Atomic Gas Cycles and Global Star Formation in Local Galaxies

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Star Formation Across Space and Time
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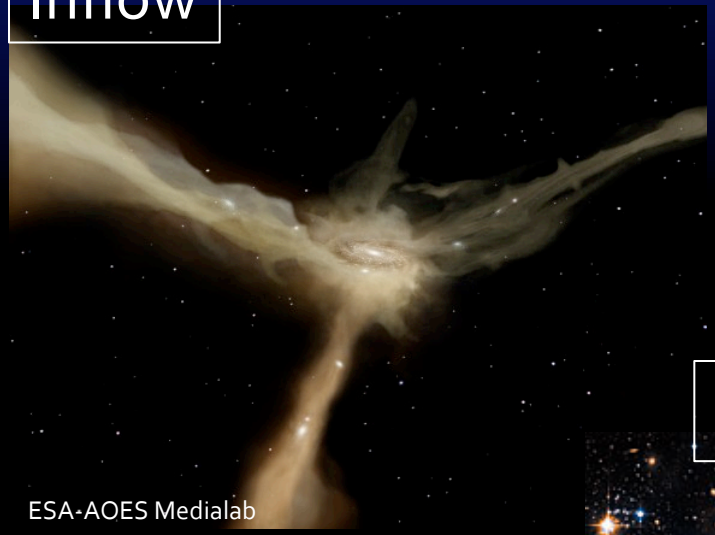
Galaxy Gas Cycles

Inflow



ESA-AOES Medialab

Feedback

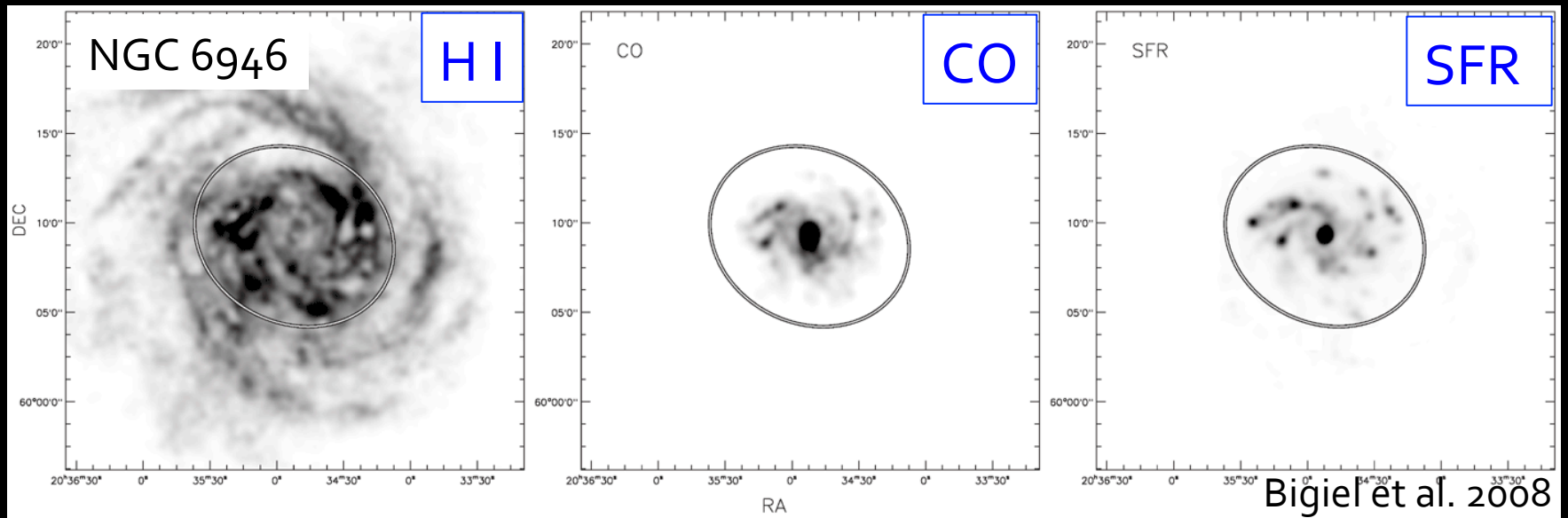
NASA/ESA

Star Formation

NASA/ESA

Atomic Hydrogen (H I)

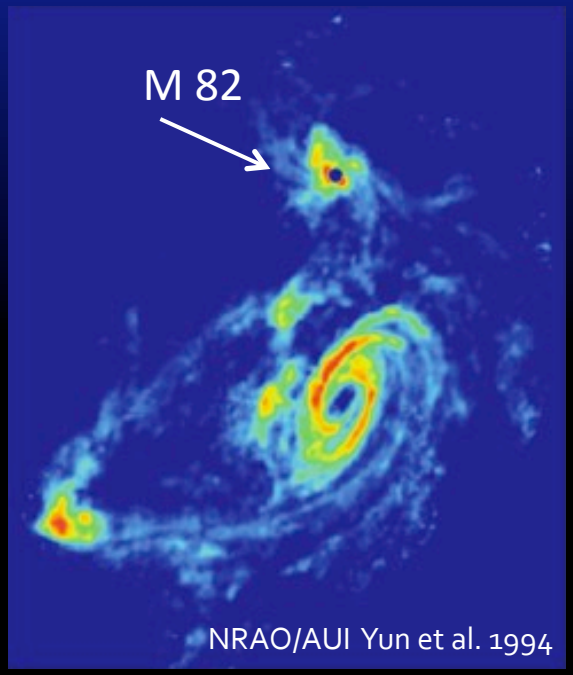
- H I traces
  - global gas supply
  - potential for future SF
  - recent accretion *(e.g. Moran et al. 2012)*
- More H I = more total SF *(e.g. Catinella et al. 2010, Huang et al. 2012)*

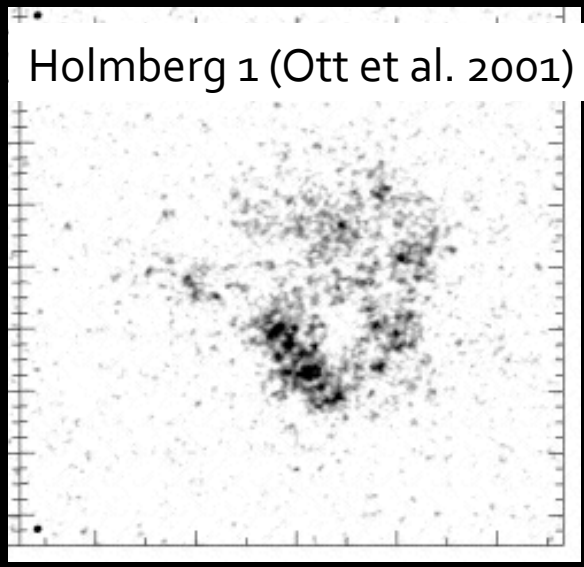


Bigiel et al. 2008

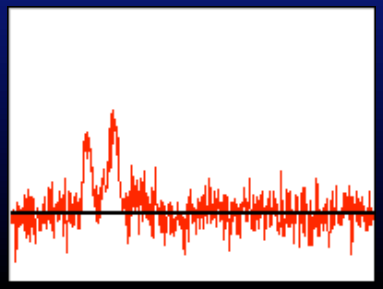
H I in Starburst Galaxies

- May reveal disturbances
- HI-rich?
  - Gordon & Gottesman 1981; Catinella et al. 2010
- HI-poor?
  - Oey et al. 2007
- Previous studies: optically-selected samples or individual targets

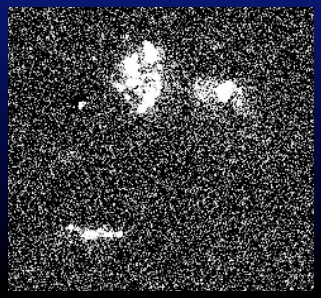




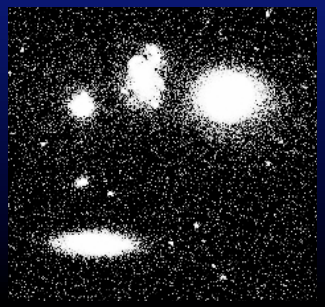
ALFALFA Hα



HI



Hα

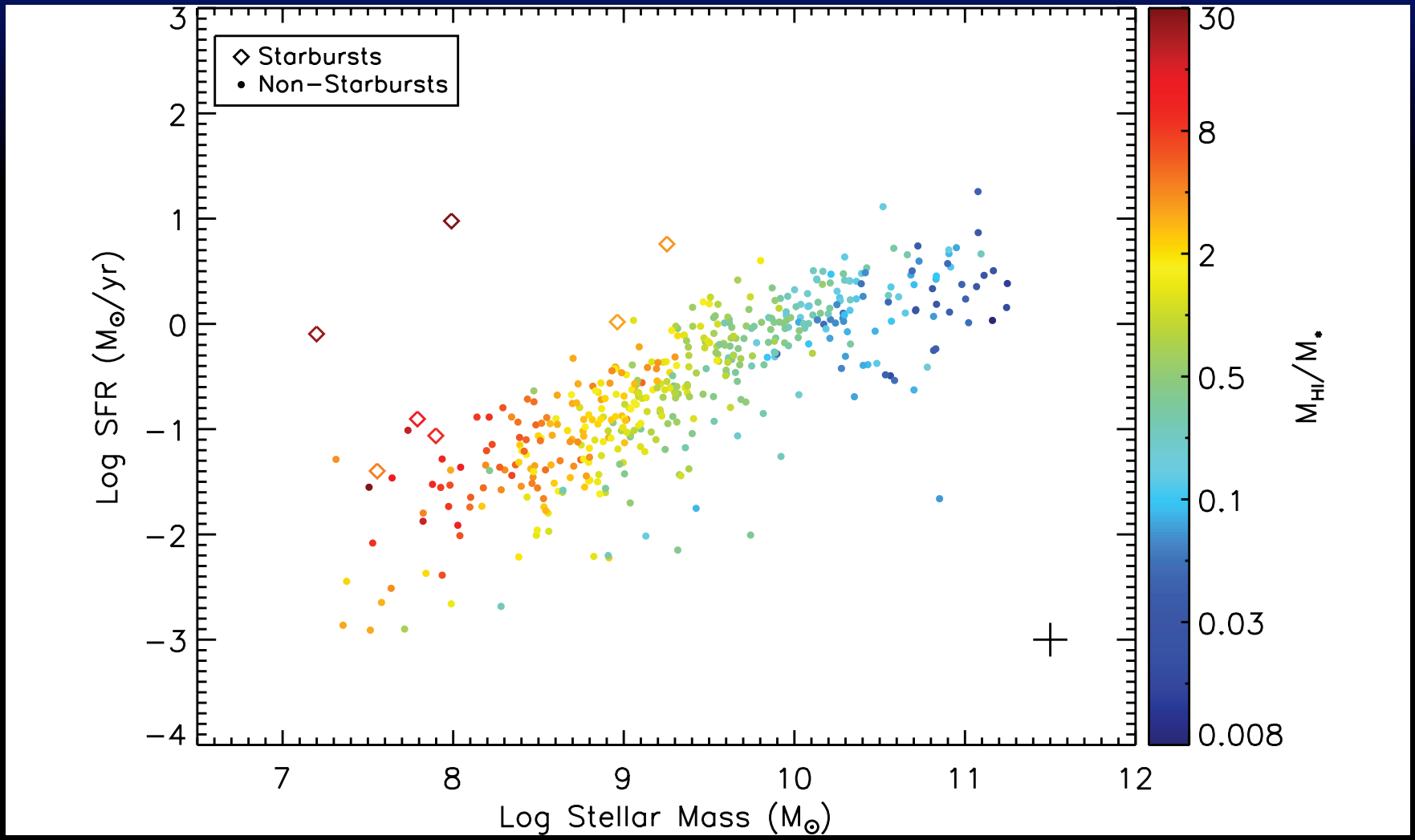


R

SDSS

- ALFALFA: Arecibo Legacy Fast *ALFA* Survey
  - Blind, volume-limited 21 cm HI survey; R. Giovanelli, P.I.
  - > 30,000 detections, 7000 square degrees
- ALFALFA Hα
  - Volume-limited subset of ALFALFA; J. Salzer, P. I.
  - 20-100 Mpc
- KPNO: Hα and *R*-band imaging
- Fall sample (565 galaxies) complete
- Starbursts: Hα equivalent width (EW) > 80 Å

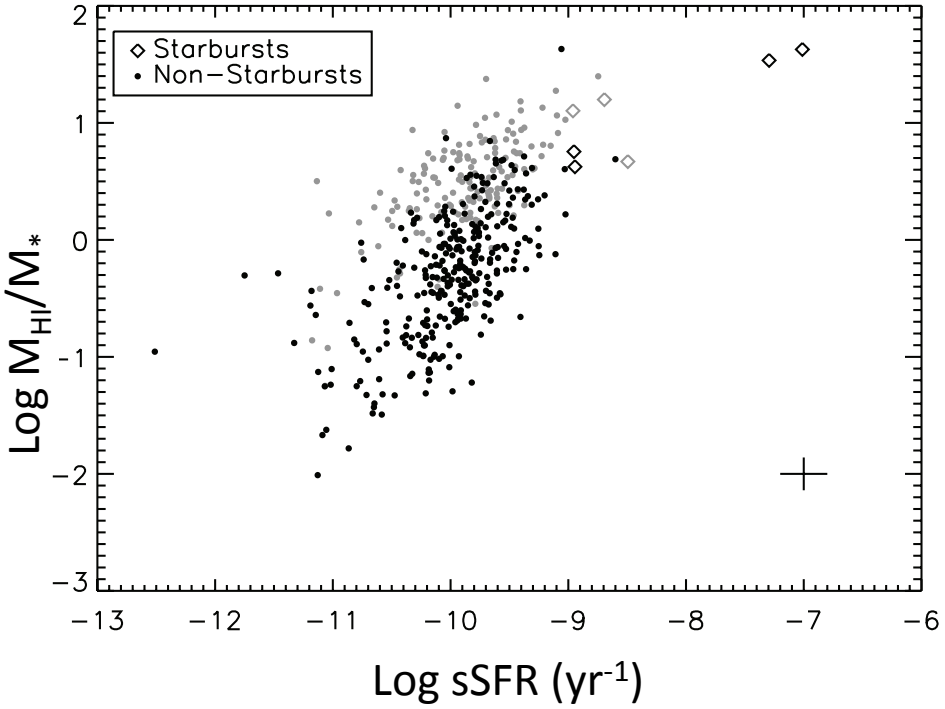
From HI to Stars

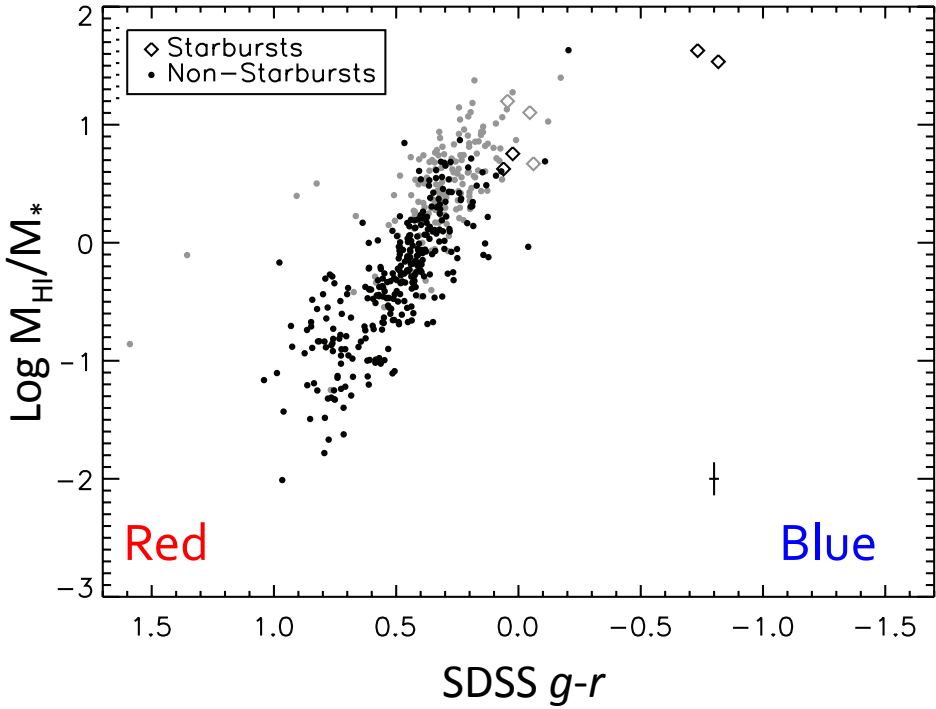


The H I and SFR Connection

Weak trend with specific star formation rate (SFR/M_*)

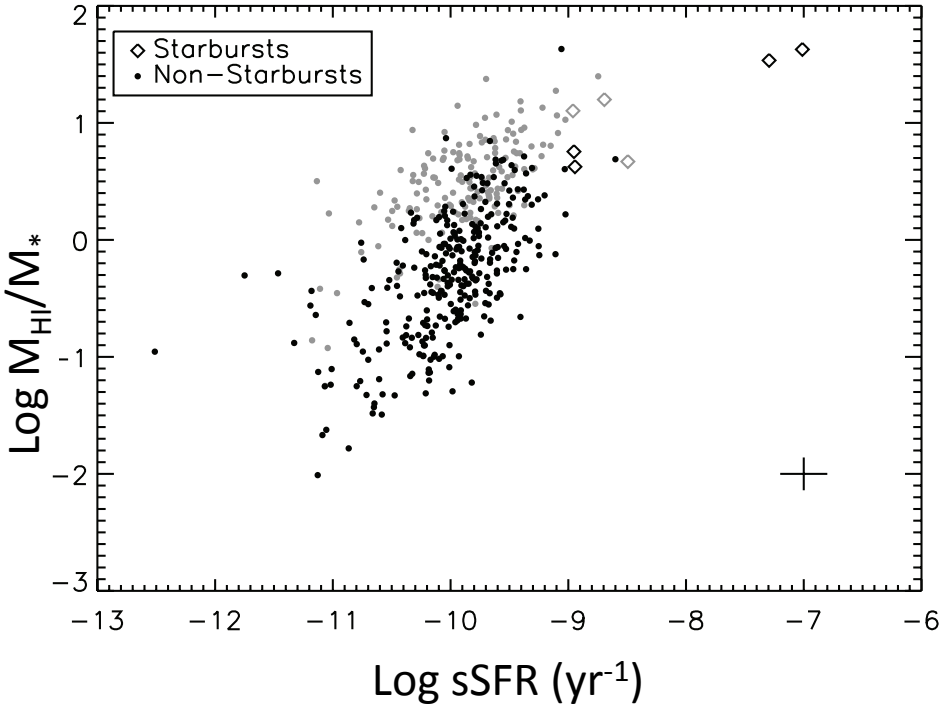
Tight trend with *g-r* color

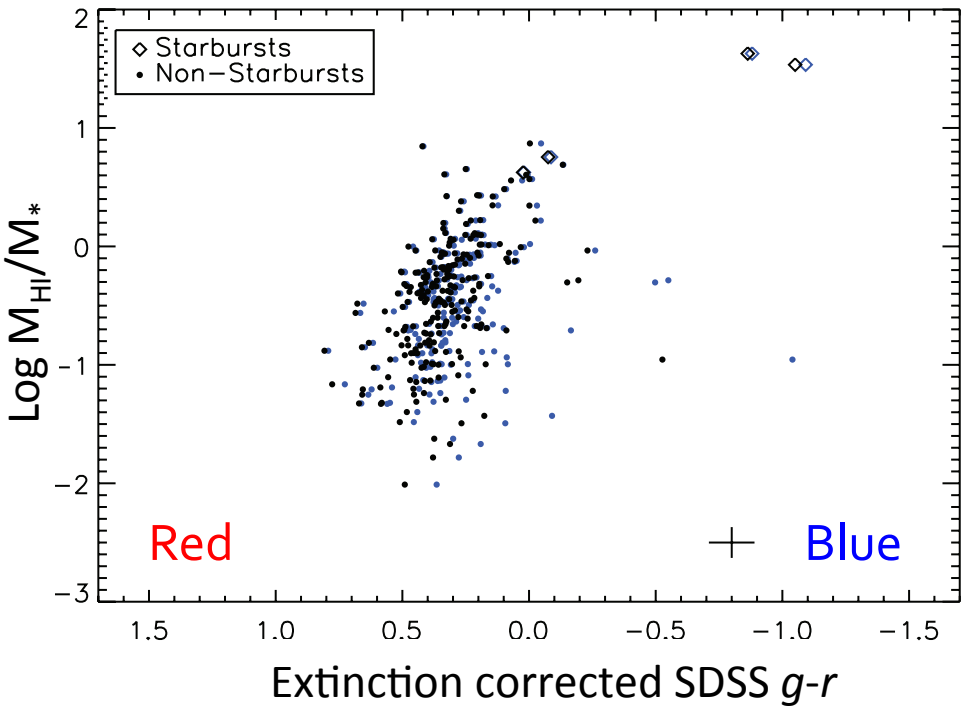




The H I and SFR Connection

After dust correction using WISE 22 μm fluxes (Wen et al. 2014)

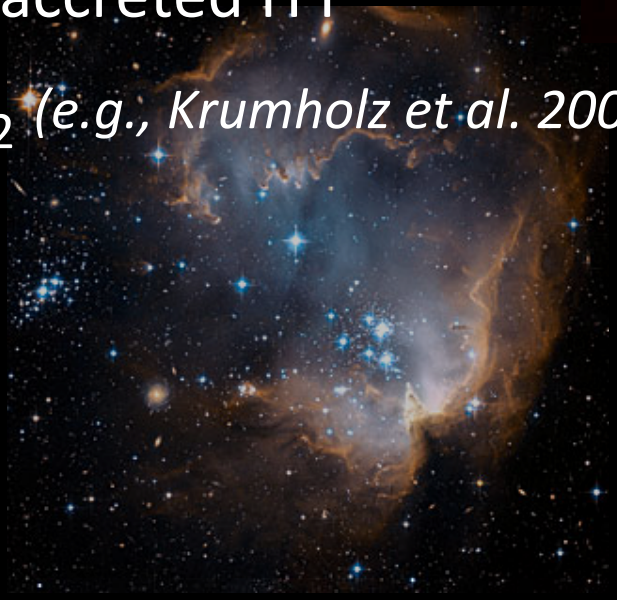




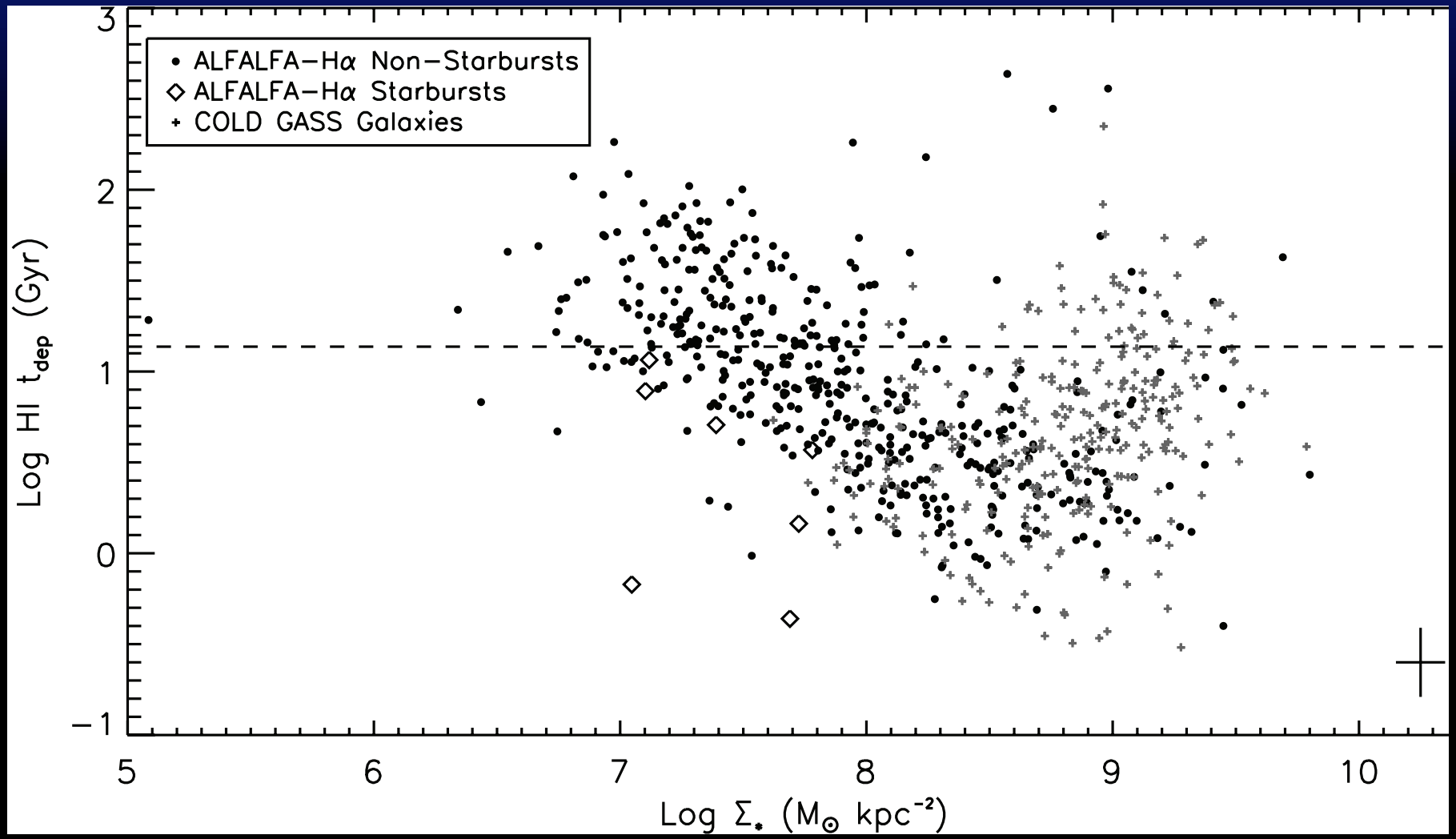
Mass-Metallicity-H I Relation (Bothwell et al. 2013)

H I and Metallicity

- Mass-metallicity relations
  - *e.g., Mannucci et al. 2010; Davé et al. 2011; Lilly et al. 2013*
  - Gas consumption
  - Gas retention
  - Dilution from accreted H I
- Shielding of H_2 *(e.g., Krumholz et al. 2009; Bolatto et al. 2011)*



H I Consumption Timescales



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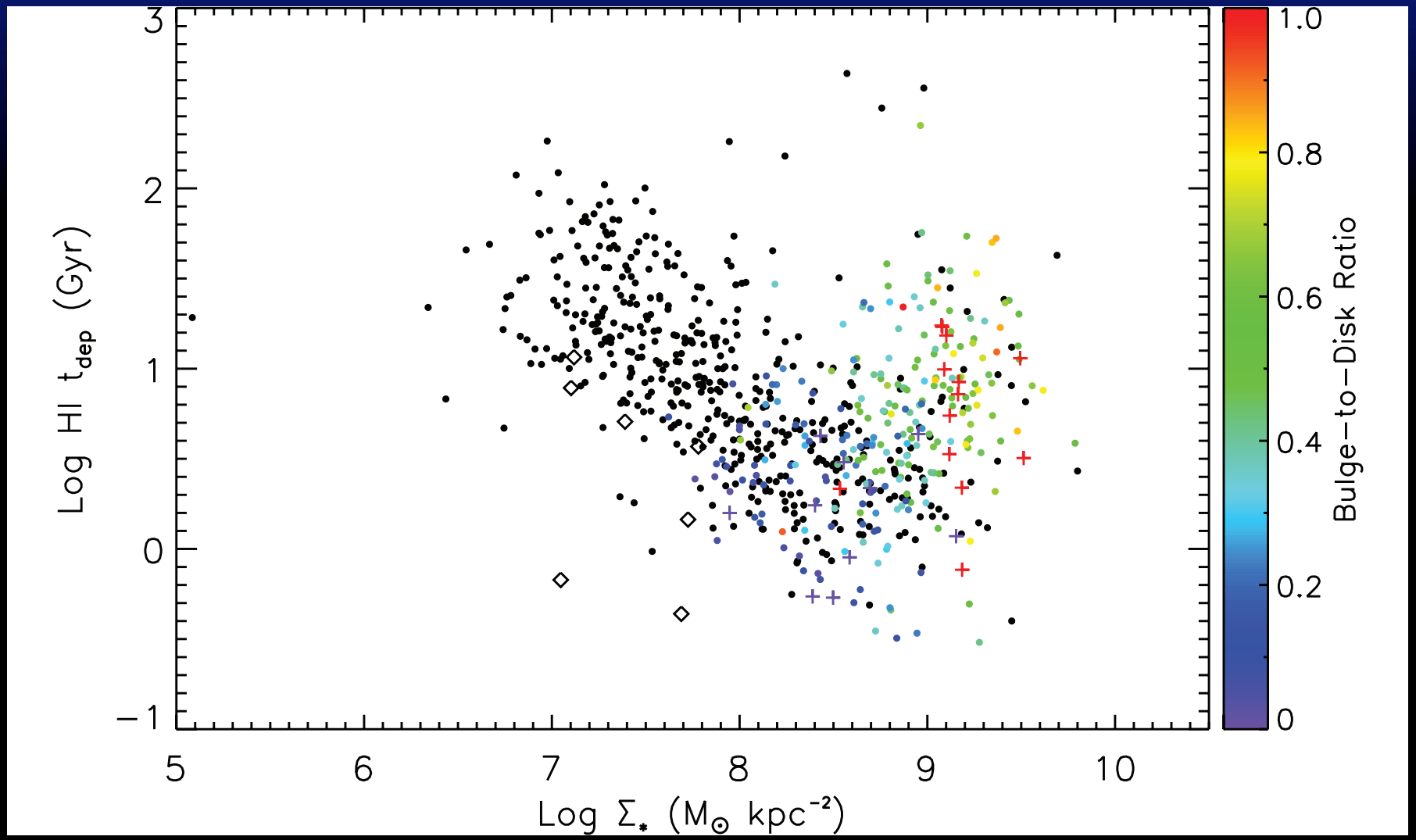
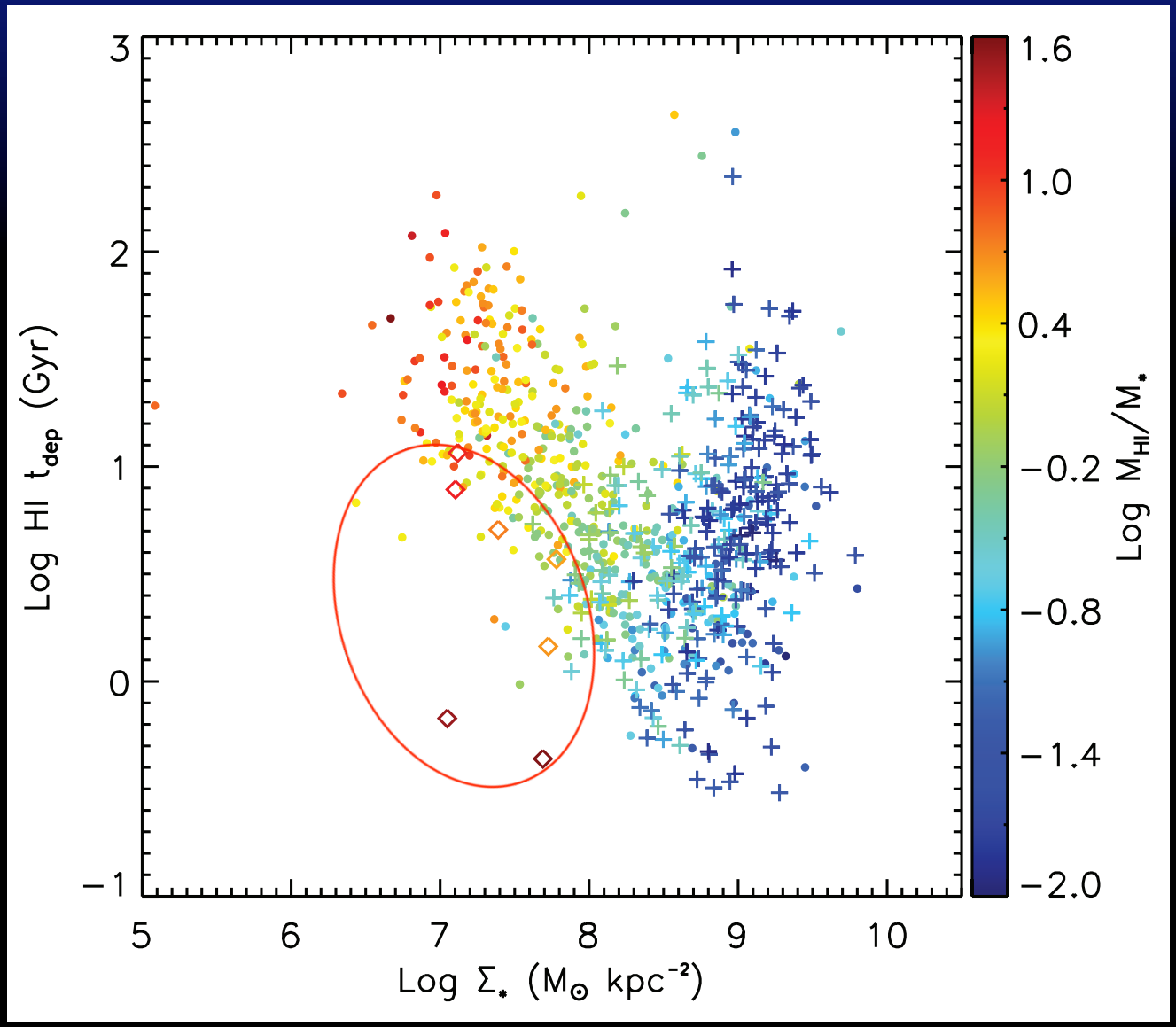


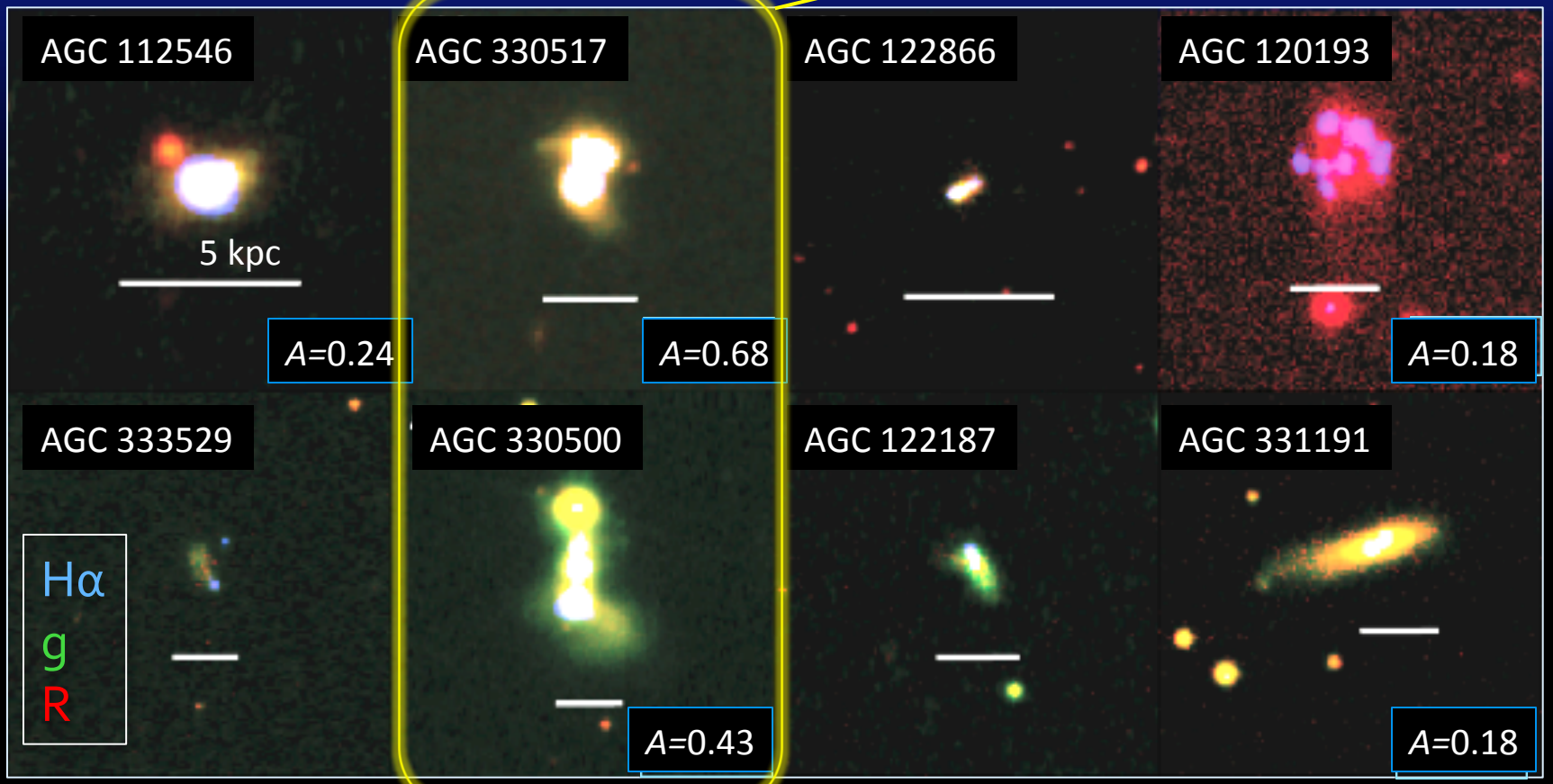
Morphological fits from Simard et al. 2011

H I Consumption Timescales



Starburst Asymmetries

Most HI-rich for their mass



- Asymmetry (Conselice et al. 2000)
- Major mergers: $A > 0.35$
- Full sample median: A=0.14
- Asymmetry peaks before peak SF (Lotz et al. 2010)

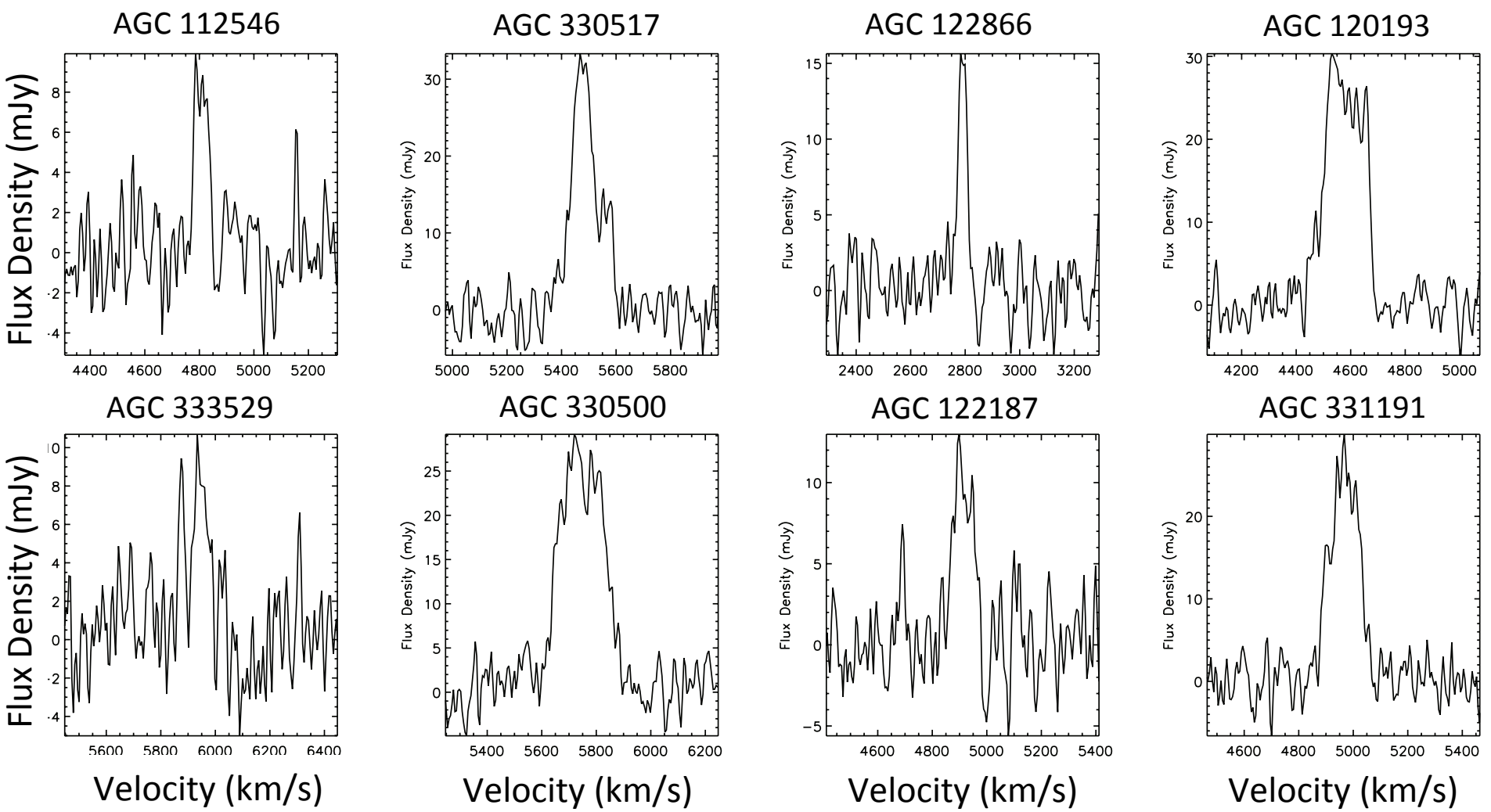
H I Regulation

- Starbursts maintain moderate H I gas fractions
  - H I inflow as merger progresses
  - Rapid conversion to H_2
  - In starburst regions, photodissociation replenishes H I (e.g., Stacey et al. 1991)
  - H I fuel available for future bursts

Mergers and H I Velocity Profiles

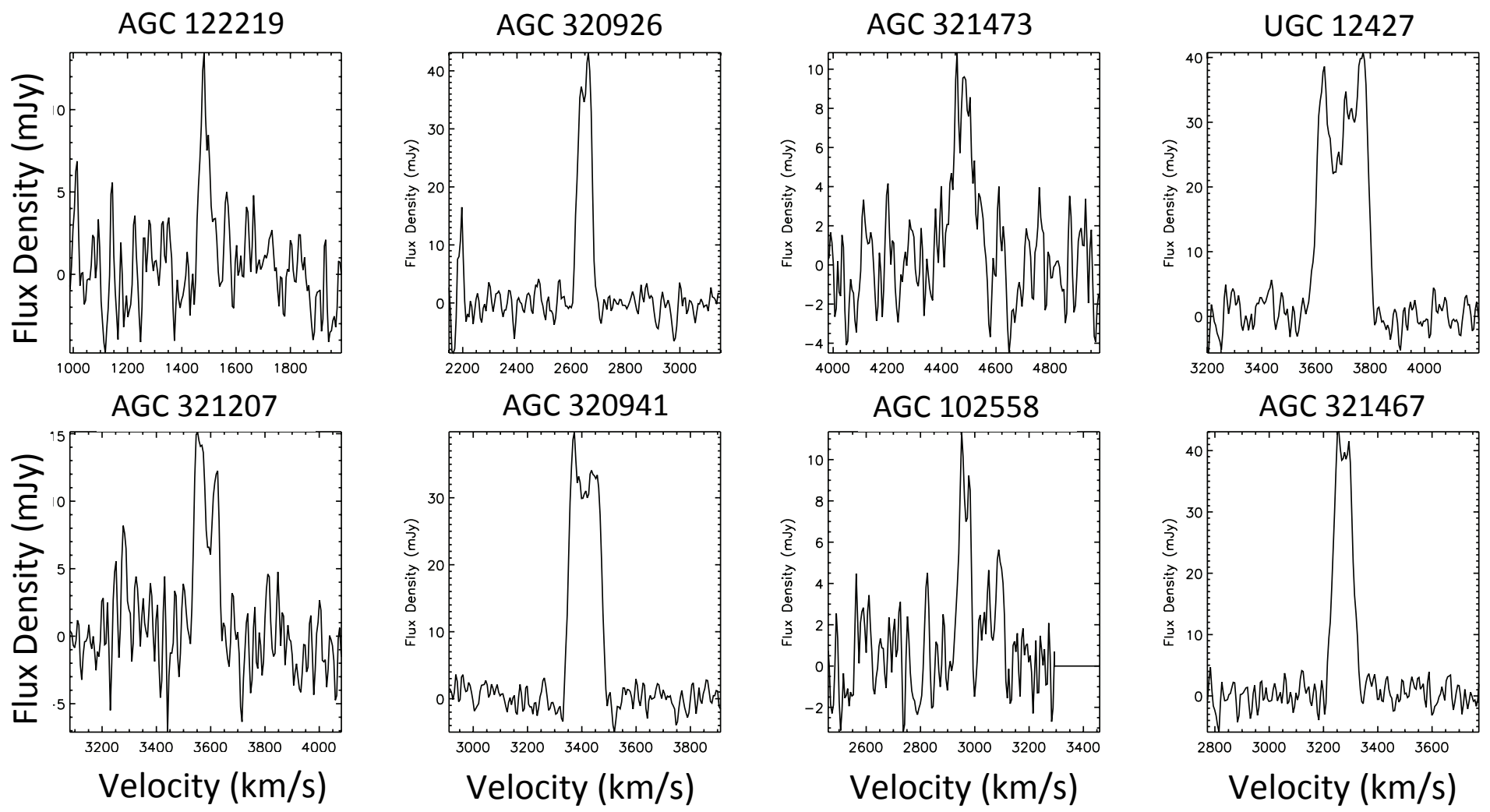
Starbursts

Higher W20/W50 indicates excess of high-velocity H I



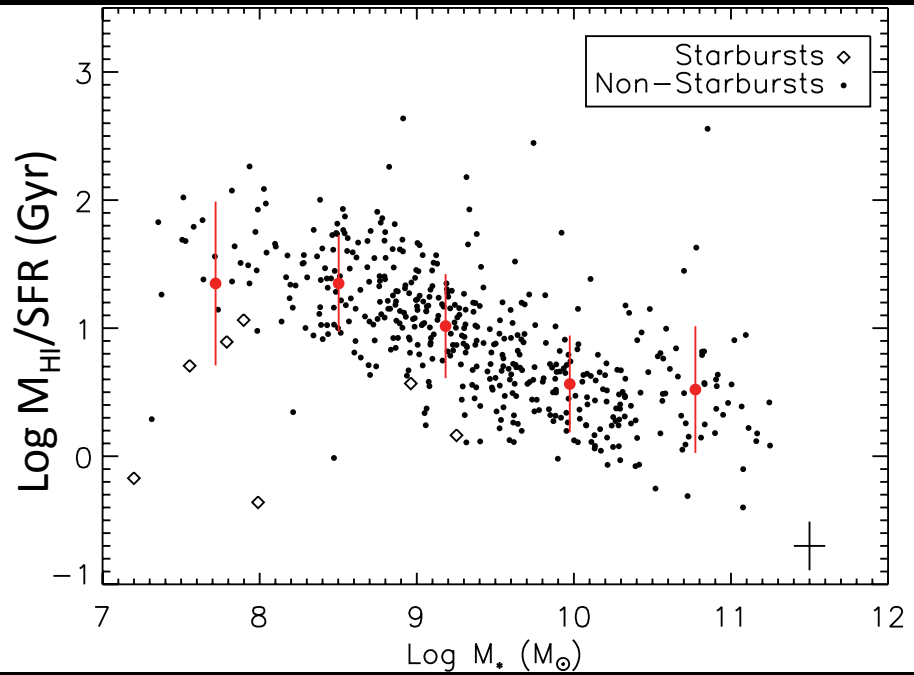
Mergers and H I Velocity Profiles

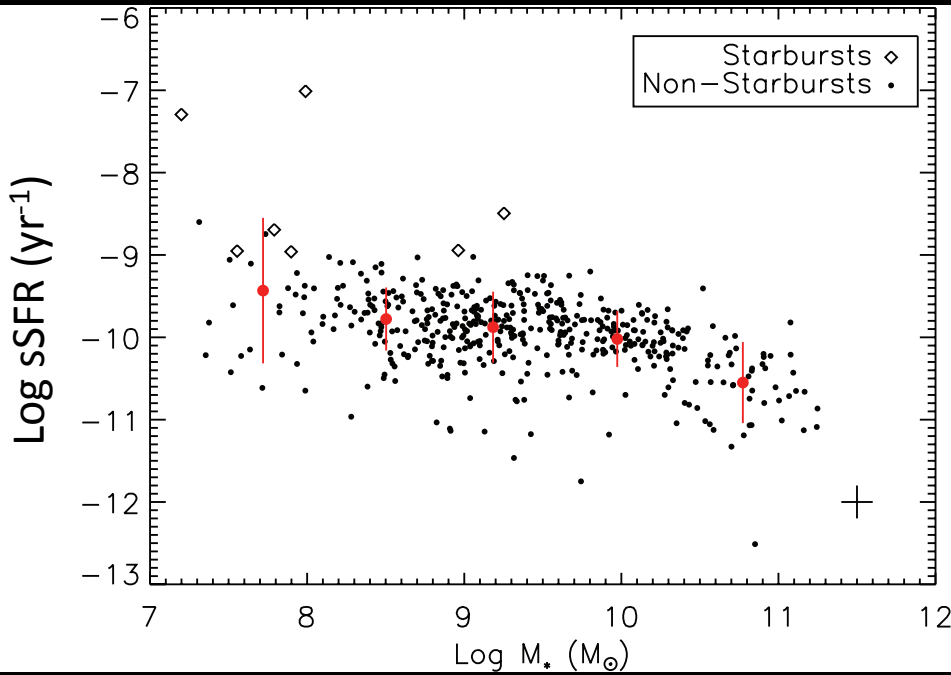
Non-Starbursts



Low-Mass Starbursts

- Are the low-mass starbursts mergers?
- Periodic bursts due to feedback
  - *e.g., Lee et al. 2007; Verbeke et al. 2014; Hopkins et al. 2014*
- Initial disturbance may no longer be detectable





Summary

- H I weakly linked to sSFR, closely coupled with metallicity
  - Gas cycles and SFE
- H I consumption time correlates with stellar surface density for disks
  - Role of mid-plane pressure?
- Spheroids may differ in access to H I
- Starbursts may maintain approximately constant H I
- Mergers trigger some starbursts
- Bursts in low-mass galaxies may be cyclical

Jaskot et al., in prep.