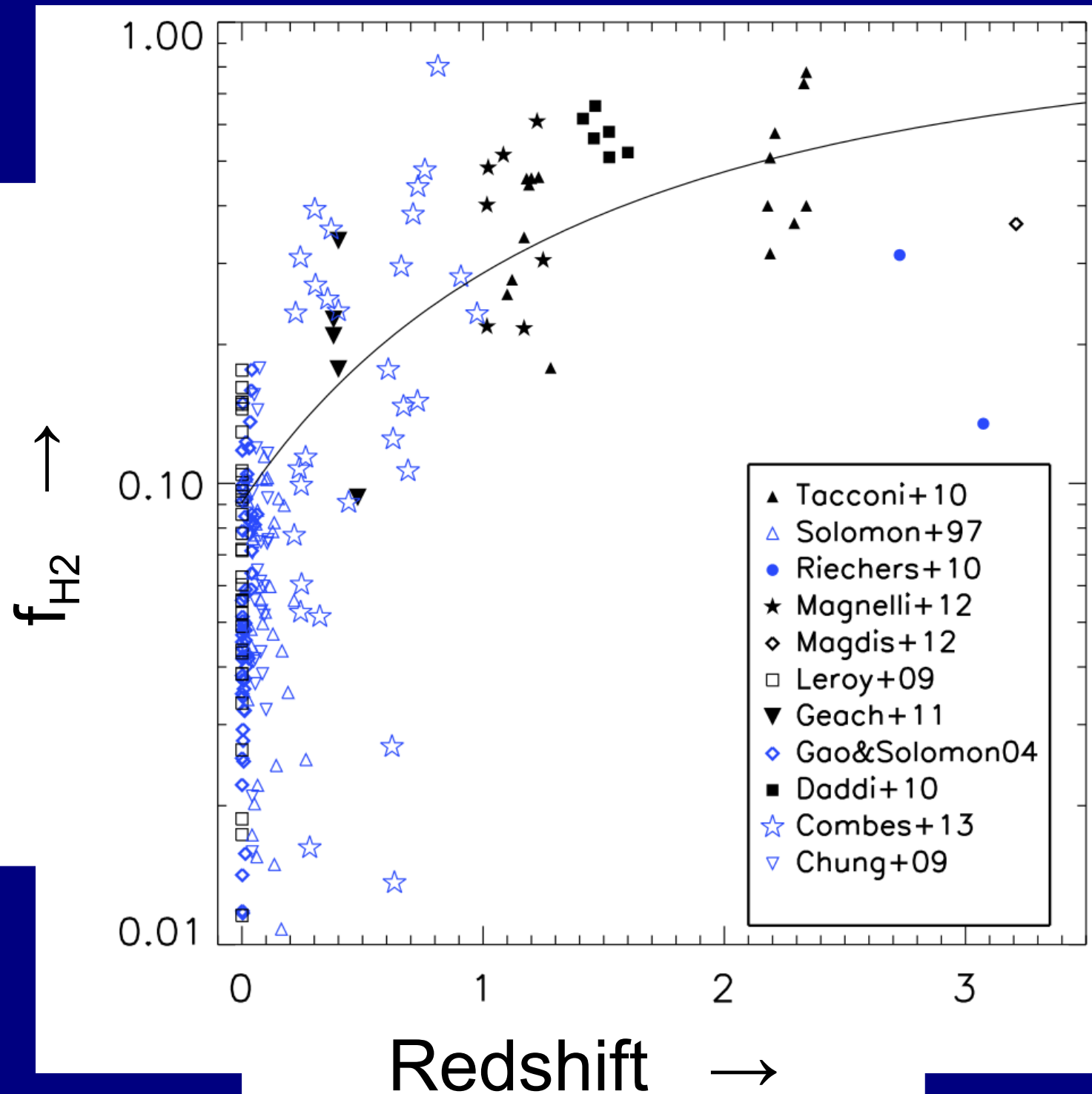


The Evolution in the Molecular Gas Content of Luminous Infrared Galaxies at $z = 0.25 - 0.65$

Kimberly Scott
NRAO

Transformational Science in the ALMA Era:
Multi-Wavelength Studies of Galaxy Evolution
August 4, 2014

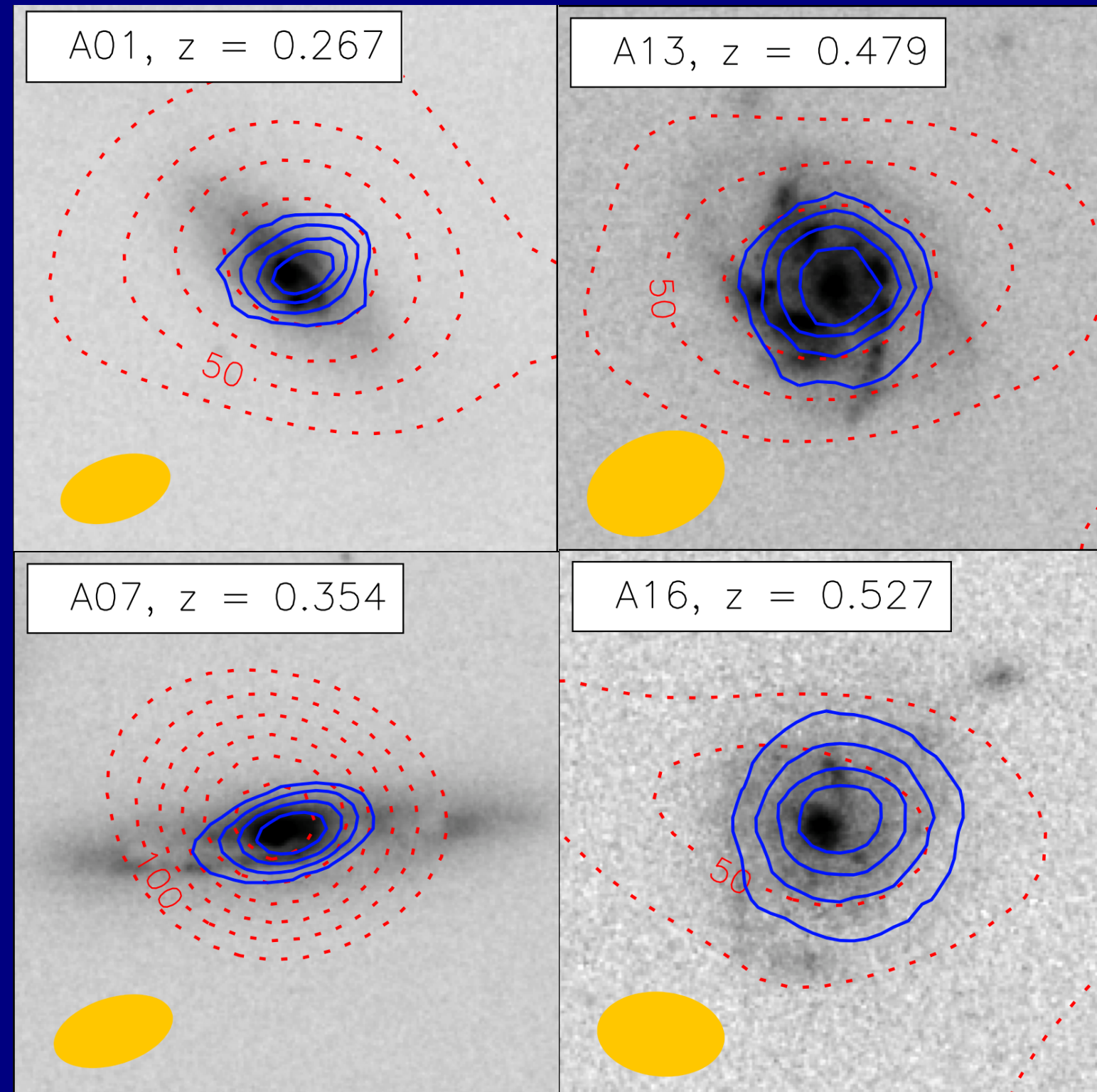
Evolution of the Molecular Gas Fraction



- 10x decline in SFR density since $z \sim 1$
- Due to decrease in f_{H_2} , or SFE?
- f_{H_2} decreases from $\sim 50\%$ to 6% between $z < 1$ and today
→ evolution due to larger gas reservoir in past
- But...

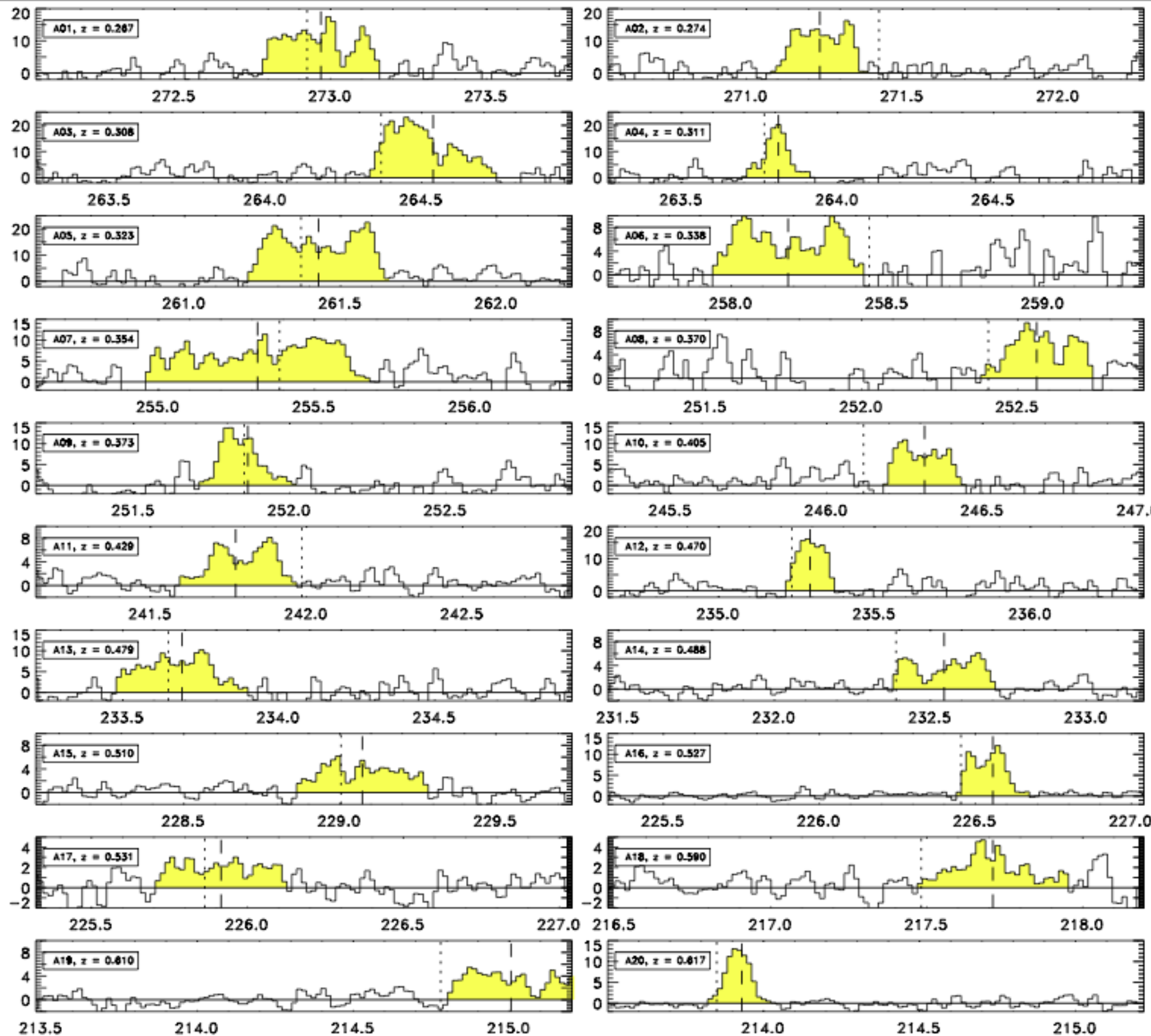
ALMA Band 6 Observations of CO in $z < 1$ LIRGs

- CO (3-2) in 20 star-forming galaxies from COSMOS
- $z = 0.25 - 0.65$ (spectroscopic)
- $L_{\text{IR}} = 1 - 4 \times 10^{11} L_{\text{sun}}$ from *Herschel*/PACS+SPIRE
- Accurate M_* from 30-band UV to near-IR SED fitting
- Angular resolution $\sim 1.3''$



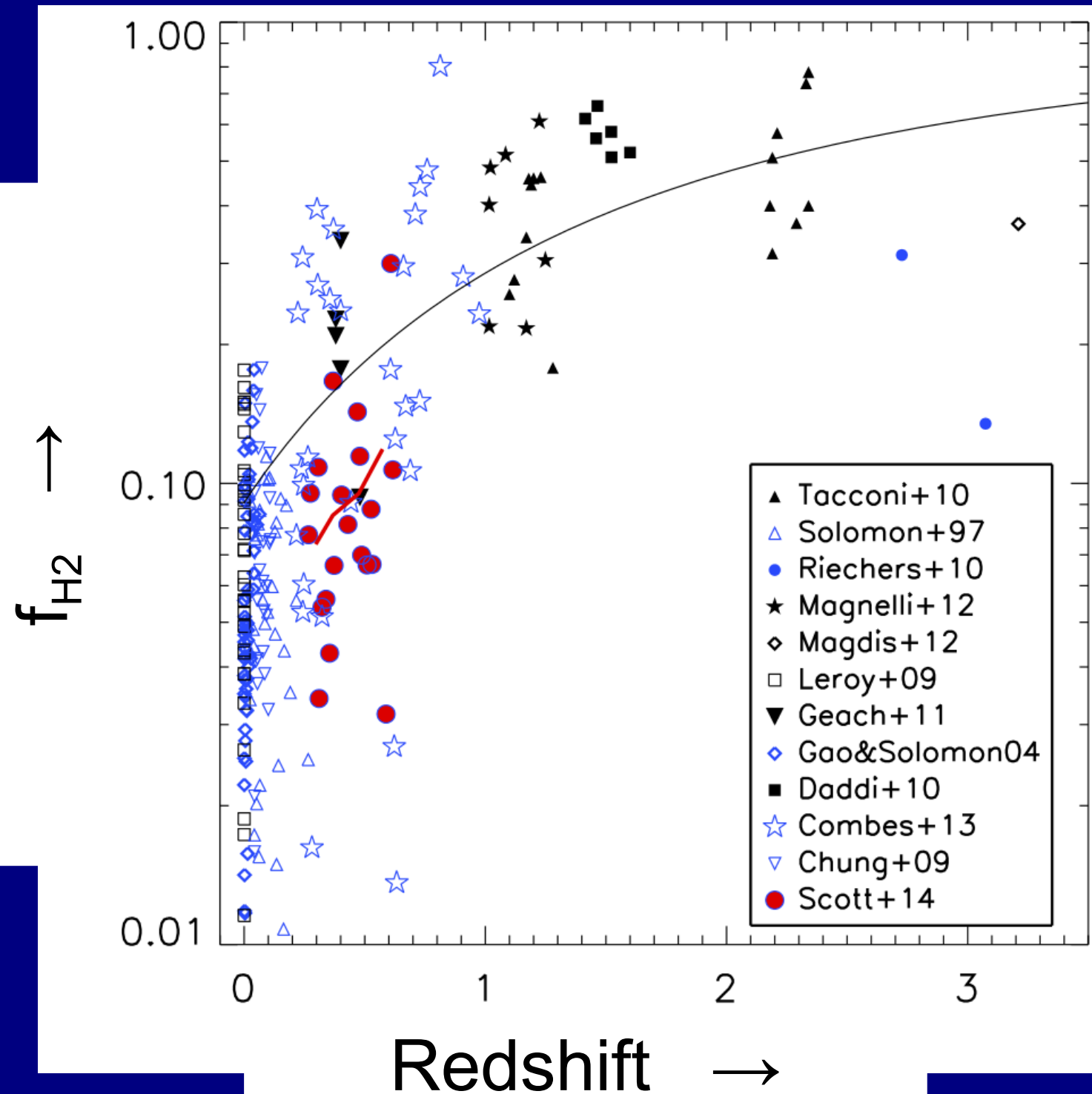
- 2 GHz bandwidth, 40 km/s channels
- 2.9 hrs on-source
- Line rms: 0.2 – 1.0 mJy
- Continuum rms: 20 – 90 μ Jy
- **100% detection rate!**
- Several have complex dynamics

↑
Flux Density (mJy)



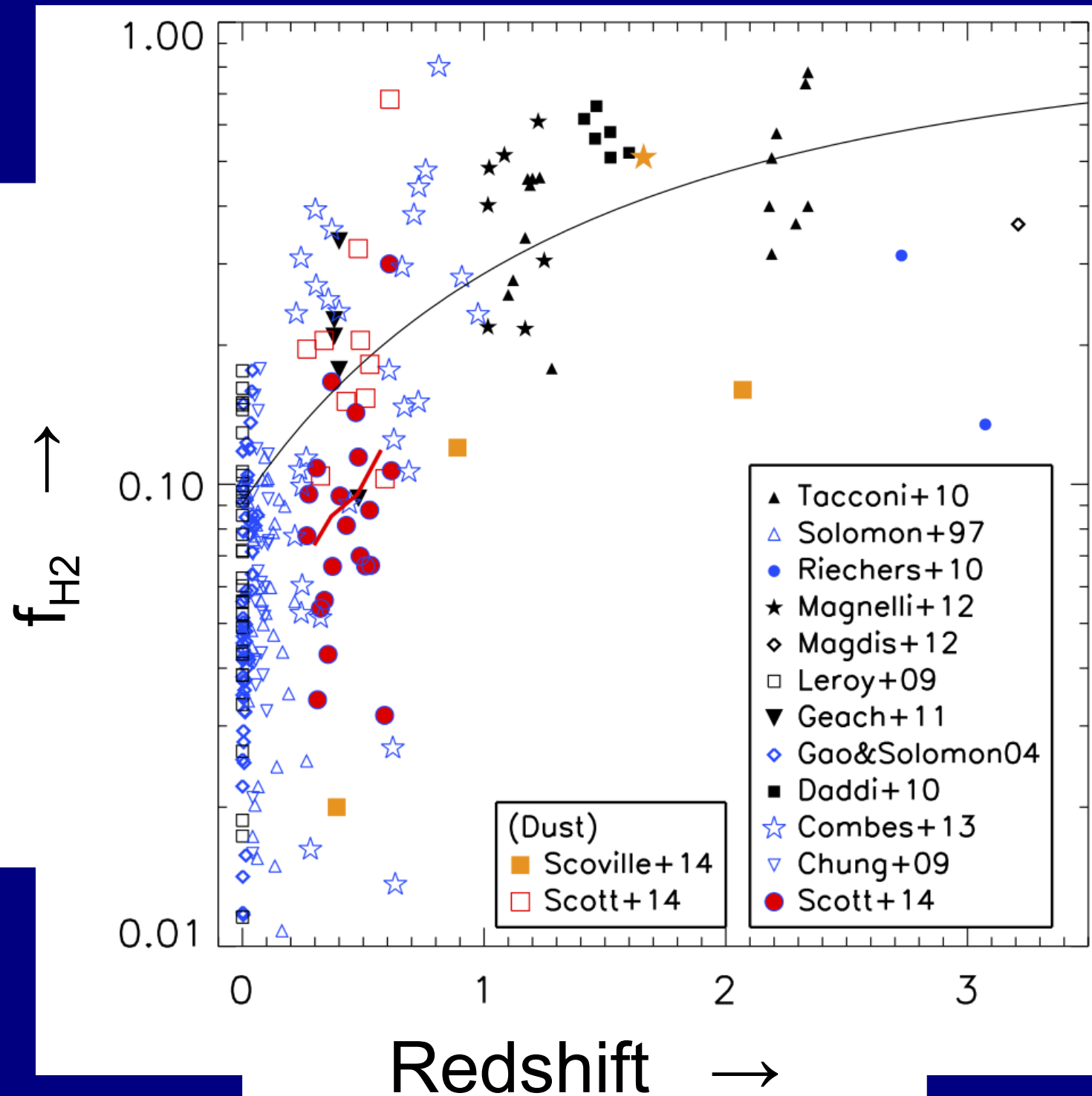
Observed Frequency →

Evolution of the Molecular Gas Fraction



- $f_{\text{H}_2} = M_{\text{H}_2} / (M_{\text{H}_2} + M_*)$
- $M_{\text{H}_2} = \alpha_{\text{CO}} L_{\text{CO}(1-0)}$
- $\alpha_{\text{CO}} = 0.8 M_{\text{sun}} / (\text{K km s}^{-1} \text{pc}^2)$
- $R_{3,1} = L_{\text{CO}(3-2)} / L_{\text{CO}(1-0)} = 0.8$
- ***2x lower than other observations at $z = 0.2 - 0.7$***

ISM Fraction from Dust Observations



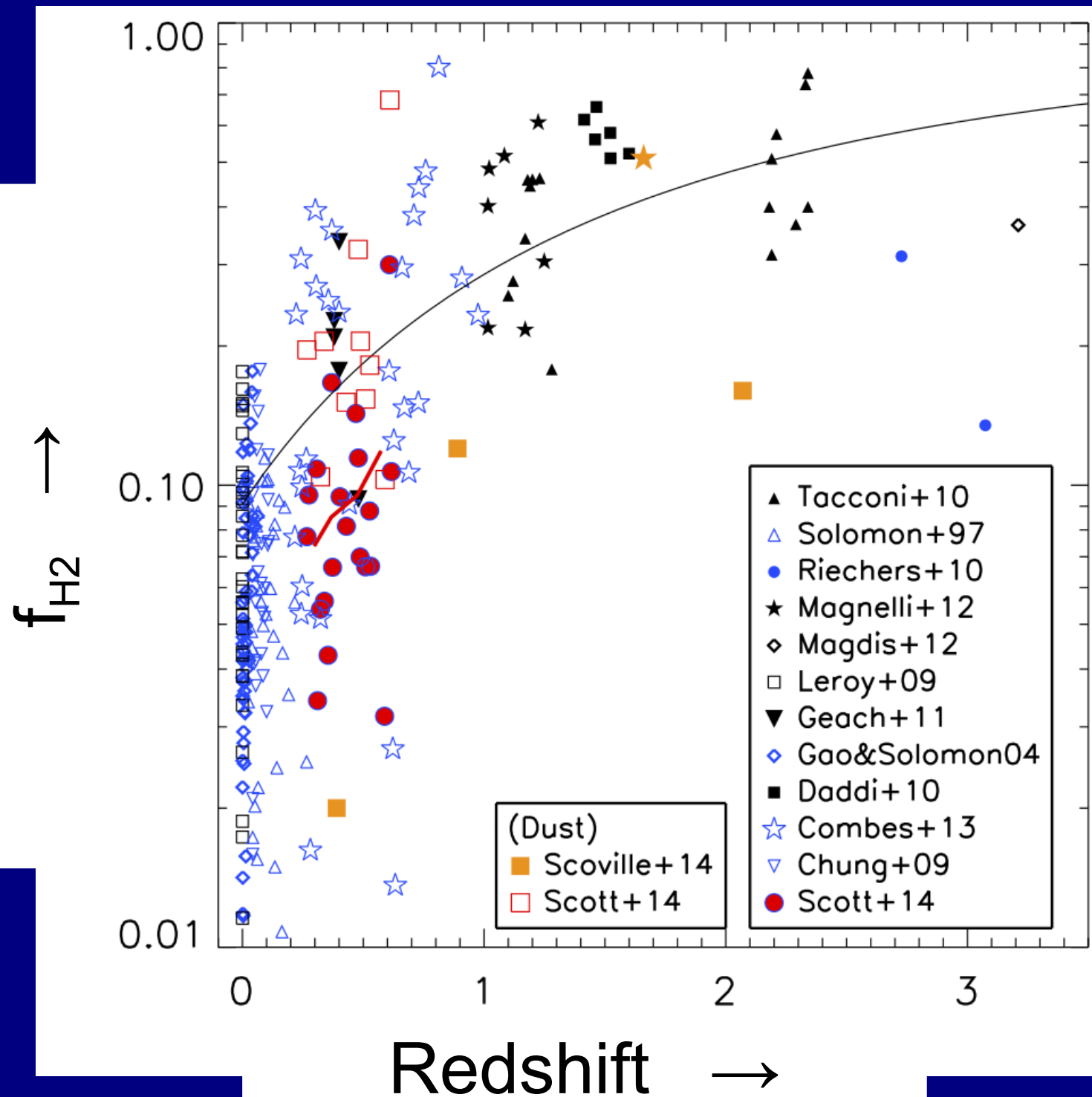
If $M_{\text{H}_2} = M_{\text{ISM}}$:

- f_{H_2} for our sample in better agreement with Combes+13 and Geach+11
- $\langle \alpha_{\text{CO}} \rangle = 2.6 M_{\text{sun}} / (\text{K km s}^{-1} \text{ pc}^2)$

If $M_{\text{H}_2} = M_{\text{ISM}} / 2$:

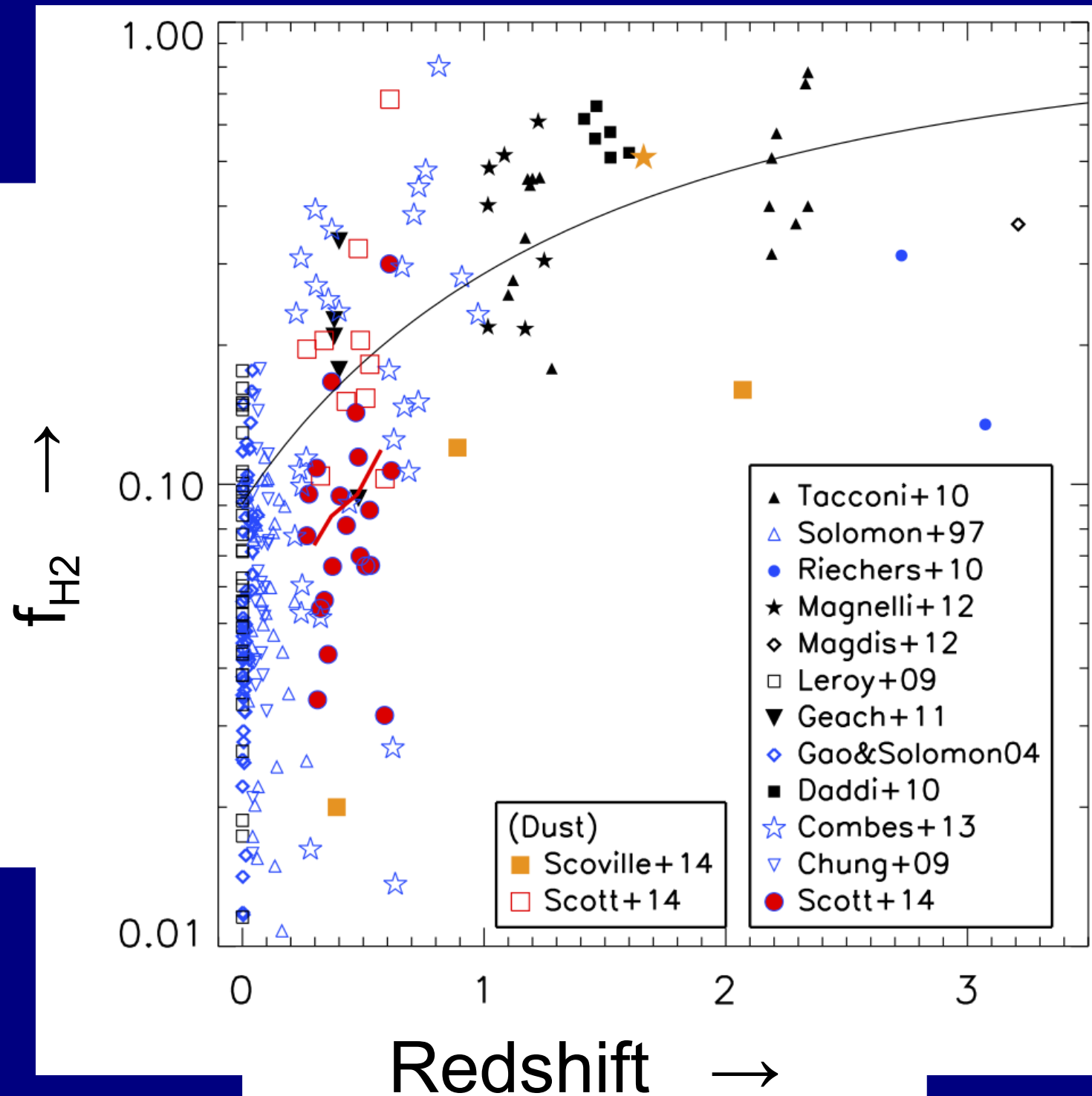
- CO and dust estimates of f_{H_2} for my sample agree!

Summary and Future CO Studies



- ALMA can detect CO in 20 LIRGs at $z < 1$ in 3 hrs (well, x2-3 with overheads...)
- $f_{\text{H}_2} \sim 10\%$, or 2x lower than that seen in 10x more luminous galaxies (or not...)
- α_{CO} remains a big uncertainty – spatially resolved CO studies will help inform on this

But I Want to Play in the Dust!



- (nearly) All of these galaxies are selected based on IR luminosity
- Scoville+14 mass-selected sample suggests IR galaxies are biased to gas-rich systems
- Evolution in the molecular gas fraction better studied through mass-selected sample

ALMA Cycle 2: Evolution of the ISM at $z < 1$ (PI Scott)

