Tracing HI Gas Cycles and Global Star Formation with the ALFALFA Hα Survey

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Life Cycle of Gas in Galaxies: A Local Perspective
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Galaxy Gas Cycles

Inflow

HI reservoir -raw material

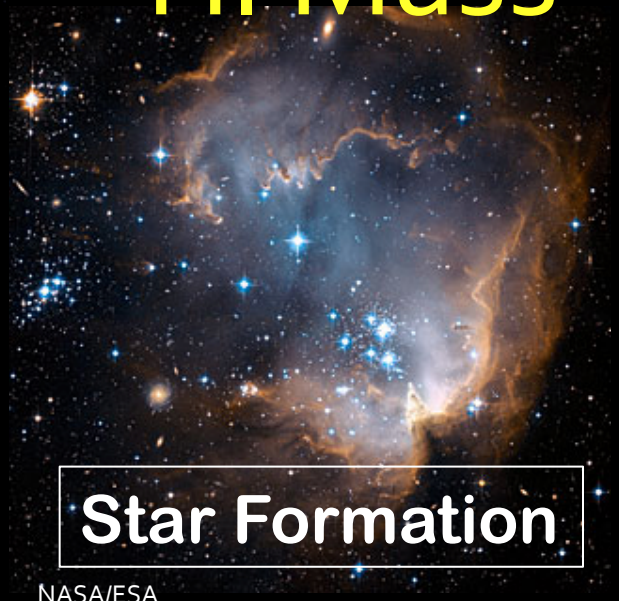
ESA-AOES Medialab

Reaccretion?

Feedback

NASA/ESA

HI Mass



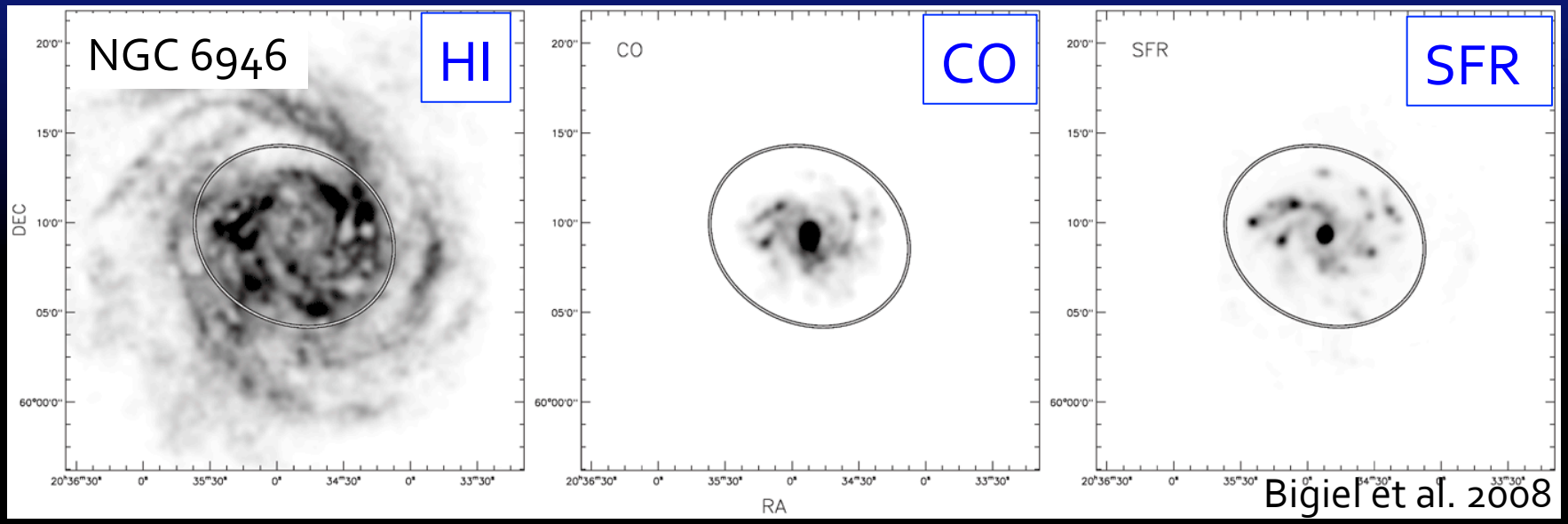
Star Formation

NASA/ESA

Radial flows and conversion to H2

Ionization, Outflows, Photodissociation

Global HI

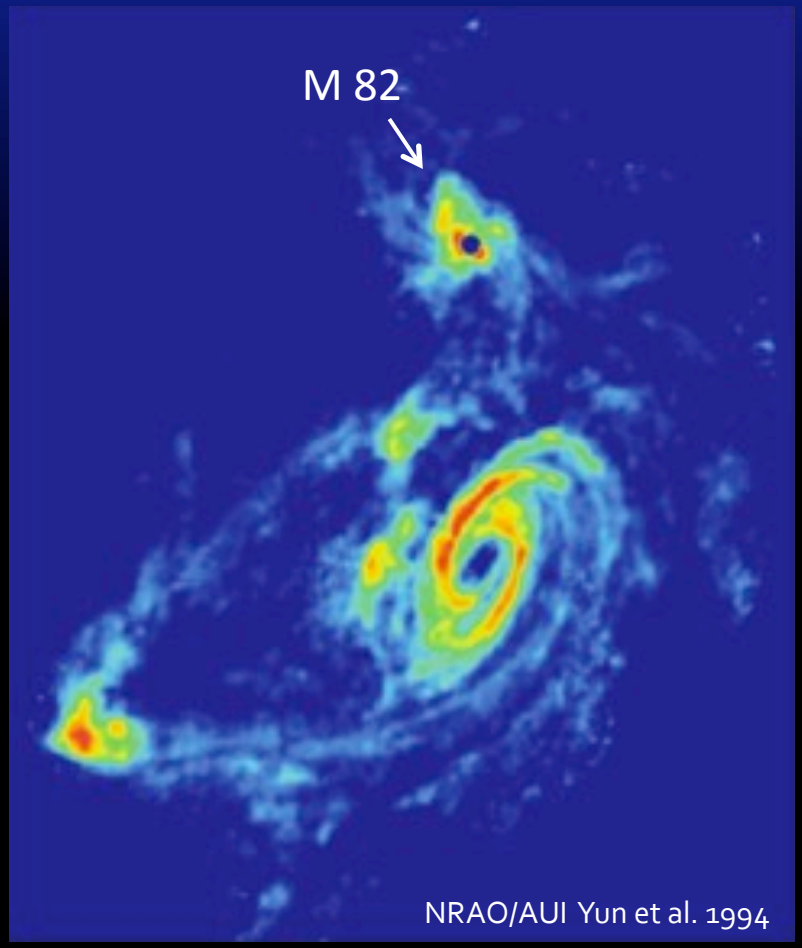


- HI mass traces
  - total gas supply
  - potential for future SF
  - recent accretion *(e.g. Moran et al. 2012)*
- More HI = more total SF

(e.g. Catinella et al. 2010, Huang et al. 2012)

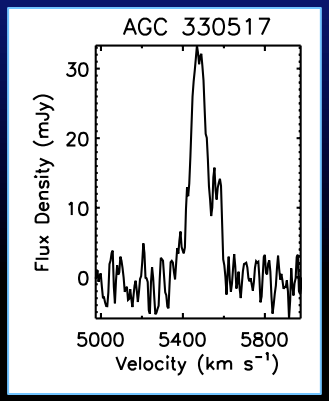
HI at high SFR

- Starbursts are HI-rich?
  - Gordon & Gottesman 1981; Catinella et al. 2010
- Starbursts are HI-poor?
  - Oey et al. 2007
- May reveal disturbances

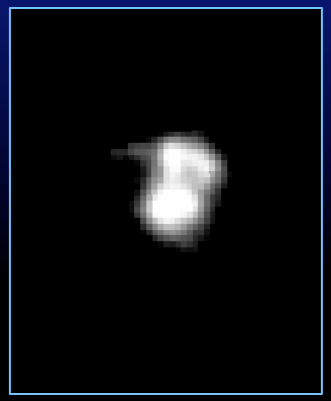


Van Sistine et al. 2015

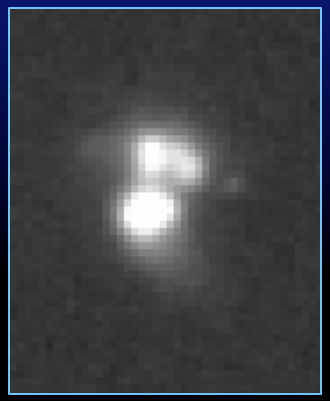
ALFALFA Hα



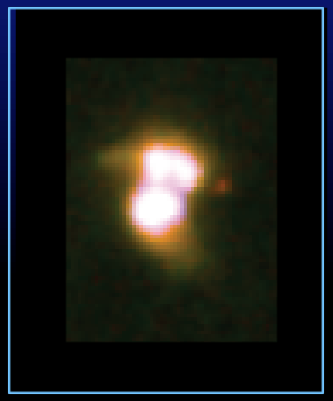
HI



Hα



R

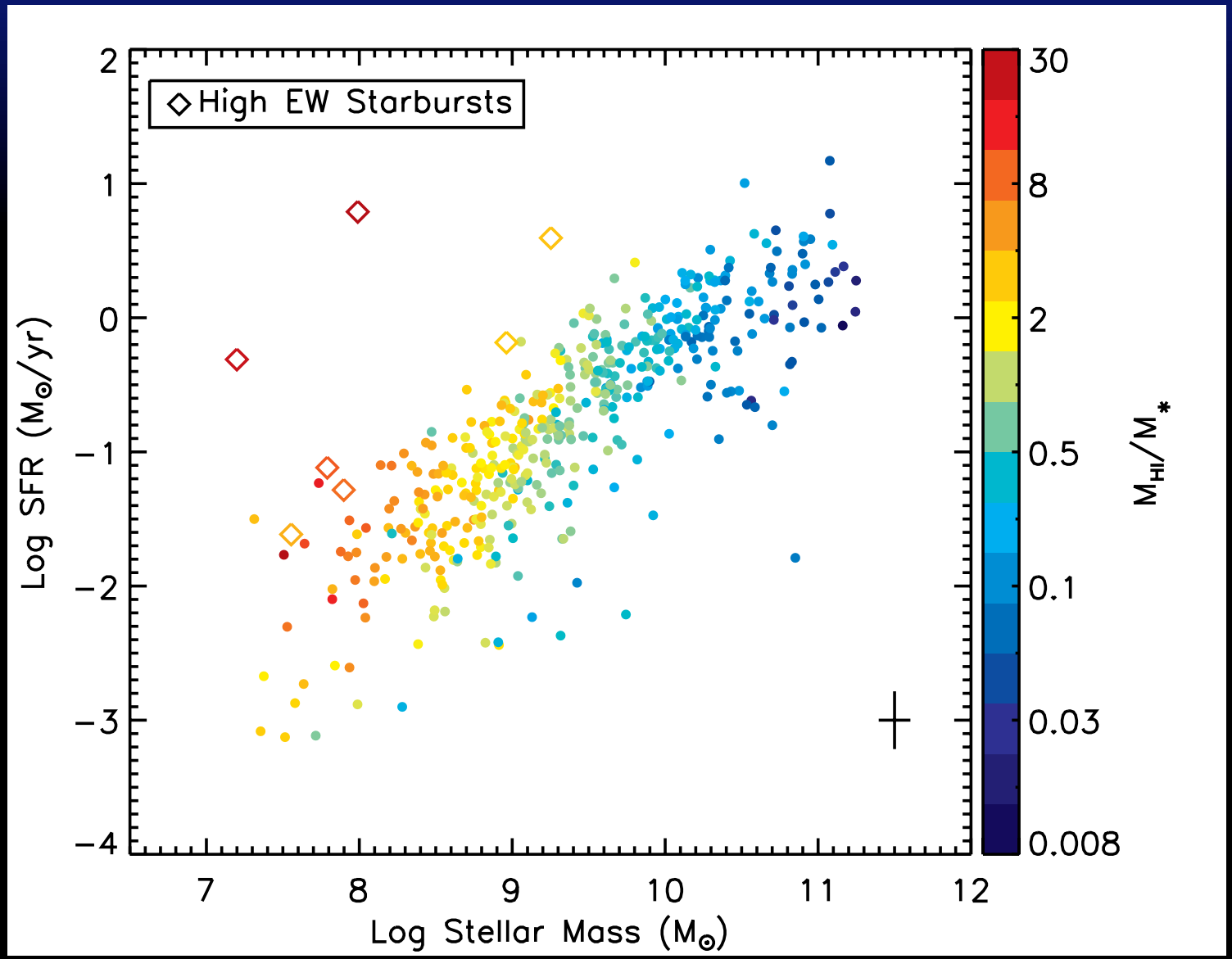


SDSS

- 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
  - 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

See talk by Saintonge

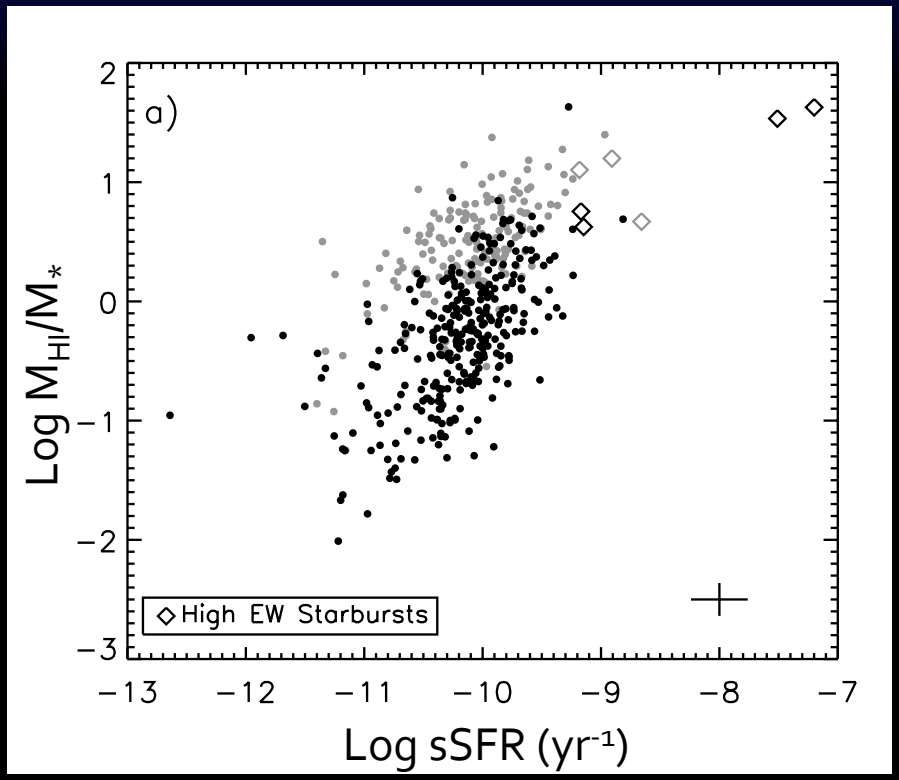


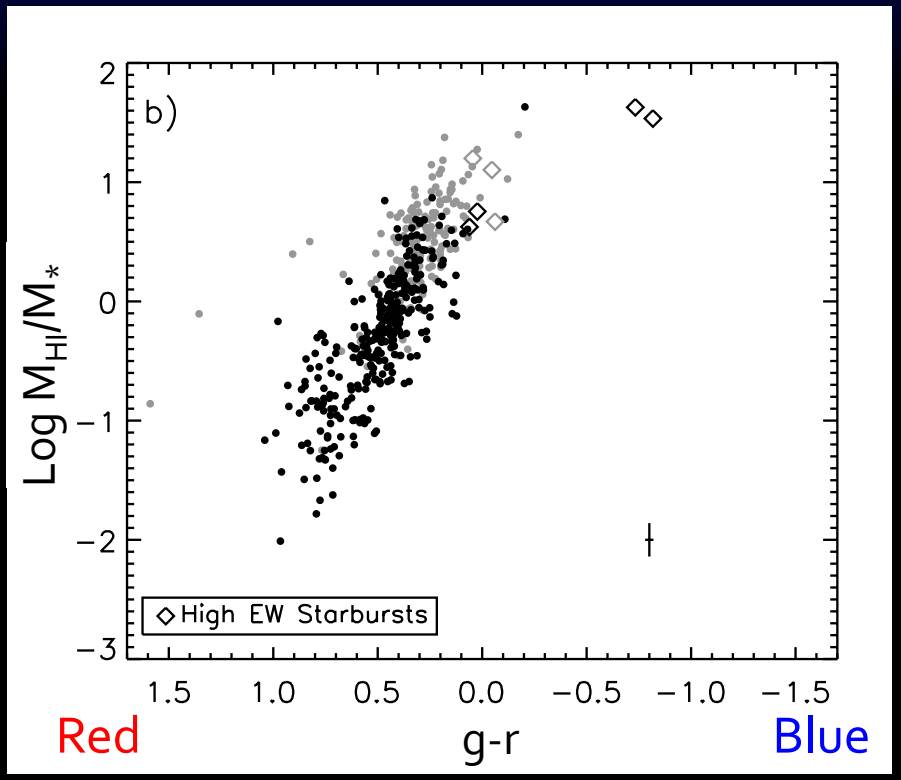
The HI and SFR Connection

e.g., Catinella et al. 2010; Huang et al. 2012

Weak…

or strong?



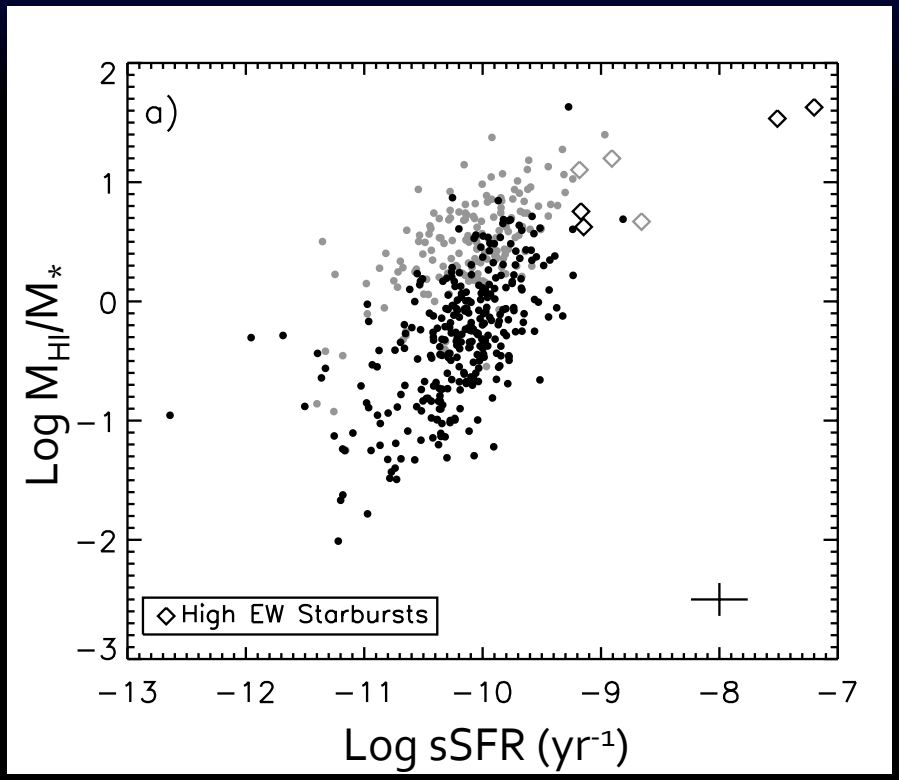


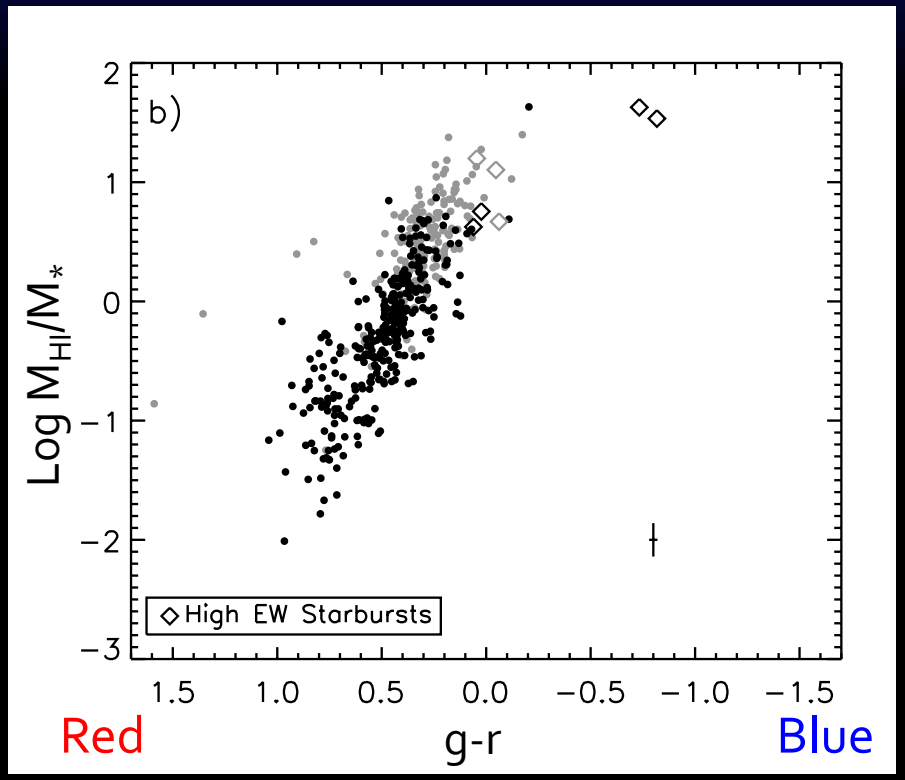
1. Link between HI and long-term averaged SF?
2. Link between HI and dust extinction?

The HI and SFR Connection

Following Wen et al. 2014

Before dust correction



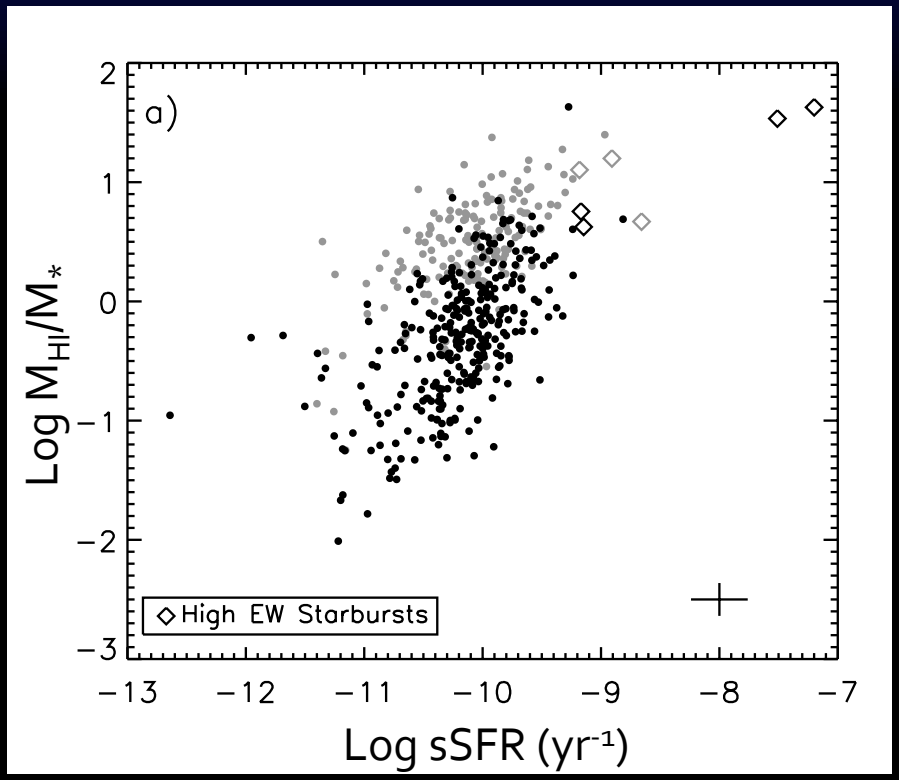


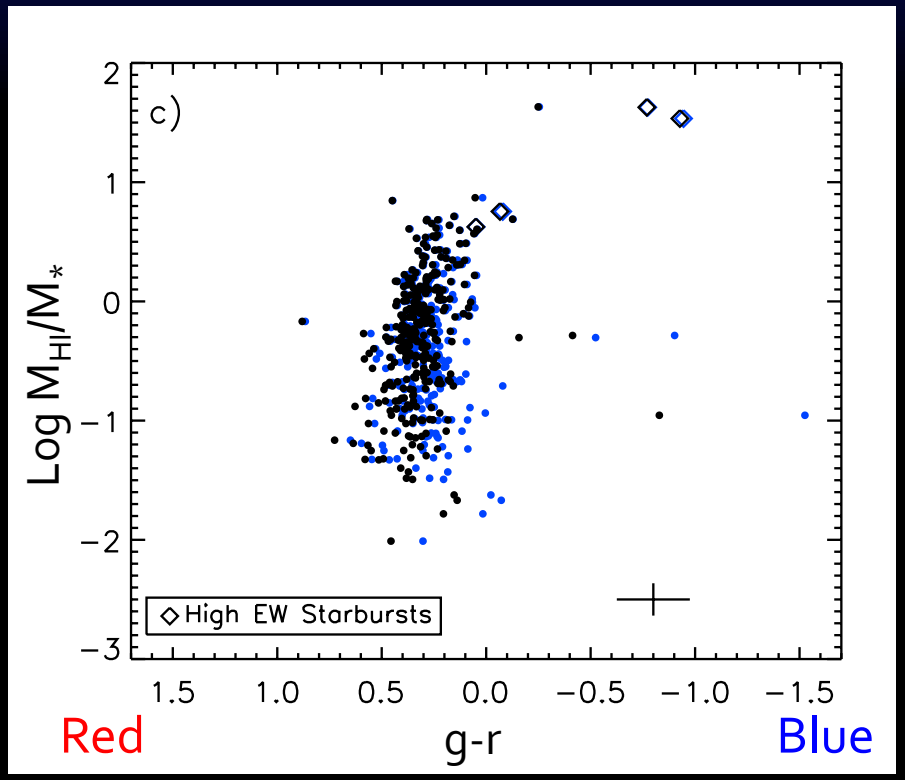
Mass-Metallicity-HI Relation (Bothwell et al. 2013)

The HI and SFR Connection

Following Wen et al. 2014

After dust correction

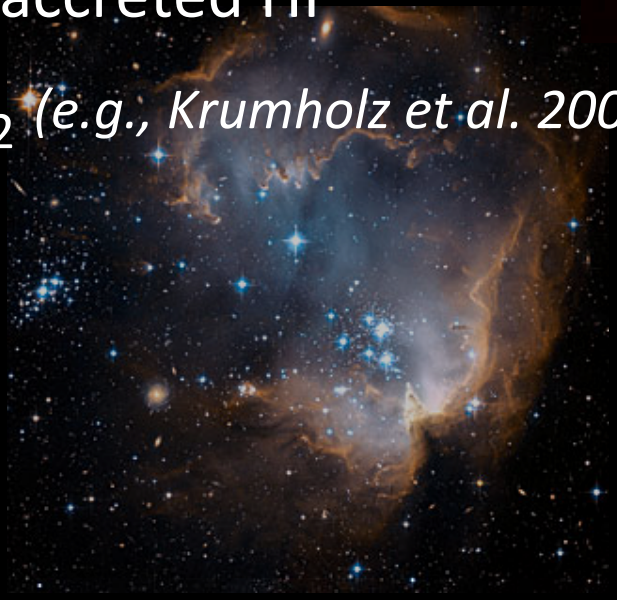




Mass-Metallicity-HI Relation (Bothwell et al. 2013)

HI and Metallicity

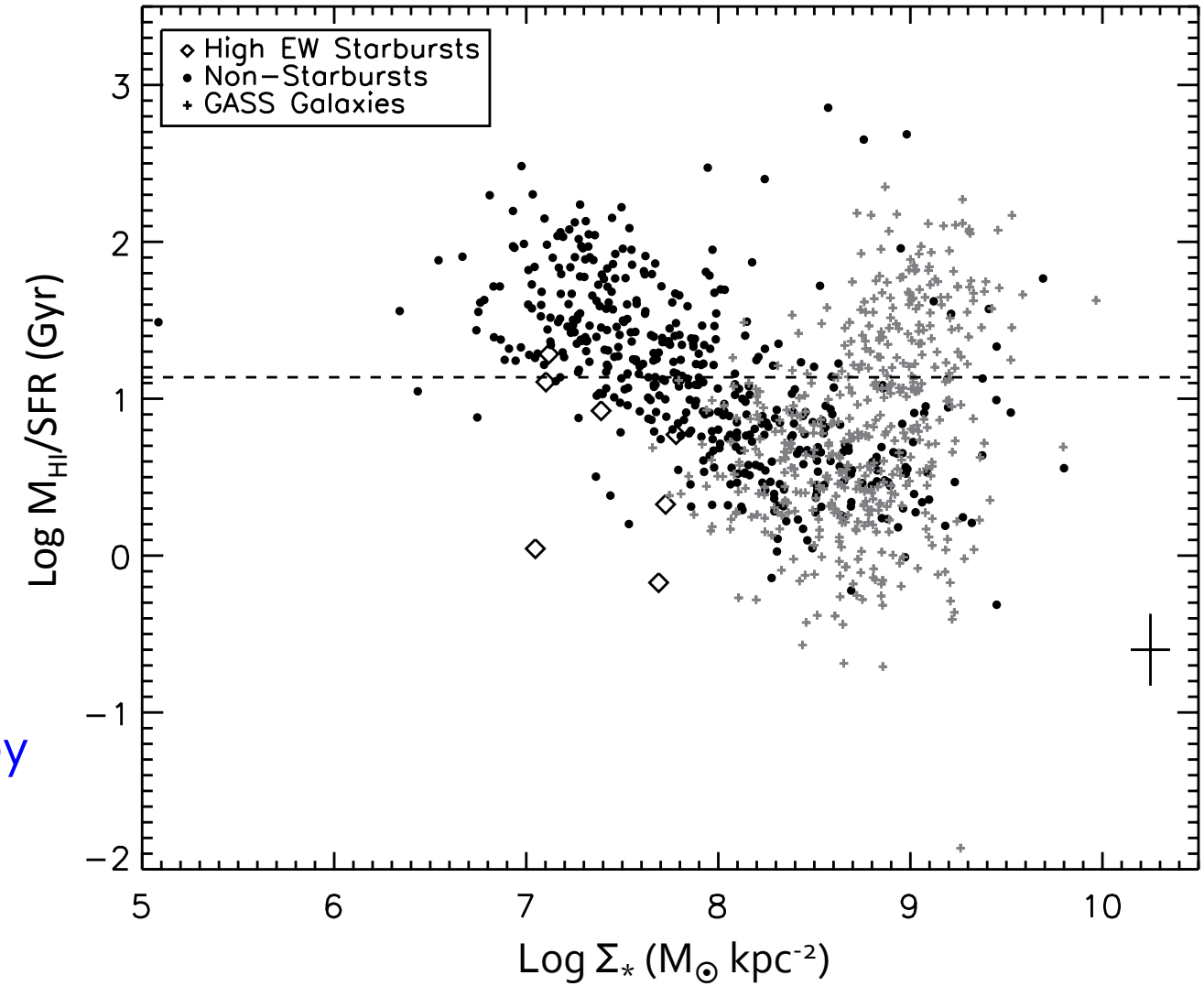
- Mass-metallicity relations
  - *e.g., Mannucci et al. 2010; Davé et al. 2011; Lilly et al. 2013*
  - Gas consumption
  - Metal retention
  - Dilution from accreted HI
- Shielding of H_2 *(e.g., Krumholz et al. 2009; Bolatto et al. 2011)*



HI Consumption Timescales

GASS galaxies from Catinella et al. 2010; 2013

Higher P = Higher H2/HI e.g., Blitz & Rosolowsky 2006

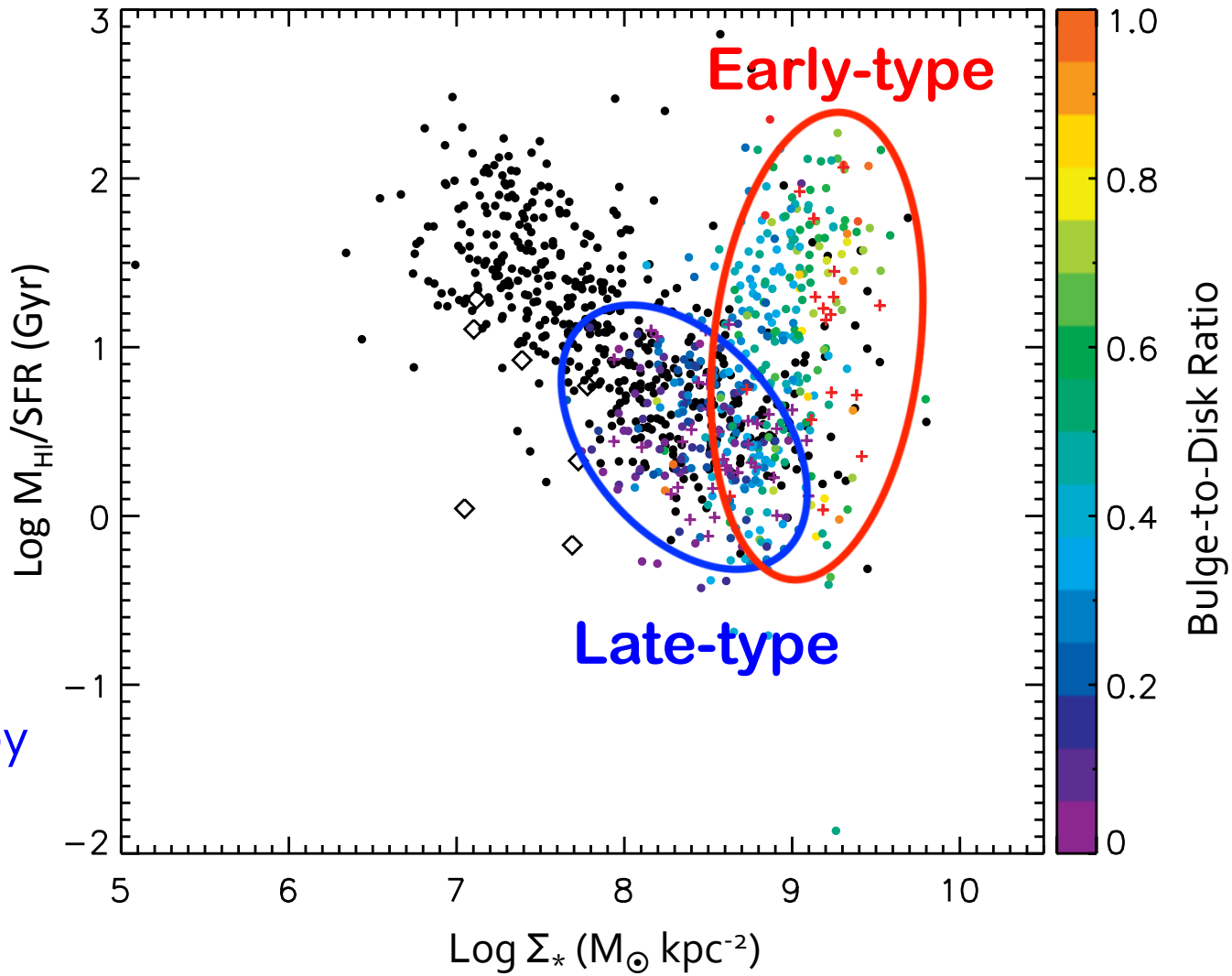


See talks by Hughes, Schruba, Bonnell

HI Consumption Timescales

Morphological fits from Simard et al. 2011

Higher P = Higher H2/HI e.g., Blitz & Rosolowsky 2006



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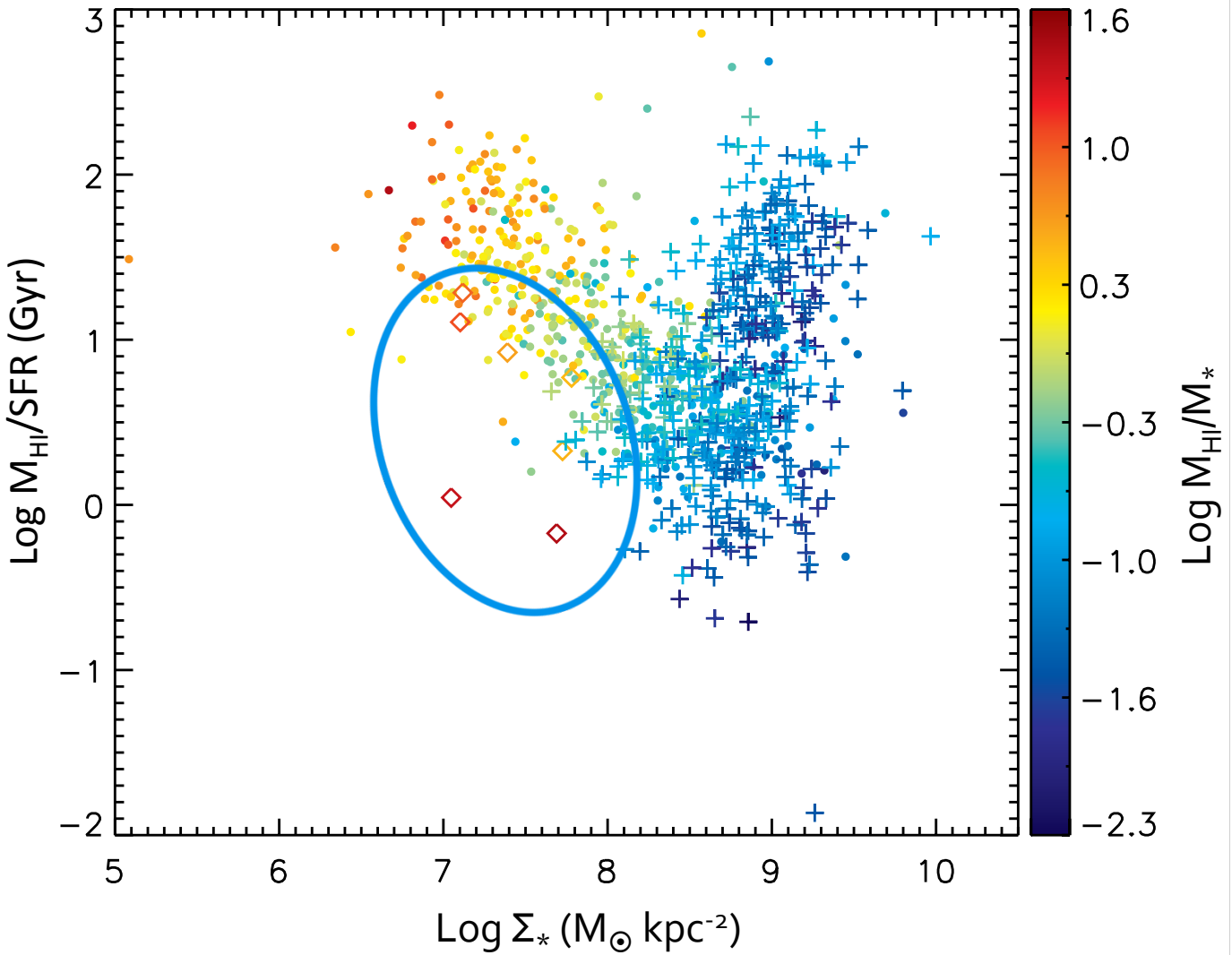
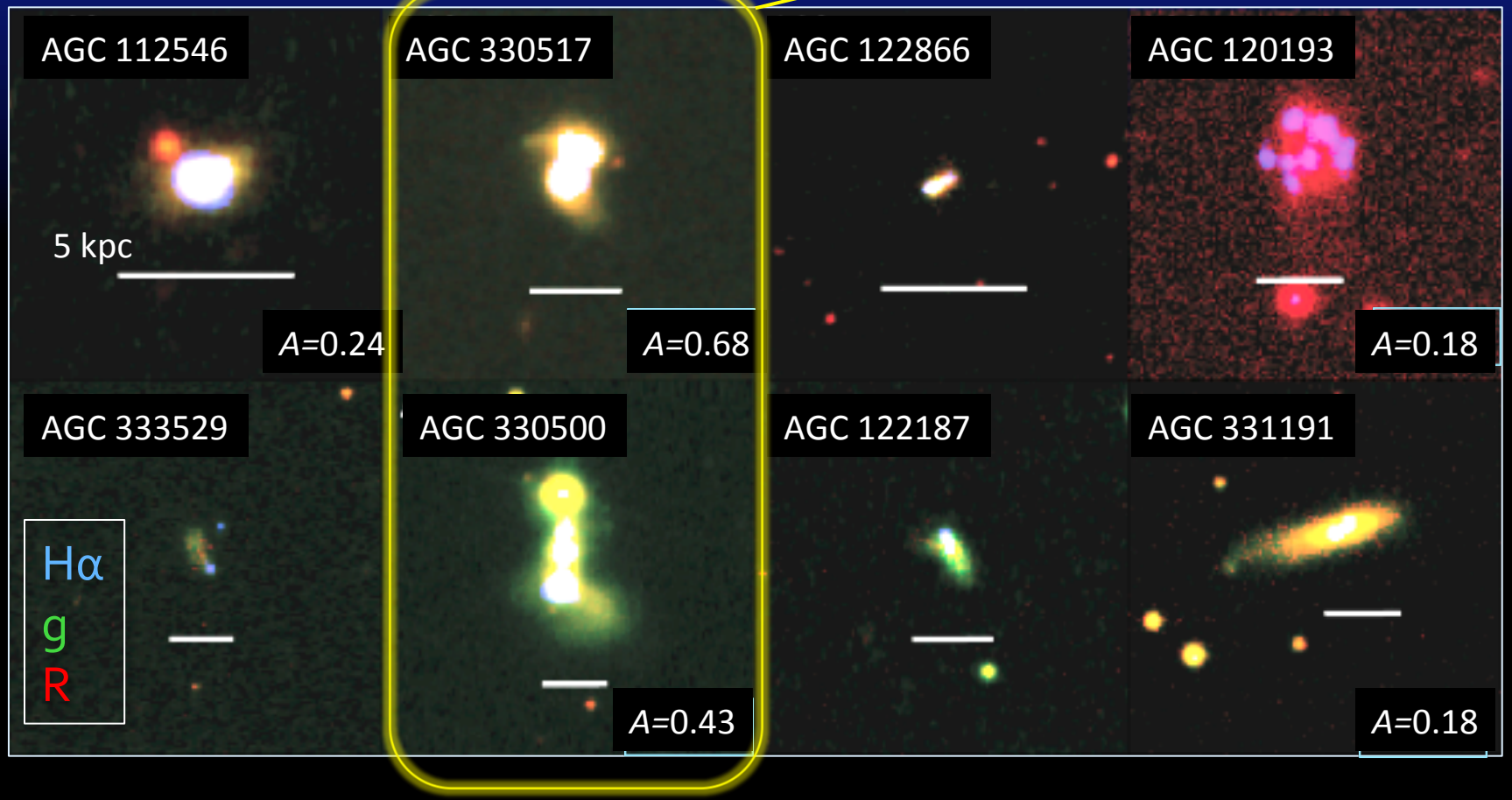
HI Consumption Timescales



Are Mergers Enhancing SFE?

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)

HI Regulation

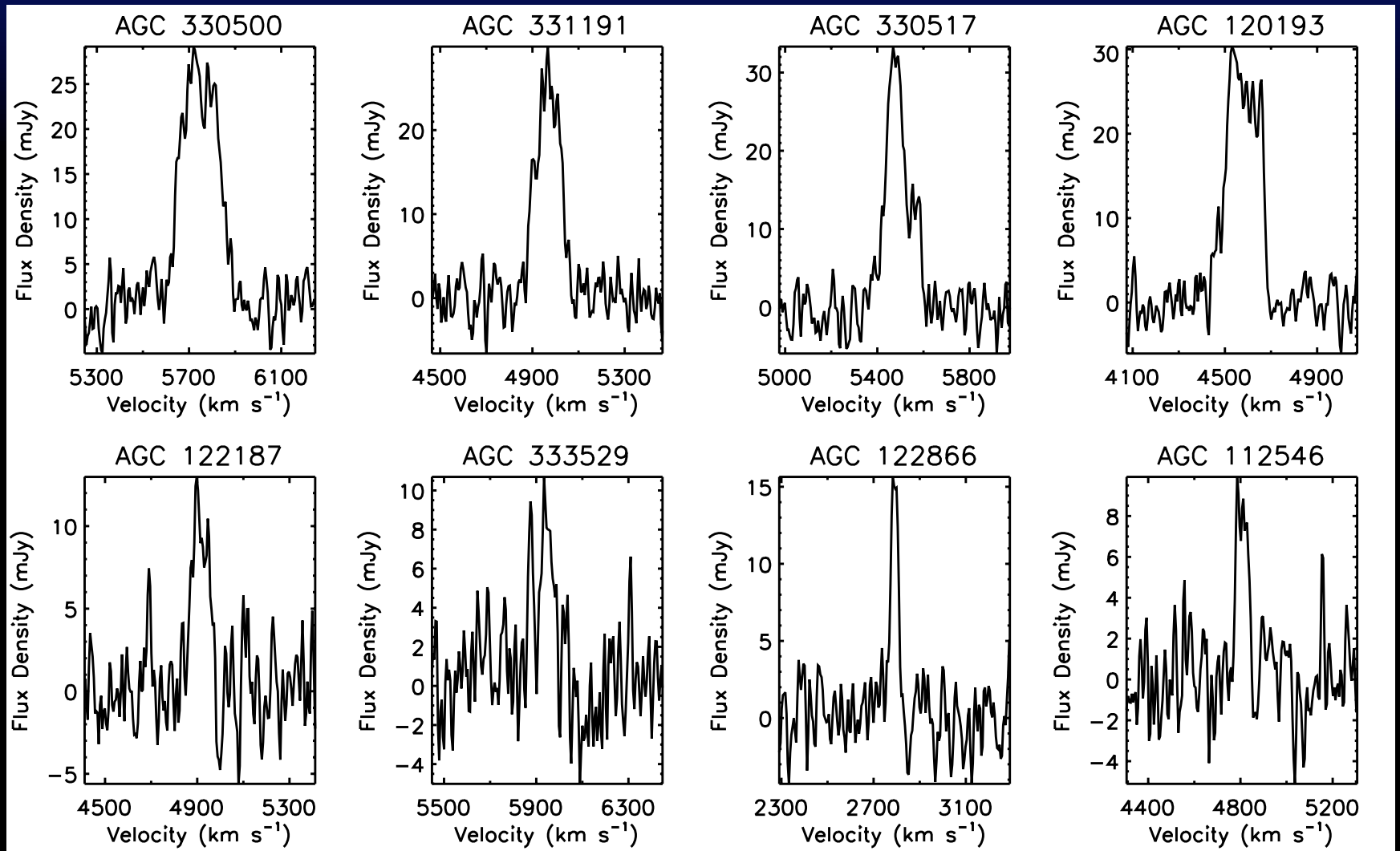
- Starbursts maintain moderate HI gas fractions
  - HI inflow and H_2 formation as merger progresses
  - In starburst regions, photodissociation replenishes HI *(e.g., Stacey et al. 1991)*
  - HI fuel available for future bursts

(see also: Stierwalt et al. 2014; Ellison et al. 2015)

Mergers and HI Kinematics

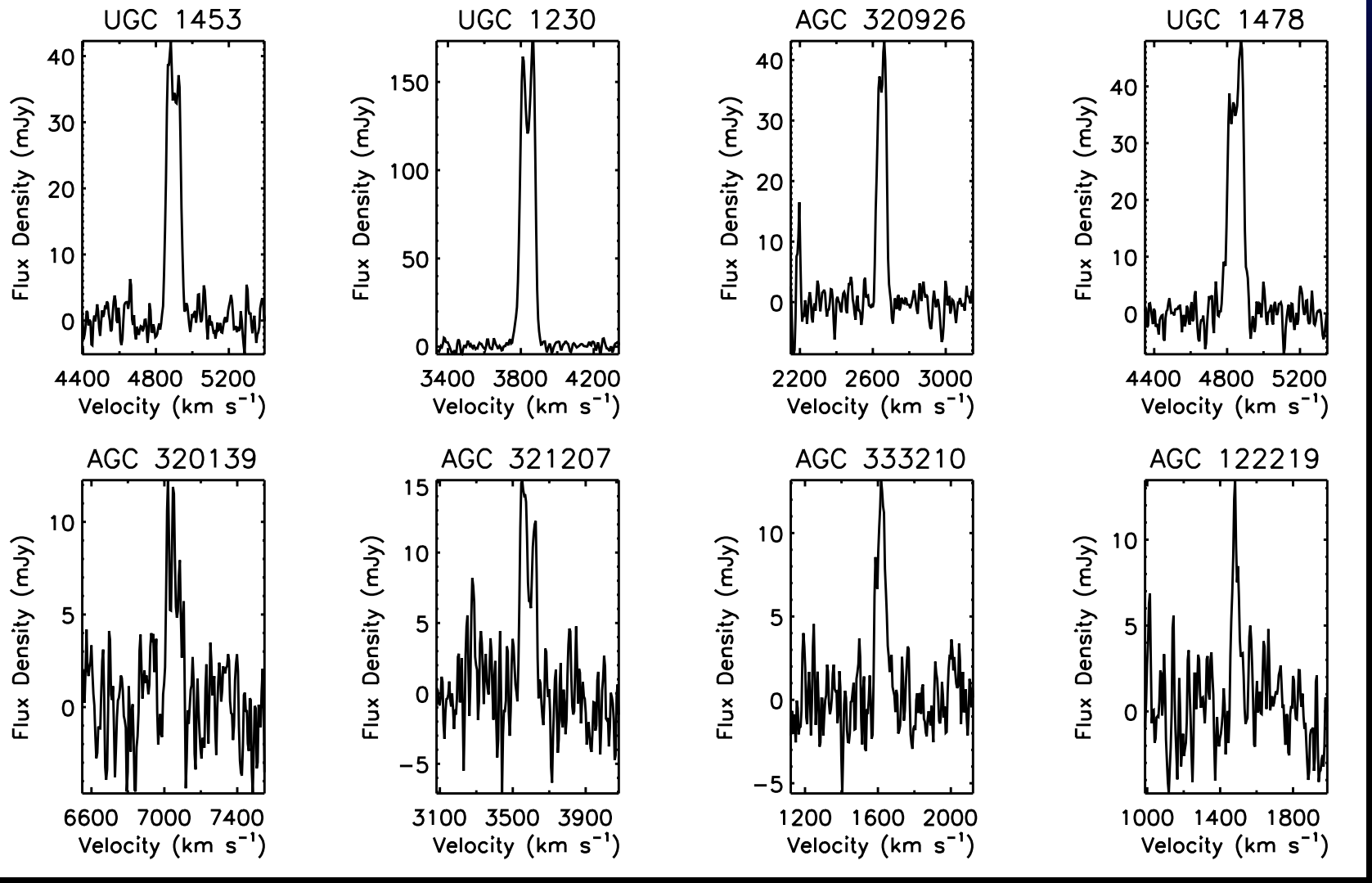
Starbursts

Higher W20/W50 indicates excess of high-velocity HI



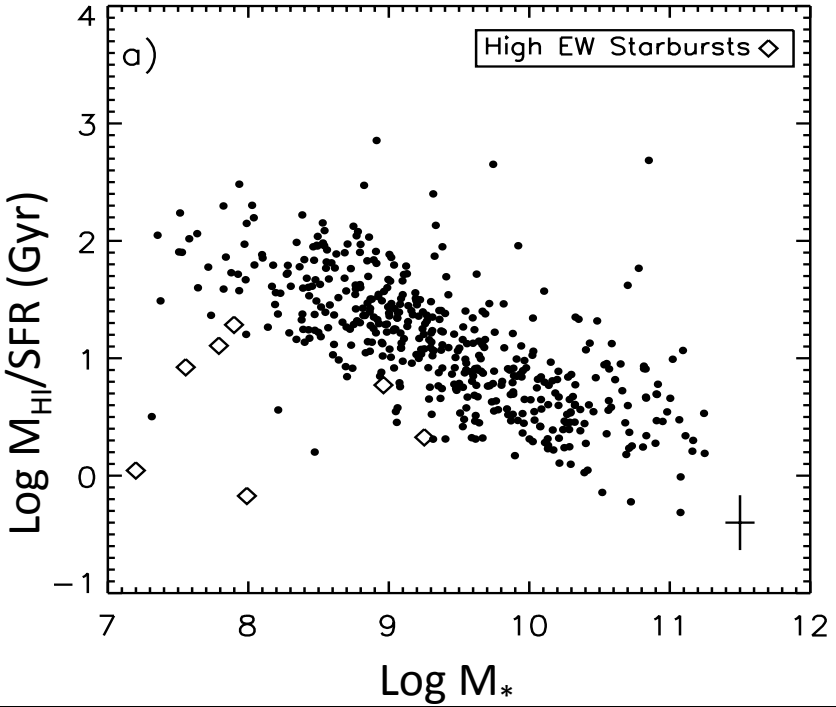
Mergers and HI Kinematics

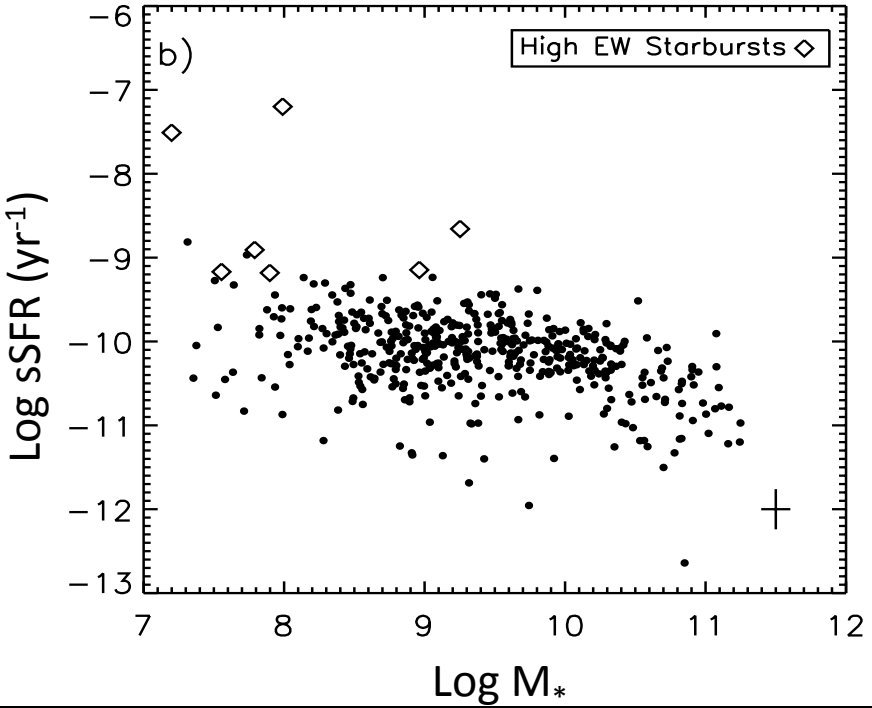
Non-Starbursts



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
- Results in variable SFRs and delayed HI consumption





Summary

- HI weakly linked to sSFR, closely coupled with dust extinction
  - Gas cycles and metallicity
- HI/SFR correlates with stellar surface density for disks
  - Role of mid-plane pressure?
- Spheroids may differ in access to HI
- Starbursts may maintain approximately constant HI
- Bursts in low-mass galaxies may be cyclical

Jaskot et al. 2015, ApJ, 808, 66