Triggering optical AGN: the need for cold gas, and the indirect roles of galaxy environment and interactions

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Introduction

- Galaxy interactions and environment play a fundamental role in the evolution of galaxies.
- Examples of interaction induced evolution:
  - Star formation.
  - Morphology.
  - Nuclear activity → quenching of star formation (feedback) → control of the growth of massive galaxies?

Nuclear activity and environment

- Apparent contradictory results in the literature
- Two types of AGN. Same effects?
  - Radiative mode: X-ray AGN, optical AGN and some radio AGN
  - Jet mode: typical radio AGN
- “Environment”: Large scale structure ≠ one-on-one interactions
- Possible spurious correlations

This study

- Different types of AGN
- Different aspects of environment
- Effect of confounding factors
  - Galaxy mass
  - Central star formation rate

Sample and data

- Galaxies in the SDSS DR7 spectroscopic survey with redshift between 0.03 and 0.1 (N ~ 268000). Volume limited with Mr - 5log(h) > -20 (N ~ 100000).
- Nuclear activity classification:
  - Optical AGN – MPA-JHU catalogue.
  - Radio AGN – Best & Heckman 2012.

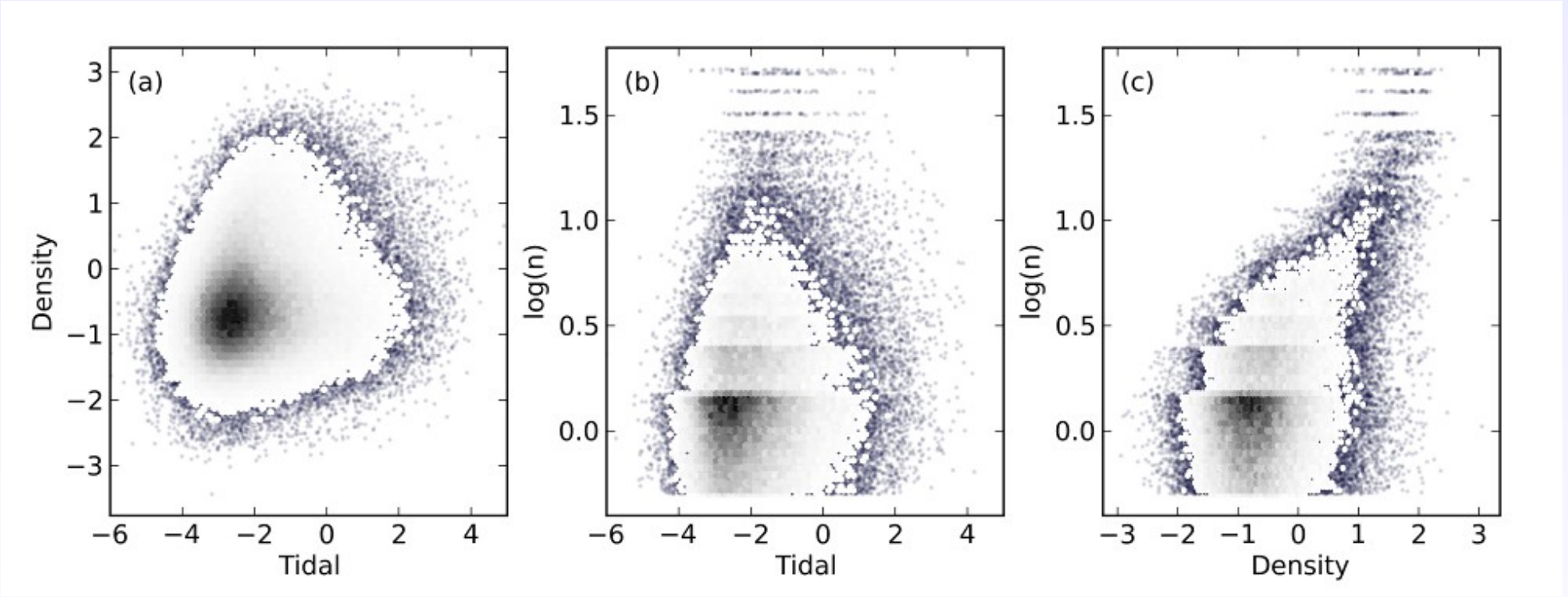
Environmental parameters

- Parameters:
  - Local galaxy density
  - Tidal parameter
  - Cluster richness (from Tago et al. 2010)
- Principal Component Analysis:
  - PCA1 – overall interaction
  - PCA2 – one-on-one interactions
  - PCA3 – relative location

Environmental parameters

- Parameters: Most relevant
  - **Local galaxy density**
  - Tidal parameter
  - Cluster richness (from Tago et al. 2010)
- Principal Component Analysis:
  - PCA1 – overall interaction
  - **PCA2 – one-on-one interactions**
  - PCA3 – relative location

Environmental parameters

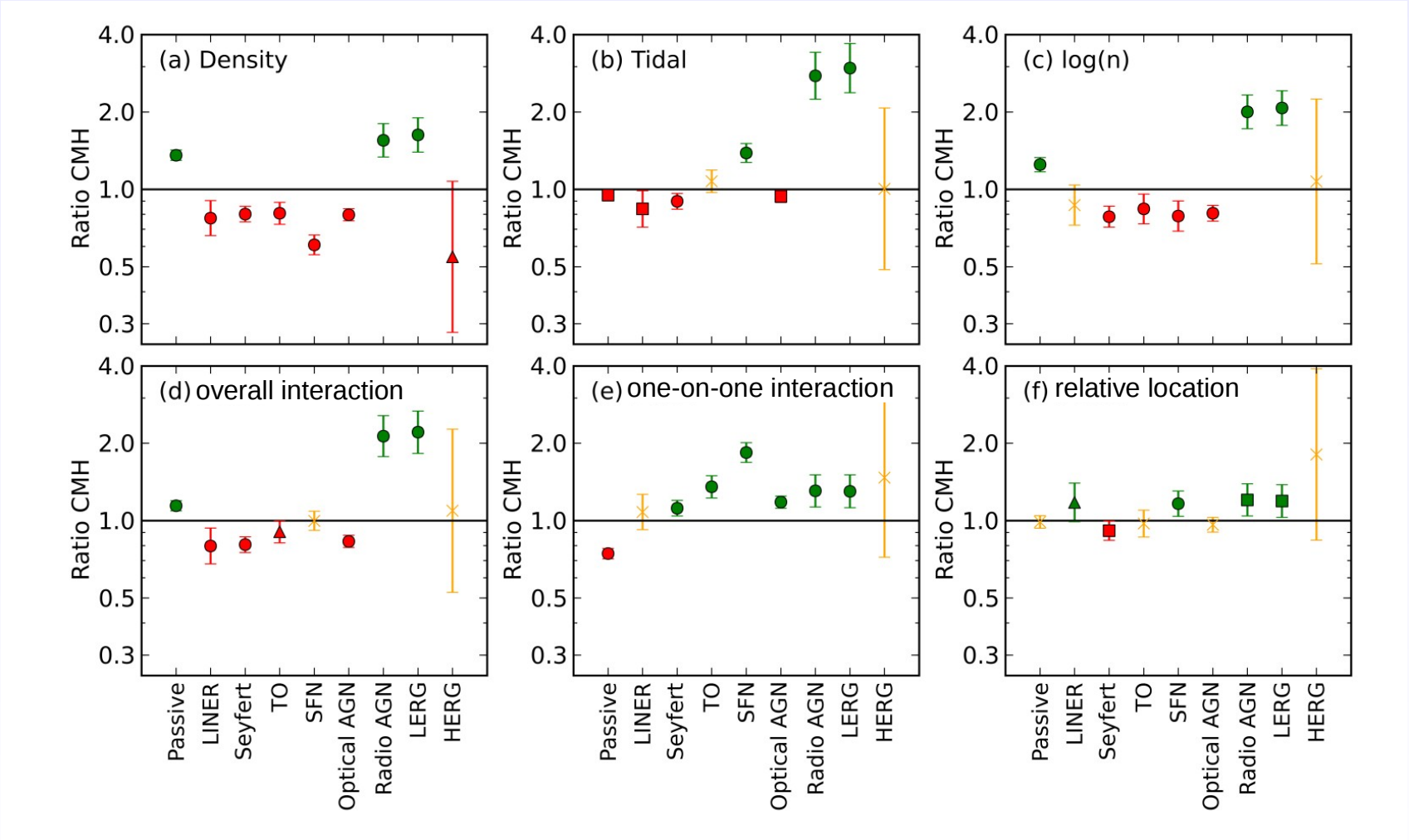


Stratified study

- Known relation between mass and AGN prevalence (Best et al. 2005; Kauffmann et al. 2003) → possible bias.
- Stratified study that considers several strata of mass. Cochrane-Mantel-Haenzsel (CMH) test.

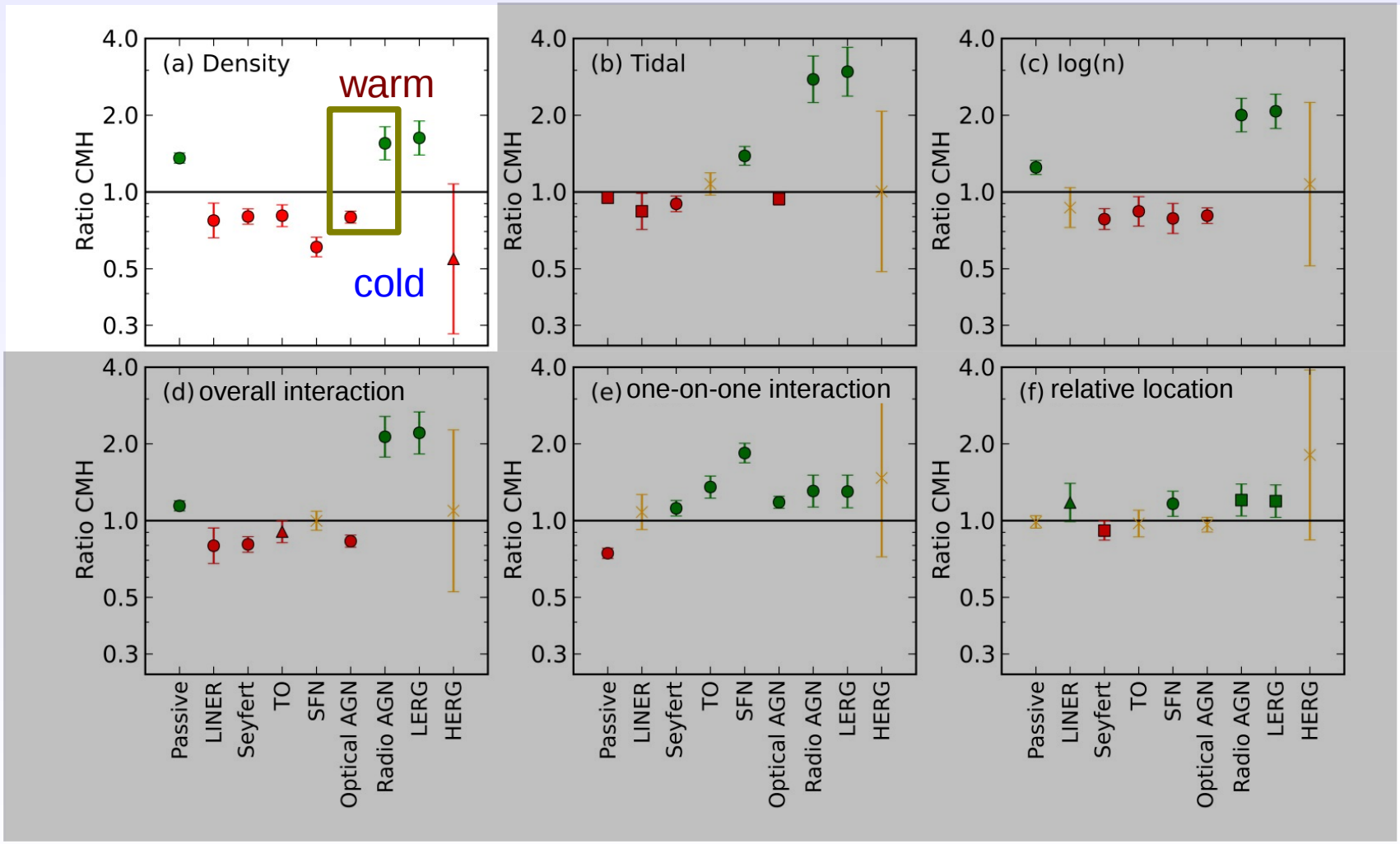
Results

CMH ratio - Relative ratio of the fraction of AGN (or nuclear activity type) from high to low values of the environmental parameter



AGN type ↔ properties of the gas

Radiative mode vs. jet mode AGN



AGN prevalence enhanced by one-on-one interactions

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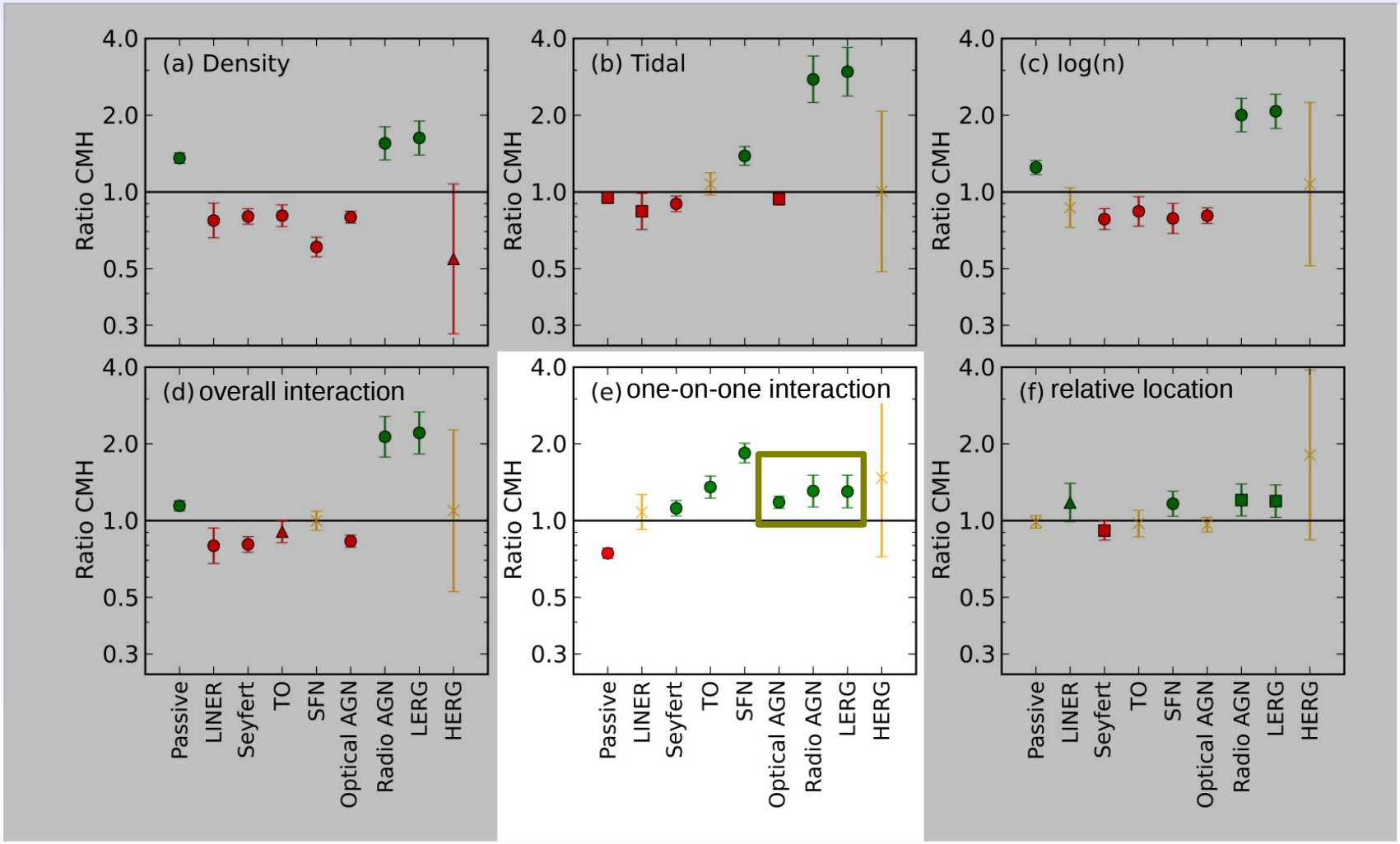


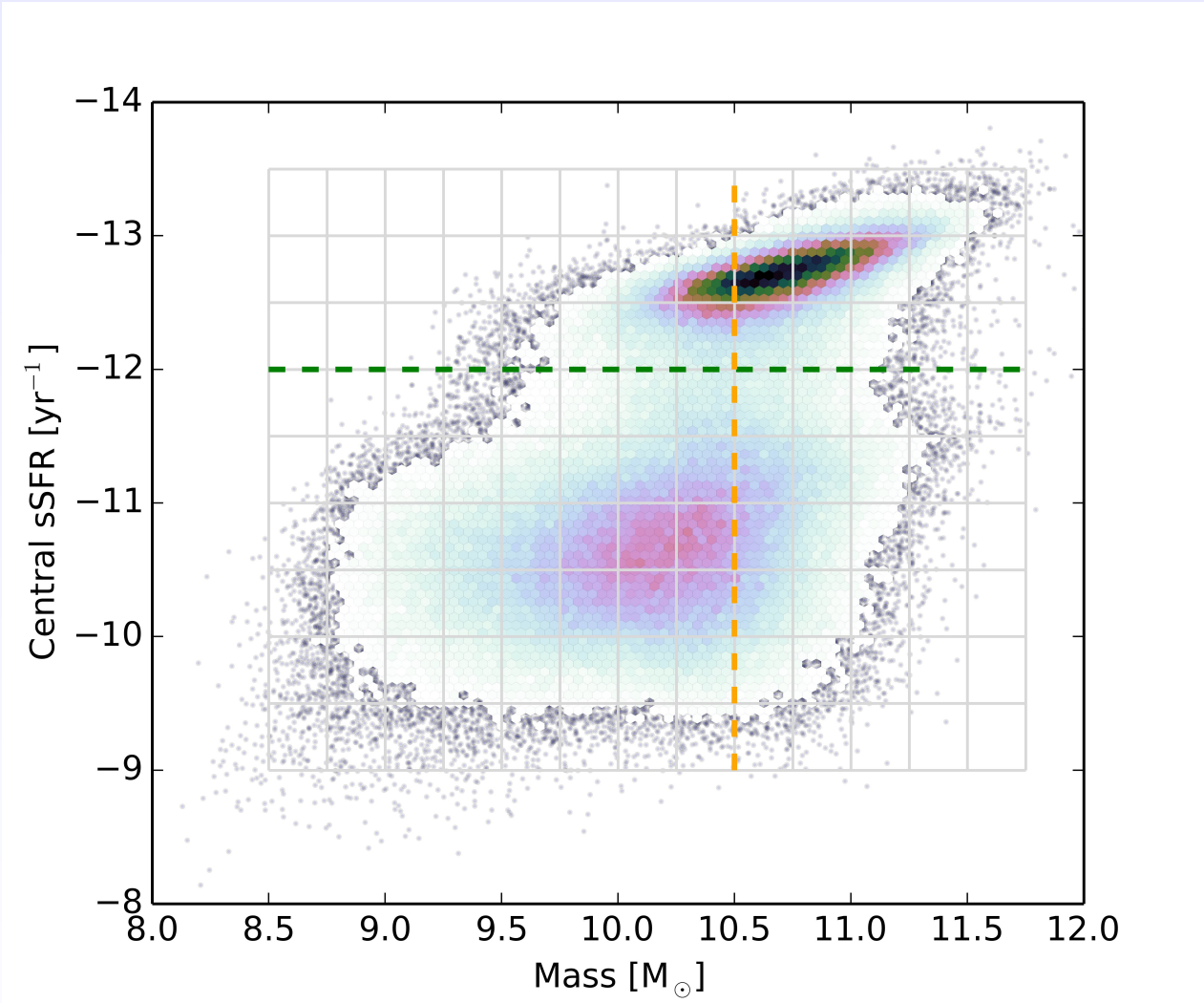
Let's focus on radiative-mode (optical) AGN and take into account the central star formation

Central star formation

- Central star formation is linked to AGN activity (Kauffmann et al. 2007; LaMassa et al. 2013)
- Consider *central specific star formation rate* as a confounding factor like mass

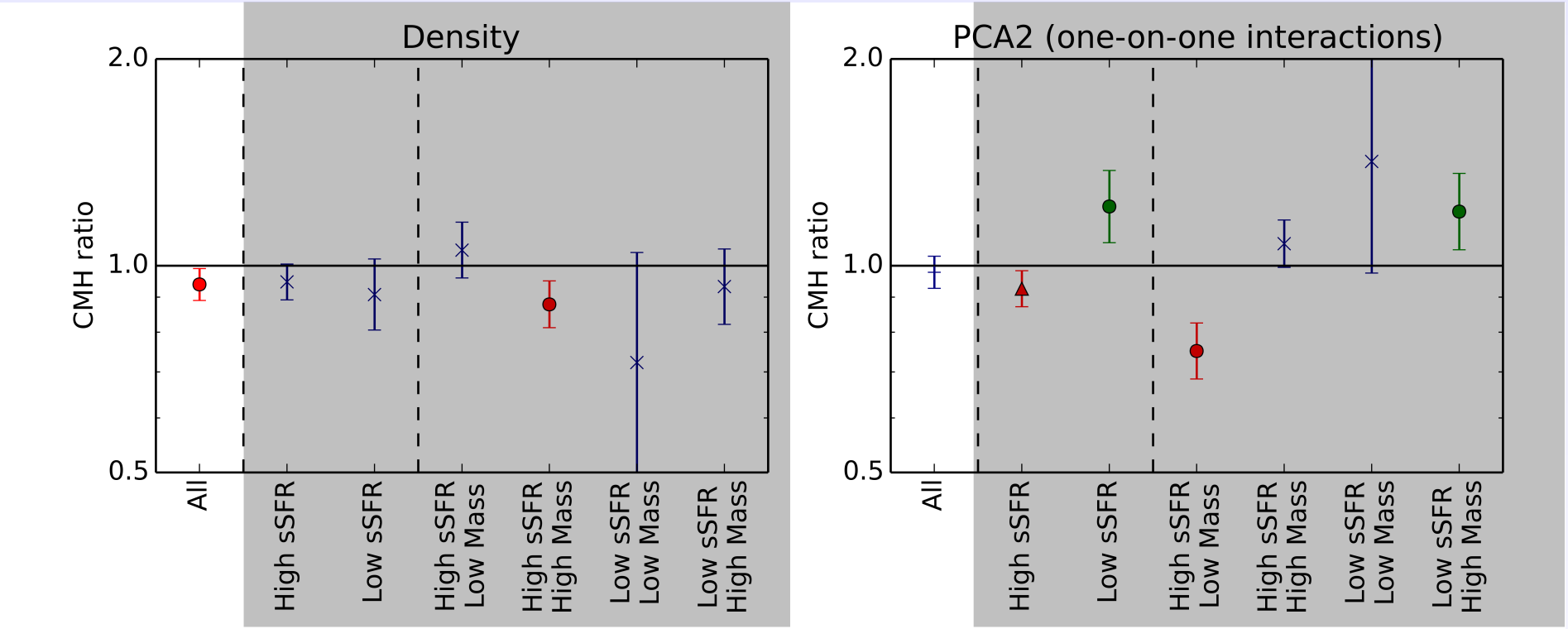
Central star formation

Specific
Star
Formation
Rate
In the centre



Galaxy stellar mass

CMH Results



- Non significant or very small trends.
- Non-homogeneous trend for PCA2 (Woolf's test)

Central star formation

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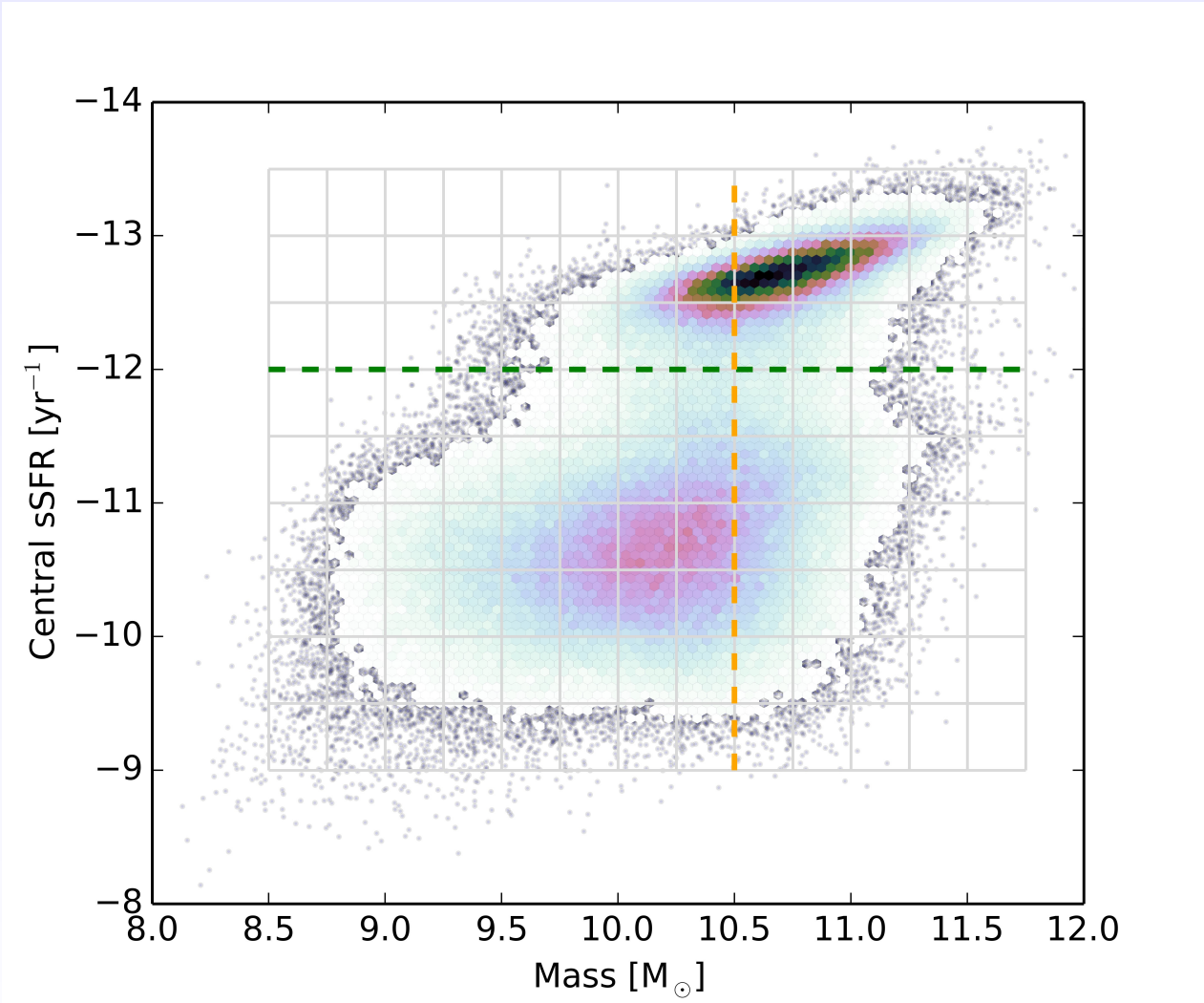

Galaxy stellar mass

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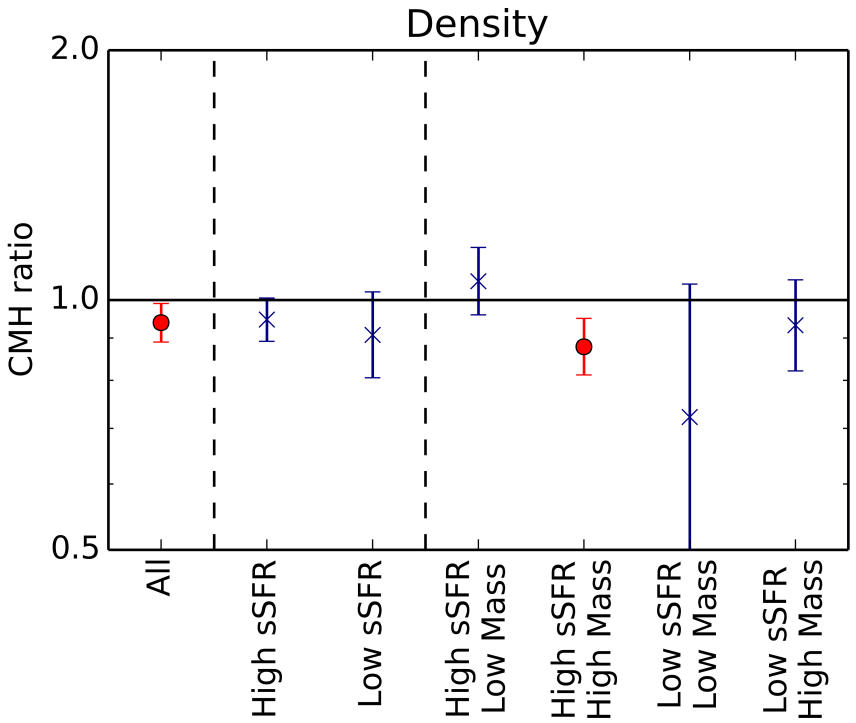
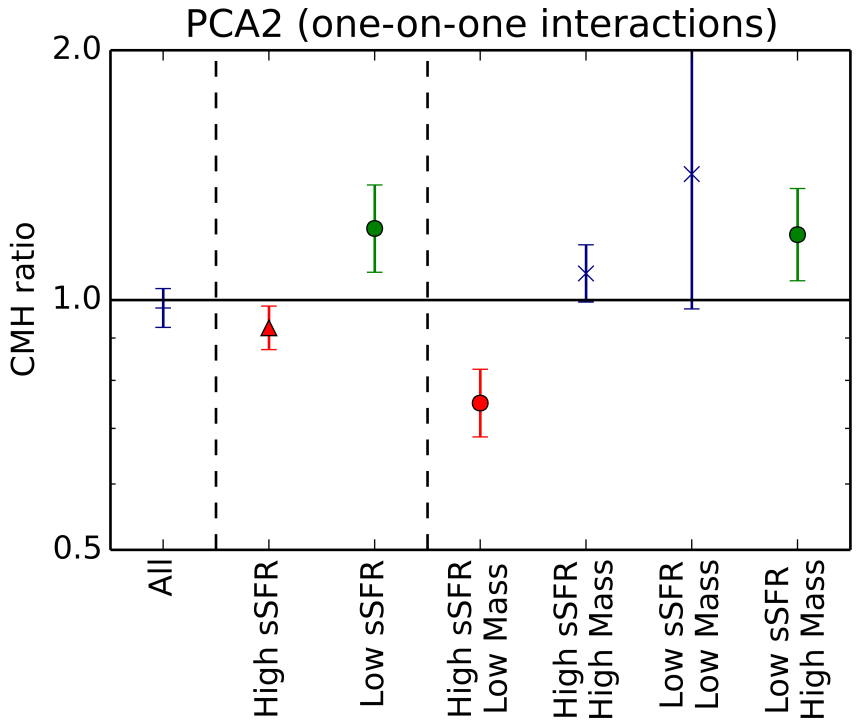
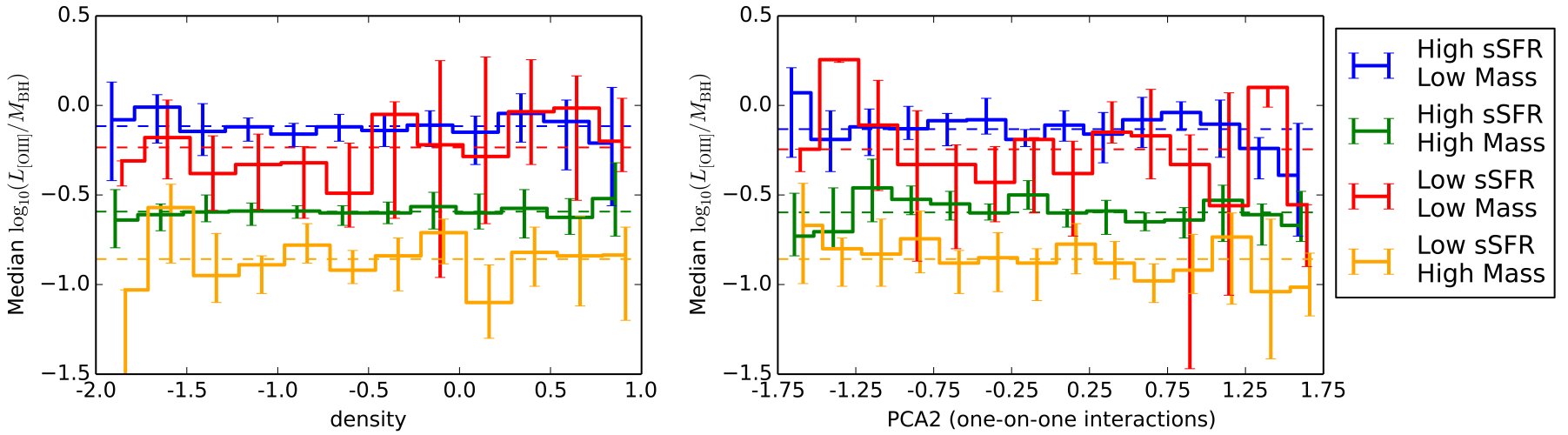




- Non significant or very small trends.
- At most ~ 20% level for some sub-samples in PCA2.

Activity level



- Activity level traced by the median of $\log(L_{[OIII]}/M_{BH})$
- No significant trends within each subsample

Conclusions I

- Decrease of radiative mode (optical) AGN and increase of jet mode (radio) AGN prevalence towards denser environments.
  - Probably explained by the presence/absence of a supply of cold gas.
- One-on-one interactions enhances both optical and radio nuclear activity prevalence.

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Conclusions II

- If central star formation is taken into account the effect of environment and interactions is minimal.
- Environment and interactions seem to affect AGN indirectly, by influencing the central gas supply.

Sabater, J. and Best, P. submitted