Star Formation Suppression due to AGN Feedback

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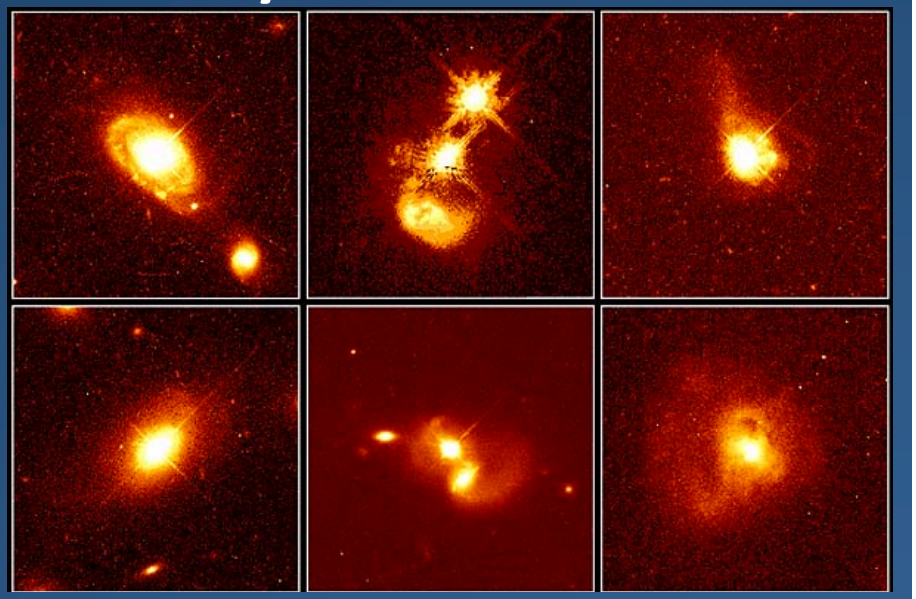
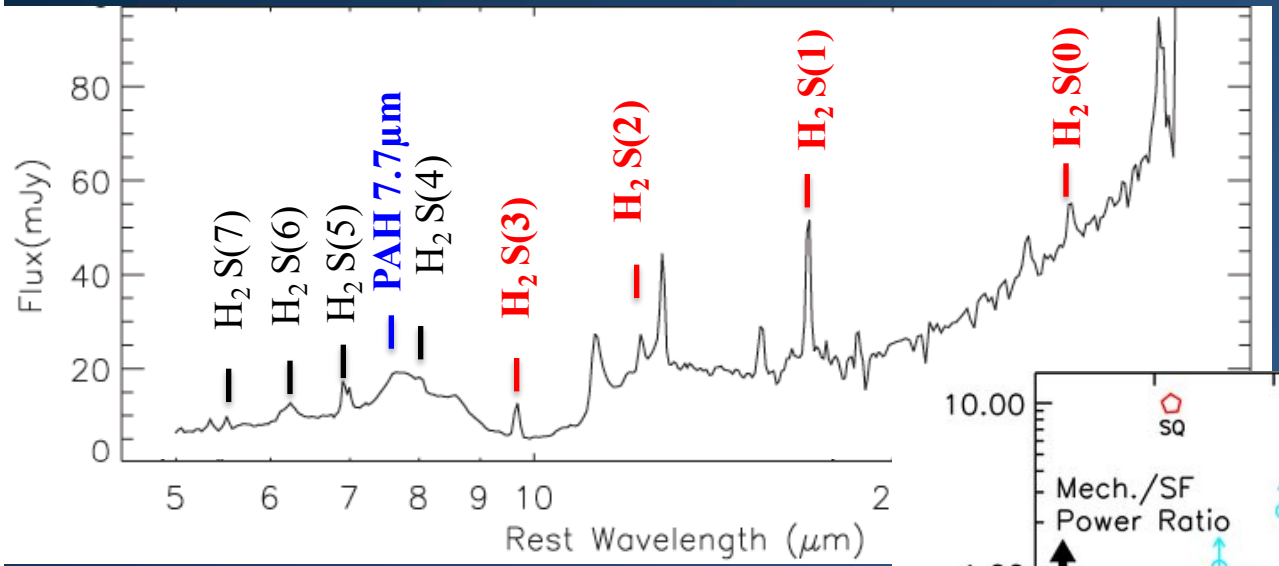
AGN Feedback in Galaxy Evolution



- Quasar Mode =
  Radiatively Driven Winds

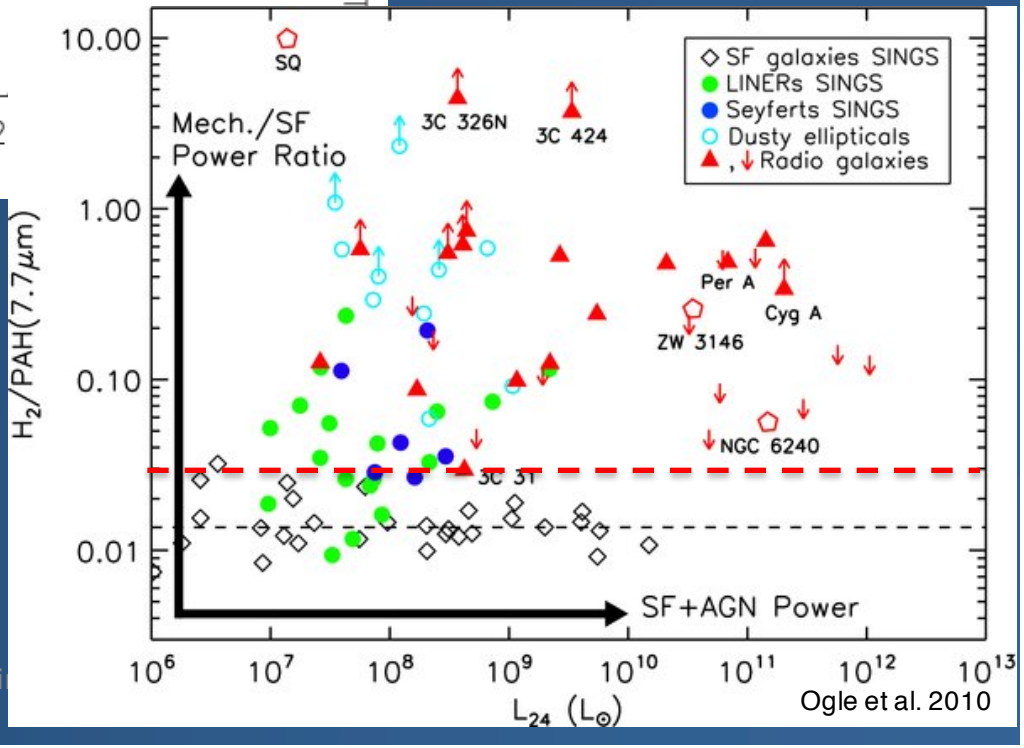
- Radio Mode =
  Jet Driven Outflows +
  Injected Turbulence

Warm H_2 Luminous Galaxies



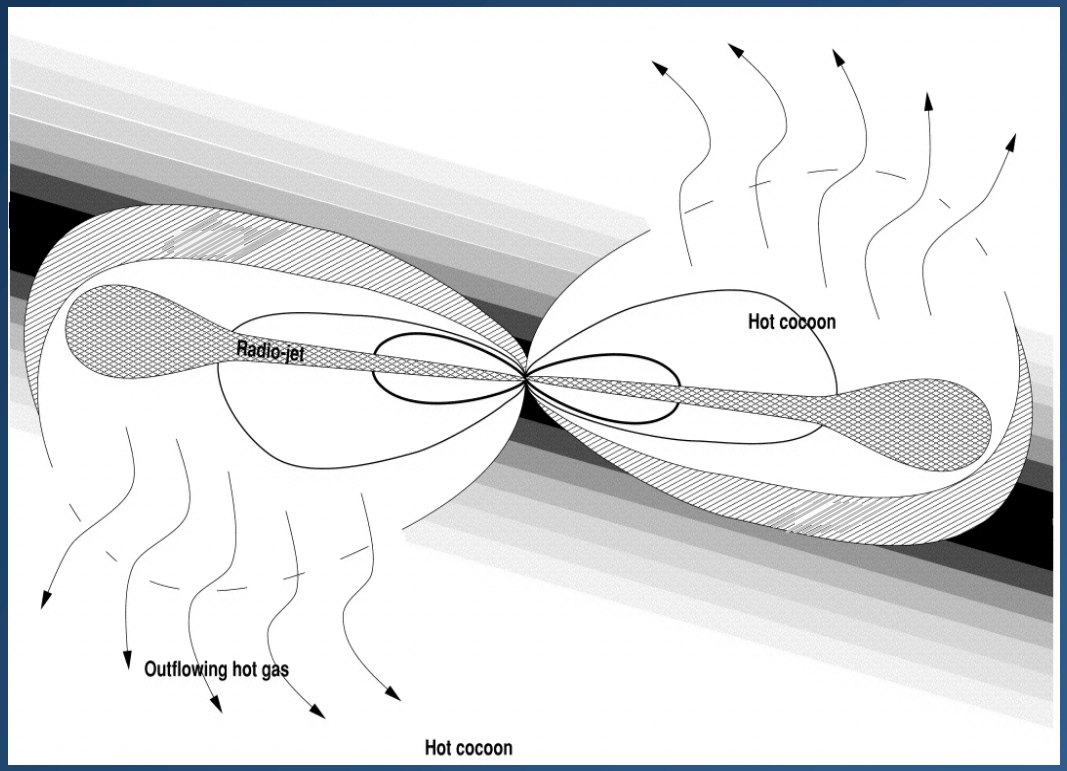
~ 30% of 3C galaxies

- $L(H_2)/L(PAH\ 7.7\mu m) > 0.04$
- $L(H_2)=7x10^{38}$-$2x10^{42}$ erg/s
- $M(H_2)$=up to $4x10^{10}\ M_\odot$
- $T(H_2)$=100-1500 K



Ogle et al. 2010

Jet Feedback on ISM



Jet

Injects Mechanical Energy into ISM

Hot Cocoon

X-ray Emission

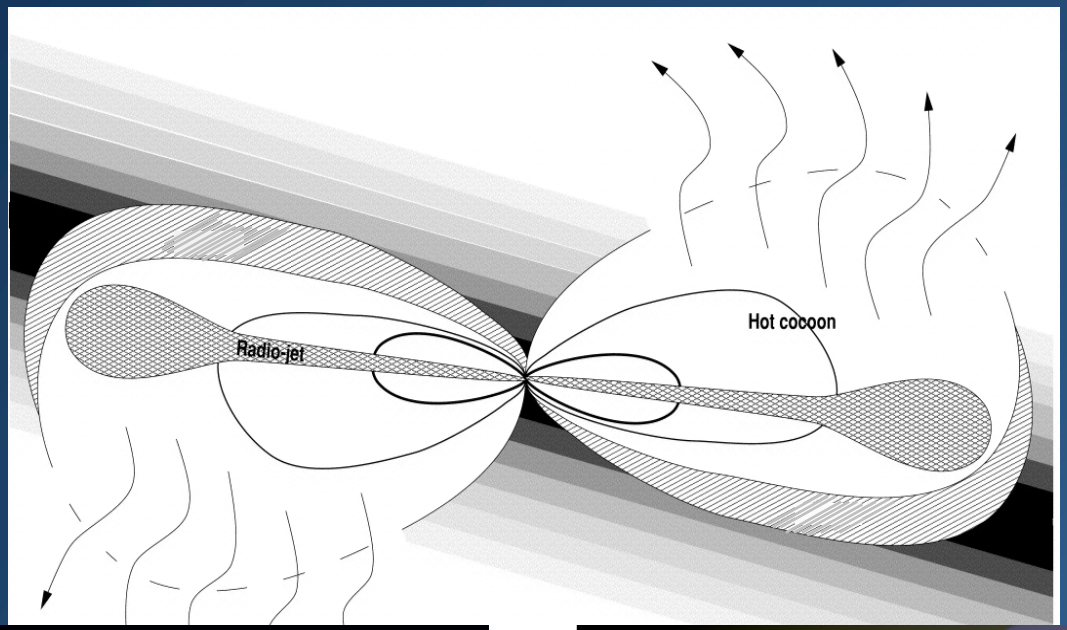
Turbulent Motions Entrain Gas and Drive Shocks into Cooler Gas

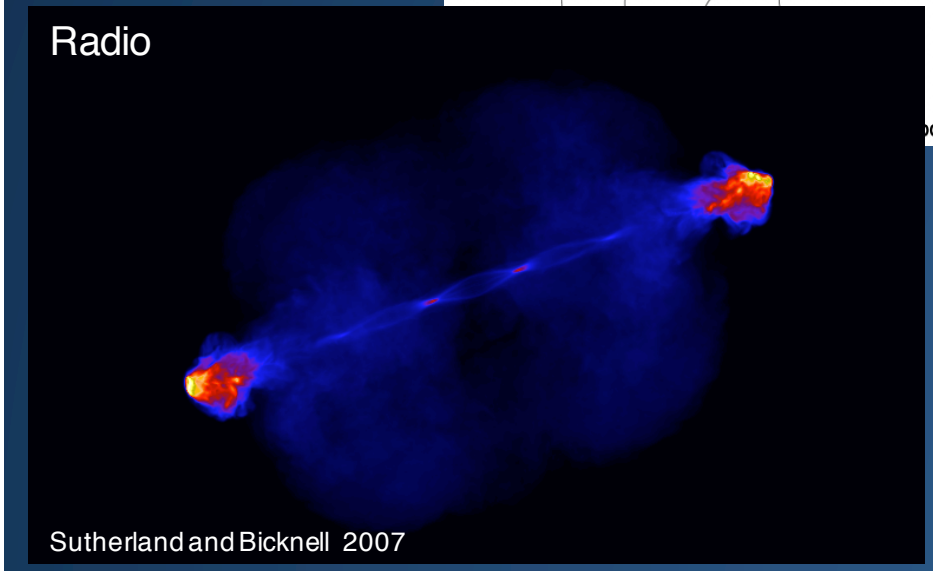
Warm Gas

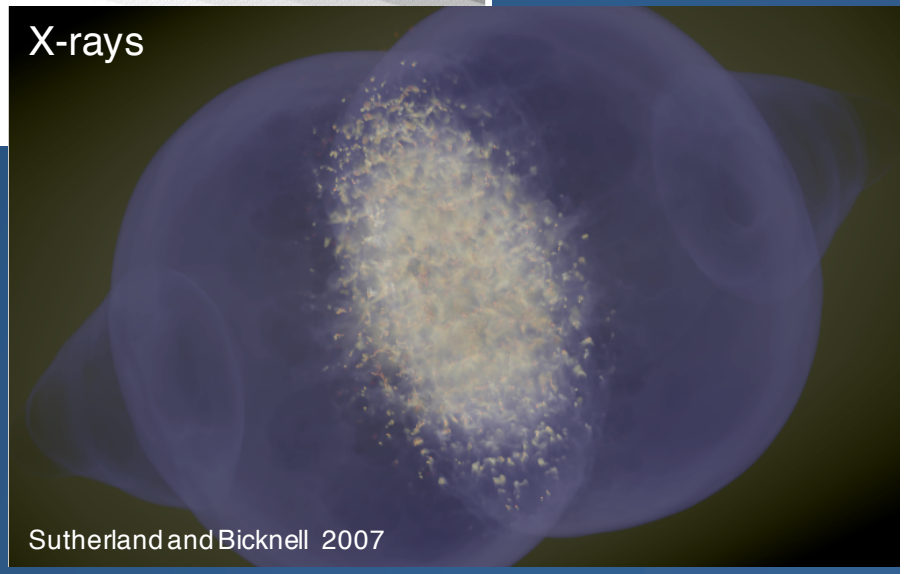
H_2 Emission

Catalina 2016, L. Lanz

Jet Feedback on ISM







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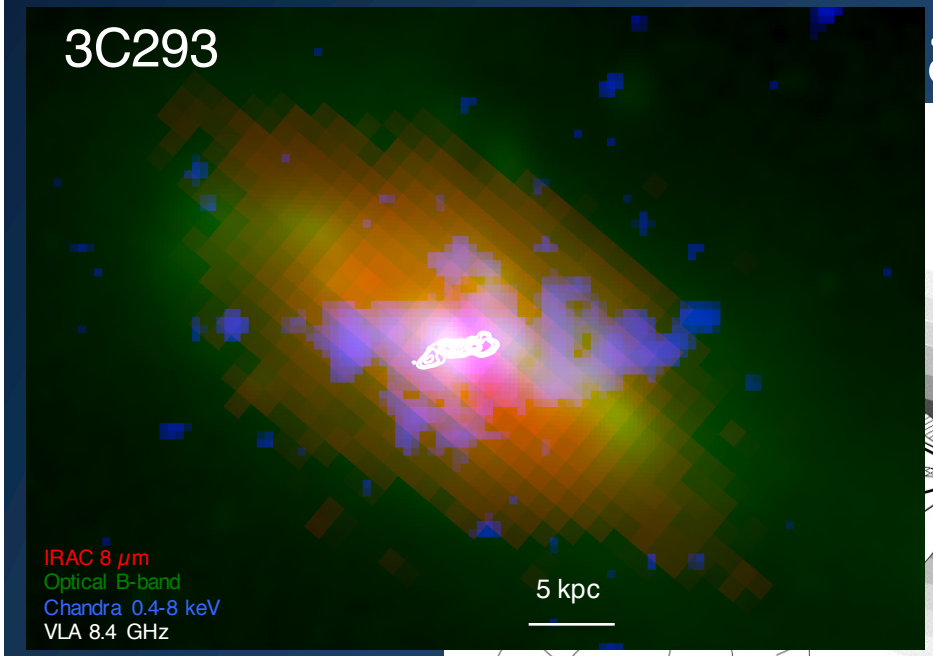
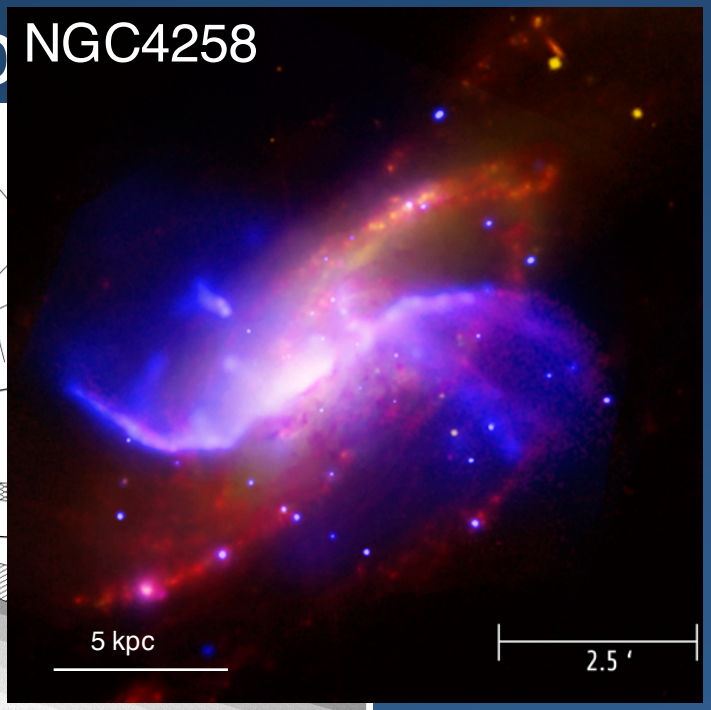
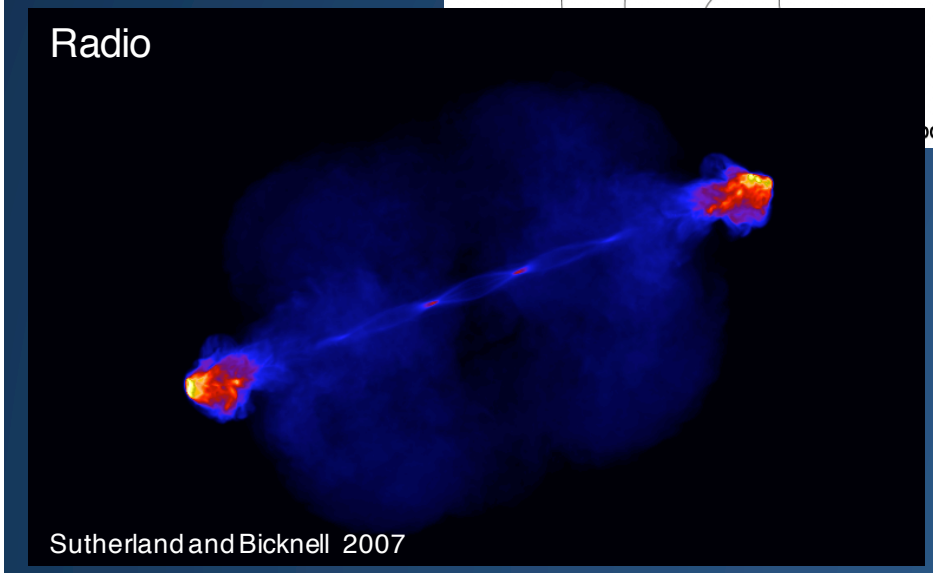
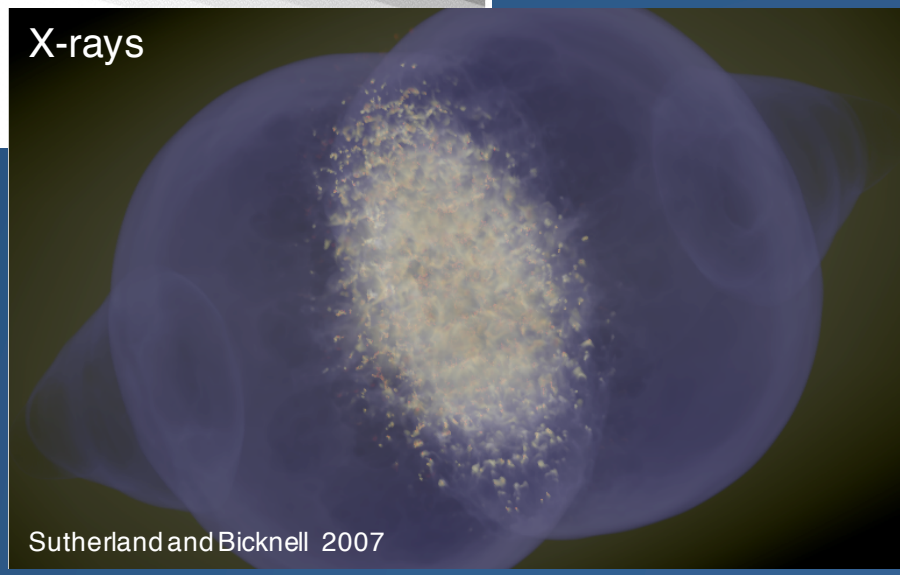


Lanz et al. 2015



Ogle, Lanz & Appleton 2014





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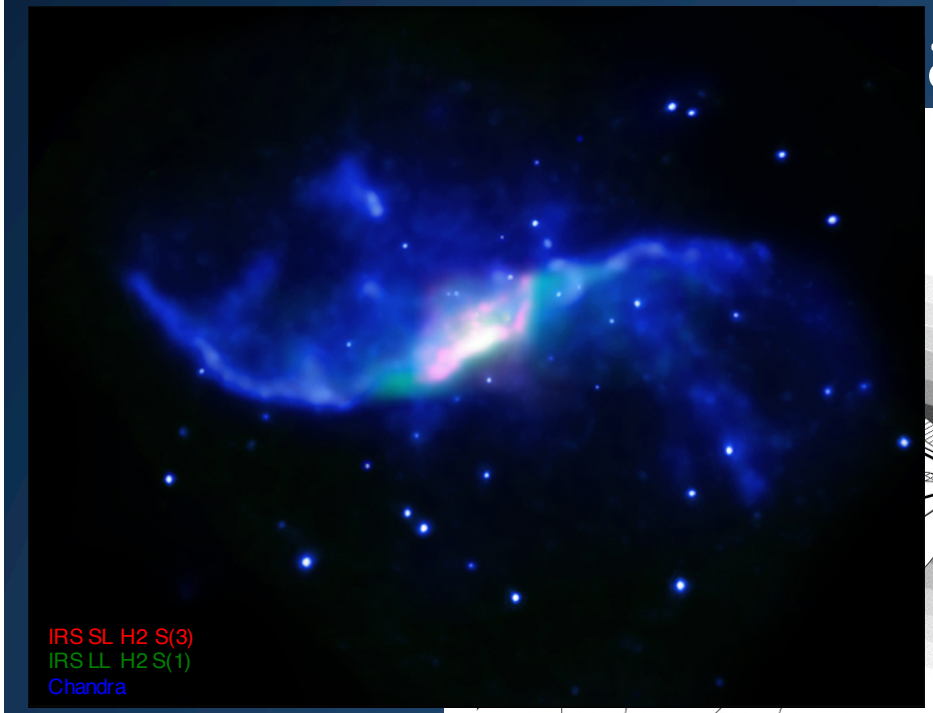

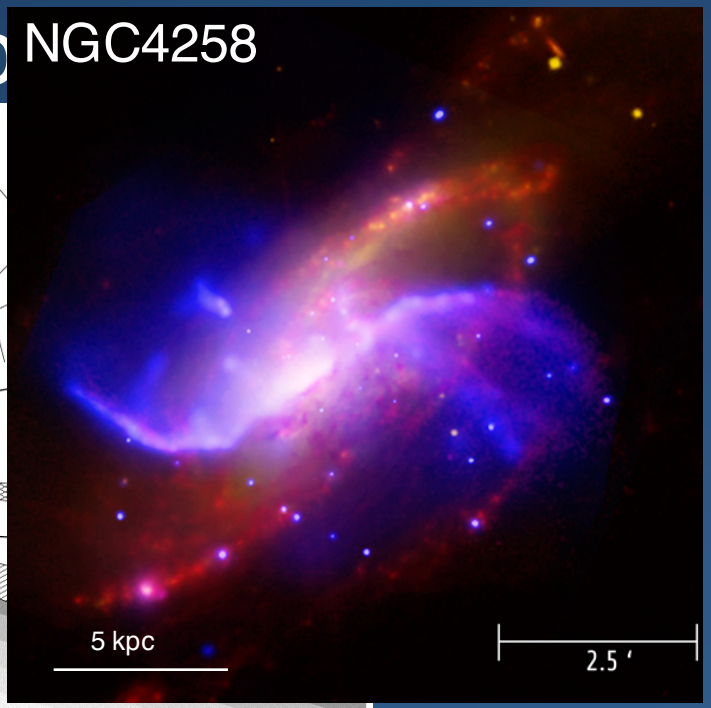

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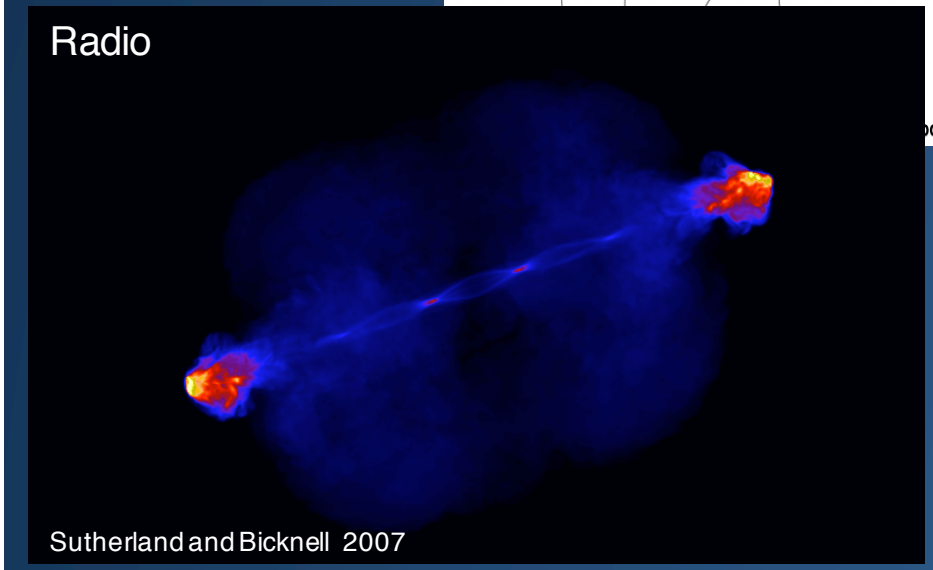
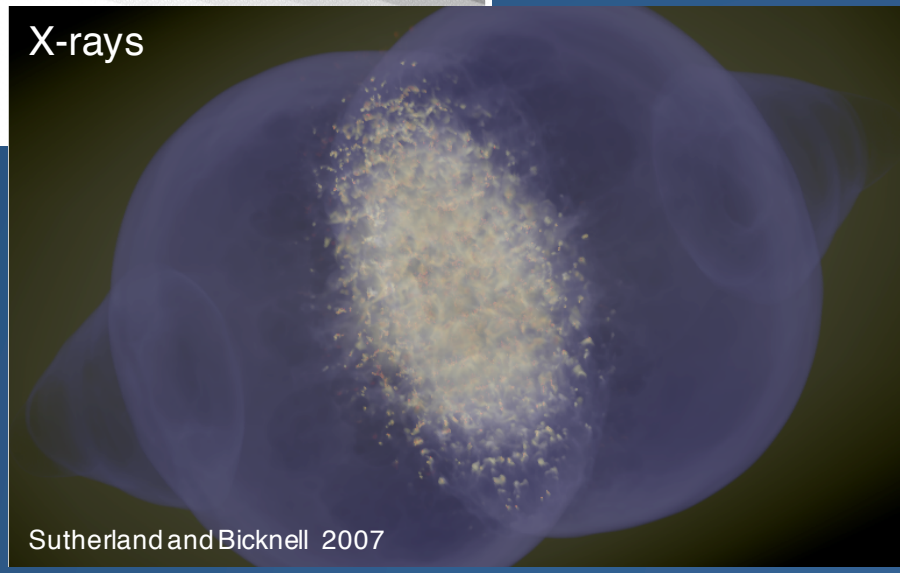
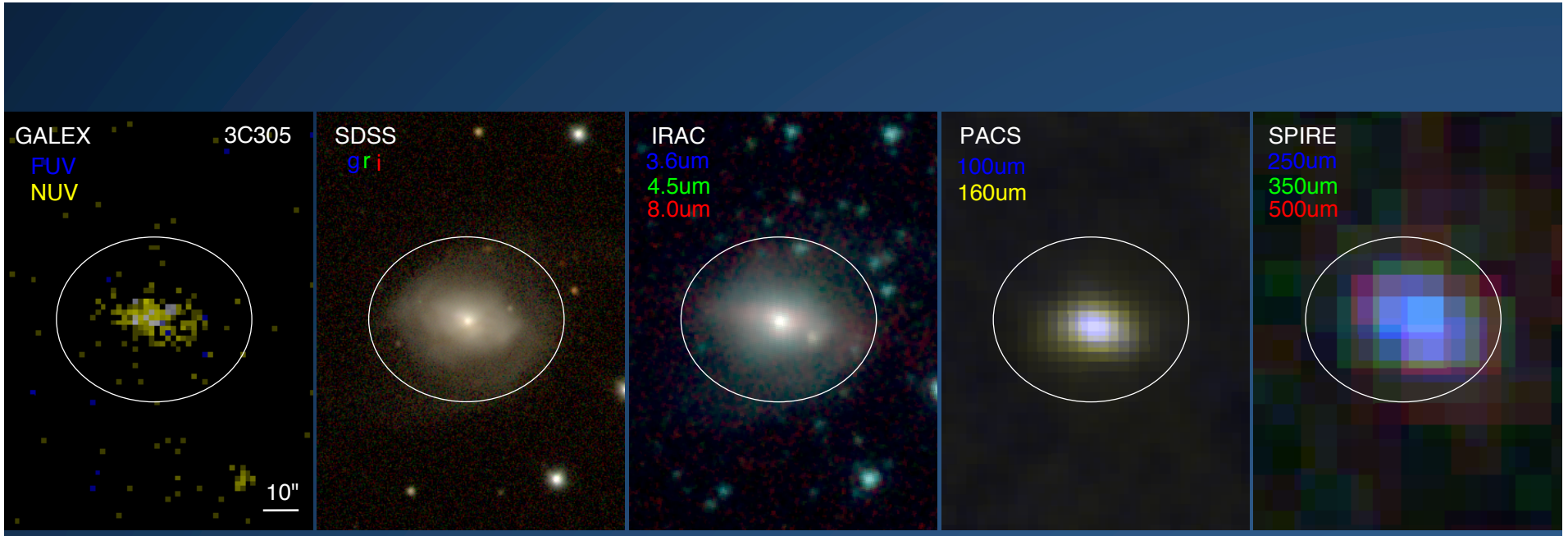


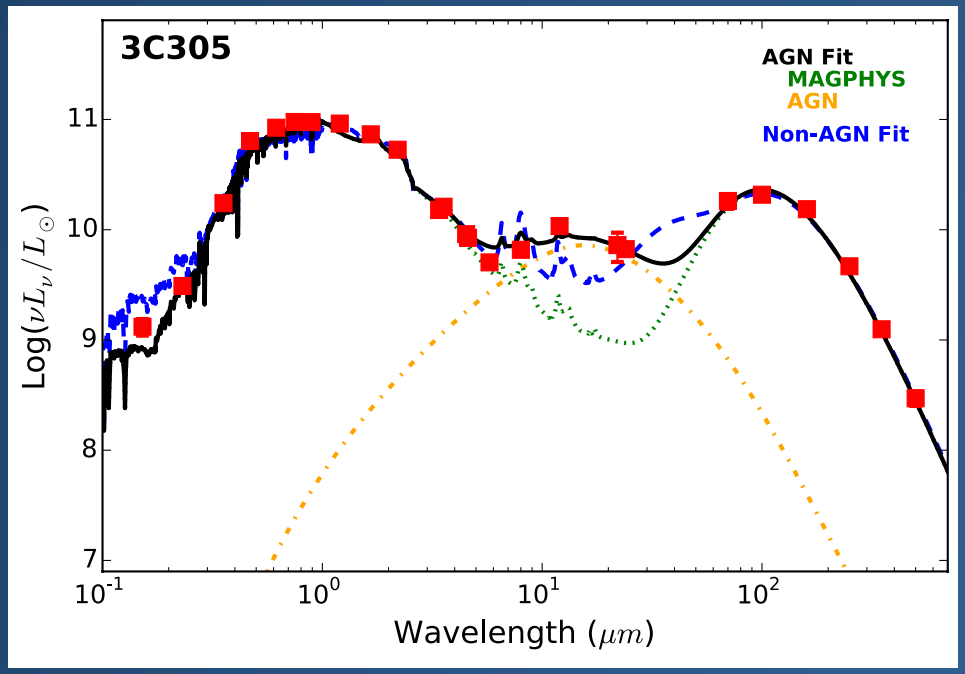


Measuring the Impact of Radio Jet Feedback on Star Formation Activity

Sample and Observations

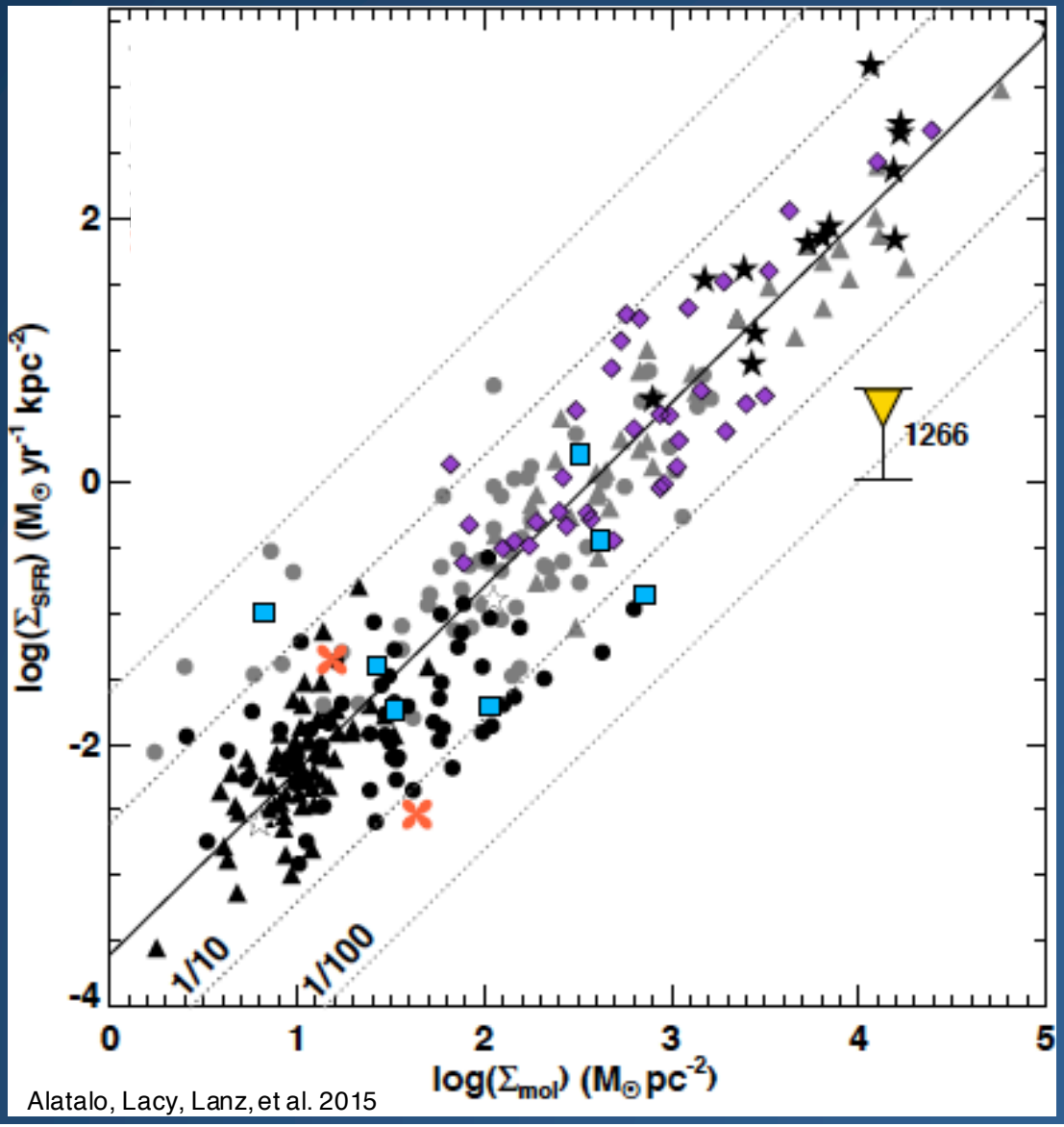
- 22 radio galaxies ($z < 0.21$) from Ogle+2010, Guillard+2012
- UV: GALEX (21/22)
- Optical: SDSS (16/22)
- NIR: 2MASS (22/22)
- MIR: IRAC (16/22), MIPS (18/22), and WISE (22/22)
- FIR: Herschel PACS and SPIRE (19/22)





Catalina 2016, L. Lanz

Measuring Star Formation Suppression



Alatalo, Lacy, Lanz, et al. 2015

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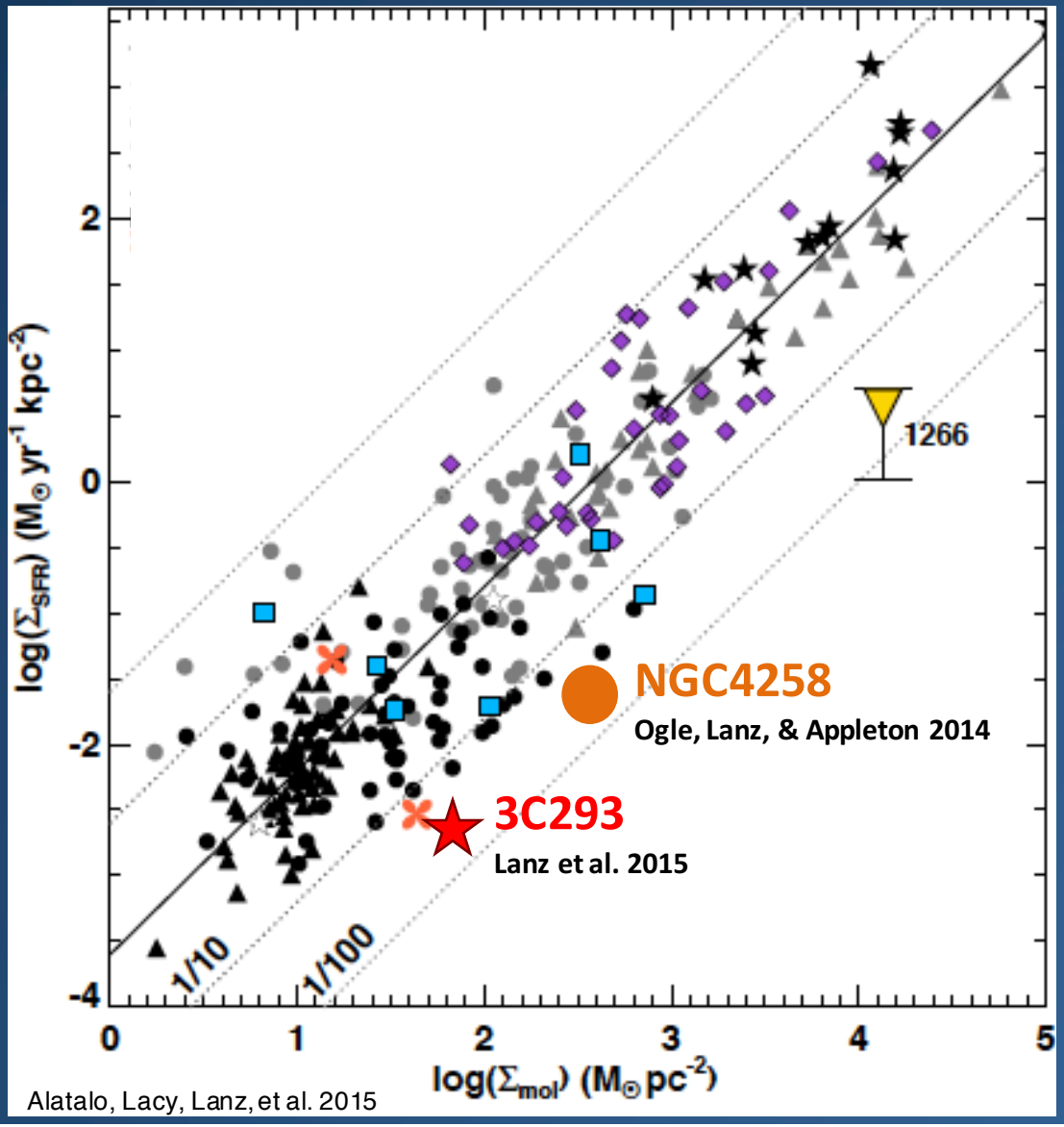

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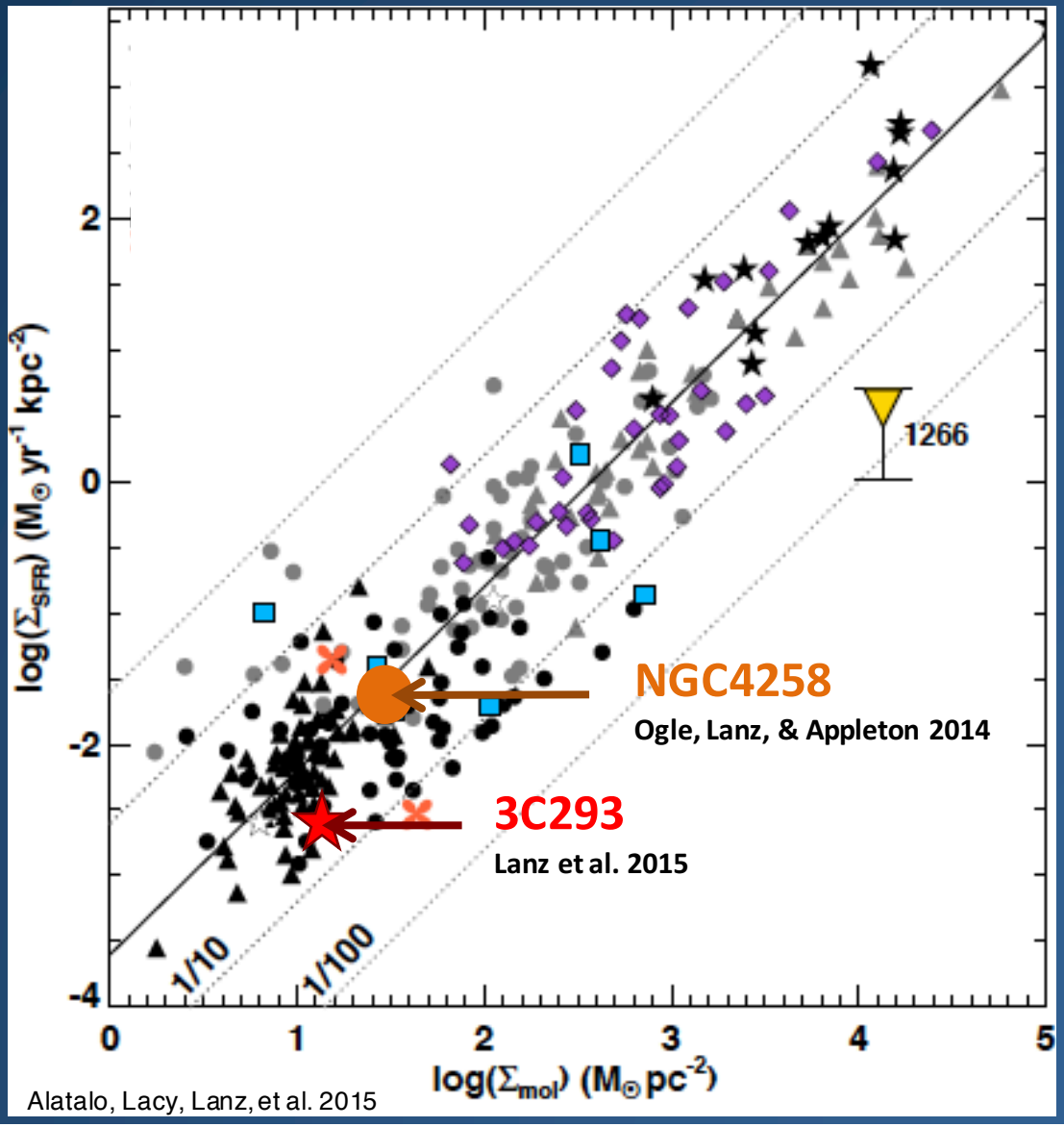

Alatalo, Lacy, Lanz, et al. 2015

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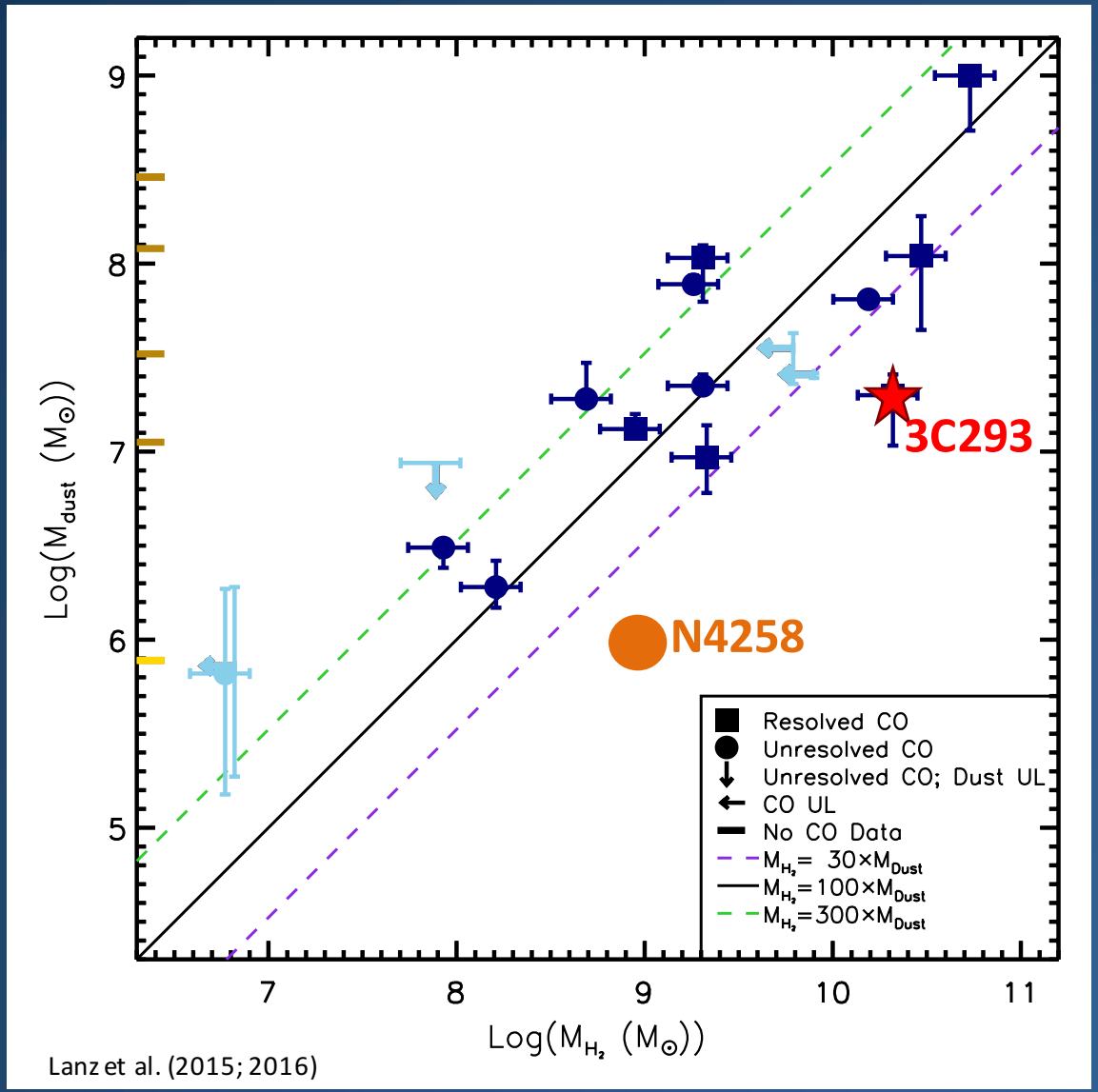
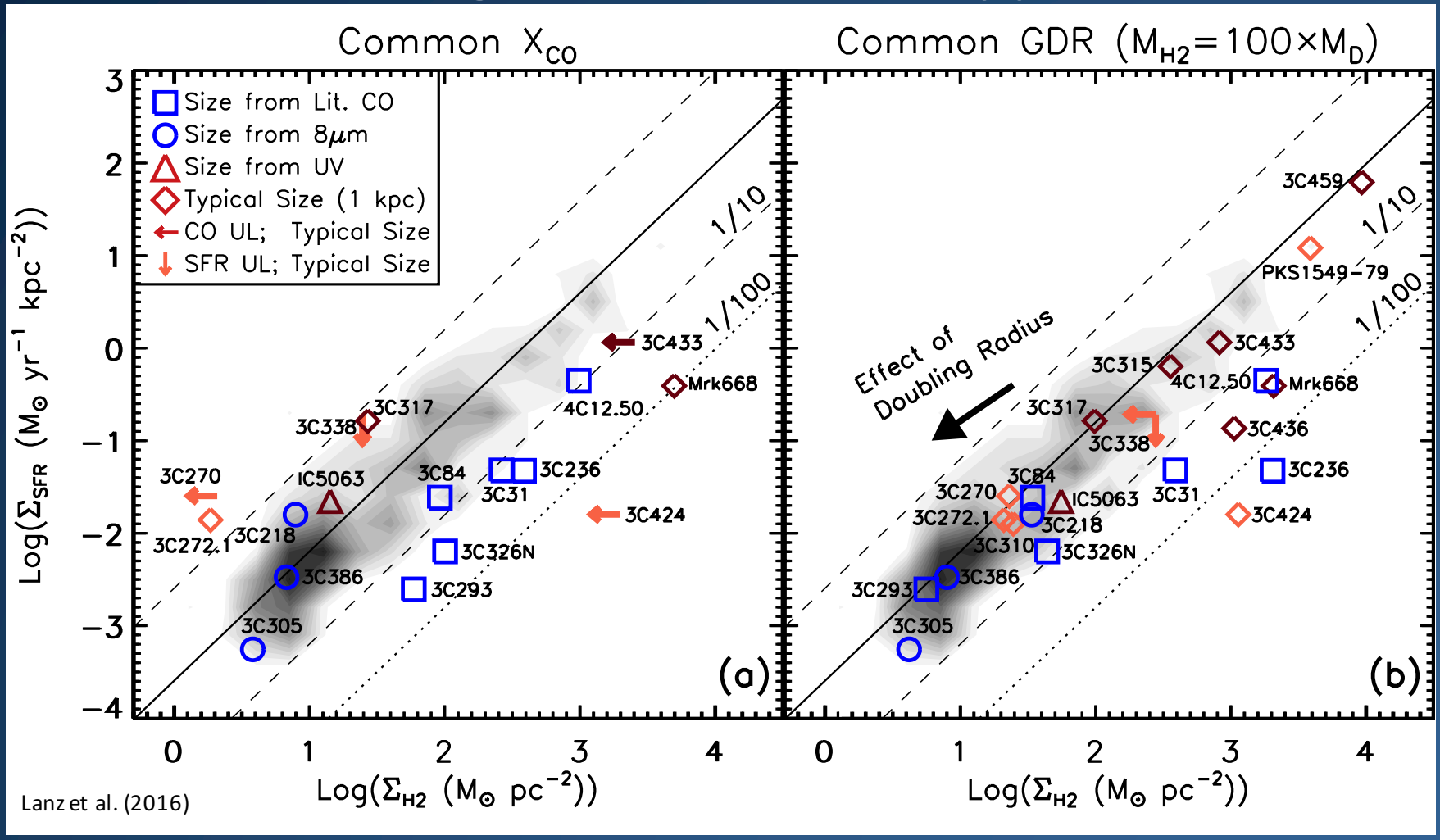


Lanz et al. (2015; 2016)

Measuring Star Formation Suppression

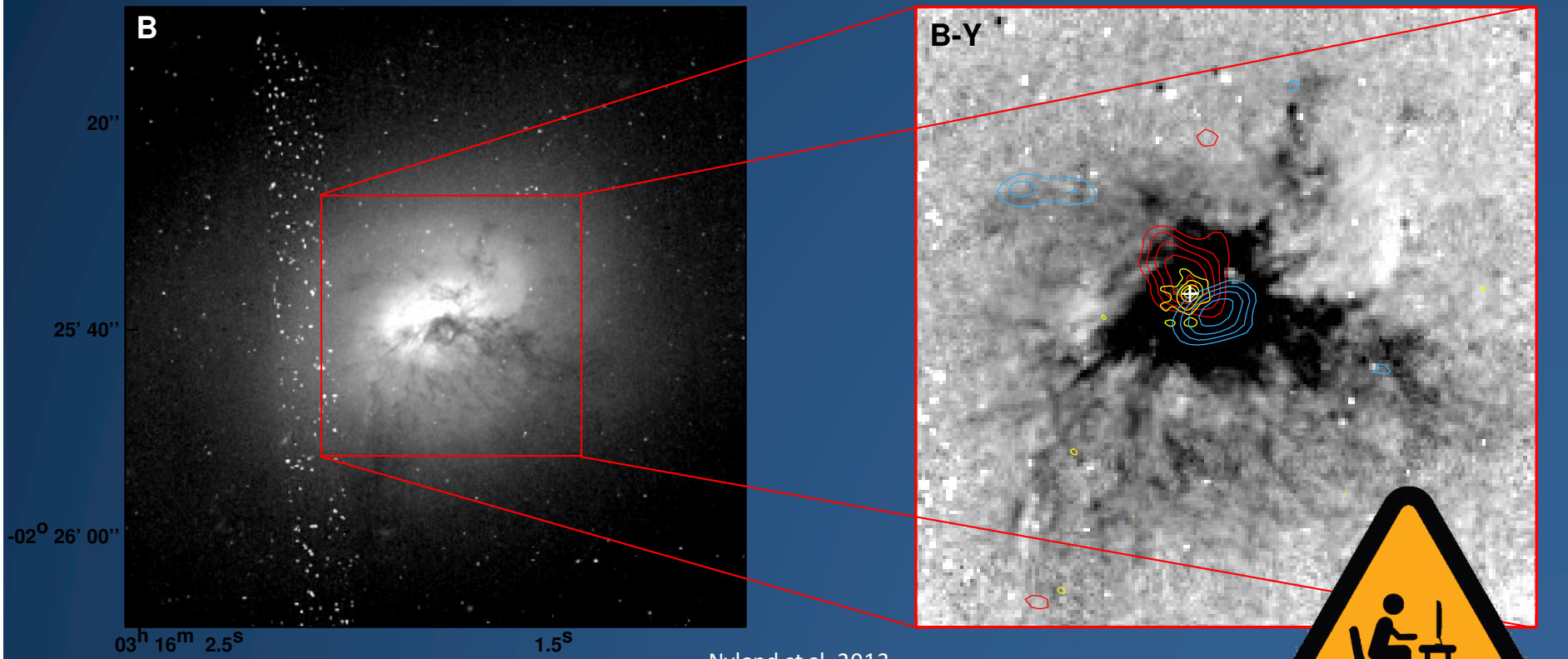


Lanz et al. (2016)

Spatially Resolving Star Formation Suppression

Spatially Resolving Star Formation Suppression

NGC1266



Nyland et al. 2013

Spatially Resolving Star Formation Suppression

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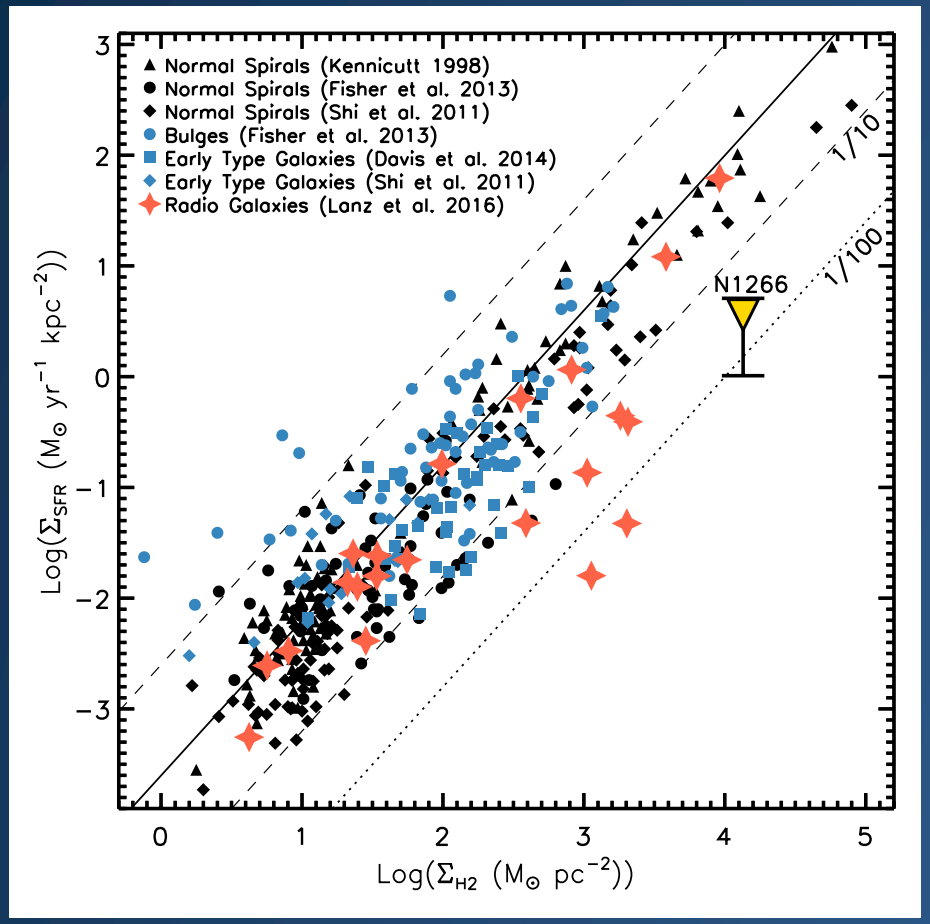

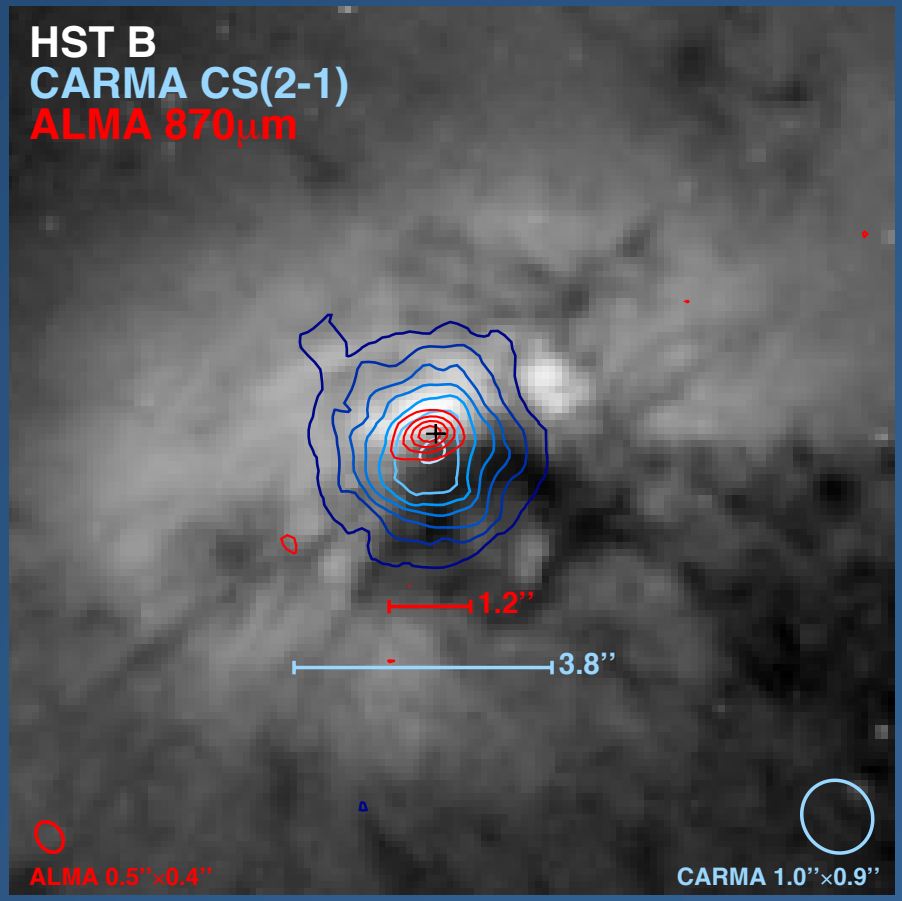

Catalina 2016, L. Lanz

Alatalo, Lacy, Lanz, et al. 2015

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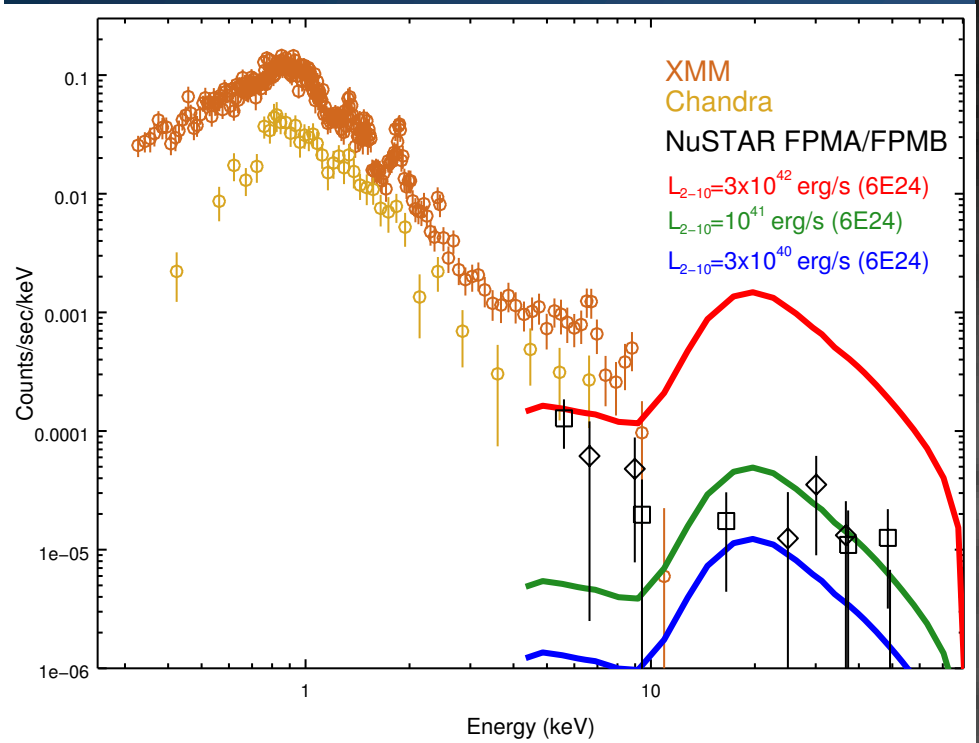
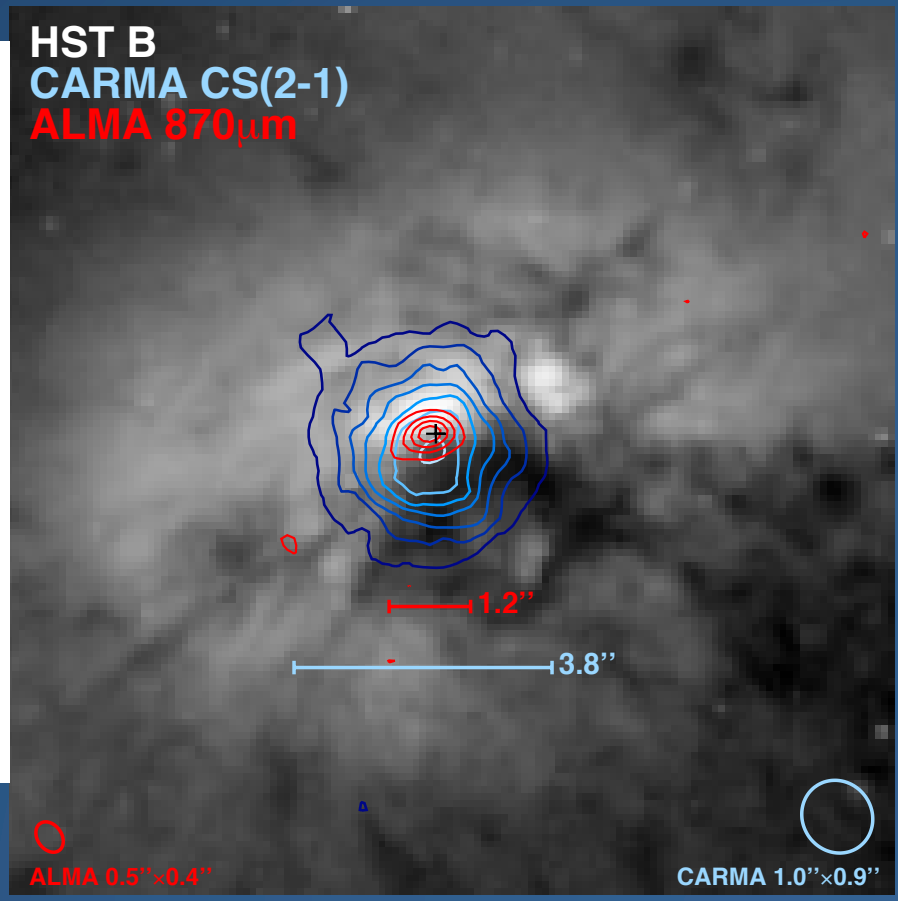


Lanz et al. (in prep.)



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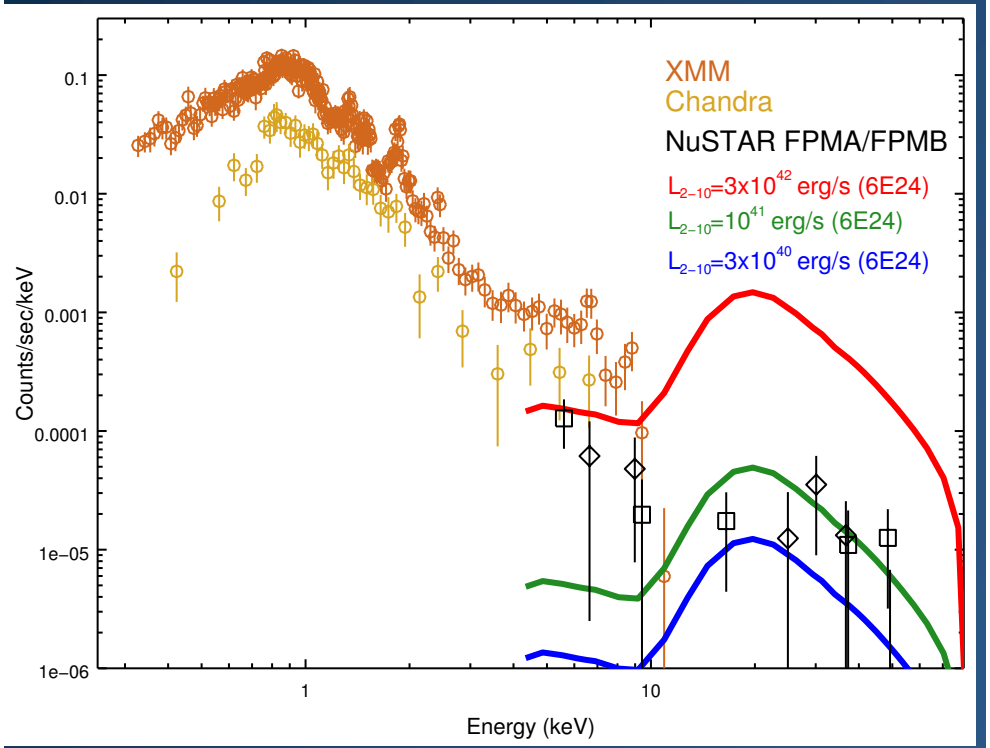

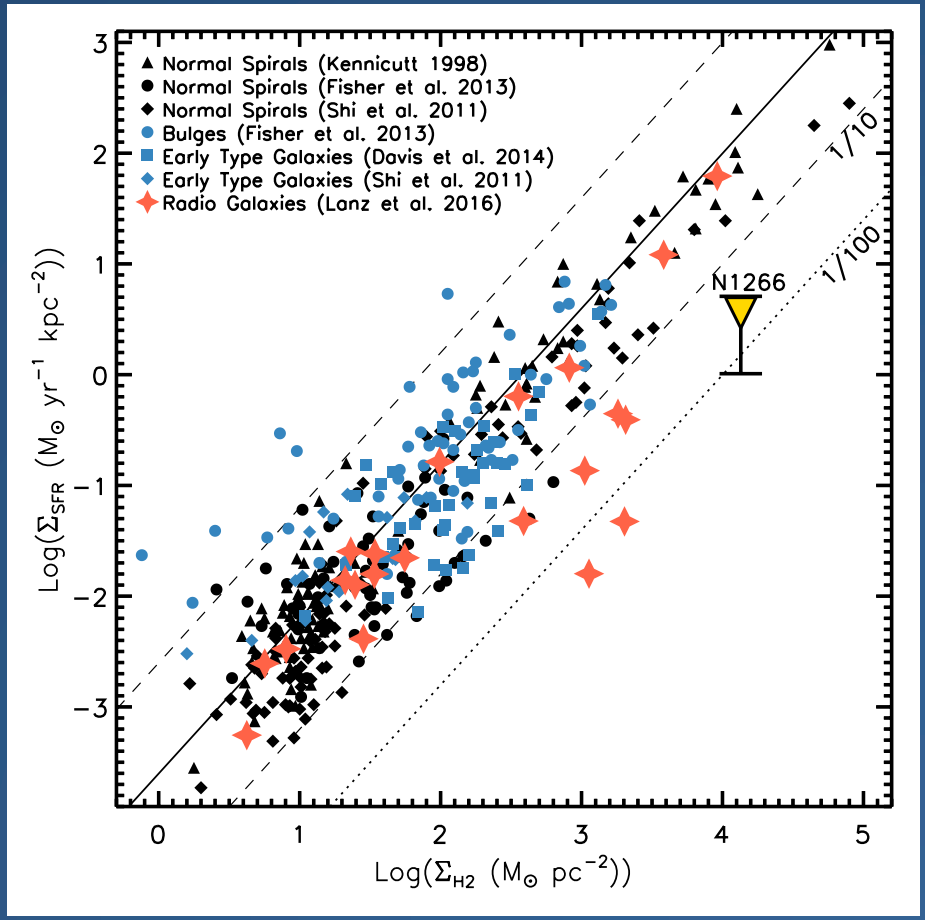

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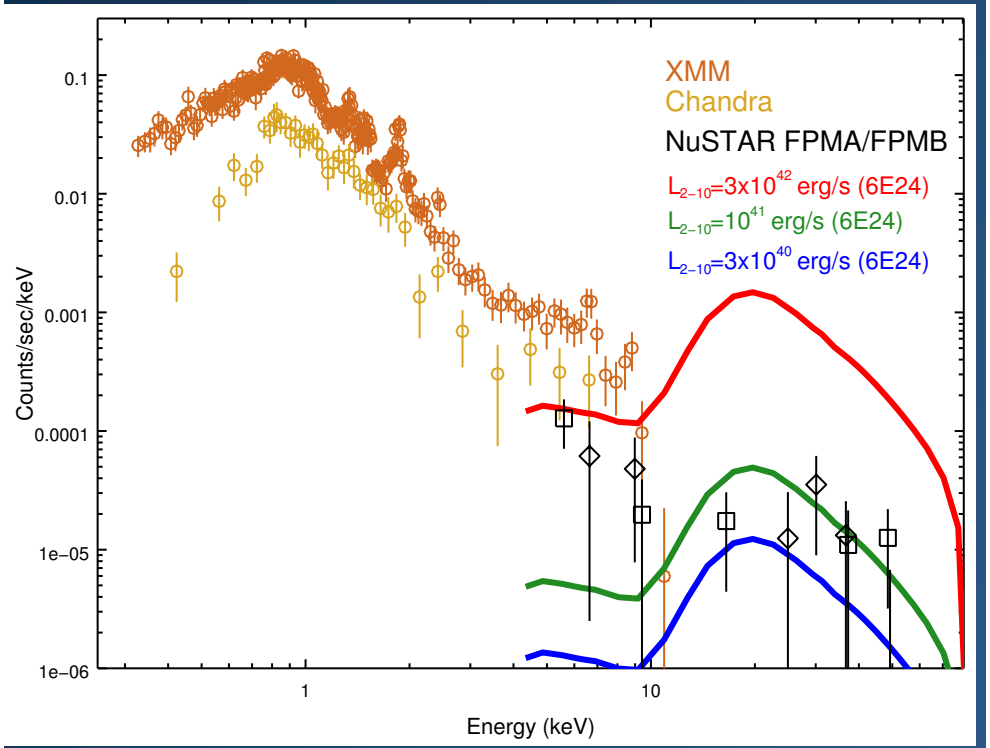

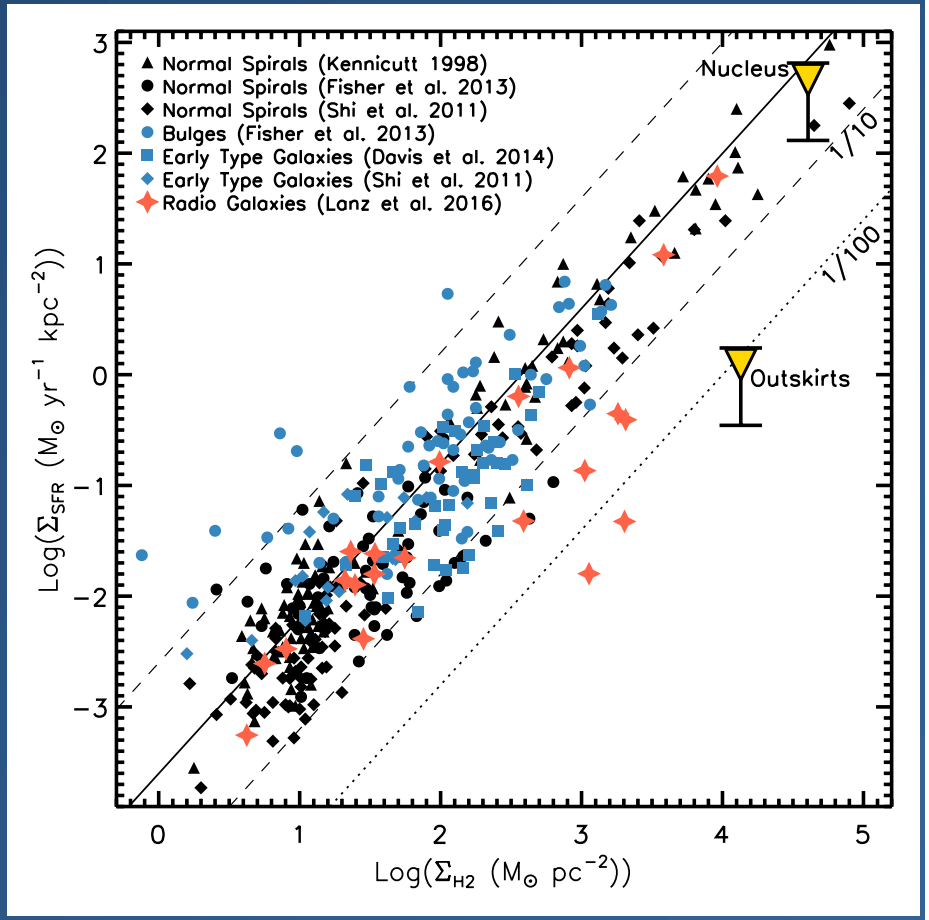

Lanz et al. (in prep.)

Summary

- ~30% of radio galaxies contain large amounts of 100-1500 K H_2, heated by shocks and have $L(H_2) \sim L_X$, consistent with both being powered by dissipation of mechanical energy from the radio jet.

- Star formation in these galaxies is suppressed by a factor of 3-6, statistically different from normal galaxies, but not clearly correlated with jet feedback indicators.

- For the nearby warm H_2 luminous, molecular outflow-hosting NGC 1266, the suppression of star formation is found primarily outside of the nuclear region.

Questions?