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BIRMINGHAM

AGN activity and host galaxy environment

Walter Del Pozzo^{1,2},
Somak Raychaudhury²,
Arif Babul³

¹NIKHEF, Amsterdam 1098 XG, Netherlands

²*School of Physics and Astronomy, University of Birmingham, Birmingham B15 2TT, UK*

³*Department of Physics and Astronomy, University of Victoria, Victoria, BC V8P 5C2, Canada*



Motivation

- AGN activity depends on:
 - i. black hole mass (and spin?)
 - ii. accretion rate
- Environment does affect AGN activity:
 - Optical: e.g. Dressler et al. 1980, 1985
 - X ray: e.g. Martini et al. 2005, 2006
 - Radio: e.g. Best et al. 2005, Lin & Mohr 2007
- How is each of the two ingredients affected?

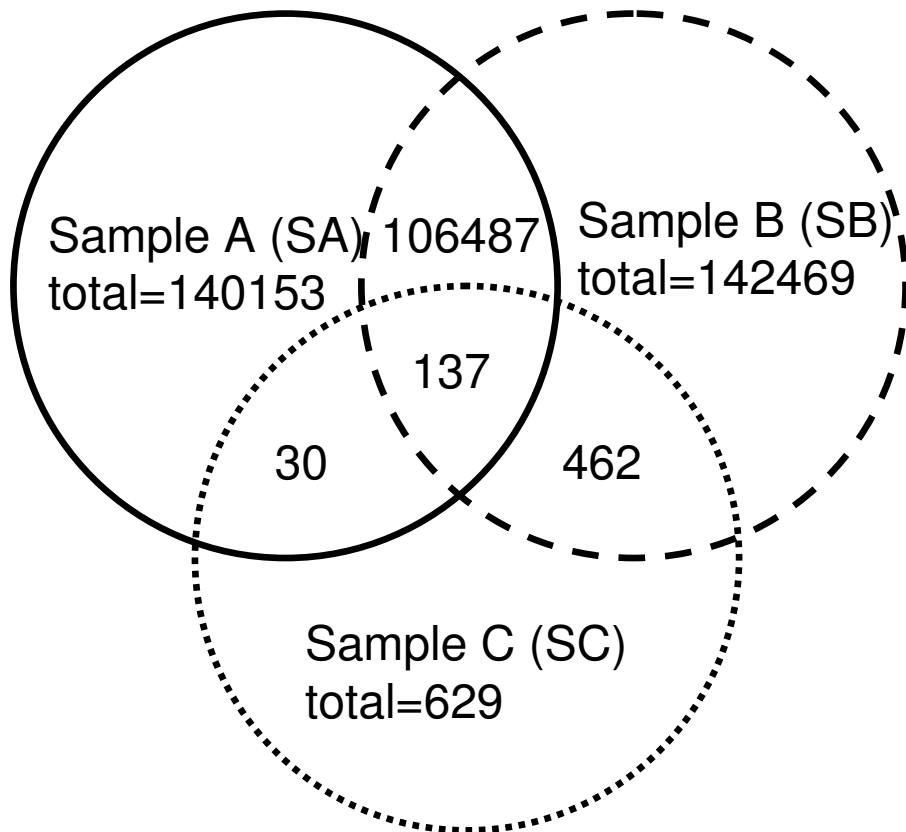


Sample

- Starting from SDSS DR6 we identified all galaxies with $r < 17.7$ and spectroscopic $z < 0.1$
 - Sample A (SA): $u-r < 2.2$ (Strateva et al. 2001);
 - Sample B (SB): $R_{50}/R_{90} < 0.33$ (Shimasaku et al. 2001)
 - Sample C (SC): H α line with: FWHM > 1000 km/s
EW > 30 Å (Greene & Ho 2005)
- Abell et al. 1989: **Cluster Catalog**
- Berlind et al. 2010: **Group Catalog**
- All the rest: Field Catalog



Sample

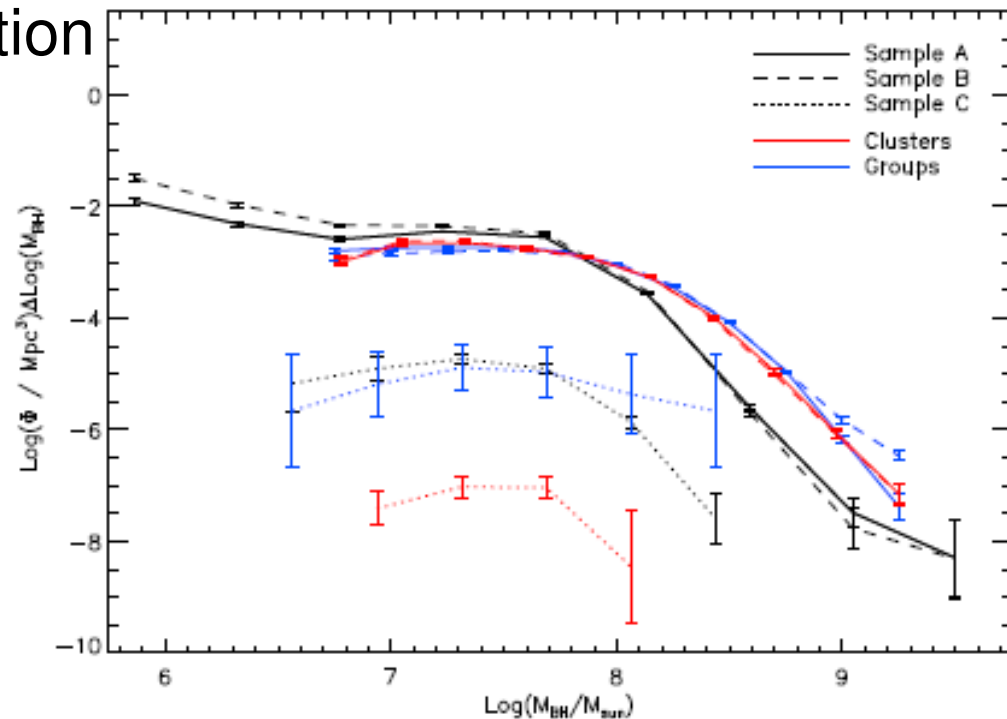


- Cluster galaxies: ~ 13 %
- Group galaxies: ~ 44 %
- Field galaxies: ~ 43 %



i. Black Hole Mass Function

- K band from the 2MASS survey to calibrate an r band Marconi & Hunt like relation
- massive BHs in **groups** and **clusters** are more common
- Optical AGN (SC) found in $10^{6.5} < M_{\text{BH}}/M_{\text{sun}} < 10^{8.5}$
- SC (optical AGN) is strongly suppressed in **clusters**.



SA: $u-r < 2.2$

SB: $R_{50}/R_{90} < 0.33$

SC: $H\alpha : \text{FWHM} > 1000 \text{ km/s}, \text{EW} > 30 \text{ \AA}$

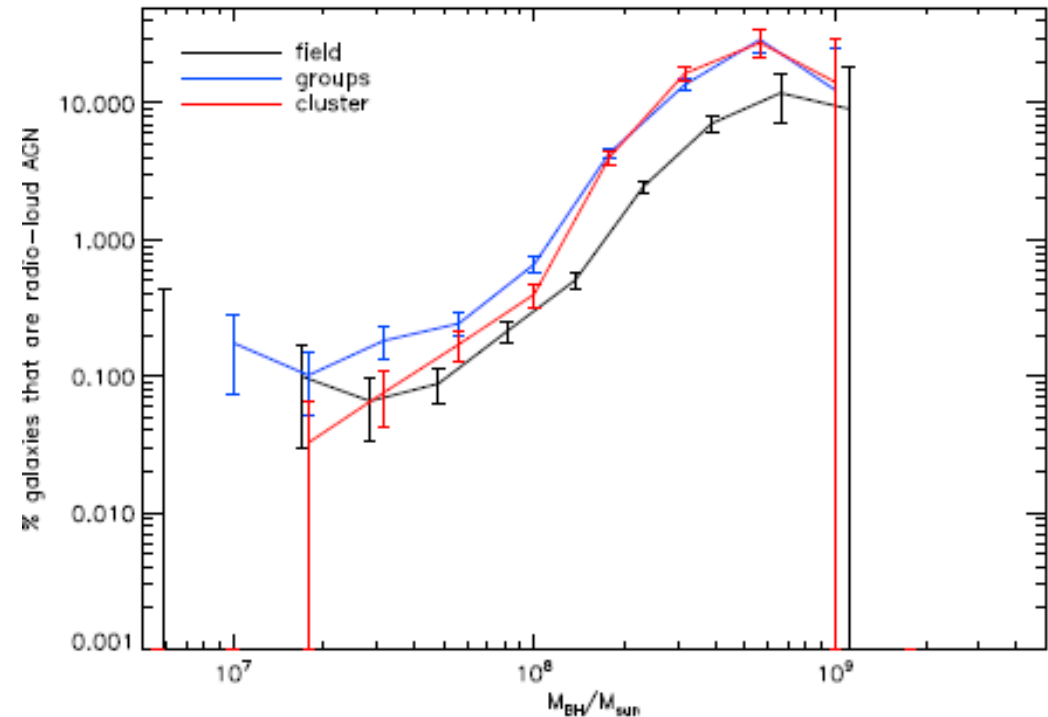


ii. Accretion Rate: Radio Active Fractions (RAF)

- $L_{1.4\text{GHz}}$ from the FIRST survey, $L_{1.4\text{GHz}} > 10^{23} \text{ W Hz}^{-1}$

- Satellite BHs (dashed lines):

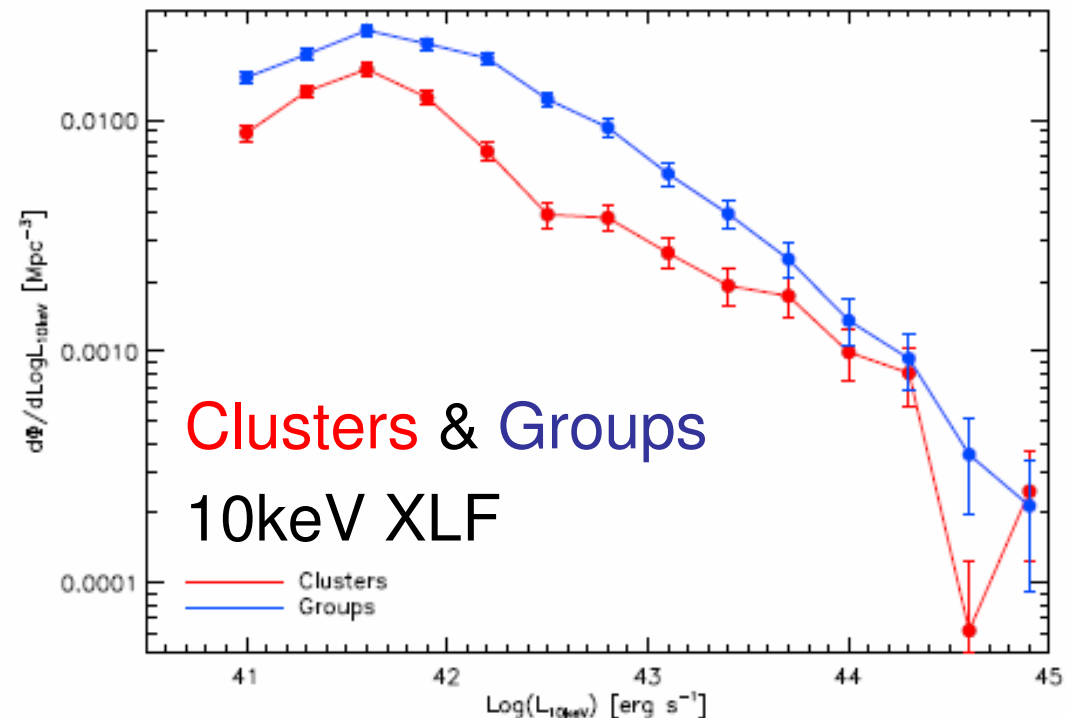
- the **cluster**/**group** RAF ~ 2 RAF field
- field/**group** $\sim M_{\text{BH}}^{1.5}$
- in **clusters** $\sim M_{\text{BH}}^{2.3}$





ii. Accretion Rate: X ray luminosity function (XLF) and fractions

- BH fundamental plane (e.g. Falcke et al. 2004) in combination with M_{BH} and $L_{1.4\text{GHz}}$
- X ray AGN more common in **groups**
- Fractions of X ray AGN in agreement with Martini et al. 2007:
 - $f(R < -20; L_x > 10^{41}) \approx 3.5 \%$
 - $f(R < -20; L_x > 10^{42}) \approx 1.5 \%$





Summary

1. massive BHs are more likely to be found in **groups** and **cluster** galaxies;
2. the **cluster** environment suppresses optical AGN;
3. at fixed BH mass, BHs in **groups** and **clusters** have higher RAF compared to field BHs:
 - a. **groups** $\sim M_{\text{BH}}^{1.5}$;
 - b. **clusters** $\sim M_{\text{BH}}^{2.3}$;
4. from the BH fundamental plane we expect X ray AGN to be more common in **groups** than in **clusters**



ii. Accretion Rate: X ray luminosity function (XLF) and fractions

- BH fundamental plane (e.g. Falcke et al. 2004) in combination with M_{BH} and $L_{1.4\text{GHz}}$

- In reasonable agreement with the $z < 0.1$ 10keV XLF from Aird et al. 2009

