New Insights on a Nearby AGN-Driven Molecular Outflow from Recent VLA and VLBA Observations

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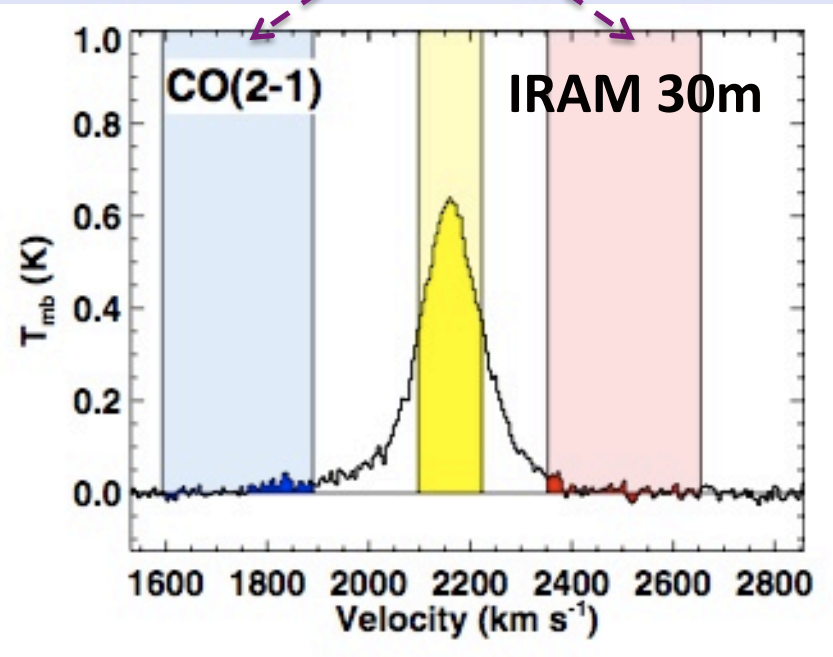
New Mexico Symposium; January 17, 2014

Background

CO observations with IRAM, CARMA, and the SMA suggest NGC 1266 hosts a molecular outflow

outflow



Alatalo et al. 2011

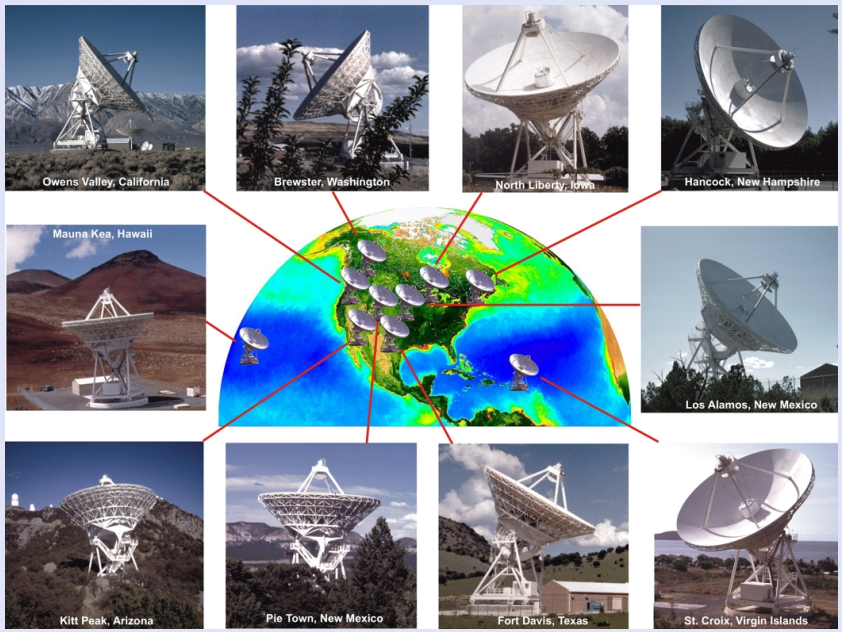
Star formation is insufficient to drive the outflow

NGC 1266 is a rare, local candidate for an AGN-driven molecular outflow

New Radio Interferometric Data

What are the conditions at the *launch-point* of the outflow?

How does the kpc-scale radio jet *interact* with the ISM?

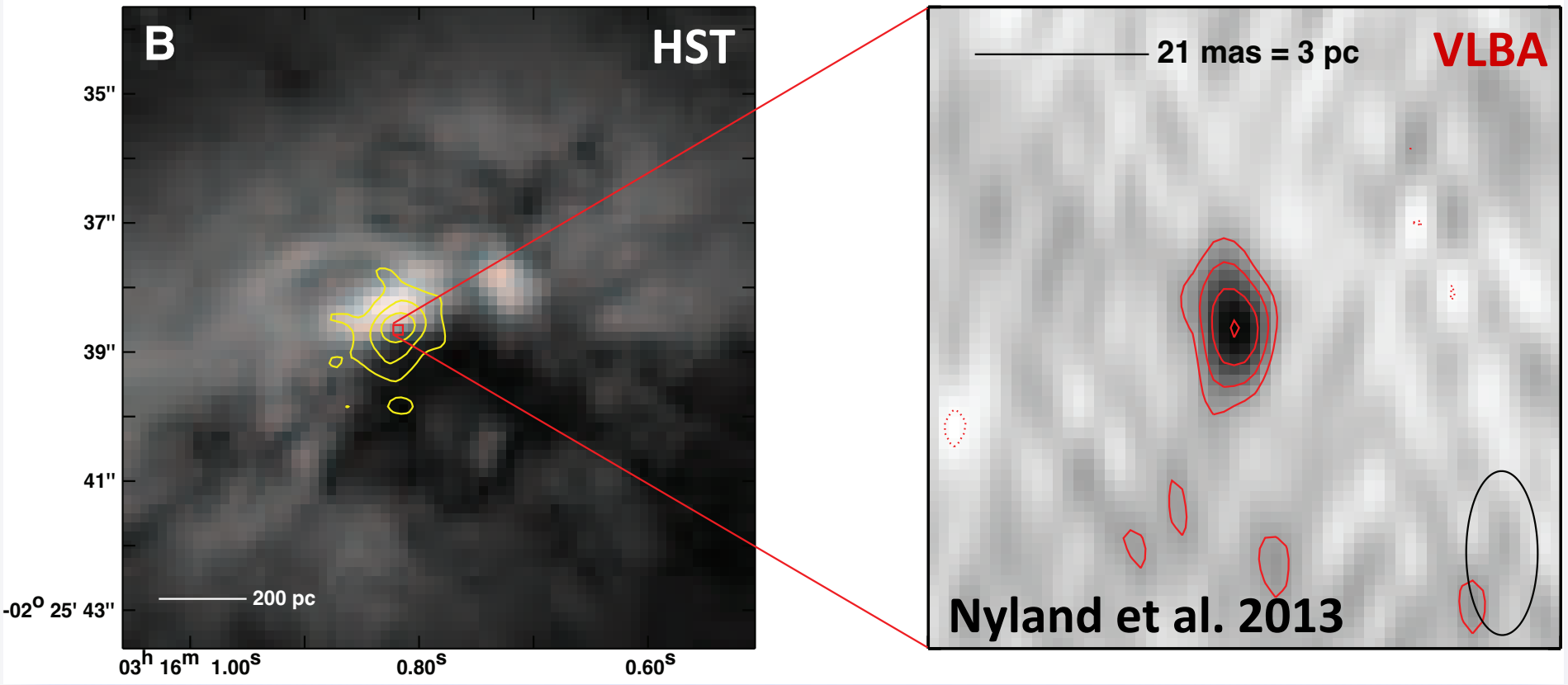


VLBA Continuum

VLA HI & Continuum

New VLBA Continuum Observations

VLBA Continuum Source



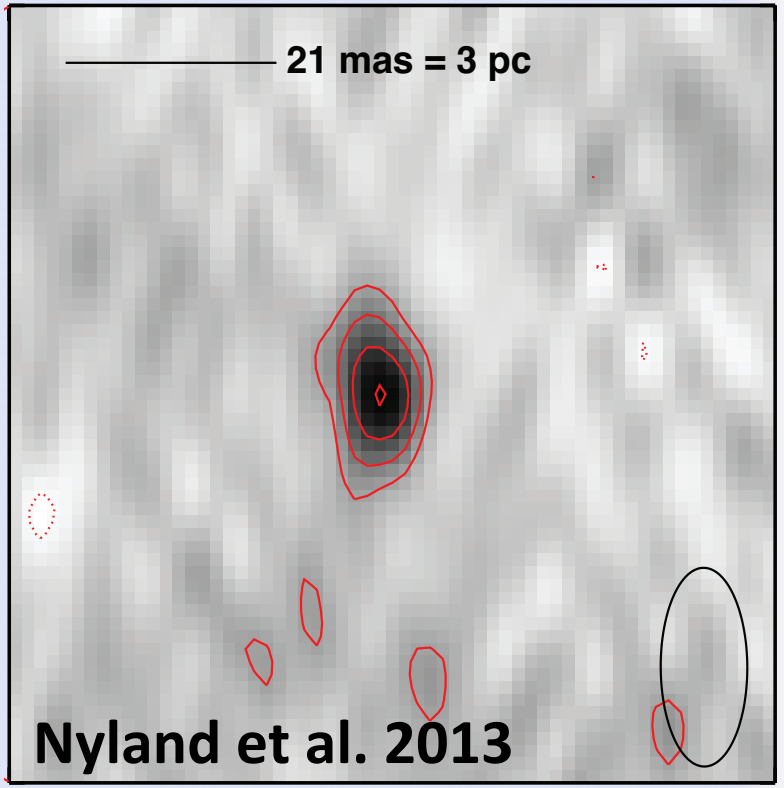
The compact VLBA emission is detected within the densest portion of the molecular gas

VLBA Continuum Source

- **Source Extent:**
  d < 8 mas (1.2 pc)

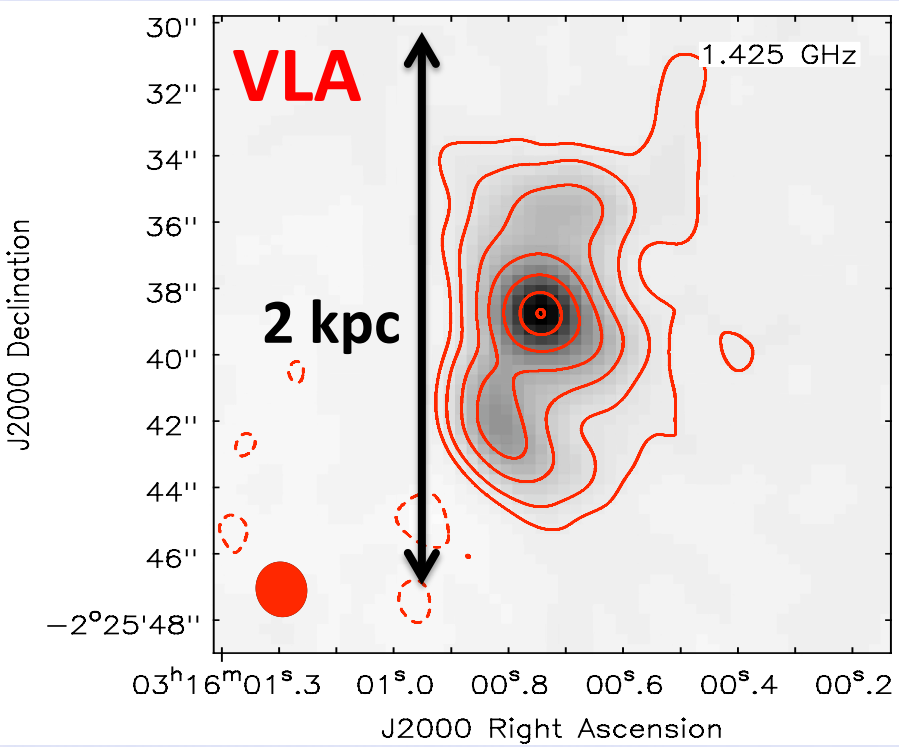
- **Radio Power:**
  $P_{radio} = 1.48 \times 10^{20}$ W Hz^{-1}

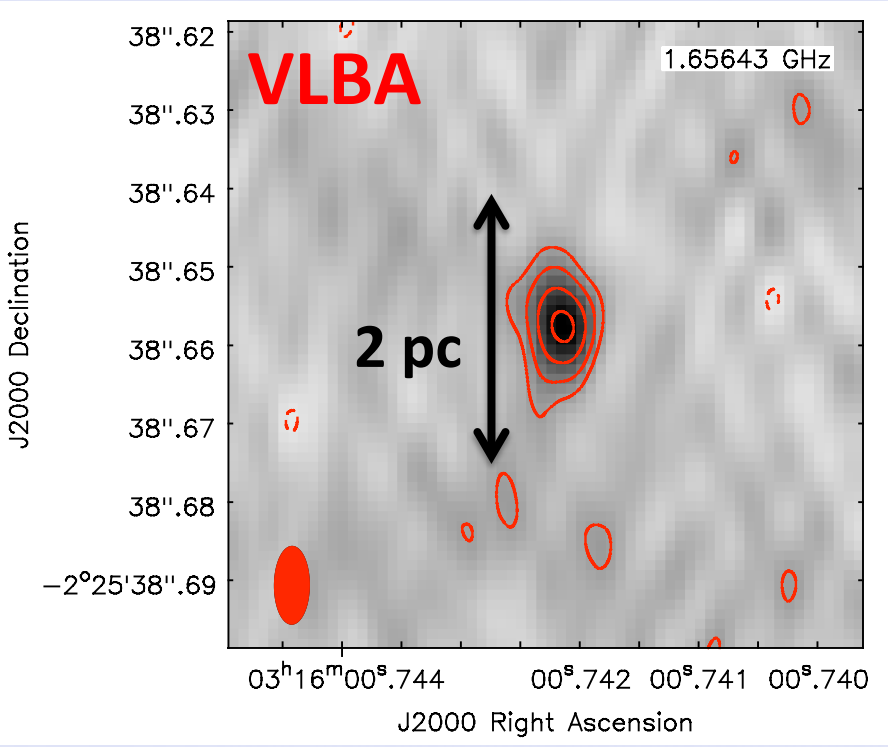
- **Brightness Temperature:**
  $T_b > 1.5 \times 10^7$ K



VLBA emission is most consistent with a low-level AGN origin

Missing VLA Flux Density?





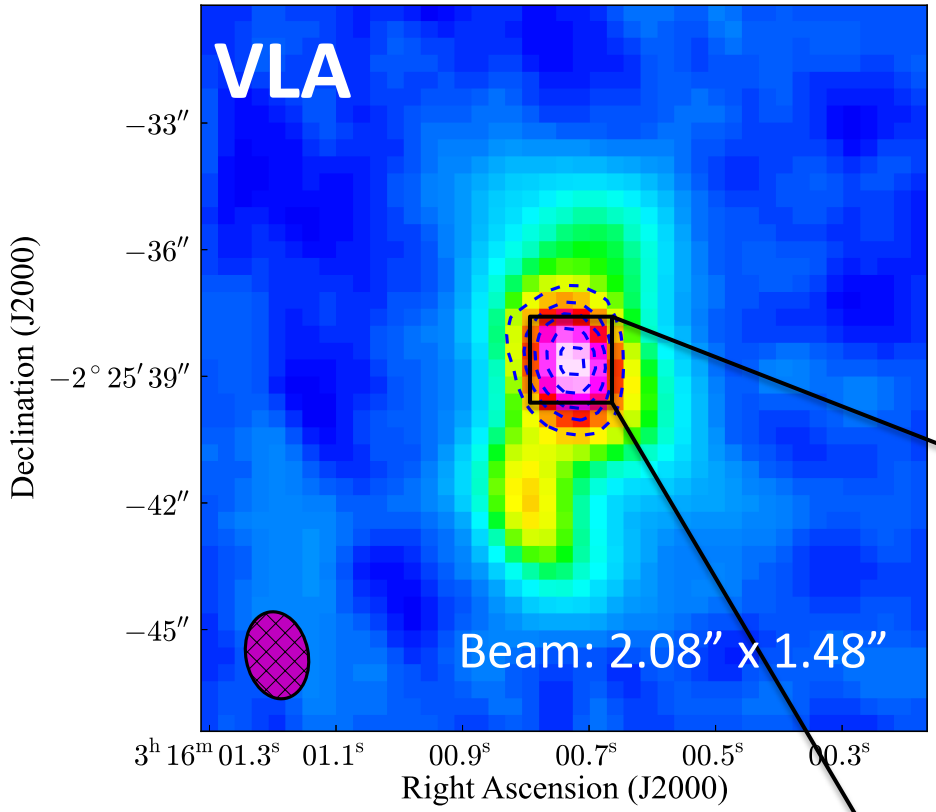
$S_{core} \approx 70.53$ mJy

$S_{total} \approx 1.38$ mJy

The VLBA recovered only ≈2% of the core VLA emission

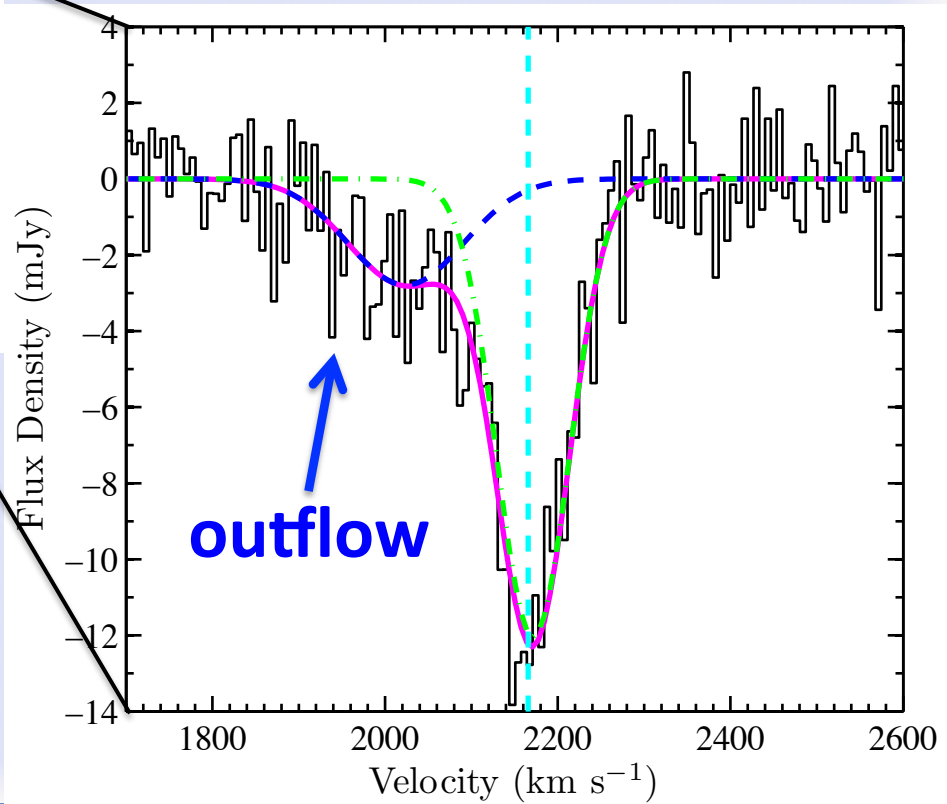
New VLA HI Observations

New HI Observations

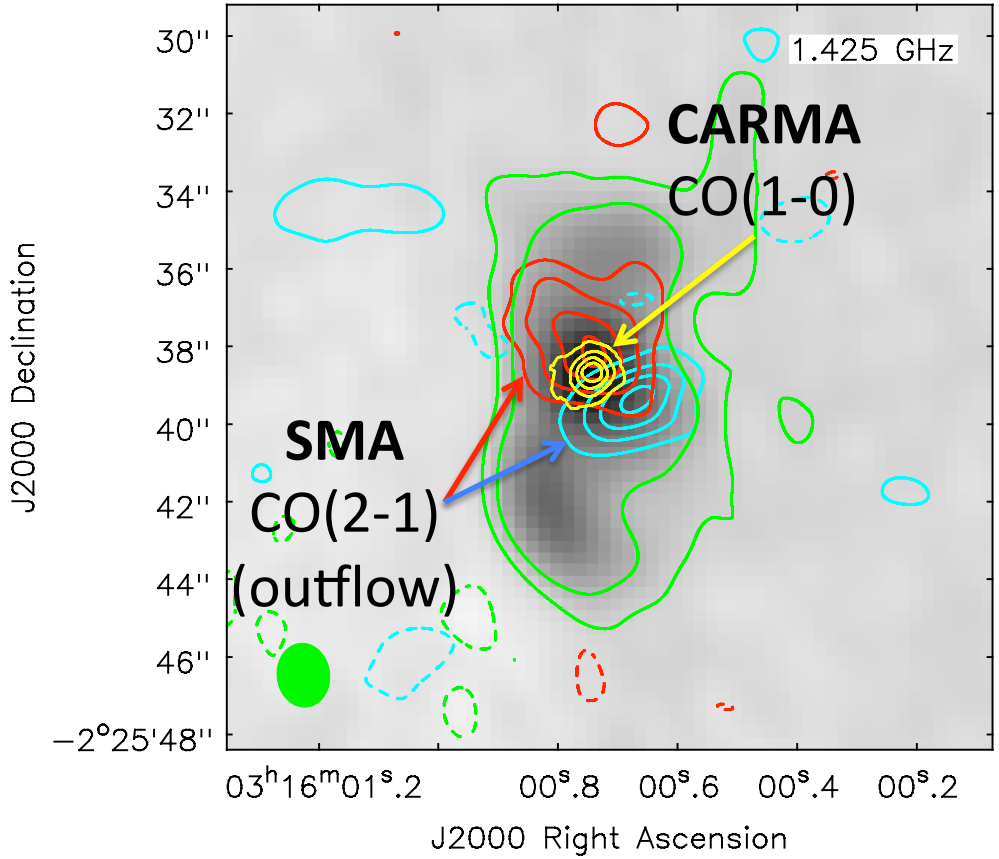


Nyland et al. 2013

HI detected in absorption only



Radio Jet-ISM Interaction?



Nyland et al. 2013

For gas entrainment by a radio jet:

The *energy* and *geometry* of the jet and gas should be similar

Radio Jet Entrained Gas - Energetics

$$U_{\rm min} = 0.5(aAL)^{4/7}V^{3/7}$$

- **Minimum Jet Energy:**
  U_{min} = 1.7 x 10^{54} erg

vs.

- **Molecular Outflow Kinetic Energy:**
  $K_{outflow}$ = 1.0 x 10^{55} erg

The radio jets *may* be able to entrain molecular gas in NGC 1266

Jet Mechanical Power (P_{jet})

Does the radio jet in NGC 1266 have enough mechanical power to drive the outflow?

- **Outflow mechanical luminosity**
  - $L_{mech} \approx 1.3 \times 10^{41}$ erg s^{-1}
- **Jet power estimates**
  - empirical relations from studies of radio jet-inflated X-ray cavities
  - $P_{jet} \approx 0.2\text{-}3.3 \times 10^{42}$ erg s^{-1}

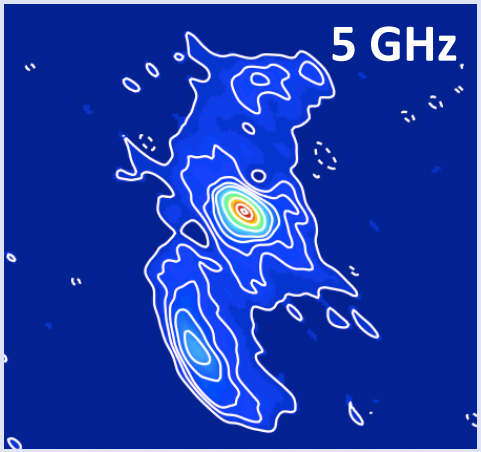
The radio jets *may* have enough mechanical power to drive the outflow

Future Work

- High Sensitivity Array imaging

+

- Deep VLA imaging + polarization and radio spectral analyses



- Low frequency radio imaging

Summary

Nyland et al. 2013, ApJ, 779, 173

- The VLBA detection of compact, central, high T_b emission strongly supports the presence of an AGN
- The origin of the remaining 98% of the kpc-scale VLA emission *not* detected by the VLBA remains unclear
- Jet-mechanical feedback may be powerful enough to drive the outflow

These findings suggest that even low-level AGNs may be able to launch massive outflows that can impact their host galaxies