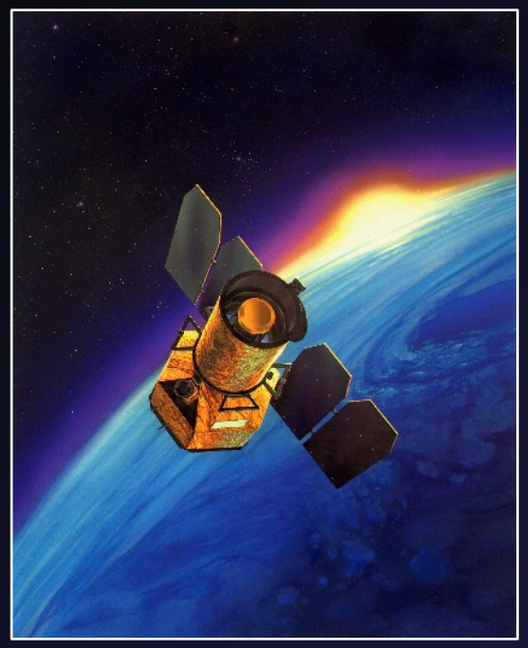
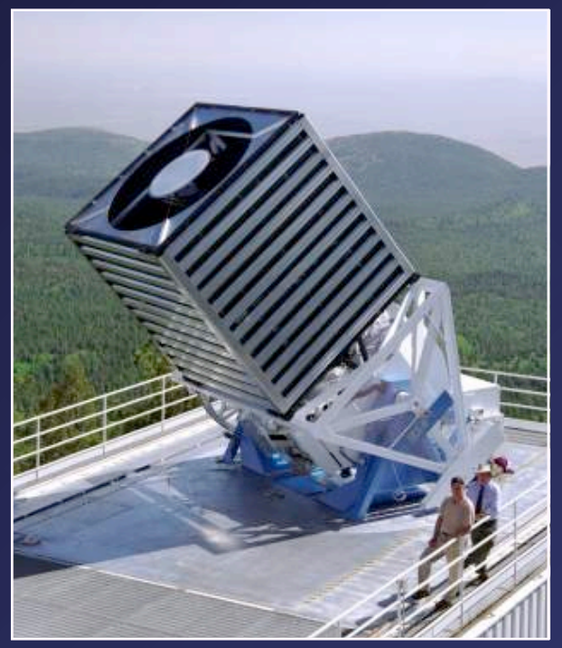
HI Scaling Relations in Nearby Massive Galaxies





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Max Planck Institute for Astrophysics

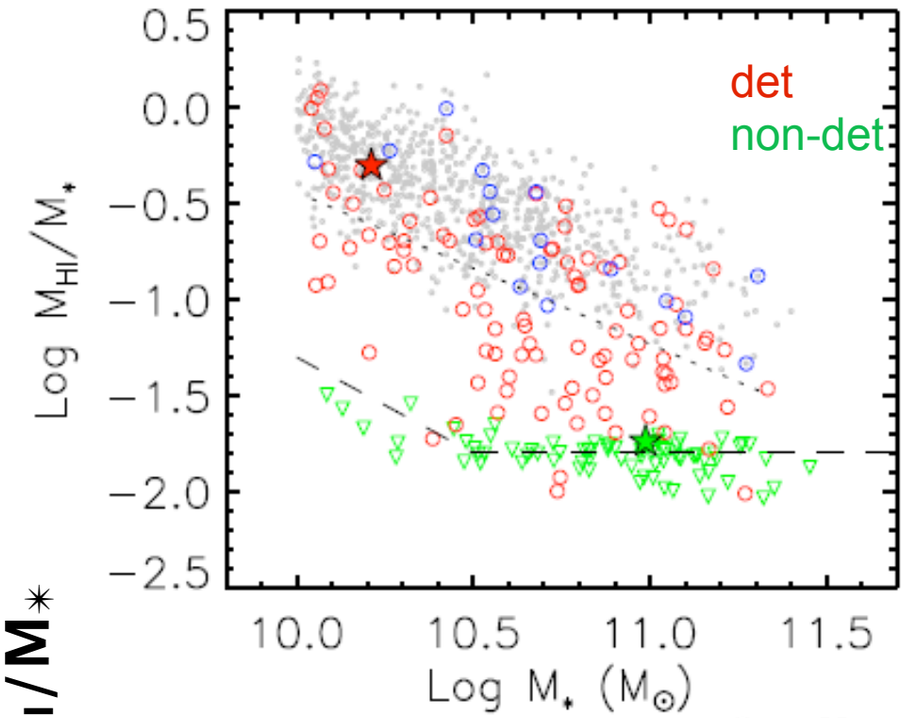
& GASS Team

Kloster Seeon, Germany, Jun 15 2011

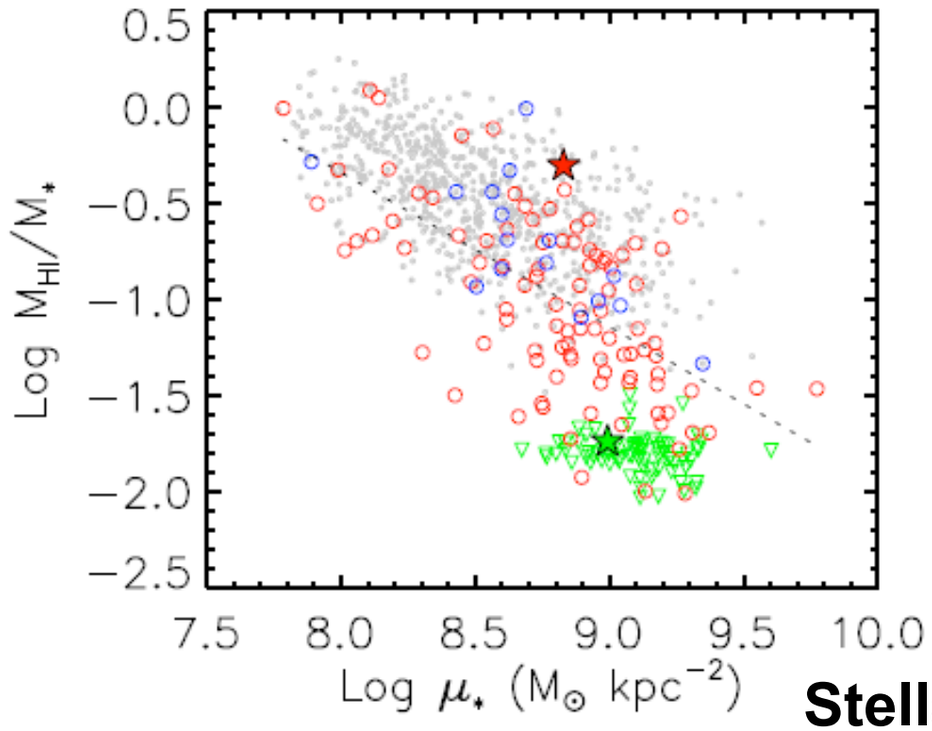
Importance of HI scaling relations

- Constraining models
- Reference for higher redshift samples
- Identifying galaxies in the process of transitioning between blue and red sequences

GASS DR1: gas fraction scaling relations



Stellar Mass

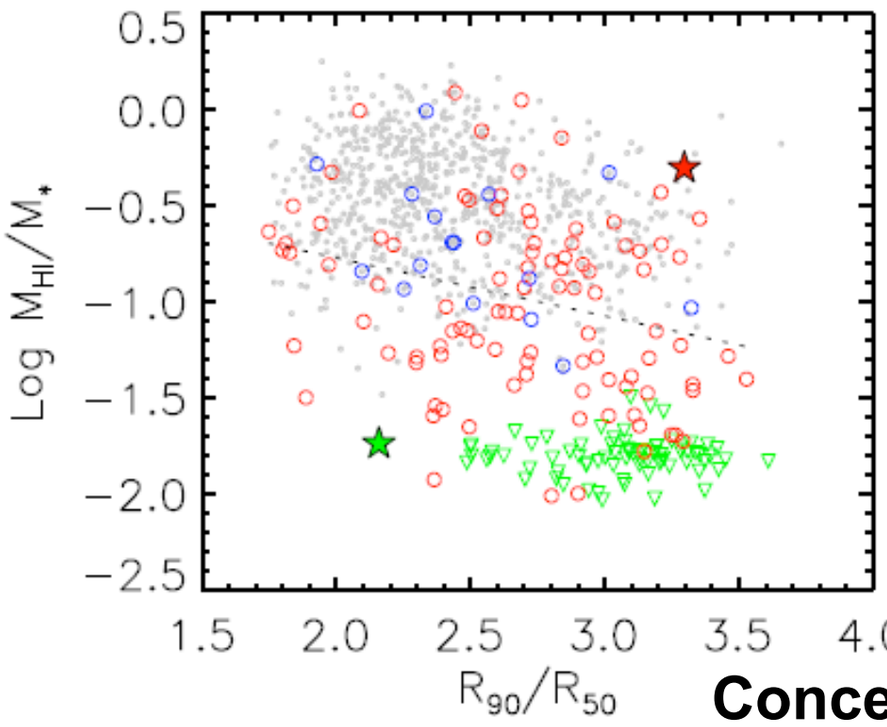


Stellar Mass Surface Density, $M_*/2\pi R_{50}^2$

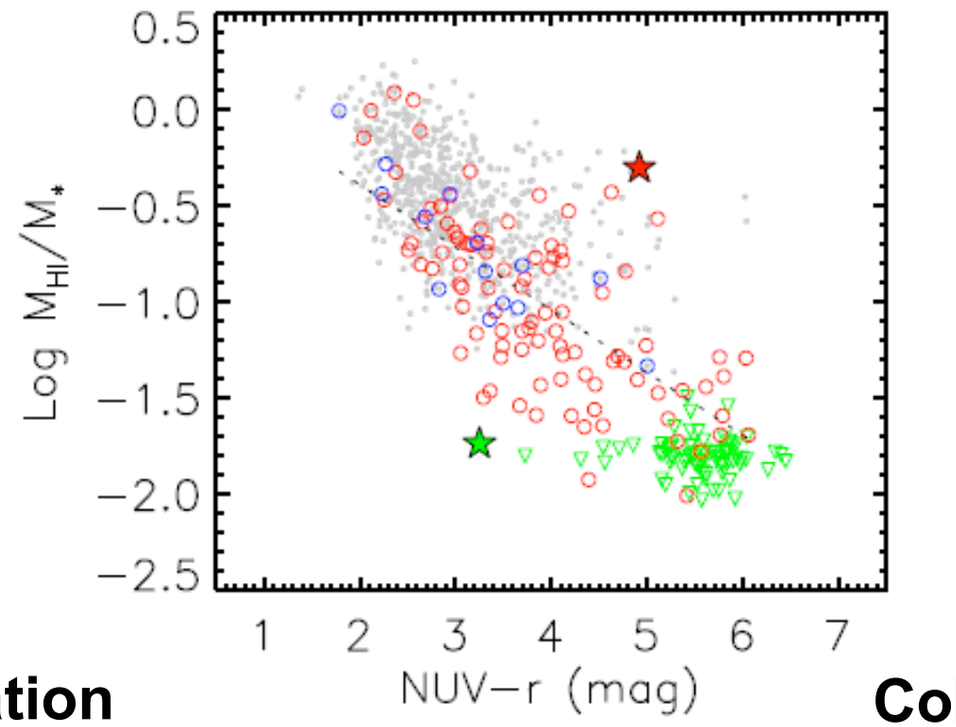
Gray: ALFALFA

Blue: HI-rich galaxies added to DR1

Dotted lines: fits to red + blue circles



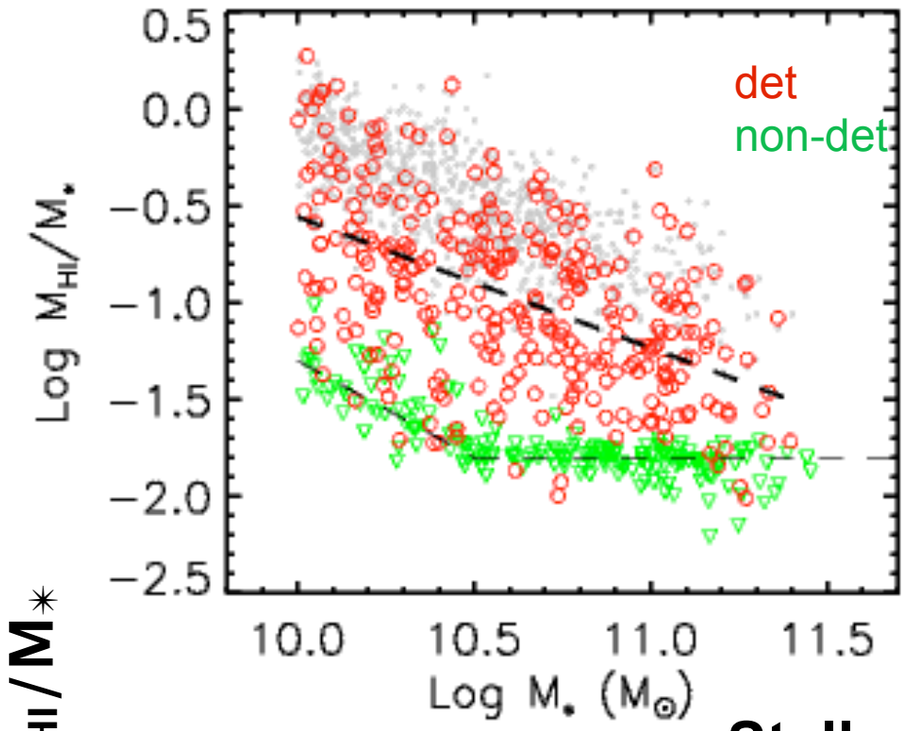
Concentration



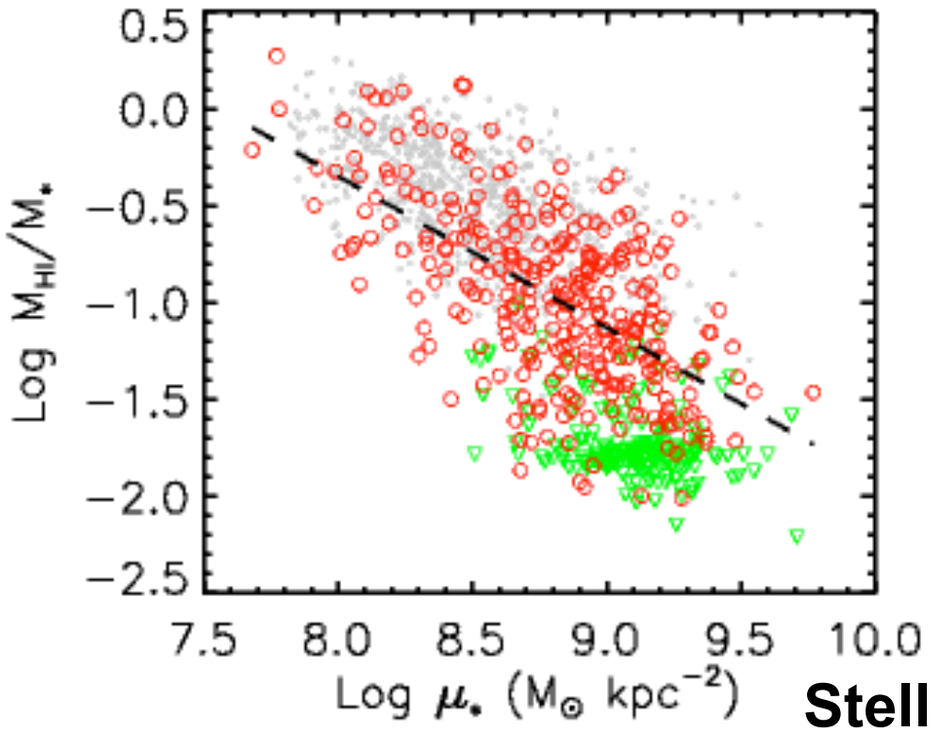
Color

Catinella, Schiminovich, Kauffmann et al. 2010

DR2 gas fraction scaling relations



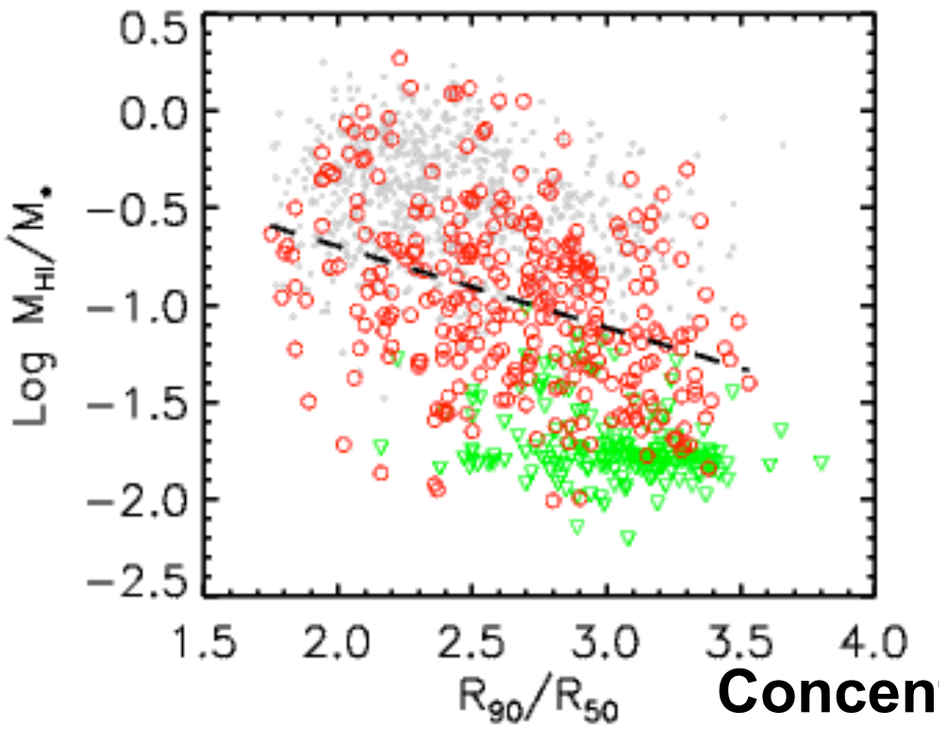
Stellar Mass



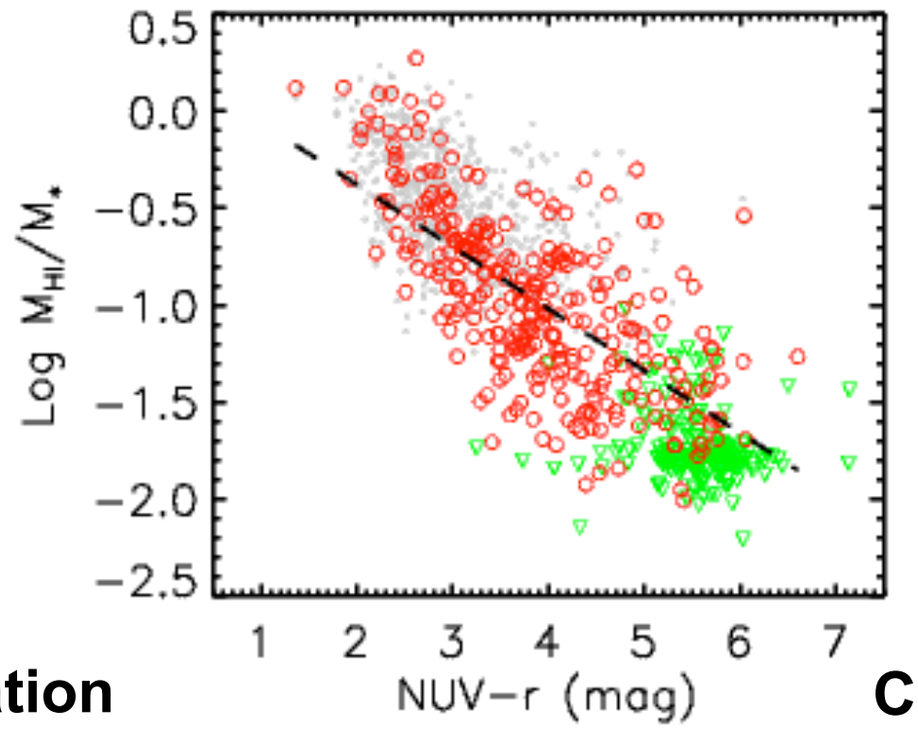
Gray: ALFALFA

Transition seen with μ_*, not M_*

Stellar Mass Surface Density, $M_*/2\pi R_{50}^2$

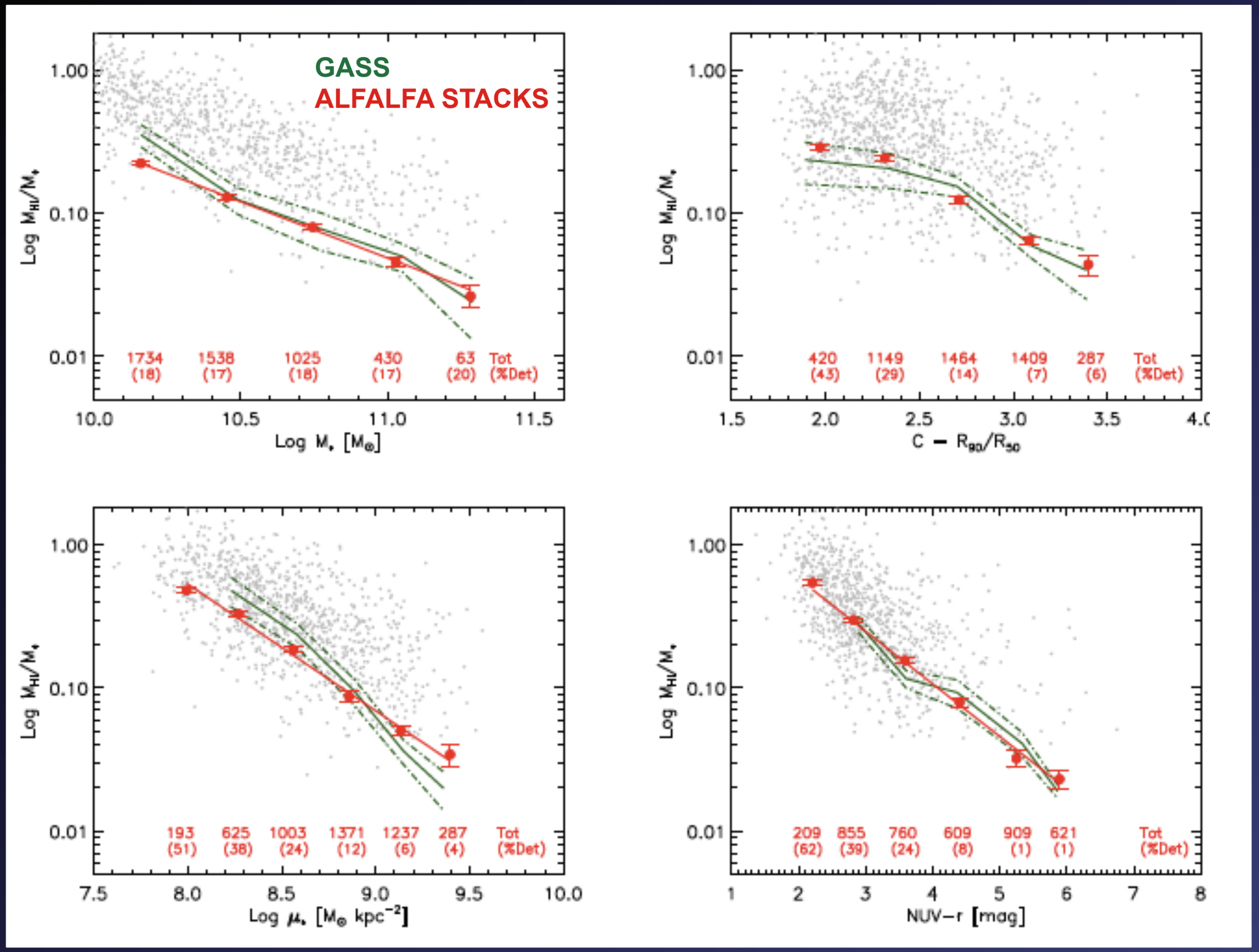


Concentration



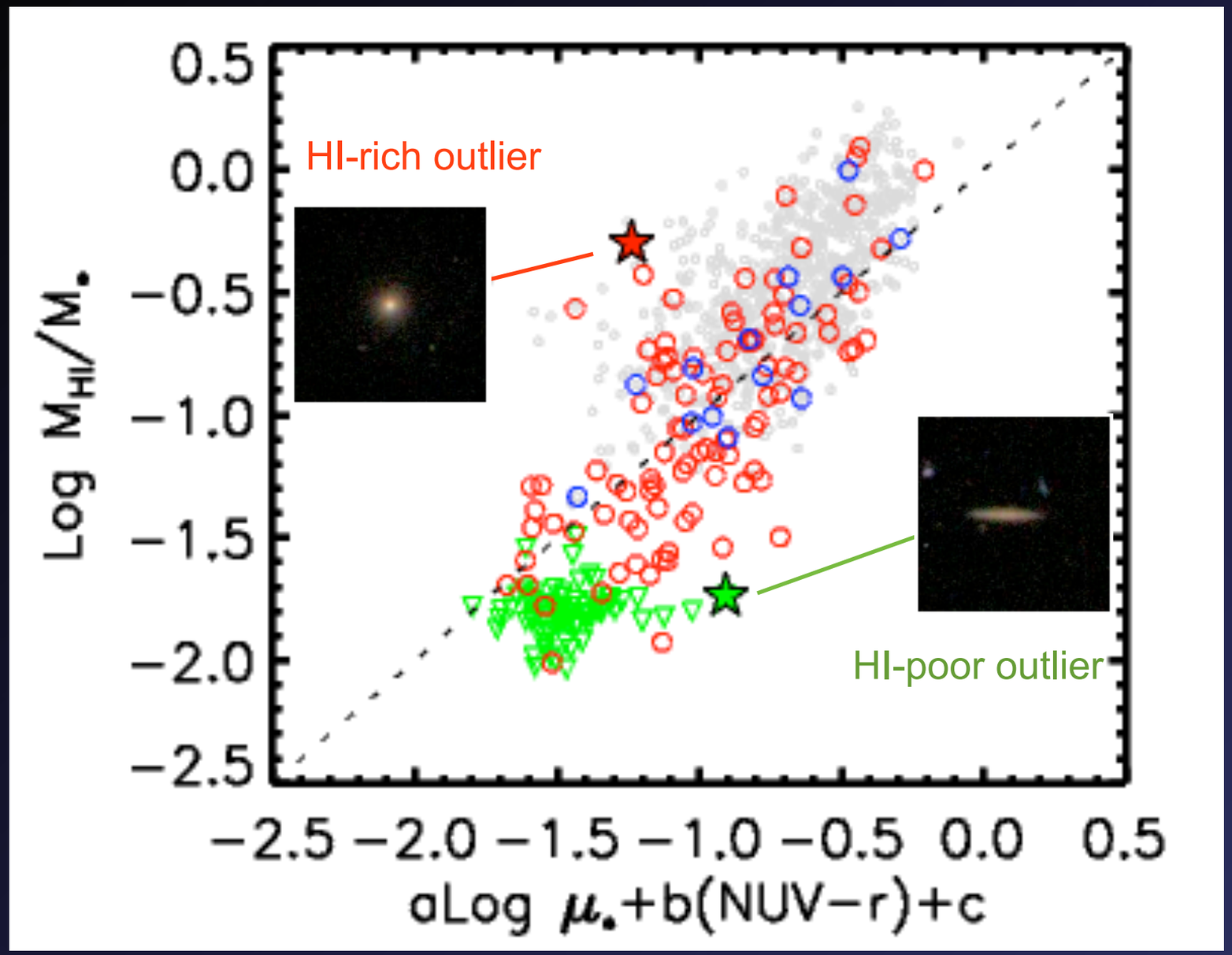
Color

ALFALFA stacking: excellent agreement with GASS!



Fabello, BC et al. 2011

HI gas fraction plane

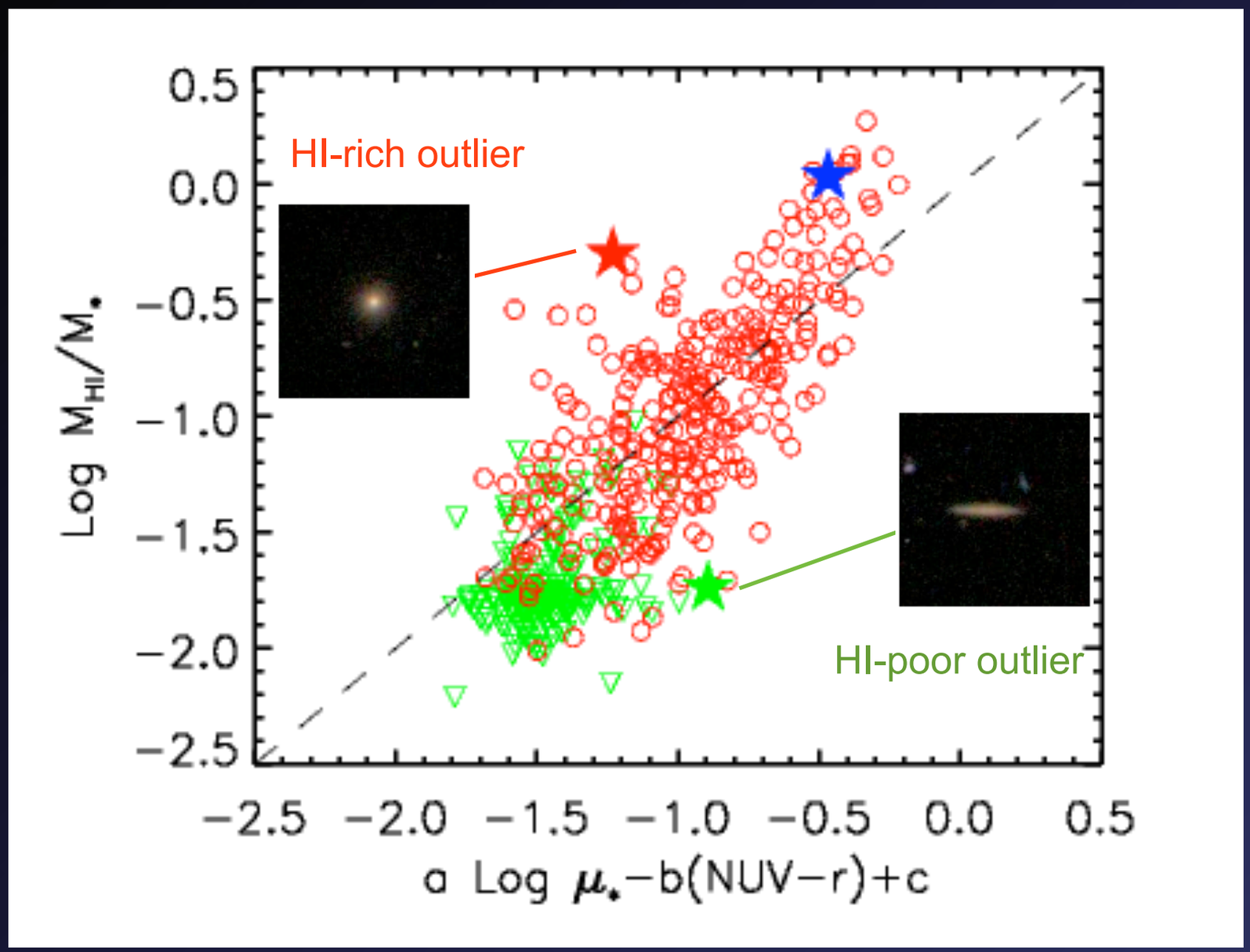


Transition galaxies: anomalous gas content given their optical/NUV colors and μ_*

BC, Schiminovich, Kauffmann et al. 2010

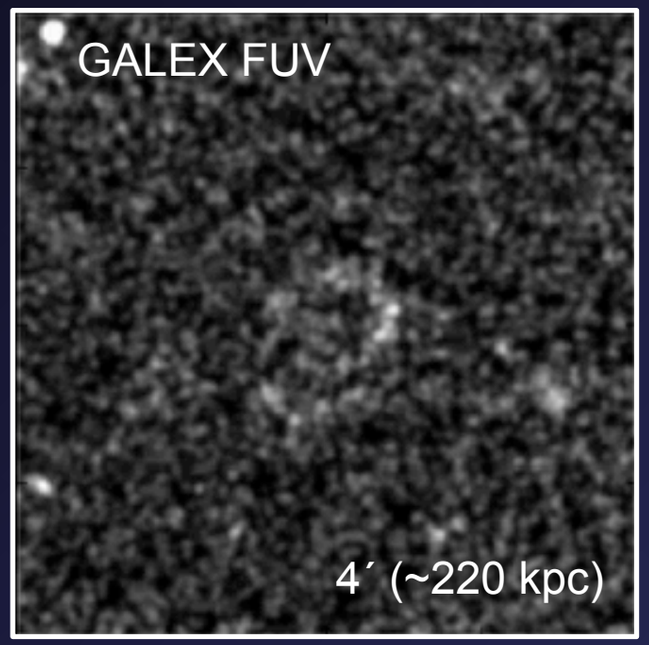
$$\Sigma_{\rm SFR} \propto \Sigma_{\rm gas}^{n} \quad \Rightarrow \quad {\rm SFR}/M_* \propto (M_{\rm gas}/M_*)^n \mu_*^{n-1}$$

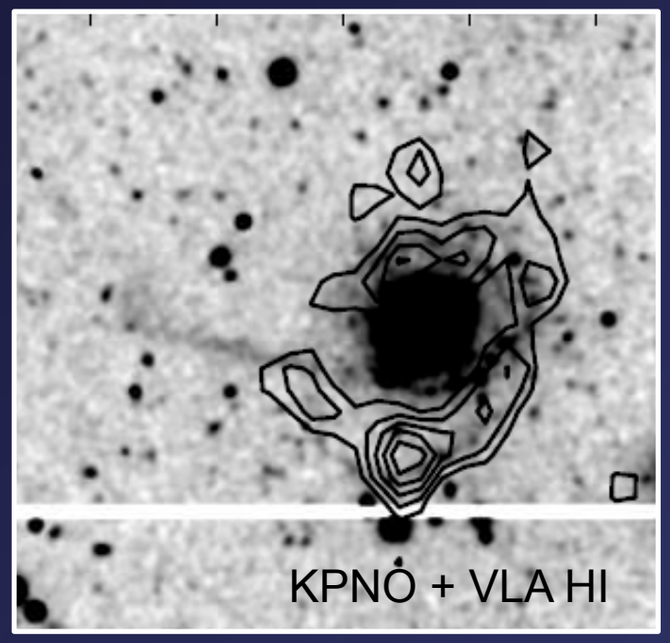
DR2 HI gas fraction plane

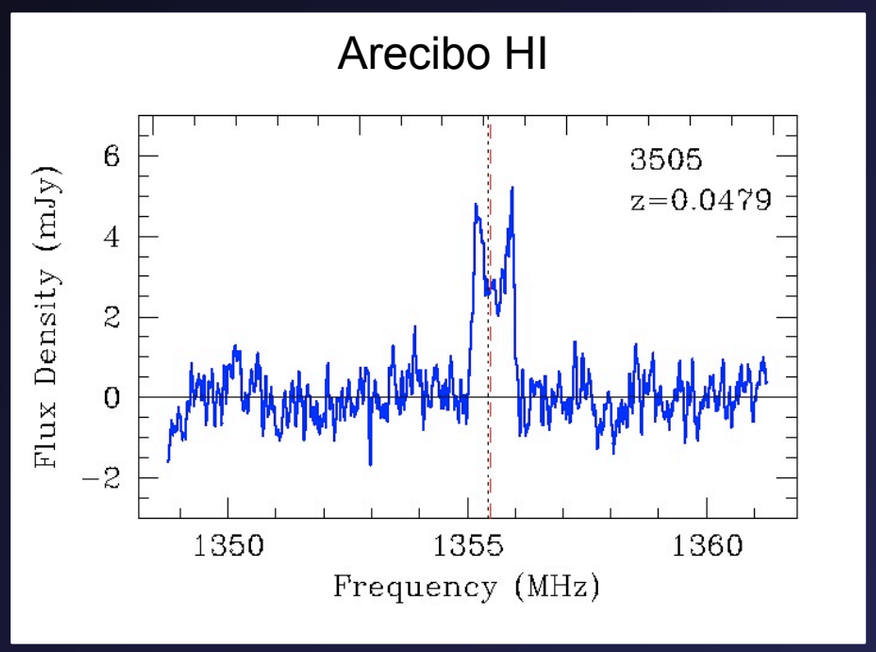


Transition galaxies: anomalous gas content given their optical/NUV colors and μ_*

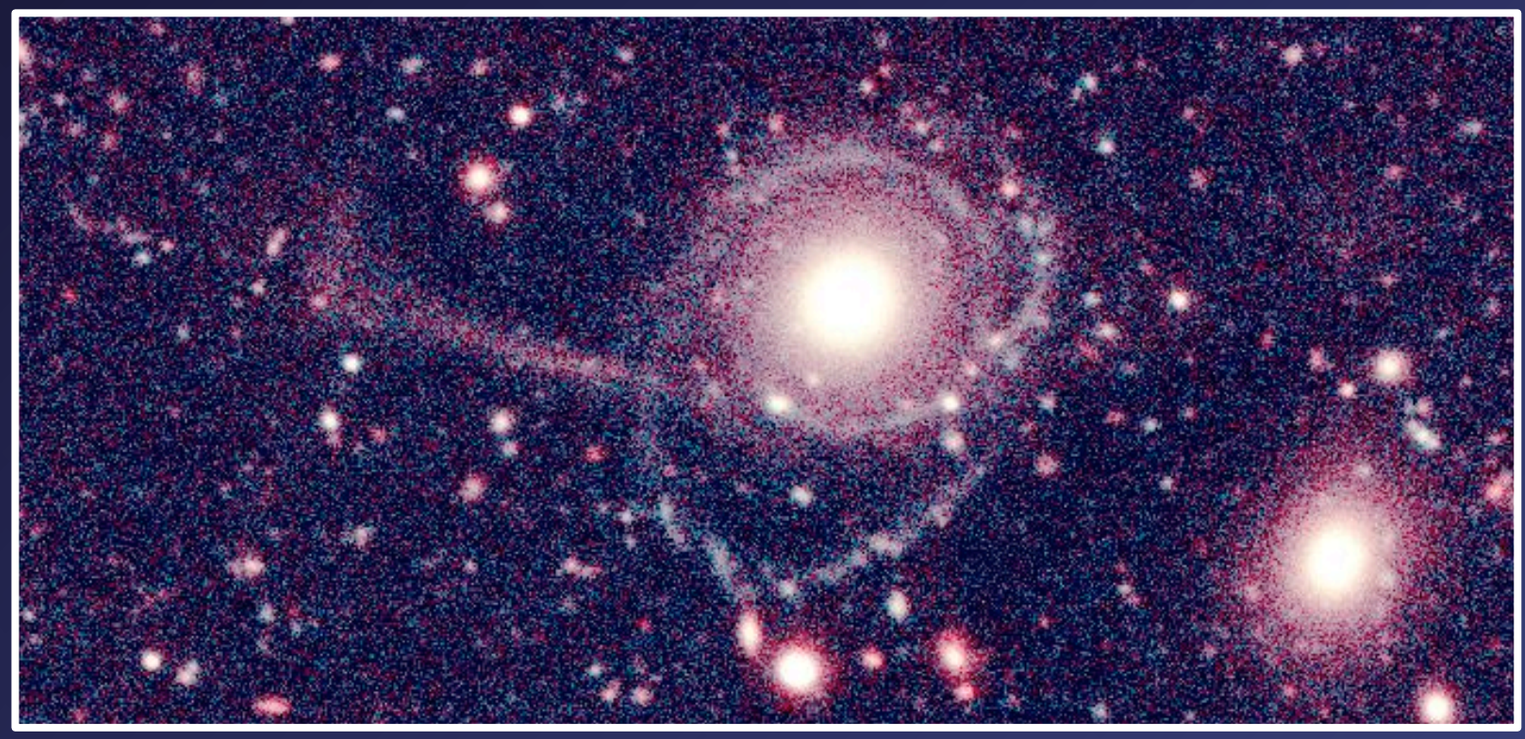
GASS 3505: a gas-rich, "red and dead" galaxy





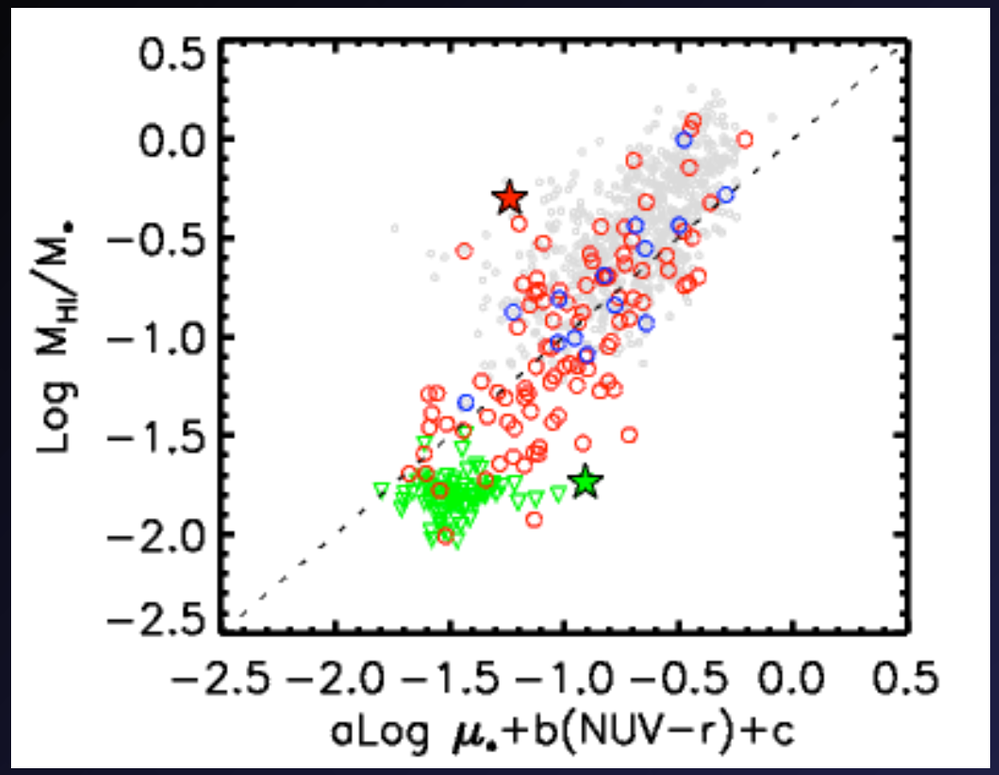


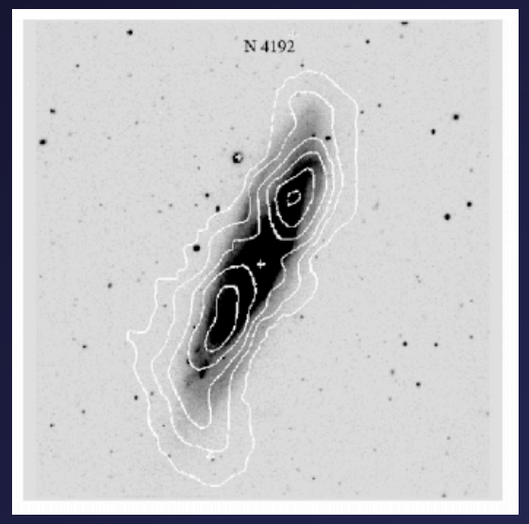
$\log M_{HI}/M_{\odot}=9.91$ $M_{HI}/M_{\star}=50\%$

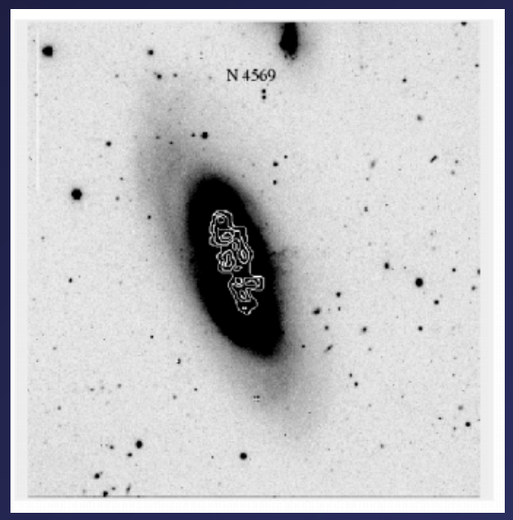


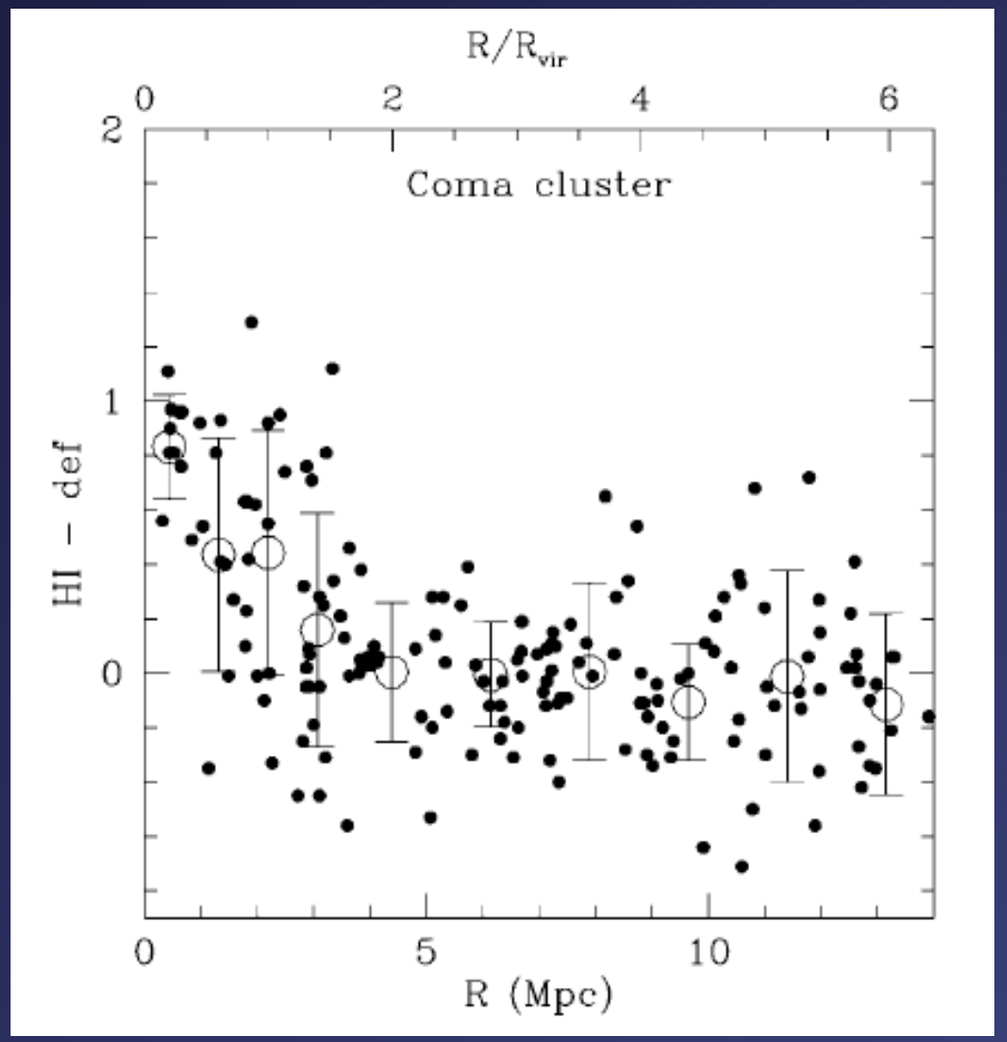
MMT g and r-band imaging (S. Moran)

Gas fraction plane and HI deficiency









HI deficiency (Haynes & Giovanelli 1984, Solanes et al. 1996...)

HIdef = Log <M(HI, D_{opt},Type)> - Log $M(HI)_{obs}$

HIdef = 1 ⇒ $M(HI)_{obs}$= 0.1 x $M(HI)_{expected}$

Boselli & Gavazzi (2006)

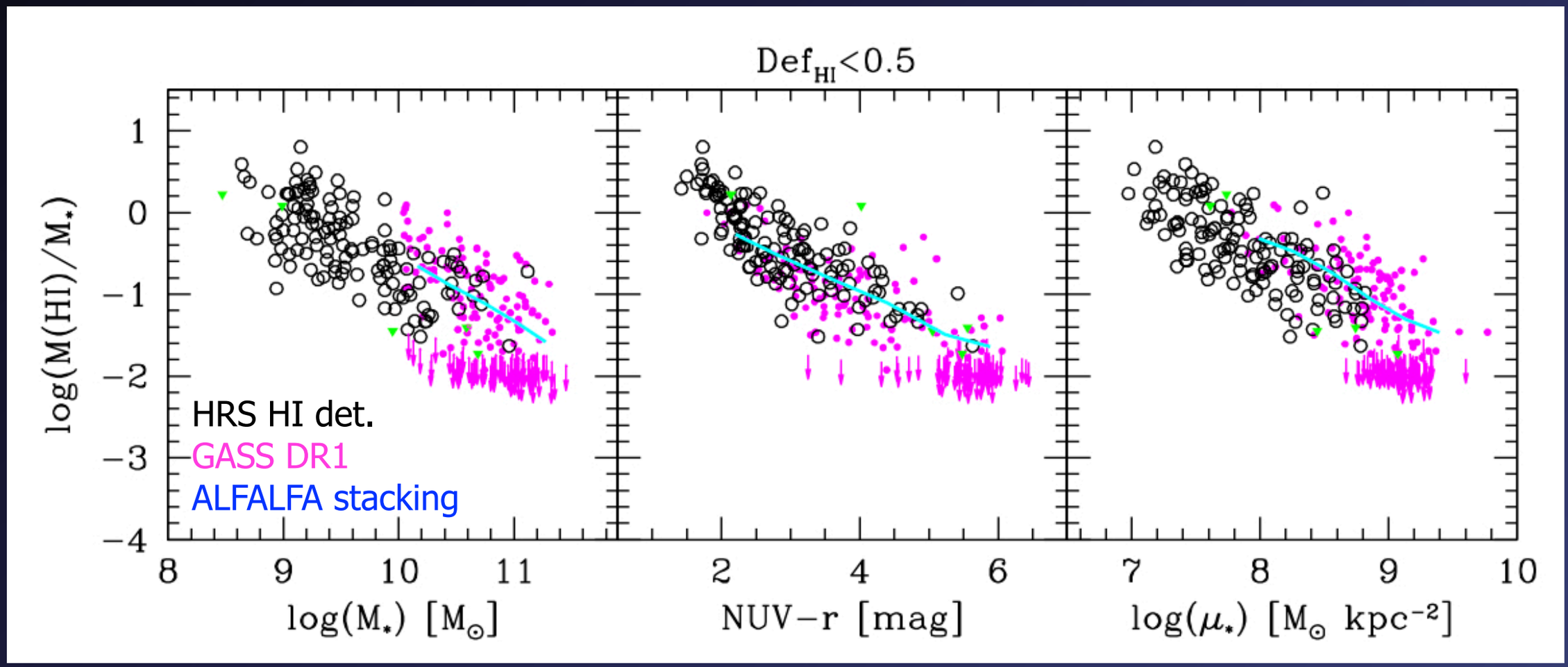
HRS HI scaling relations

Herschel Reference Survey (Boselli et al 2010)

322 galaxies (65 E/SO, 257 Sp./Irr)

Volume/Stellar Mass limited - From isolated to cluster galaxies

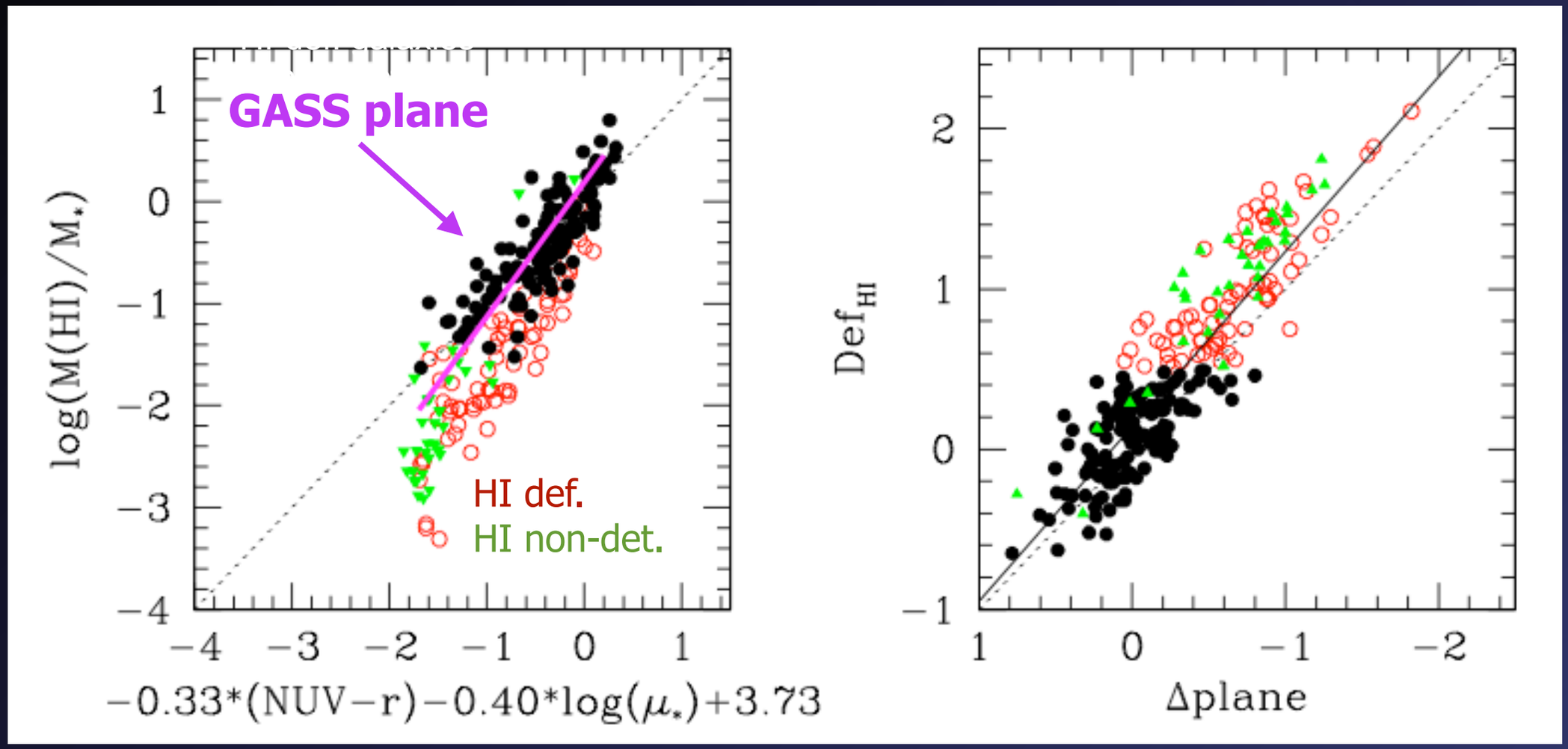
Nicely extend GASS scaling relations to lower $M_\star$ and $\mu_\star$



Cortese, BC et al. 2011

HI gas fraction plane and HI deficiency

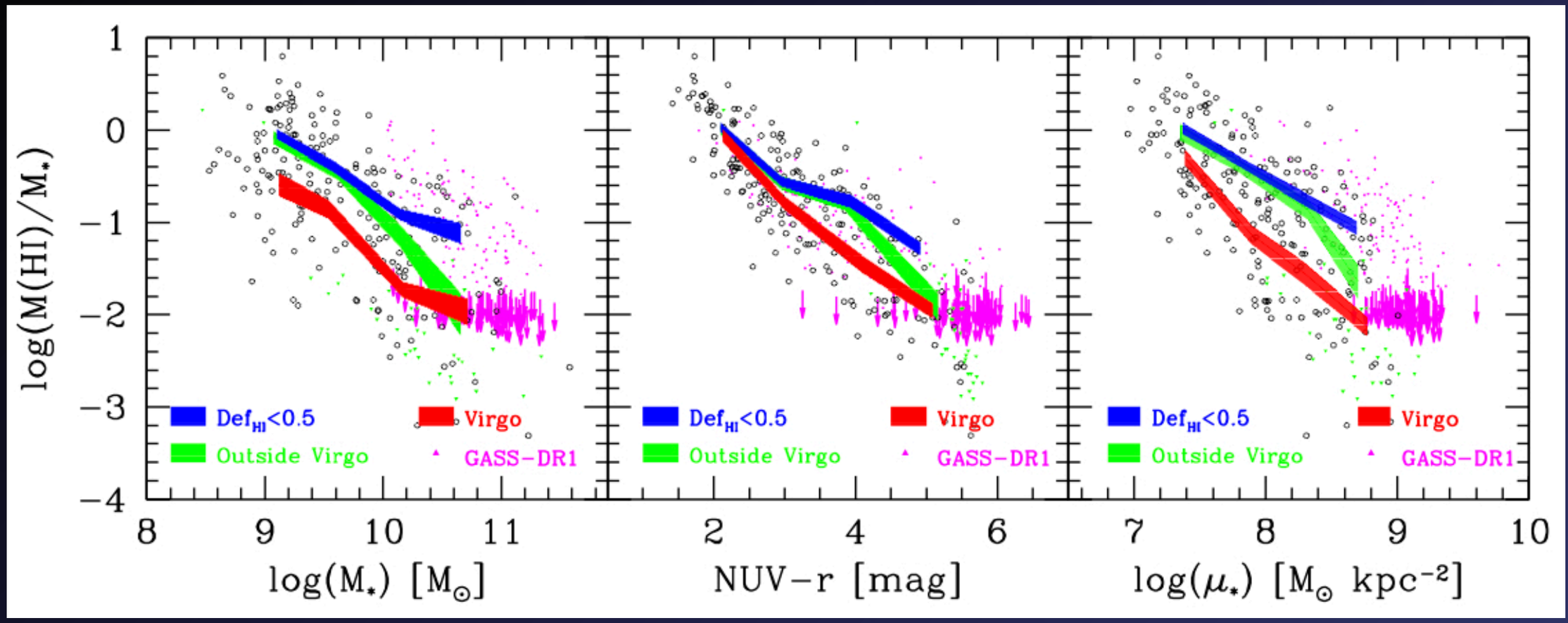
HRS plane for HI-normal galaxies



Cortese, BC et al. 2011

Strong correlation between HI deficiency and distance from the gas fraction plane → the two approaches are consistent

Next step: HI scaling relations and environment



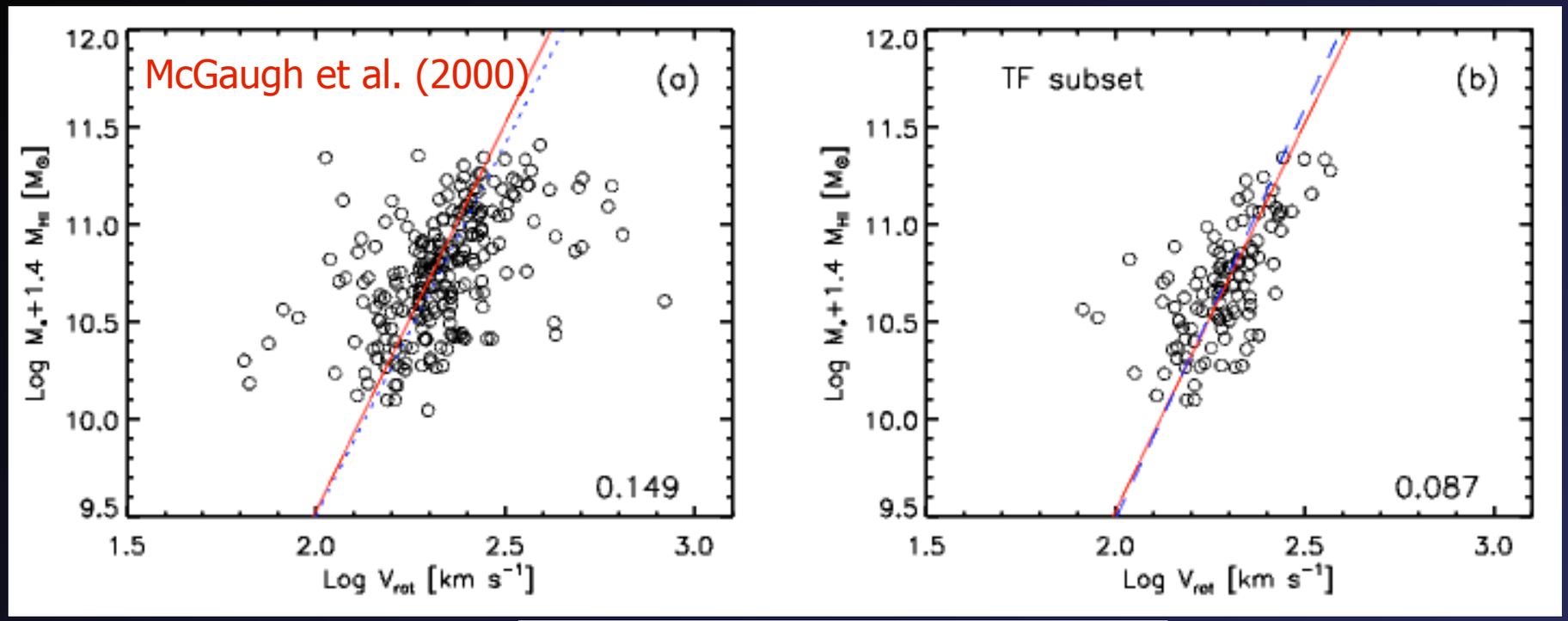
Cortese, BC et al. 2011

HRS: strong difference between field and cluster galaxies

GASS+ALFALFA stacking will sample the intermediate to isolated density regime

Dynamical scaling relations

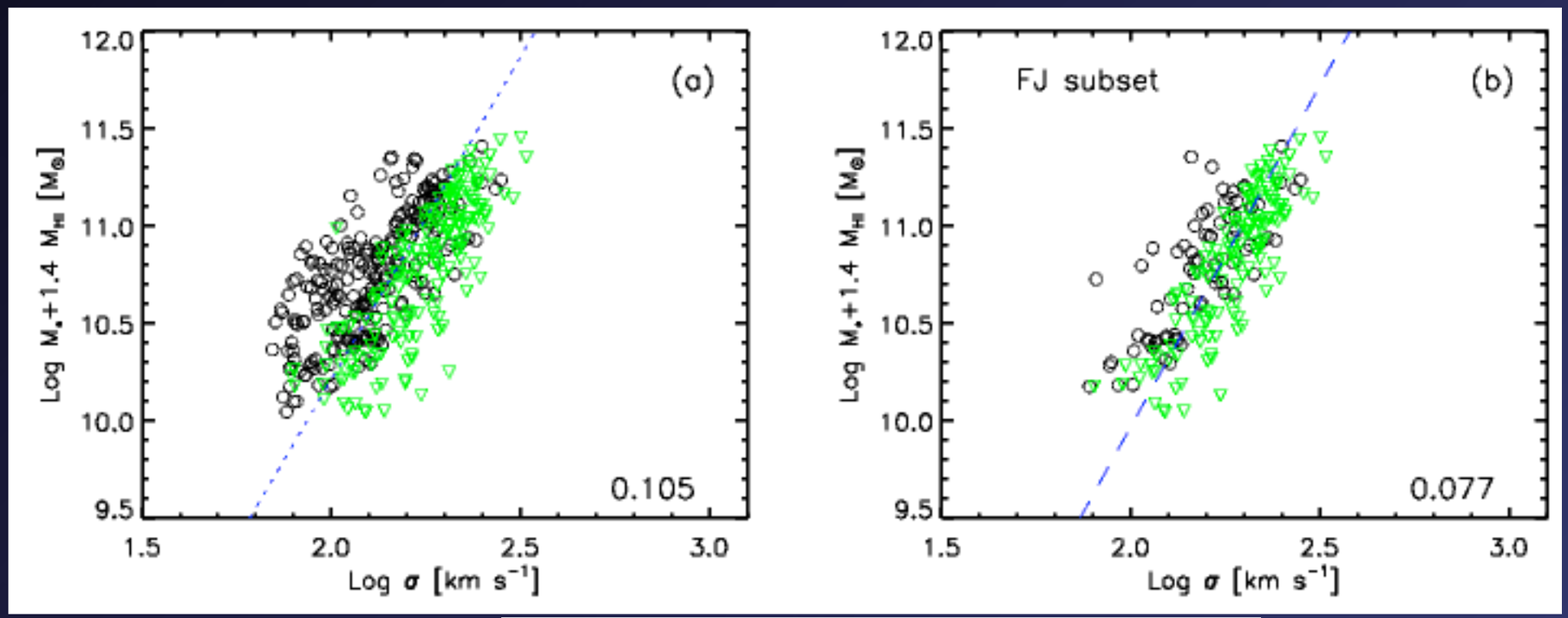
Baryonic Tully-Fisher and Faber-Jackson relations



GASS DR2, N=480
(~300 detections)

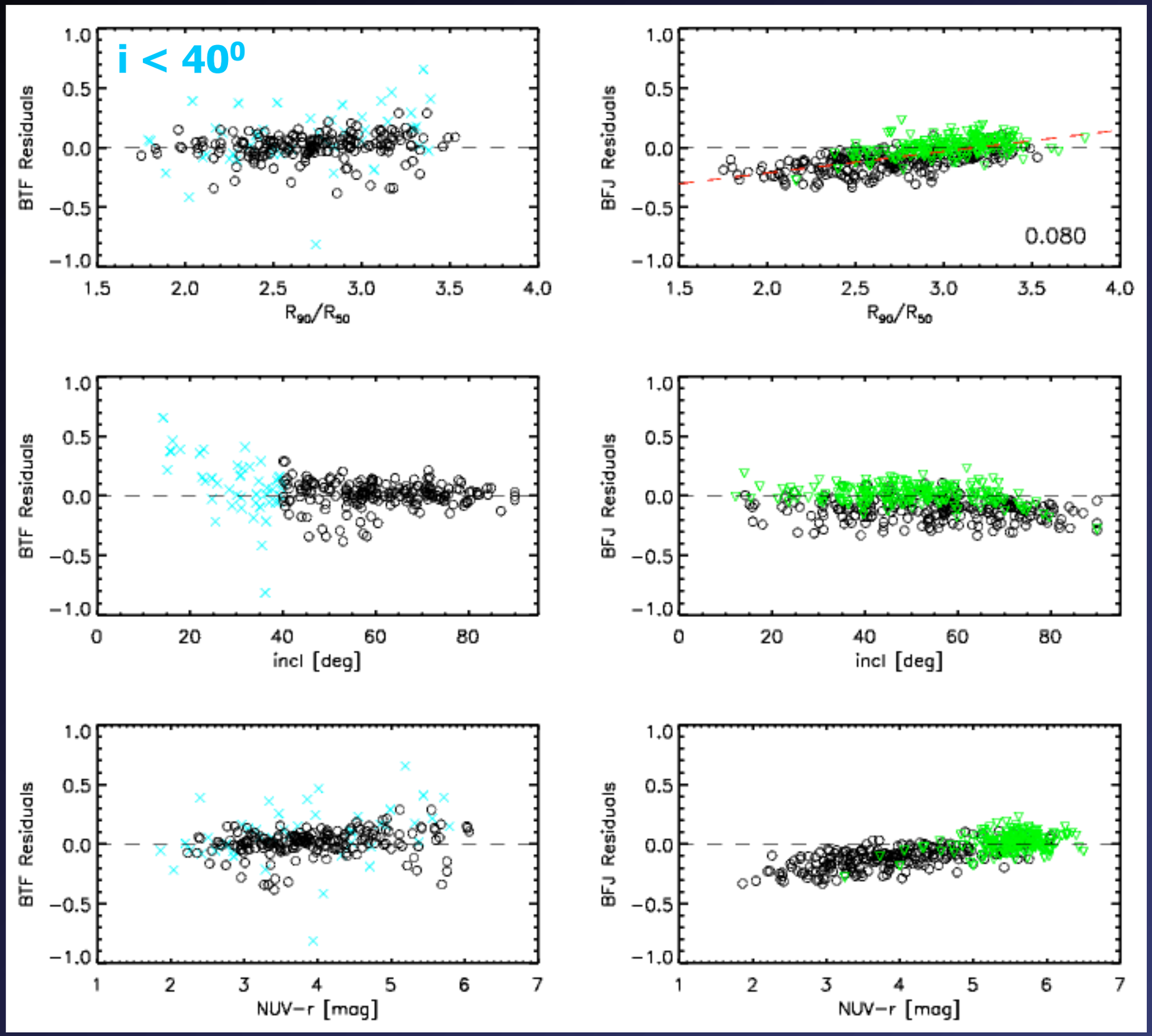
BARYONIC MASS

HI ROTATIONAL VELOCITY



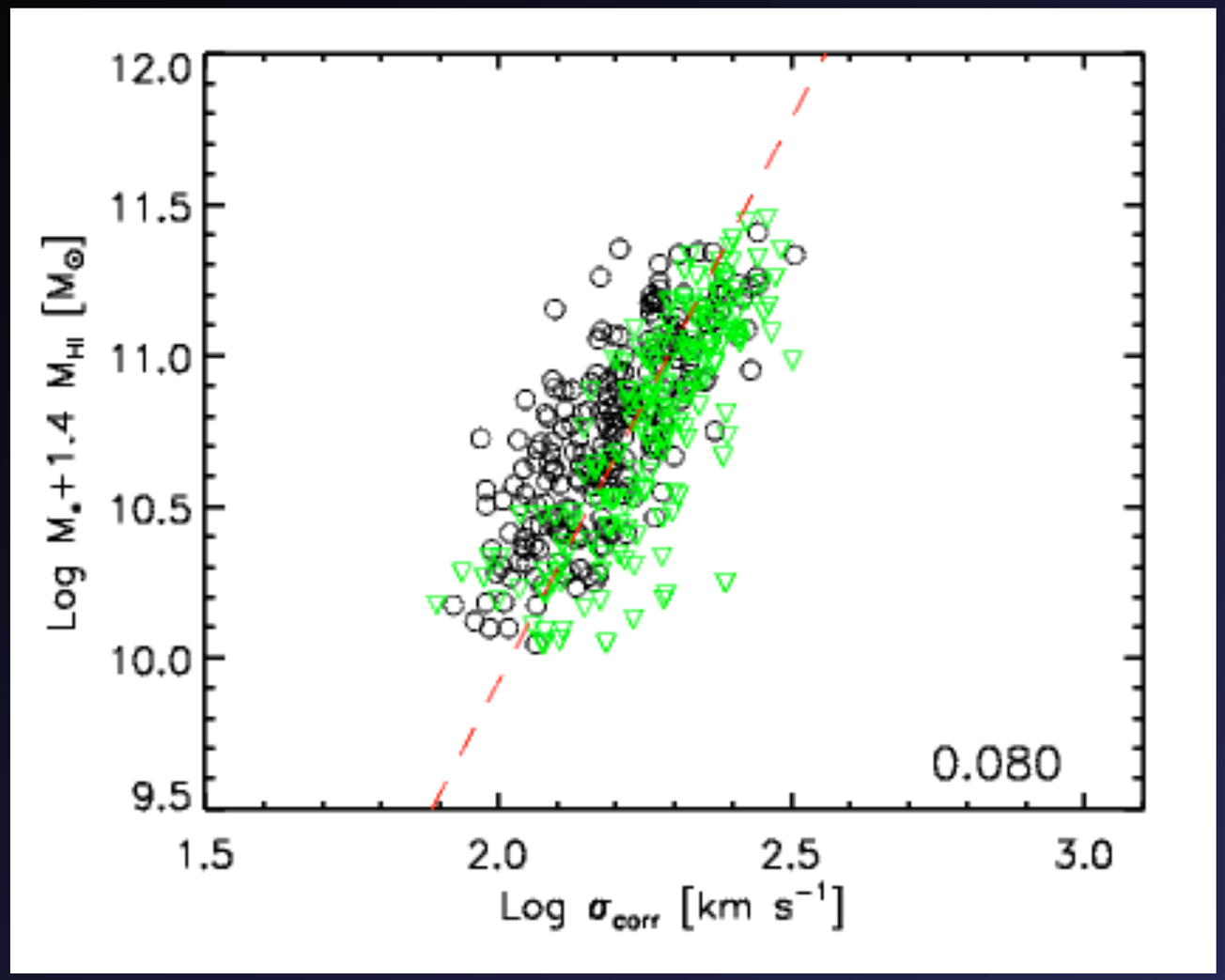
STELLAR VELOCITY DISPERSION

Baryonic TF and FJ Residuals



Baryonic FJ corrected for dependency on R_{90}/R_{50}

BARYONIC MASS



No sample pruning!

No morphological selection, no inclination cuts

CORRECTED STELLAR VELOCITY DISPERSION

- applicable to large samples
- less affected by systematics than TF, FJ -- interesting for evolution of scaling relations
- comparison with models

SUMMARY

- GASS is the first study to specifically target a sample that is homogeneously selected by stellar mass ($10 < \log M_\star/M_\odot < 11.5$).

- HI gas fraction scaling relations: the majority of the star-forming, massive galaxies lies on a well-defined plane, linking HI fraction, NUV-r color and stellar mass surface density. Outliers from main relation are candidates for galaxies in transition between blue and red sequences. Distance from plane is a proxy for HI deficiency.

- Dynamical scaling relations: disks and spheroids can be brought onto the same Faber-Jackson relation with a simple correction to the observed dispersion (which depends systematically on bulge-to-total ratio). This relation is tight (0.08 dex) and holds for all massive galaxies, regardless of morphology and inclination.