



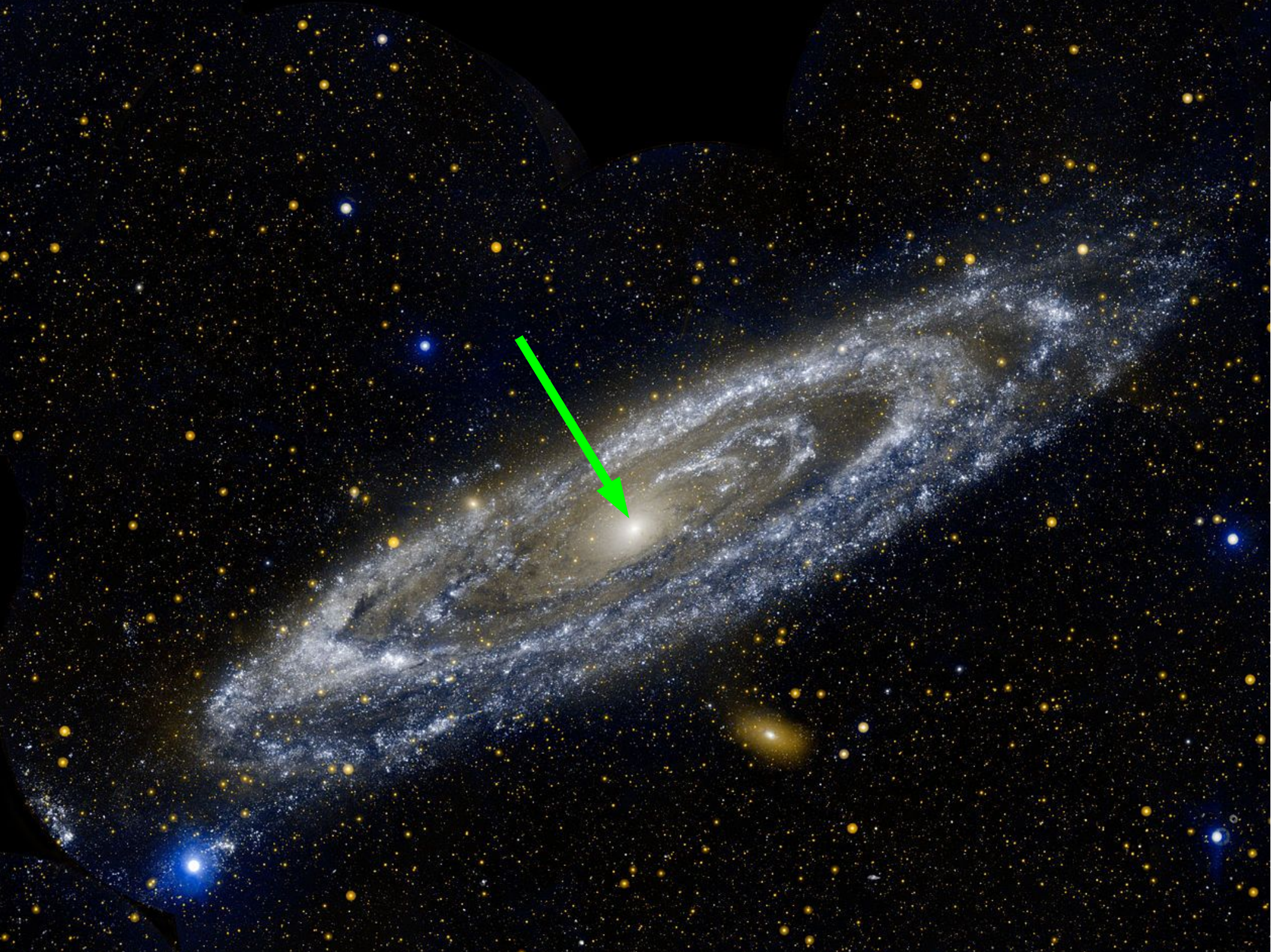
Why do supermassive Black Holes accrete?

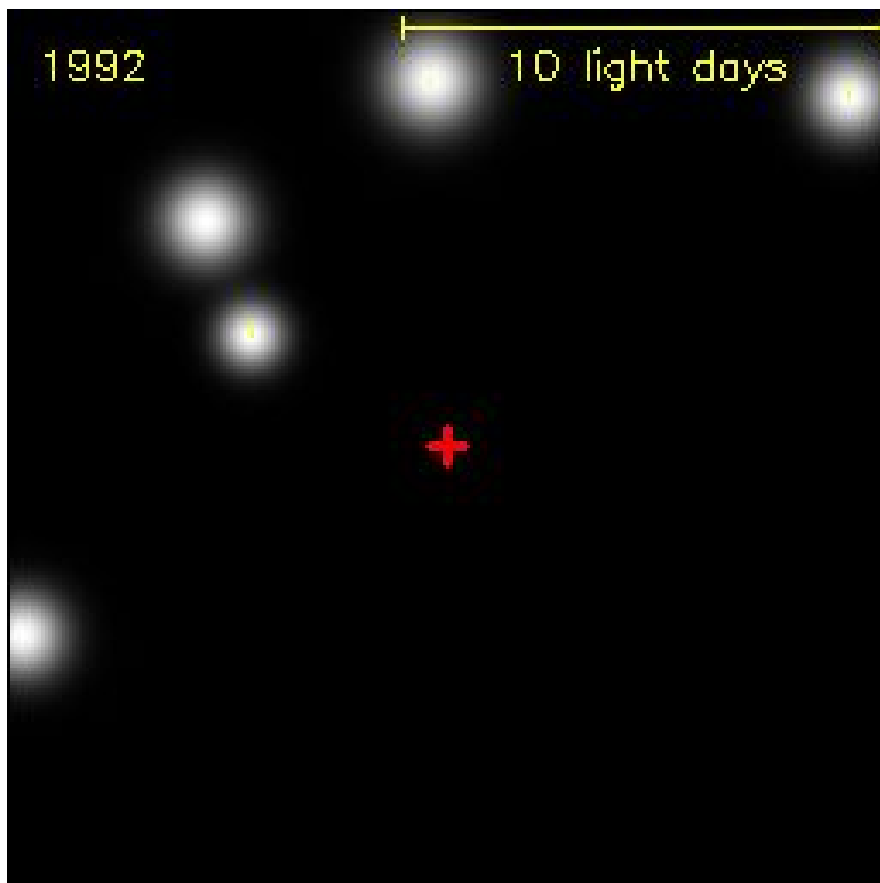
**Our knowledge on violent
and peaceful triggers**

Knud Jahnke

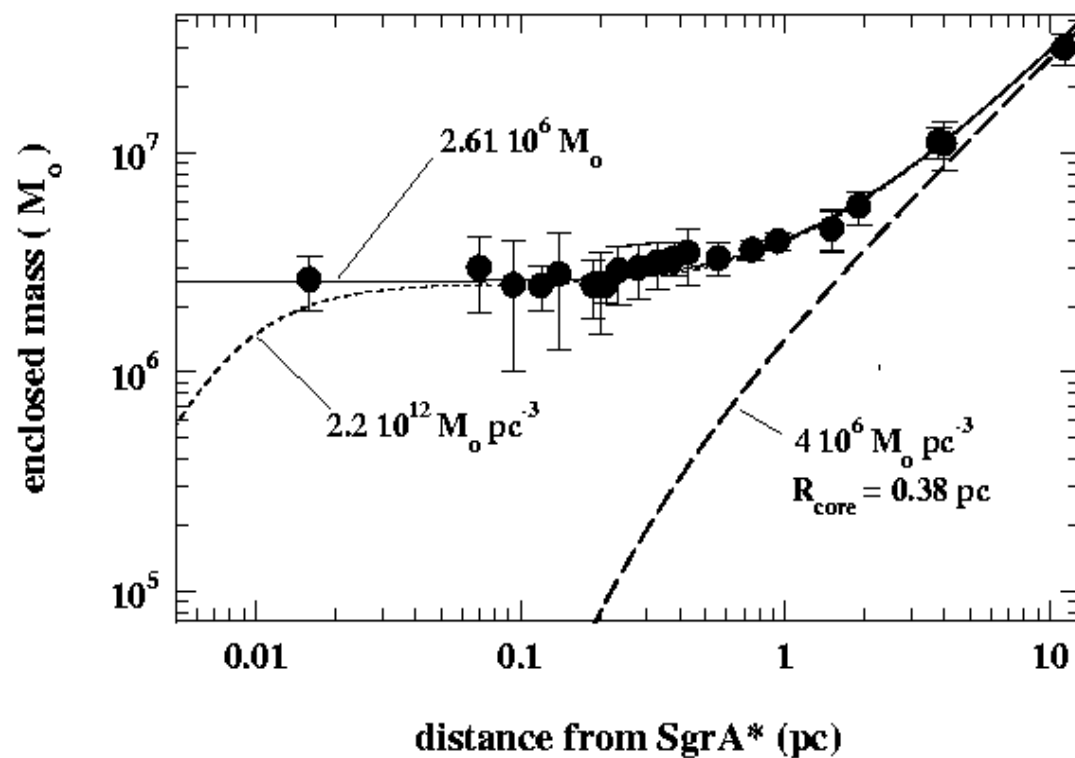
MPIA, Heidelberg

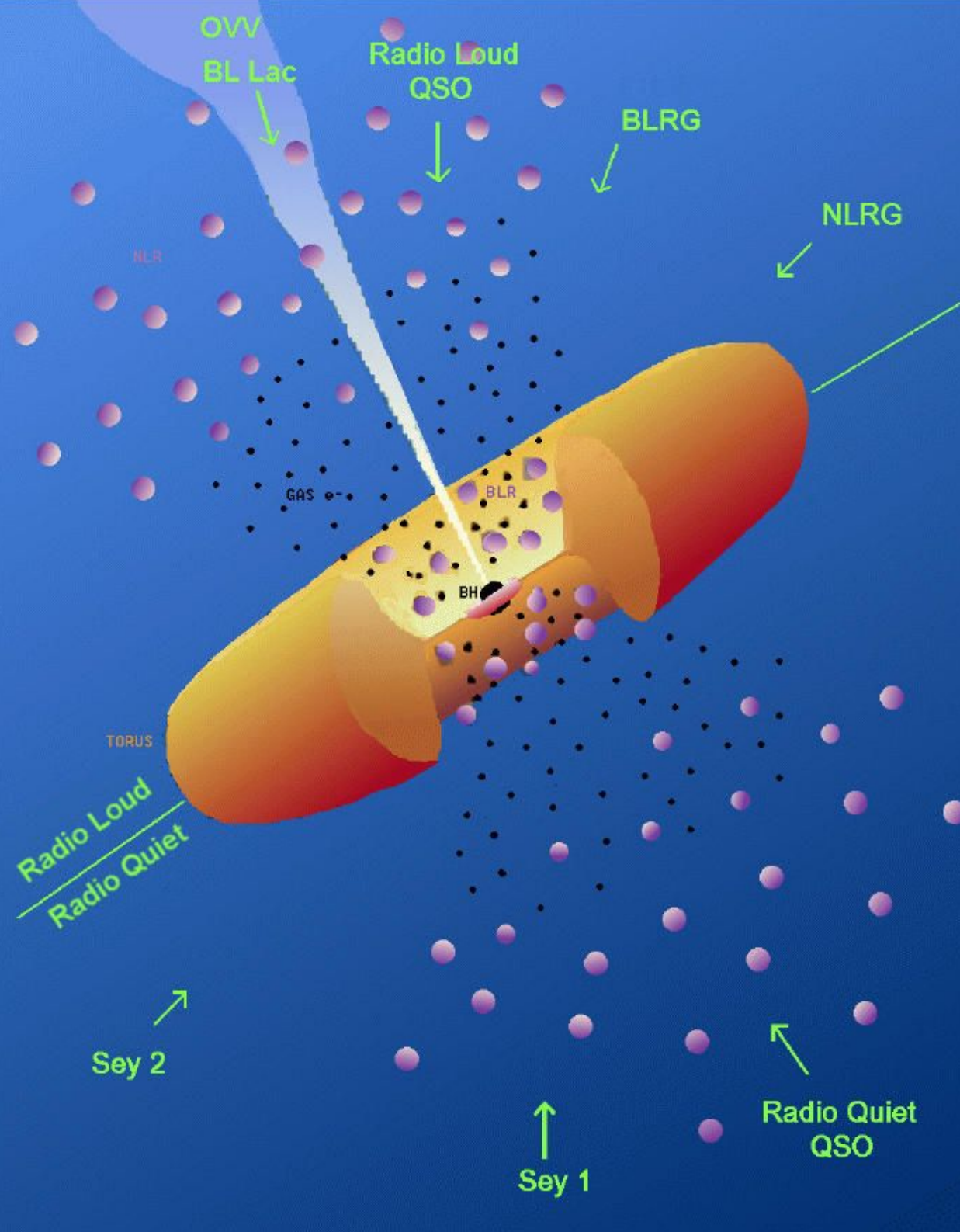






Stars near the center of
the Milky Way







OVV

Radio Loud

Sey 2

↑
Sey 1

Radio Quiet
QSO





How to feed the monster?

Mechanism	Torques?	Gas?	Important?



How to feed the monster?

Mechanism	Torques?	Gas?	Important?
Major merger			
Minor merger			
Bars			
Disk Instabilities			
Stellar winds			

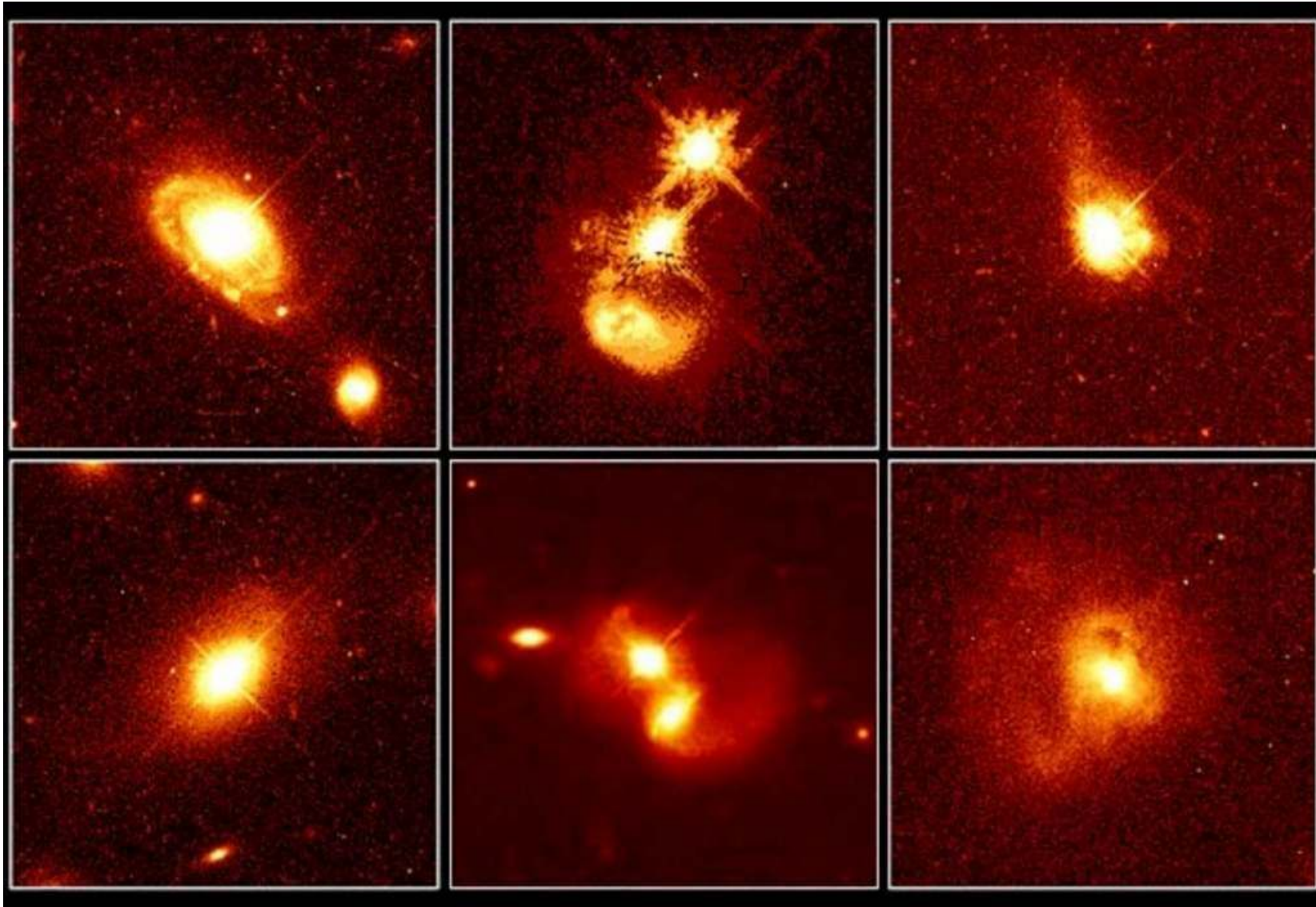


How to feed the monster?

Mechanism	Torques?	Gas?	Important?
Major merger	Yes (to $>100\text{pc}$)	Yes (lots?)	
Minor merger			
Bars			
Disk Instabilities			
Stellar winds			



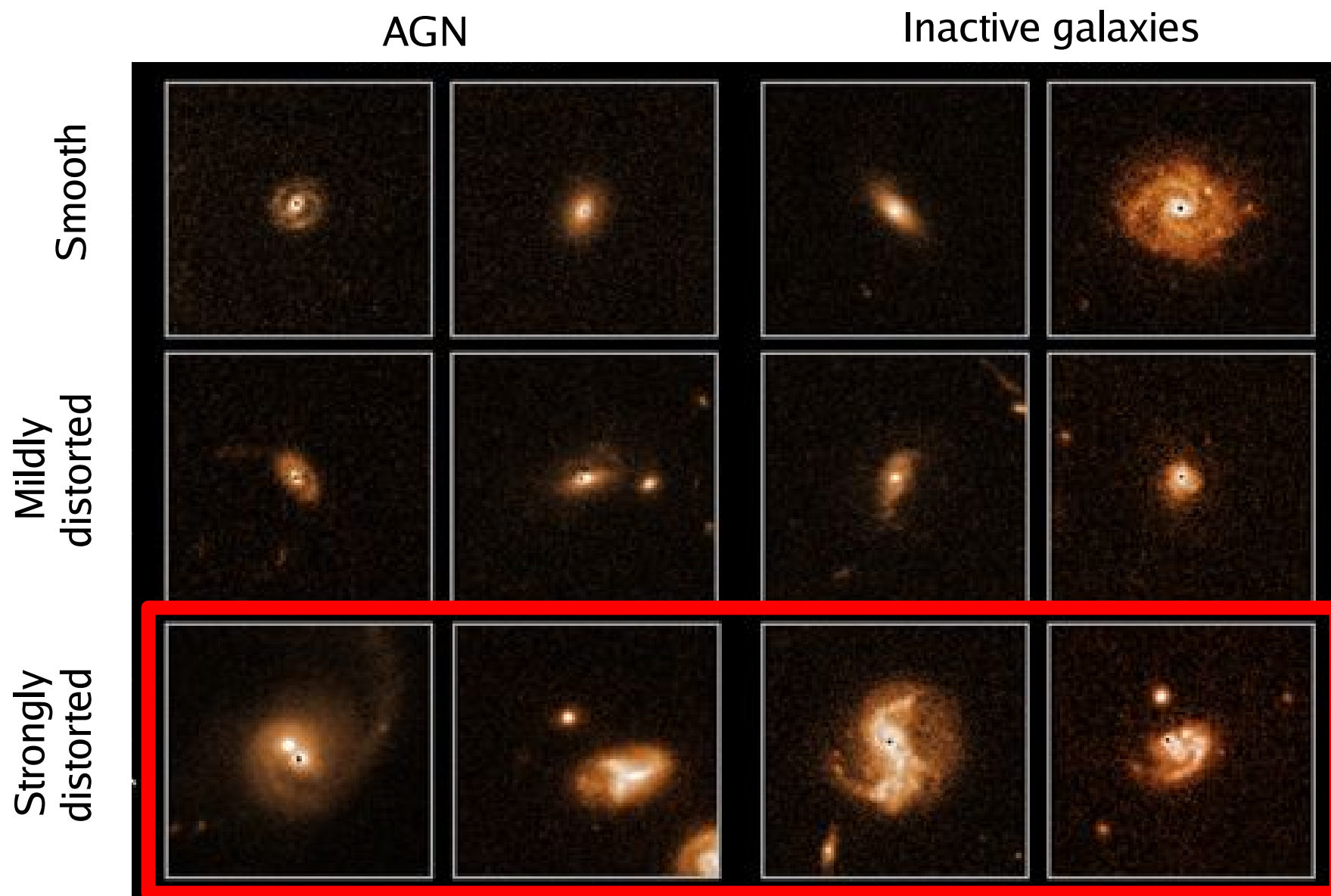
Major galaxy merging



QSO host galaxies, HST: Bahcall+ 1997



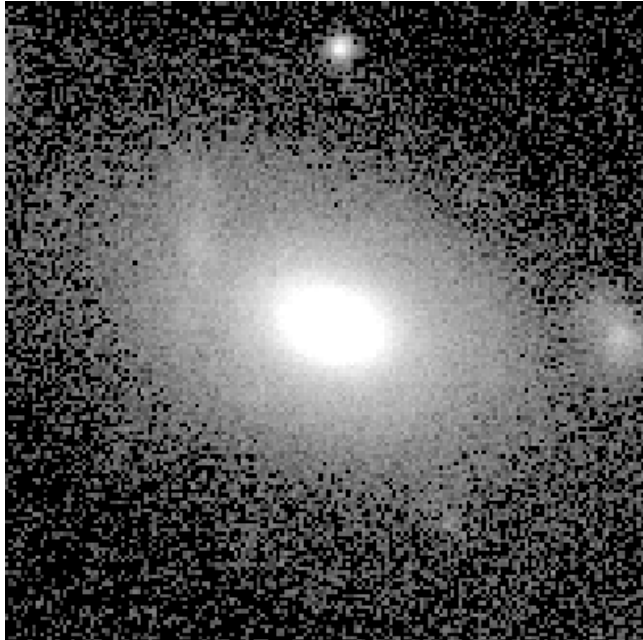
Major galaxy merging



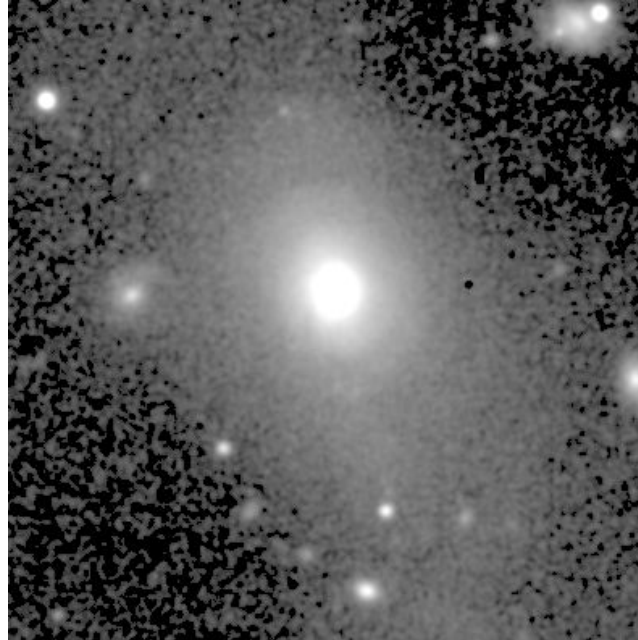
$z < 1$, COSMOS/HST: Cisternas, KJ+ 2011



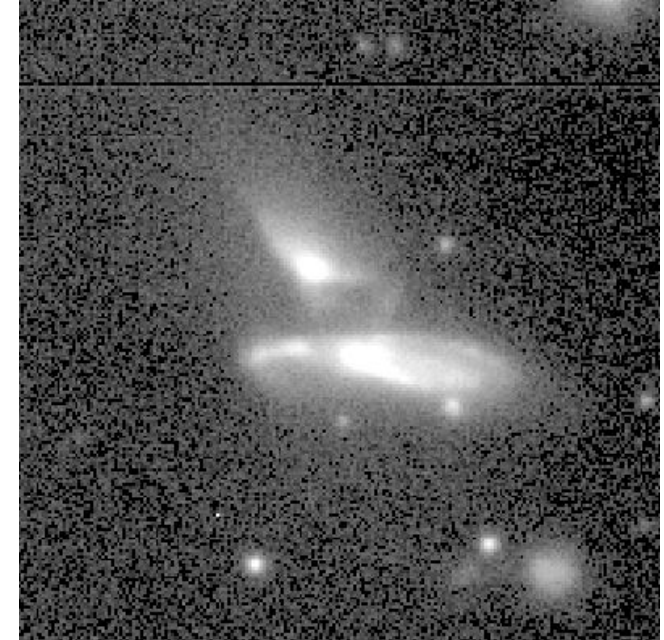
Major galaxy merging



HE 1514-0606,
 $\log \text{MBH} = 8.9$



inactive



inactive

P91, VLT/FORS, 0.6", 28 QSOs $\log \text{MBH} \sim 9.0$ + 28 comparison galaxies

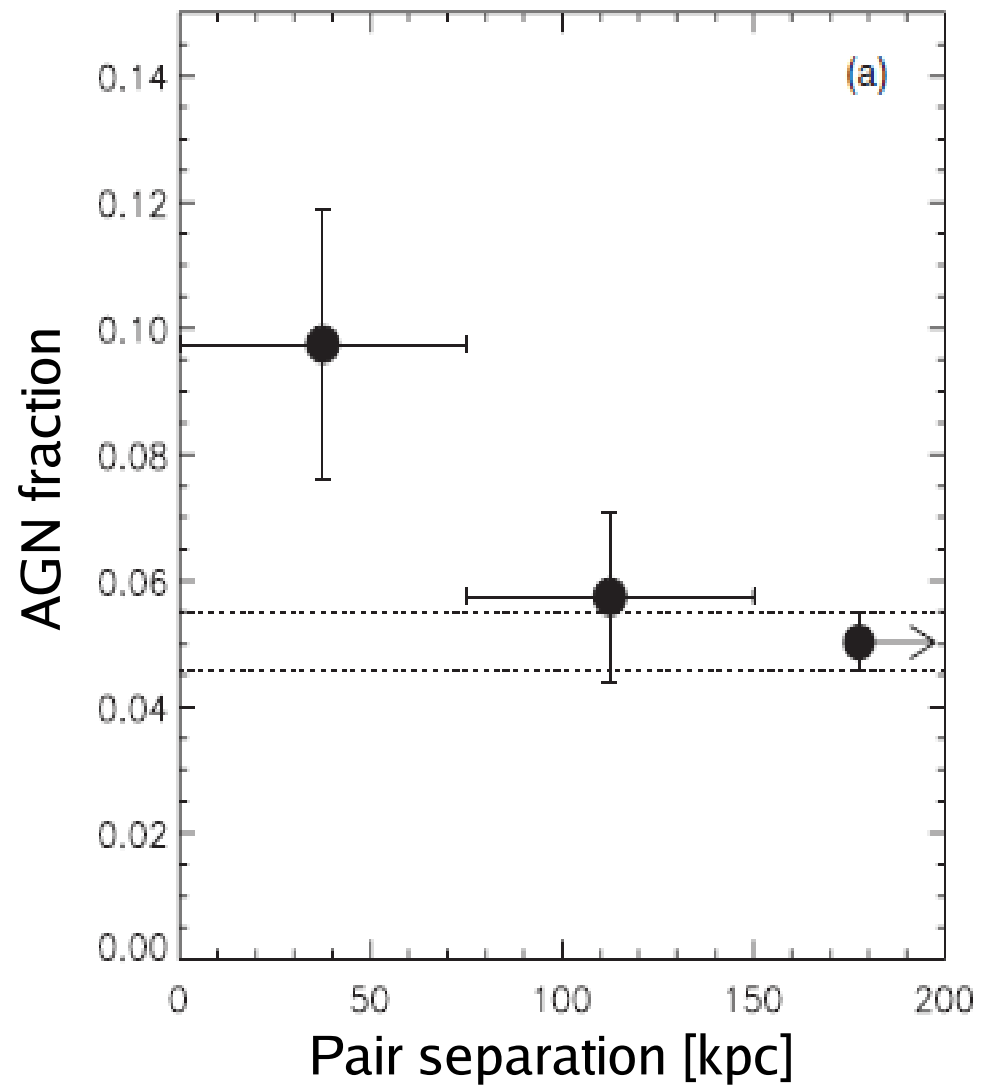
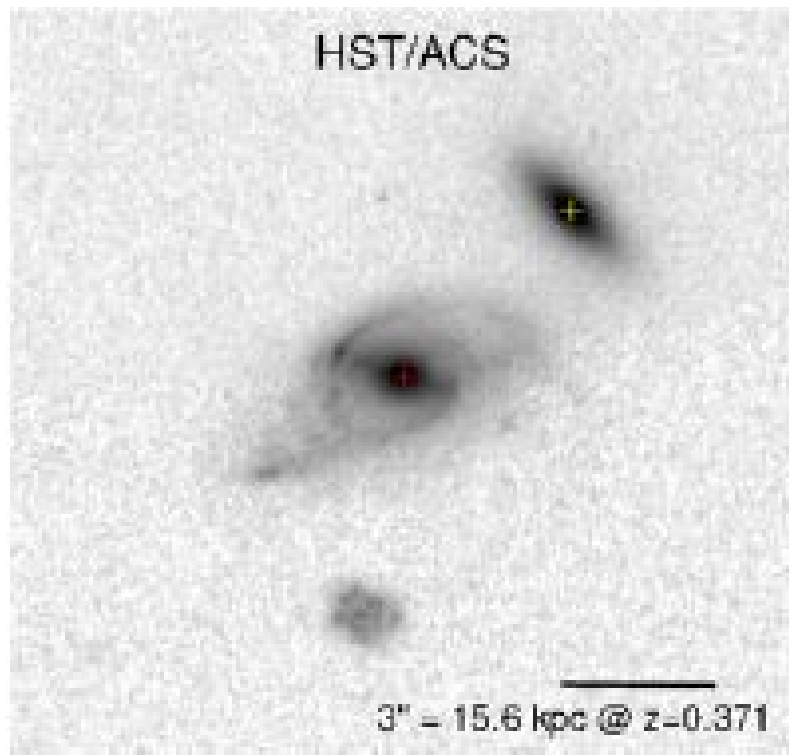


Major galaxy merging

- Diagnostics:
 - Distortions (Cisternas+ 2011, Koss+ 2012, Kocevski+ 2012,...)
 - Close pairs (Silverman+ 2011, Ellison+ 2011, Lackner+ in prep)
- Caveats:
 - Distortion fraction vs. excess over comparison samples



Major galaxy merging



COSMOS/HST: Silverman, Kampczyk, KJ+ 2011



Major galaxy merging

- Diagnostics:
 - Close pairs (Silverman+ 2011, Ellison+ 2011, Lackner+ in prep)
 - Distortions (Koss+ 2012, Cisternas+ 2011, Kocevski+ 2012)
- Caveats:
 - Distortion fraction vs. excess over comparison samples
 - “Distortion” dependent on resolution, depth, band, person
 - Ill-/undefined selection functions
 - Qualitative vs. quantitative



Major galaxy merging

- Current state:
 - $z < 1$: ~25% of BHA due to merging
 - $z \sim 2$: no merger triggering for lower-L half of BH accretion
 - $z < 2$: many many disk host galaxies
- Most of BHA not triggered by violent events?



How to feed the monster?

Mechanism	Torques?	Gas?	Important?
Major merger	Yes (to $>100\text{pc}$)	Yes (lots?)	
Minor merger			
Bars			
Disk Instabilities			
Stellar winds			



How to feed the monster?

Mechanism	Torques?	Gas?	Important?
Major merger	Yes (to $>100\text{pc}$)	Yes (lots?)	$z<1$ (2?): no
Minor merger			
Bars			
Disk Instabilities			
Stellar winds			

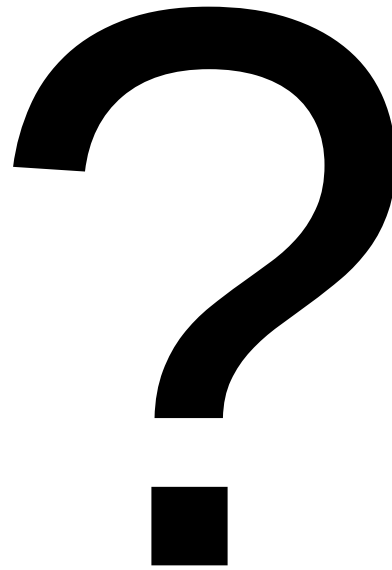


How to feed the monster?

Mechanism	Torques?	Gas?	Important?
Major merger	Yes (to $>100\text{pc}$)	Yes (lots?)	$z<1$ (2?): no
Minor merger	Yes (radius?)	Yes (lots?)	
Bars			
Disk Instabilities			
Stellar winds			



Minor galaxy merging



How to feed the monster?

Mechanism	Torques?	Gas?	Important?
Major merger	Yes (to $>100\text{pc}$)	Yes (lots?)	$z<1$ (2?): no
Minor merger	Yes (radius?)	Yes (lots?)	?
Bars			
Disk Instabilities			
Stellar winds			

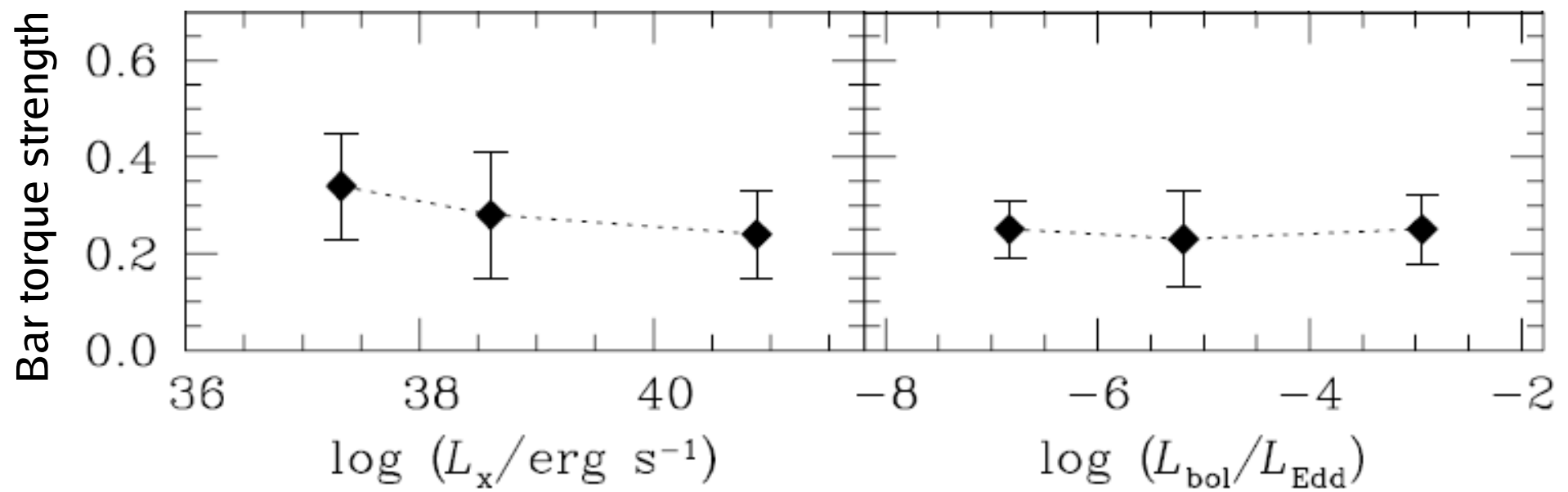
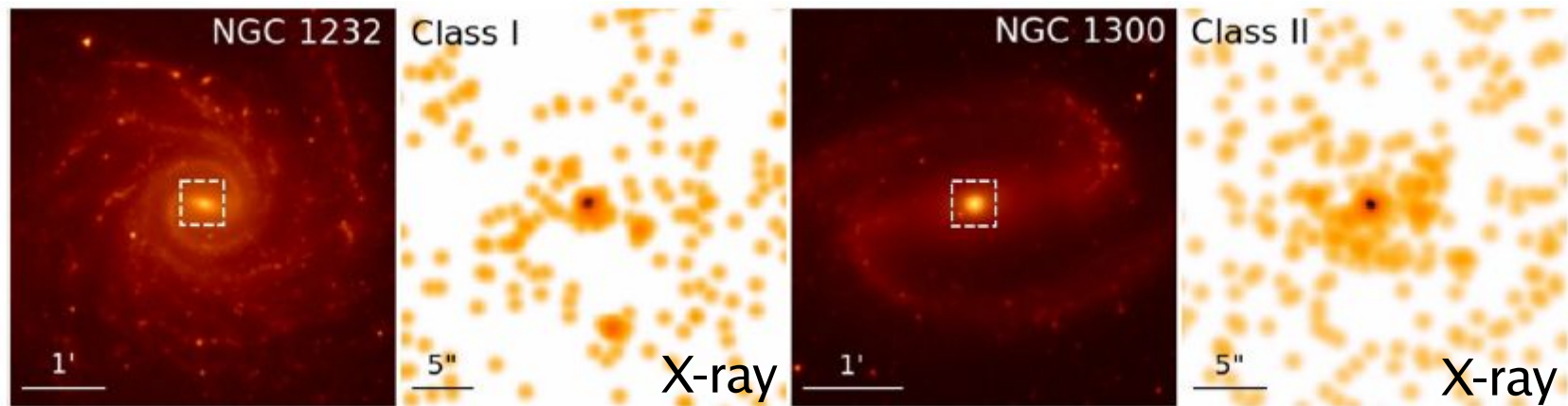


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Minor merger	Yes (radius?)	Yes (lots?)	?
Bars	Yes (to $<1\text{pc}$?)	No	
Disk Instabilities			
Stellar winds			



Galactic bars



S4G: Cisternas+ 2013



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Minor merger	Yes (radius?)	Yes (lots?)	?
Bars	Yes (to $<1\text{pc}$?)	No	no
Disk Instabilities			
Stellar winds			



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Disk Instabilities	Yes (to $<1\text{pc}$)	No	
Stellar winds			



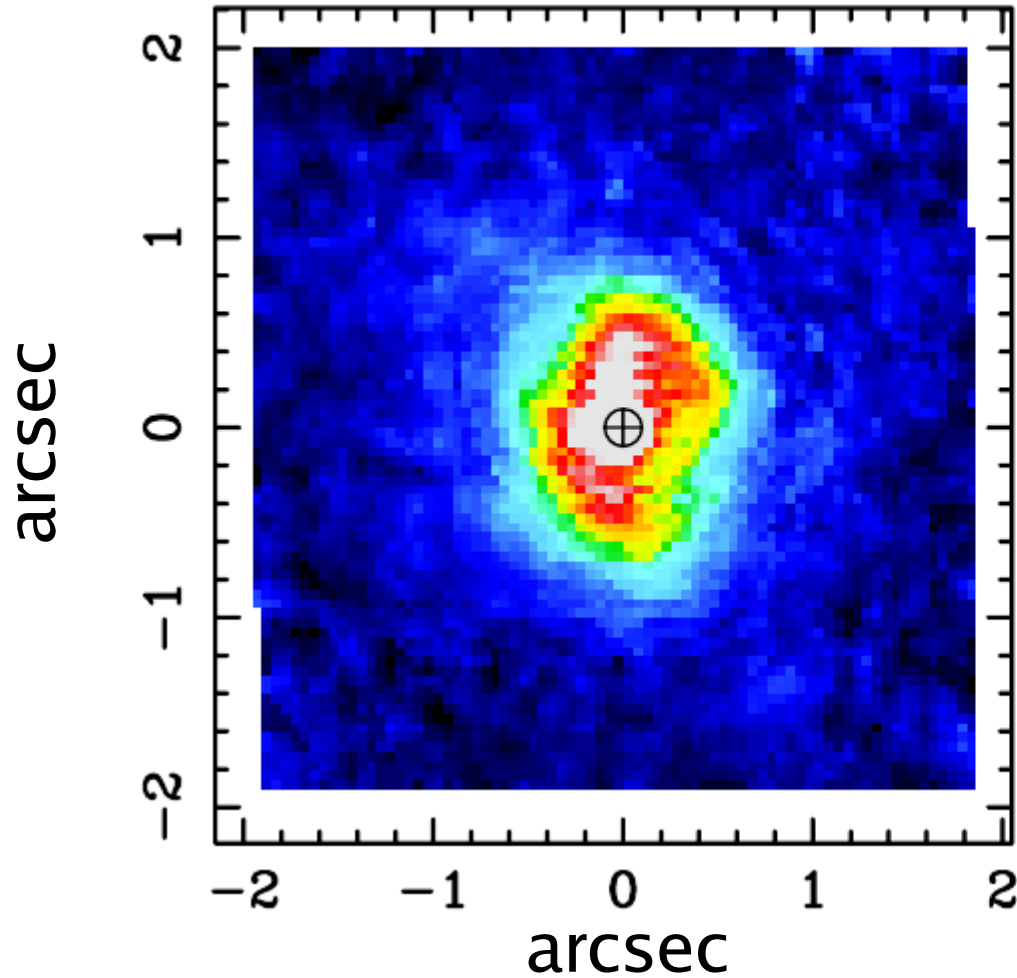
Fundamental problem: spatial resolution

- Low-M BHs:
 - Contributing $\sim 0\%$ to BH mass density growth
 - nearby
 - spatial resolution: < 100 pc
- High-M BHs/Quasars:
 - Contributing $\sim 100\%$ to BH mass density growth
 - $z > 0.05$
 - spatial resolution > 1 kpc



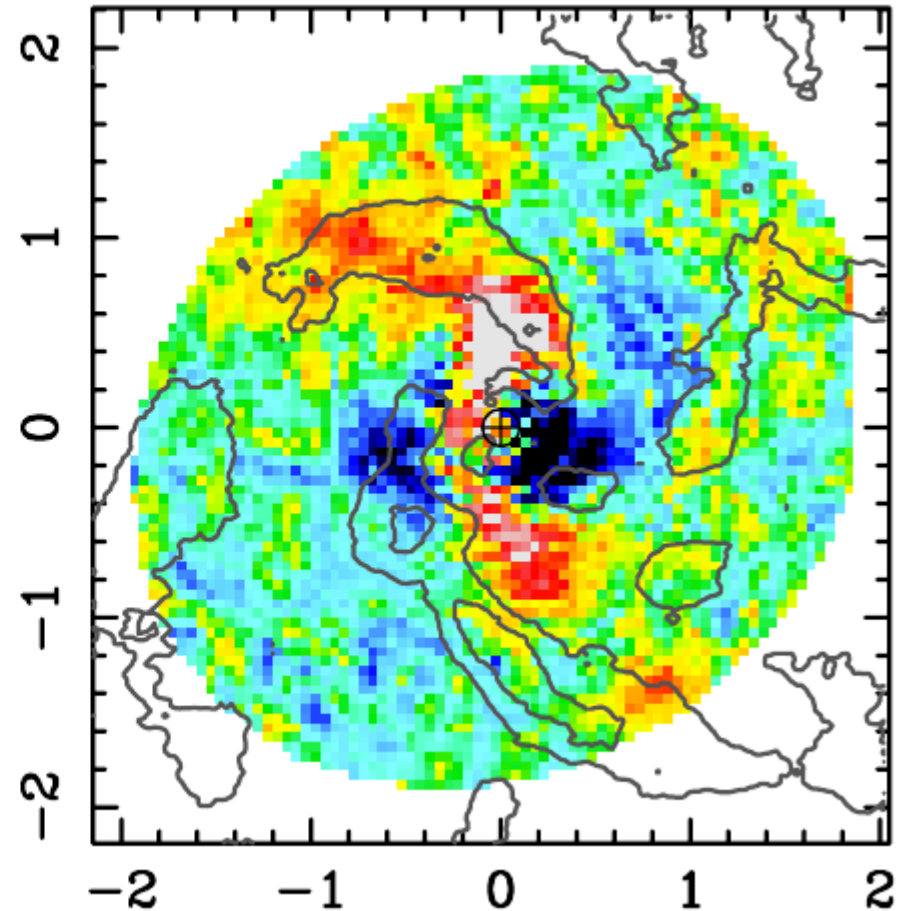
Nuclear spirals <100pc

H₂ 1-0S(1) flux



(1''~85pc)

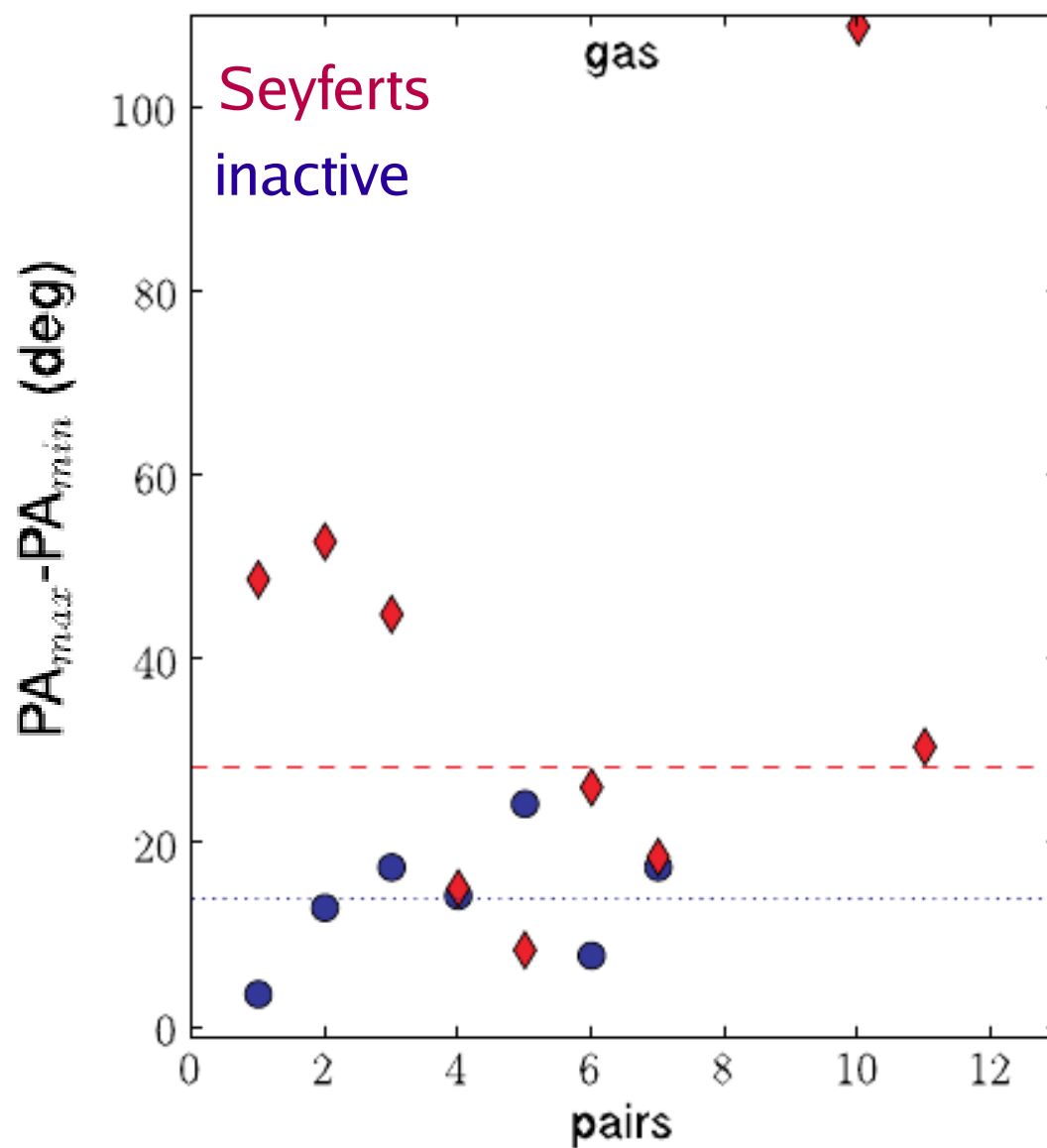
H₂ residual flux



Davies+ 2009 (SINFONI)



Small-scale gas velocity distortions



Dumas+ 2007
(central 1.5 kpc)



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Bars	Yes (to $<1\text{pc}$?)	No	no
Disk Instabilities	Yes (to $<1\text{pc}$)	No	likely
Stellar winds			

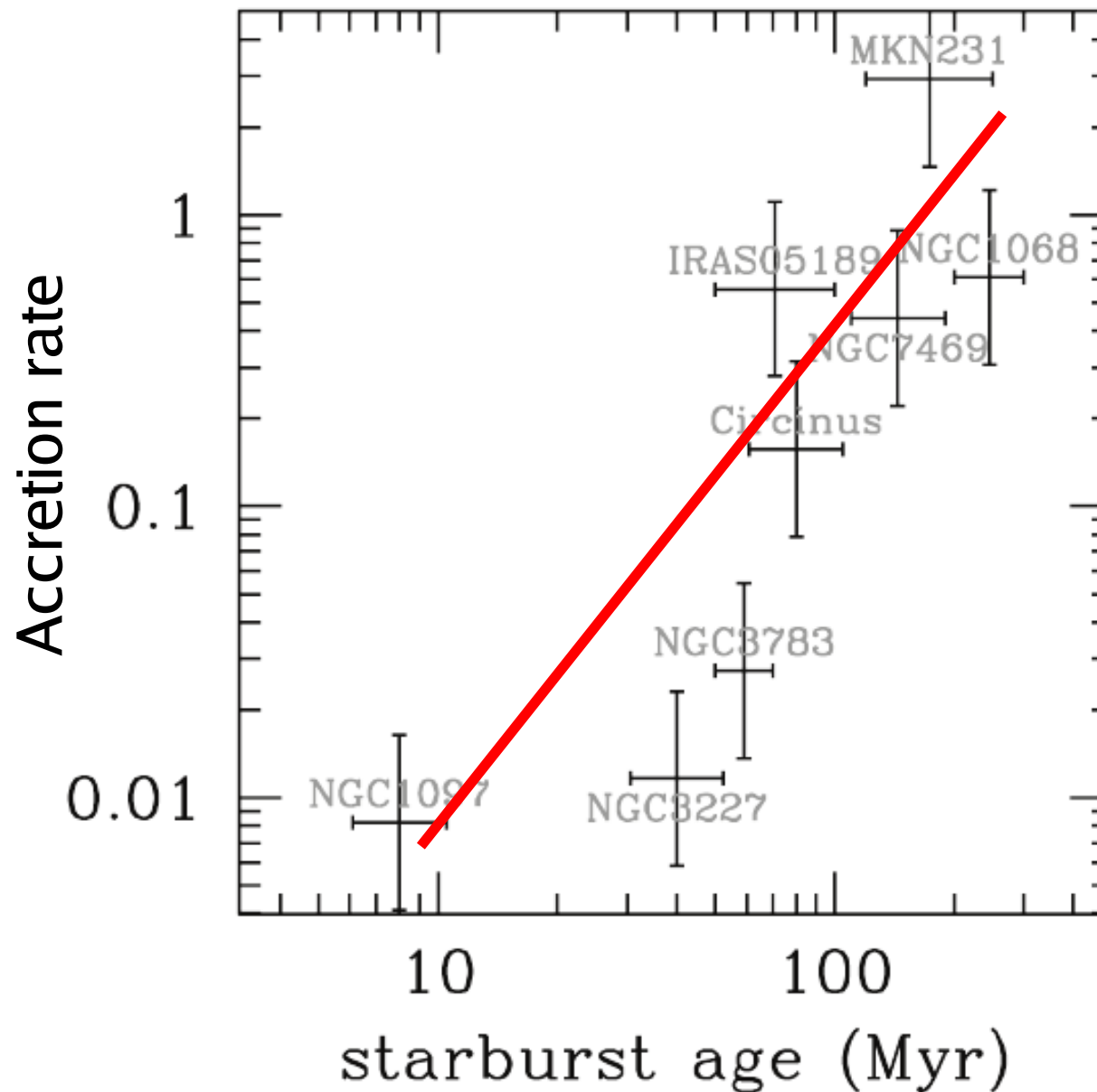


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Minor merger	Yes (radius?)	Yes (lots?)	?
Bars	Yes (to $<1\text{pc}$?)	No	no
Disk Instabilities	Yes (to $<1\text{pc}$)	No	likely
Stellar winds	No	Yes (low-M)	



Stellar winds?



Davies+ 2007



How to feed the monster?

Mechanism	Torques?	Gas?	Important?
Major merger	Yes (to $>100\text{pc}$)	Yes (lots?)	$z<1$ (2?): no
Minor merger	Yes (radius?)	Yes (lots?)	?
Bars	Yes (to $<1\text{pc}$?)	No	no
Disk Instabilities	Yes (to $<1\text{pc}$)	No	likely
Stellar winds	No	Yes (low-M)	low-L?





Summary

- Major merging: subdominant at $z < 2$
 - But what about $z > 2$, highest L ?
- Non-violent triggers:
 - Indirect knowledge
 - Dominating at $z < 1$, possibly $z < 2$
 - Instabilities/triggering of instabilities
 - Simulations starting to capture this
- Future: ALMA will solve everything (guaranteed!)

