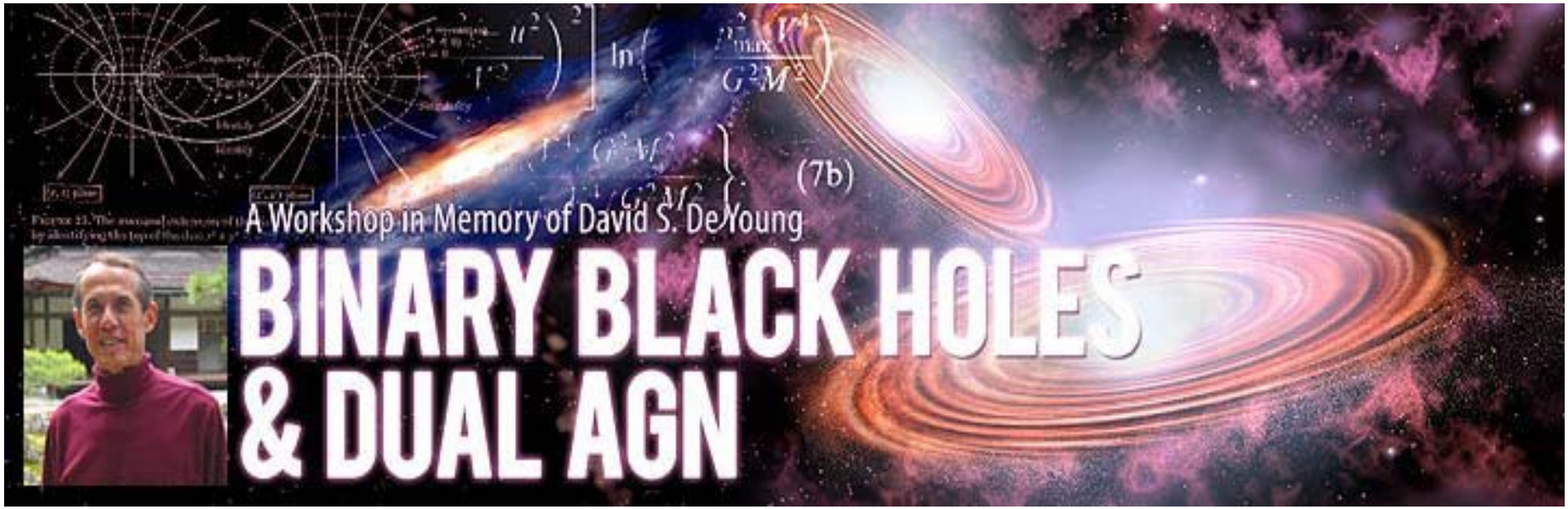

Conference Summary

My own work with Dave

THE EFFECT OF CENTRAL STARBURSTS ON THE INTERSTELLAR MEDIUM OF DWARF GALAXIES

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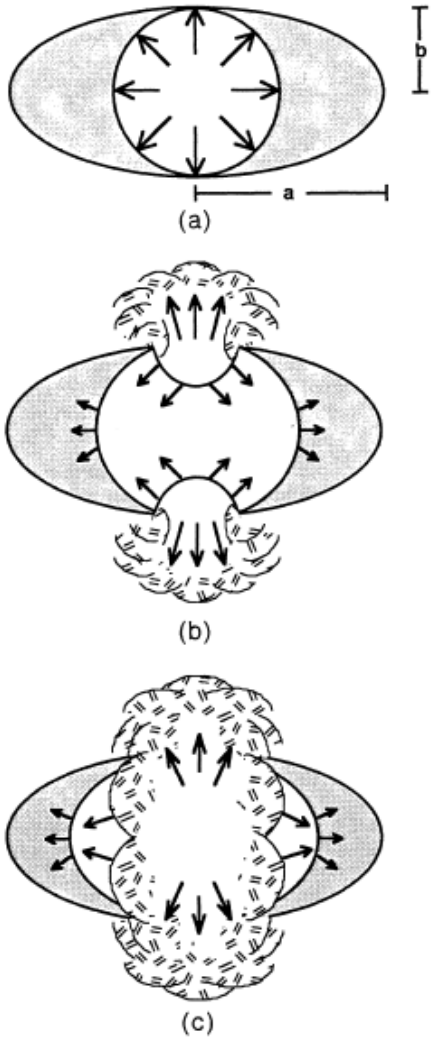
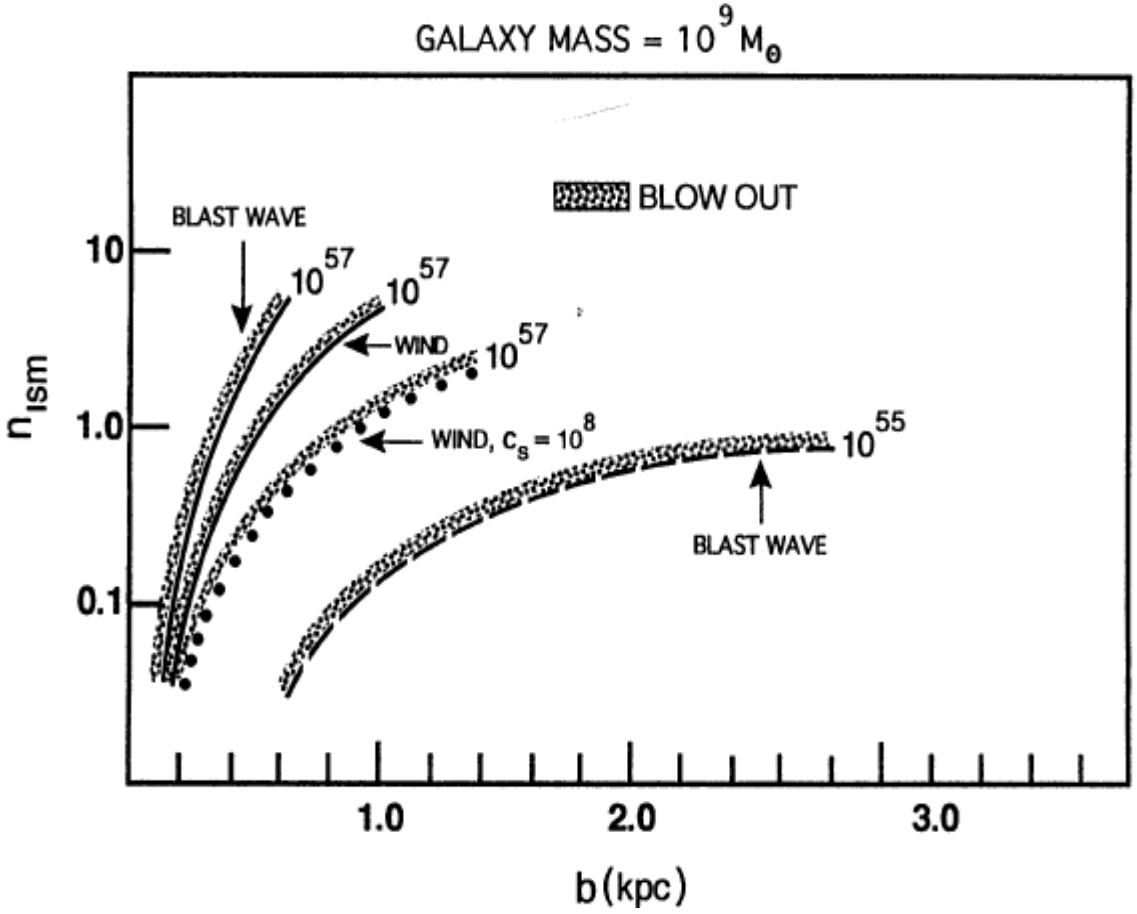
ABSTRACT

Major starburst events can last tens of millions of years, and in the process they can deposit significant amounts of energy into the surrounding interstellar medium. This energy from supernova and stellar winds imparts enough momentum to the interstellar medium (ISM) that portions of the ISM can become unbound and leave the parent galaxy, taking the metal-enriched stellar debris along. In dwarf galaxies, starbursts can produce enough total energy to unbind most or all of the ambient ISM. Whether this actually occurs is a strong function of the ellipticity of the ISM distribution, with flat disks and spheres being the limiting cases. We calculate whether "blow out" along the symmetry axis of "blow away" of the entire ISM occurs during a central starburst in dwarf galaxies as a function of galactic mass, starburst energy, ISM density, and ISM ellipticity. The calculations cover a range of 10^7–10^9 $M_\odot$ for dwarf galaxies and include "normal" galaxies of 10^{11} $M_\odot$ as well. No massive dark matter halos are assumed to be present. We find that for physically reasonable values of total ISM mass and starburst energy a blow out along the symmetry axis occurs in the majority of cases, though a significant fraction of small dwarf galaxies can lose most of their ISM. As no dark matter halos or clumpy ISM distributions are included, it is apparent that the ISM in most dwarf galaxies may be generally resistant to significant disruption by a central starburst event. The effects of this range of behavior on the metallicities that would be observed in these galaxies is discussed.

Subject headings: galaxies: evolution — galaxies: ISM — galaxies: starburst — galaxies: structure

“Blow-Out vs. Blow-Away”
136 citations and going strong





Conference Summary: An Outsiders Perspective

SDSSJ092712.65+294344.0: NGC 1275 AT $z = 0.7$?

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ABSTRACT

SDSSJ092712.65+294344.0 was identified by the Sloan Digital Sky Survey as a quasar, but has the unusual property of having two emission-line systems offset by 2650 km s^{-1}. One of these contains the usual combination of broad and narrow lines; the other contains only narrow lines. In the first paper commenting on this system, it was interpreted as a galaxy in which a pair of black holes had merged, imparting a several thousand km s^{-1} recoil to the new, larger black hole. In two other papers, it was interpreted as a small-separation binary black hole. We propose a new interpretation: that this system is a more distant analog of NGC 1275, a large and small galaxy interacting near the center of a rich cluster.

Key words: black hole physics – galaxies: nuclei

The major themes of this conference

- How are jets formed and what do they do?
- How important is the merger channel for forming/growing SMBH?
- How common are dual AGN and what is their role in galaxy/BH co-evolution?
- Have we observed (can we observe) true binary SMBHs or their evolved descendants?

Jets

- Closest to Dave' heart
- Incredible progress on simulations and understanding on:

1) How jets are formed (Steve Hawley)

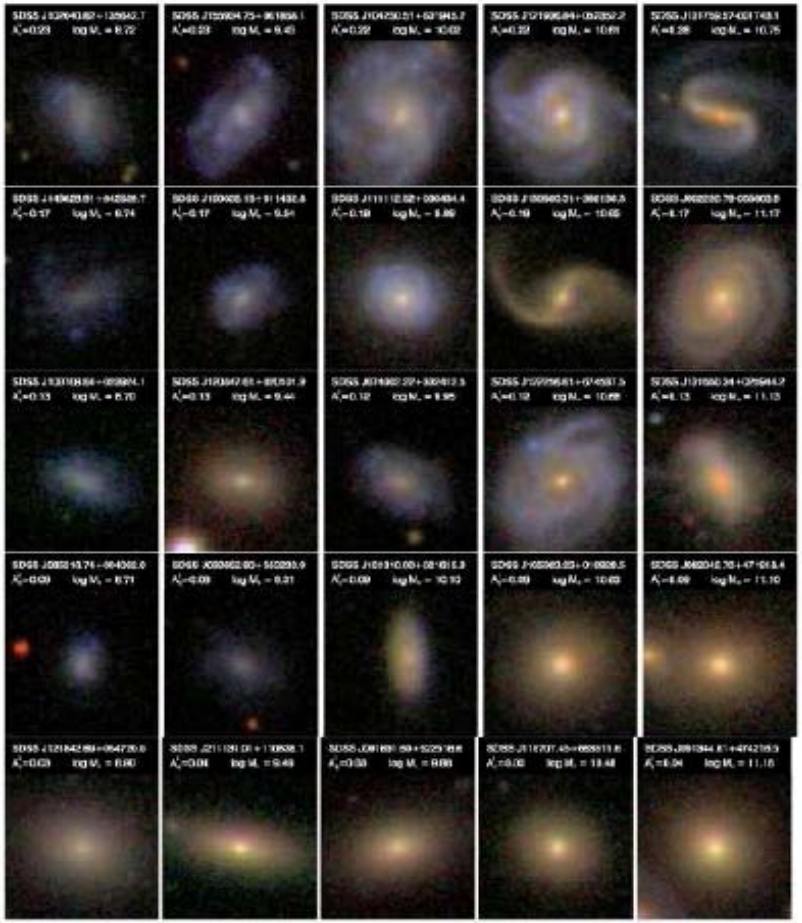
2) What they do to their surroundings (Tom Jones)

3) How they may probe close to the event horizon (Jason Dexter)

Mergers

- Nice summary by Claire Max
- Evidence from BAT AGN (Mike Koss)
- A longstanding and contentious issue
- Here's my take (Reichard et al. 2009) using SDSS Type 2 AGN

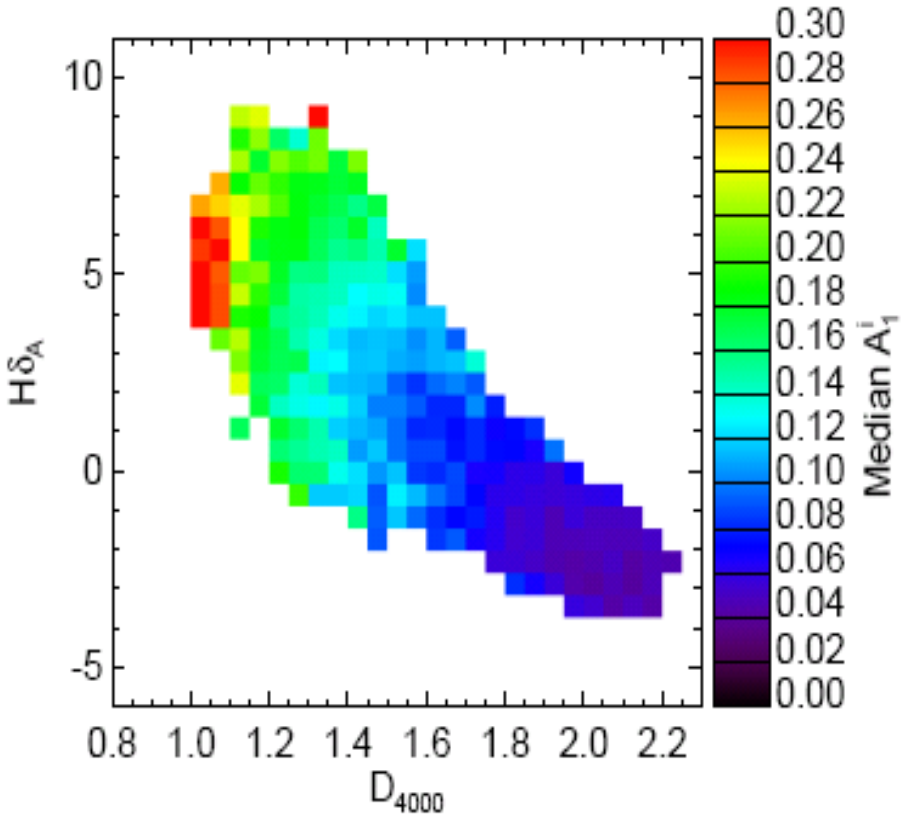
Mergers or Interactions?

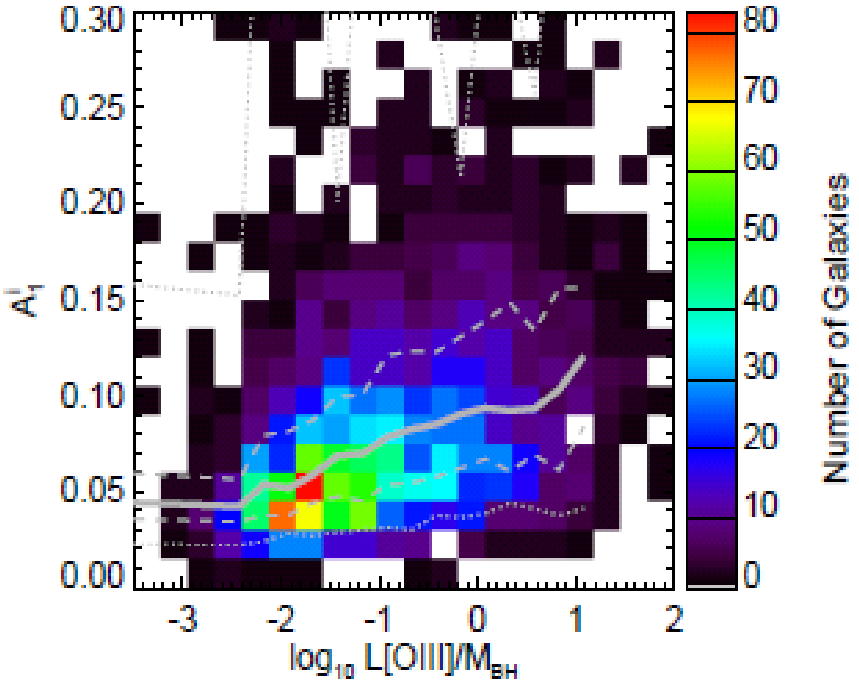


Reichard et al. (2009)

- Measure “lopsidedness” of galaxy
- Signpost of interactions & minor mergers

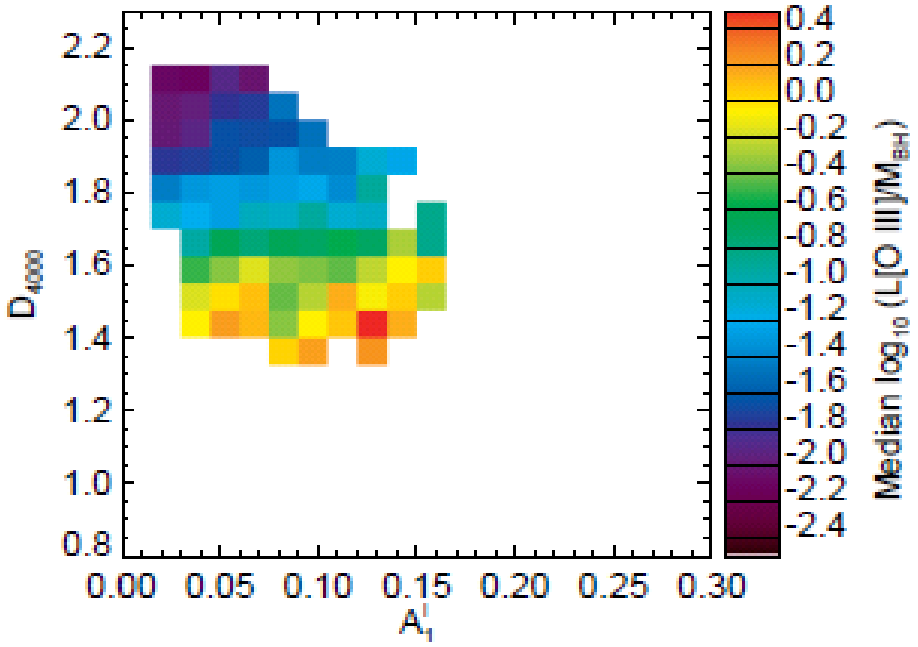
Mergers as a Trigger?

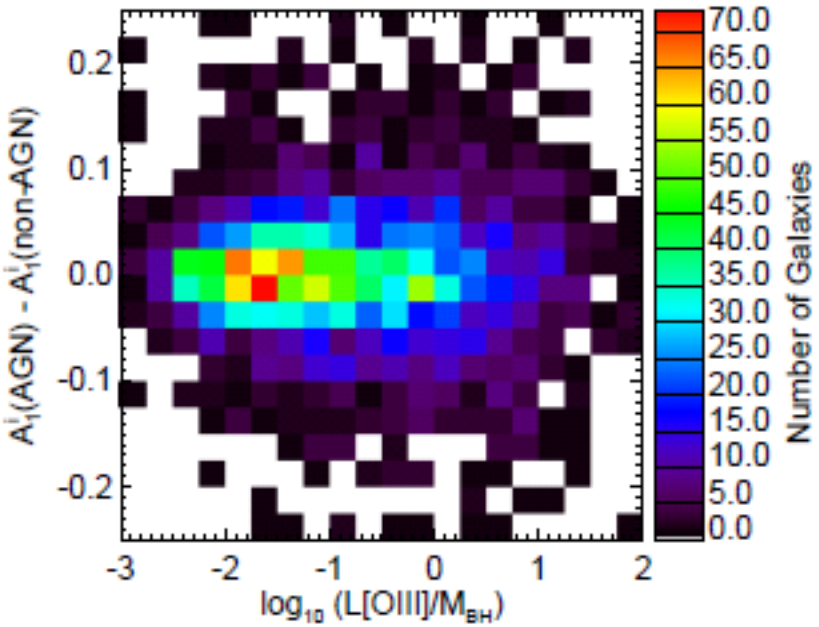




- Strong link between lopsidedness & young bulge
- Higher black hole growth = mildly lopsided galaxies

Physical vs. Induced Correlations





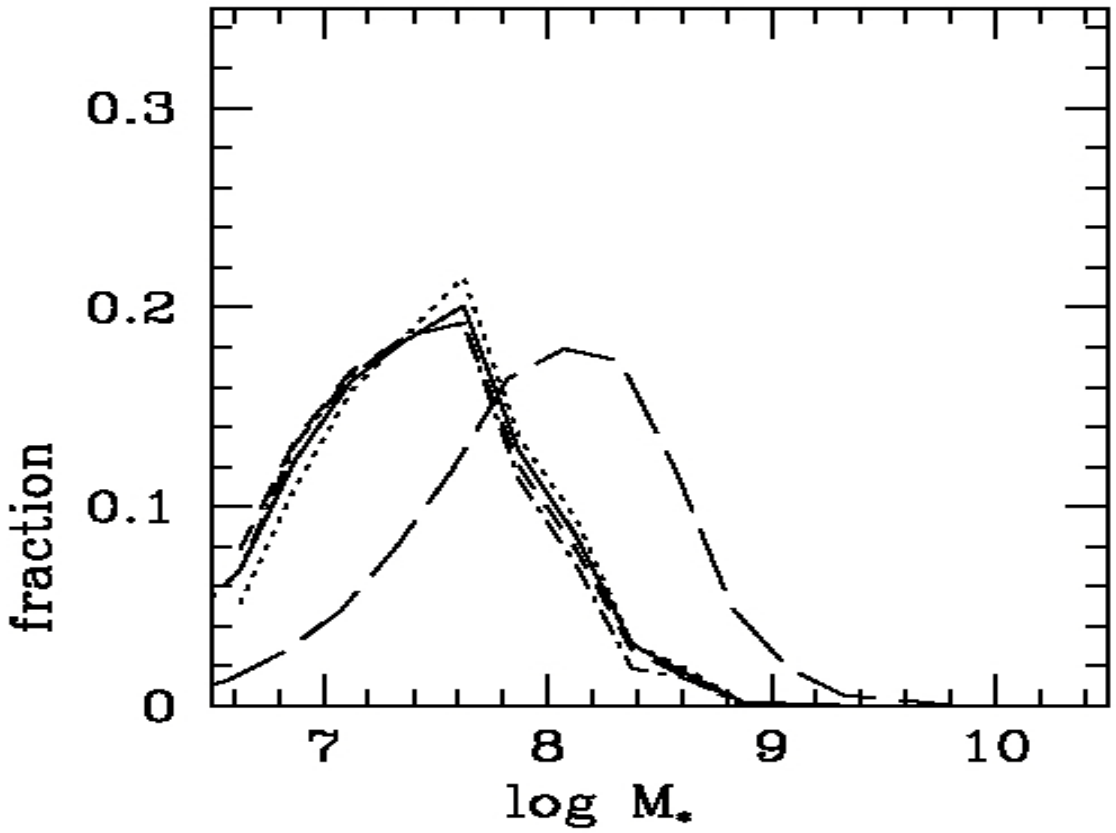
> The primary correlations are between:

1) lopsidedness and star-formation

2) star formation and black hole growth

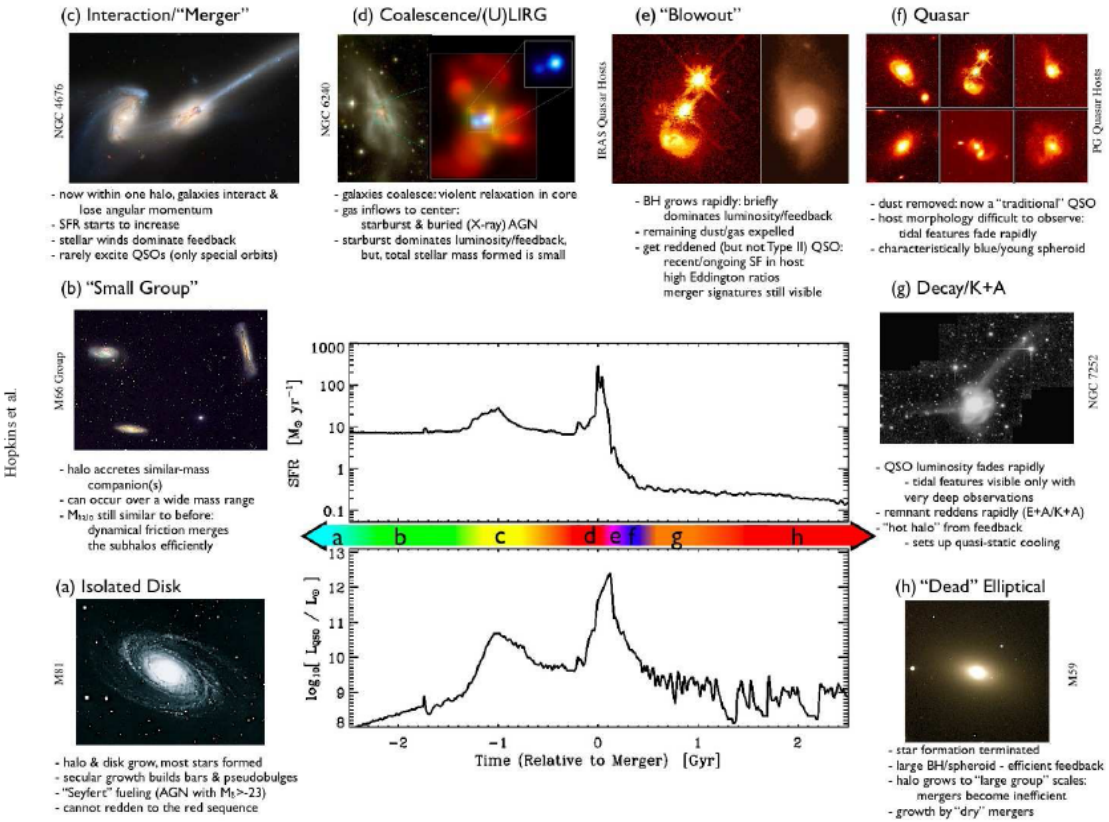
> The apparent correlation between lopsidedness and black hole growth is induced (not physical)

WHICH BLACK HOLES ARE GROWING?



- Mass resides in the more massive black holes
- Growth dominated by less massive ones

When is the merger paradigm crucial?



- A reasonable model for understanding the most luminous AGN at low-z (high BH mass and high Eddington ratio). Dramatic event needed to revive these high-mass BHs?
- Probably not the dominant channel for overall BH and galaxy growth over cosmic time (accretion and/or secular processes)

Binary BH vs. Dual AGN

- Binary BH implies the two BH's are gravitationally bound to one-another. They may merge and be ejected from host.
- Dual AGN implies the two active BHs are bound within the gravitational potential of a merging or merged galaxy.
- Velocity offset Delta_v >> sigma vs. Delta_v ~ sigma
- Transition radius r_tran ~ G M_BH/sigma^2
- r_tran ~ 15 (sigma/200 km/s)^2 pc
  ~ 12 (M_BH/10^8 M_sun)^0.5 pc
  ~ 0.01 - 0.1 arcsec even for nearest AGN (200 – 20 Mpc)

Tough to directly observe the proverbial "smoking gun"

Evidence for Dual AGN

- Delta_v ~ sigma and r_host > Delta_r >> r-trans
- Double X-ray sources (Koss & Mazzarella)
- Dissection of (U)LIRGs (U, Medling, Mazzarella)
- Double radio galaxies (Jones & Phinney)
- ***Some*** double-peaked narrow-emission-line profiles (Blecha, McGurk, Barrows, Ge, Comerford)

It's clear that dual AGN exist but **the demographics are not established**. Lots of faux-systems that take a lot of work to identify and weed out.

Beware of selection effects!

Evidence for Binary SMBH

- Delta_v (BH-BH) >> sigma and Delta_r (BH-BH) < r_tran
- Beautiful summaries of the ways we might be able to recognize these (Phinney) and how they might form (Blandford, Merritt)
- Evidence is scant. One case turned up with VLBI (Rodriguez+06) , but such systems are rare (1:3000 - Burke-Spolaor 2011)
- Candidates (Eracleous;Barrows;Steinhardt) but interpretation as such is not secure

Binary BH & the future

- The most convincing way to detect and study binary SMBH is via gravitational radiation both before and during a merger (Blandford, Phinney)
- This may happen sooner rather than later (Ravi) using pulsar timing

Evidence for merged and ejected SMBH

- Delta_v (AGN – Host) >> sigma and Delta_r (BH – nucleus) >> r_tran
- Rather little discussion in this conference
- Candidates, but nothing truly convincing so far
- Davide et al. poster describes search for offsets of BH from galaxy center-of-mass. None found with offsets > 10 pc.

Finally: Thanks!

>Thanks to Dave for being Dave

> Thanks to the SOC for this wonderful opportunity to honor Dave by discussing exciting new science