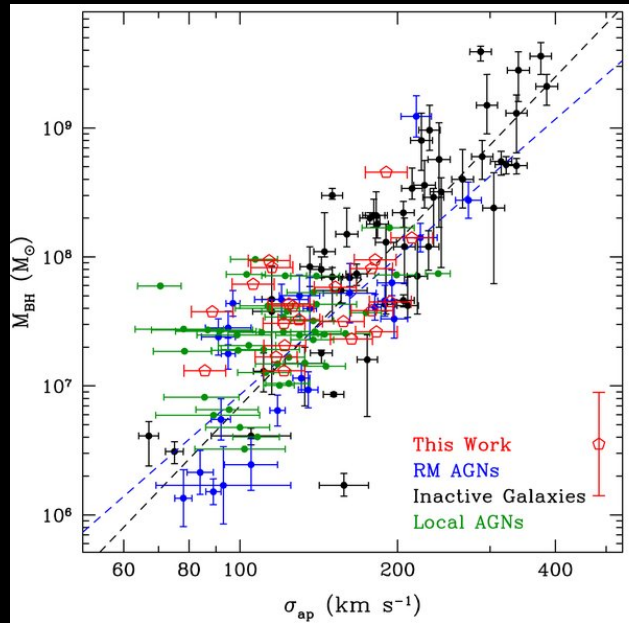


Current Outstanding Questions in AGN and their Relationship to Galaxy Evolution

Brandon C. Kelly, Aleks Diamond-
Stanic, Aaron Barth

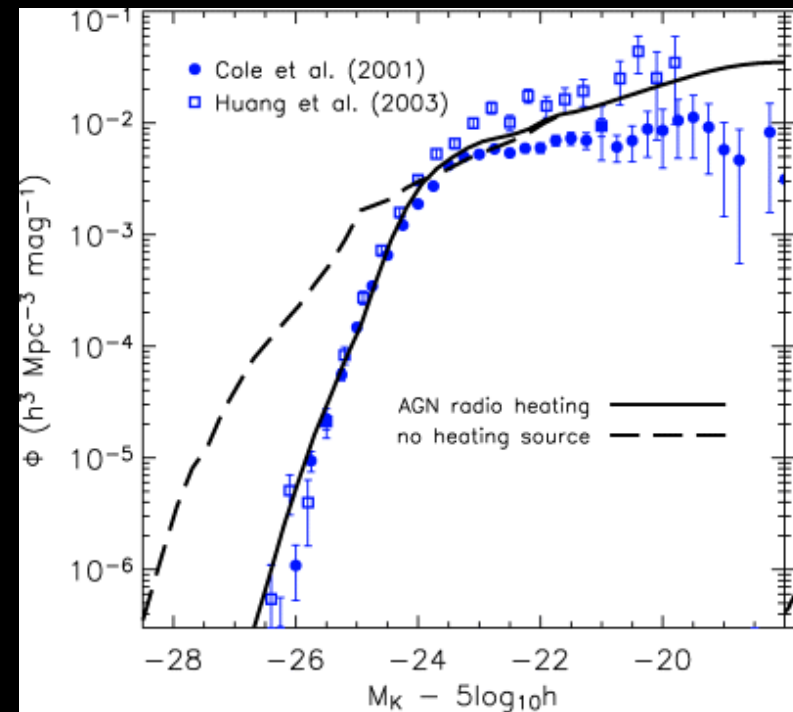
AGN Feedback



Bennert et al. (2011)

'Quasar' Mode: Source of feedback is AGN radiation

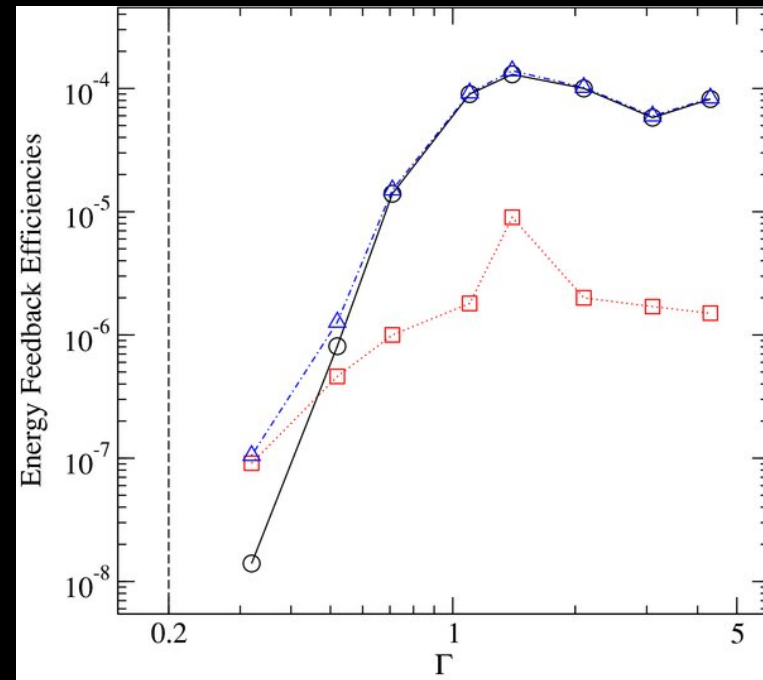
'Radio' Mode: Source of feedback is AGN Jet



Croton et al. 2006

How does feedback work?

- Theory:
 - Feedback efficiency is treated as a free parameter to match the local scaling relationships, lack physical description
 - Need improvements in modeling of feedback, better spatial resolution in simulations
- Observation:
 - How often is outflowing material observed near AGN?
 - Match kinetic energy in outflows to AGN output
 - Improvements to ground-based telescopes will help (e.g., TMT, GMT, AO), so will IXO



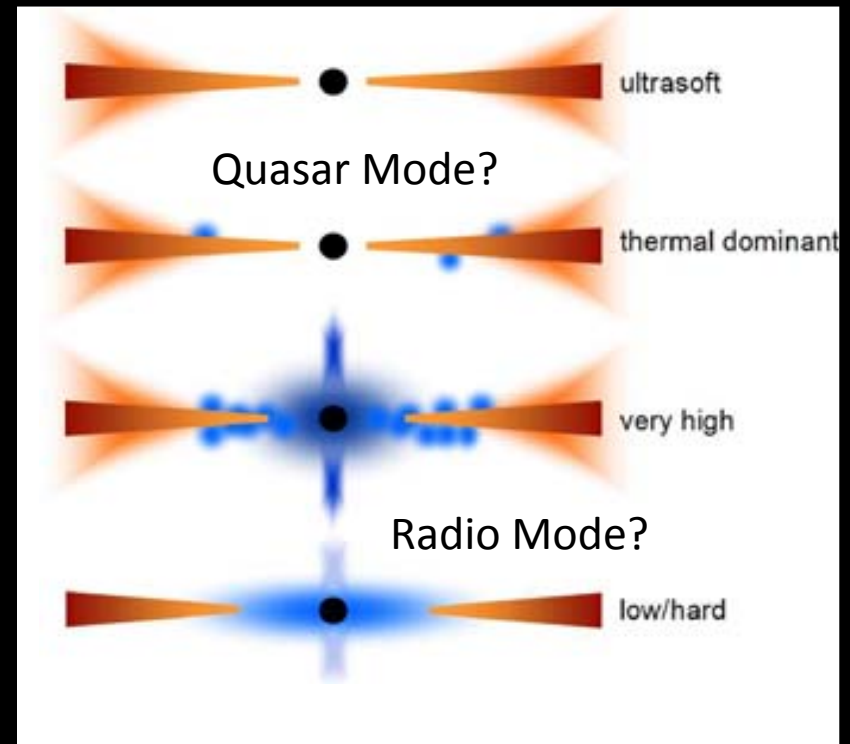
Eddington Ratio \longrightarrow

Kurosawa et al. (2009)

Radio vs. Quasar Mode

- Theory:
 - How do jets form? Is spin important?
How frequently do they form?
 - X-ray binaries exist in different states, do AGN?
- Observation
 - Multiwavelength SEDs of Jets (Fermi)
 - Census of BH spin for AGN (IXO, AGN demographics)
 - Continue AGN/X-ray binary comparisons (X-ray + radio studies of LLAGN)

Interpretation of GBH States



Done et al. (2007)

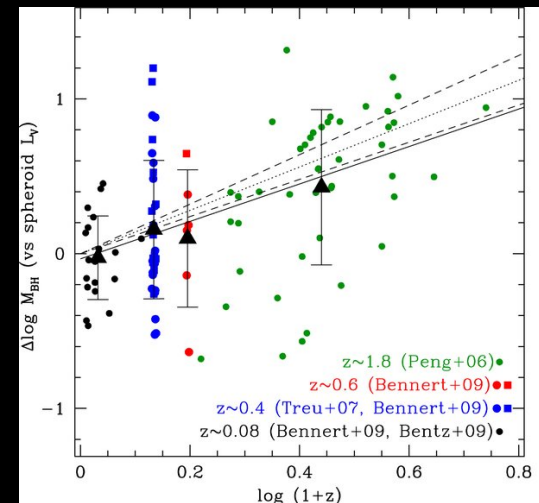
AGN Fueling

- What fueling mechanisms dominate AGN? Major mergers, minor mergers, stochastic accretion?
- How does gas get to the BH? Does it fragment, or is it a continuous stream?
- ALMA will be able to resolve inner 10-100 pc, directly observe gas near BH
- Further work on AGN/host galaxy scaling relationships and AGN demographics will provide clues

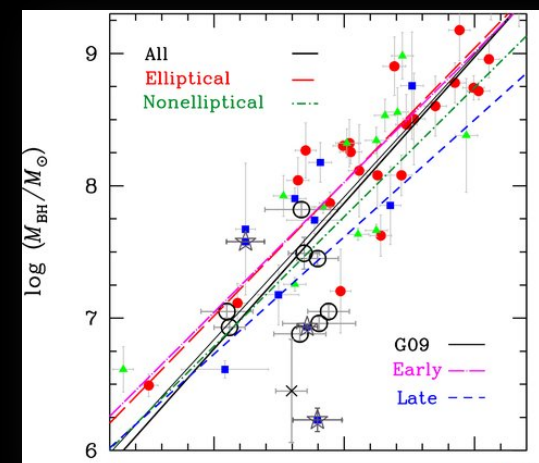
Further improvements to the $M_{\text{BH}}-\sigma$ relationship

- More measurements at the low M_{BH} end
 - Does the amplitude of the scatter increase at low BH mass? What value of M_{BH} does this occur at?
- Improved constraints on evolution of scaling relationship
 - Does the slope/normalization/scatter evolve?
- Next generation of ground based telescopes (TMT/GMT) will enable measurements of BH mass based on dynamical modeling of stellar bulge, probe evolution and low mass end

Bennert et al (2010)



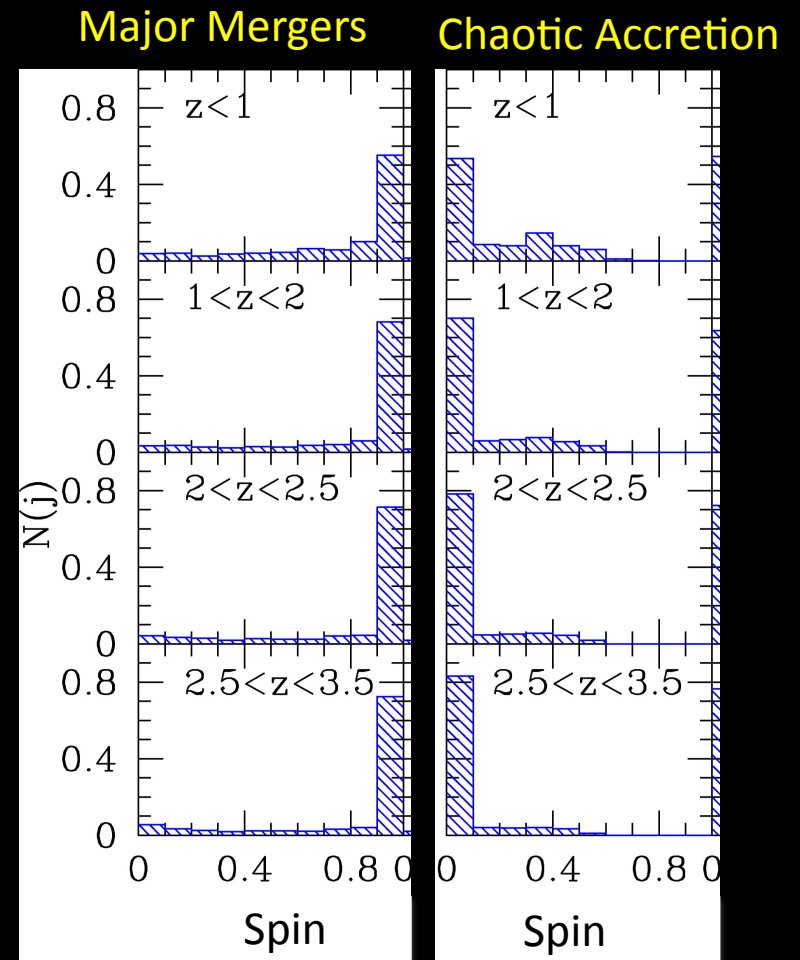
Greene et al (2010)



$\log \sigma \longrightarrow$

Better AGN Demographics

- How does AGN clustering depend on M_{BH} ?
 - LSST + spectroscopy should help
- What is the spin distribution of AGN?
 - IXO and LISA might provide some answers
 - Continuity equation arguments have potential
 - Need multiwavelength deep and wide samples + spectroscopy to get low M_{BH} and L / L_{edd} objects



Berti & Volonteri (2008)

Questions for Discussion

- How efficient is AGN feedback? How does this depend on AGN SED and/or geometry?
- How often are AGN in the quasar mode? How about the radio mode?
- What fueling mechanisms dominate black hole growth? How does this depend on halo mass?