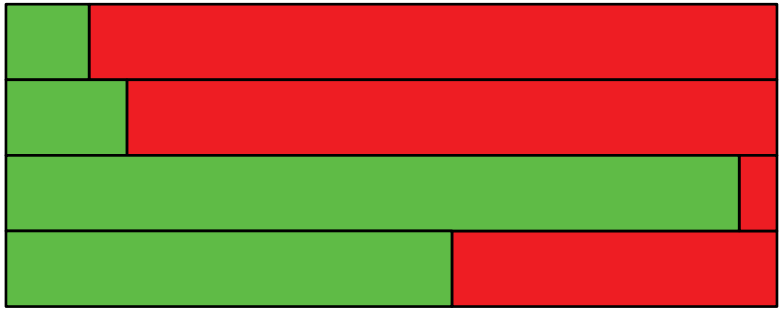
Brainstorm in progress.

What physical processes are important in driving AGN activity

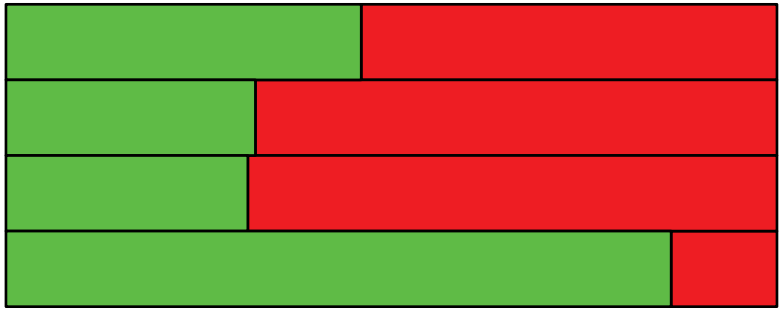
in luminous AGN (quasars) ?

Stellar winds
Supernovae
Major mergers
Secular processes



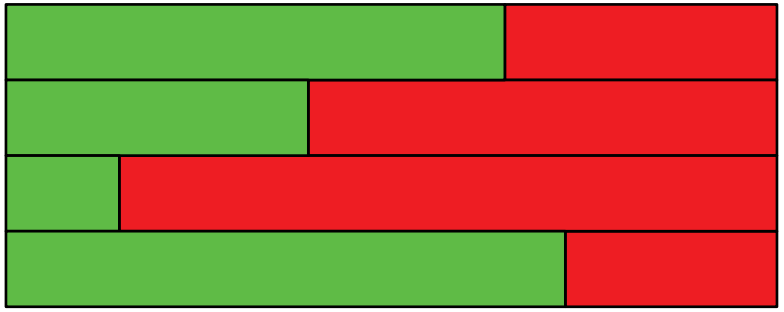
in moderate luminosity AGN (Seyferts) ?

Stellar winds
Supernovae
Major mergers
Secular processes



in low luminosity AGN ?

Stellar winds
Supernovae
Major mergers
Secular processes



What physical processes are important in driving AGN activity

Other issues raised:

- Angular momentum
- ISM physics/properties
- Cluster environment
- Timing of trigger events (& observational signatures) and accretion onto BH
- Is the story different at high vs low redshift? (e.g. clumpy disks)
- Role of stochastic accretion: minor mergers, intergalactic (stripped) gas, cosmic cold streams

Talks

Causal connection between the two phenomena

Negative feedback

Positive feedback (absence of negative)

Combes

Davies

Zanella

Saintonge

LaMassa

Kocevski

Lackner

Alonso-Herrero

Blank

Bauer

Wild

Hampton

Thacker

Dubois

Structure and influence of nuclear environmental components

Posters

Causal connection between the two phenomena

Negative feedback

Positive feedback (absence of negative)

Annuar

Bessiere

Chies Santos

Fan

Frank

Lansbury

Lin

Richardson

Rovilos

Schulze

Vignali

Villforth

Weigel

Cashmore

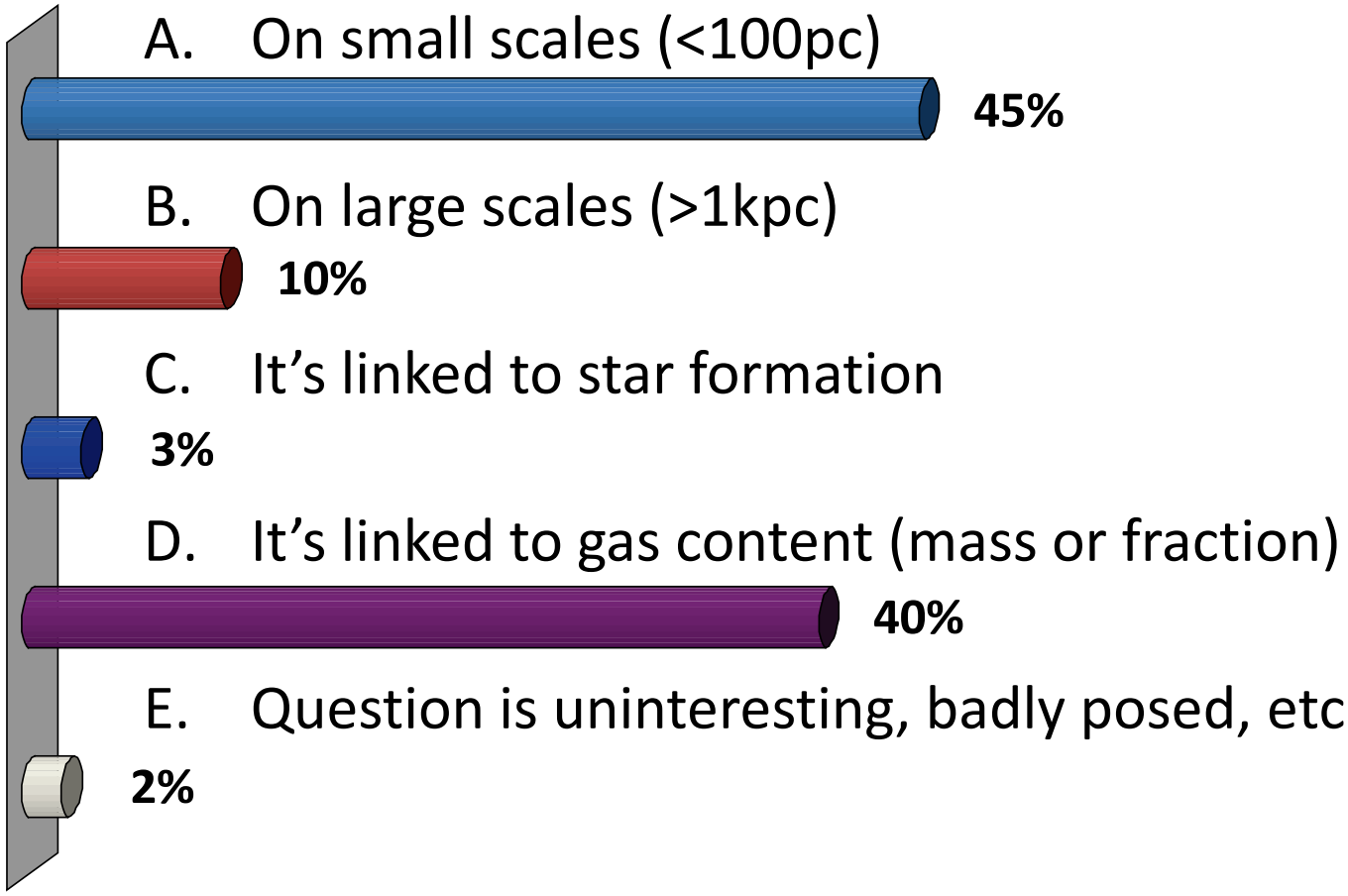
Croom

Detailed Individual objects

Structure and decomposition of nuclear environmental components

New searches

Where should we look for the best evidence of a (putative) causal link between AGN fueling and host galaxy properties?



What you said yesterday…

What is (the best) evidence for a symbiotic connection?

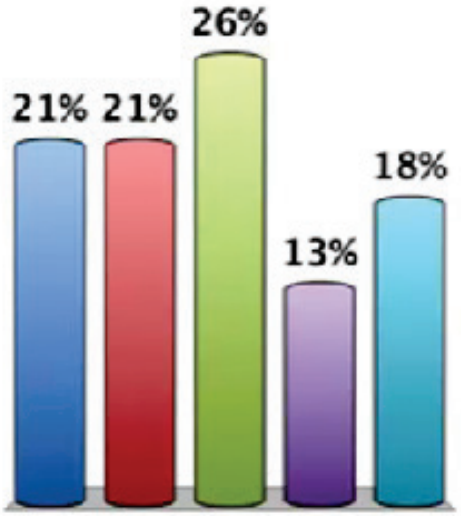
A. Correlations between **nuclear** SFR and instantaneous L_{AGN}

B. Correlation of SFR and **average** L_{AGN} (or BH accretion rate)

C. Increased AGN **fraction** in SF galaxies

D. Radio AGN are associated with quiescent galaxies/high mass halos/hot atmospheres

E. None of these



What physical processes are important in driving AGN activity

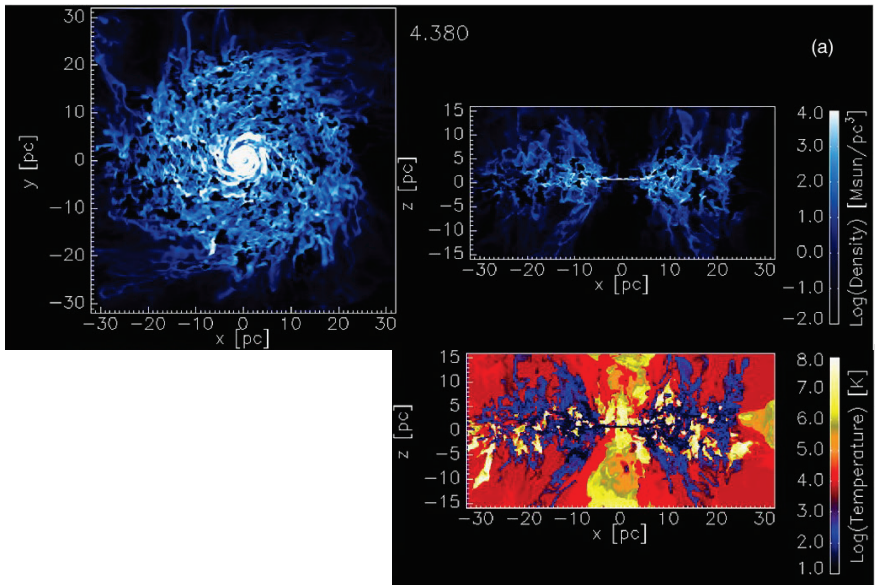
Questions:

1. Star formation: winds vs supernovae; steady-state vs episodic
2. Is the torus the interface between AGN and star formation?
3. Do Seyfert 2s have more star formation than Seyfert 1s?
4. Is there an evolutionary sequence for Seyferts and/or QSOs?
5. Low vs High redshift: slow vs violent secular processes
6. Can local AGN be used as templates for higher redshift AGN?
7. Role of stochastic accretion (e.g. minor mergers) and how to observe it
8. Are major mergers the dominant trigger for all quasars?

1a. Can both stellar winds & supernovae contribute to inflow?

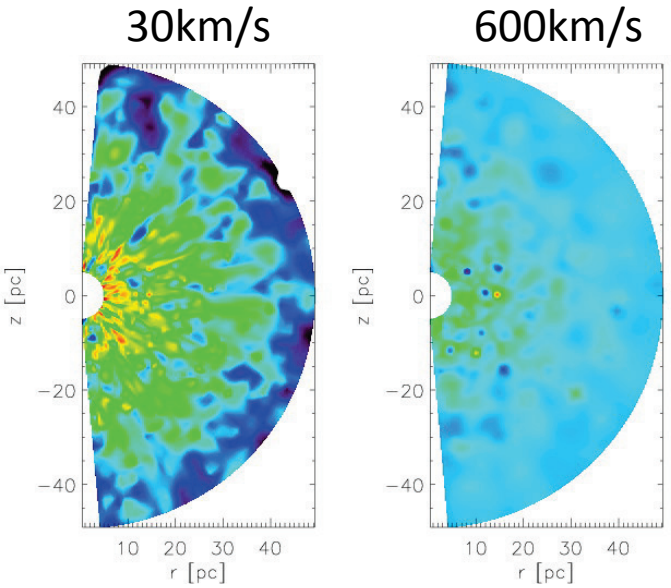
1b. Is star formation steady-state or episodic?

Wada+ 09



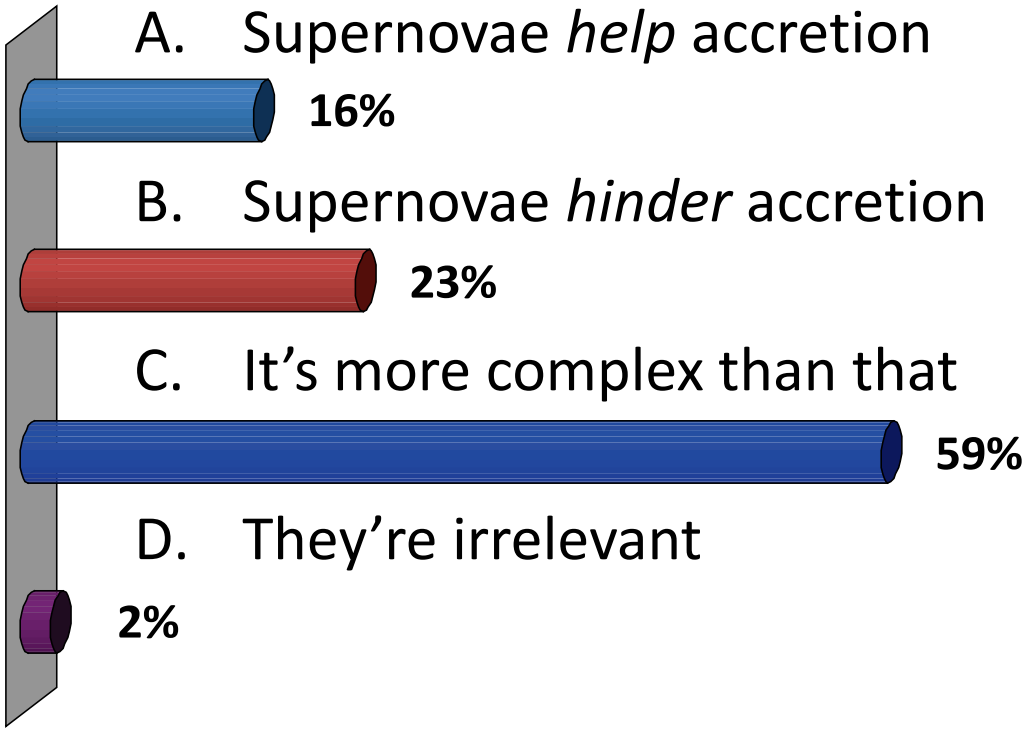
- Steady-state star formation (i.e. stellar winds & supernovae simultaneously) in thin disk
- Supernovae generate turbulence, creates viscous thick disk, which drives inflow

Schartmann+ 10

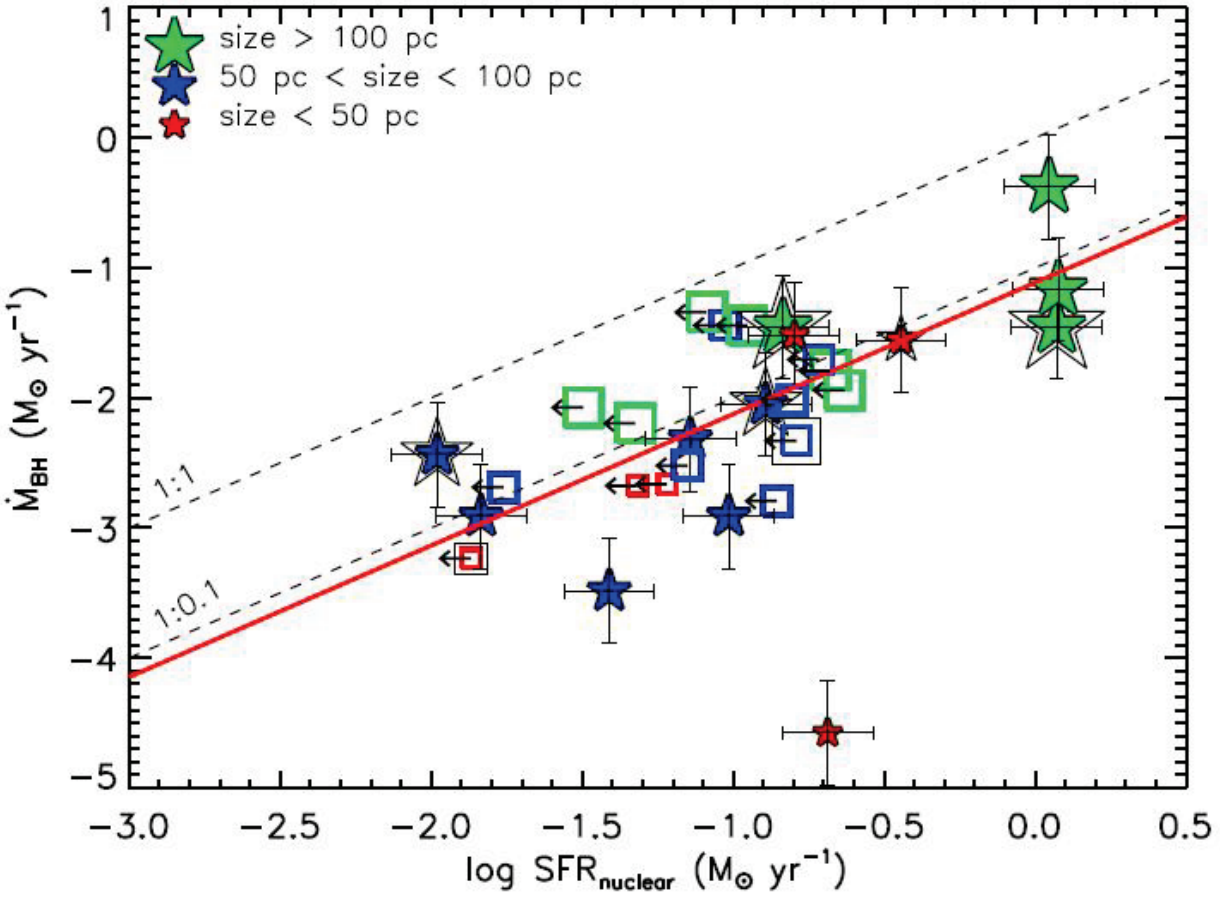


- fast ejecta: OB winds (GC) & supernova (M82) blow gas out
- stars of 1-8M_{sun} reach AGB phase after ~50Myr; winds remain bound & can accrete

Do supernovae in nuclear (<100pc) star-forming regions help or hinder accretion to smaller scales?



2. Is the torus the interface between AGN and star formation?

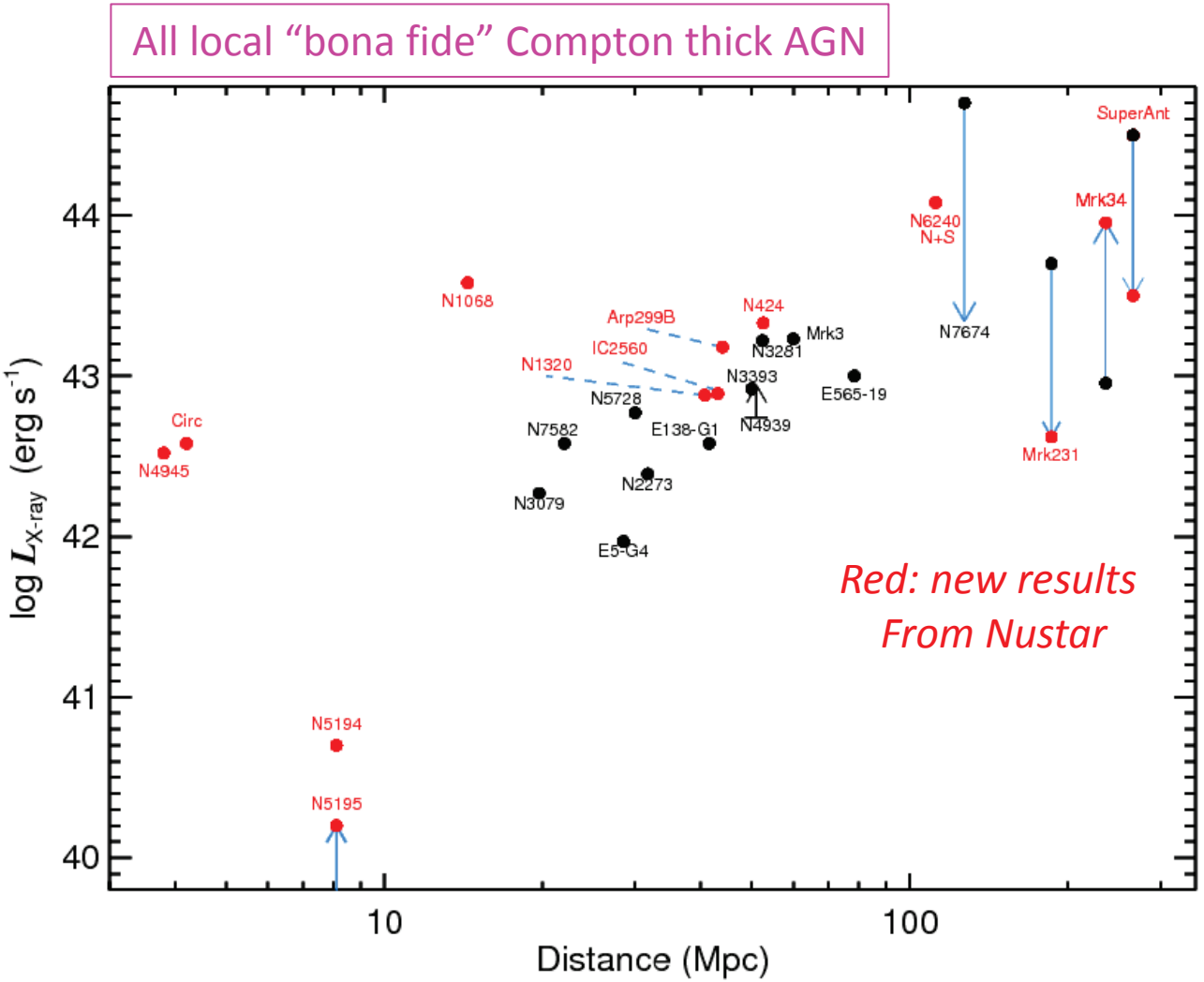


— Role of obscuration and Compton-thick AGN not fully appreciated?

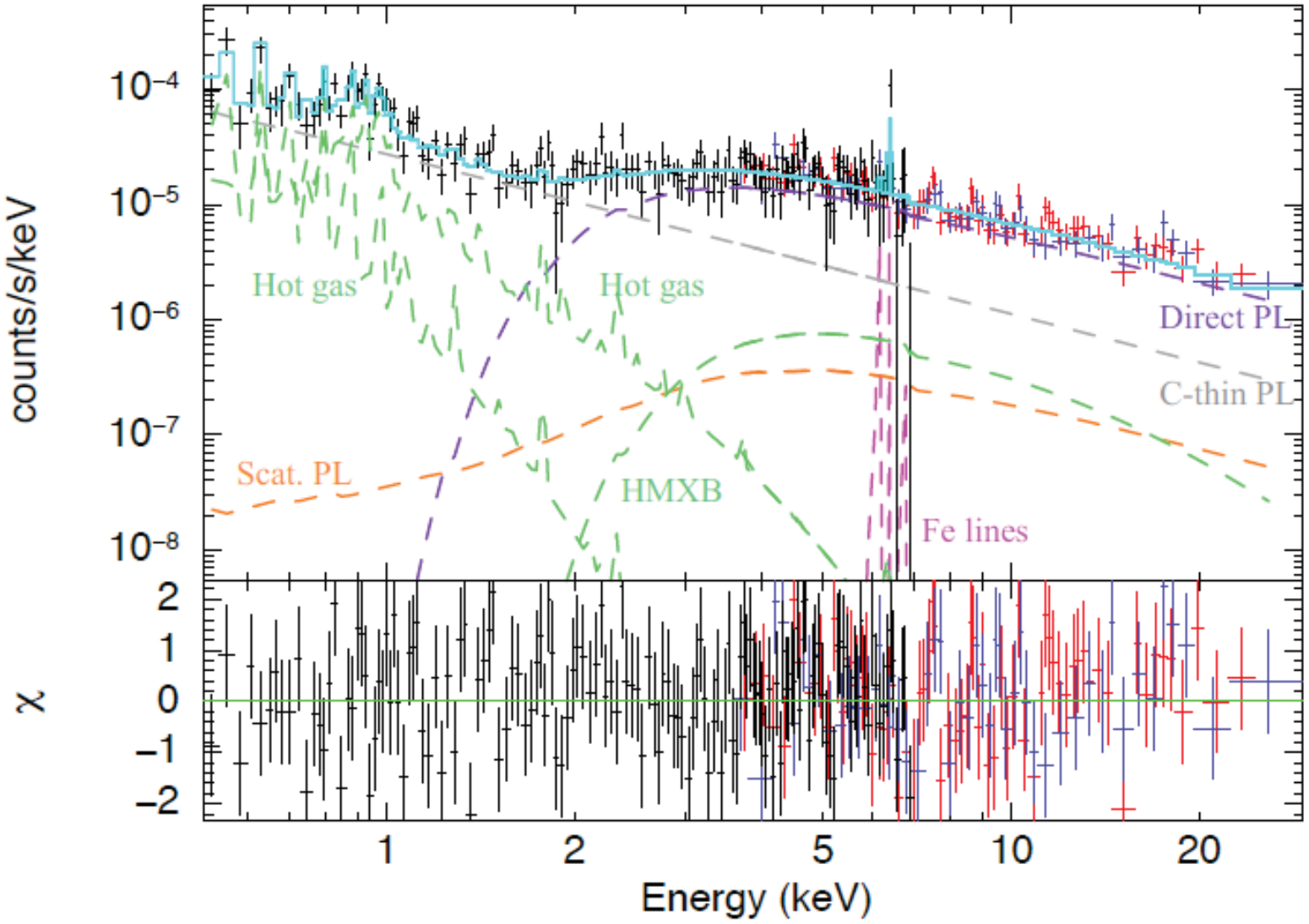
— “Torus” is actually agglomeration of large-scale gas clumps?

— Higher (20x) nuclear SFR surface density within ~70 pc (Esquej et al. (2013)
=> stronger SF feedback on tori?

Interestingly, the most luminous AGN, those with plenty of host gas supply, are not (obviously) the most obscured

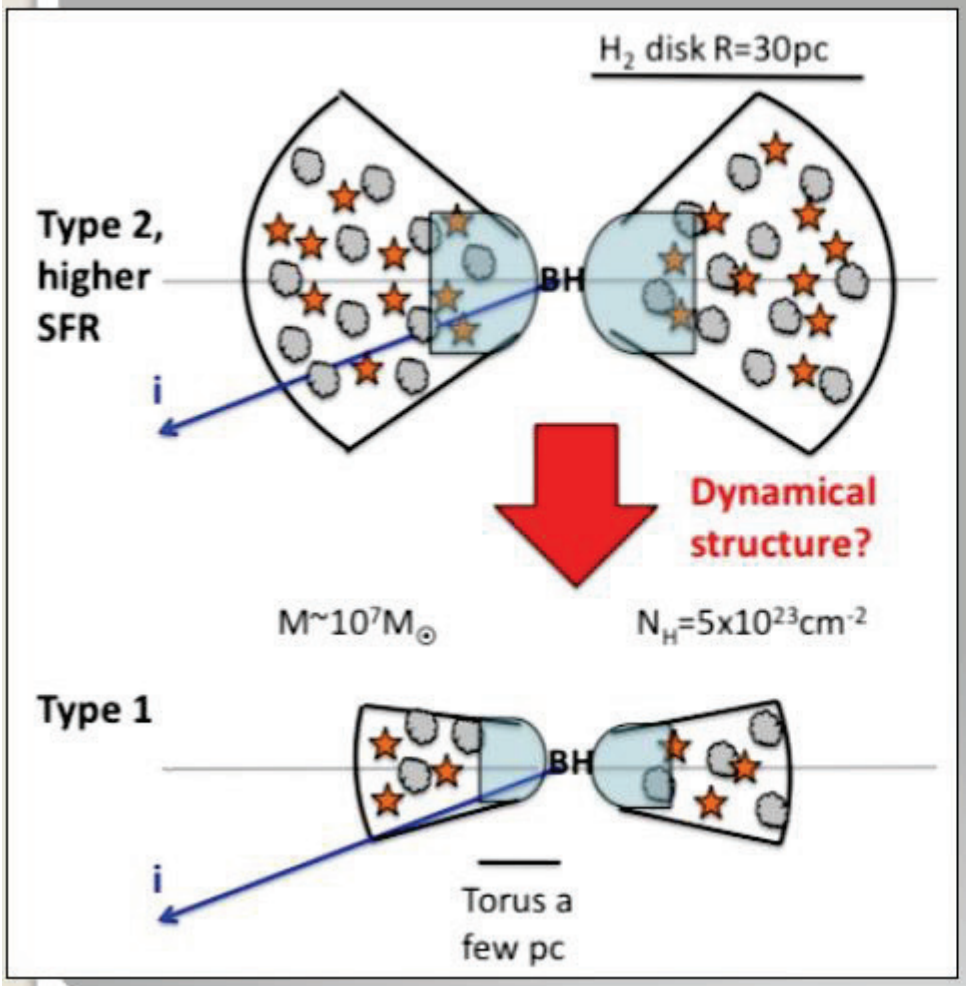


(Based upon Gandhi et al. 2014, Teng et al. 2014, Ptak et al. 2014)


counts/s/keV
10^{-4}
10^{-5}
10^{-6}
10^{-7}
10^{-8}
Hot gas
Hot gas
Direct PL
C-thin PL
Scat. PL
HMXB
Fe lines
χ
2
1
0
−1
−2
1
2
5
10
20
Energy (keV)

Teng+ 14

3. Do Seyfert 2s have more star formation than Seyfert 1s?



Nuclear SF likely to play a role in obscuring the AGN.

Molecular gas disks might be the external part of the AGN torus.

Higher SF activity would be able to support the vertical extent of the torus and AGN would be more likely classified as a type 2 AGN.

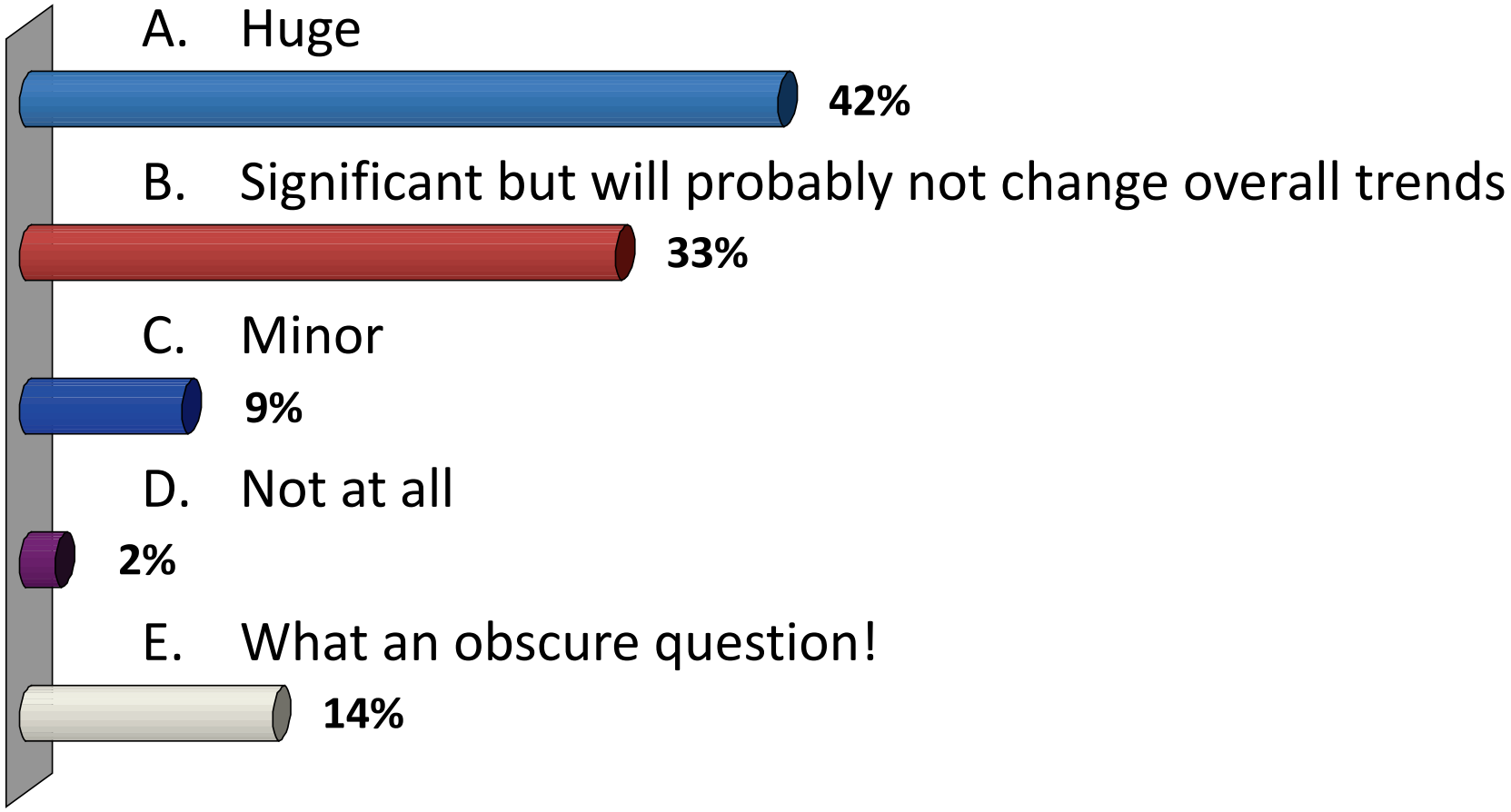
Lower (decreasing) SFR would result in a thinner disk and a more likely classification as type 1 AGN.

Consistent with lower covering factors in Seyfert 1s and Seyfert 2s Ramos Almeida et al. (2011)

— Is this now settled?

— Any role left for orientation?

How important a bias does obscuration introduce in the our understanding of the star-formation/AGN connection?



4a. Is there an evolutionary sequence between star formation, Seyfert 2s, and Seyfert 1s?

4b. What about obscured and unobscured QSOs?

A. Only for Seyferts

0%

B. Only for QSOs

0%

C. Both Seyferts & QSOs (although perhaps different)

0%

D. Neither

0%

E. Jury is still out

0%

F. I'm all out

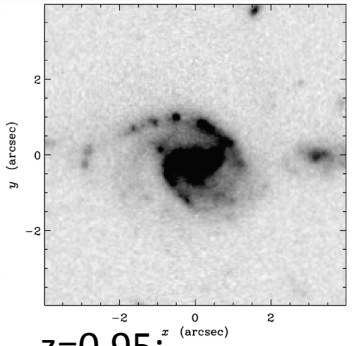
0%

5. To what redshift are (slow) secular processes important?

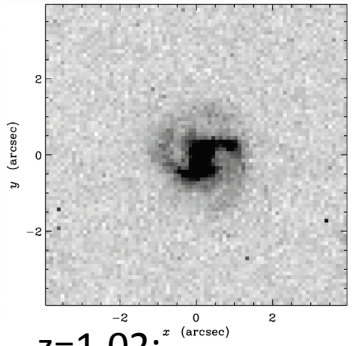
Disk galaxies show characteristics of the local Hubble Sequence to z~1

Van den Bergh+ 00, Kajisawa+ 01 HDF North
Conselice+ 04 GOODS South
Oesch+ 10 COSMOS

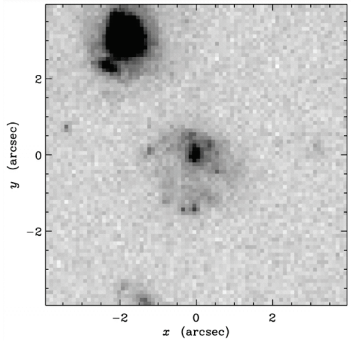
z=0.32: highest z barred spiral



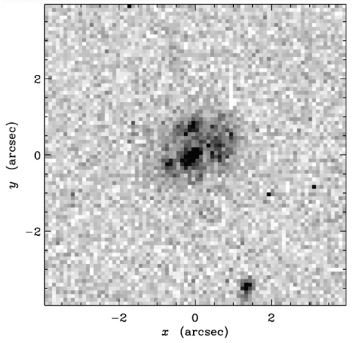
z=0.90: rare spiral at high z



z=0.95: clumpy disk

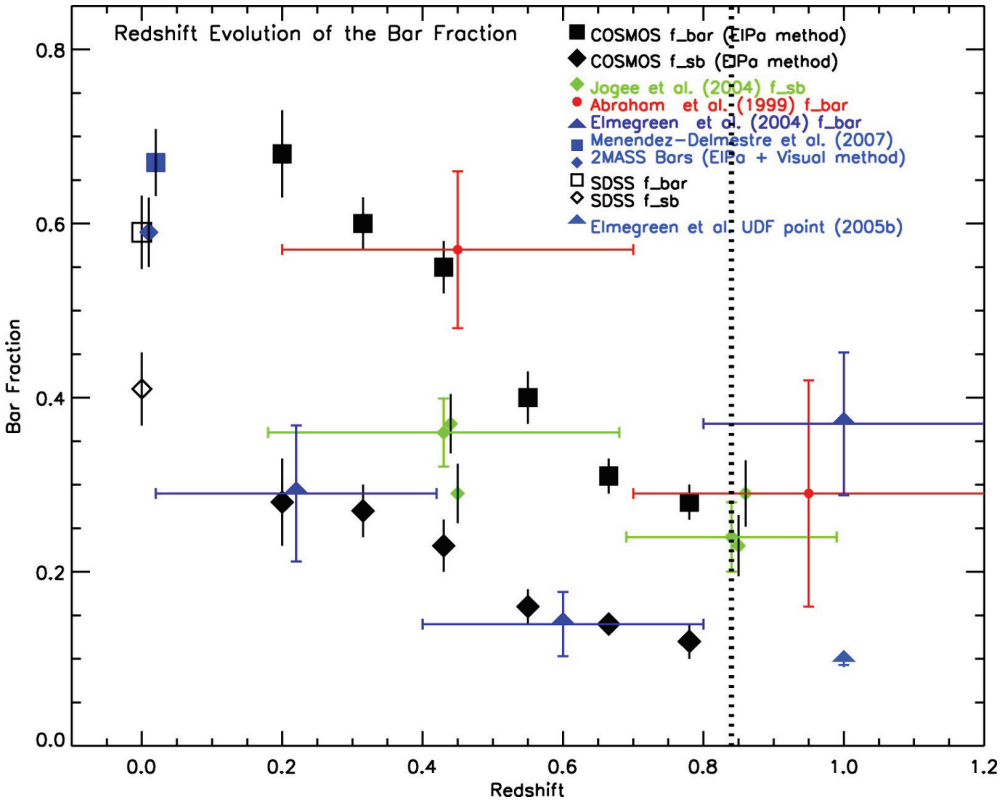


z=1.02: clumpy disk

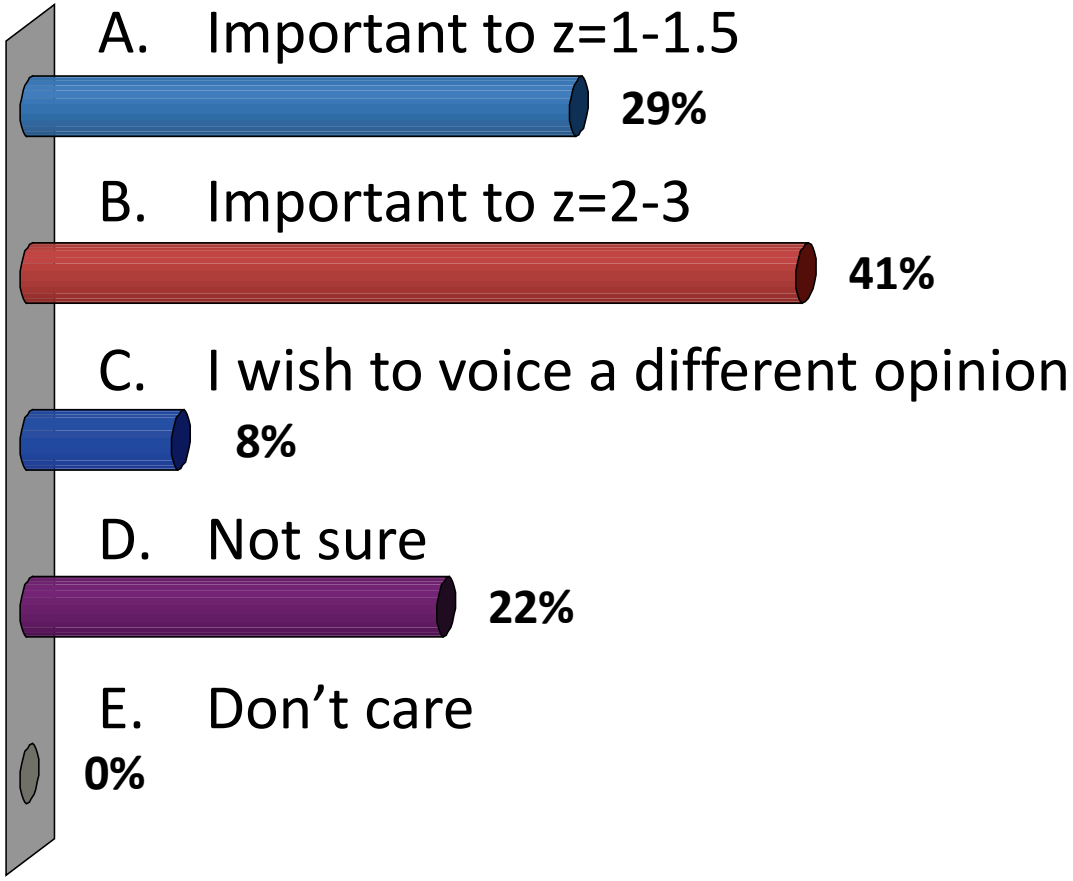


Fraction of bars and strong bars decreases with redshift; bars can be traced to z~1

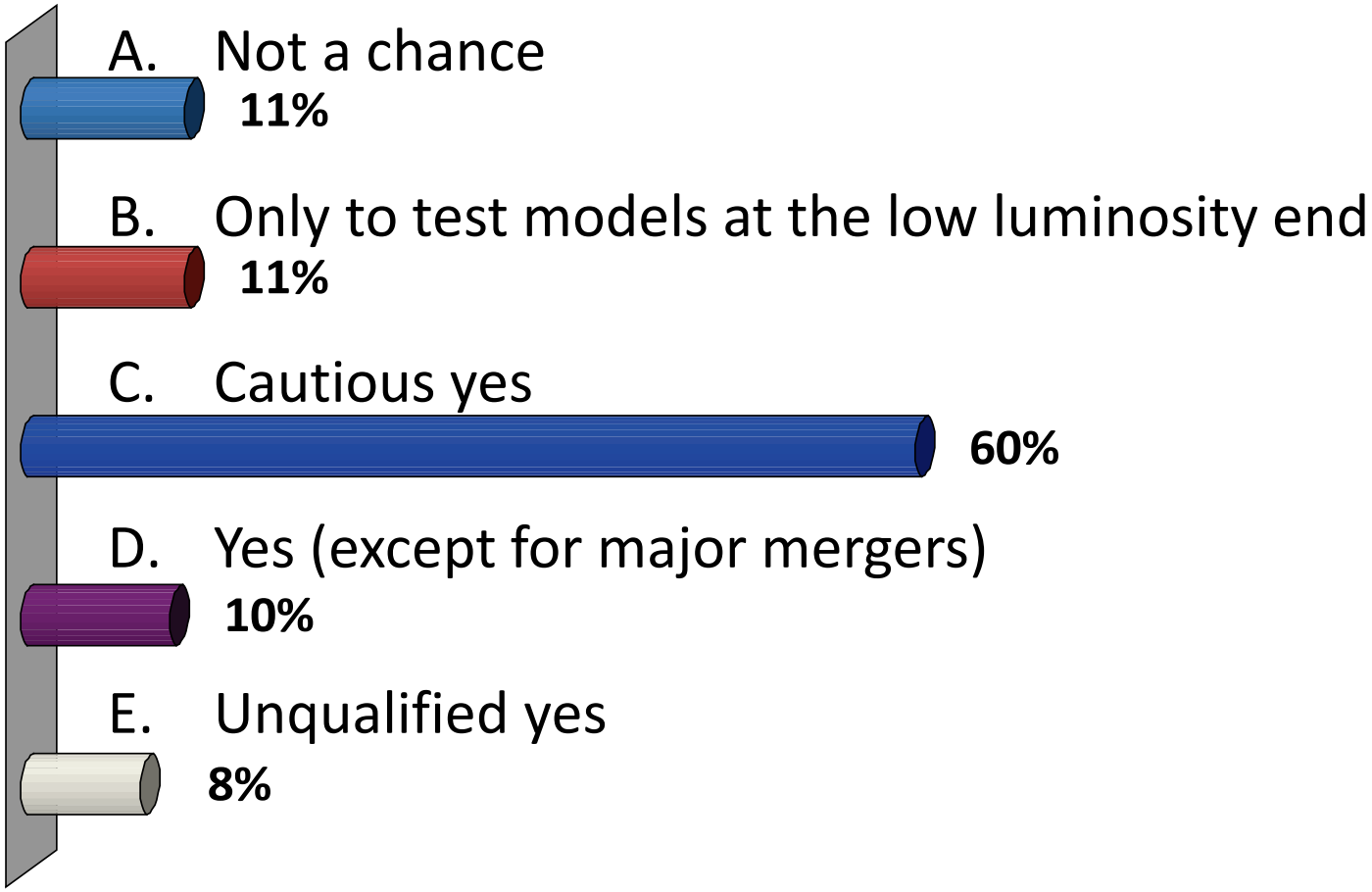
Sheth+ 08 COSMOS



“Secular Processes are important in moderate & low luminosity AGN.”
Spiral/bar driven inflow (cold disk processes) are…



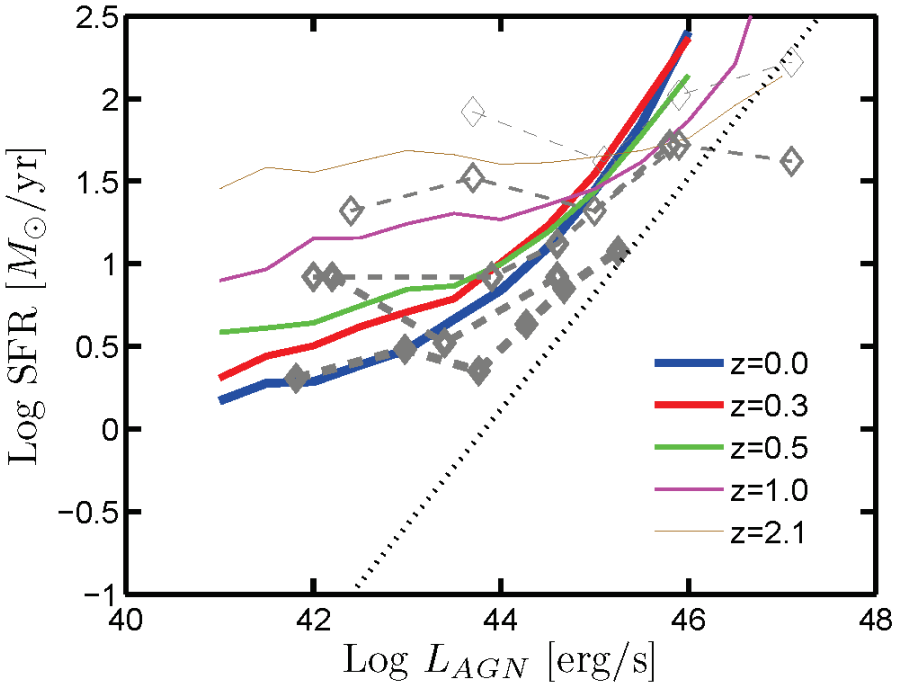
6. Can local AGN be used as templates for inflow/outflow in higher redshift AGN?



7. What about minor mergers, intergalactic gas, cold streams? What observations are needed to probe these processes?

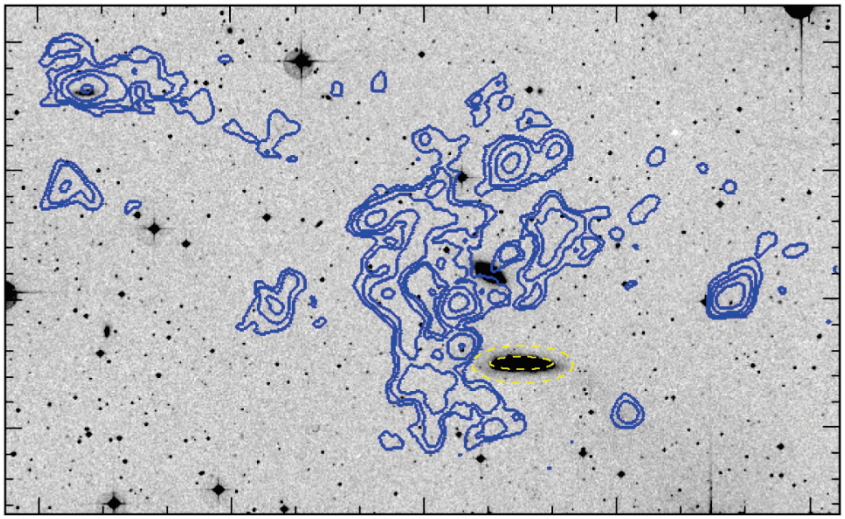
Neistein & Netzer 2014

AGNs with low or intermediate luminosity are mostly being triggered by minor merger events

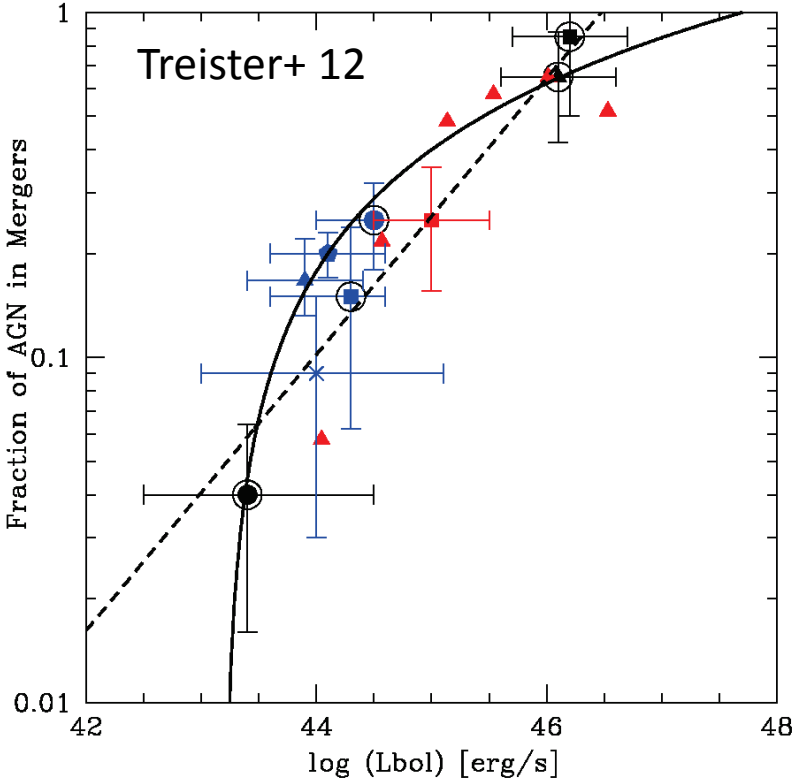


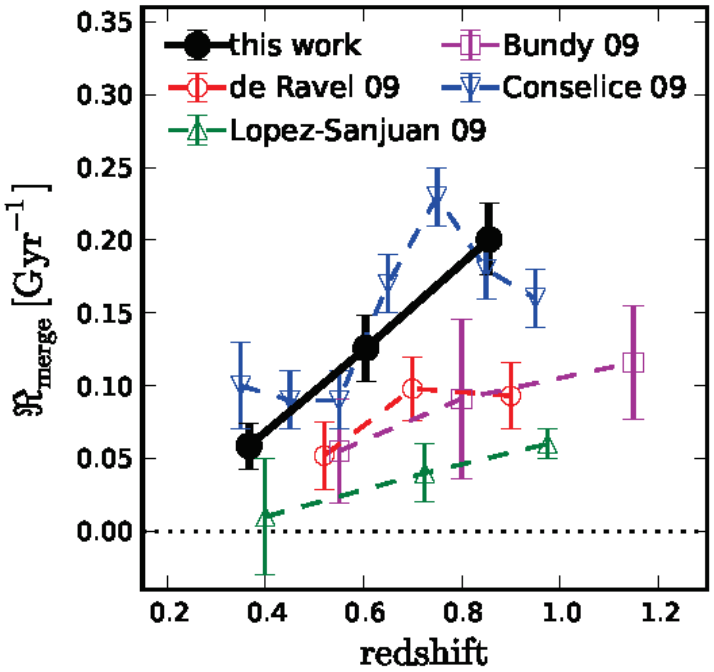
Hibbard+ 01

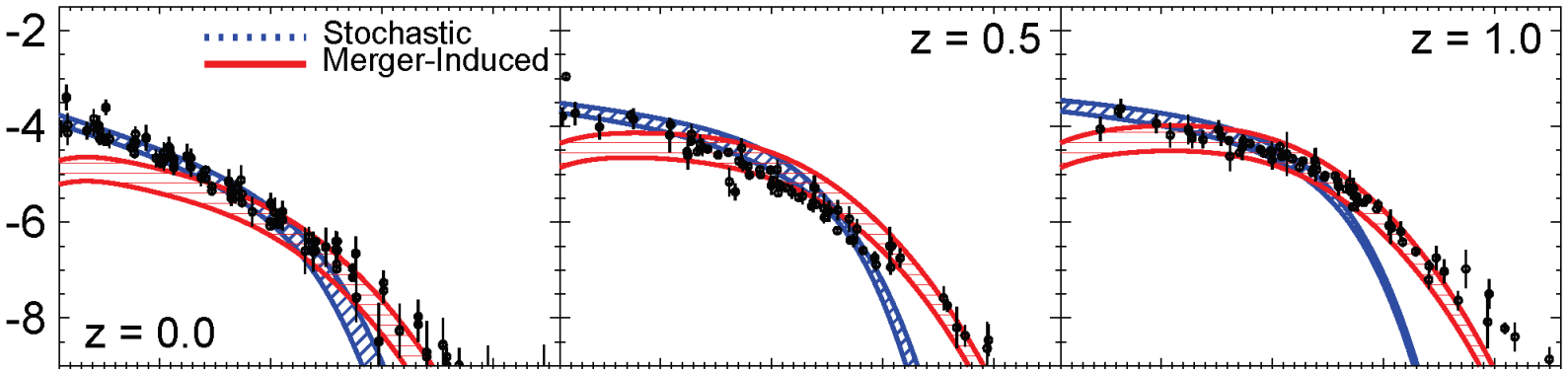
Intergalactic HI around NGC 5506/7



6. At what luminosity do major mergers become important?







Are major mergers the dominant trigger for quasars?

A. Only dominate at highest QSO luminosities

0%

B. Are important even at moderate QSO luminosities

0%

C. Not yet clear (e.g. due to variability, obscuration, etc)

0%

D. I wish to voice an opinion

0%

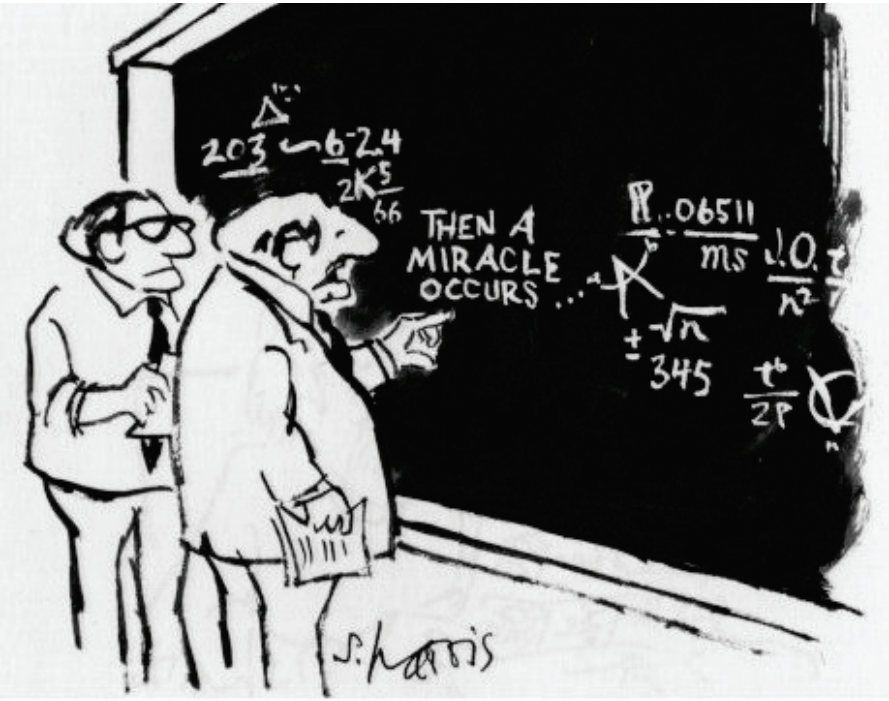
E. I don’t have an opinion

0%

F. I need coffee

0%

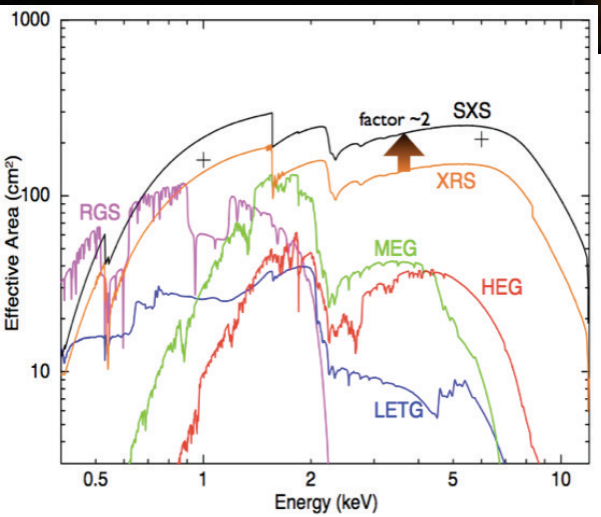
How can we connect large scale properties (host, environment, etc) to BH accretion when the timescales are so different?

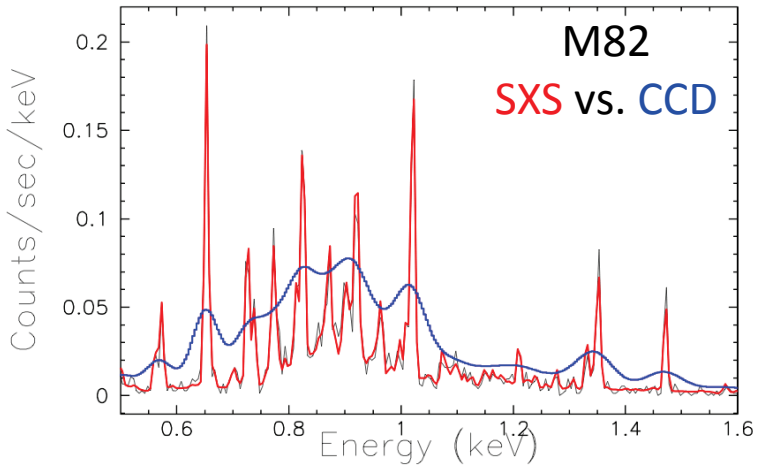


"I think you should be more explicit here in step two."

from *What's so Funny about Science?* by Sidney Harris (1977)

One thing we have not heard much about: X-ray diagnostics of star formation





Other issues we need to consider?...

- Is there just too much complexity when we get down to smallest scales?
- Or do we just not have enough physics yet?
- Can we develop ***simple*** codes with a few parameters for fitting inflow/outflow models to data? Or is this an unrealistic hope?
- Are we guilty of (sometimes/often?) over-interpretation?

  For example,

  — plotting inferred quantities rather than observables

  — comparing an apple (on one axis) with the same apple (on the other axis).

An approximate quote:

“To be successful we need to ask questions that are important and that we can answer”

Jerry Ostriker (via Martin Haehnelt)

"Everyone *finally* agrees: the only consensus is there's no consensus."