Exploring how galaxy colour depends on local environment measures and geometric environment

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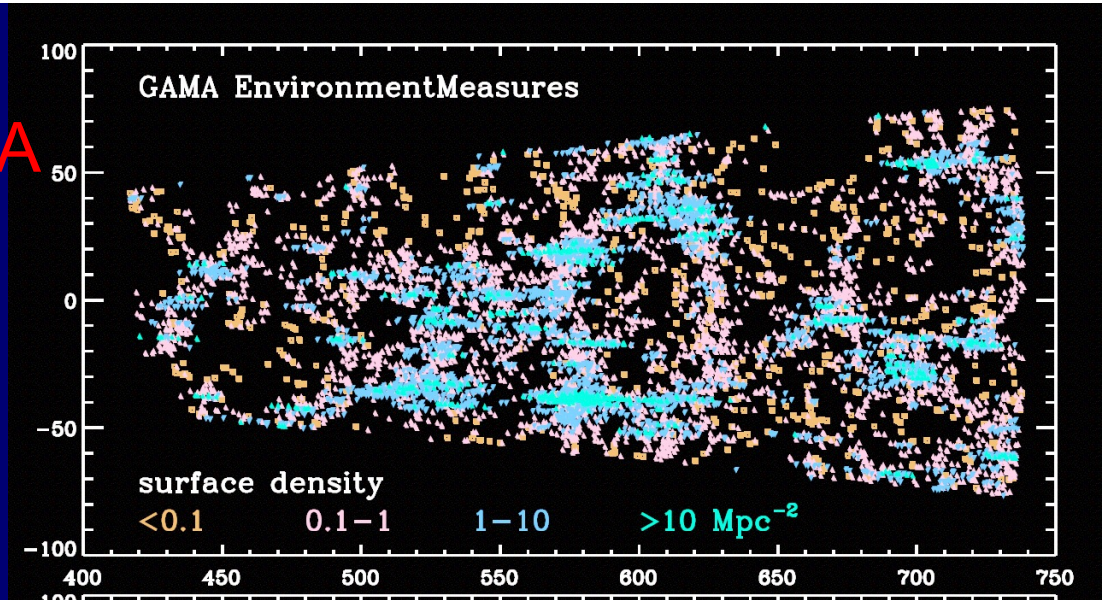
Galaxy Sample

- GAMA survey (very high completeness)
- $0.05 < z < 0.18$
- $10^9\,M_{sun} < M < 10^{11.6}\,M_{sun}$
- ~ 50,000 galaxies
- Environments defined using density-defining population (DDP)
- Bhambhani et al. 2023

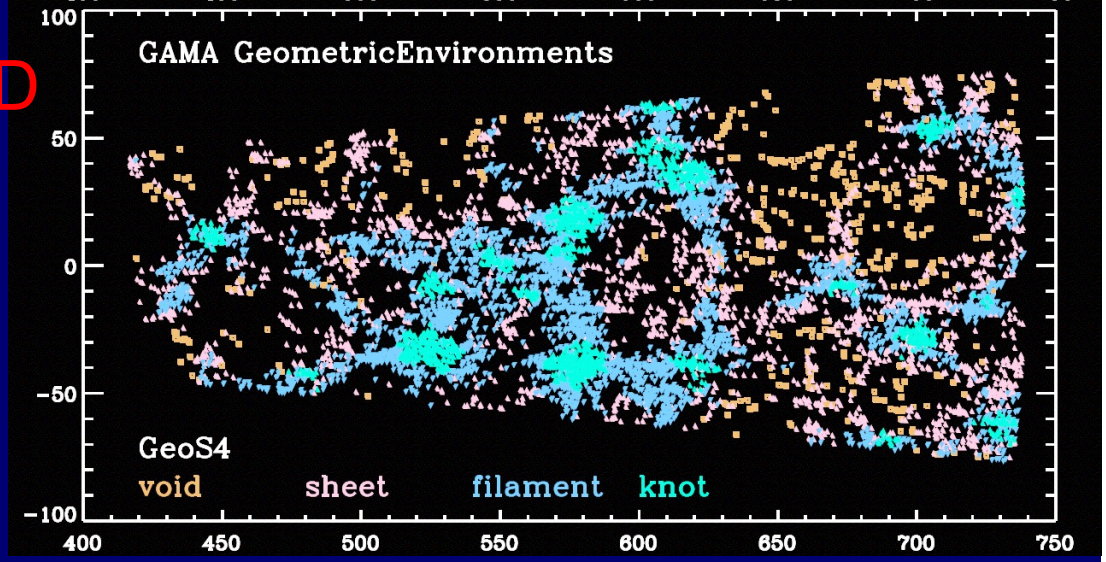
Environment measures

A) Distance to fifth nearest neighbour (within 1000 km/s)
B) Counts in a cylinder
C) Adaptive-Gaussian Ellipsoid (AGE)
D) Geometric Enviro.

A



D



C

$$\mathrm{AGE} = \frac{1}{\sqrt{2\pi}\sigma} \sum_i \exp\left[-\frac{1}{2}\left(\left(\frac{r_{a,i}}{\sigma}\right)^2 + \left(\frac{r_{z,i}}{\mathrm{AGEScale} * \sigma}\right)^2\right)\right]$$

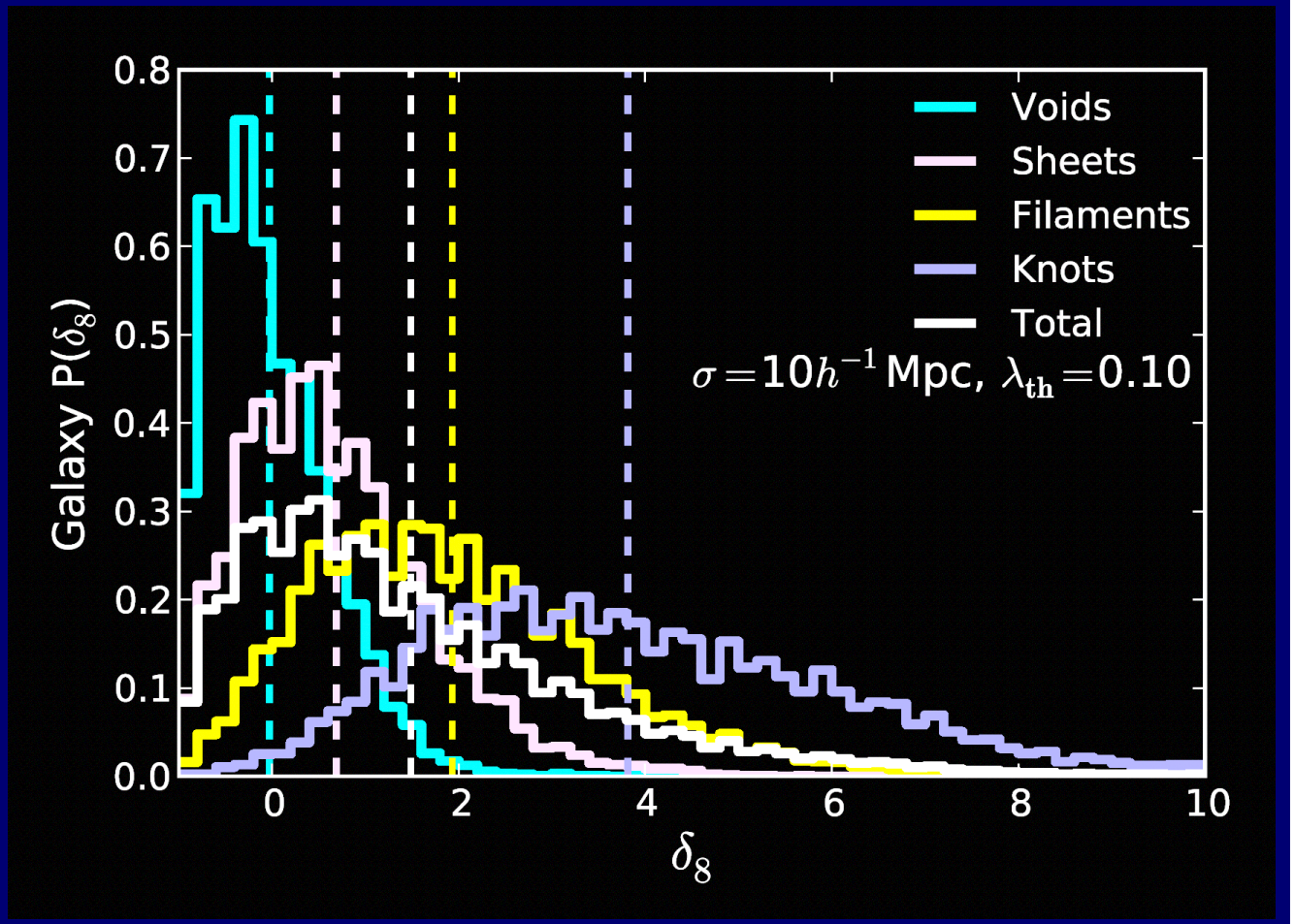
Yoon et al. 2008

Geometric Environment

Geo Enviro. uses approximations to the tidal tensor -> three eigenvalues.

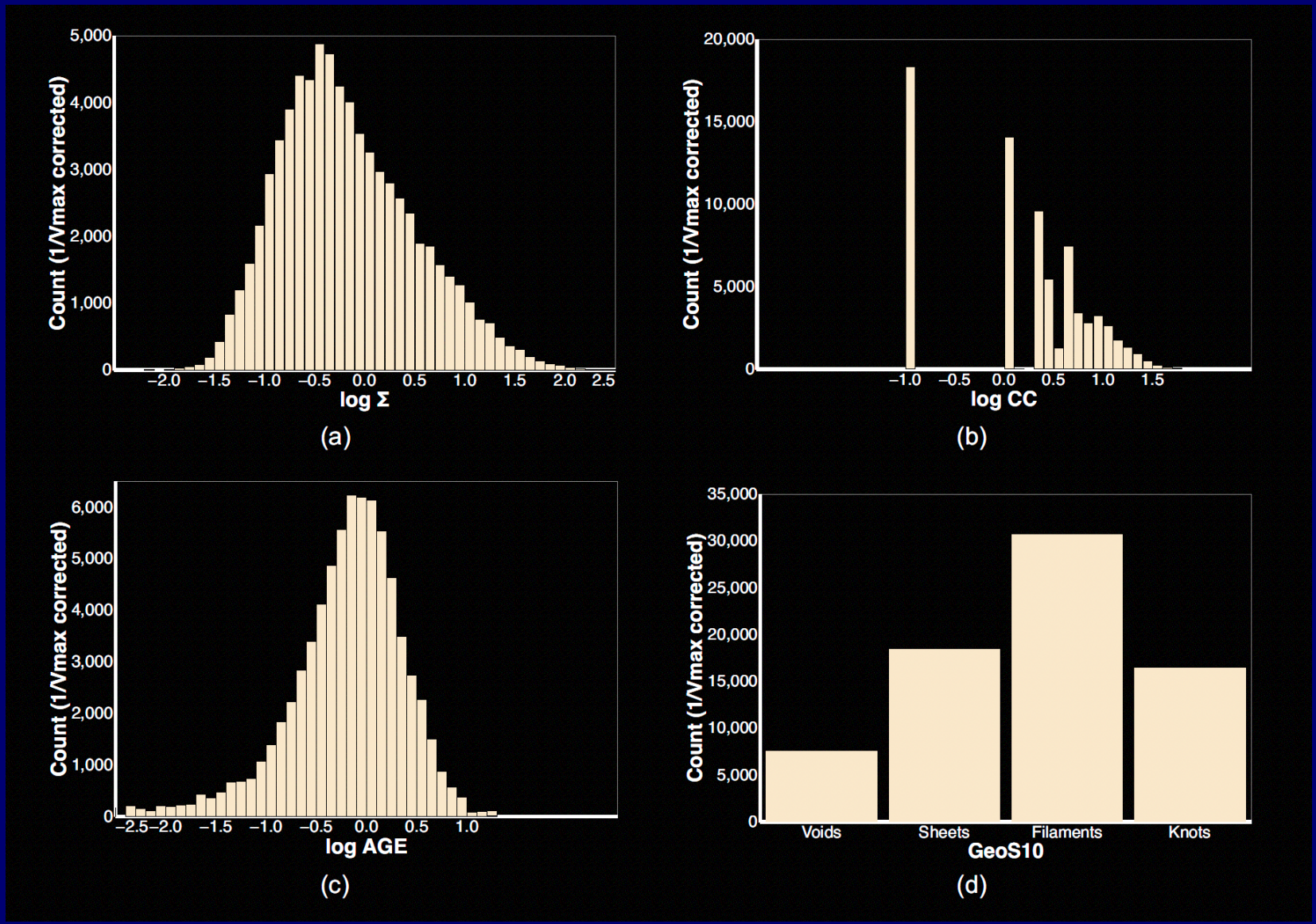
A ‘void’ is surrounded by similar or higher density regions i.e. not collapsing towards the galaxy.

A sheet is collapsing in one dimension

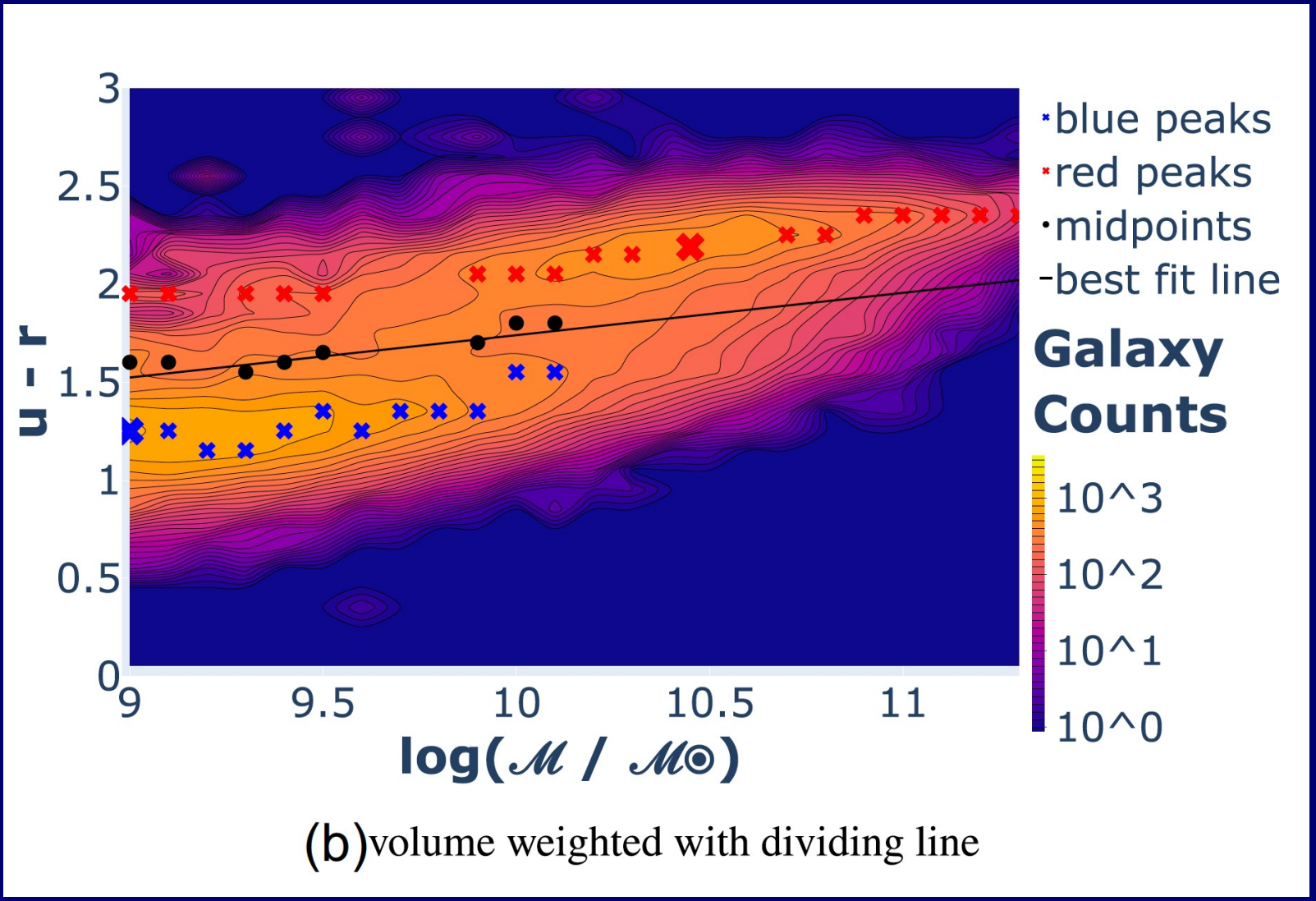


Eardley et al. 2015

Environment distributions

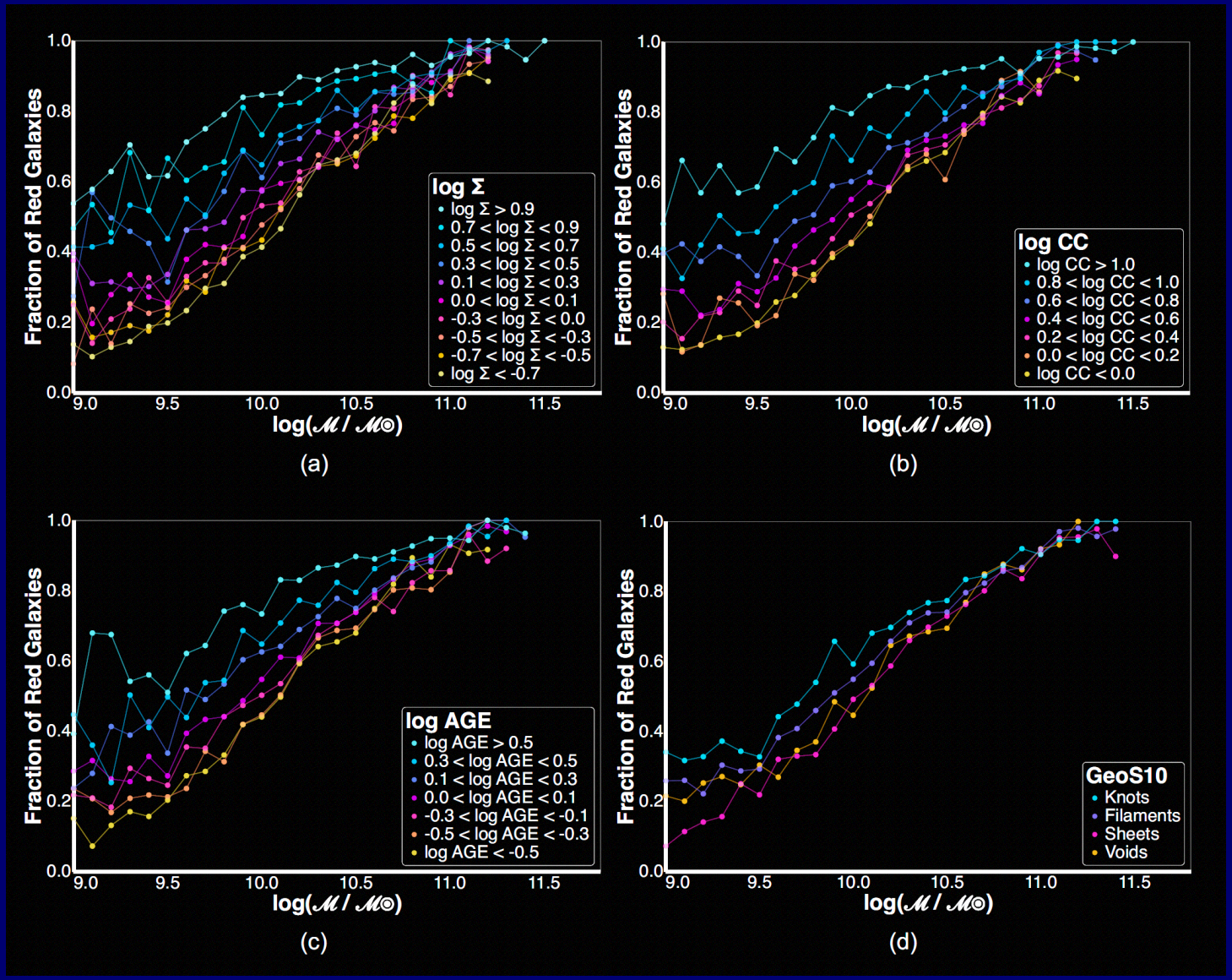


Colour divide

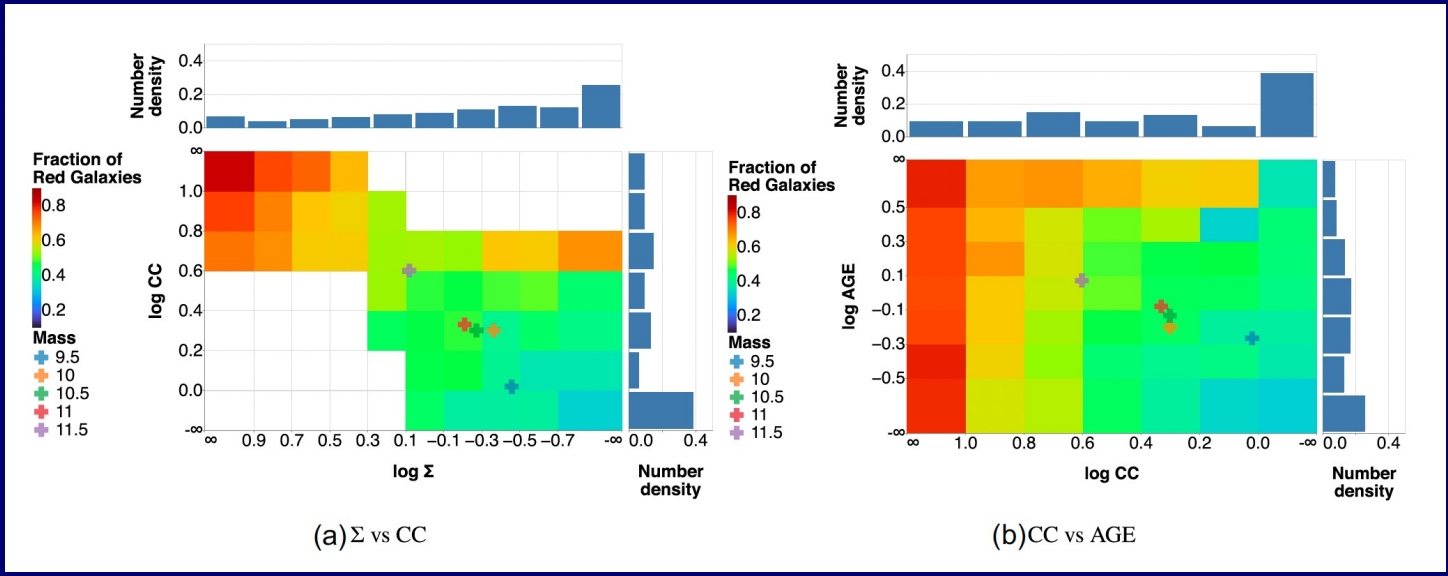


(b)volume weighted with dividing line

Trends with environment and mass

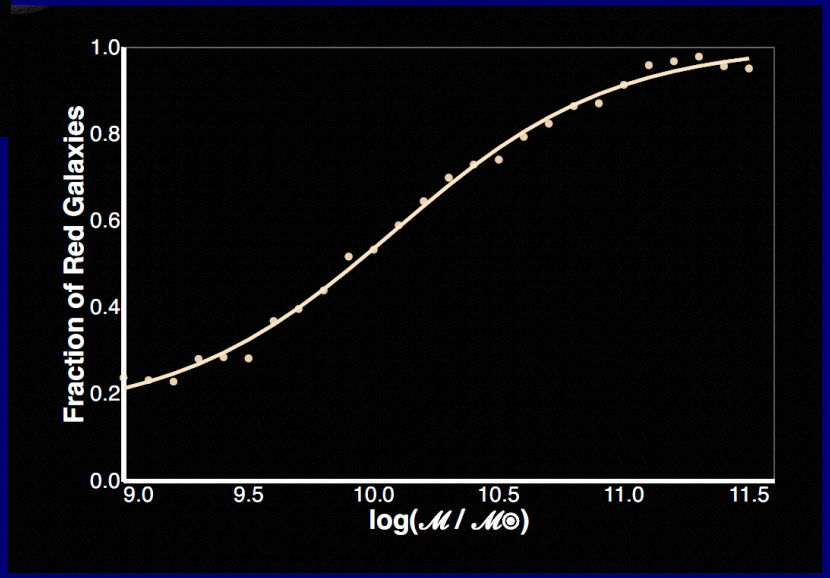


Looking for residuals

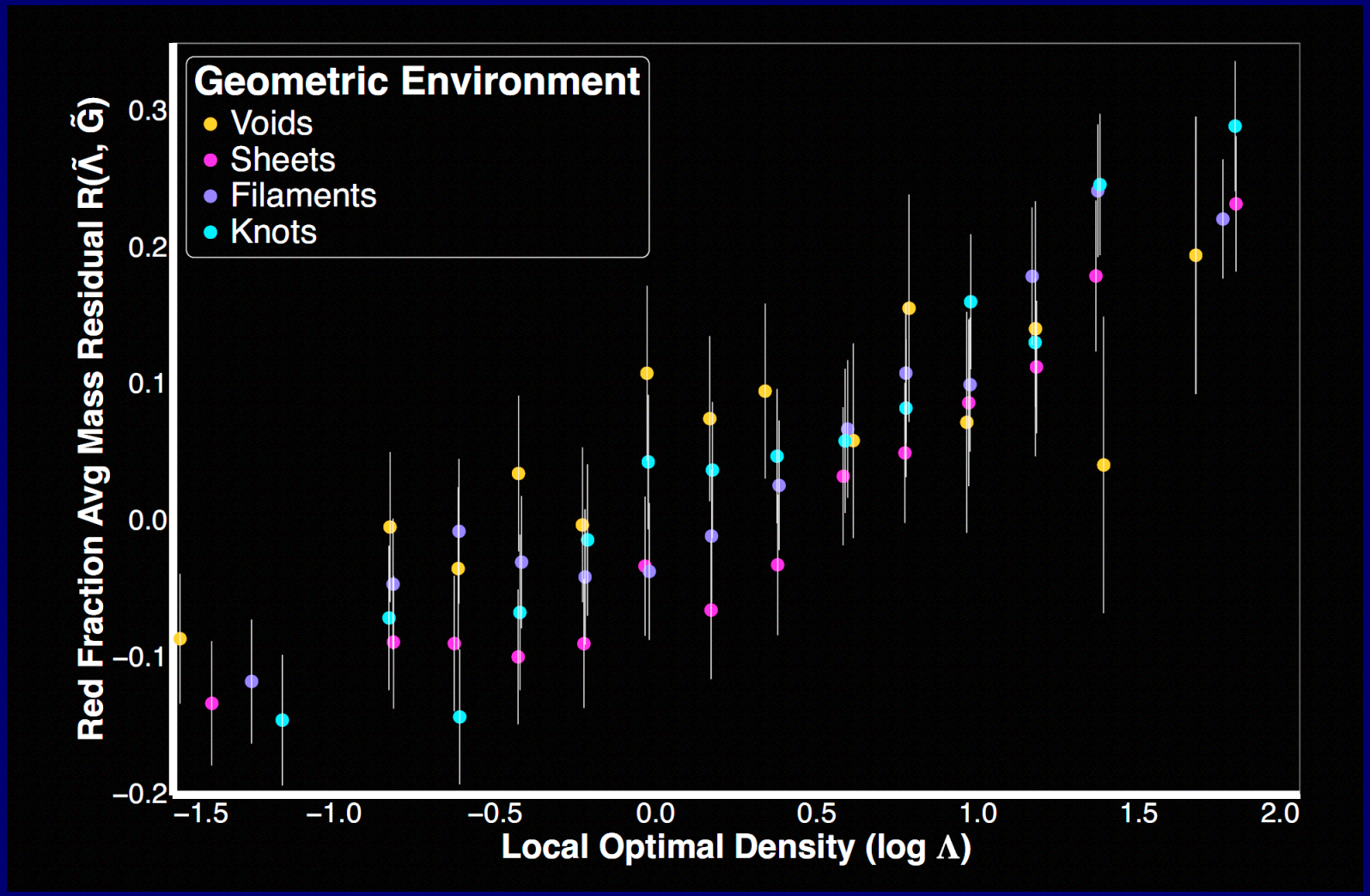


$$\log \Lambda = \log \Sigma + \alpha \log \mathrm{CC} + \beta \log \mathrm{AGE}$$

- Optimize combination of local measures
- Account for stellar-mass dependence



Geometric Environment residuals



Ivan Baldry, Liverpool JMU; at NAM, Durham, July 2025

Summary

- Red fraction varies strongly with local-environment and stellar mass
  - Need to control for these factors to explore large-scale environment trends.
- Residual effect of geometric environments is most noticeable for ‘void’ galaxies
  - Surrounding gas is not collapsing toward the galaxy on large scales
  - Slight reduction in refueling?