A Mid-Infrared Spectroscopic Study of Submillimeter Galaxies: Luminous Starbursts at High Redshift

Valiante et al. 2007, ApJ, 660, 1060

Chelsea Sharon

Ph 689: 10/22/2009

Outline

- History
- Characterization of SMGs
  - Specifically, this paper
- The Big Picture
  - Local Analogues

SMGs = Submillimeter Galaxies

Submillimeter Galaxies: History

- FIR/submm background first resolved with SCUBA (JCMT) and MAMBO (IRAM 30m)
- Small instrument bandwidth required accurate redshifts for follow-up observations
- Expensive to obtain redshifts
  - Radio Counterpart
  - Optical Spectroscopy
  - CO line detection

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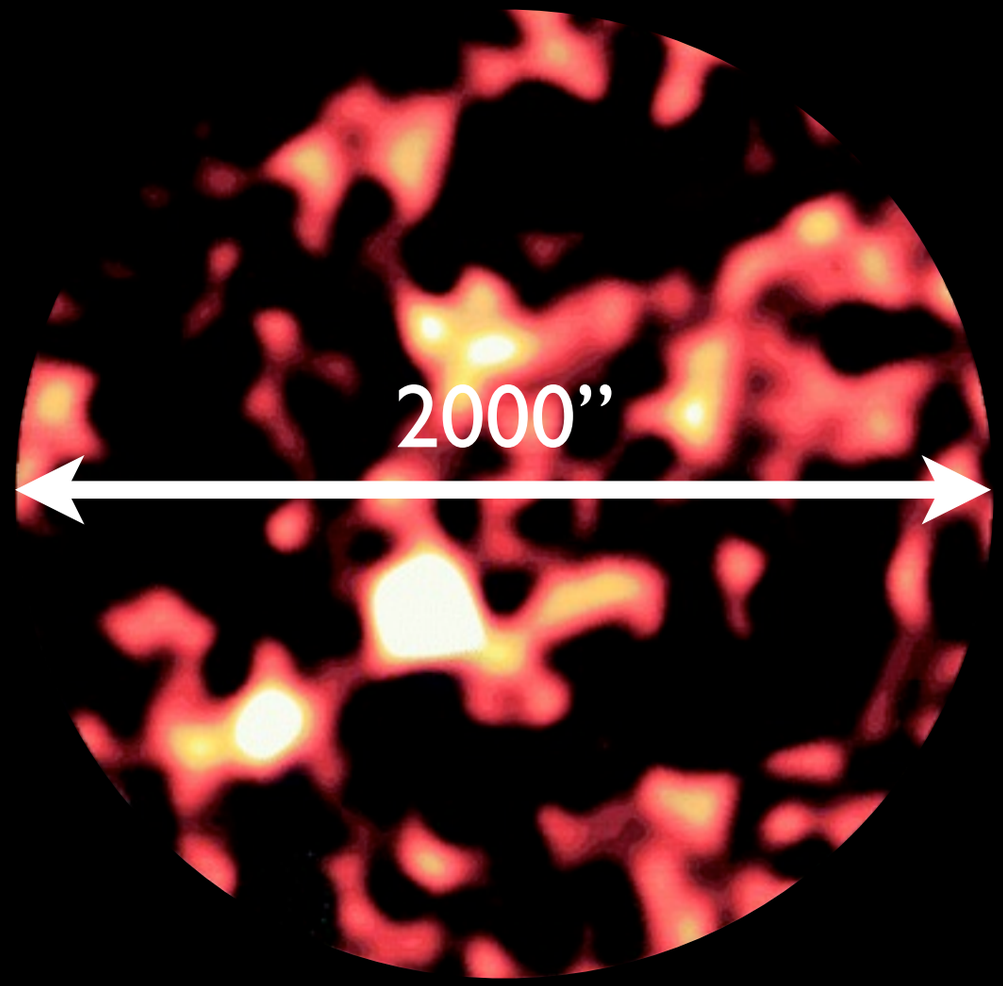

Hughes et al. 1998

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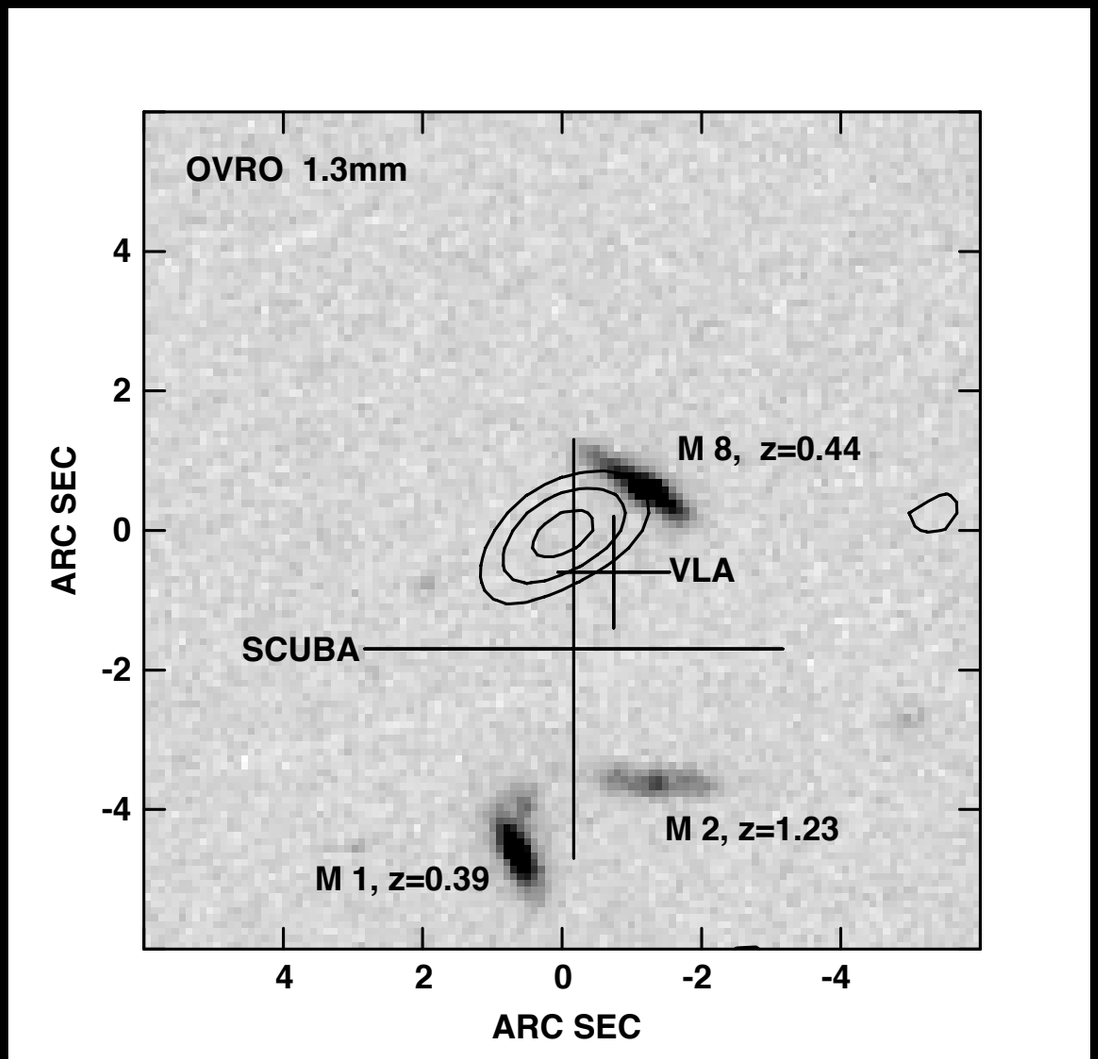
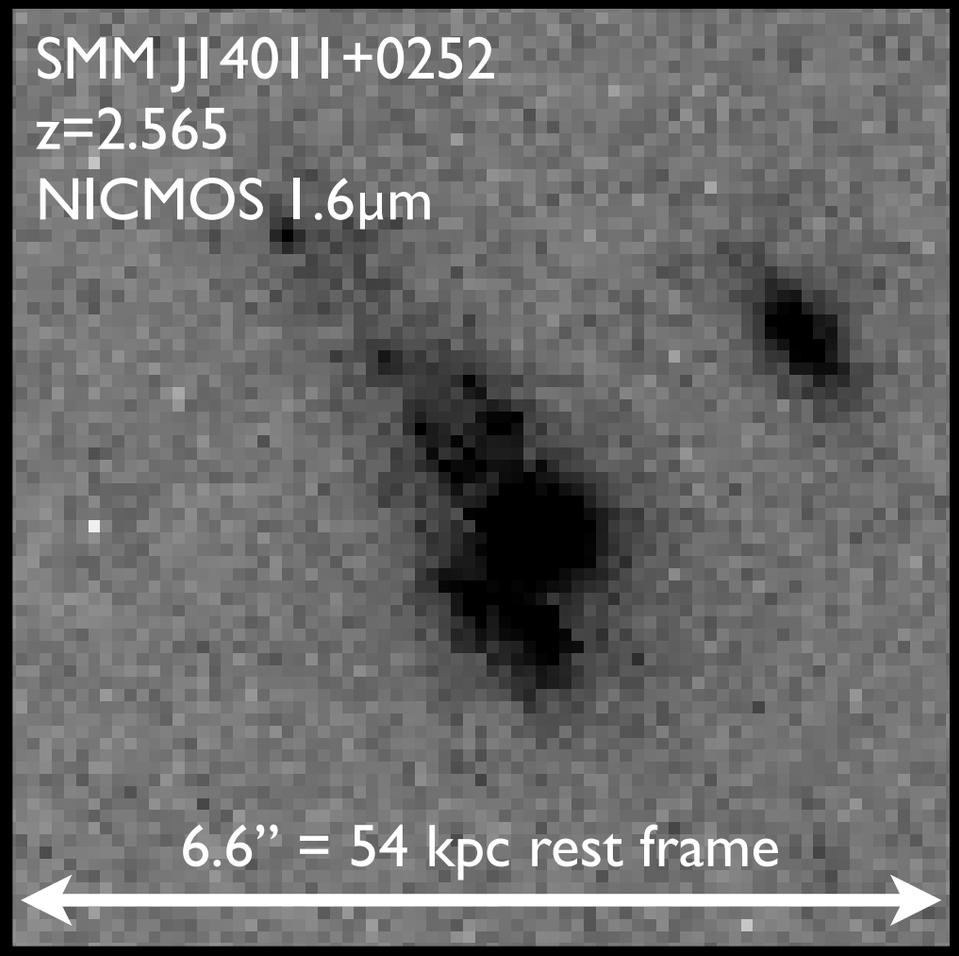


Frayer et al. 2000

Characteristics of SMGs: Morphology and Distribution

- Morphology: disturbed and compact
- Redshift distribution
  - Ranges from 2-3
  - Chapman et al. (optical) peaks at z=2.3
  - Valiante et al. (7.7 μm) peaks at z=2.8
- Spatial distribution?



Baker et al. (in prep)

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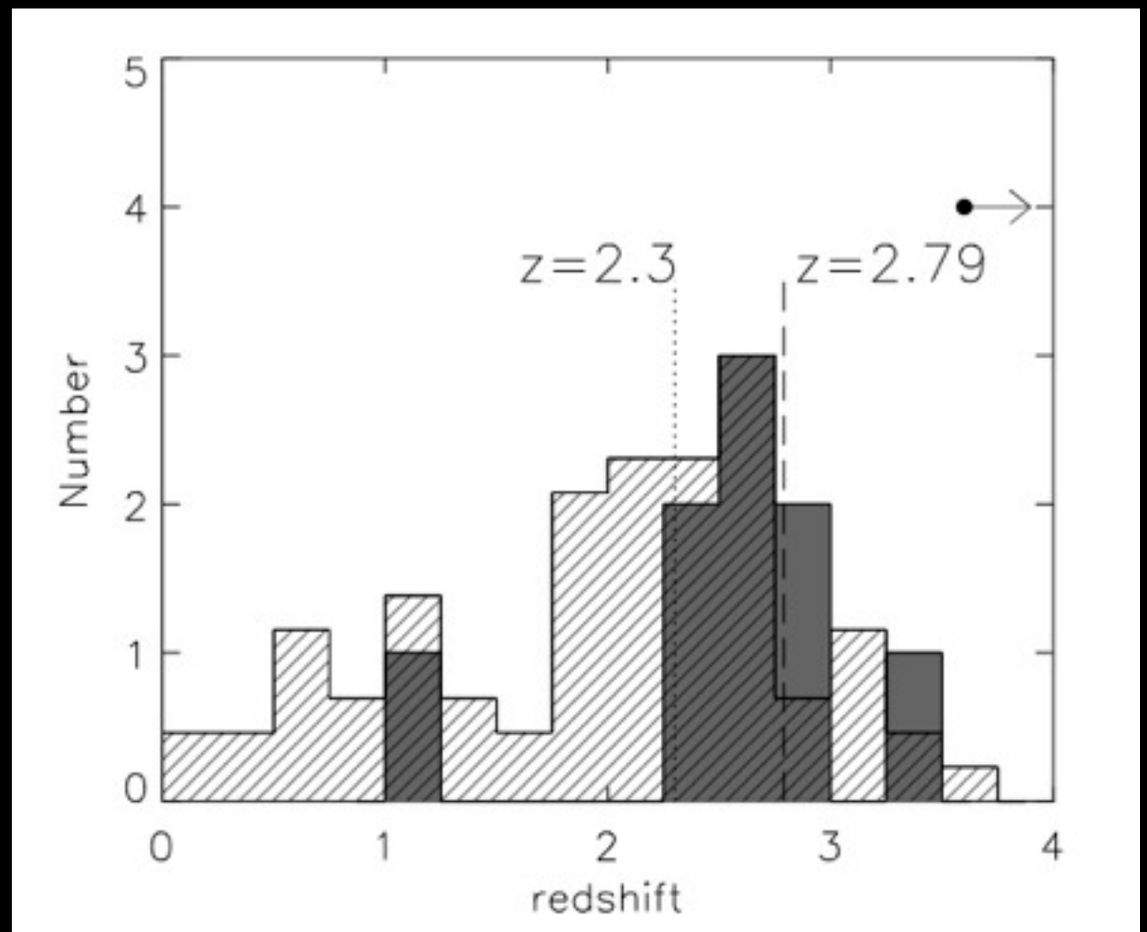
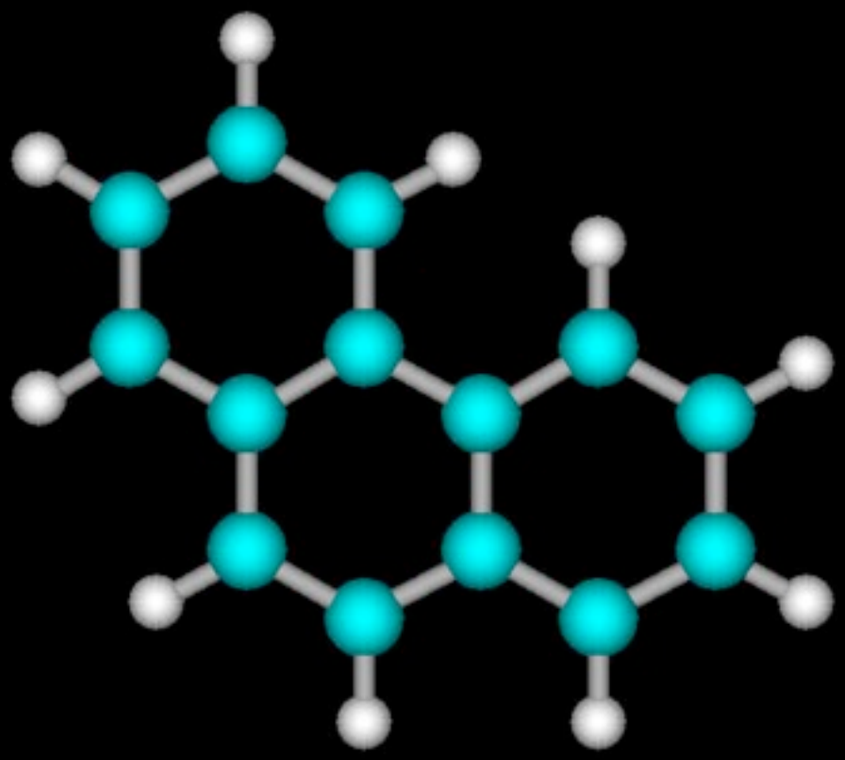


Characteristics of SMGs: Emission

	X-ray	Optical	mid-IR	Submm	Radio
Rest-frame	Harder X-ray	UV	near-IR	far-IR	High-frequency radio
Source	AGN	Young, massive stars	PAH signatures	Thermal dust emission	Synchrotron from SNR
Amount	~10% of sources	~80% of radio sources	~70% of sources (Valiante et al.)	10^4 L_{MW}	~2/3 of sources
Tells us...	Few or highly-obscured AGN	Recent star formation	Warm dust, star-burst dominated (not AGN)	Dusty, gas ~40% M_b, high SFR	???

Characteristics of SMGs: Emission



mid-IR
near-IR
PAH signatures
~70% of sources (Valiante et al.)
Warm dust, star-burst dominated (not AGN)

PAH = Polycyclic Aromatic Hydrocarbon

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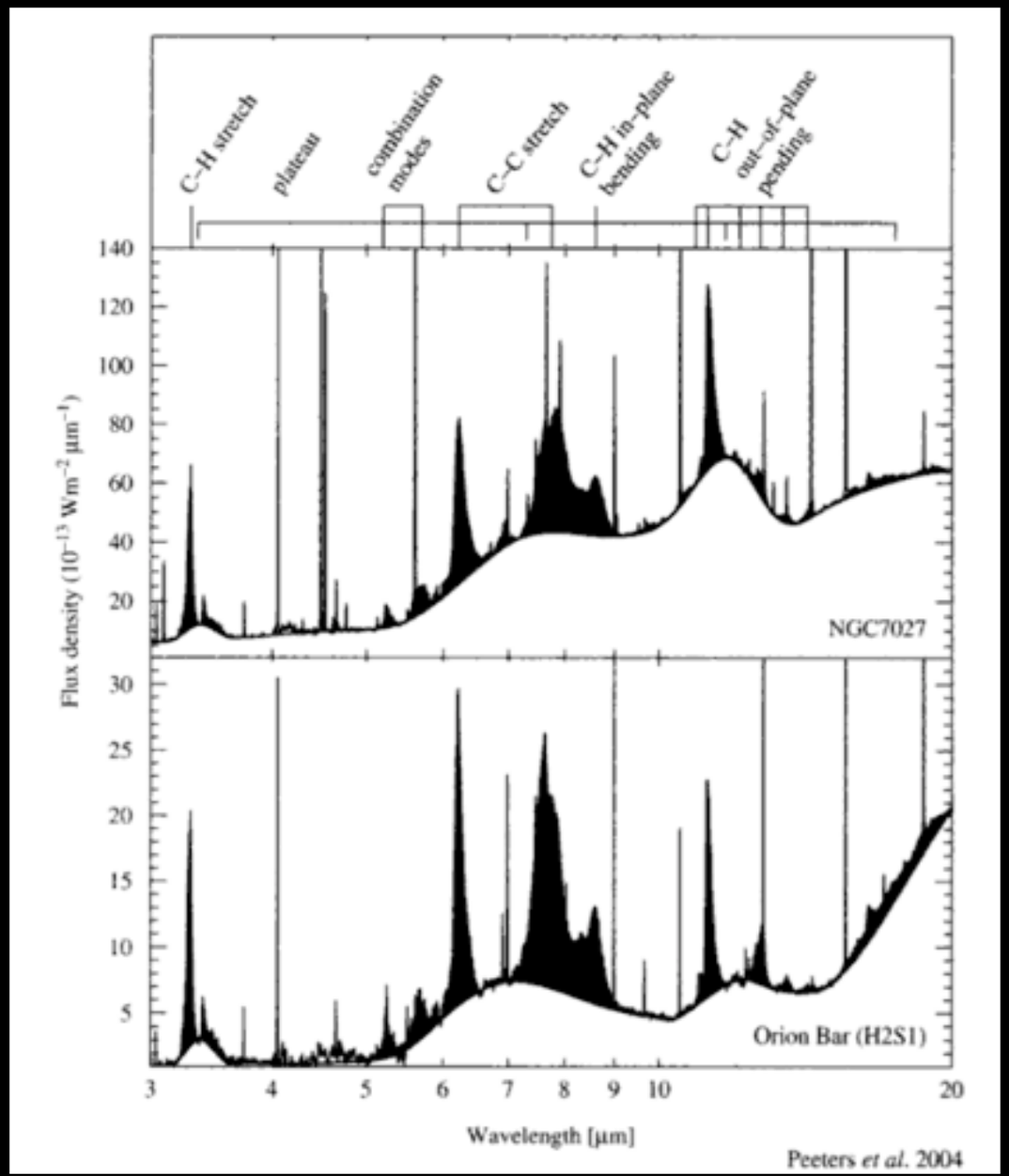

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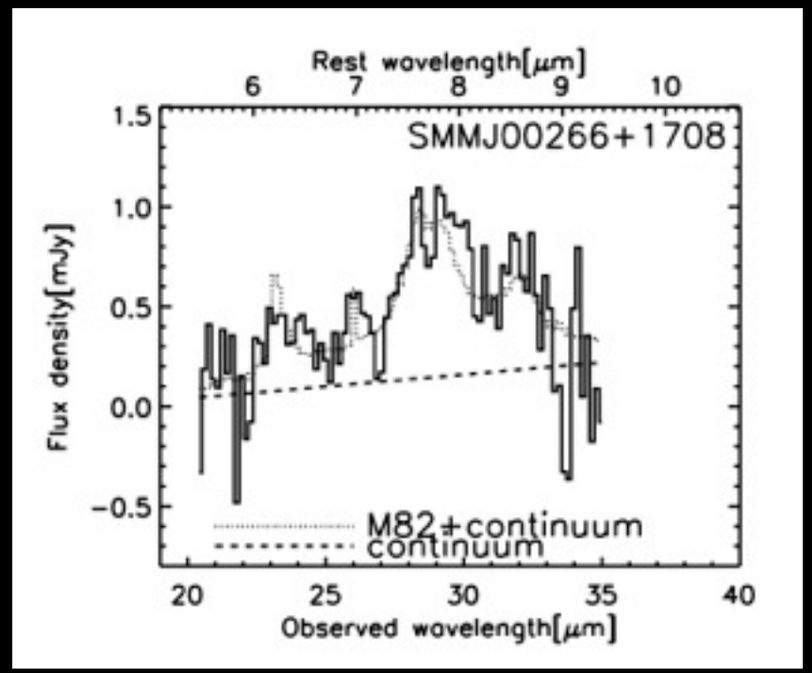


Characteristics of SMGs: Emission

CO Lines!

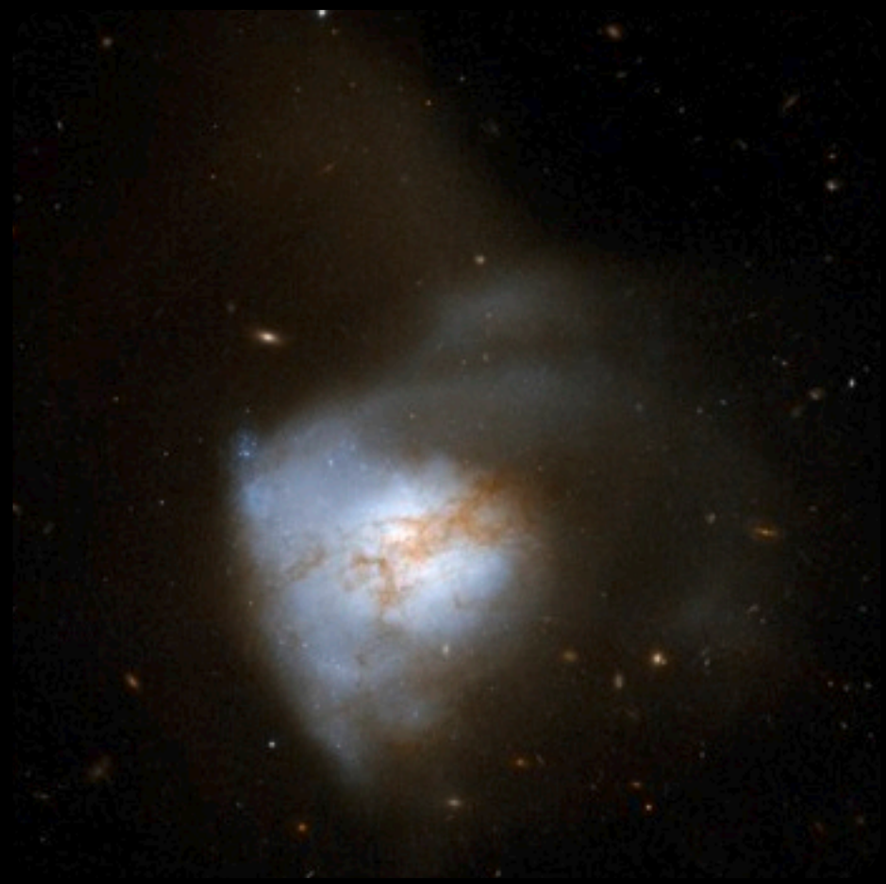
- CO is the best tracer for molecular gas
  - $M_b = 10^{11}\ M_{sun}$
- Molecular gas fuels star formation
- Line profiles probe dynamical state of gas
  - $M_{dyn} = 6 \times M_{gas}$

Caution! Extreme Model Dependance

Radio
High-frequency radio
Synchrotron from SNR
~2/3 of sources
???

The Big Picture

- Local Analogues = ULIRGs
- SMGs are major mergers caught in star-burst phase
- Progenitors of modern massive elliptical galaxies



ARP 220 (VIXENS Survey)

(U)LIRGs= (Ultra-) Luminous Infrared Galaxies

In Summary, SMGs are...

- Massive, infrared-luminous galaxies at z~2-3
- Dusty and gaseous
- Starburst dominated; may have AGN components
- Likely formed during major mergers
- Likely the progenitors of the most massive elliptical galaxies
- Similar to scaled-up versions of ULIRGs