The Environments of z~1 AGN

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Introduction

- Reasons for studying the environments of AGN
  - Investigate their use as tracers of high-redshift clusters
  - Link between BH and galaxy formation implies a link between AGN and environment
  - Assess differences between quasars and RG – orientation or fuelling mechanism?

Do AGN Trace Over-Densities?

- Reasons to expect AGN to reside in clusters
  - Extended X-ray emission from AGN fields (Crawford & Fabian 1996)
  - Powerful RGs are as luminous as BCGs and have $R^{1/4}$ light profiles (Best et al. 1998)
  - Production of such luminous radio sources requires a dense environment to confine the radio lobes (Barthel & Arnoud 1996)
  - Luminous quasars are thought to be fuelled by gas-rich galaxy mergers (Hopkins et al. 2008)

Previous Studies

- Low-redshift:
  - AGN avoid rich clusters and are more commonly found in groups or poor cluster environments (e.g. Coldwell et al. 2002)
  - Evidence of increased clustering around quasars on small scales (<100 kpc; Serber et al. 2006)
- High-redshift:
  - Results similar to low-redshift (e.g. Best 2000), but also found in richness class 2 clusters (Sanchez et al. 2002)

An AGN-Environment Link?

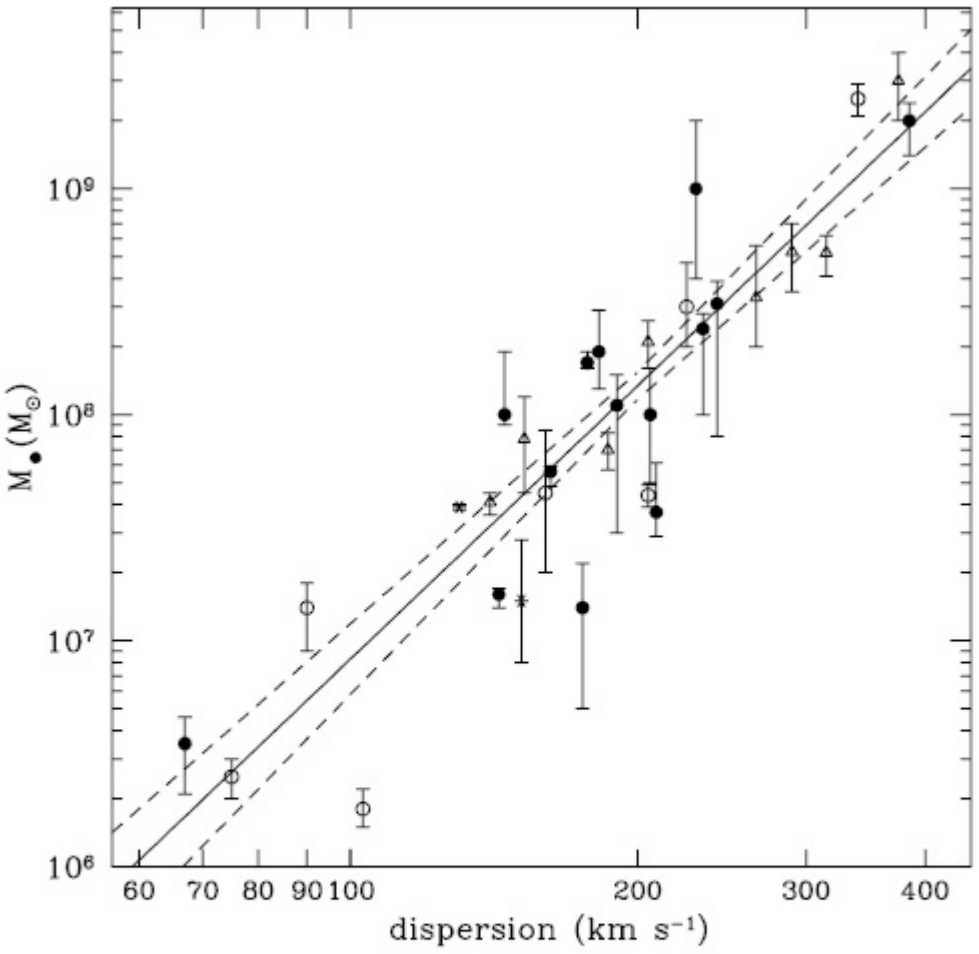
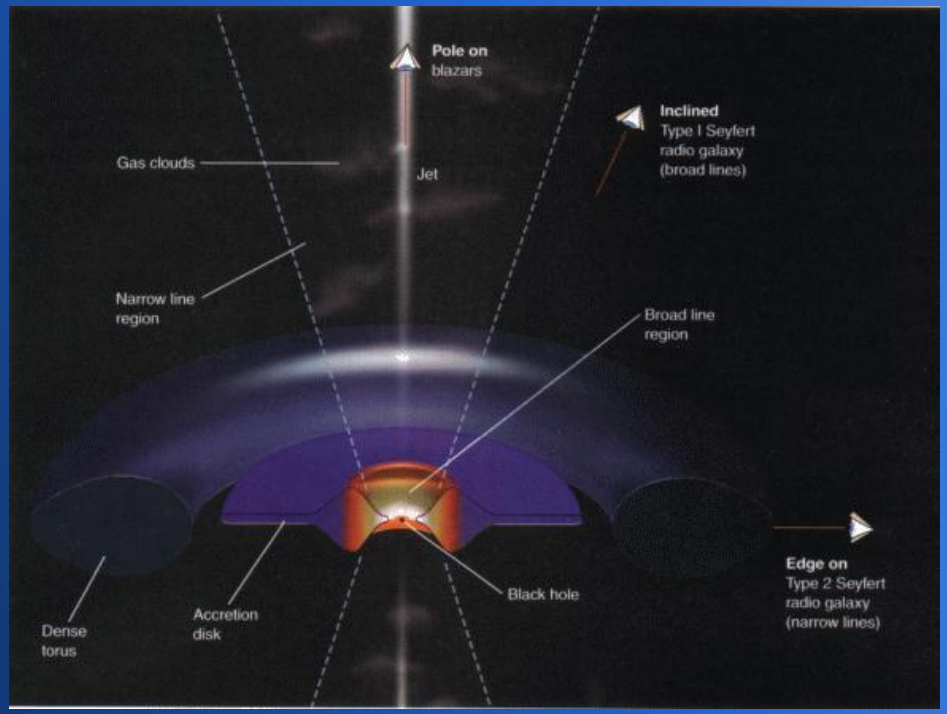


FIG. 7.—Data on black hole masses and dispersions for the galaxies in Table 1, along with the best-fit correlation described by eqs. (1) and (19). Mass measurements based on stellar kinematics are denoted by circles, on gas kinematics by triangles, and on maser kinematics by asterisks; Nuker measurements are denoted by filled circles. The dashed lines show the 1 σ limits on the best-fit correlation.

- $M_{BH} \propto \sigma^a$ (Tremaine et al. 2002)
- Many galaxy properties are correlated with environment, e.g. colour and morphology
- Reasonable to expect a correlation between AGN and environment

AGN Properties

- Two main interpretations of differences in AGN properties
  - Differing viewing angles (Antonucci 1993)
  - Differing fuelling mechanisms (e.g. Hopkins et al. 2006)



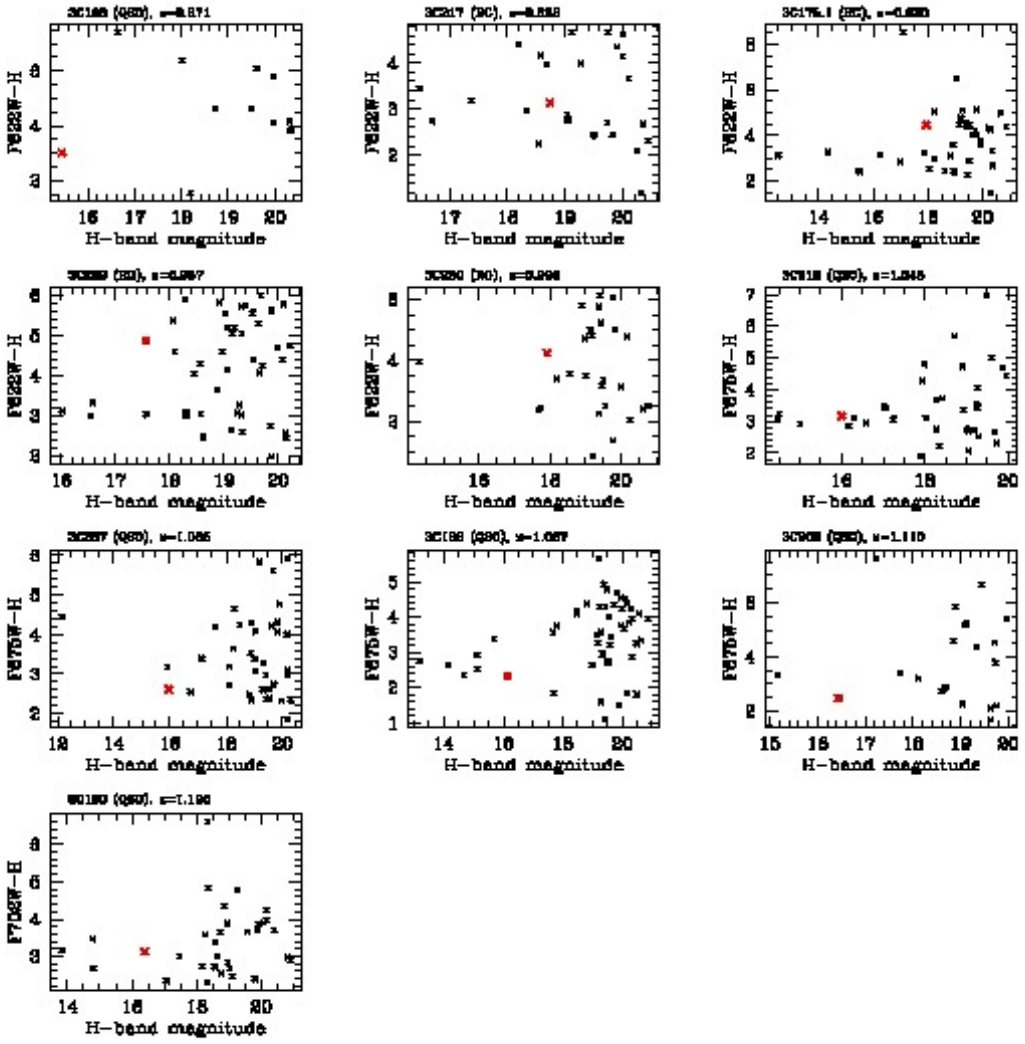
Sample

Name	z	Type	L_{178MHz} (10^{25} W/Hz/sr)
3C175.1	0.92	RG	396
3C186	1.07	Quasar	830
3C190	1.20	Quasar	1010
3C196	0.87	Quasar	1930
3C208	1.11	Quasar	954
3C212	1.05	Quasar	729
3C217	0.90	RG	338
3C280	1.00	RG	931
3C287	1.06	Quasar	556
3C289	0.97	RG	441

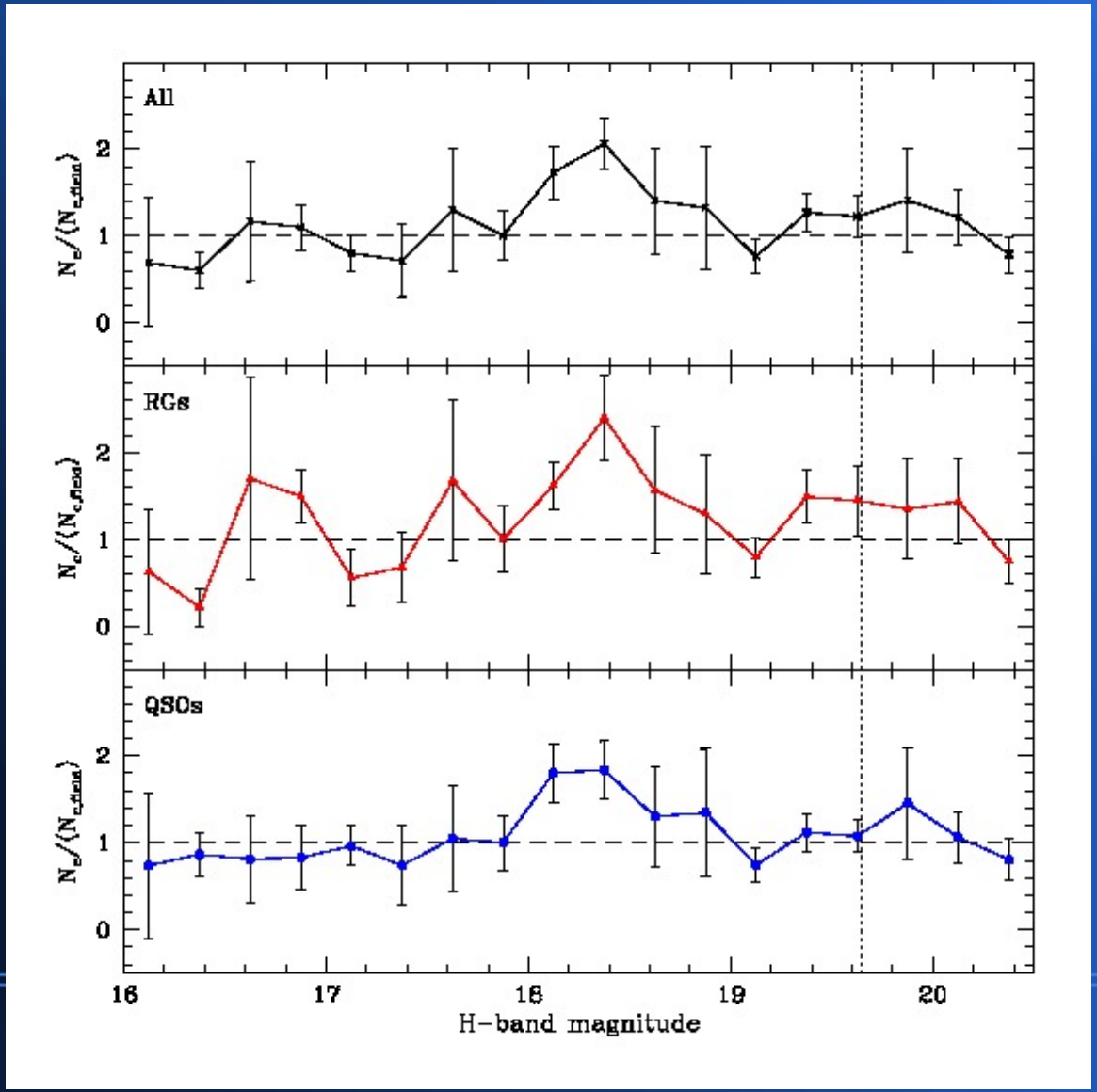
Observations

- H-band observations with QUIRC, ~7000 s
  - ~3 Mpc x 1.5 Mpc
  - Offset fields ~1.5 Mpc x 1.5 Mpc
- WFPC2 observations using F622W, F675W or F702W, 8000s
  - AGN was placed on chip 3
- Sextractor
  - 50% completeness: H=20.2 to 21.1 (2.5σ)
  - H*+0.6 to H*+1.5

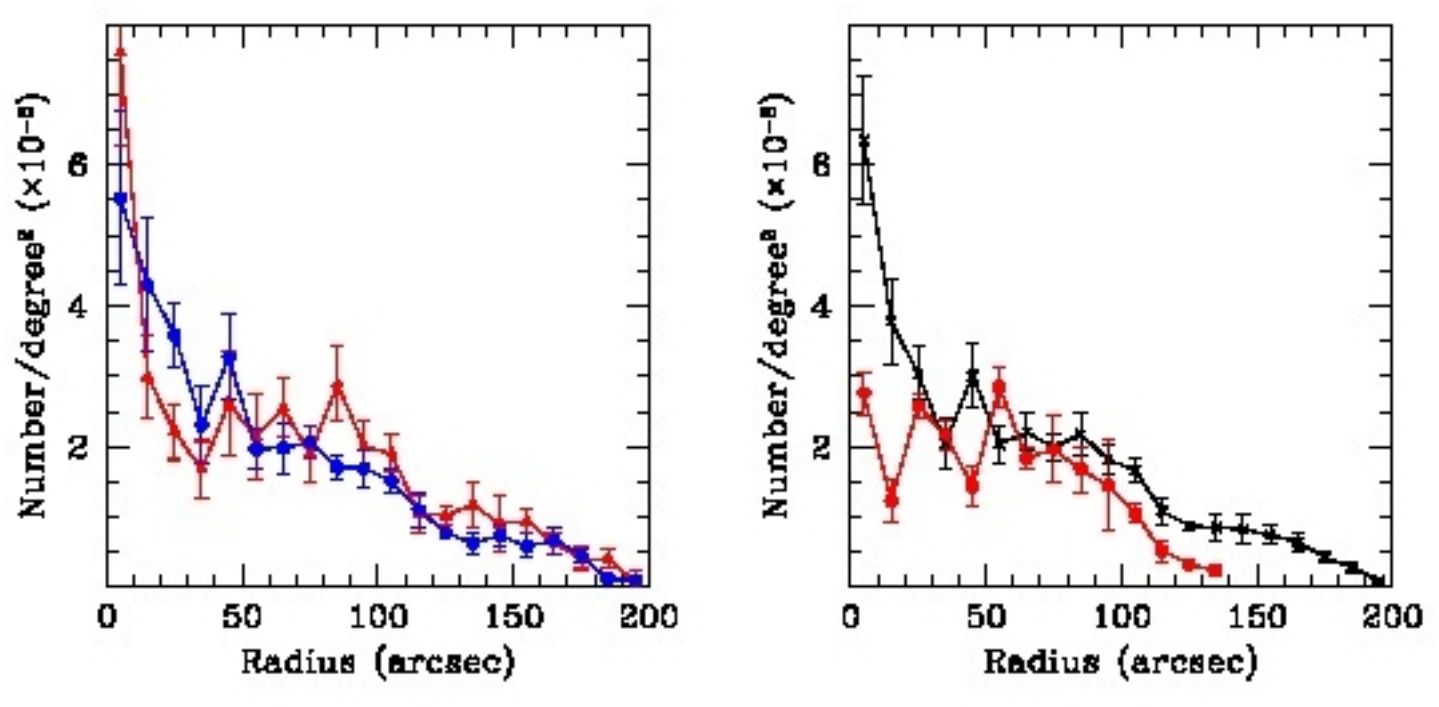
CM Relations



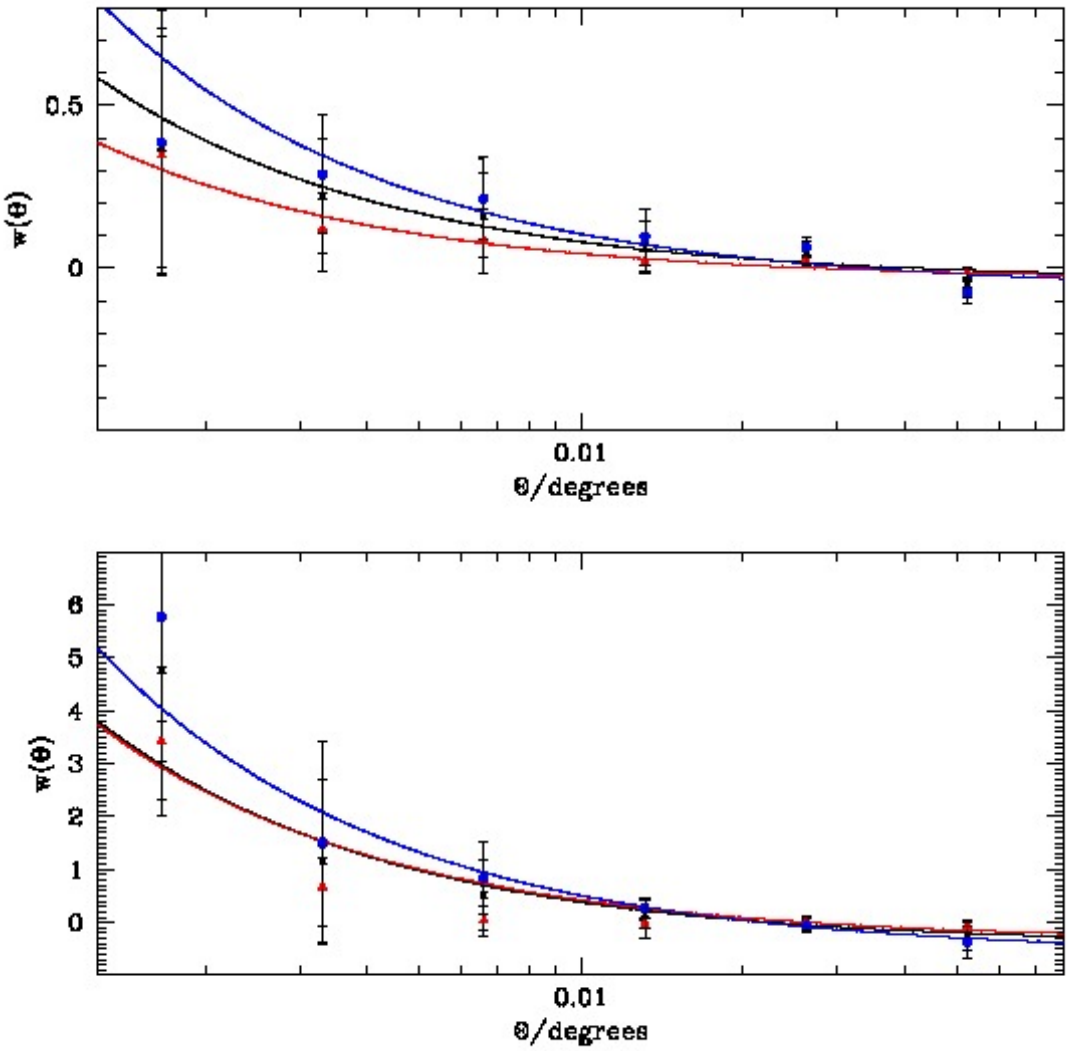
Excess Galaxy Counts



Projected Surface Density



2-Point Correlation Function



- Standard estimator

  $w_G(\Theta)=GG(\Theta)/GR(\Theta)-1$

  $w_A(\Theta)=AG(\Theta)/AR(\Theta)-1$

- Power law form:

  $w(\Theta)=A(\Theta/\mathrm{deg})^{-\delta}$

  where $\delta=0.8$

Summary

- Evidence of a red sequence in more than half of the fields
- Marginal evidence of a galaxy excess at H* in the RG fields
- Over-density of galaxies around AGN on scales <25” (~100 kpc at z=1)
- AGN are more strongly clustered than galaxies on scales <30”
- On average, AGN reside in environments similar to those of rich groups/poor clusters and, with the exception for the galaxy excess around RG, there are no significant differences between quasars and RGs