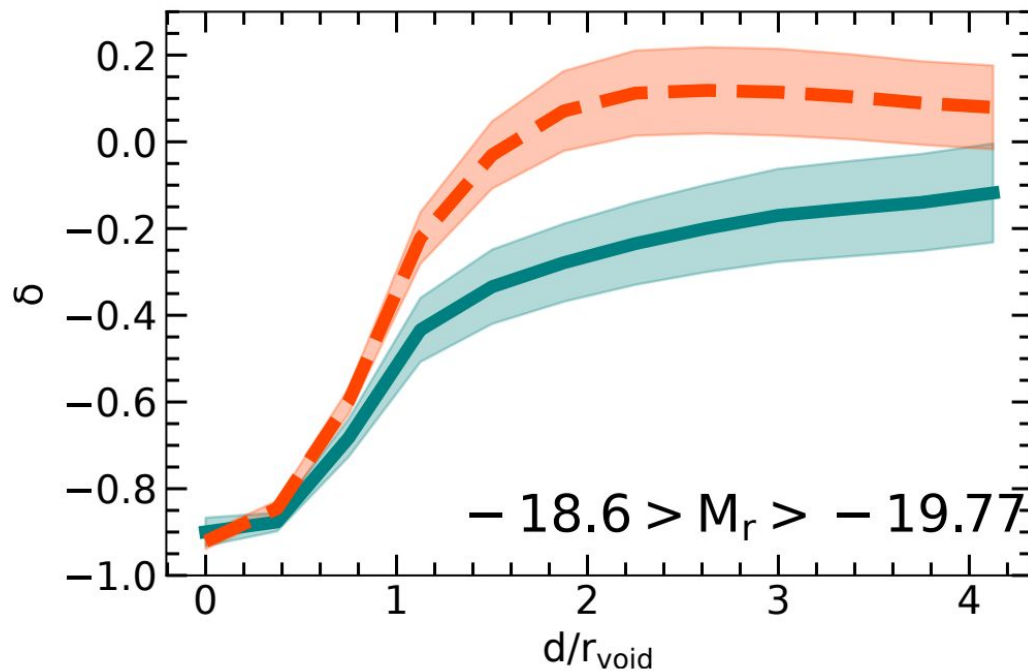
Antecedentes

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Void dichotomy

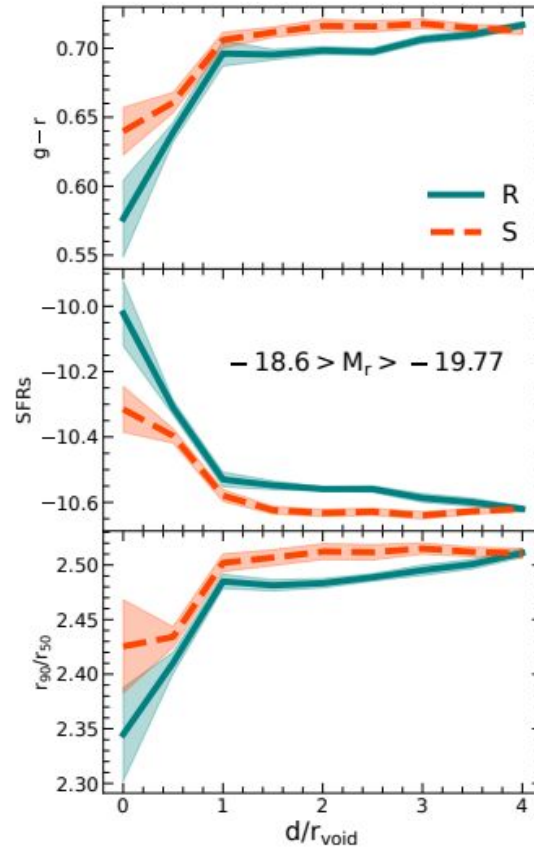
We separate the voids into R and S. We study the properties of the galaxies in bins of Magnitude M_r



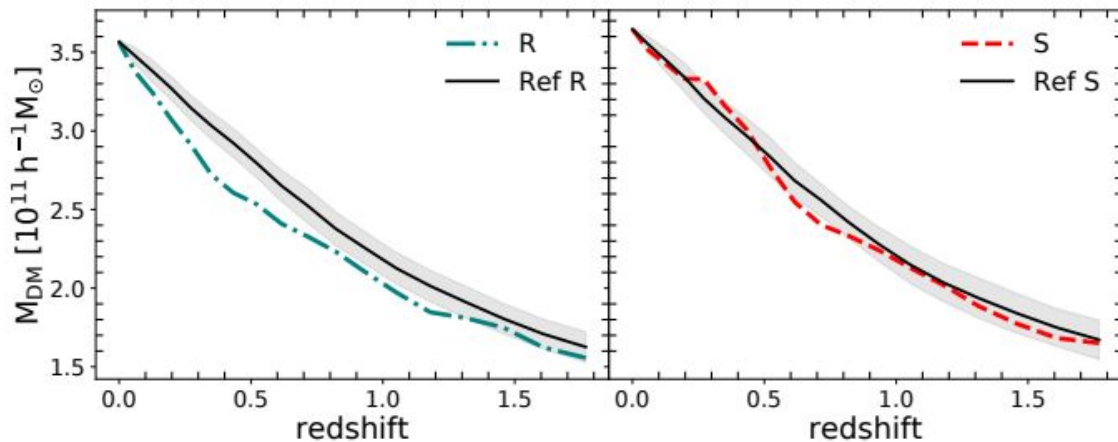
Effects of void type ?

We calculate the mean color, sSFR and concentration as a function of the distance to the void center (according to R or S type) for galaxies in one magnitude bin.

- **Bluer, more star-forming and less concentrated in R-type voids.**

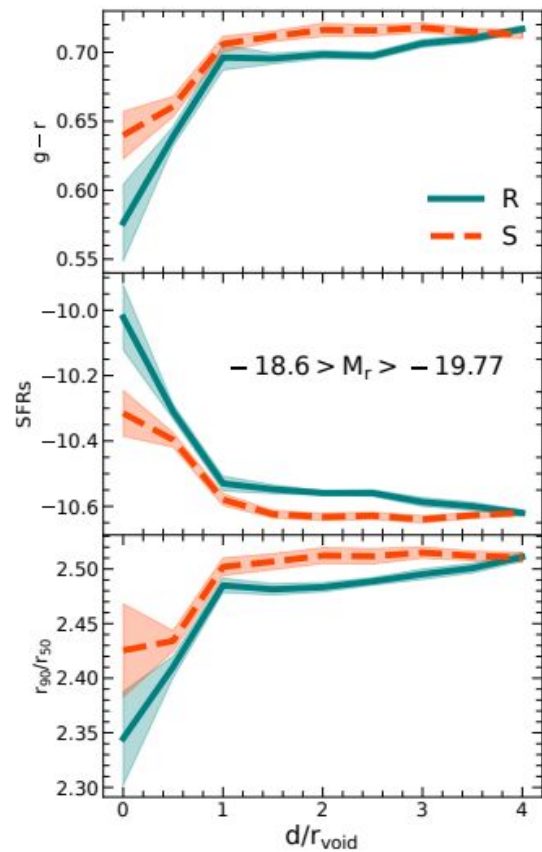


Effects of void type ?



Rodríguez-Medrano et al. 2022

Differences in color, sf, concentration are consistent with different "evolution rate" of galaxies.



Rodríguez-Medrano et al. 2023

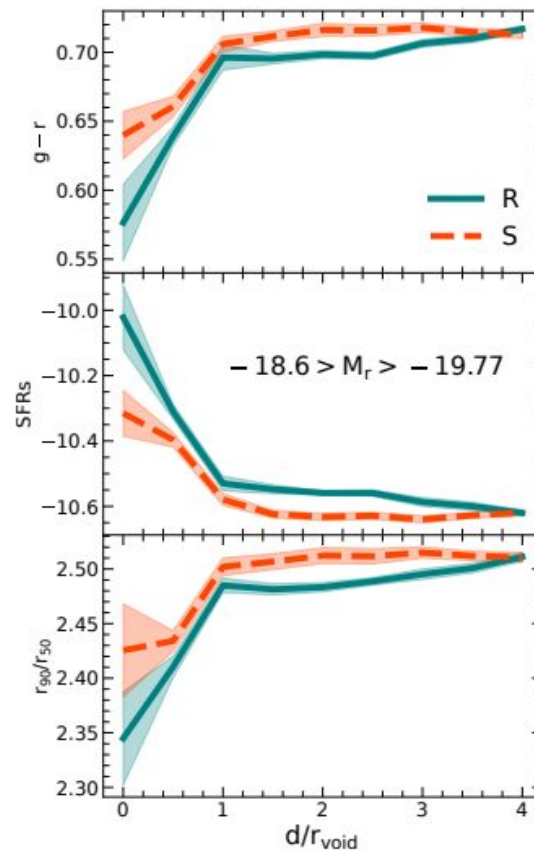
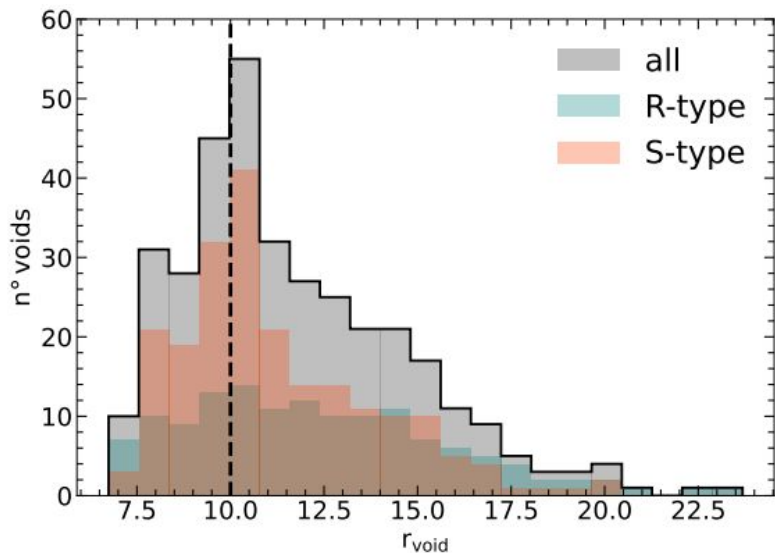
Conclusions

- We find properties in voids galaxies that suggest an influence of the large-scale environment on their evolution (at local density, voids galaxies are bluer, more SF and less concentrated than "medium universe" galaxies).
- Galaxies present different properties according to the type of void to which they belong (R or S).

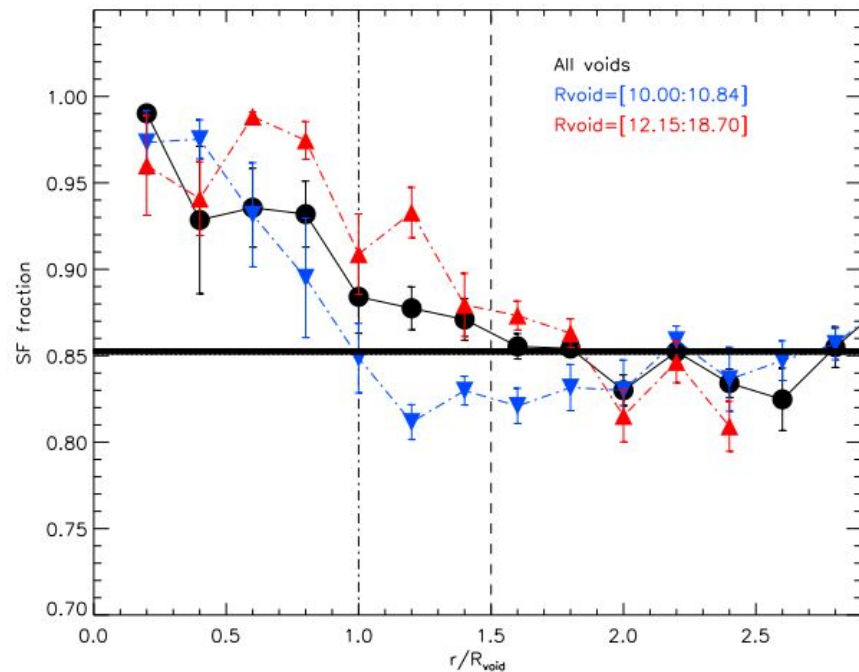
R-type Voids: bluer, SF and less concentrated galaxies

Effects of void type ?

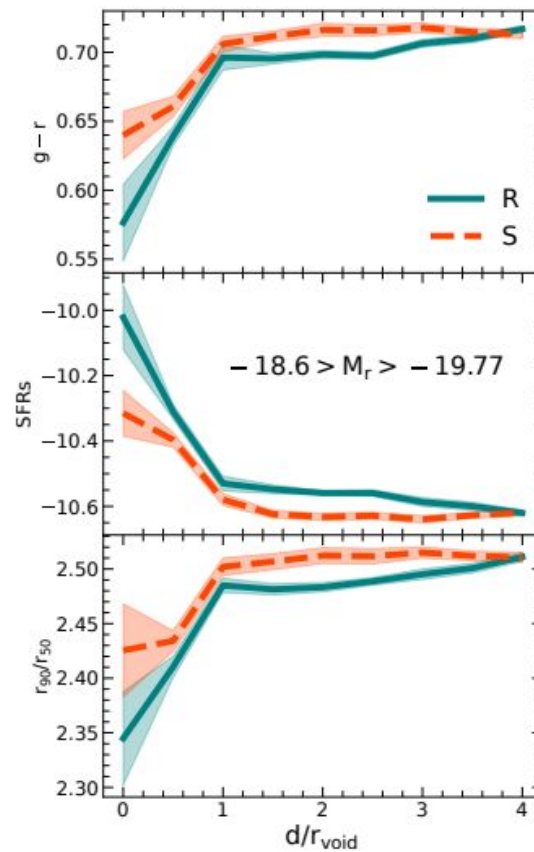
Dependence of void type on size



Effects of dynamics ?



Ricciardelli et al. 2014



Rodríguez-Medrano et al. 2023

Effects of void type ?

