



# The science with the Cosmic web

from 3D (spectroscopic surveys) to 2D mapping (imaging surveys)

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with

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C. Laigle, C. Pichon, S. Codis (IAP)

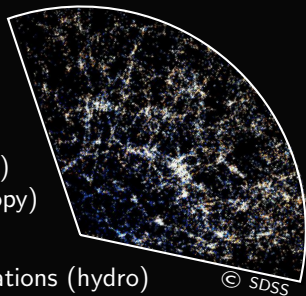
## 1 Connectivity of the cosmic web

### low-z

- observations (SDSS) / simulations (hydro)
- 2D (photo-z from CNN) / 3D (spectroscopy)

### high-z

- observations (PFS/3D, LSST/2D) / simulations (hydro)



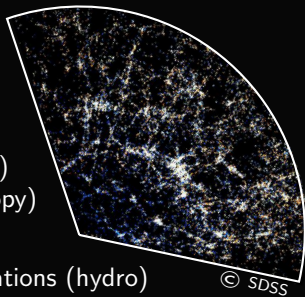
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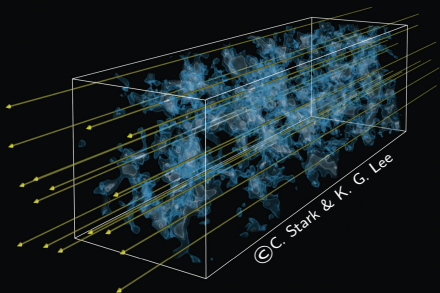
### high-z

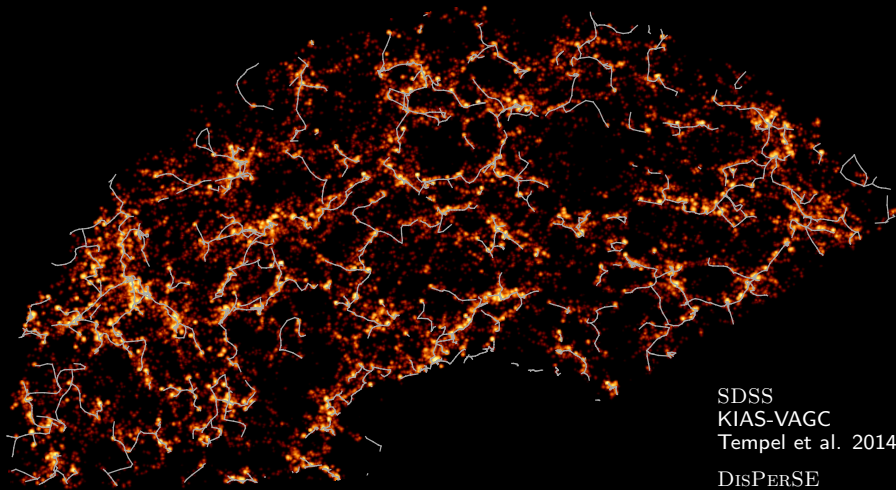
- observations (PFS/3D, LSST/2D) / simulations (hydro)



## 2 Lyman- $\alpha$ tomography

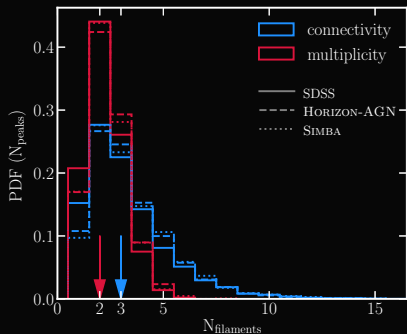
- PFS / WEAVE-QSO
- clustering of critical points





SDSS  
KIAS-VAGC  
Tempel et al. 2014

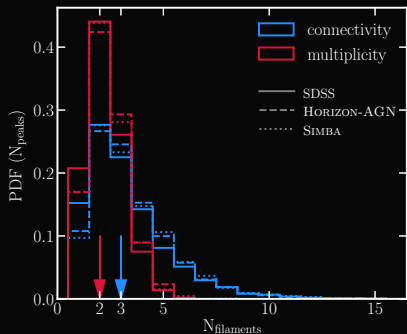
DISPERSE  
Sousbie et al. 2011



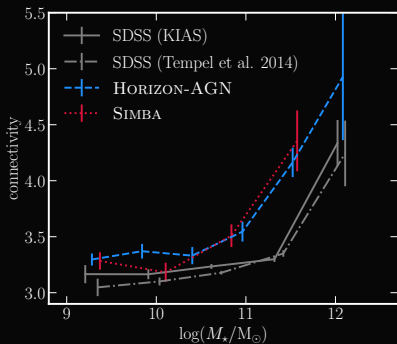
see Codis et al. 2018 for GRF

Kraljic et al. 2020

see also Darragh-Ford et al. 2019 for BCGs



see Codis et al. 2018 for GRF

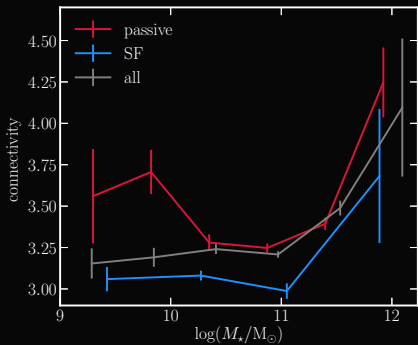


Kraljic et al. 2020

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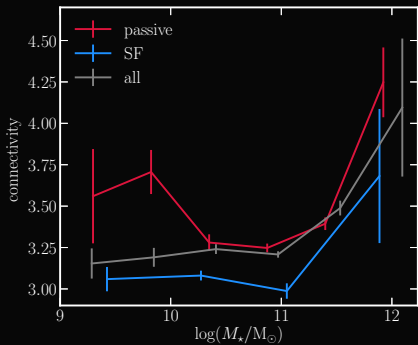
Star formation  
(also Morphology)

Stellar mass

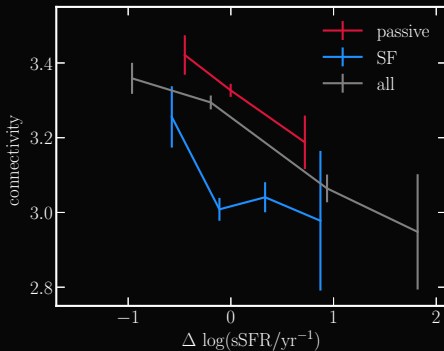


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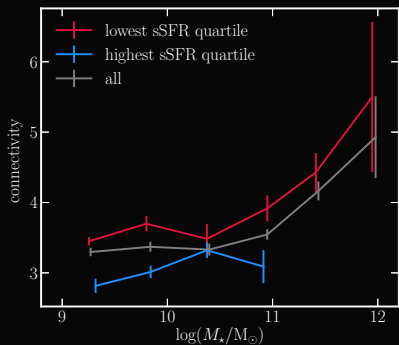
sSFR residuals



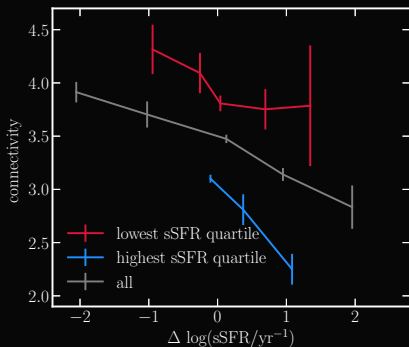


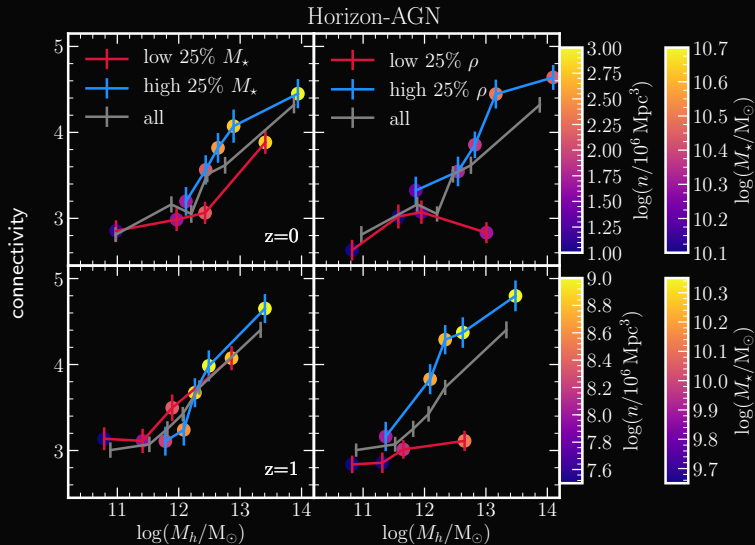
Star formation  
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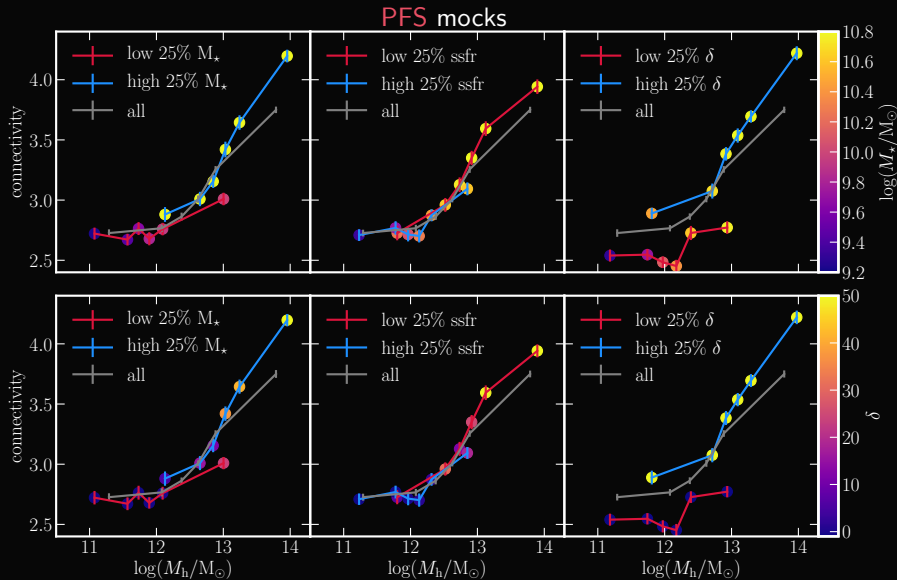
Stellar mass

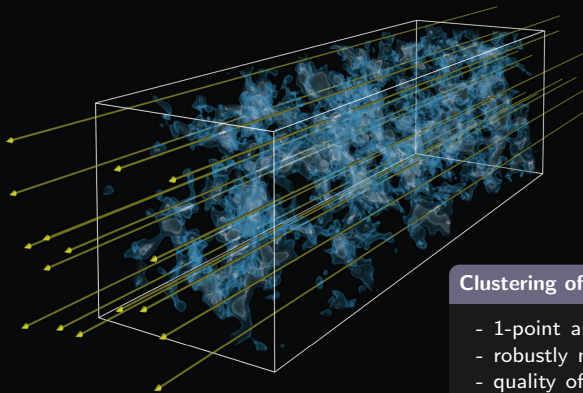


sSFR residuals



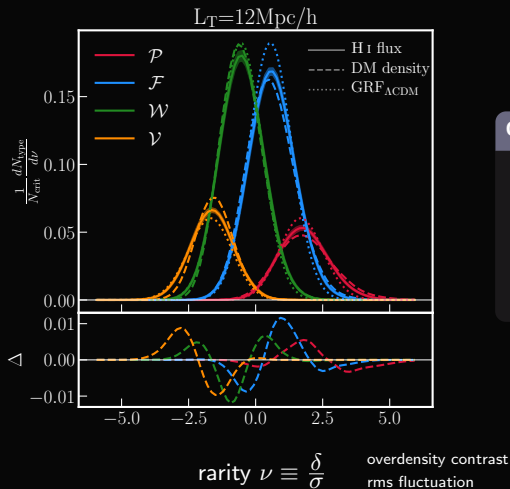






## Clustering of critical points

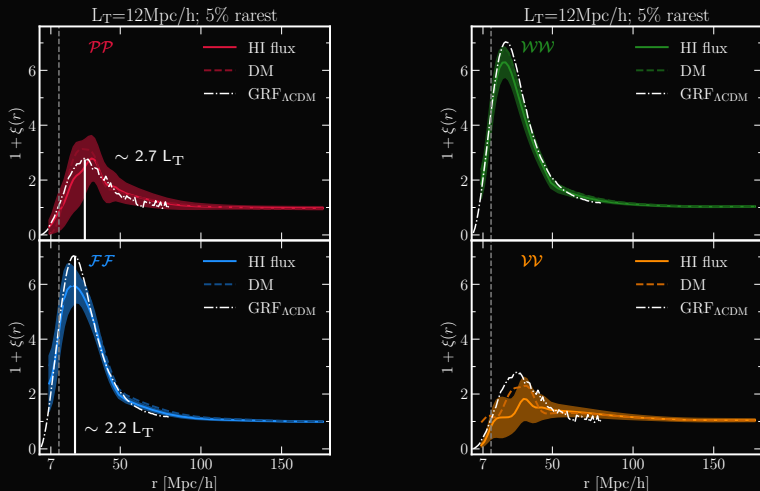
- 1-point and 2-point statistics
- robustly measured at  $z > 2$
- quality of reconstruction
- survey optimisation
- standard ruler? (Shim+2022)



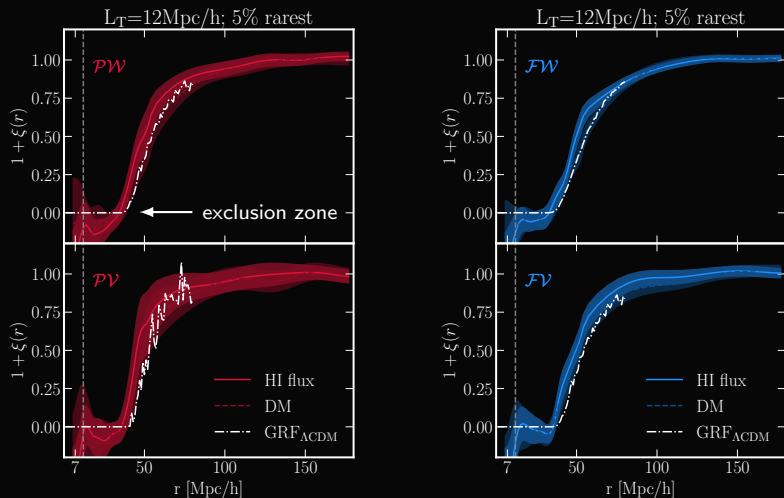
## Critical points

- $\mathcal{P}$  - peaks (- - -)
- $\mathcal{F}$  - filaments (- - +)
- $\mathcal{W}$  - walls (- + +)
- $\mathcal{V}$  - voids (+ + +)

## Auto-correlation of critical points

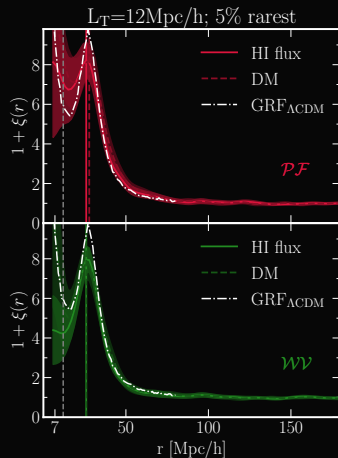


1/ anti-clustering at small  $r$ ; 2/ positive & max; 3/ decrease towards 0 at large  $r$

Cross-correlation of **over** & **under-dense** critical points

1/ exclusion zone at small  $r$ ; 2/ monotonically increasing; 3/ anti-clustered at all scales

Cross-correlation of **same overdensity sign** critical points



1/ divergence at small  $r$ ; 2/ local max; 3/ decrease towards 0 at large  $r$

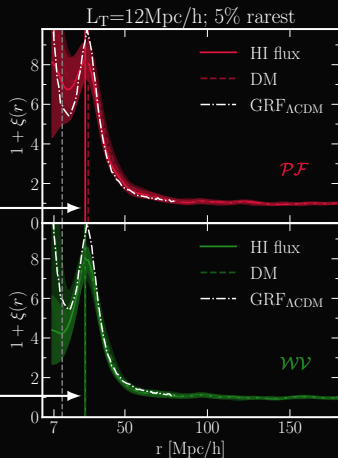


Cross-correlation of **same overdensity sign** critical points

Topological properties of the Cosmic web:

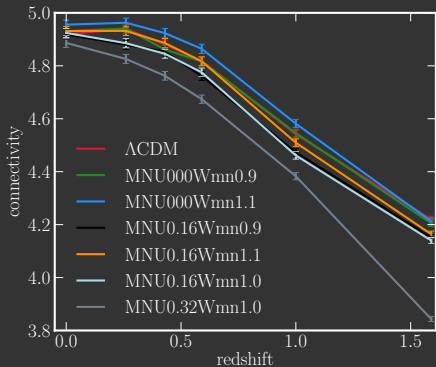
typical filament length

typical void size/radius



1/ divergence at small  $r$ ; 2/ local max; 3/ decrease towards 0 at large  $r$

Neutrino mass: Demnuni



Dark energy: DEUS

