Not All AGNs are Created Equal: How Galaxies Feed and Obscure Their SMBHs

Jonathan Trump

UC Santa Cruz
COSMOS + CANDELS

Collaborators: Chris Impey (AZ), Sandy Faber, David Koo, Dale Kocevski (UCSC), Martin Elvis, Brandon Kelly, Francesca Civano (CfA), Yoshi Taniguchi, Tohru Nagao (Ehime), Knud Jahnke, Marcella Brusa, Mara Salvato, Paul Nandra (Max-Planck), Anton Koekemoer (STScI)
A Paradigm for SMBH Activity

• What ignites the AGN phase?
  – Galaxy mergers? (Sanders+88, Hopkins+06)
  – Isolated disks? (Hopkins & Hernquist 06, Bournaud+11)

• Why do AGN look so different?
  – Broad / narrow lines, luminosity, SED vary widely
  – Caused by different obscuration, or accretion physics?
  – Governed by host?

Is there a Unified Model to describe different active galaxies???
The Historical AGN “Unified Model” (Antonucci 93)

Orientation explains:
- Luminous / Faint
- Obscuration
- Type 1 (BL) / 2 (NL)
- Reflected BLR in spectropolarimetry

But many objects don’t fit!
Many Type 2’s have little X-ray absorption (Trouille+09), no IR torus (Trump+09c,11b) & no reflected BLR (Tran 01,03)

from Urry & Padovani 1995
AGN Fueling (unobscured only: $N_H < 10^{22} \text{ cm}^2$)

- $L_{\text{int}}/L_{\text{Edd}}$: accretion rate
- With $L_{\text{disk}}/L_X$, $E_{\text{peak}}$ of disk, X-ray slope

![Graph showing the relationship between $L_{\text{int}}/L_{\text{Edd}}$, $L_{\text{disk}}/L_X$, and $E_{\text{peak}}$ for Type 1 and Type 2 AGNs and optically dull AGNs.](Trump+11b)
AGN Fueling

Different $L_{\text{int}}/L_{\text{Edd}}$ for unobscured Type 1/2

Broad-Line AGN

Unobscured Narrow-Line & Lineless AGN
AGN Fueling

- Disk gets brighter & hotter as accretion rate increases (difference is >3σ)
Accretion Rate and Radio Jets

• Weakly accreting AGN are more radio-loud!
• Weak AGN may be more important for radio-mode feedback (e.g. heating cluster cores, IGM enrichment)
What about Obscured AGN?

- High $L_{\text{int}}/L_{\text{Edd}}$ like unobscured Type 1s (using $L_{\text{int}} = 8L_{6\mu m}$, Richards+06)
Accretion in AGN Unification

$L_{\text{int}}/L_{\text{Edd}} \sim 0.1$ (BL AGN)

$L_{\text{int}}/L_{\text{Edd}} > 0.01$

$L_{\text{int}}/L_{\text{Edd}} \sim 10^{-2.5}$ (no BLR)

$L_{\text{int}}/L_{\text{Edd}} < 0.01$

Trump+11b
Two Axes in AGN Unification

- Quasars
- Obscured Type 2s
- "Naked" Type 2s
- Optically dull AGNs
- LINERs

Do AGN with different accretion rate / obscuration have different hosts?

$N_H \approx 10^{22} \text{ cm}^{-2}$

$L/L_{Edd} \sim 0.01$
Do Mergers feed Quasars?

- ULIRG AGNs (Sanders+88, Kartaltepe+10)
- Hard X-ray (Swift) AGN (Koss+10)
- BALQSOs (Urrutia+08)

All these are obscured, rapidly accreting, and local
X-ray AGNs are not more likely to be in Mergers

- Not in mergers!
- (Grogin+05, Pierce+07, Gabor+09, Cisternas+10)
- Is this because the AGN only appears after the merger is relaxed?

From Cisternas+10

Kocevski+11
Are Active Galaxies Disks or Spheroids?

• AGNs are frequently in disks! (e.g. Schawinski+11)
• Disks are unlikely to have recent merger (but see Robertson+06)
• But, AGNs are more typically in spheroids... and spheroid fraction increases with $L_{\text{AGN}}$

Weak X-ray AGNs in disks,
Luminous X-ray AGNs in spheroids
AGN Host Types

- Obscuration
- Accretion Rate

- Quasars, Spheroids
- Obscured Type 2s, Mergers
- "Naked" Type 2s, Disks
- Optically dull AGNs / LINERS, dead spheroids

- $N_H \sim 10^{22} \text{ cm}^{-2}$
- $L/L_{\text{Edd}} \sim 0.01$
How important is disk fueling?

- More disks than predicted (~40×)
- QSOs (& mergers?) still dominate XLF

**Hopkins & Hernquist 06 model**

**XLF from Aird+10**

**Cisternas+10**

**Kocevski+11**

>50% disks  <50% disks

0.5 < z < 0.8

0.8 < z < 1.0

1.5 < z < 2.0

2.0 < z < 2.5
QSO hosts are S0 / green valley, not red dead ellipticals

- QSO host galaxies from SDSS, with QSO removed from phot.
- Trump & Hsu in prep.
AGN presence in low-mass galaxies at $z \sim 2$

- WFC3 slitless grism
- $z \sim 2$ galaxies typically have AGN ratios in stacked core!
- Similar result from Wright+10 (1 galaxy)
- Also see recent Aird+11 paper

Trump+11c (submitted)
Summary

Accretion Rate: new axis in AGN

Unification

• Low accretion rate: ADAF at inner radii
• ADAF: radio-loud, cooler + weaker disk, different IR, BLR disappears
• Rapid accretion / obscured -> merger
• Rapid accretion / unobscured -> spheroid
• Weak accretion (“naked” Type 2) -> disk