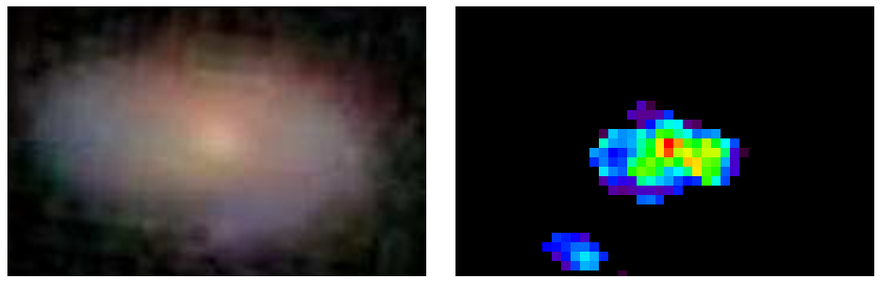
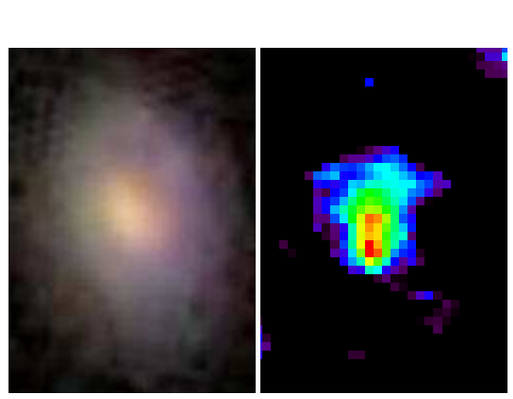
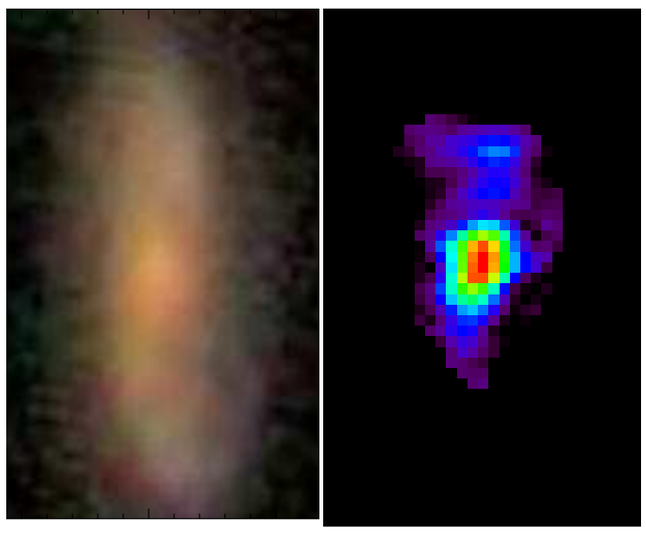
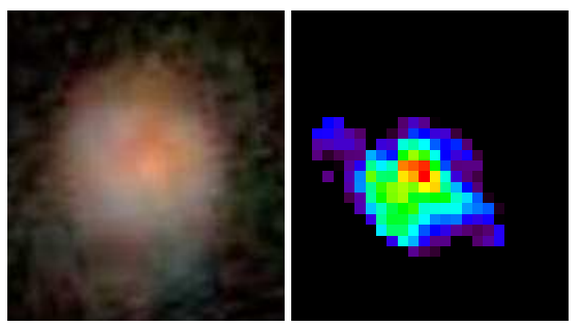
The Evolution of molecular Gas in Normal Galaxies (EGNoG) Survey: **First Results**

Amber Bauermeister
UC Berkeley





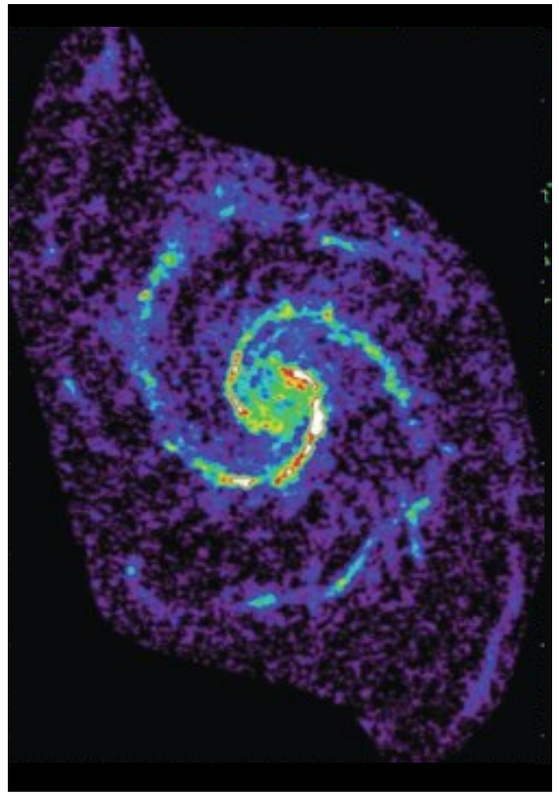




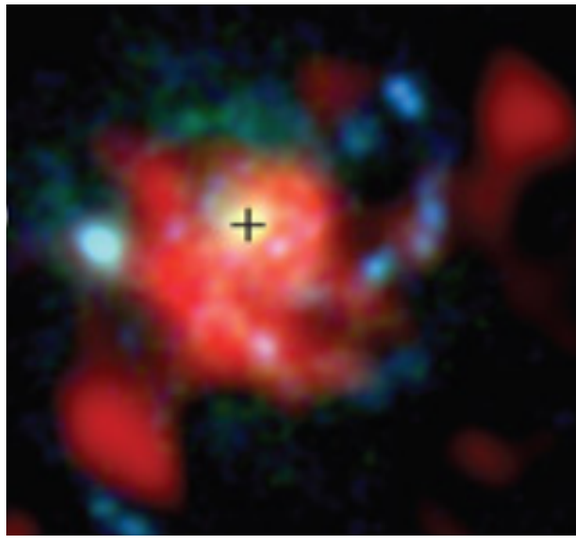
EGNoG Team:
Leo Blitz (UCB)
Alberto Bolatto (UMD)
Martin Bureau (Oxford)
Adam Leroy (NRAO)
Eve Ostriker (UMD)
Peter Teuben (UMD)
Mel Wright (UCB)

Molecular Gas z~1-2 to Today

- Local galaxies have molecular gas fractions of ~5%!



- Recent work at z~1-2 find molecular gas fractions in SFGs of ~50%!
  (Tacconi et al. 2010,
  Daddi et al. 2010)



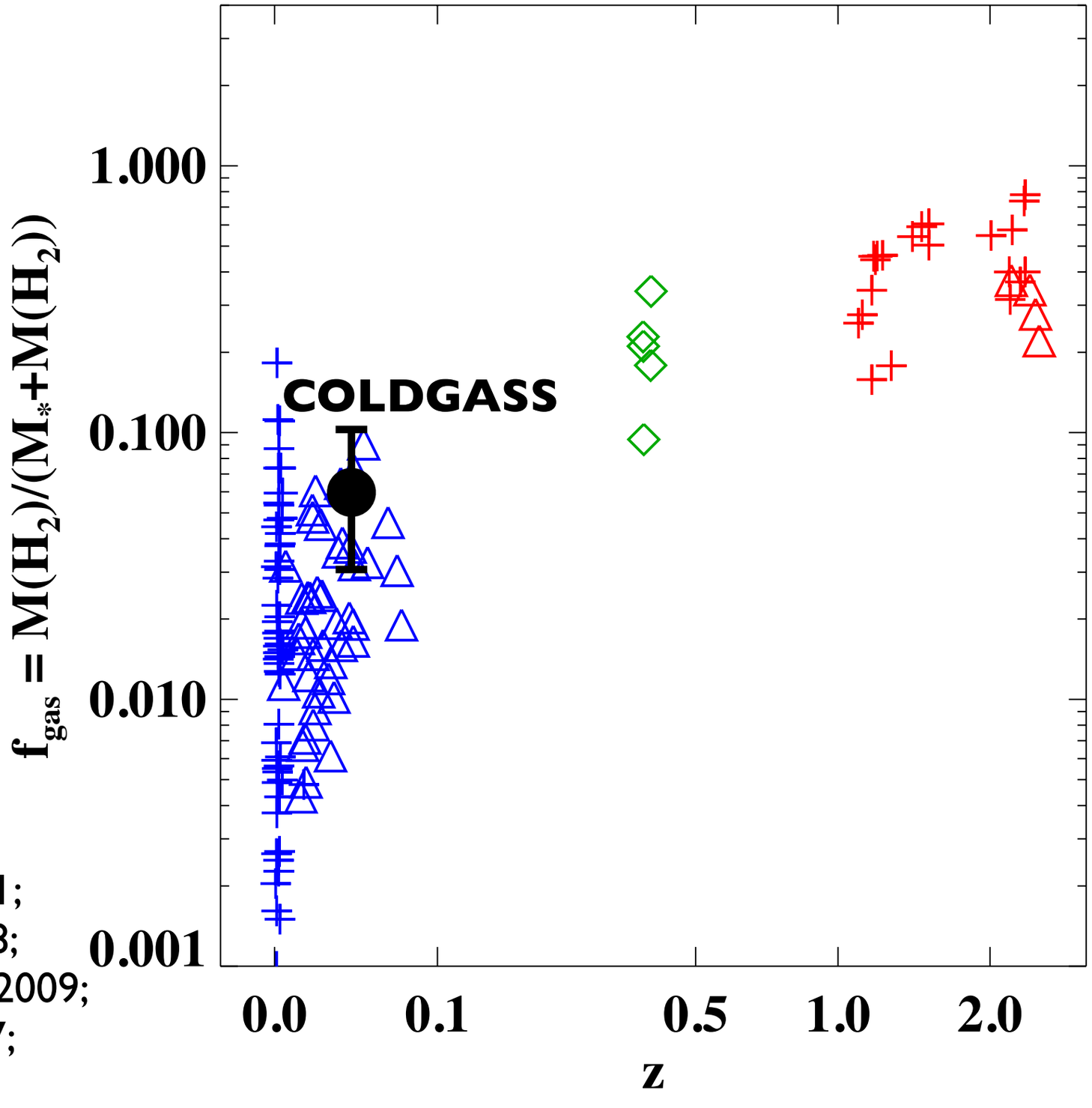
Molecular Gas z~1-2 to Today

+ z~0 normal
△ z~0 starburst

+ z~1–2 normal
△ z~1–2 starburst

◇ z~0.4 Geach11

CAVEAT:
CO-H_2 conversion!



Gao & Solomon 2004; Geach et al. 2011;
Howell et al. 2010; Kennicutt et al. 2008;
Leroy et al. 2008; Obreschkow & Rawlings 2009;
Sanders et al. 1991; Solomon et al. 1997;
Daddi et al. 2010; Genzel et al. 2010

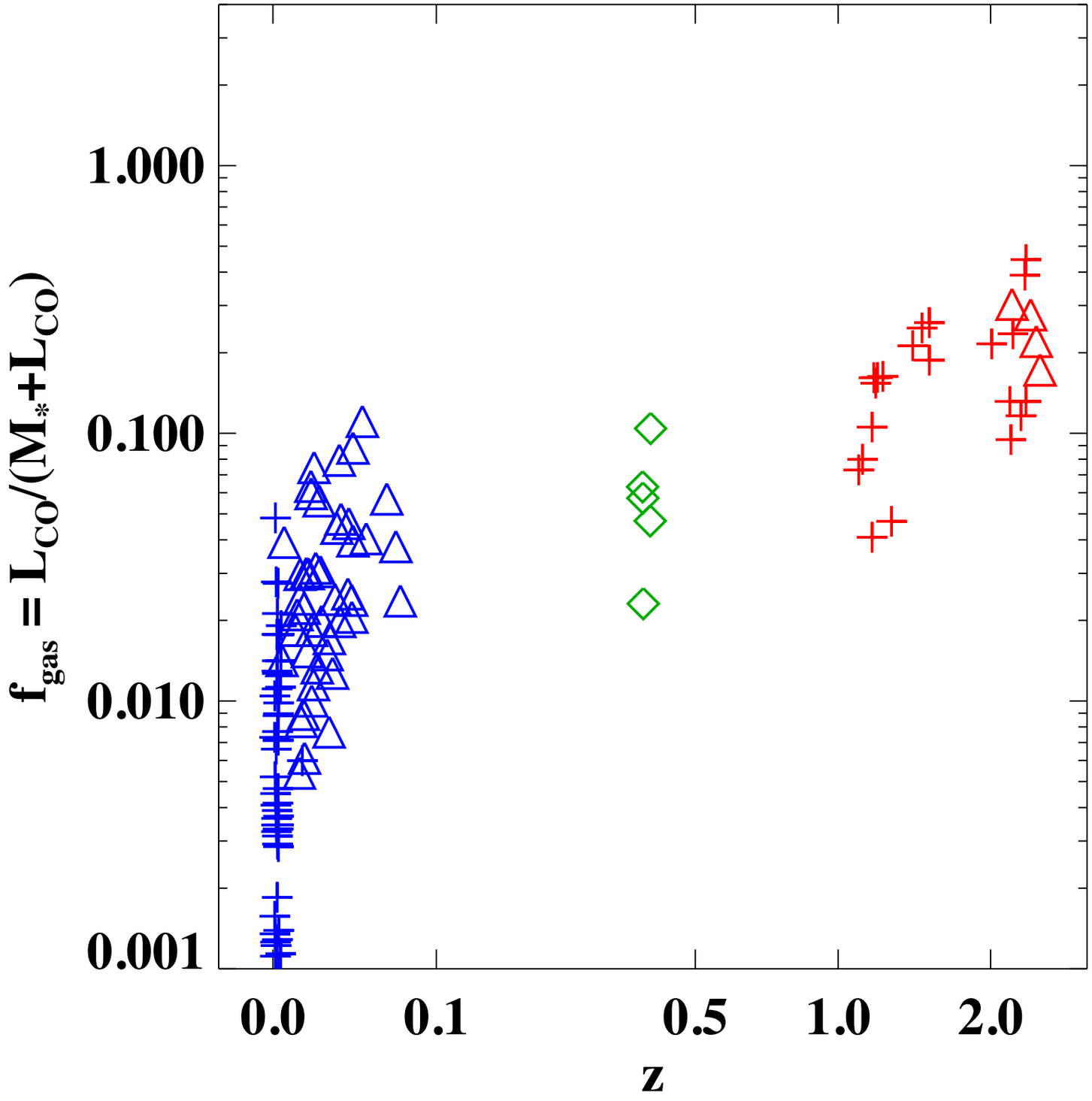
Molecular Gas z~1-2 to Today

+ z~0 normal
△ z~0 starburst

+ z~1–2 normal
△ z~1–2 starburst

◇ z~0.4 Geach11

Plot using L_{CO} to remove conversion



The **E**volution of molecular **G**as in **No**rmal **G**alaxies (EGNoG) Survey

- Traces molecular gas in intermediate redshift galaxies using CO rotational lines
- Going forward as a key project at CARMA (Combined Array for Research in Millimeter-wave Astronomy)
- 15 to 23 element interferometer at 1cm, 3mm, 1mm

Survey Design

- CO(1-0) 3mm, z=0-0.36; CO(3-2) 1mm, z=0.28-0.61
  - overlap region at z~0.3: both lines!
- Observe galaxies in 4 bin in redshift z=0.05-0.53
- Sample drawn from SDSS and COSMOS surveys, sampling the high-mass end of the MS of SFGs

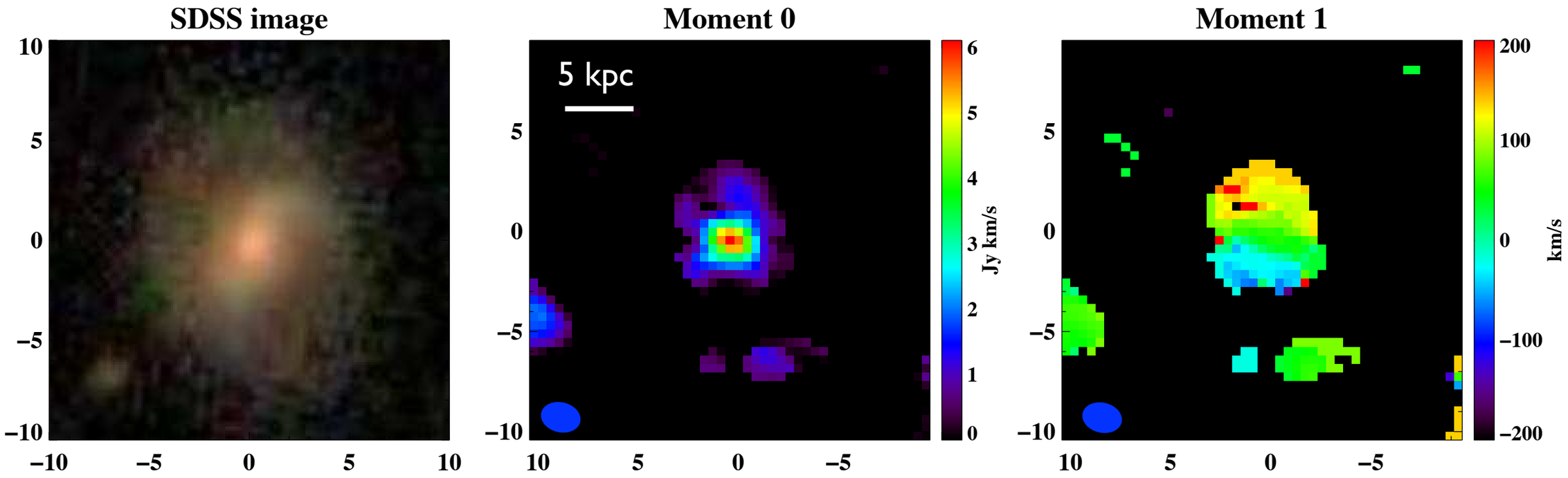
redshift bin	redshift range	sample size	parent sample	SFR cut (M_{Sun} yr^{-1})	obs. status
A	0.05-0.10	13	SDSS	4	complete
B	0.16-0.20	10	SDSS	50	2012a
C	0.28-0.32	4	SDSS	60	obs. now
D	0.47-0.53	4	COSMOS	60	obs. now

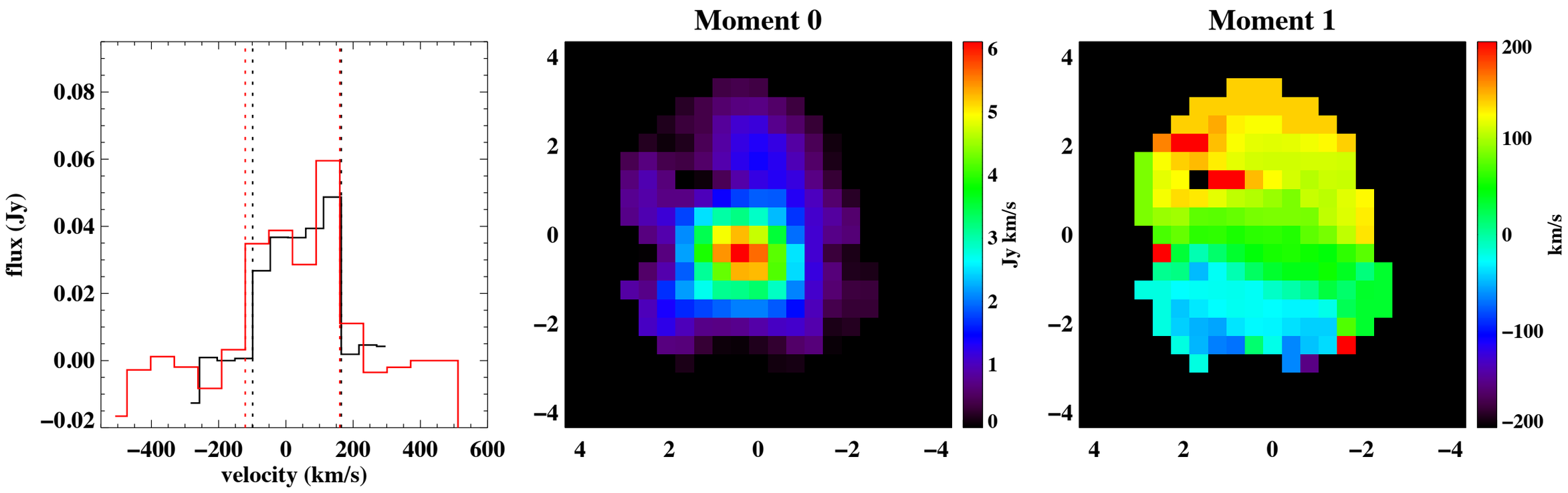
First Results: bin A

A2

SFR: 30 M_{Sun} yr^{-1}

M_*: 10^{11} M_{Sun}



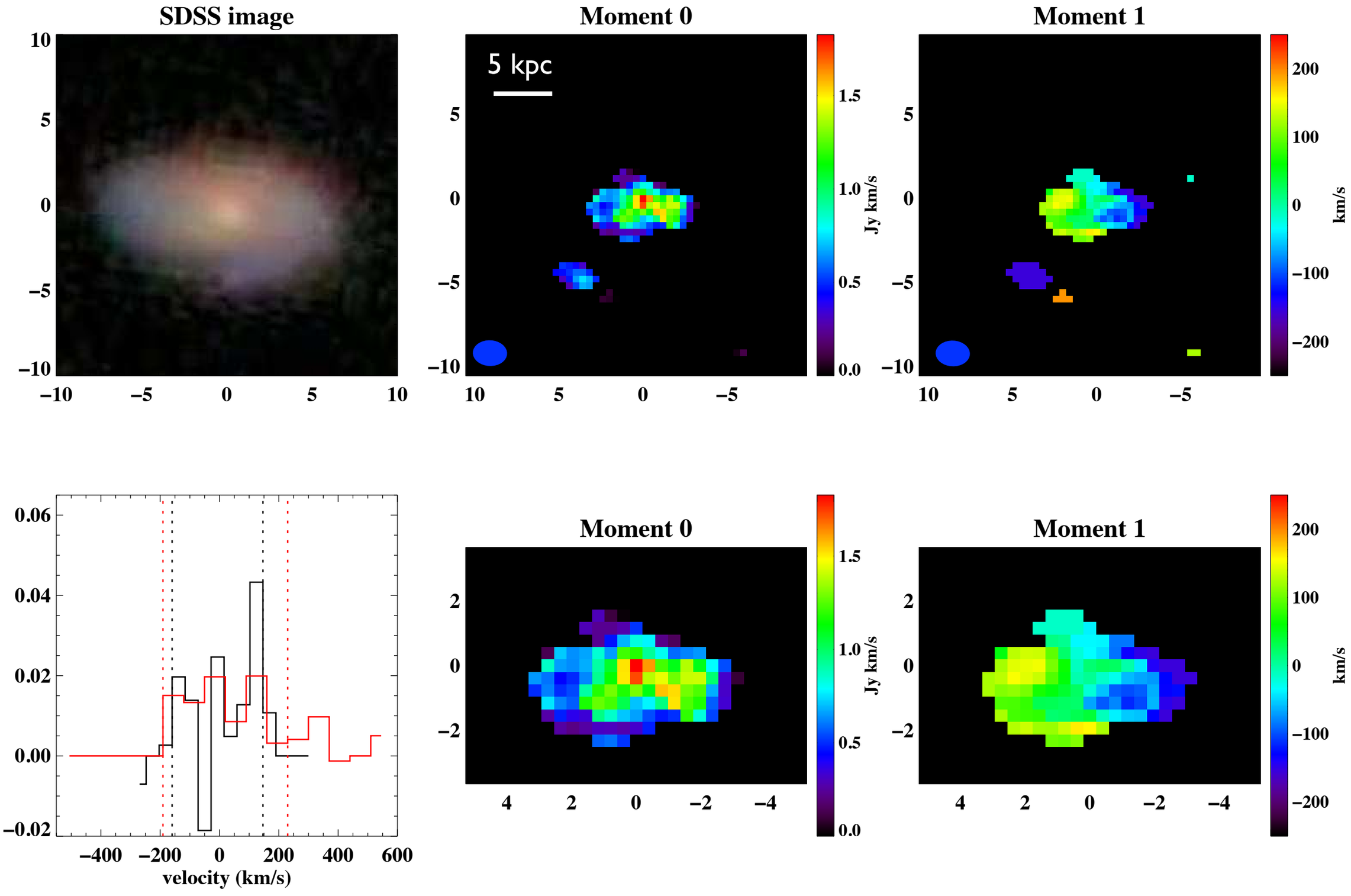


First Results: bin A

A9

SFR: 4 M_{Sun} yr^{-1}

M_*: 4x10^{10} M_{Sun}

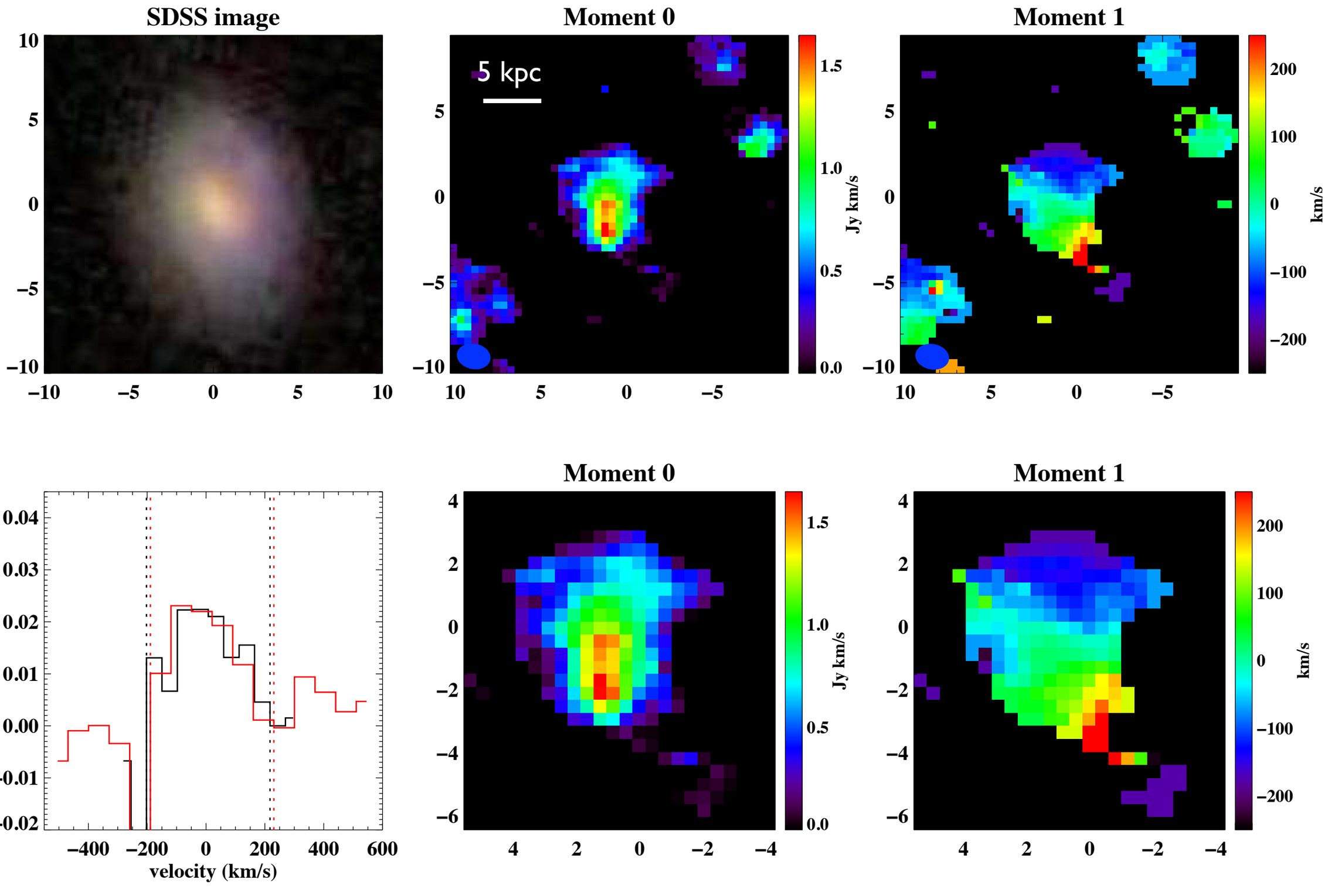


First Results: bin A

All

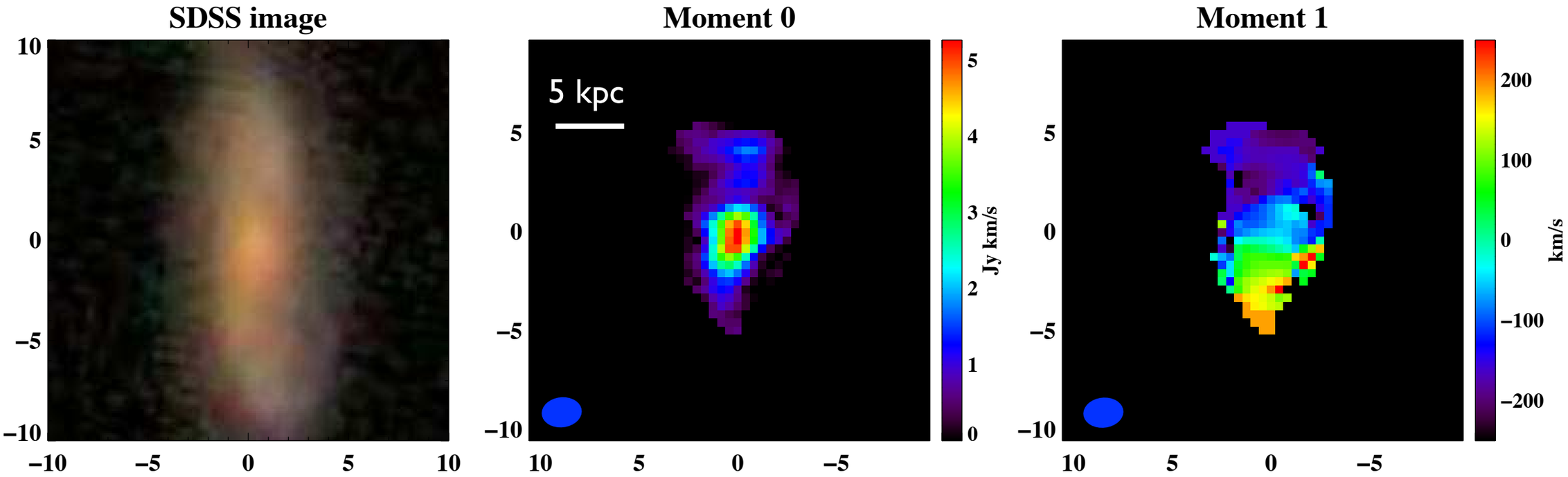
SFR: 10 M_{Sun} yr^{-1}

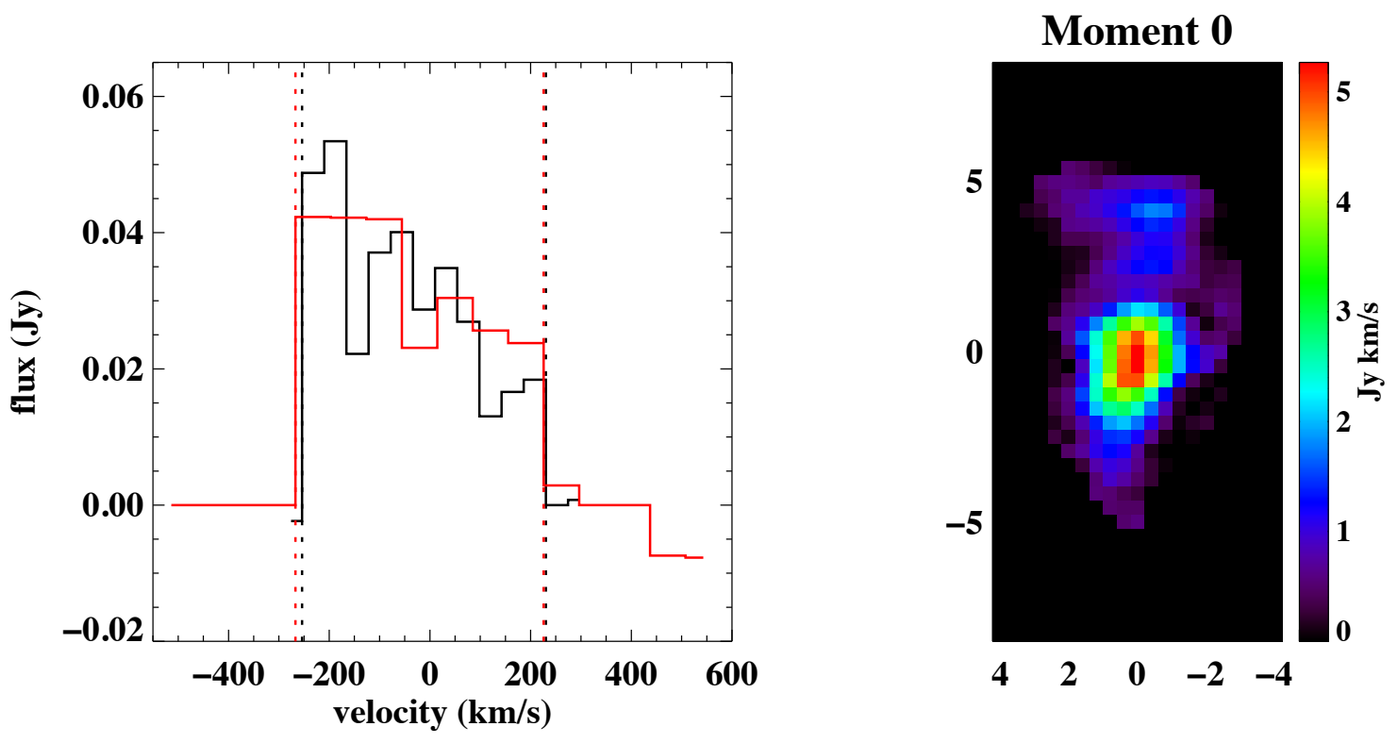
M_*: $6x10^{10}$ M_{Sun}



First Results: bin A

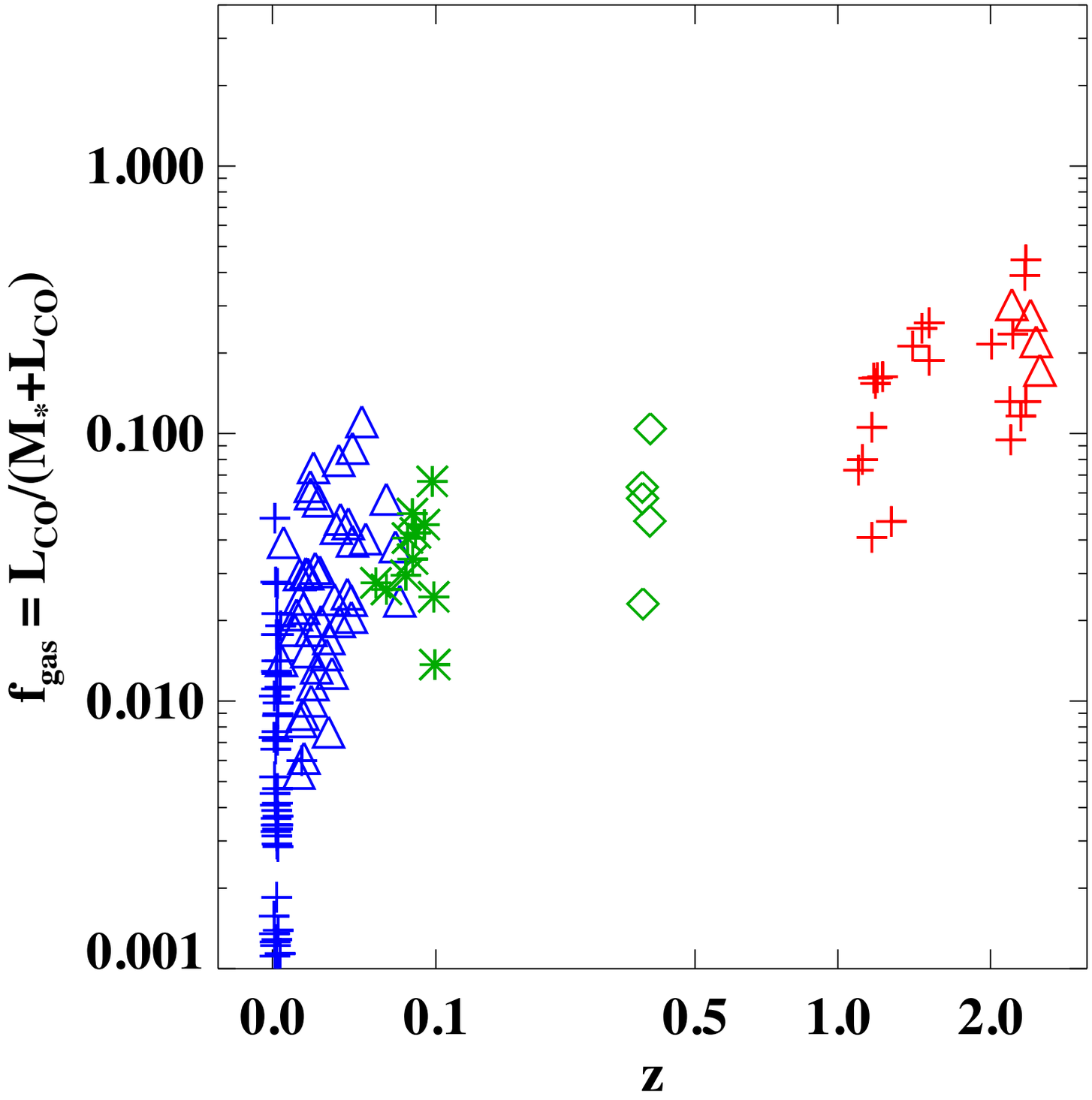
A13
SFR: 13 M_{Sun} yr^{-1}
M_*: 10^{11} M_{Sun}





EGNoG Survey: So Far..

+ z~0 normal
△ z~0 starburst
+ z~1–2 normal
△ z~1–2 starburst
◇ z~0.4 Geach11
✳ z~0.1 EGNoG



EGNoG Survey: Going Forward

- So far, 13 galaxies observed at z~0.05-0.1 (11 detected)
- Complete survey will trace gas evolution from z=0.05 to z~0.5
- Sample at z~0.3: observe CO(1-0) and CO(3-2), adding to the limited data at mid and high redshift