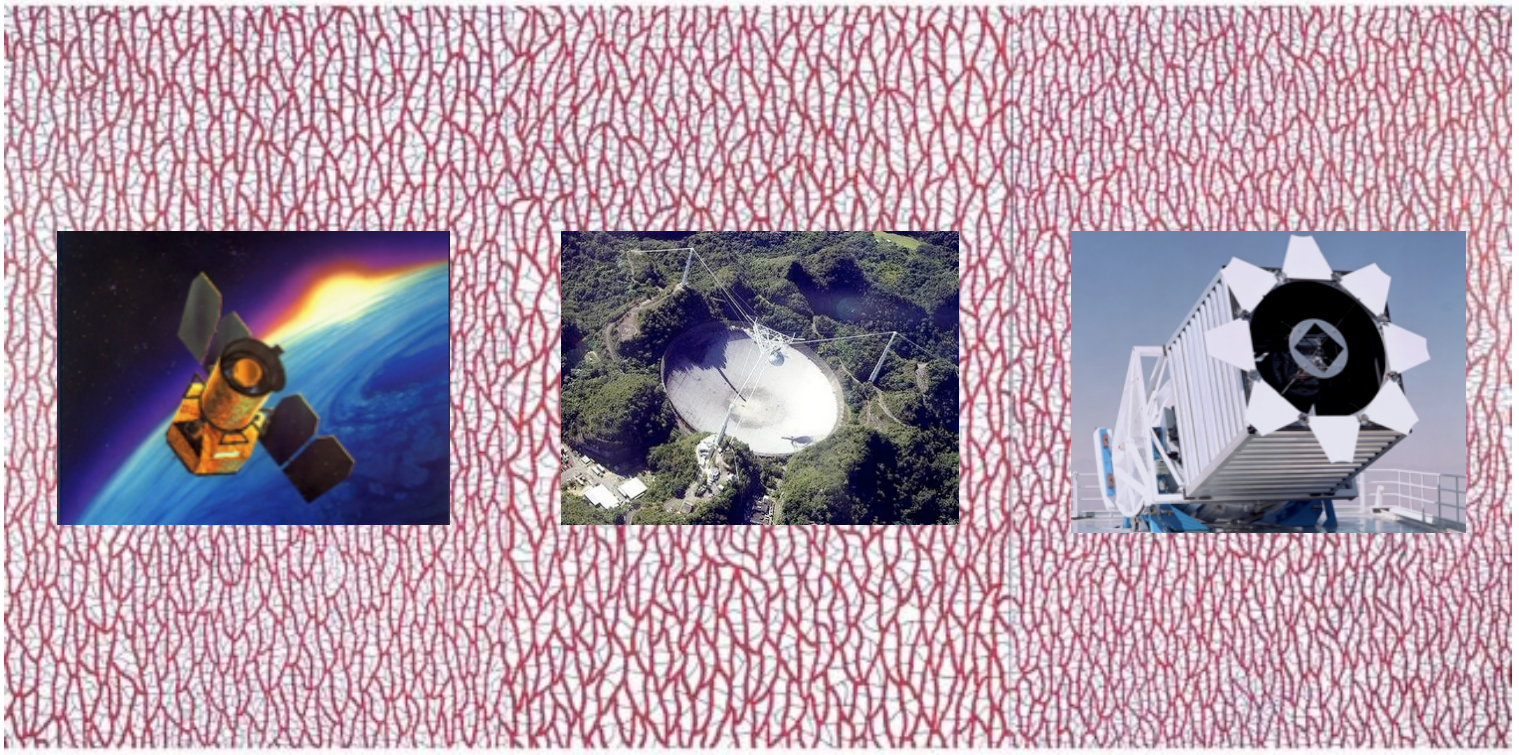


# The GALEX Arecibo SDSS Survey (GASS)

D. Schiminovich (Columbia University)
and GASS team

The Milky Way (triptych)
Yayoi Kusama

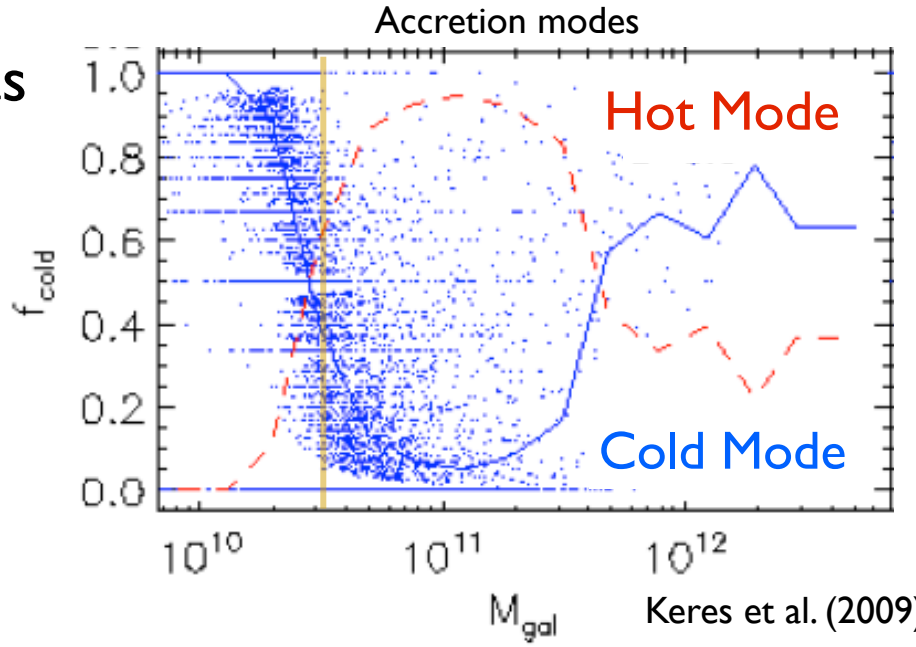
# Motivation: Understand the cold gas content of massive galaxies

$$\log M_\star \geq 10$$

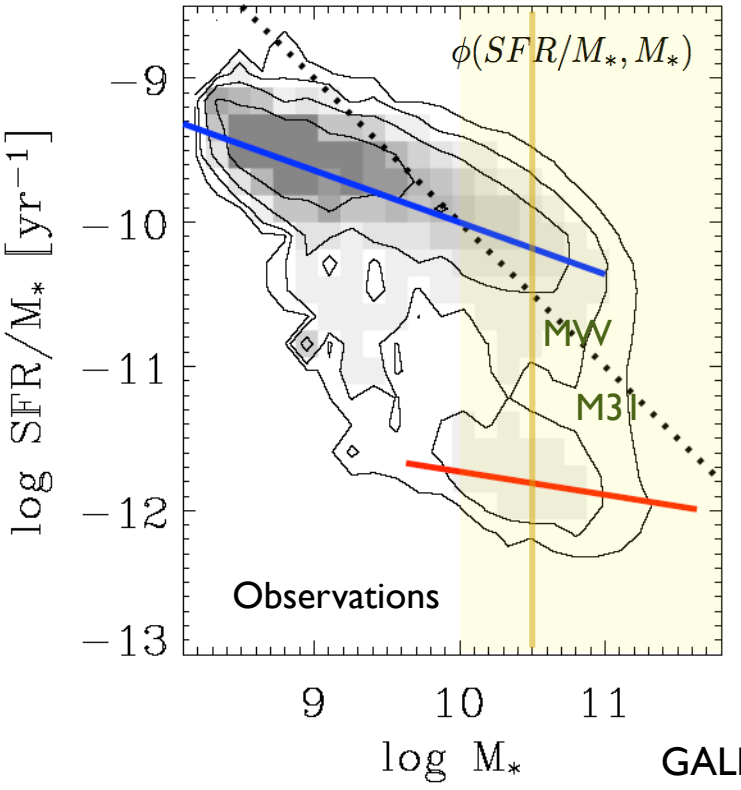
Probe transition in galaxy properties at $M_* \sim 3 \times 10^{10}\ M_{sun}$

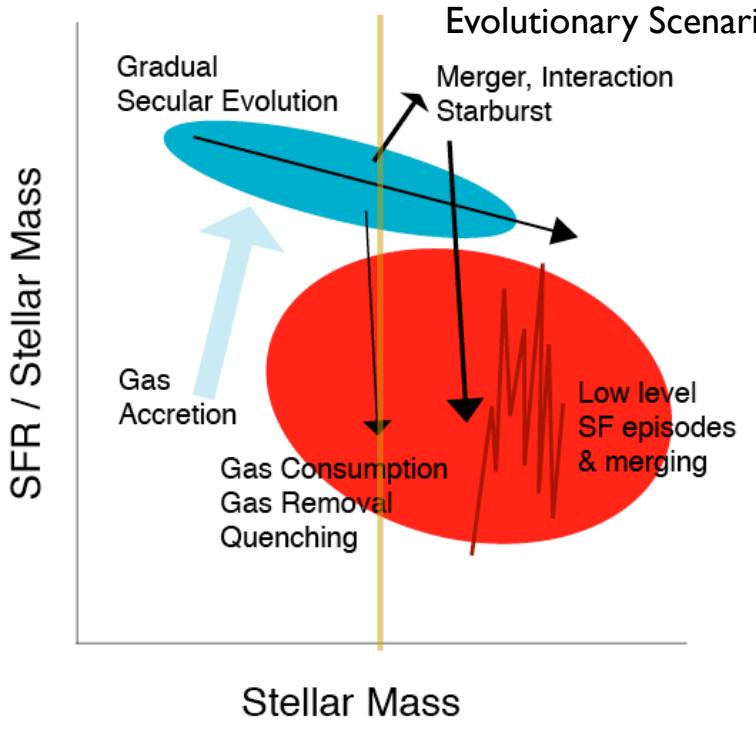
e.g. Kauffmann et al. (2003)

incl. formation of massive, red galaxies




Keres et al. (2009)




GALEX: DS, Wyder, Martin et al. (2007) & Salim et al. (2007)

# GASS: The cold gas content of massive galaxies

$$\log M_\star \geq 10$$

- HI survey of ~1000 galaxies selected from SDSS main galaxy sample
- Redshift range: 0.025<z<0.05 (110-220 Mpc)
- Footprint: Overlap of ALFALFA HI survey, SDSS (sp), and GALEX
- Depth: *HI mass fraction limit* — $f_{gas}$>0.02 (typ. log $M_{HI}$>8.5-9)
- Arecibo large program (~1000 hours), initial observations in 2008.
- Public Release: DR1 w/ 20-25% of survey (Catinella et al. 2010)

*First statistically significant sample of massive "transitional" galaxies with homogeneously measured stellar masses, SFR and gas properties.*

- "Sweet spot" in terms of taking full advantage of data from on-going wide field surveys (e.g. SDSS, GALEX, WISE)
- Complementary to Arecibo blind, large area surveys (ALFALFA, AGES); useful for planning future deep EVLA and pathfinder HI surveys

Barbara Catinella

Sean Moran

Arecibo control room

# GASS Team

DS, Catinella, Kauffmann, Heckman, et al.

+ Jing Wang, Andrew Cooper

Silvia Fabello

Ronin Wu

Jenna Lemonias

Cameron Hummels

# GASS Team

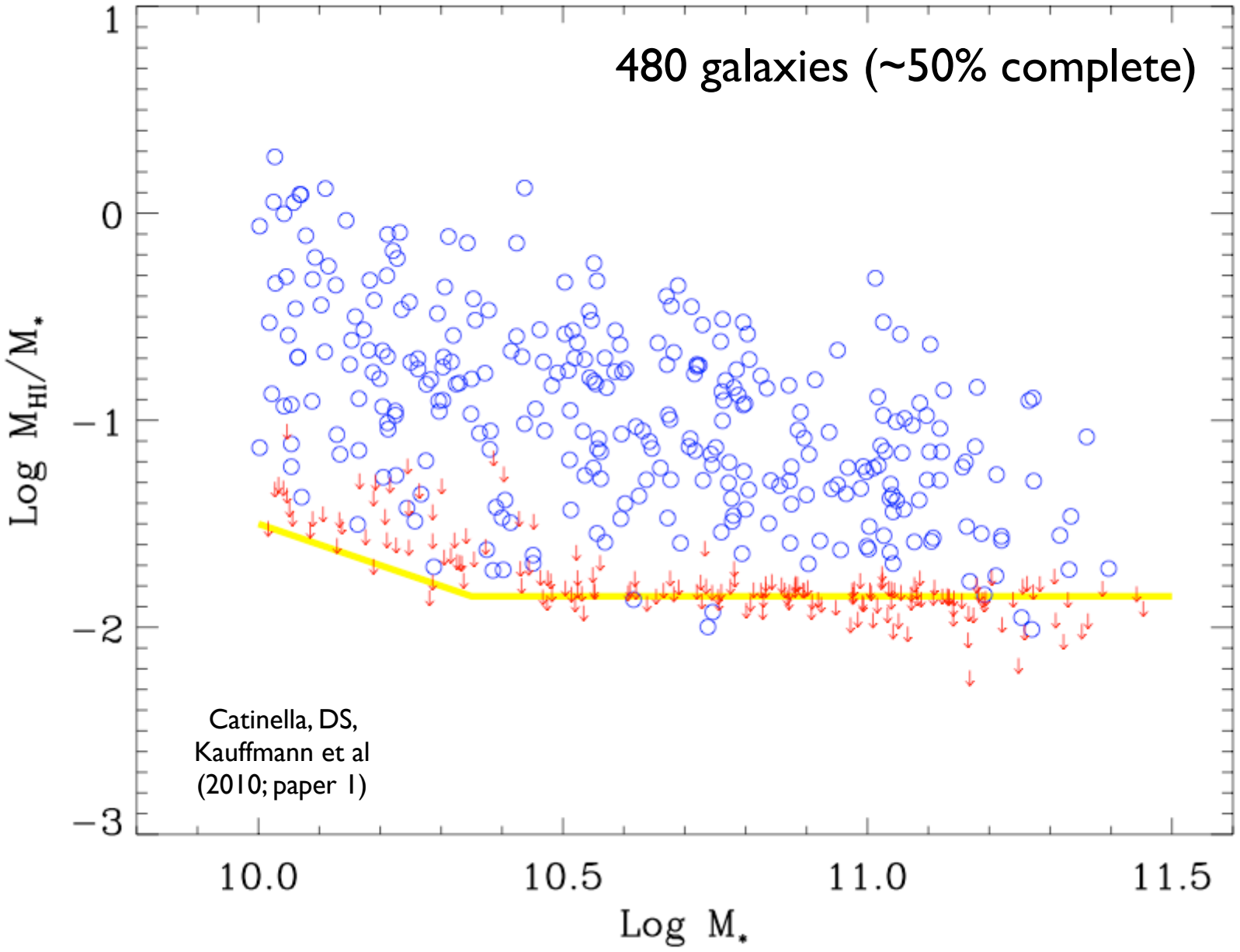
| Name | Affiliation | Specific tasks |
|---|---|---|
| D. Schiminovich | Columbia | Principal Investigator. Survey management, observing, HI follow-up |
| M. Blanton | NYU | HI follow-up, complementary analysis (SDSS, local samples) |
| J. Brinchmann | Leiden | SDSS corollary analysis, spectroscopy follow-up |
| T. Budavari | JHU | Archiving, SDSS and GALEX corollary analysis |
| B. Catinella | MPA | Observing and data analysis lead, web dev., ALFALFA, HI follow-up |
| S. Fabello* | MPA | Observing and data analysis, ALFALFA data stacking |
| R. Genzel | MPE | CO follow-up |
| R. Giovanelli | Cornell | Coordination with ALFALFA, adaptation of ALFALFA software |
| J. Gracia-Carpio | MPE | CO follow-up |
| T. Goncalves* | CIT | GALEX corollary analysis |
| M. P. Haynes | Cornell | Coordination with ALFALFA, NVO data access |
| T. Heckman | JHU | SDSS and GALEX corollary analysis |
| D. Hogg | NYU | SDSS corollary analysis |
| C. Hummels* | Columbia | Observing |
| B. Johnson | Cambridge | GALEX corollary analysis |
| G. Kauffmann | MPA | Theory, SDSS corollary analysis |
| R. Kennicutt | Cambridge | Complementary analysis (local comparison samples) |
| J. Lemonias* | Columbia | Observing, HI follow-up, GALEX corollary analysis |
| C. Li | MPA | Corollary analysis, theory |
| B. Madore | OCIW | Corollary analysis |
| C. Martin | CIT | GALEX corollary analysis, spectroscopy follow-up |
| S. Moran | JHU | Observing, spectroscopy follow-up |
| R. Overzier | MPA | GALEX corollary analysis |
| M. Rich | UCLA | GALEX corollary analysis, spectroscopy follow-up |
| A. Saintonge | MPE/MPA | CO follow-up |
| L. Tacconi | MPE | CO follow-up |
| D. Thilker | JHU | HI follow-up, complementary analysis (GALEX, local samples) |
| L. Vican** | Columbia | HI follow-up, GALEX corollary analysis |
| J. Wang* | MPA | GALEX corollary analysis |
| V. Wild | MPA | Theory, spectroscopy follow-up |
| R. Wu* | NYU | Observing, GALEX corollary analysis |
| T. Wyder | CIT | Complementary analysis (GALEX, local comparison samples) |

# GASS Current Status

- Goal: ~1000 galaxies, including 20% from ALFALFA, existing HI archives.
- Observations on-going (~250 hours/year)
- ~70% complete (75% by mid-September).
- Final observing season Winter/Spring 2011-2012
- Next data release: 50% of data have been fully reduced. DR2 release in coming months (480 galaxies)
- First results in several papers last year: Catinella et al.; DS et al.; Moran et al.; Wang et al.; Fabello et al. (2010)

These and new results in this session + Kauffmann after lunch
Saintonge (Thursday) and Lemonias (poster)

# GASS is unlike most typical surveys: *HI mass fraction limit*



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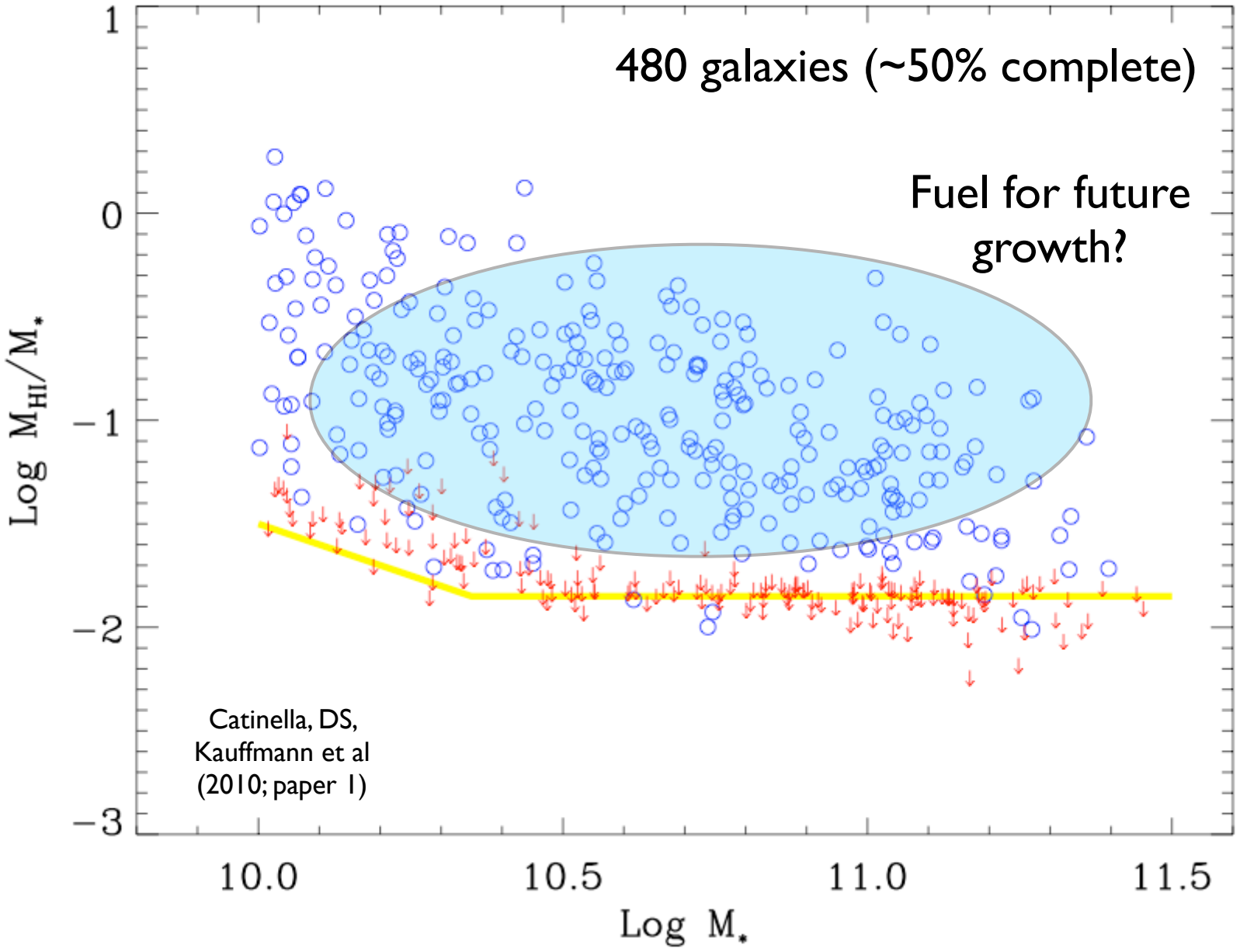

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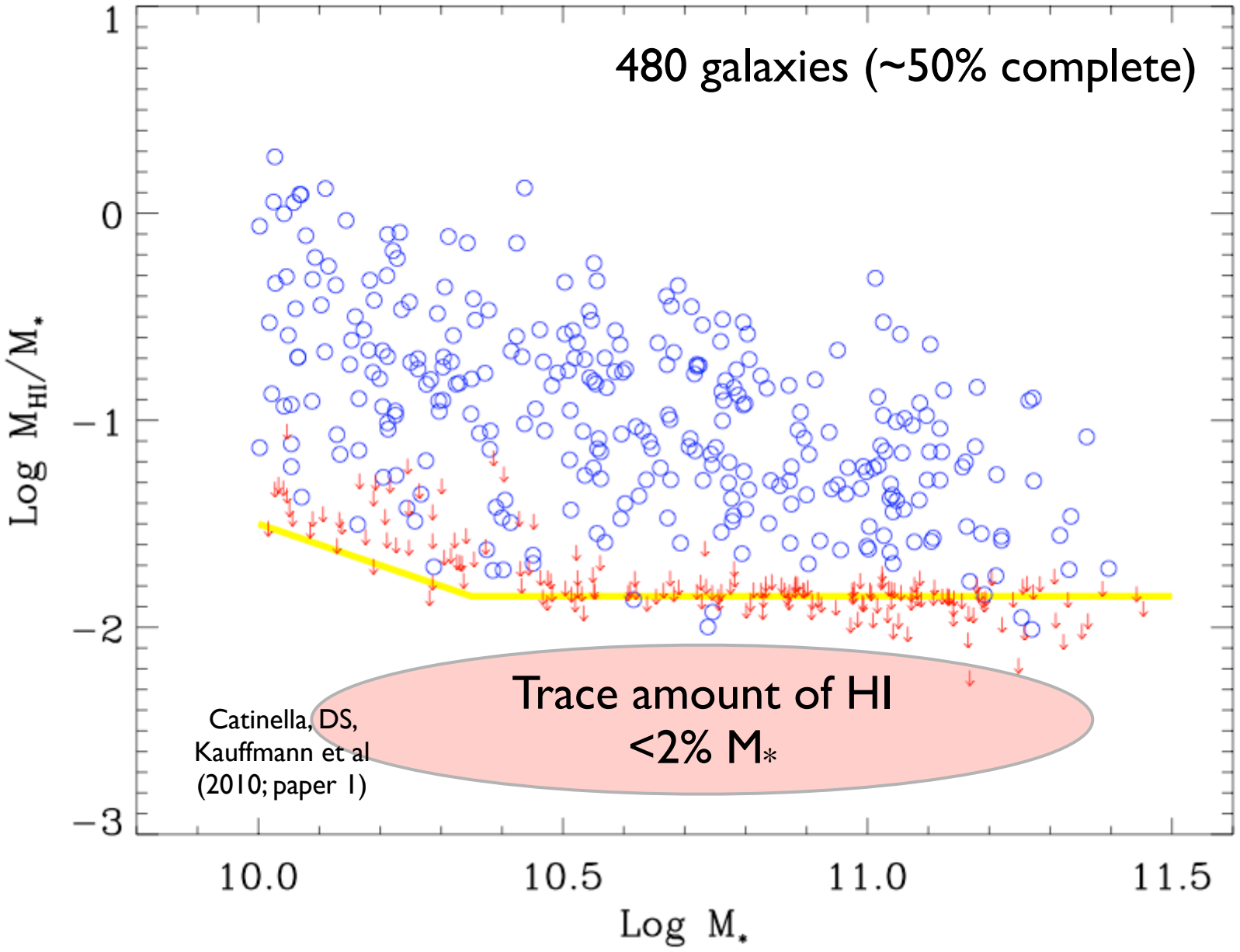
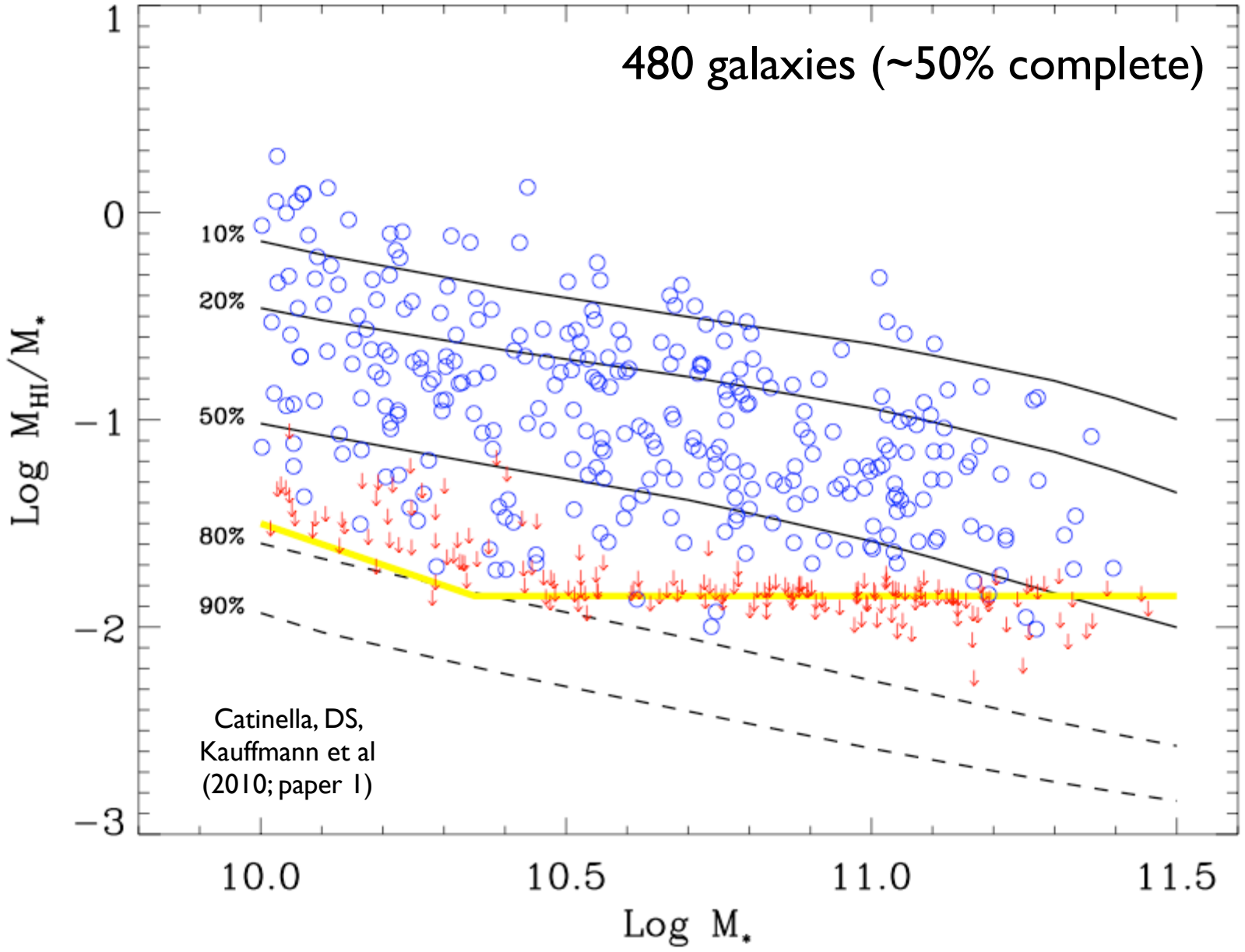


# GASS detects HI in most massive galaxies



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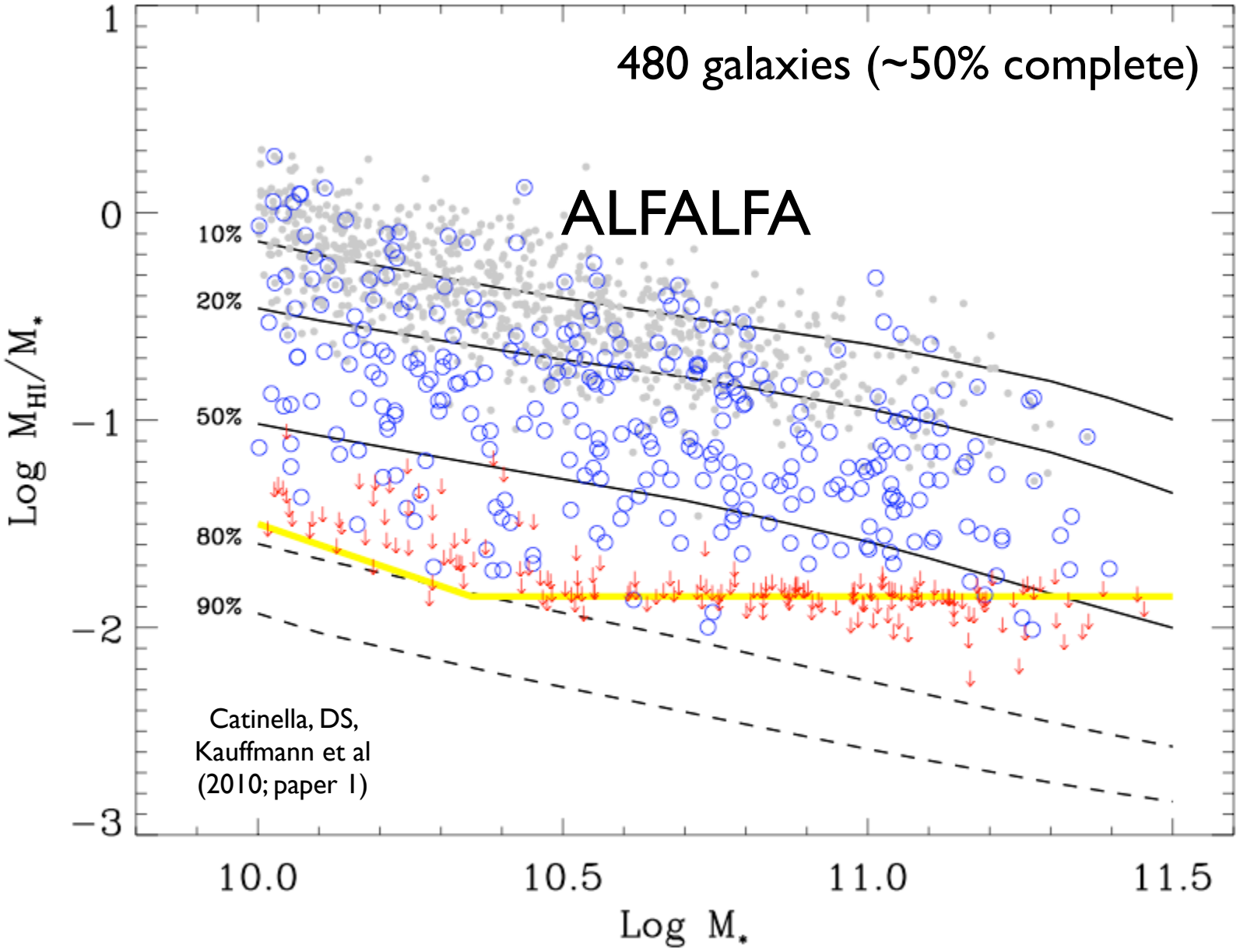
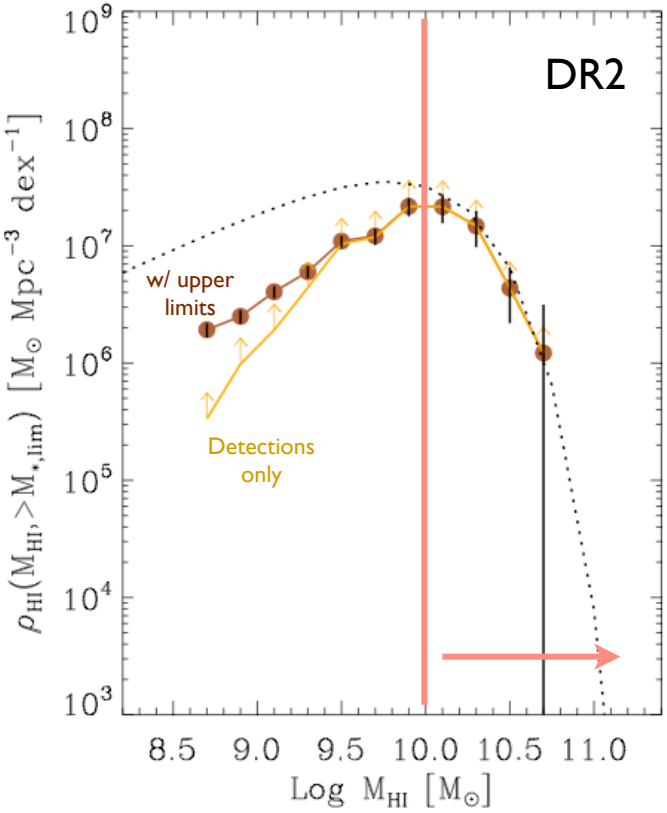
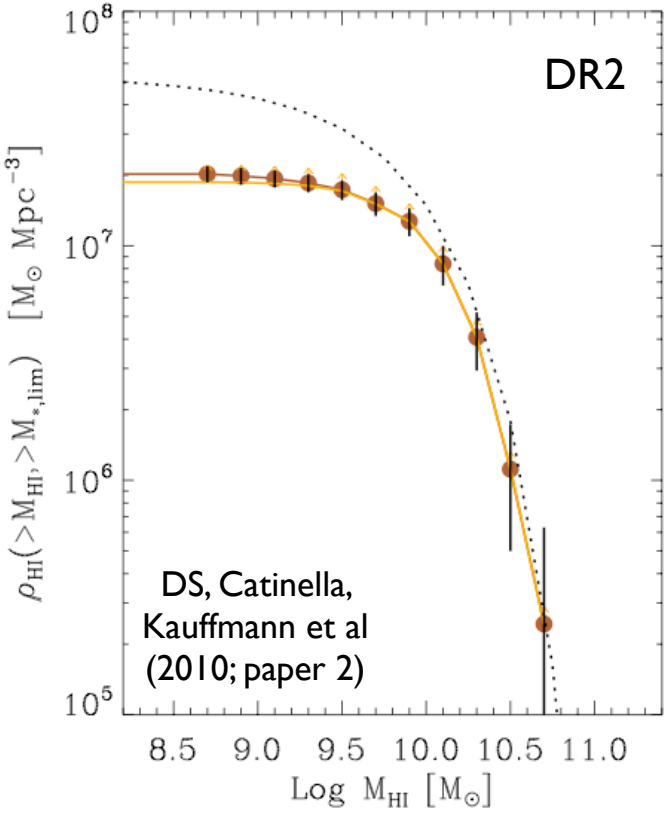


# GASS selection enables measurement of HI distribution functions

HI Mass density function for massive galaxies




Cumulative HI Mass density function




Nearly all galaxies with ($\log M_{HI} > 10$) are massive ($\log M_* > 10$)

... converse is not true

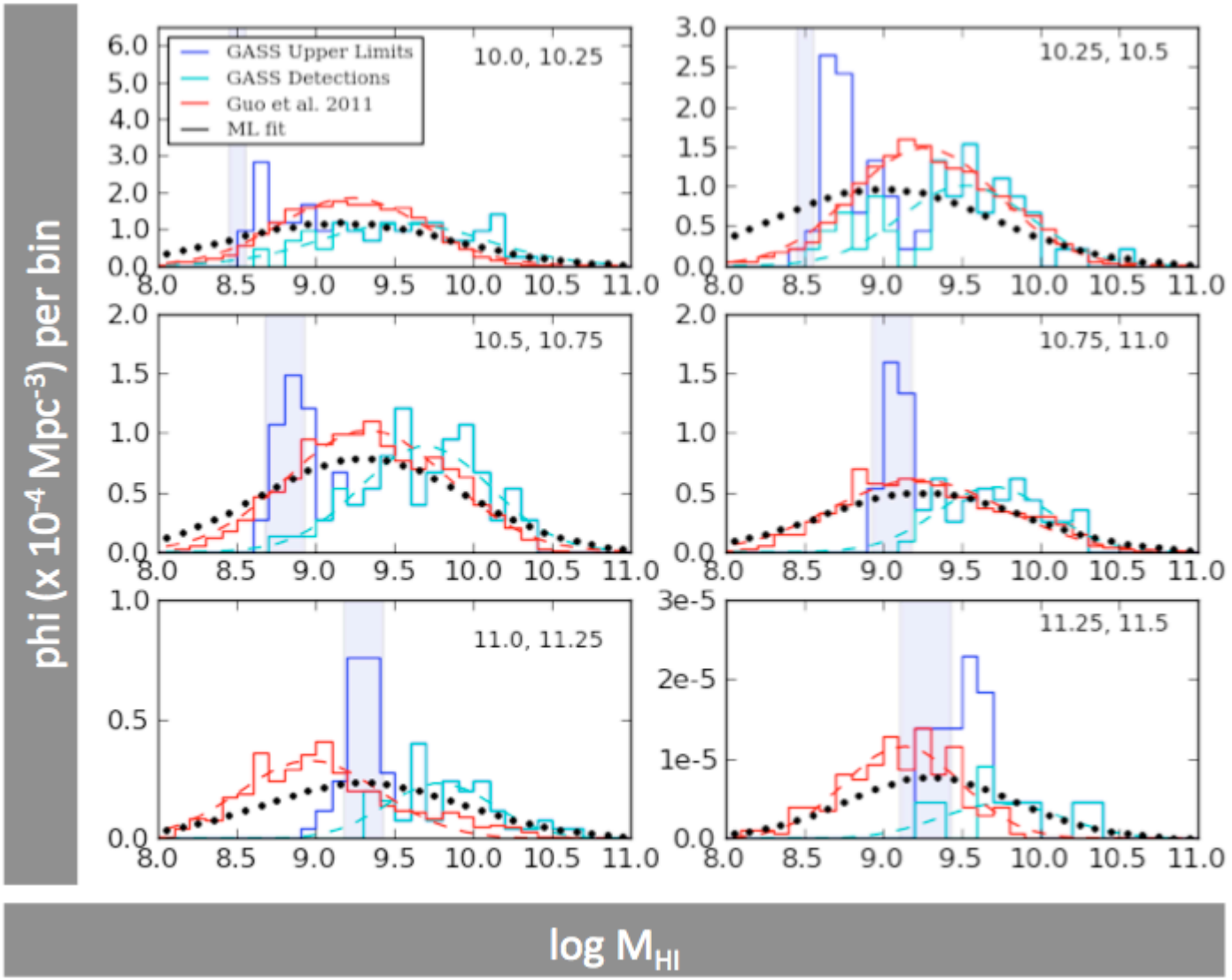
~40% of HI in local universe is found in GASS galaxies ($\log M_* > 10$)

.... and ~50% of total SFR density

Cumulative HI mass density

$$\rho_{HI}(\log M_\star > 10) = \int_{10^{10}}^{\infty} \int_{0}^{\infty} M_{HI}\phi(M_{HI}, M_\star) dM_{HI} dM_\star$$

# GASS selection enables measurement of HI distribution functions



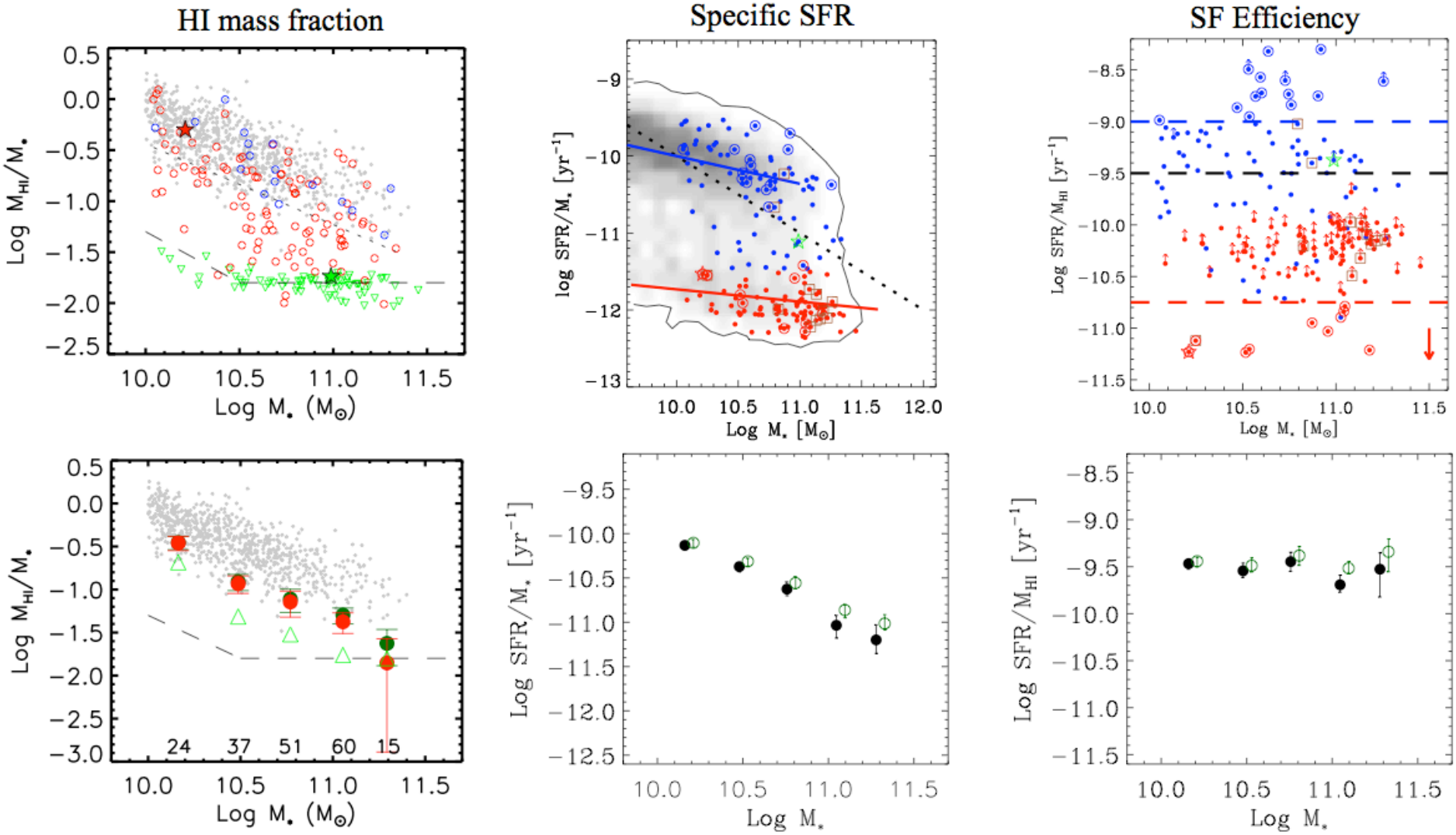

Bivariate distribution function

$$\phi(M_{HI}, M_{\star})$$

with simple ML fit:
Schechter ($M_*$)
x lognormal ($M_{HI}$)

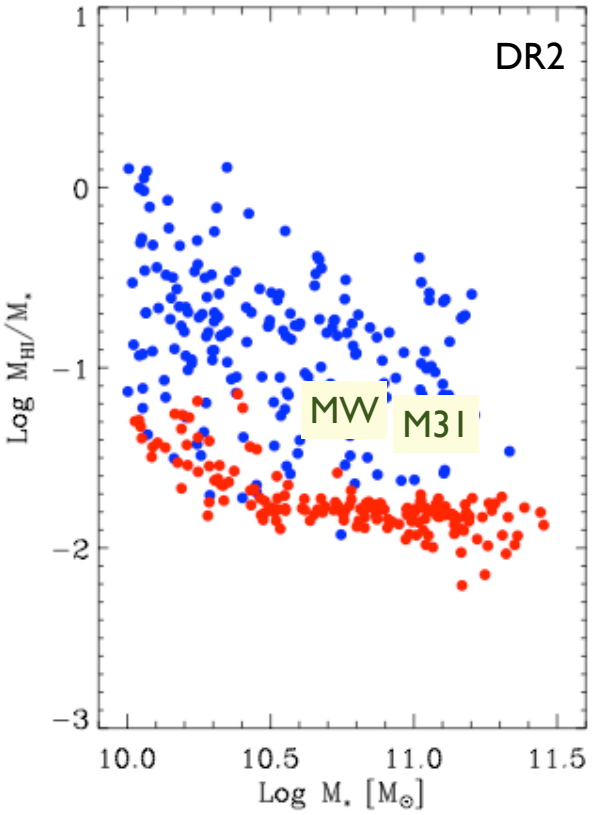
see Lemonias poster, this meeting

# Gas and SFR scaling relations

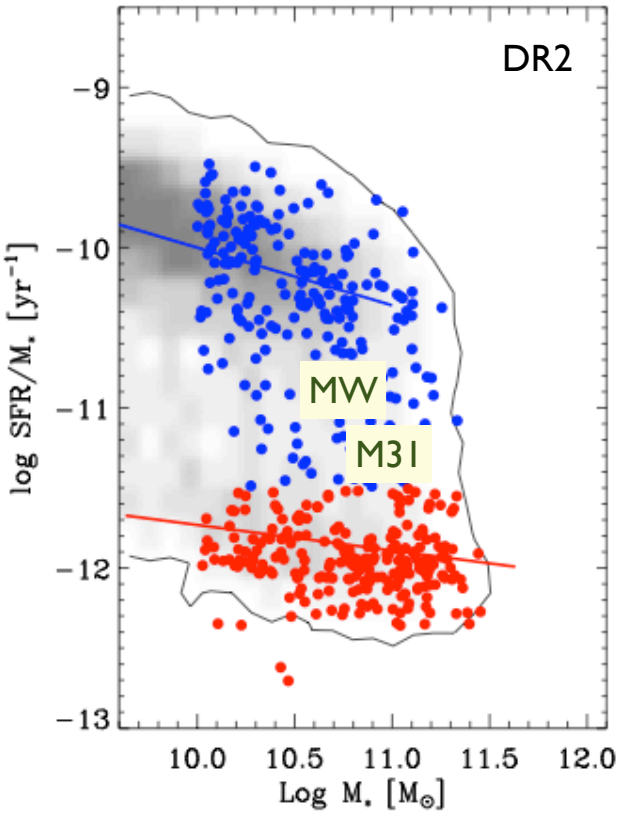


# Gas and SFR scaling relations

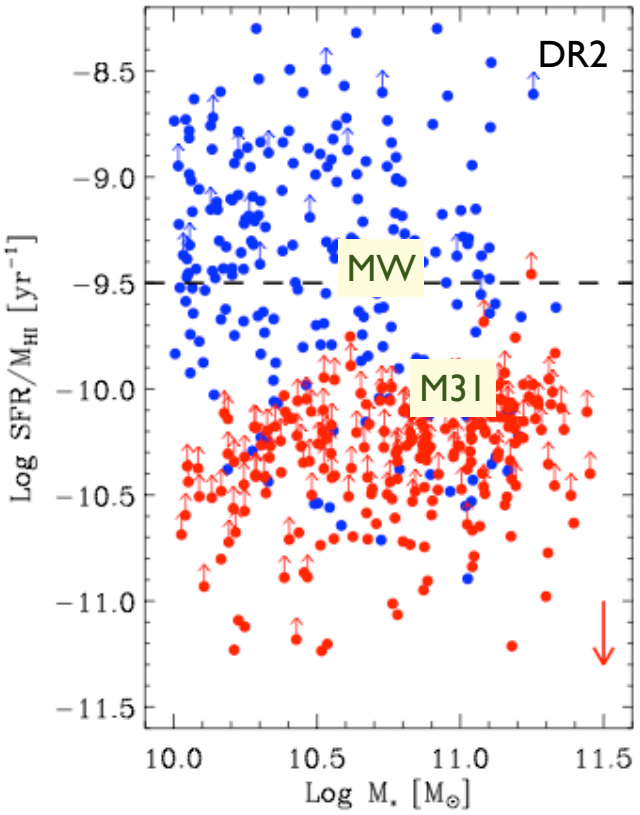
HI Mass Fraction




Specific SFR (SFR/$M_*$)



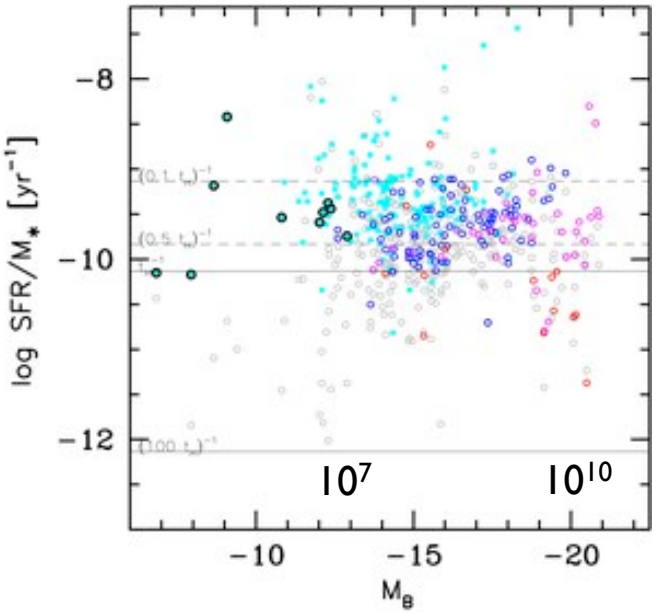

SFR Efficiency (SFR/$M_{HI}$)



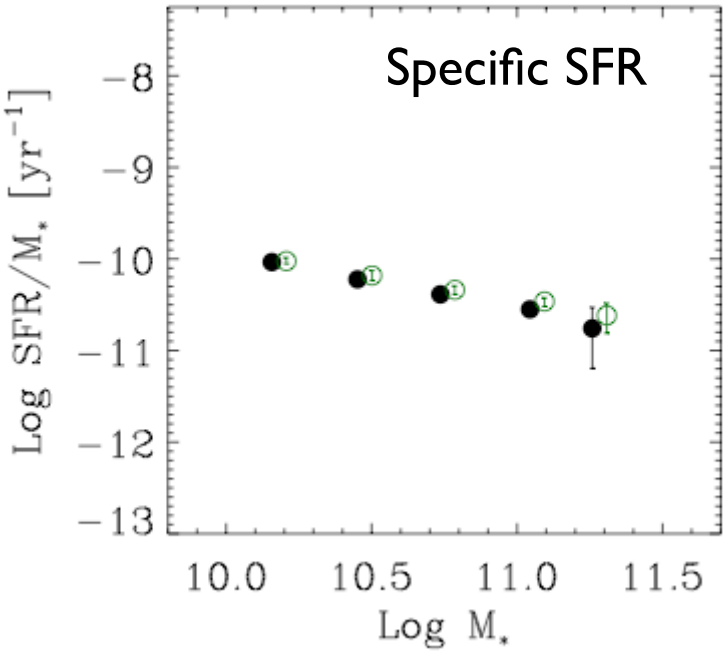

Mutch et al. (2011)

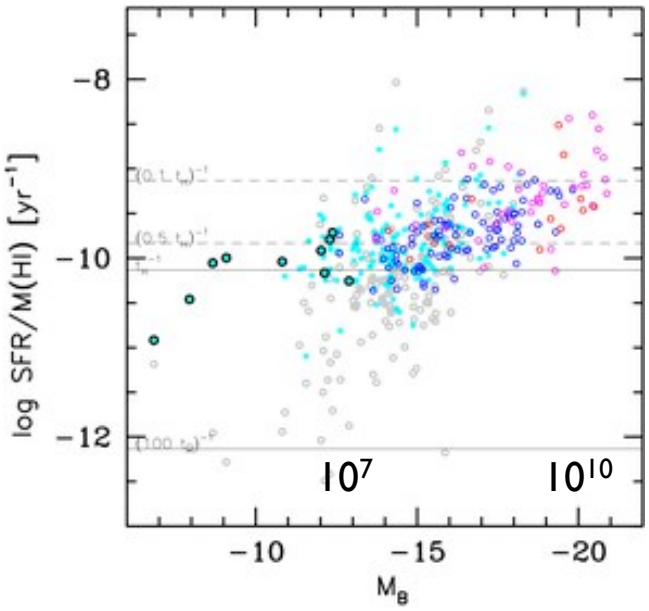
# Gas and SFR scaling relations

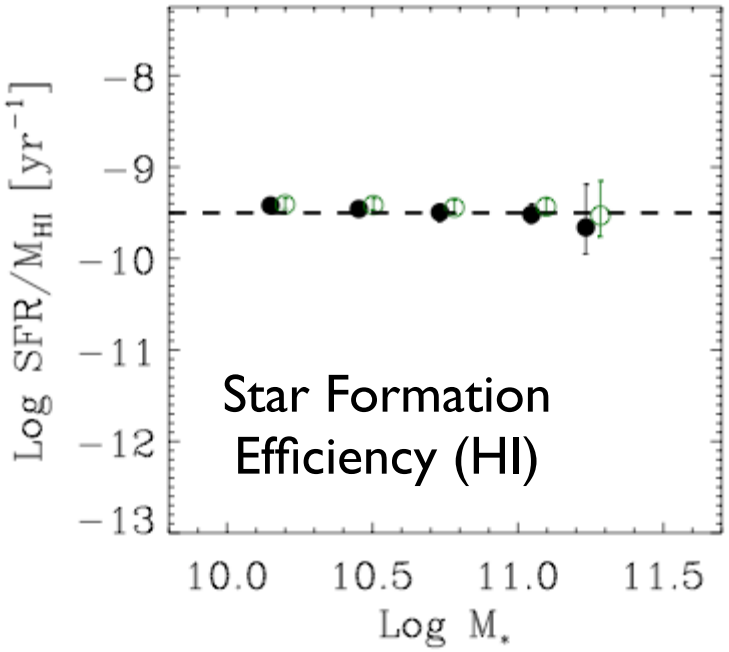
11HUGS/LVL (log $M_* < 10$)




GASS (log $M_* > 10$)



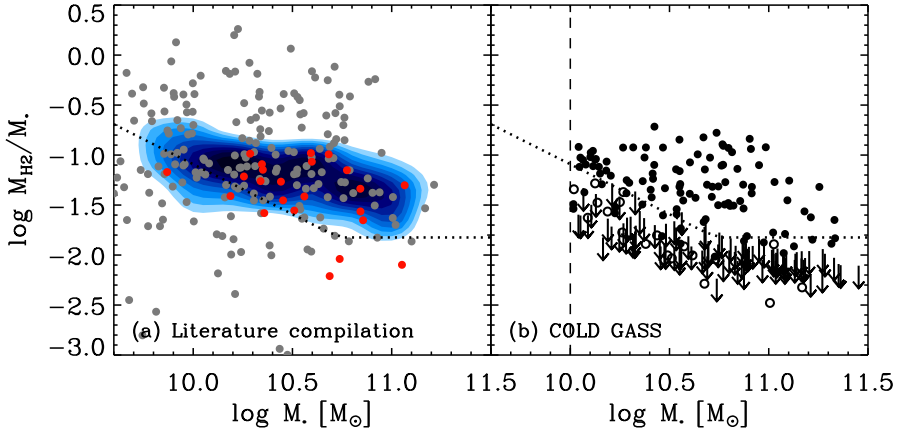




What might this be telling us about:
1) how gas accretes onto galaxies?
2) how star formation is quenched?

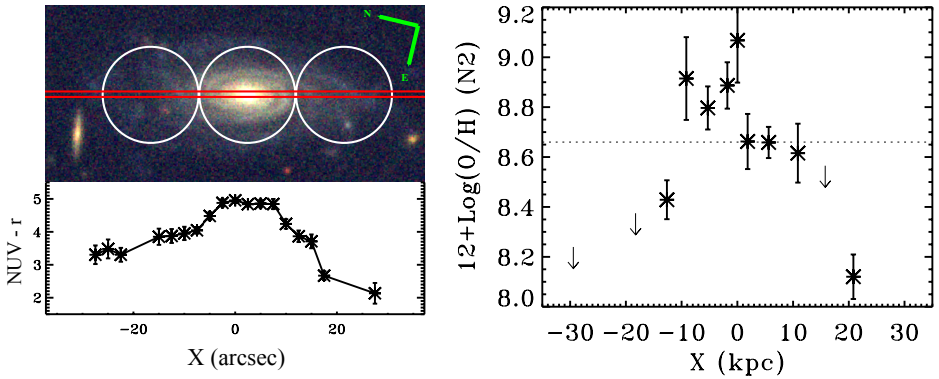
GASS vs. 11HUGS, Local Volume Legacy Survey; Lee et al (2010)

# GASS Corollary Projects

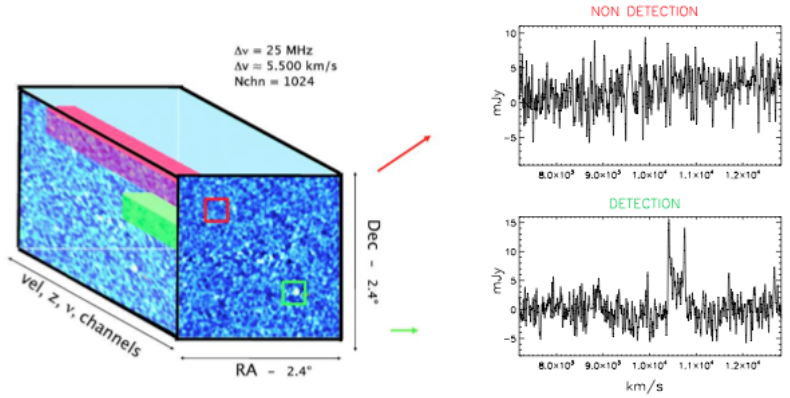
## COLDGASS - CO ($H_2$) survey, IRAM 30m
## ~350 galaxies (Saintonge, Kauffmann et al.)




## Long slit spectroscopy (ionized gas. metallicities)
## ~300 galaxies (Moran, Heckman et al.)




## ALFALFA stacking of massive galaxies
## (Fabello et al.)




## HST Large Program - Cosmic Origins Spectrograph
## Cycle 19 - 52 galaxies (Heckman et al.)