

# The ISM of Lyman Break Analogs: Nebular and Molecular Gas



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Santiago, June 2011



# GALEX Galaxy Evolution Explorer



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## JHU

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Borthakur



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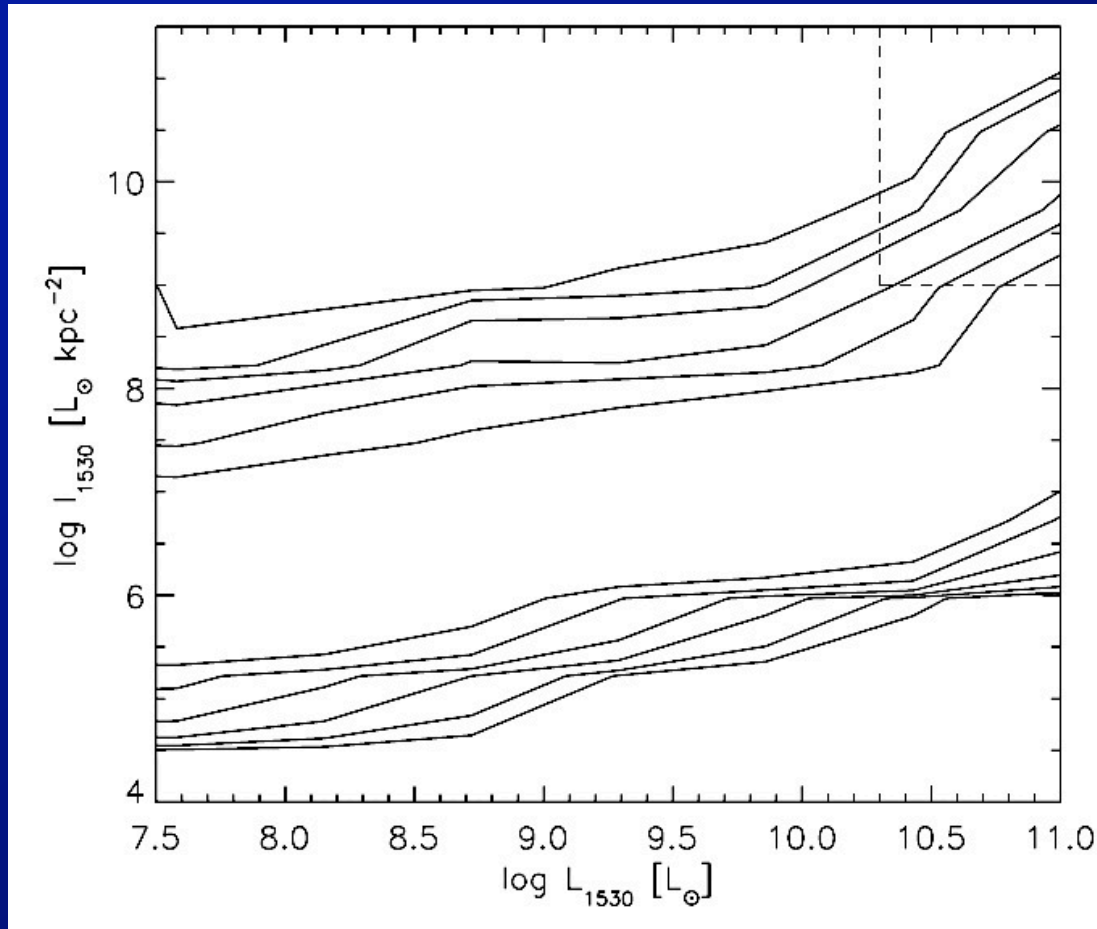
Antara Basu-Zych



## UCLA

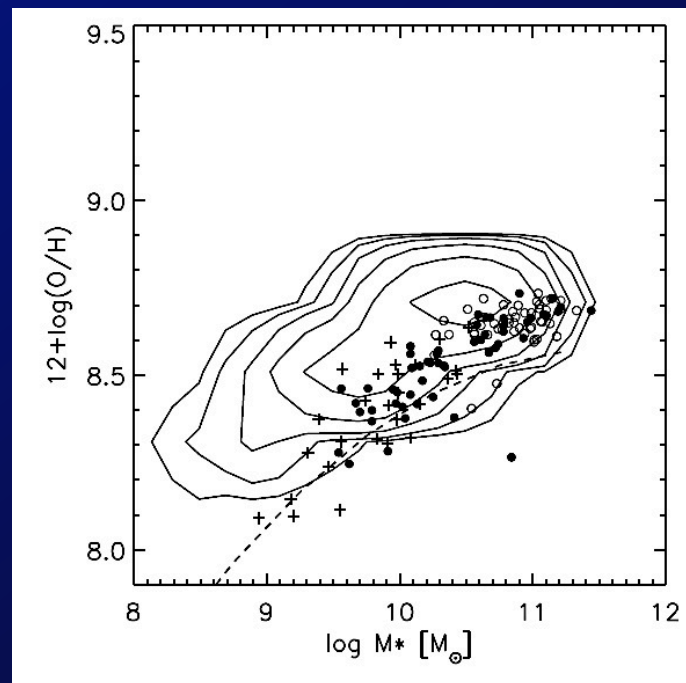
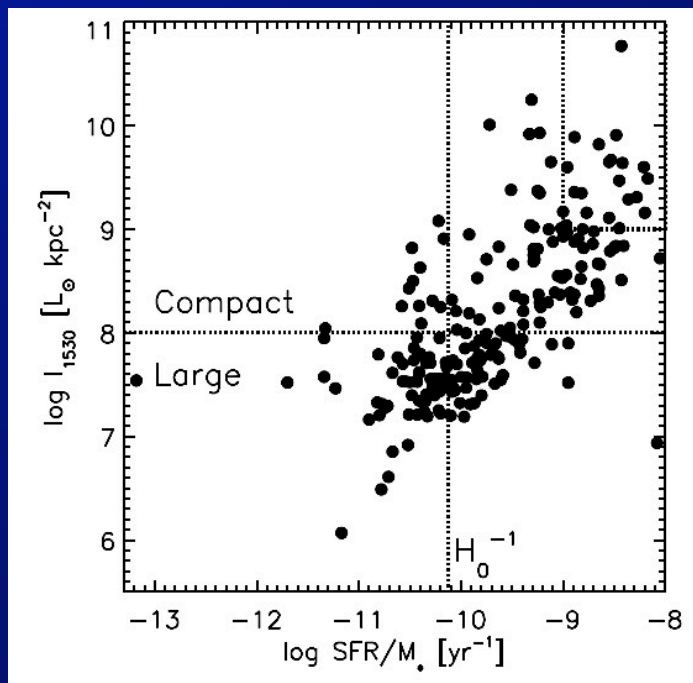
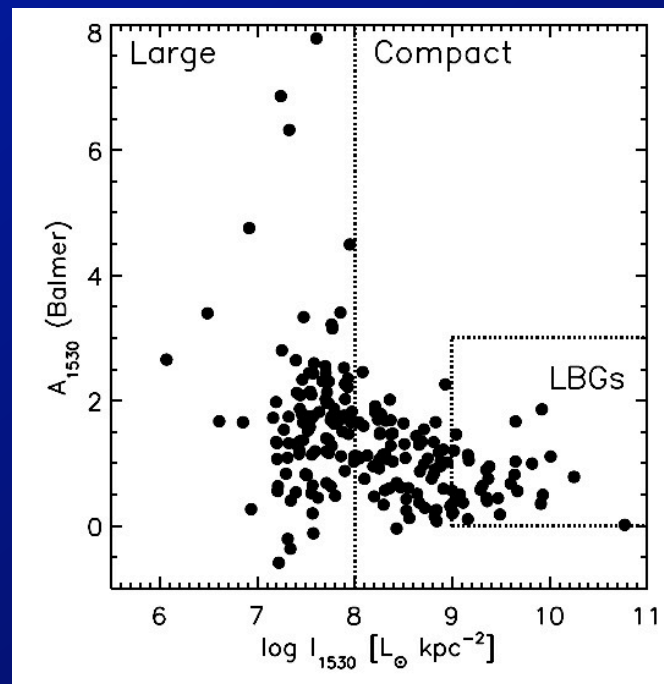
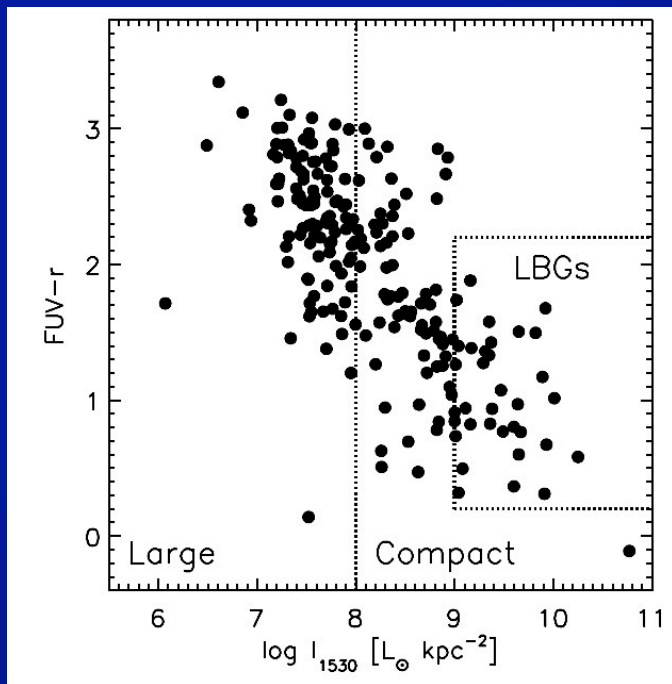
David R. Law

# Lyman Break Analogs: defining a sample



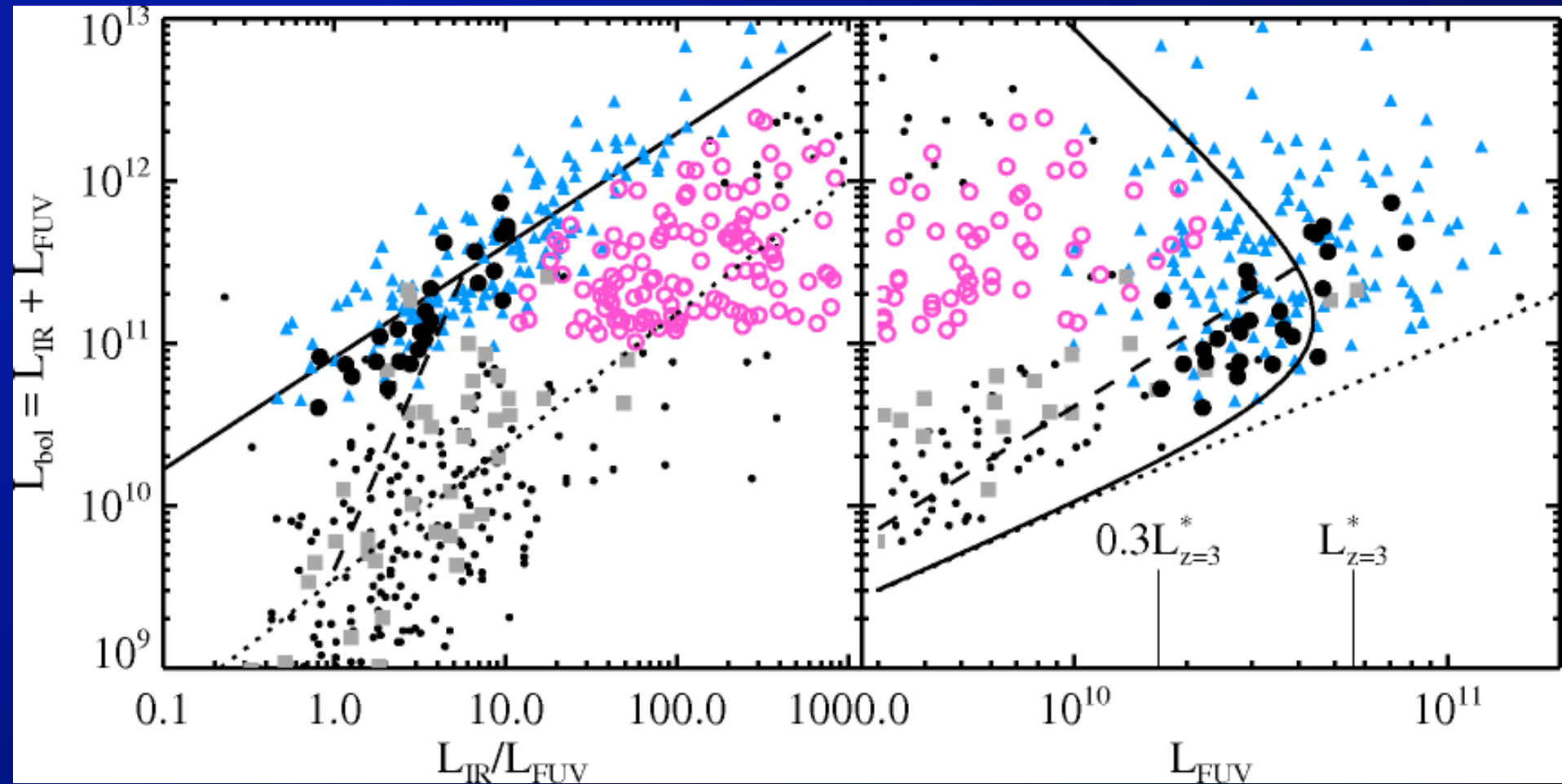
$$L_{\text{FUV}} \geq 2 \times 10^{10} L_{\odot}$$
$$I_{1530} \geq 10^9 L_{\odot} \text{ kpc}^{-2}$$

Hoopes et al  
(2007)





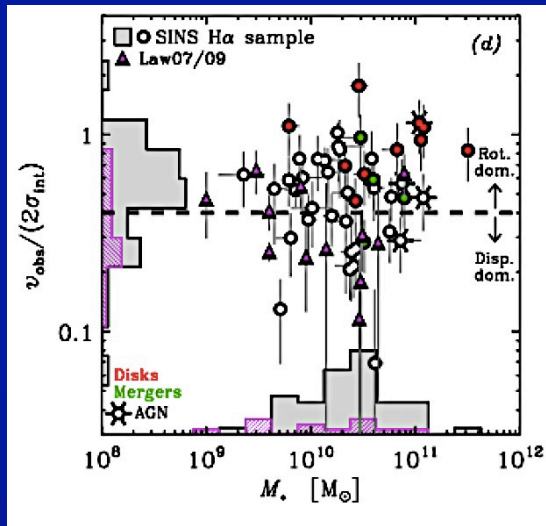
# Extinction properties



Overzier+11

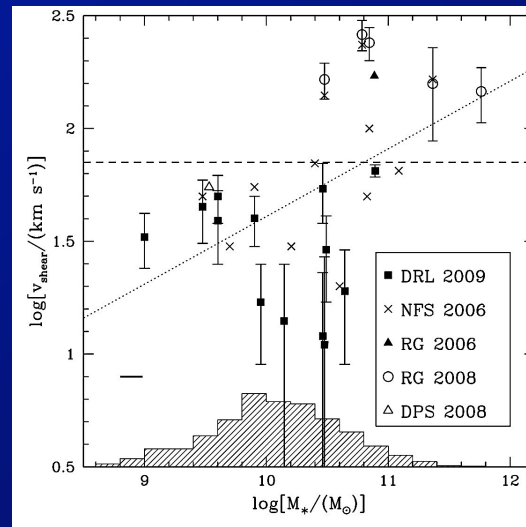
***The Nebular  
Gas in LBAs***

# IFU studies at $z \sim 2$



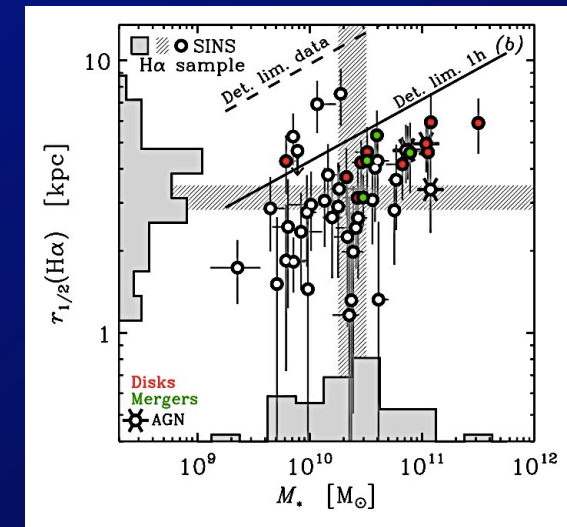
FS09

**High velocity dispersion**



Law09

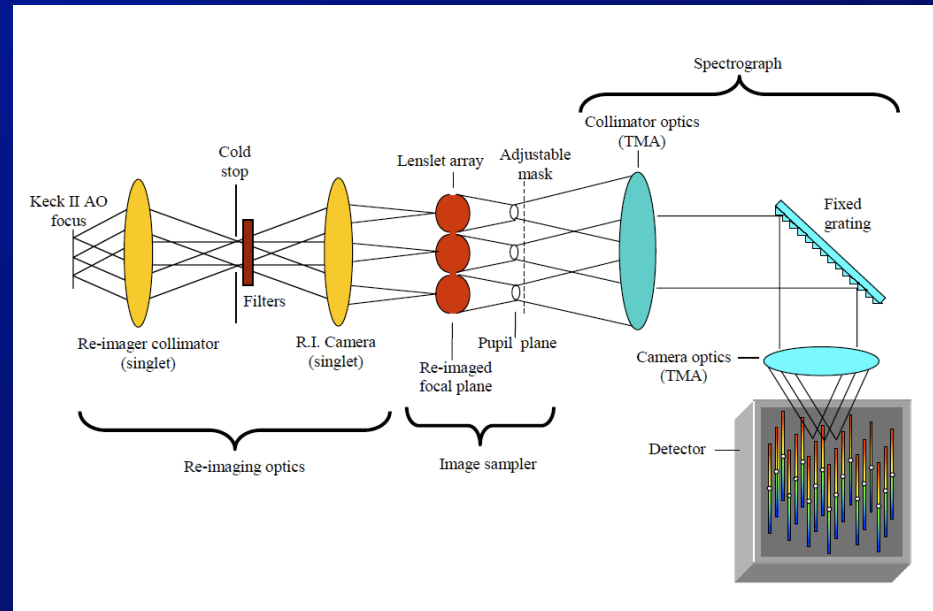
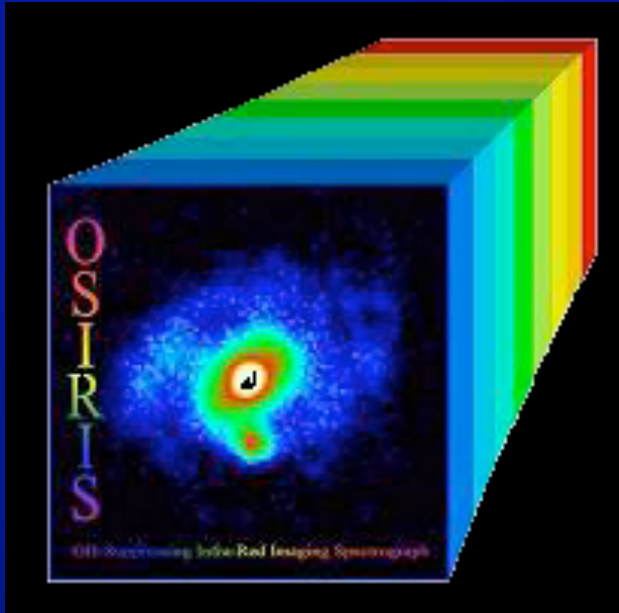
**Stellar mass dependence of observables**



FS09

- Stellar mass of selected sample
- Samples with and without AO
- Issues with observations at high  $z$ : Surface Brightness / Resolution

# OSIRIS!!!



- Compact objects, high SFR, strong line emission – great case!
- Resolution down to 200pc with AO, very close to diffraction limit in a 10m telescope
- Observed line: Pa- $\alpha$  in the K-band



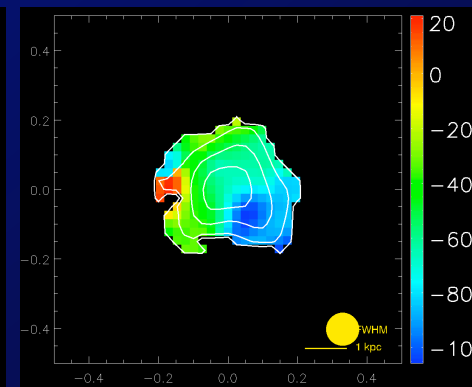
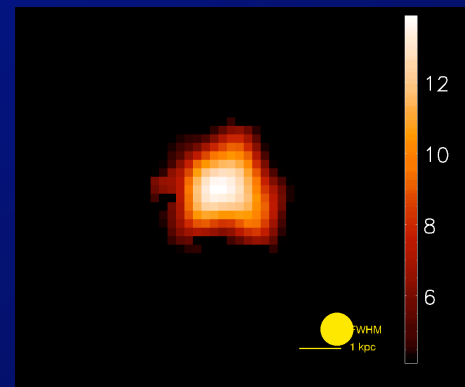
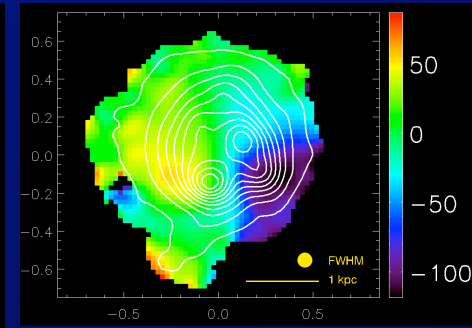
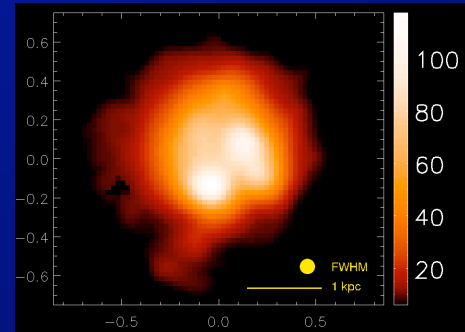
# Data at high $z$ ?

Real data

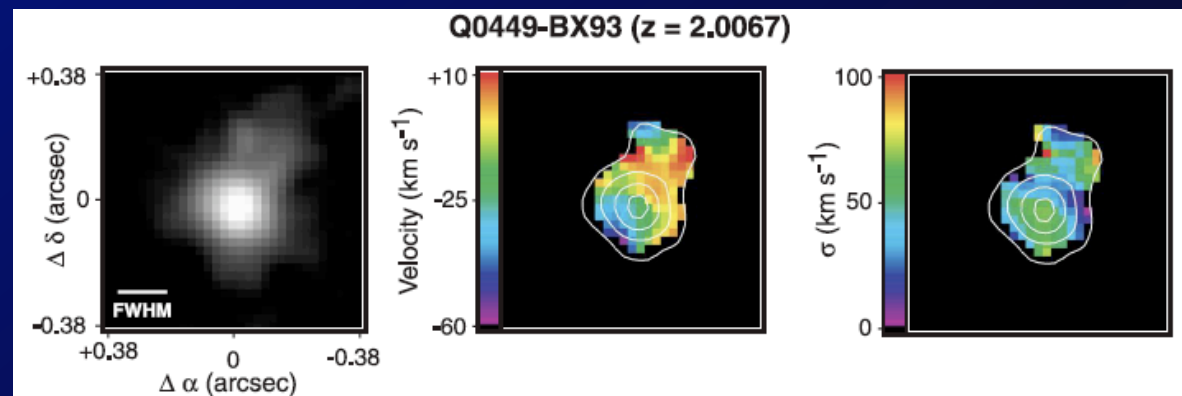
Artificially  
redshifted  
to  $z=2.2$

S/N

V (km/s)

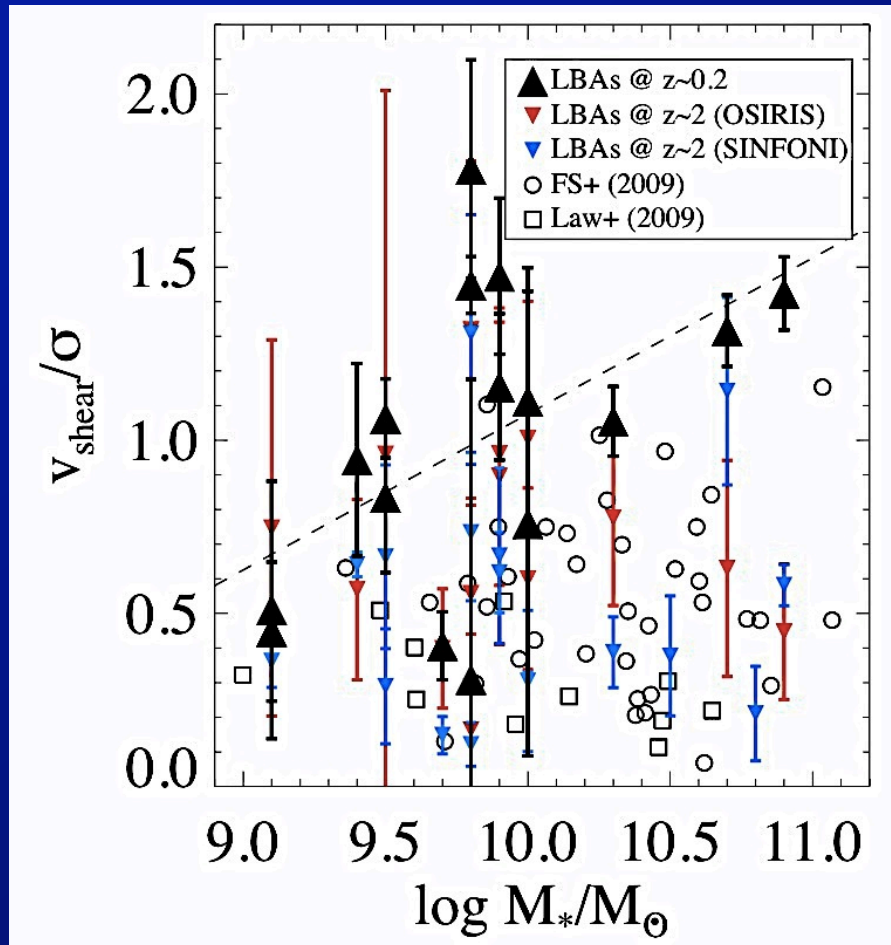


Law et al. 2007

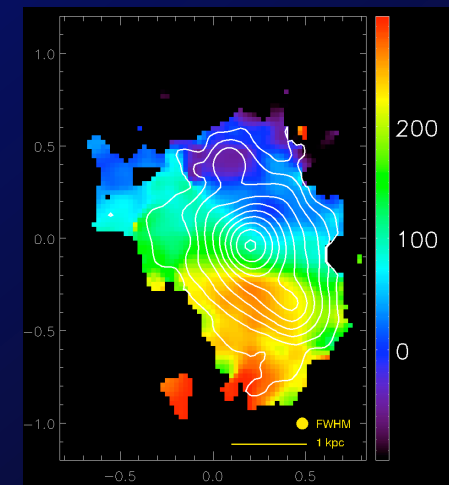
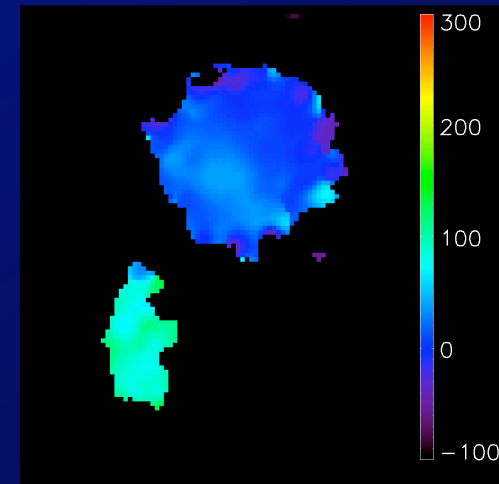


Gonçalves+10

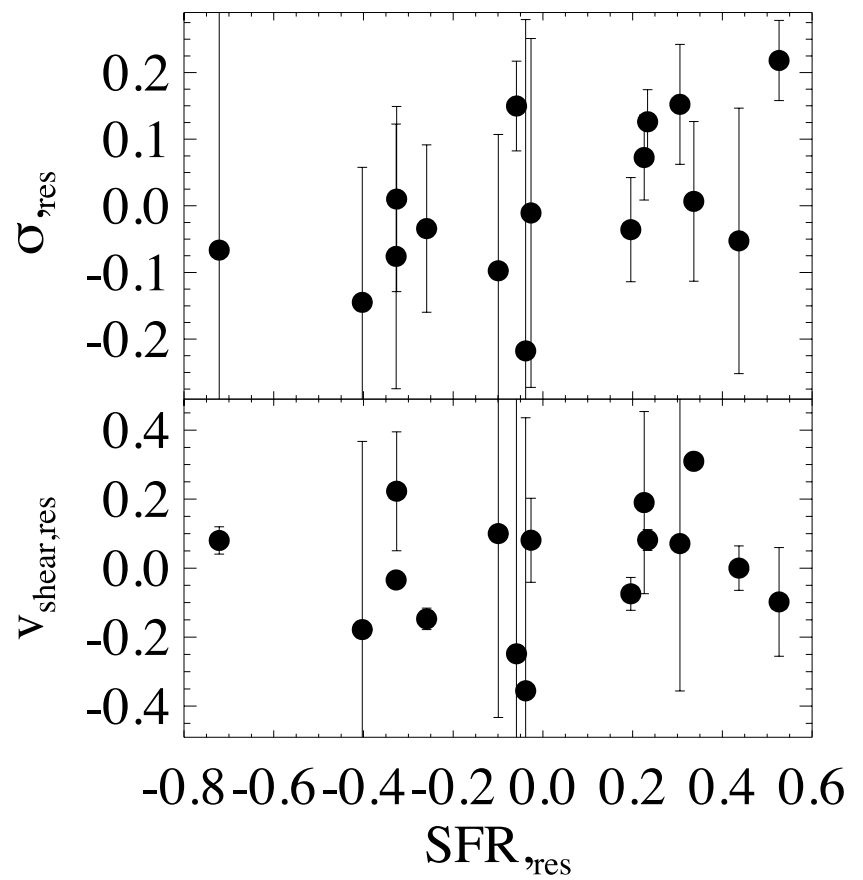
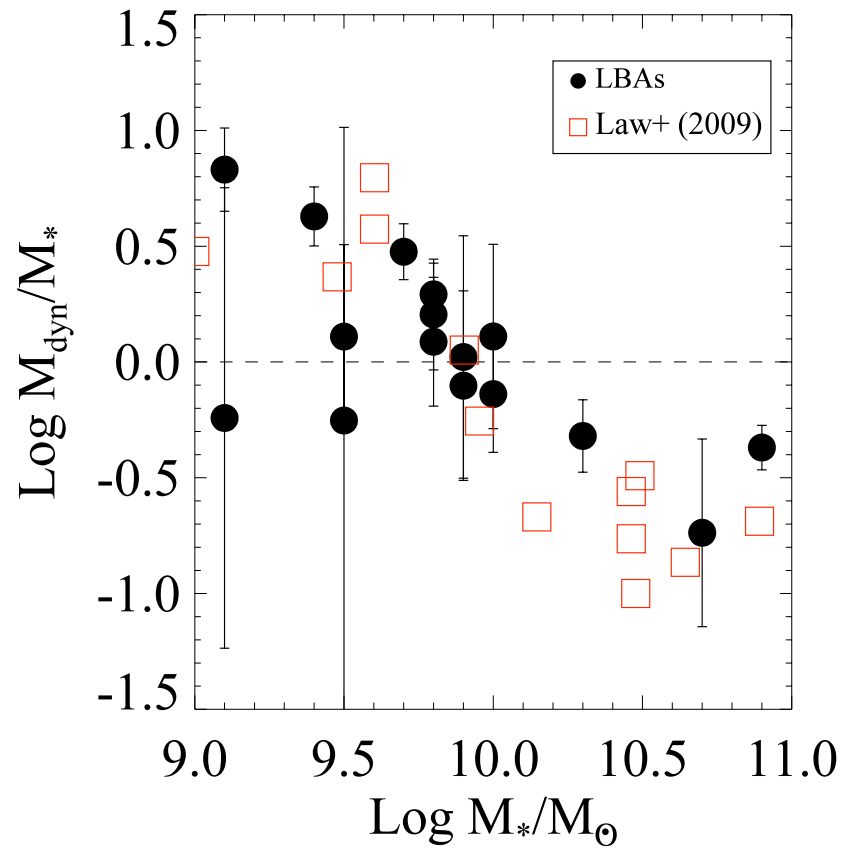
# Stellar mass dependence



More massive objects show stronger velocity shears with similar values to high- $z$



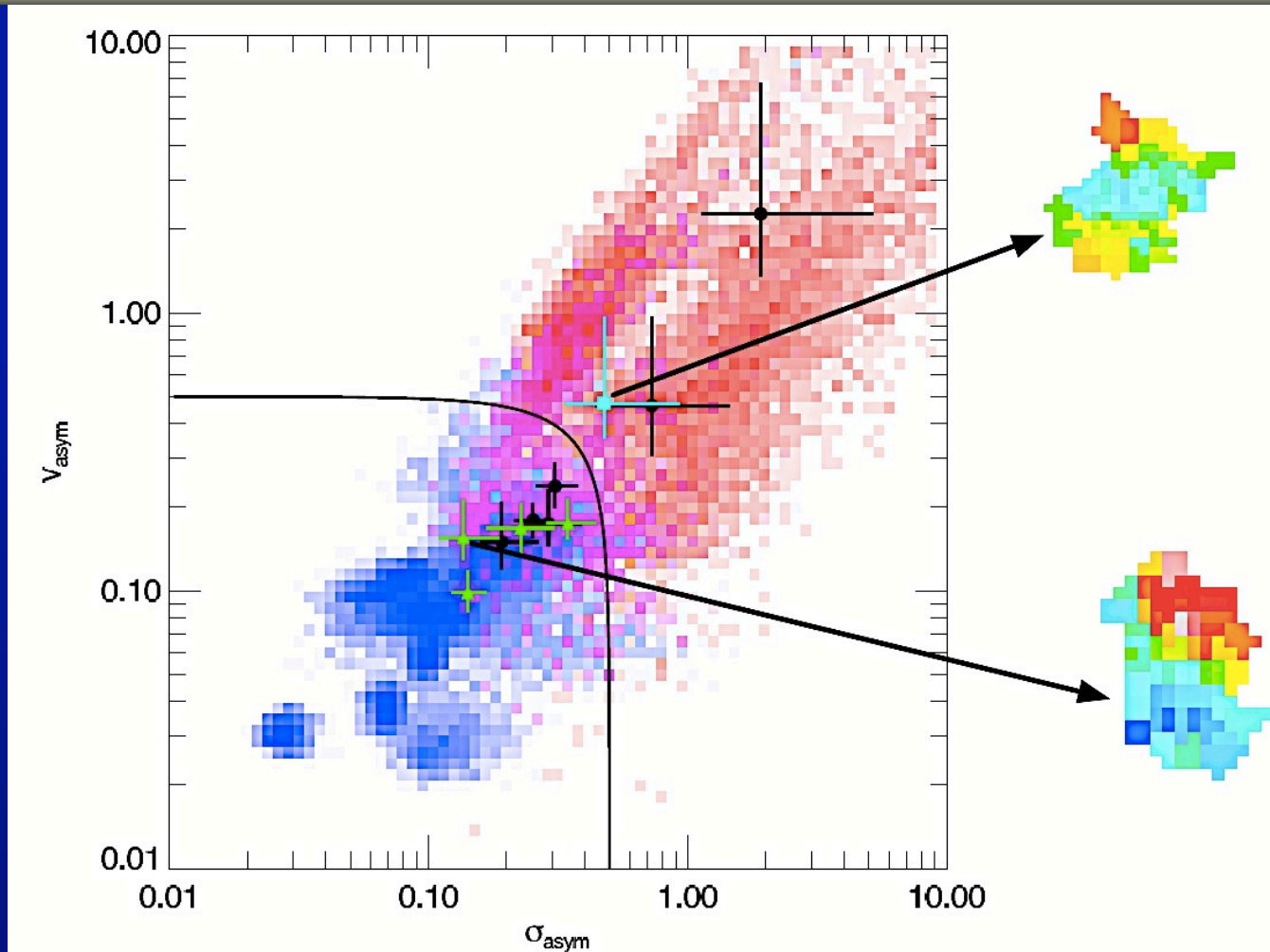
Gonçalves+10



Gonçalves+10

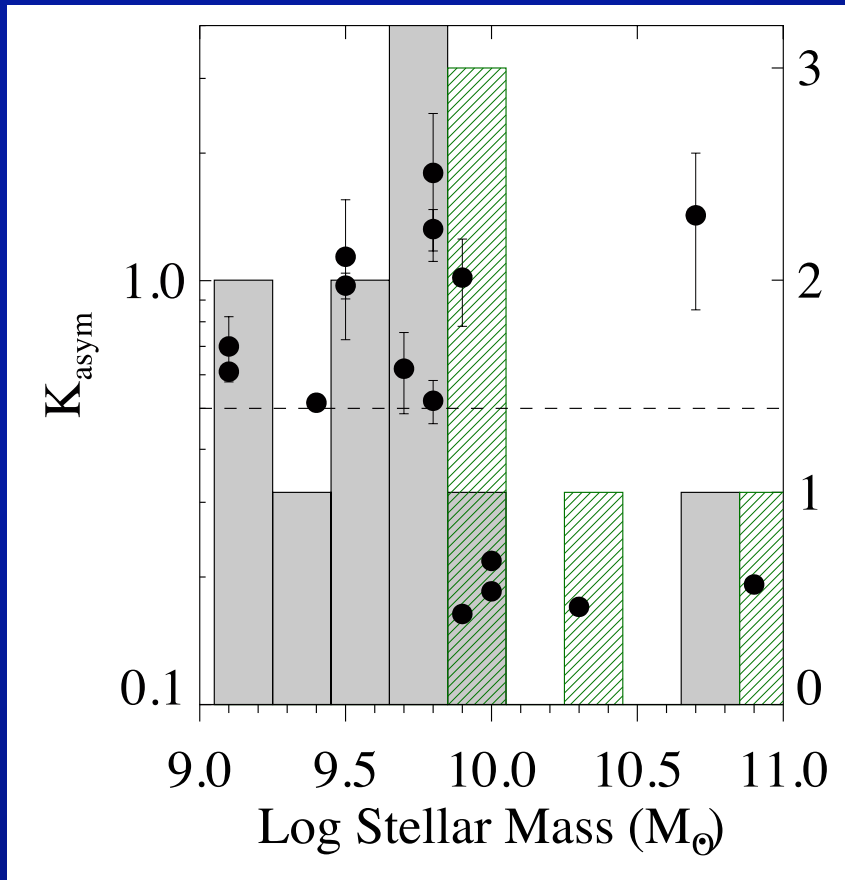
# Kinematics

Krajnović et al. 2006  
Shapiro et al. 2008



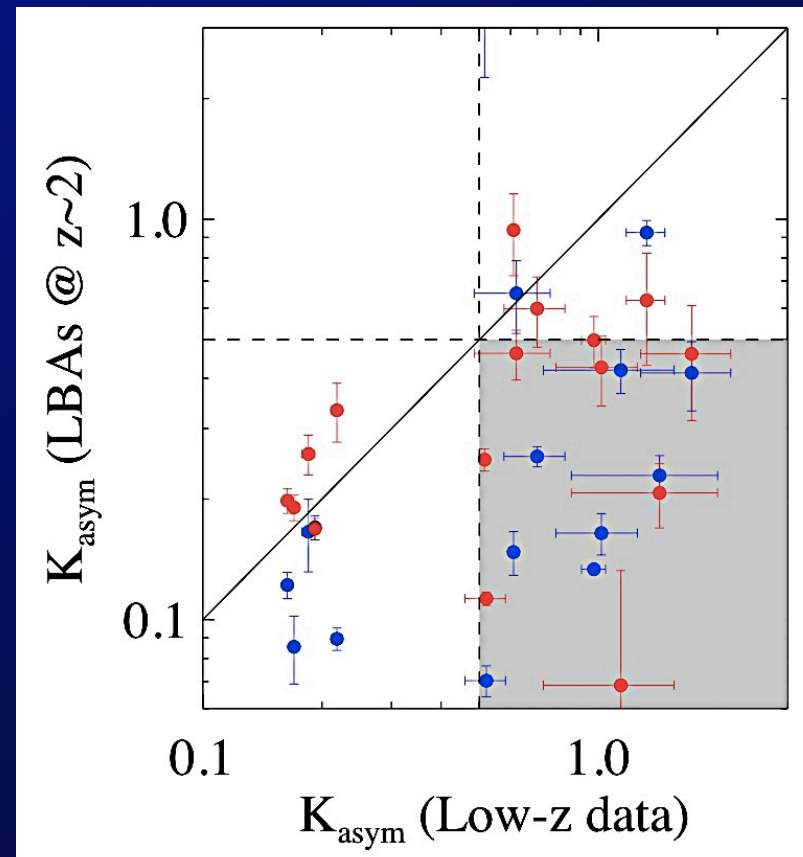
- Asymmetry measurement
- Distinction between mergers and rotating disks





Galaxies classified as rotating disks are more massive

High-redshift data underestimates the asymmetry levels



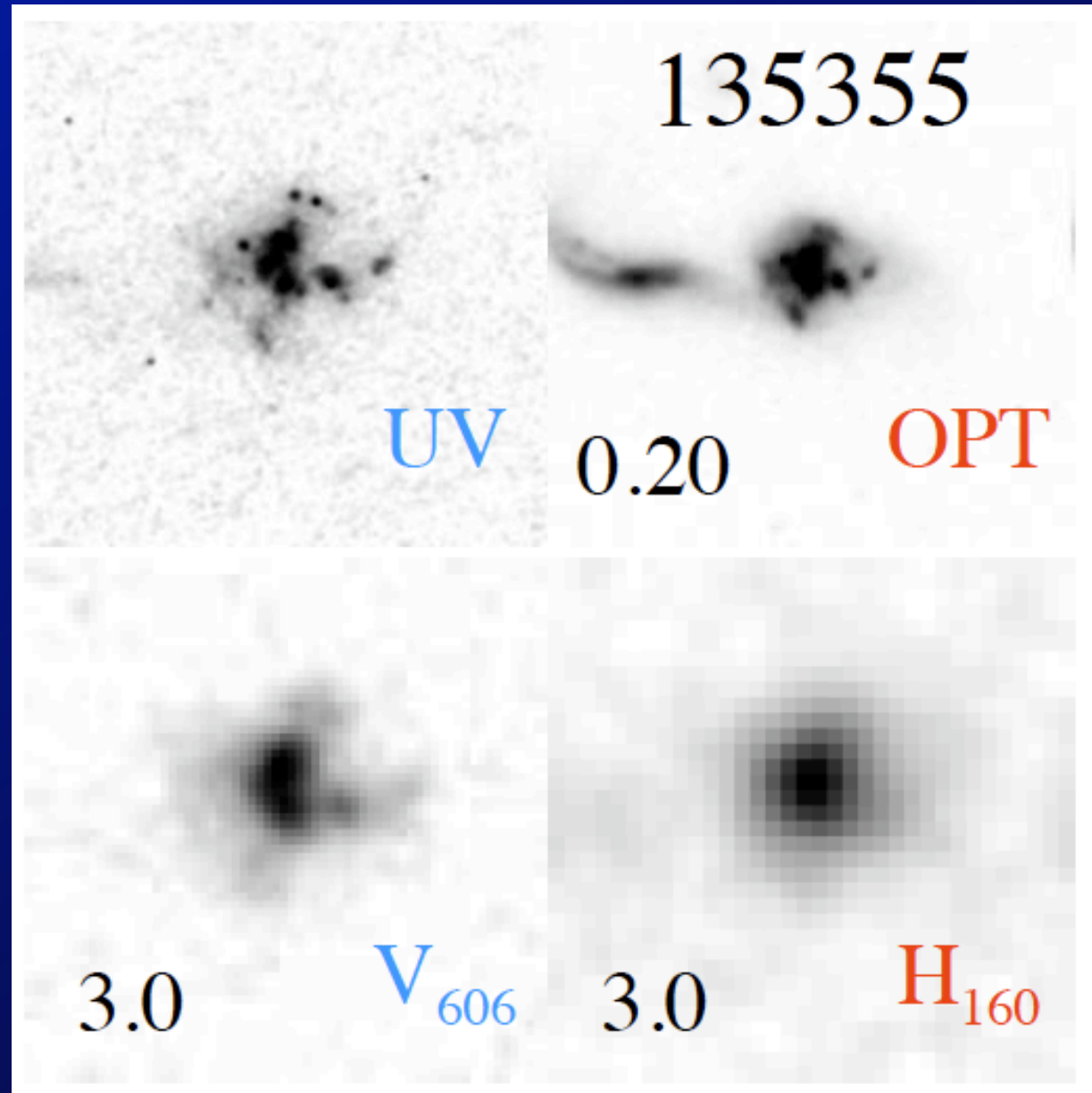
Gonçalves+10

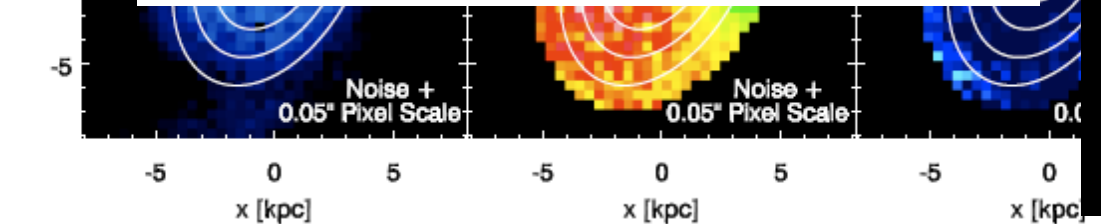
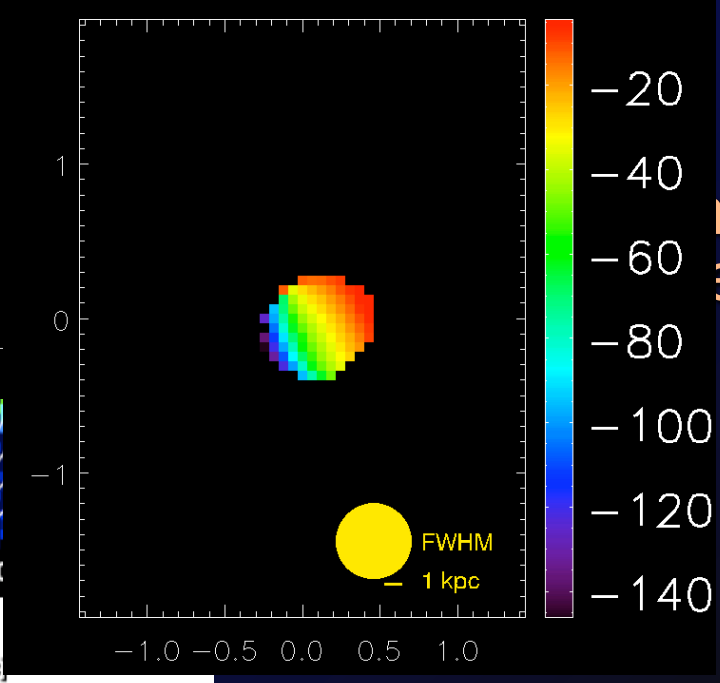
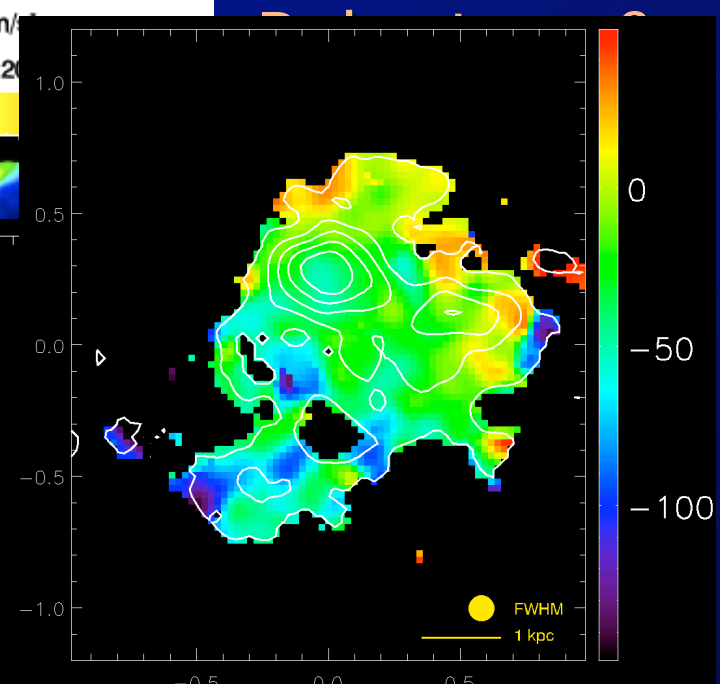
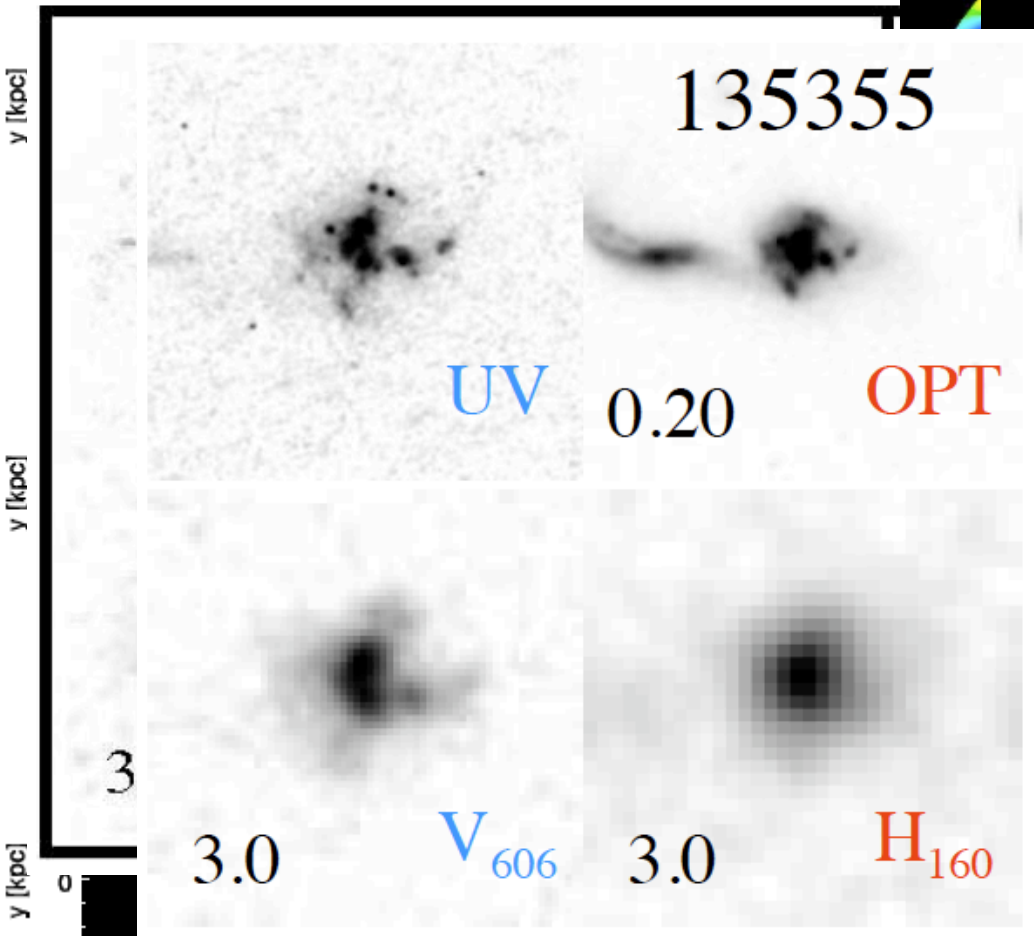
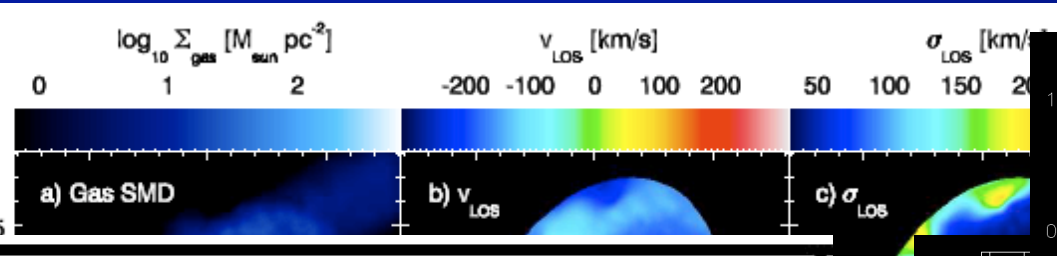
# Detectability of mergers

Mergers? Could we see that at high  $z$ ?

Relative importance of merging events at low and high redshift

Distinction between major and minor mergers

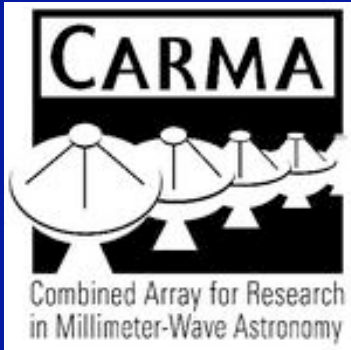




IS

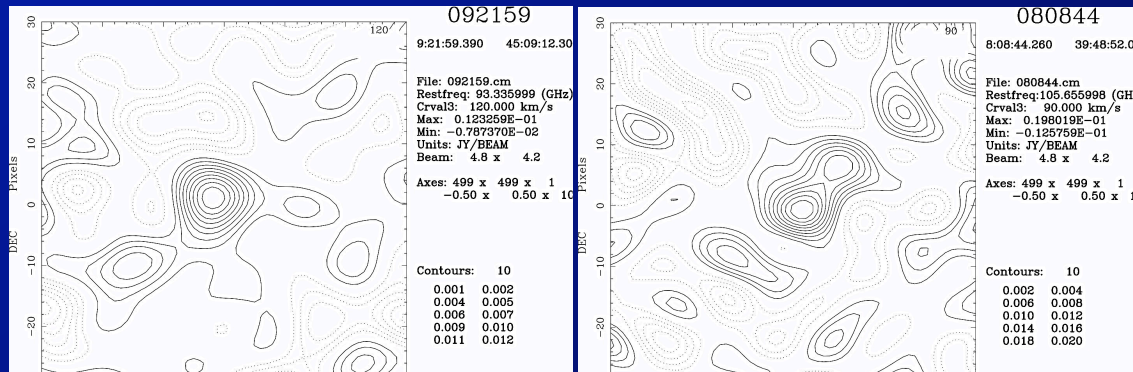
***The Molecular  
Gas in LBAs***



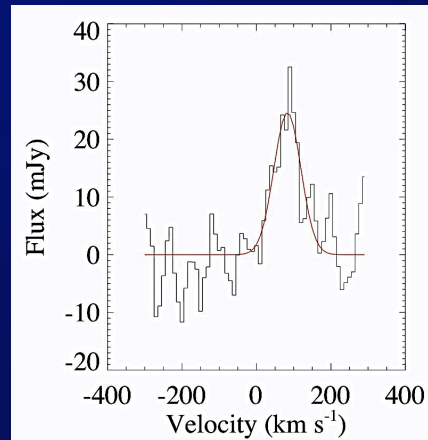
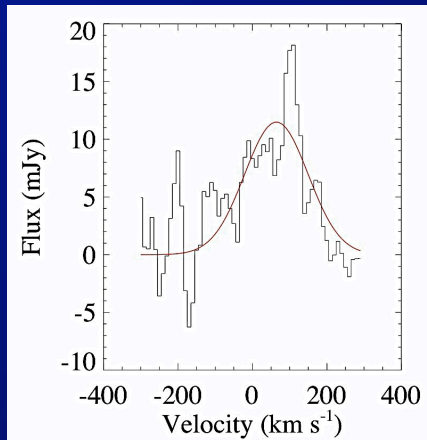


• CO(1-0) survey of Lyman break analogs with CARMA

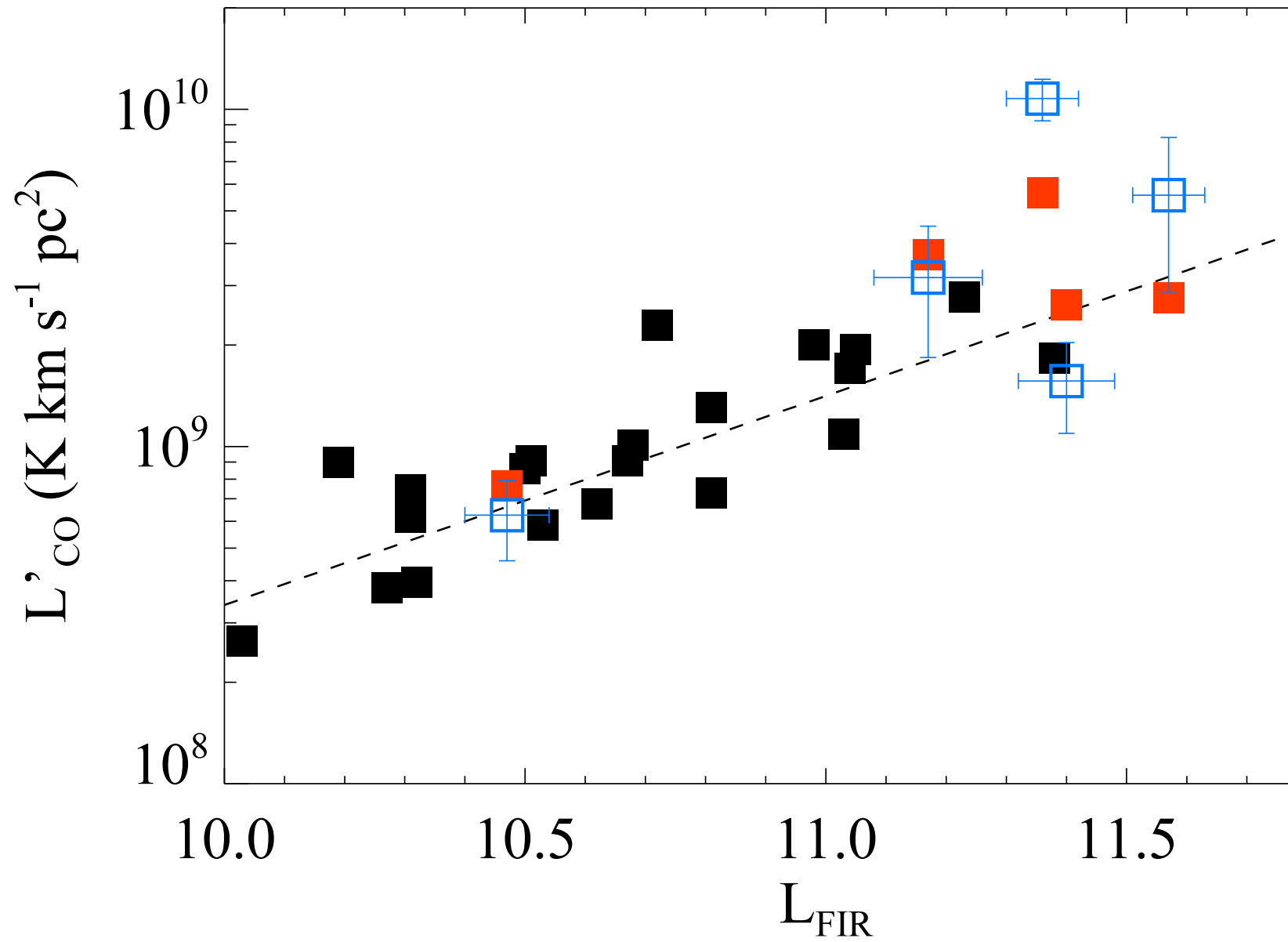
(PI: Gonçalves)

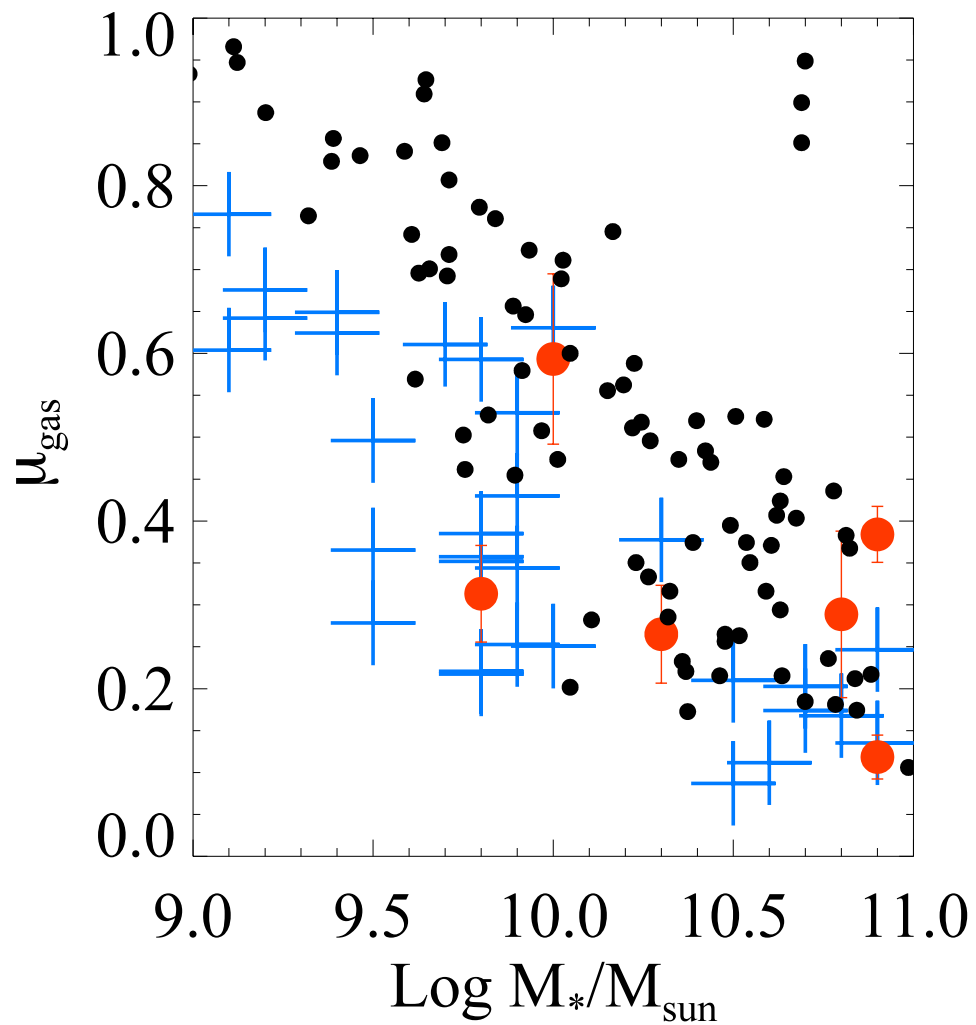


• ~100h awarded, ongoing



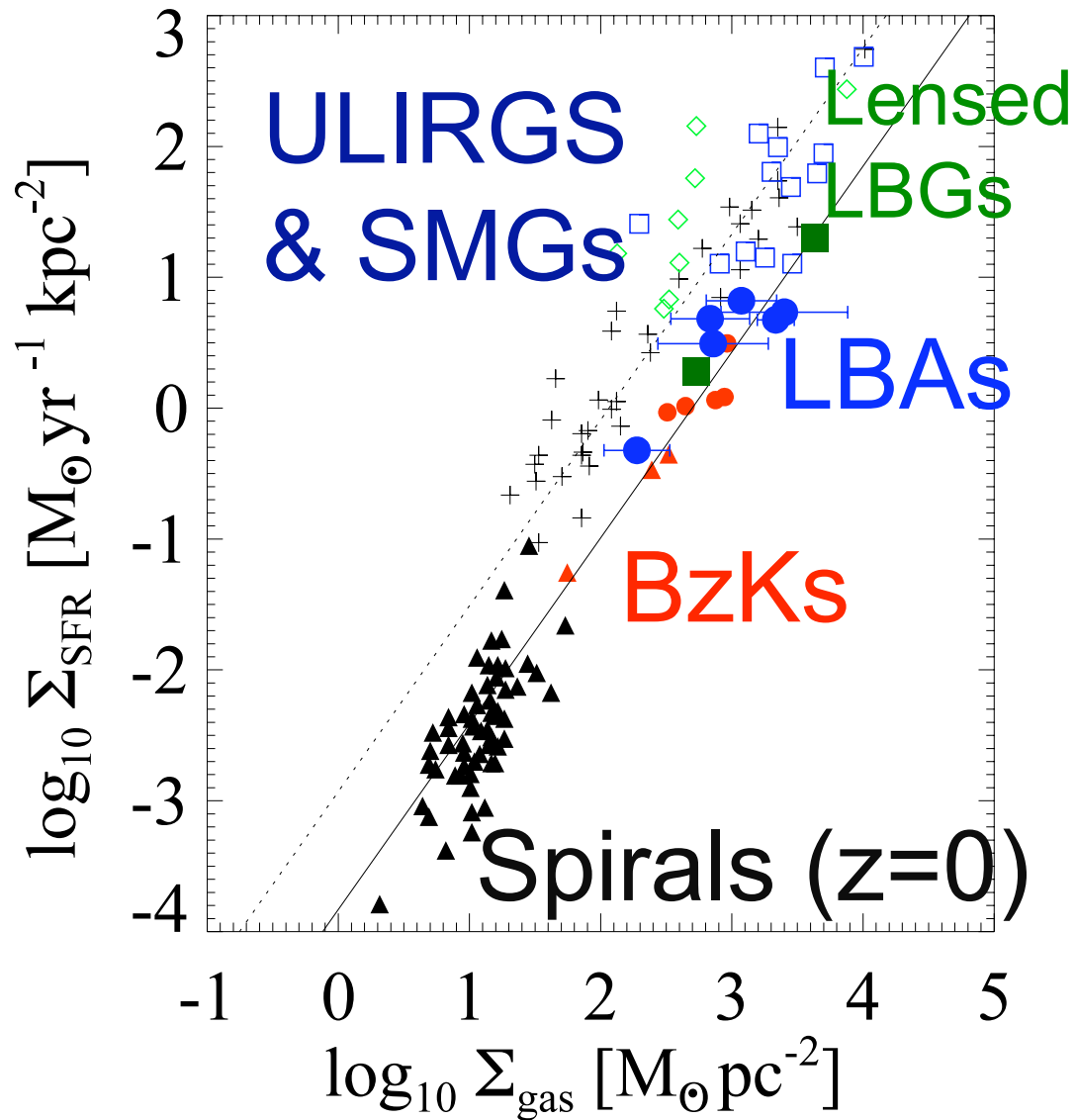
Gonçalves+11





- Gas fractions similar to LBGs

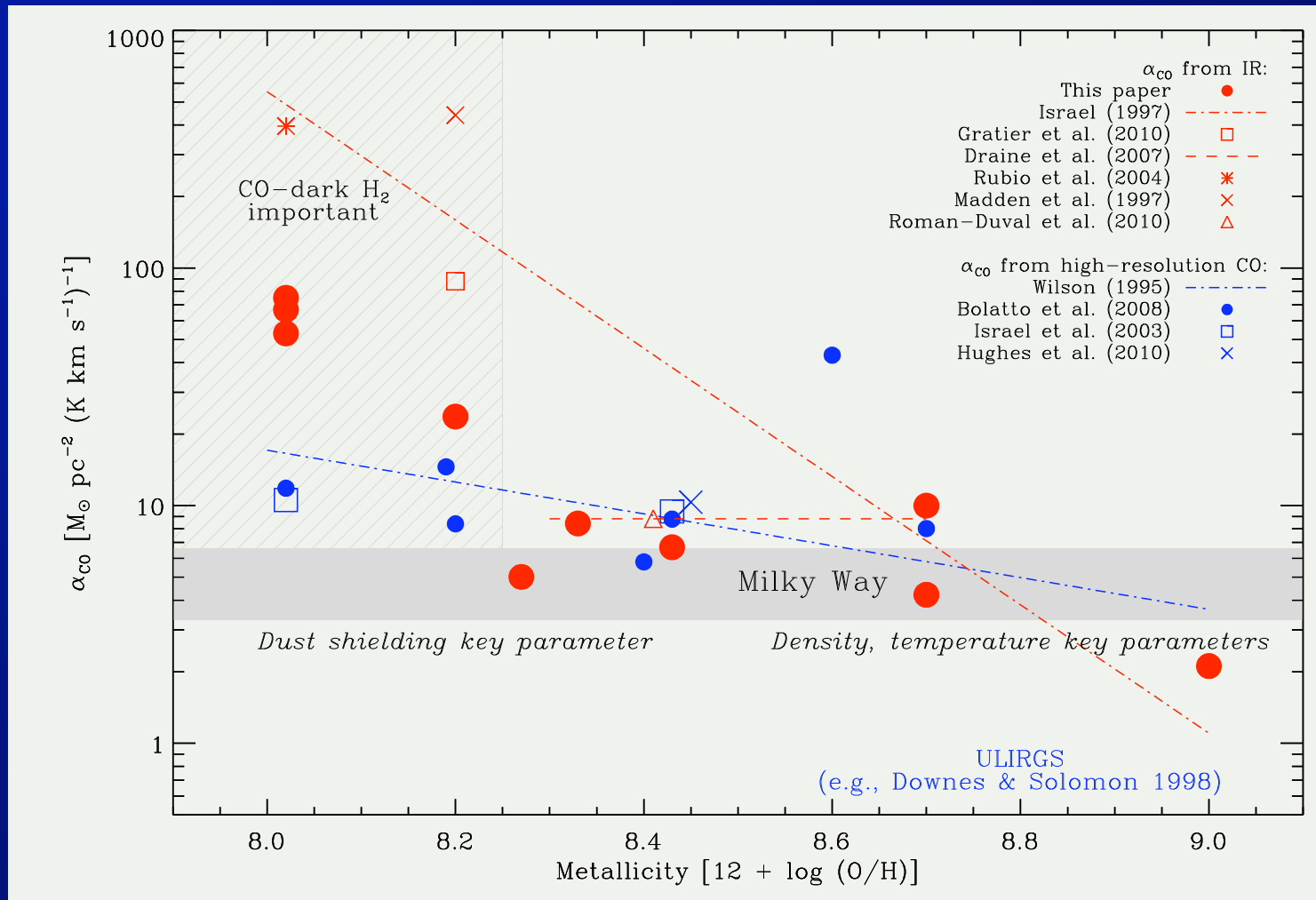
from Erb+06



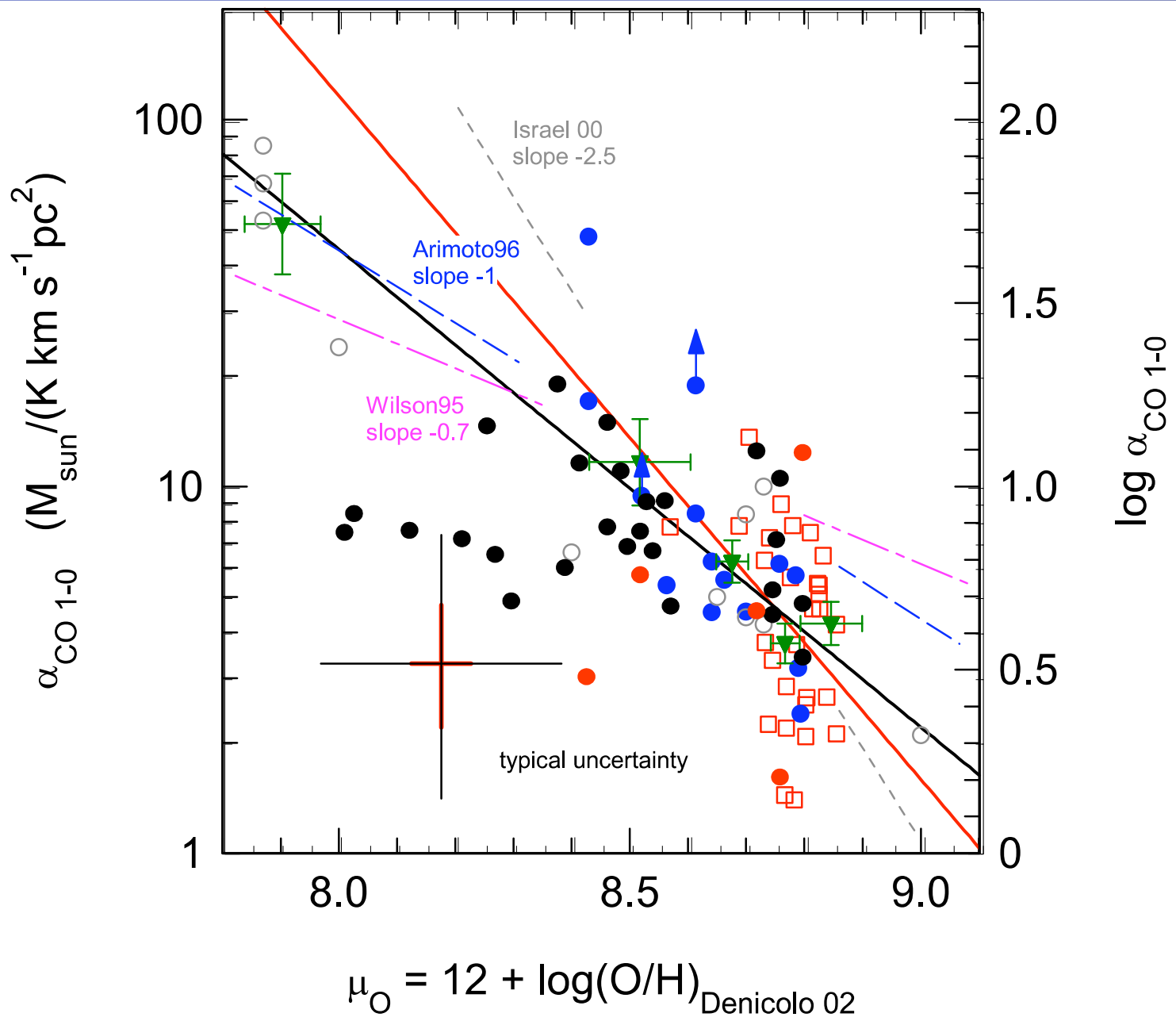
from Daddi+10



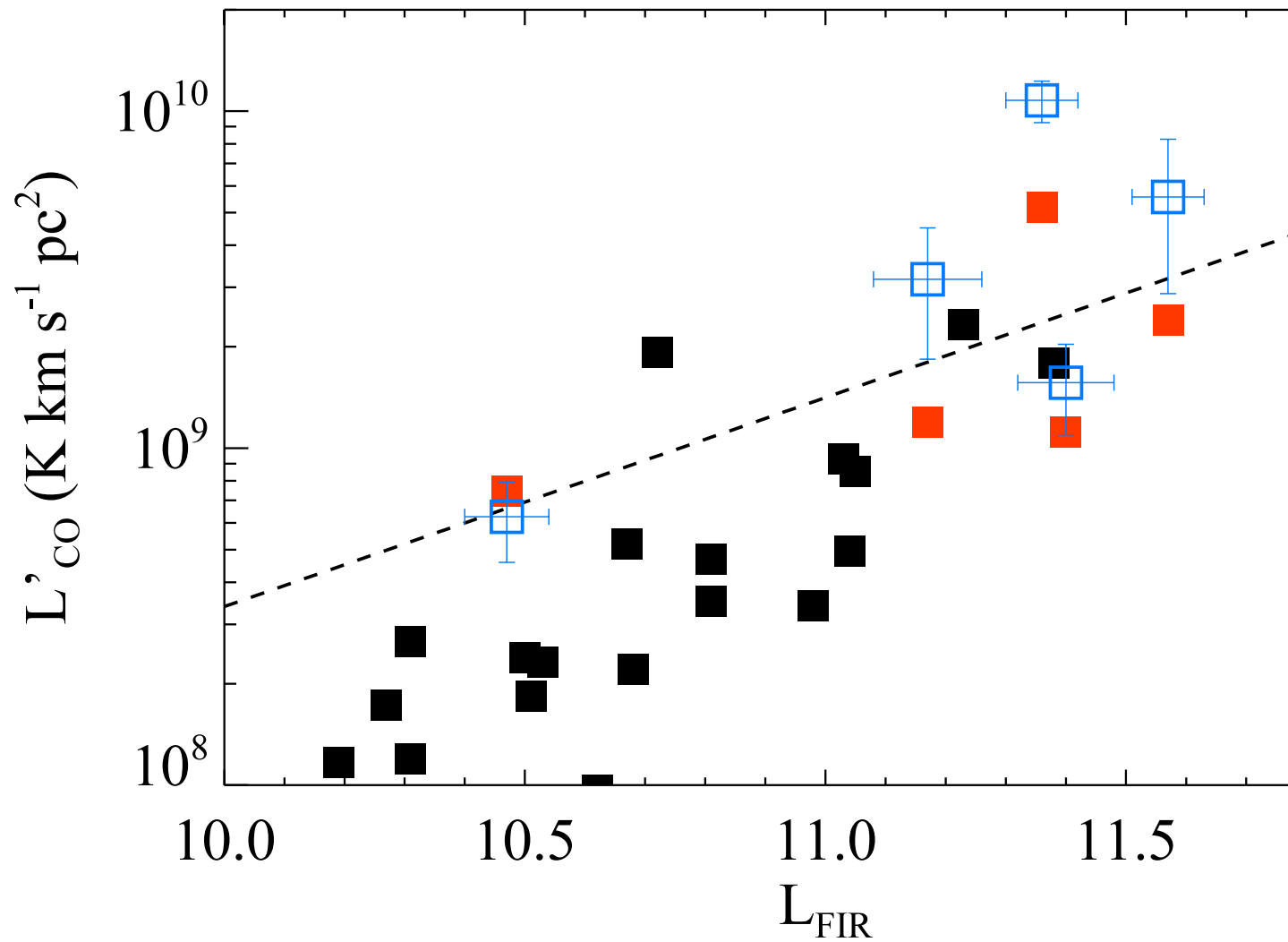
# The conversion factor?



Leroy+11



Genzel+ 11



S-K Law?  $\alpha(Z)$ ?  $L'(\text{CO})-L(\text{FIR})$ ?

***ALMA!***

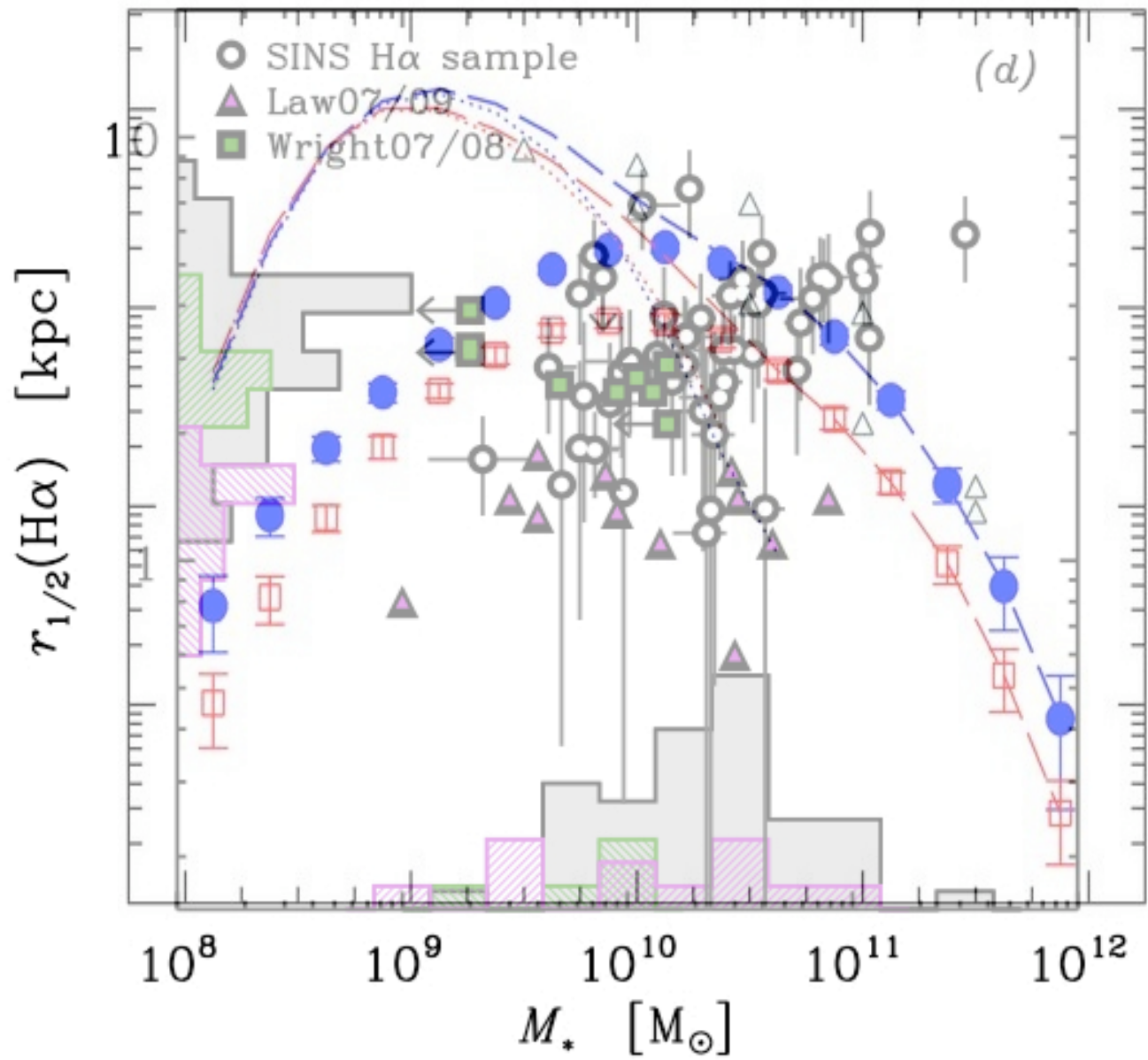
# Summary

- LBAs make an excellent case for local analogs to star forming galaxies at  $z \sim 2-3$
- Some detail might be lost due to SB brightness effects + loss of spatial resolution
- There is a clear trend of observed properties as a function of stellar mass
- Symmetry of gas kinematics is not a good diagnostic to rule out mergers as origin for the starburst

# Molecular gas

- Gas properties are similar to those of LBGs at high redshift
- LBAs appear to follow the same S-K relation as local galaxies
- The conversion factor?





Reddy & Steidel, 2009