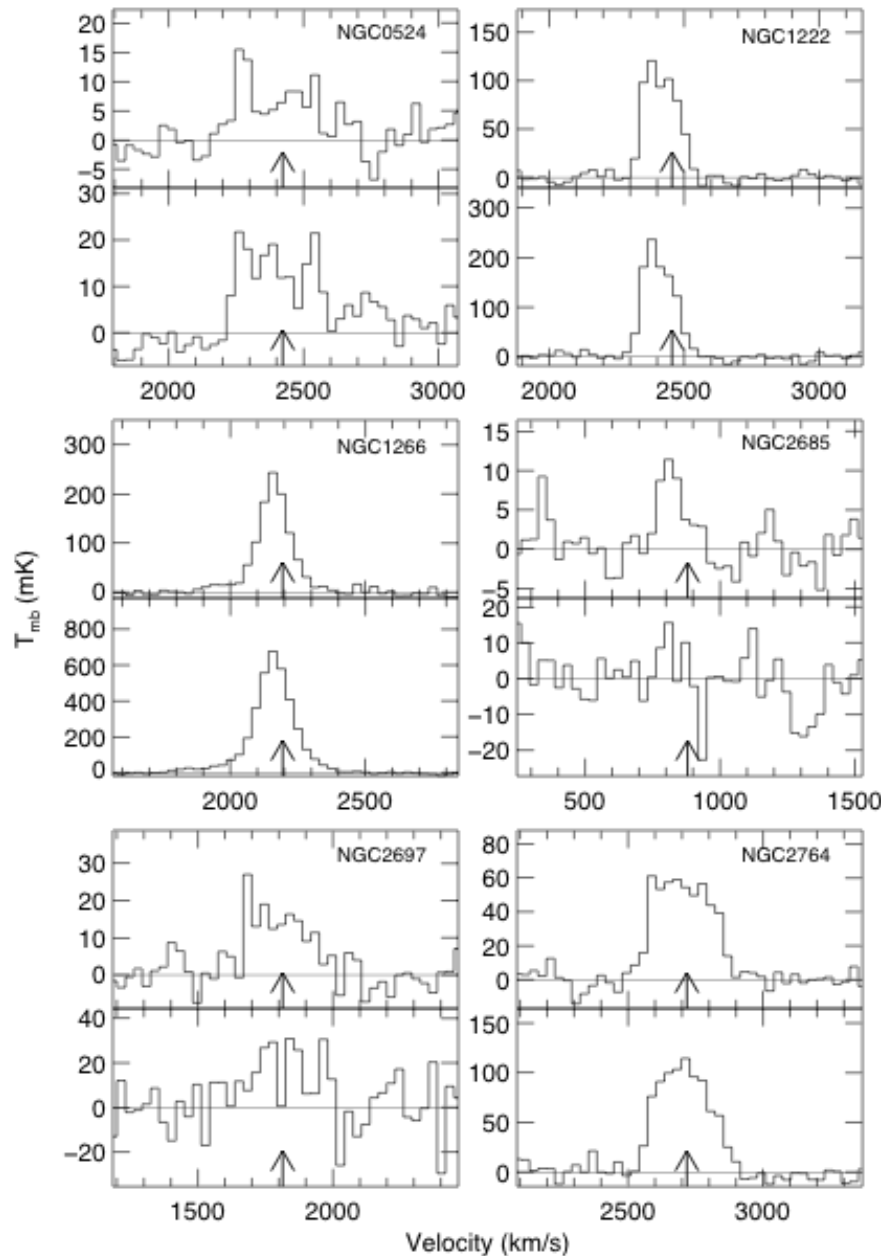


# Molecular Feedback from the Mysterious Galaxy NGC 1266

Katey Alatalo, Leo Blitz & the Atlas<sup>3D</sup> team

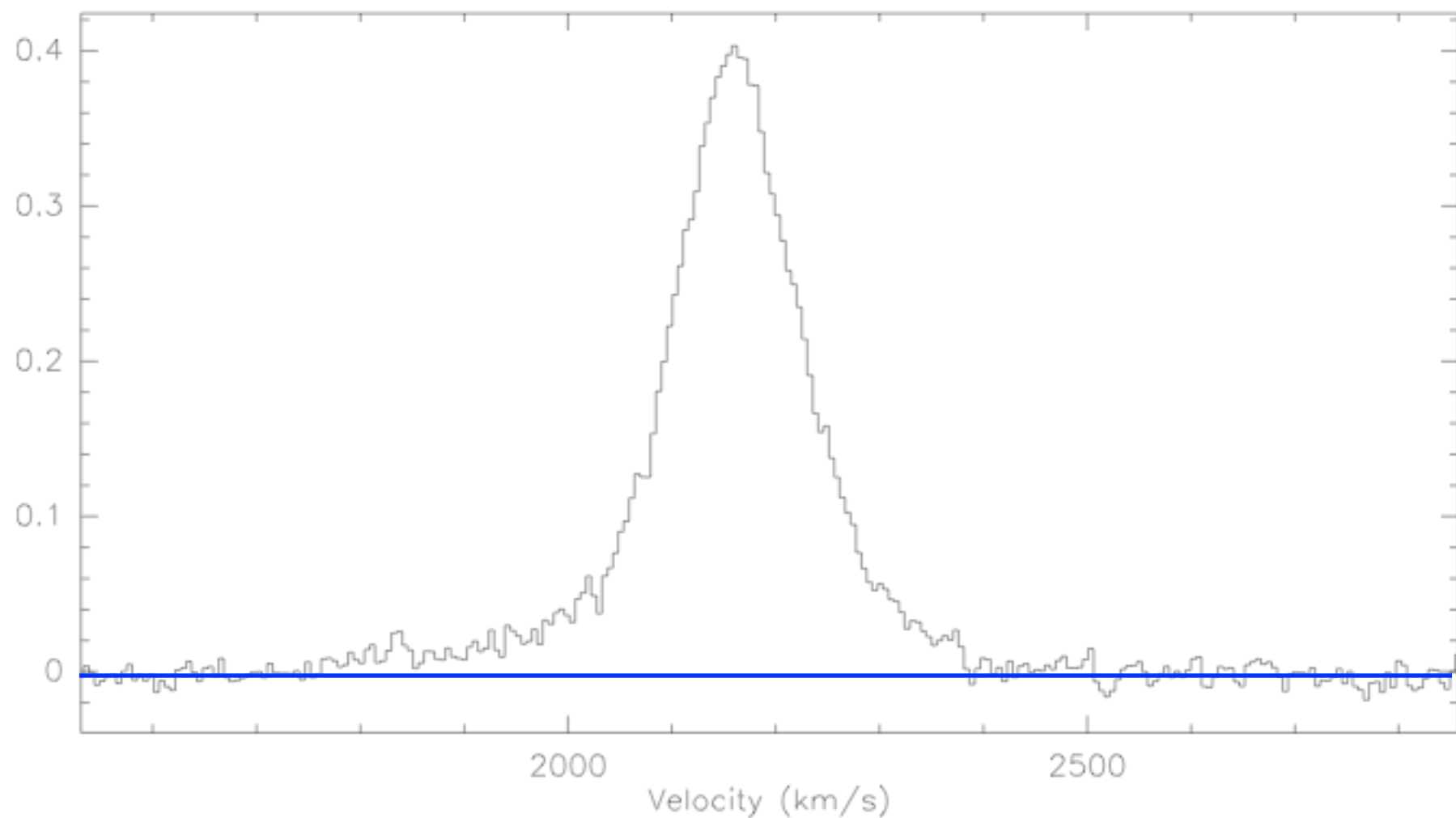
# E and S0 galaxies

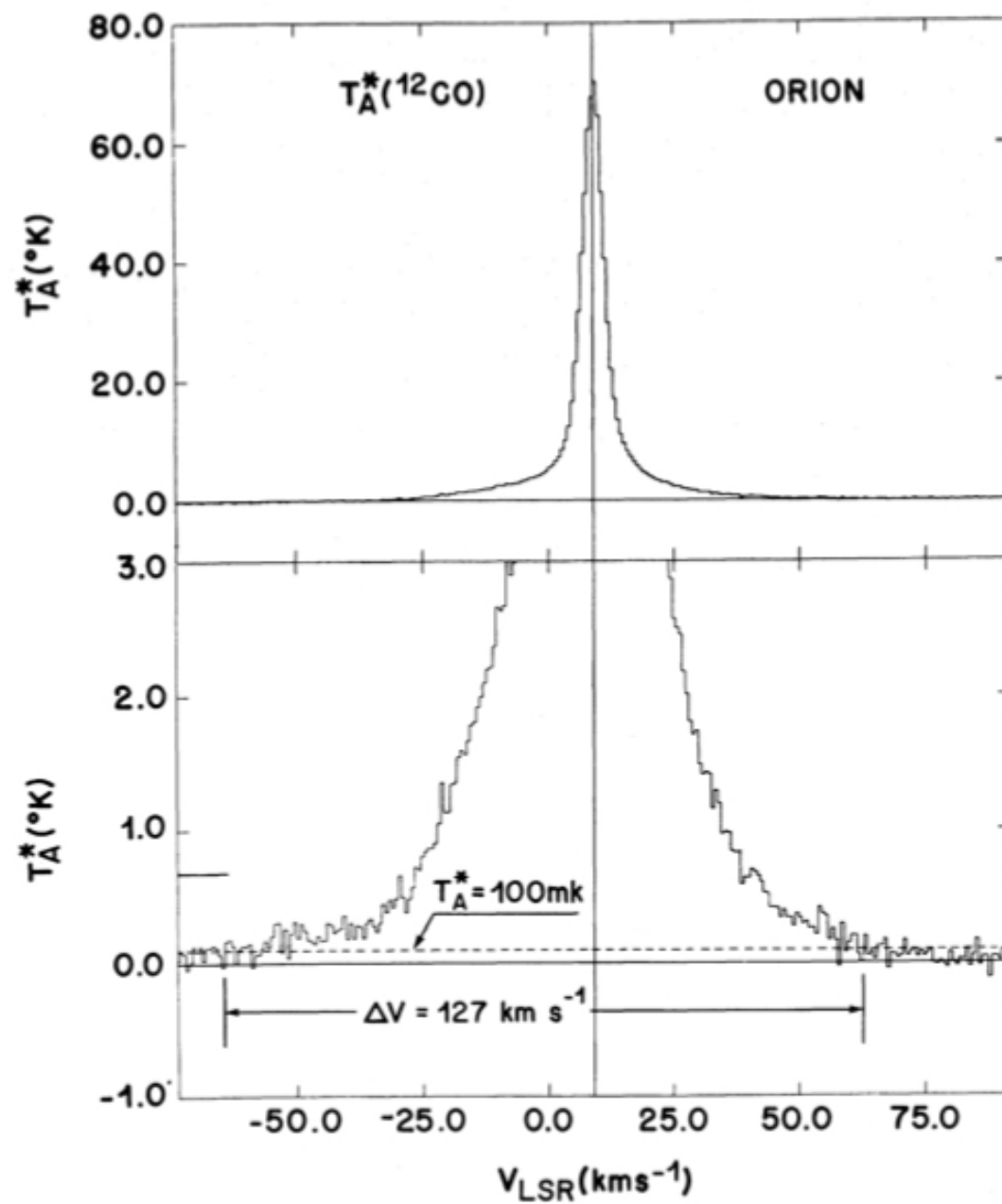
23% of E and S0 galaxies have detectable CO !



Young et al. (2011)

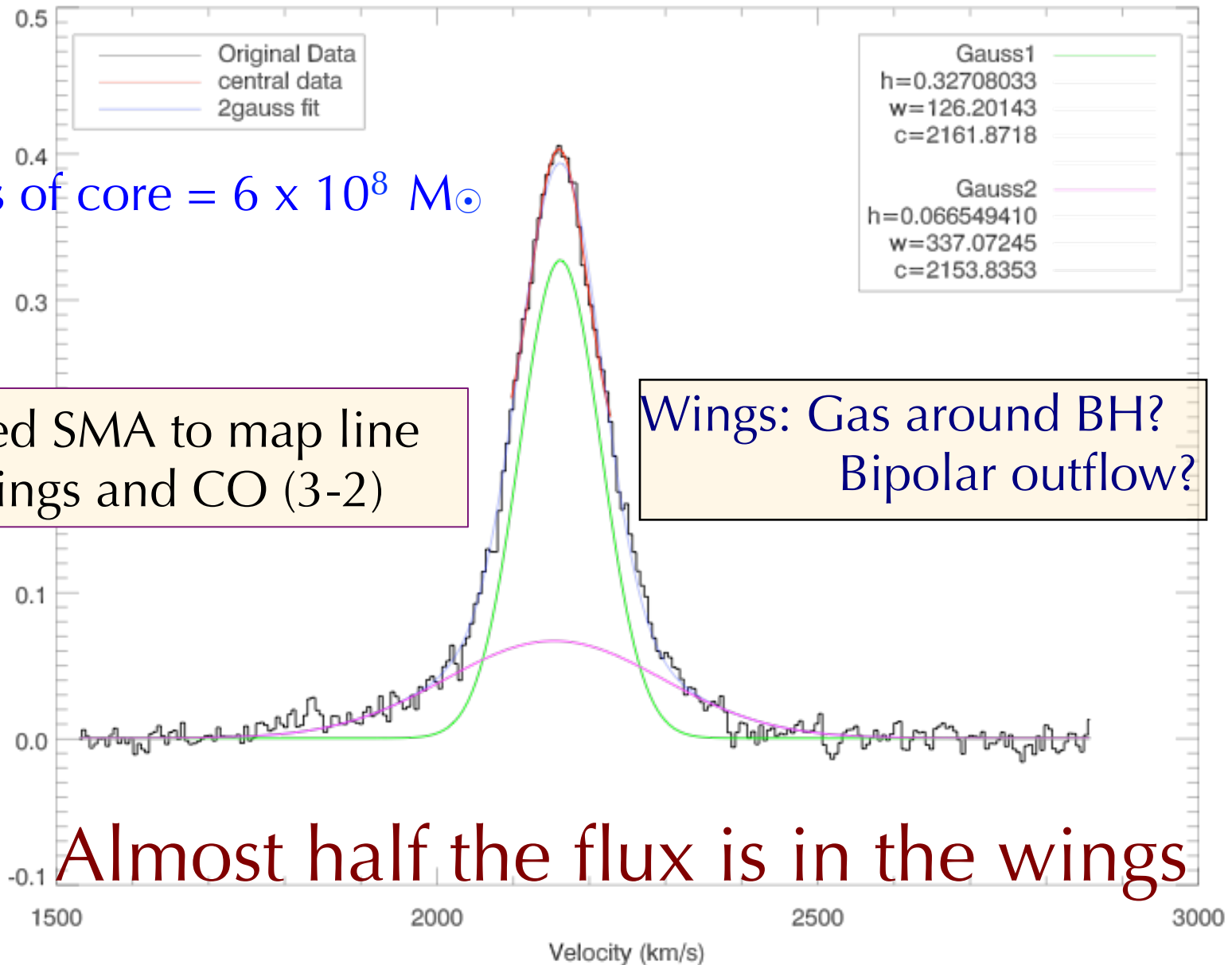
03:16:00.750 -02:25:38.50 Eq 2000.0 Offs: +0.0 +0.0  
Unknown tau: 0.200 Tsys: 358. Time: 22. min El: 46.8  
N: 256 I0: 128.5 V0: 2.194E+03 Dv: -5.20 Hel.  
F0: 230537.990 Df: 4.000 Fi: 238484.087



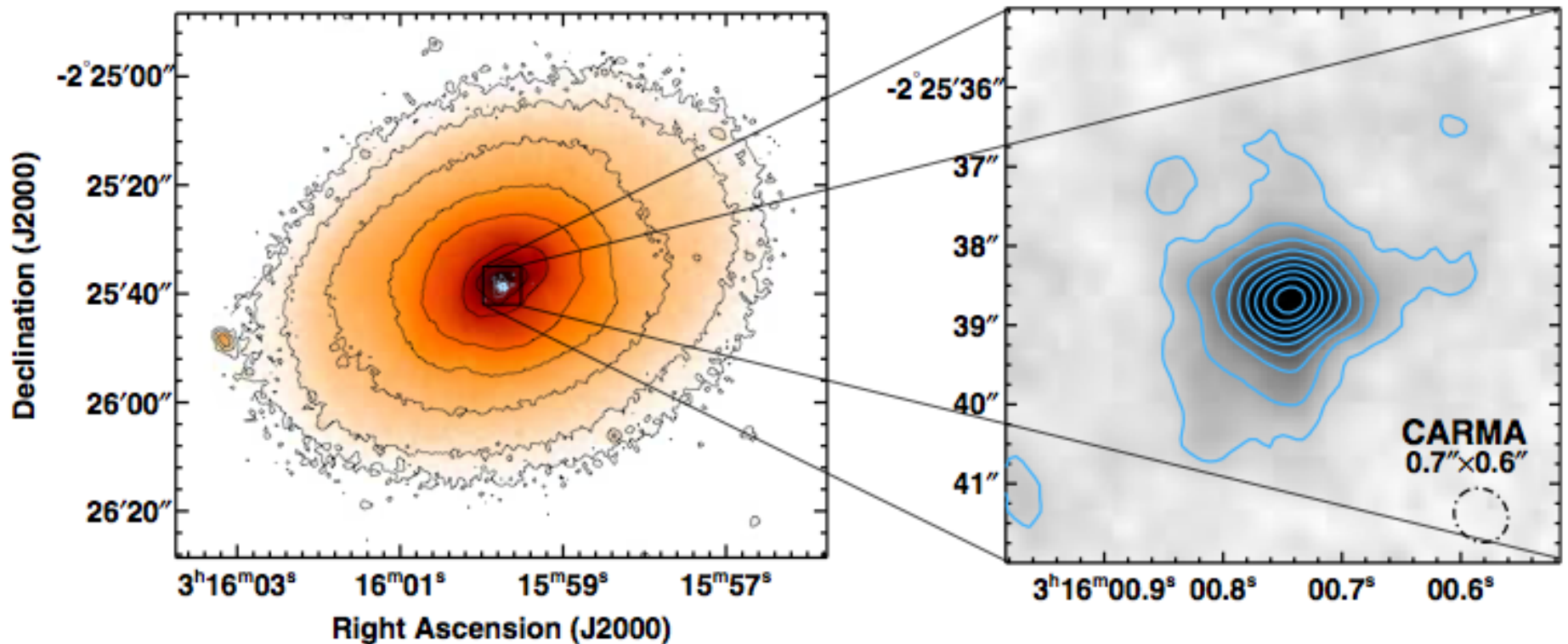


Bally & Lada 1983

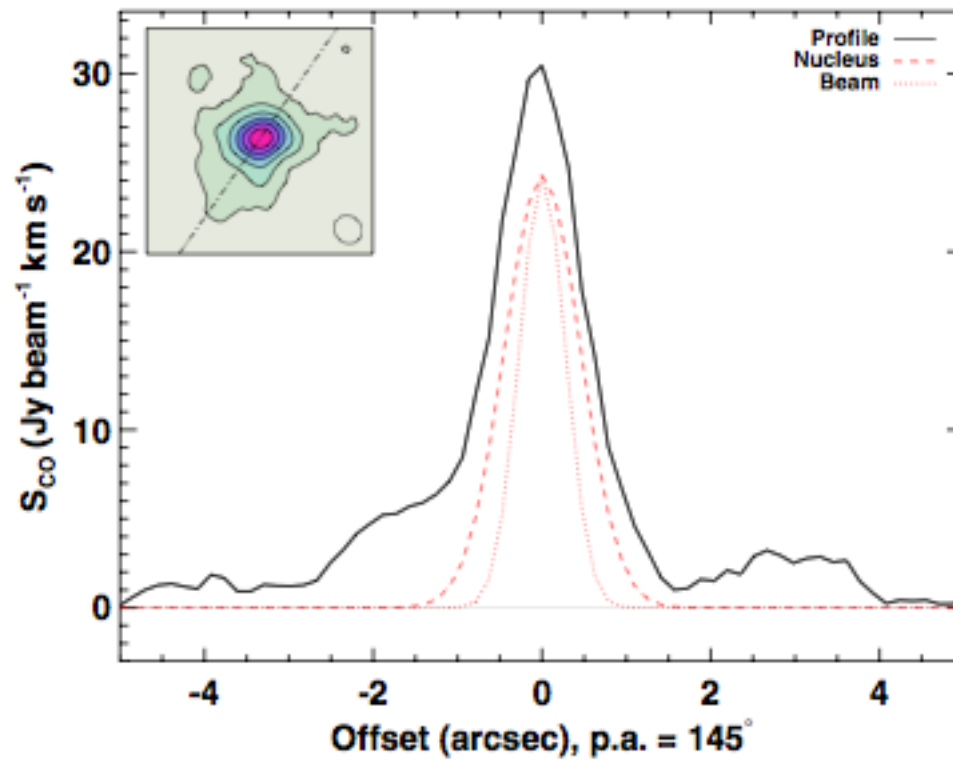
NGC1266 CO(2-1) Spectrum from IRAM



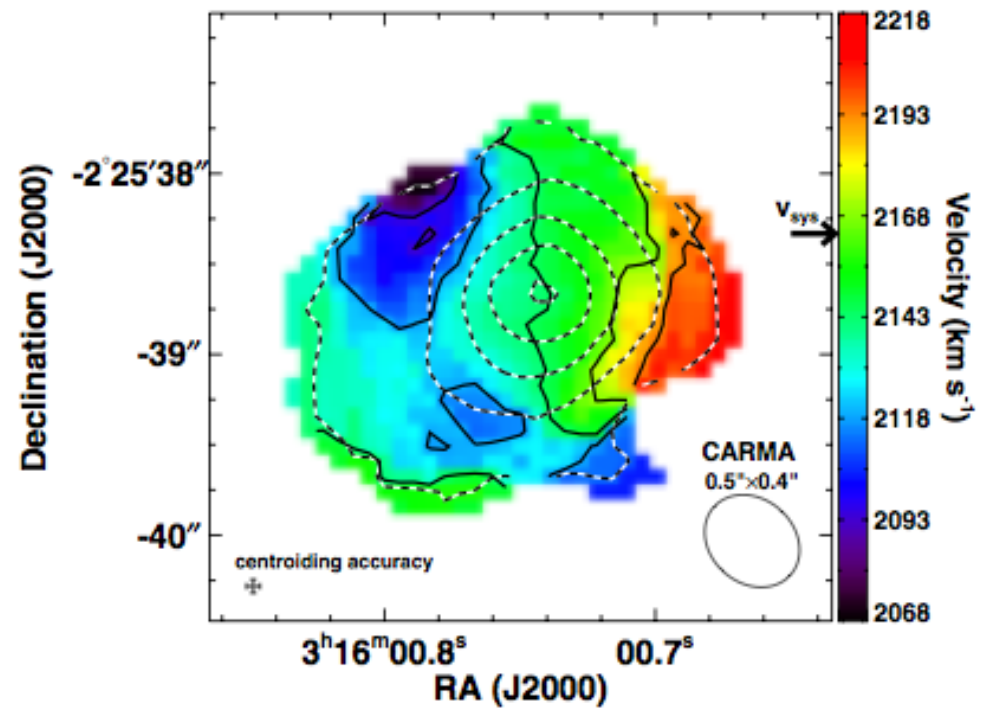
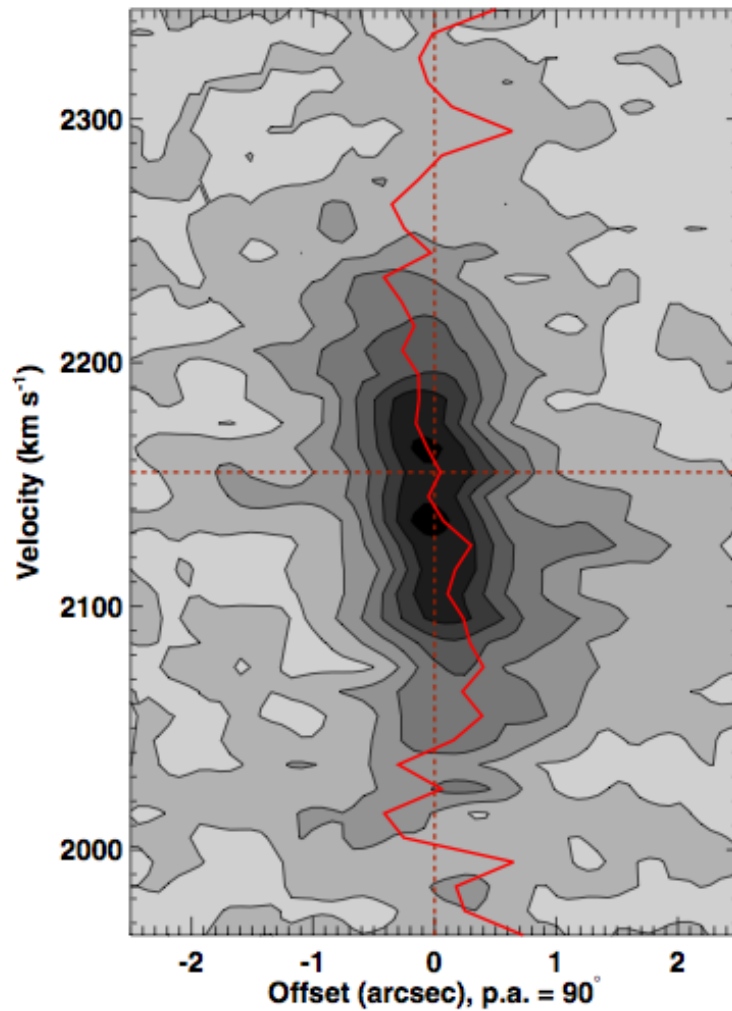
How did all of that gas fall into such a small volume at the center?



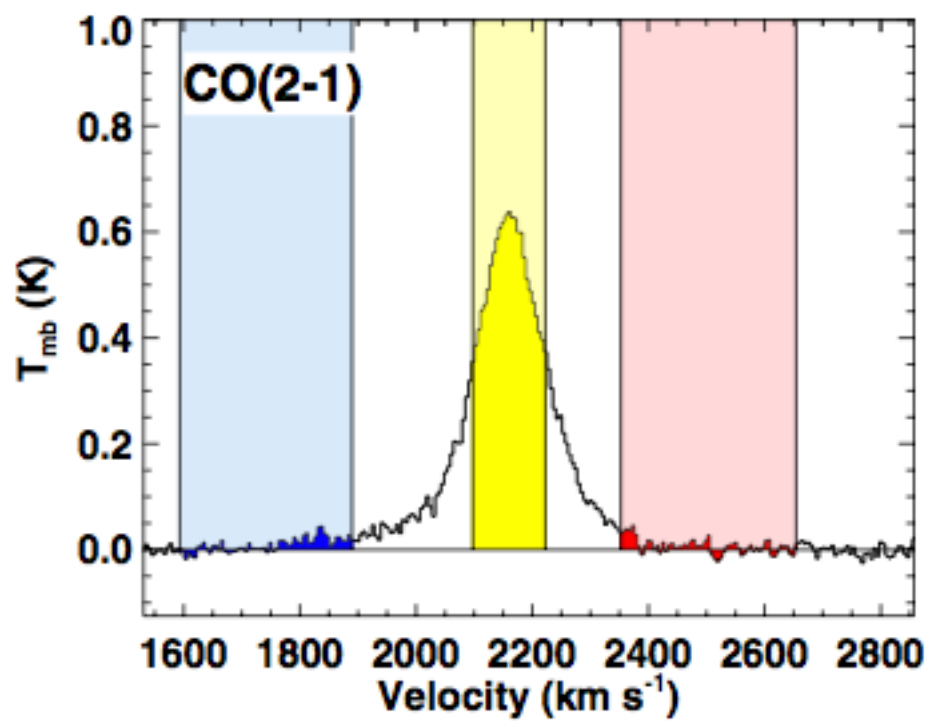
# Spatial Distribution of Gas in the Core of the Line



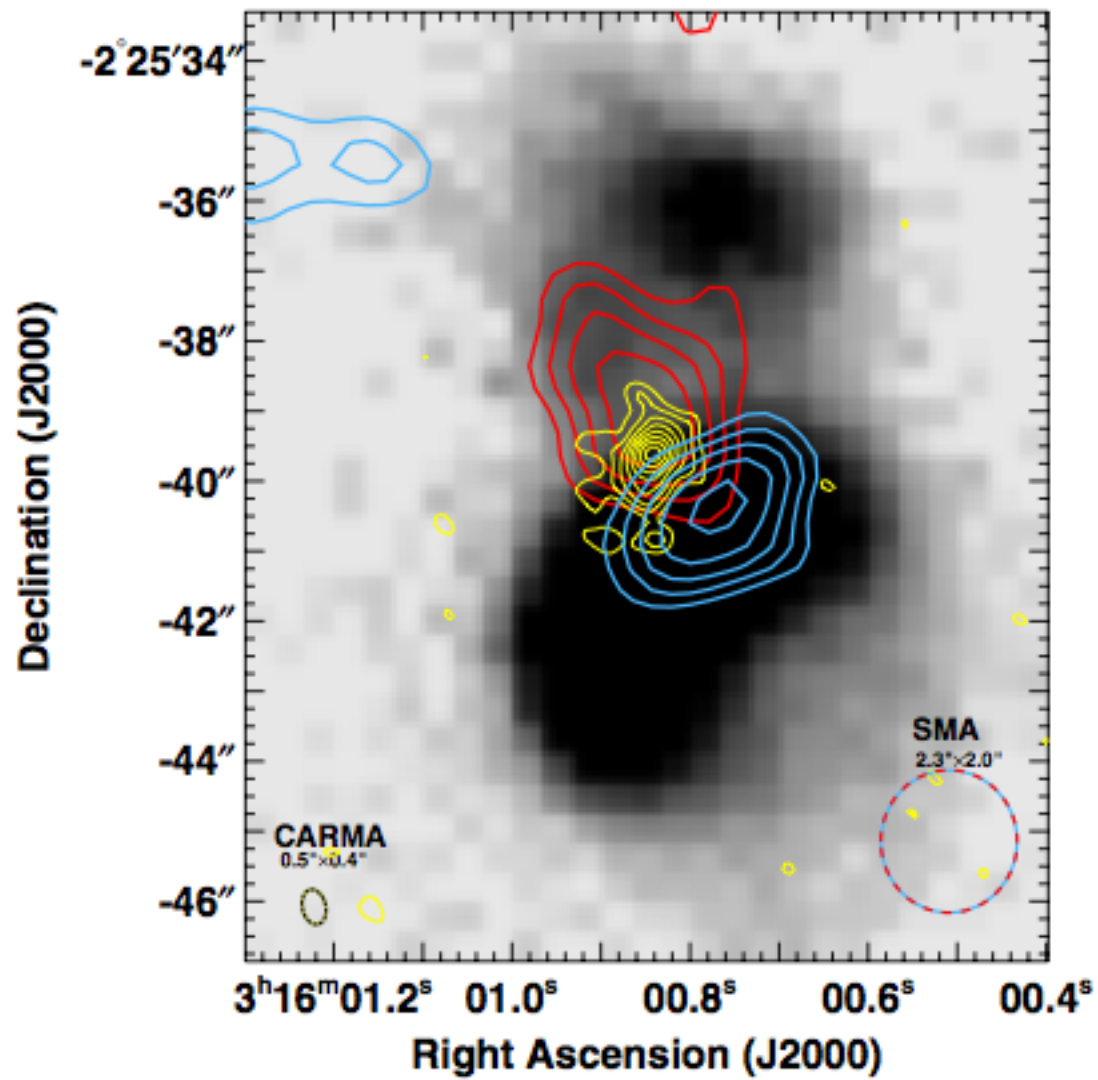
# Rotation of the Nucleus



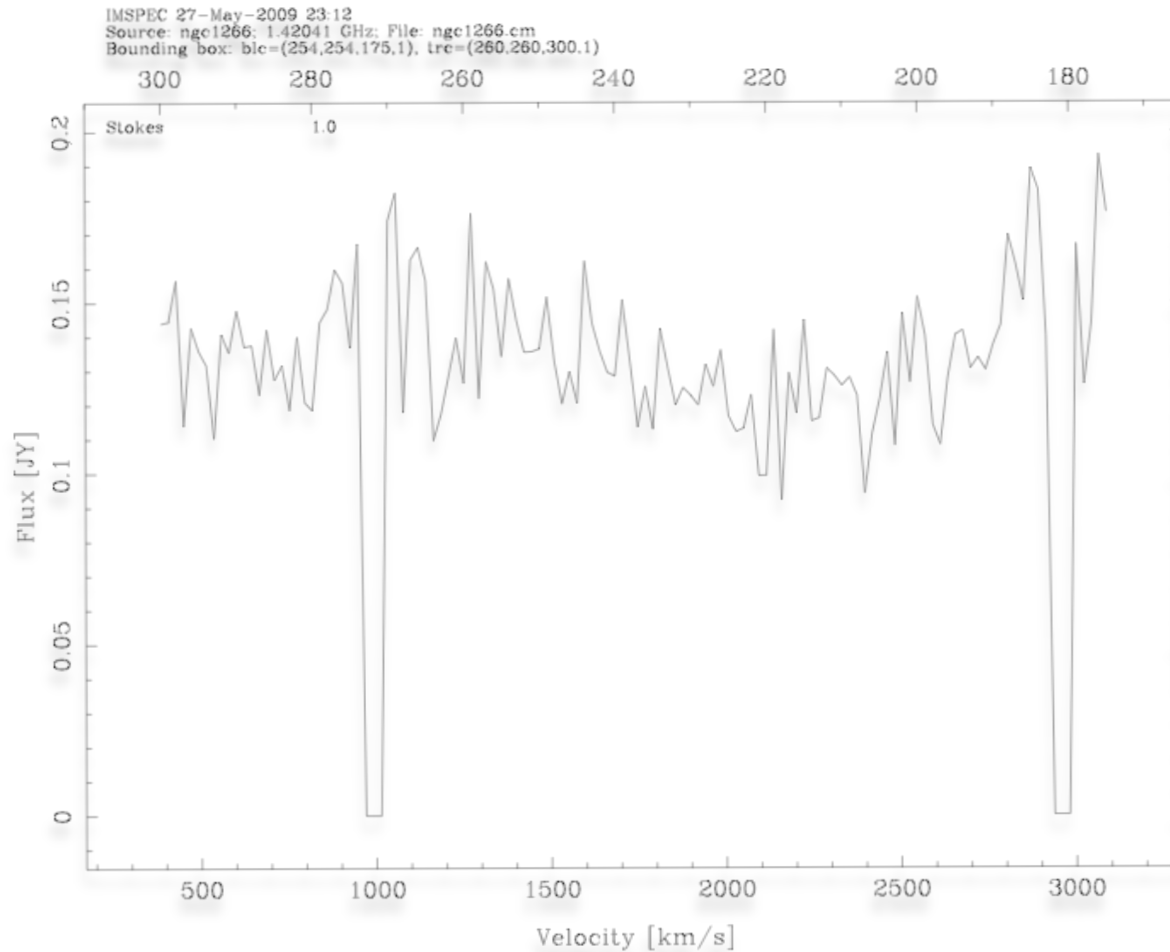




# CO on H $\alpha$

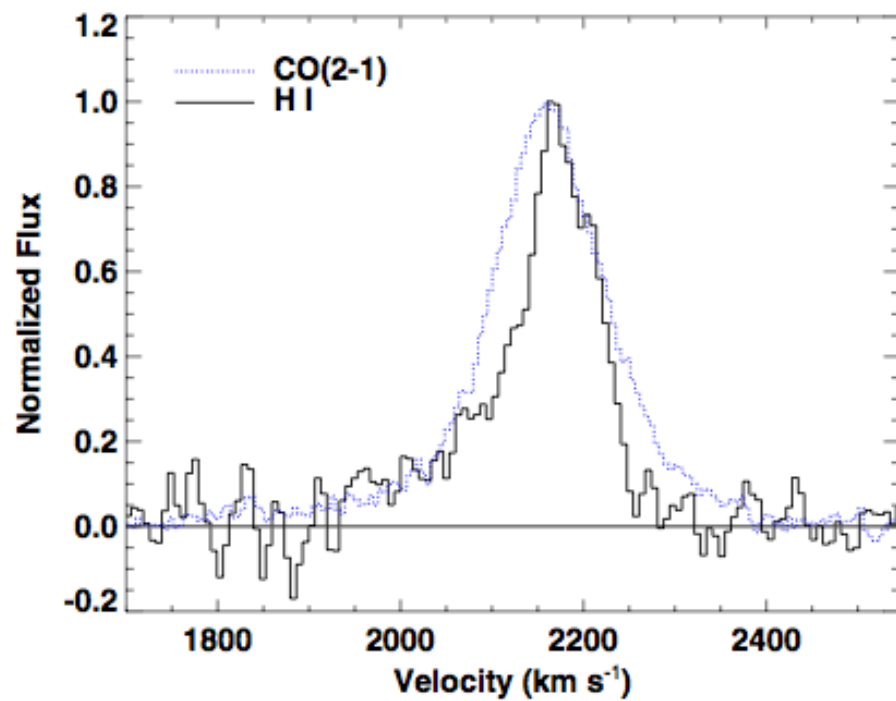
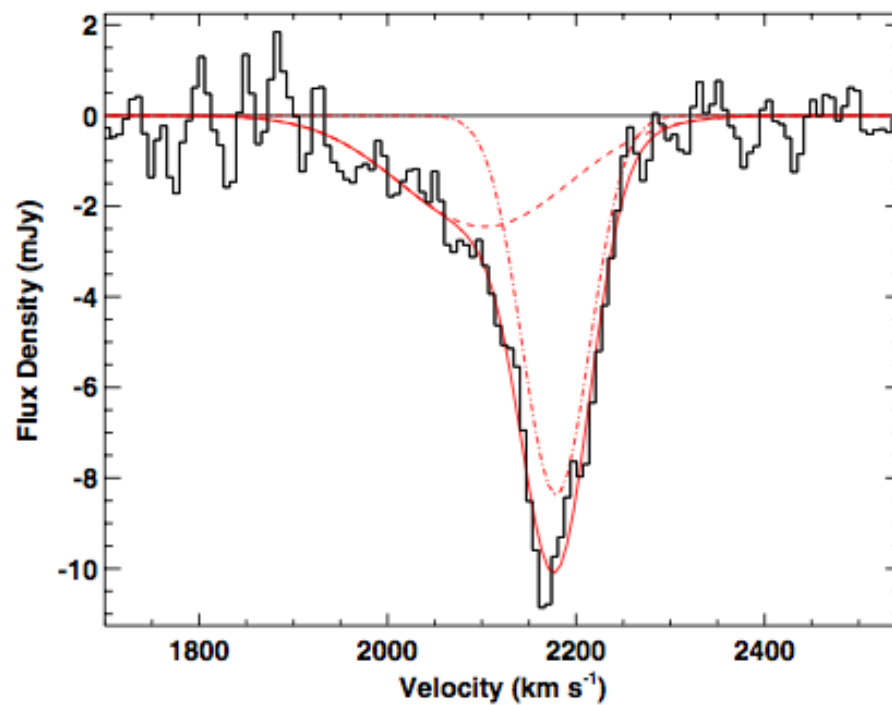


# What About HI?

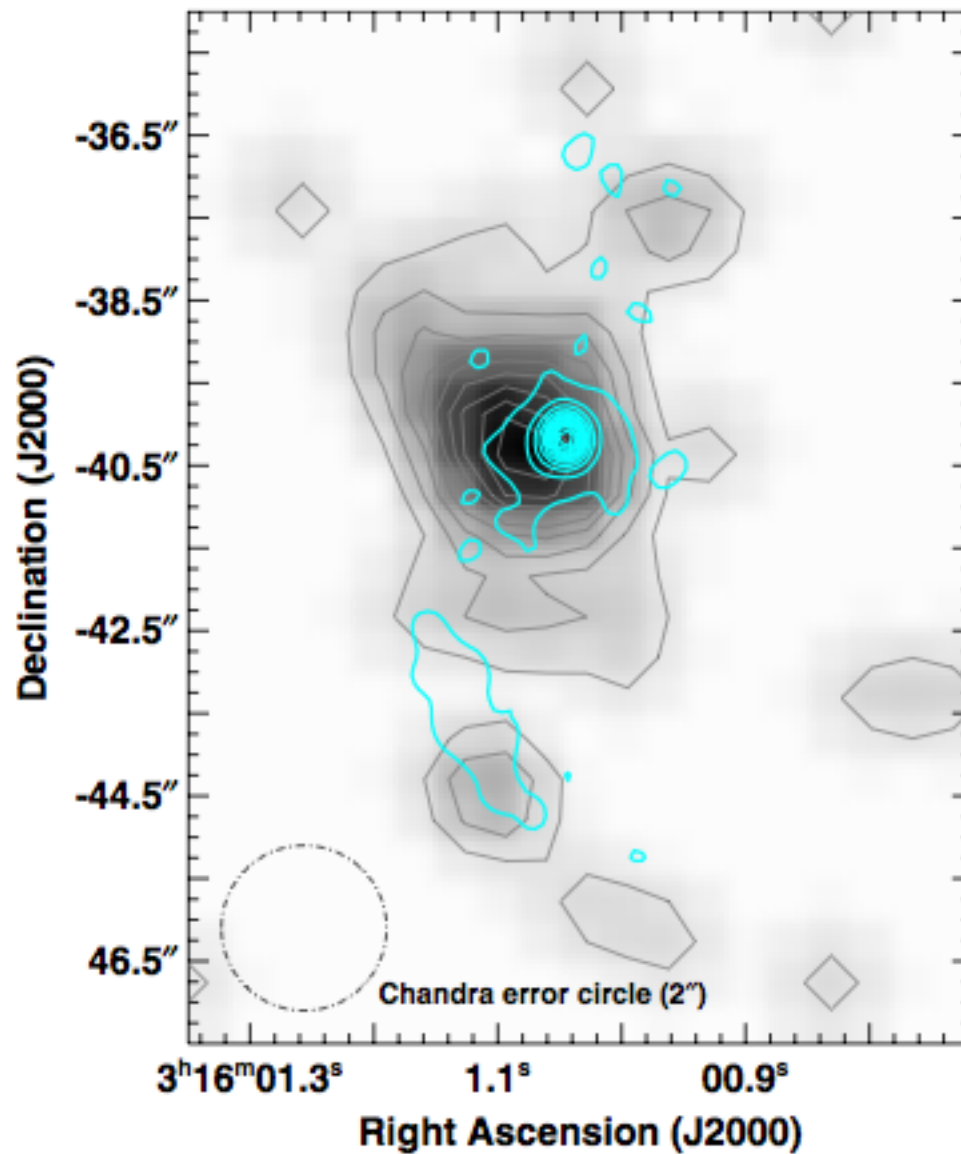


$$M(\text{HI}) < 3 \times 10^7 M_{\odot} \quad 3s$$

$$M(\text{H}_2)/M(\text{HI}) > 20$$



# Chandra 4-8 keV on 5 GHz



# Molecular Detections to Date

## CARMA

CO (1-0)

$^{13}\text{CO}$  (1-0)

HCN

CS

SiO

HNC

## SMA

CO (3-2)

CO (2-1)

$^{13}\text{CO}$  (2-1)

$\text{HCO}^+$  (3-2)<sub>cc</sub>

## Herschel + other

CO (1-0) to (13-12)

$\text{H}_2$

$\text{H}_2\text{O}$

[C I], [C II], O [I], [N II]

## Resolution

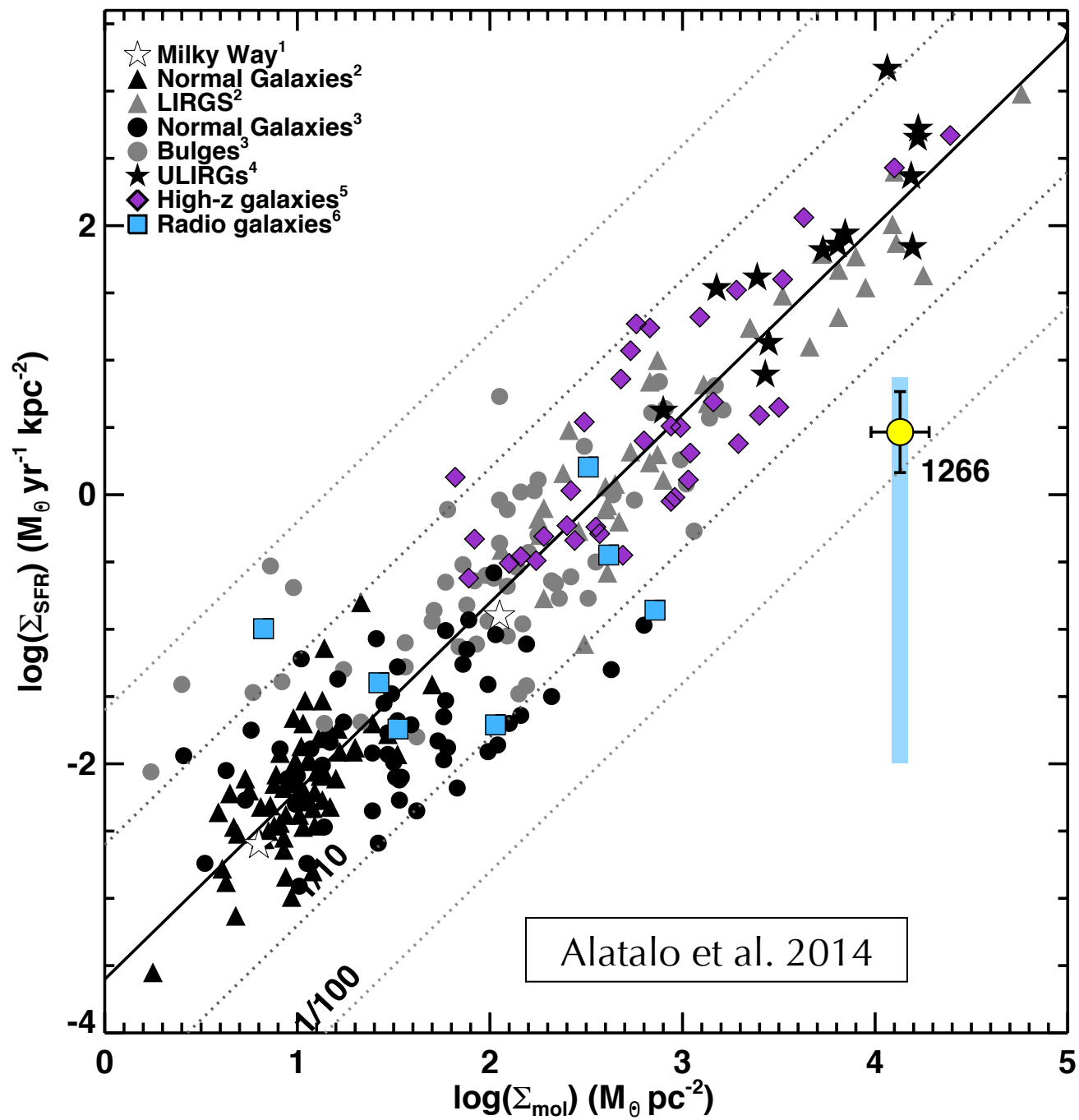
5'' - 0.3''

750 pc - 50 pc

## Some Numbers

Mass of Nucleus	$\sim 3 \times 10^8 M_{\odot}$
Radius of Nucleus	$\sim 60 \text{ pc}$
Surface Density of Nucleus	$\sim 2.7 \times 10^4 M_{\odot} \text{ pc}^{-2}$
Compare to MW GMC	$\sim 100 M_{\odot} \text{ pc}^{-2}$
Outflow dynamical time	$\sim 1.5 \times 10^6 \text{ y}$
Outflow total lifetime	$\sim 0.3 - 3 \times 10^7 \text{ y}$
Outflow energy	$\sim 3 \times 10^{55-56} \text{ ergs}$
SN equivalent	$\sim 3 \times 10^{4-5}$
Velocity of outflow	$\sim 400 \text{ km s}^{-1}$

At least some  $\text{H}_2$  escapes NGC 1266





# Summary

Stunning example of extragalactic *molecular* outflow from nucleus; only a few other known examples (Mk231; NGC1068).

Like a protostellar disk and outflow on steroids.

Driver of molecular gas and star formation  
Not known.

# Questions

- How did a Milky Way's worth of molecular gas fall into such a small region in the nucleus of NGC 1266?
- Why does this galaxy look so much like a protostellar disk and outflow?
- Could this be how E, SO galaxies get rid of their gas?
- Could this be a major source of feedback for galaxy evolution?