The QSO–morphology connection
Is there one?
and: do we care?

Or: way too much fame for bulges and mergers?

Knud Jahnke (MPIA)
+ Katherine Inskip, Matt Mechtley, Liyu Ambachew (MPIA),
Mauricio Cisternas (IAC), John Silverman (IPMU) + COSMOS
The role of QSOs

• AGN feedback?
  • Maintenance (=radio) mode:
    → in clusters, ok, elsewhere?
  • Quenching (=QSO) mode:
    → ??? → dependency on M, env., z?

• Conditions for QSO activity?
  • Environment → non-cluster
  • Mass
  • Morphology → what about bulges?
What are the ... 

... properties of AGN (QSO) host galaxies?

... conditions for fueling massive Black Holes?
Fundamental pitfall

I USED TO THINK CORRELATION IMPLIED CAUSATION.

THEN I TOOK A STATISTICS CLASS. NOW I DON'T.

SOUNDS LIKE THE CLASS HELPED. WELL, MAYBE.

xkcd.com/552
BH–galaxy scaling relations

\[ \log \left( \frac{M_{BH}}{M_\odot} \right) \]

\[ \log \left( \frac{L_{3.6,\text{bul}}}{L_\odot,3.6} \right) \]

Sani+ 2011
BH–galaxy scaling relations

KJ & Maccio 2011
(see Peng 2007)
BH–galaxy scaling relations

Initial

Final

KJ & Maccio 2011
(see Peng 2007)
BH–galaxy scaling relations

Observation
Simulation

KJ & Maccio 2011

log(bulge mass)

log(BH mass)
BH–galaxy scaling relations

• What does this mean?
  • BH scaling relations consequence of LCDM assembly
  • No feedback needed
  • Modification by self-regulation and normalization → open
  • Historical misunderstanding: all BH fueling recipes successful

• In Q+Q context: *The bulge is not (necessarily) an active player*
No AGN–starburst relation

Luminous AGN: same stellar ages as SF galaxies
No AGN–starburst relation

KJ+ 2004a,b; Sanchez, KJ+ 2004

\[ z \approx 0.1 \]
\( \text{col–mag} \)

\[ 0.4 < z < 1.3 \]
\( \text{col–z} \)

\[ 1.7 < z < 2.5 \]
\( \text{col–z} \)

+Herschel (Santini+ 2012):

**Luminous AGN are normal SF galaxies, not starbursts**
The role of QSOs

What are the ...  

... properties of AGN (QSO) host galaxies?  

... conditions for fueling massive Black Holes?
How to feed a monster BH

• Presence of gas $\rightarrow$ see SF

• Need for a “trigger”?  
  • Favorite mechanism: major merging  
    - SAMs $\rightarrow$ Rachel S.  
    - SPH $\rightarrow$ Di Matteo/Phil H./Springel  
    - Analytics $\rightarrow$ Andrew K.
QSOs = Major Merging?

QSO host galaxies, HST: Bahcall+ 1997

Warning: unknown selection function!
QSOs = Major Merging?

Low-z, high mass: P91, VLT/FORS, 0.6”, 28 QSOs $\log M_{BH} \sim 9.0$ + 28 comparison galaxies

HE 1514–0606, $\log M_{BH}=8.9$

inactive

inactive

Ambachew, KJ+, in prep.
QSOs = Major Merging?

z=2, high mass: HST WFC3/IR, 19 QSOs, logM$_{BH}$~9.5

Mechtley, KJ+, in prep.
QSOs = Major Merging?

AGN host galaxies

Bulge-dom.  Disk-dom.

AGN: >50% disks (massive end: open)

COSMOS z<1: Cisternas, KJ+ 2011
(see also Kocevski+ 2012,
Schawinski+ 2011/12)
QSOs = Major Merging?

Cisternas, KJ+ 2011
QSOs = Major Merging?

• In brief:
  • z<2: many many disk host galaxies
  • z<1: <~25% of BH accretion due to merging
  • z~2: no merger triggering for lower-L half of BH accretion
QSOs = Major Merging?

• Further diagnostics:
  • Close pairs (Silverman+KJ+ 2011, Ellison+ 2011, Lackner+KJ+ 2014)
QSOs = Major Merging?

COSMOS/HST: Silverman, Kampczyk, KJ+ 2011
QSOs = Major Merging?

• In brief:
  • $z<2$: many many disk host galaxies
  • $z<1$: $\sim 25\%$ of BH accretion due to merging
  • $z\sim 2$: no merger triggering for lower-L half of BH accretion

→ Most of BH accretion not triggered by major merging
So?

→ QSO phase \neq\text{ morphology change phase}

→ modelers?
Summary

For AGN/QSOs...

- ...the bulge is not (necessarily) an active ingredient
  → if you still want this, find a first principle reason, please!

- ...host galaxies are normal starforming galaxies
  → no AGN–starburst connection; avoid ULIRG–QSO picture

- ...major merging is subdominant for AGN at z<2
  → so why is this still in models?