Alessandro Bianchetti, Giulia Rodighiero, Ed Elson, Francesco Sinigaglia, Mattia Vaccari
MIGHTEE & CHILES collaborations

5th National SKA Workshop, Bologna

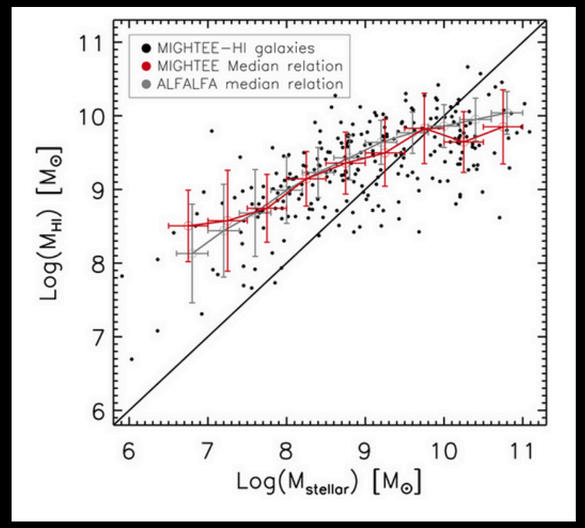
ISARP RADIOMAP Joint Research Scheme
INAF Large Grant: MeerKAT and LOFAR Team up: a Unique Radio Window on Galaxy/AGN co-Evolution

HI in galaxies below the Main Sequence

with stacking

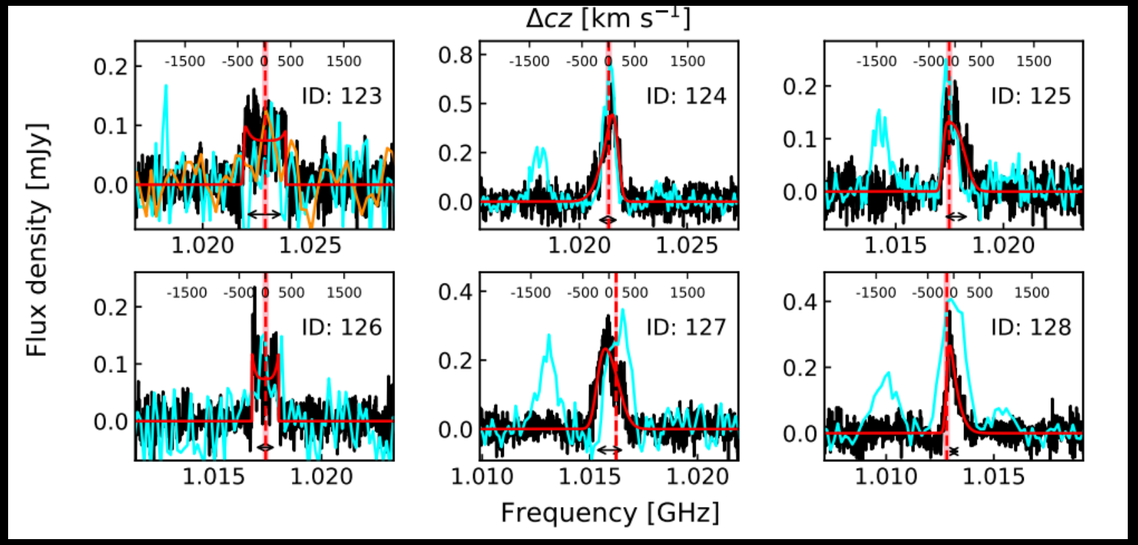
HI emission beyond the local Universe

direct detections of HI emission

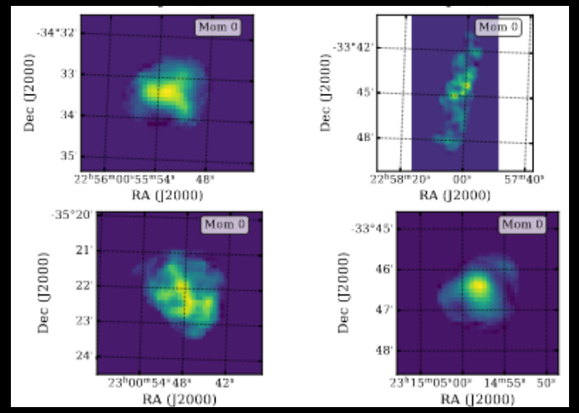


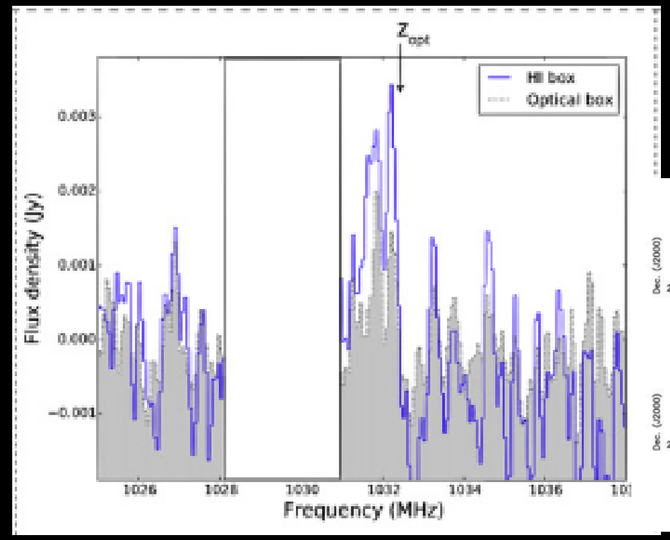
z = 0.1
Maddox+21
MIGHTEE-HI (MeerKAT) vs ALFALFA (Arecibo)

z = 0.4
Xi+2024
FUDS survey
FAST 500m dish

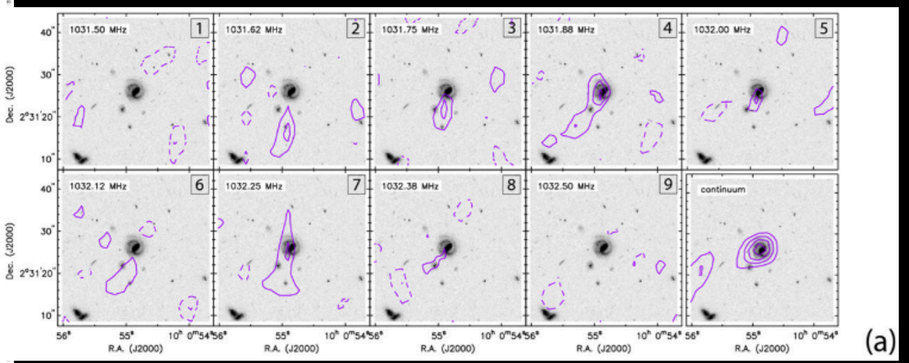


z = 0.01
Rhee+23 - DINGO survey - ASKAP





z = 0.34
Fernandez+16 - CHILES survey - VLA



HI emission beyond the local Universe

sparse detections, and redshift limits
we lack statistics

→

stacking is a cost-effective alternative

- Signal ∝ N
- Noise ∝ √N
- SNR ∝ √N

HI emission beyond the local Universe

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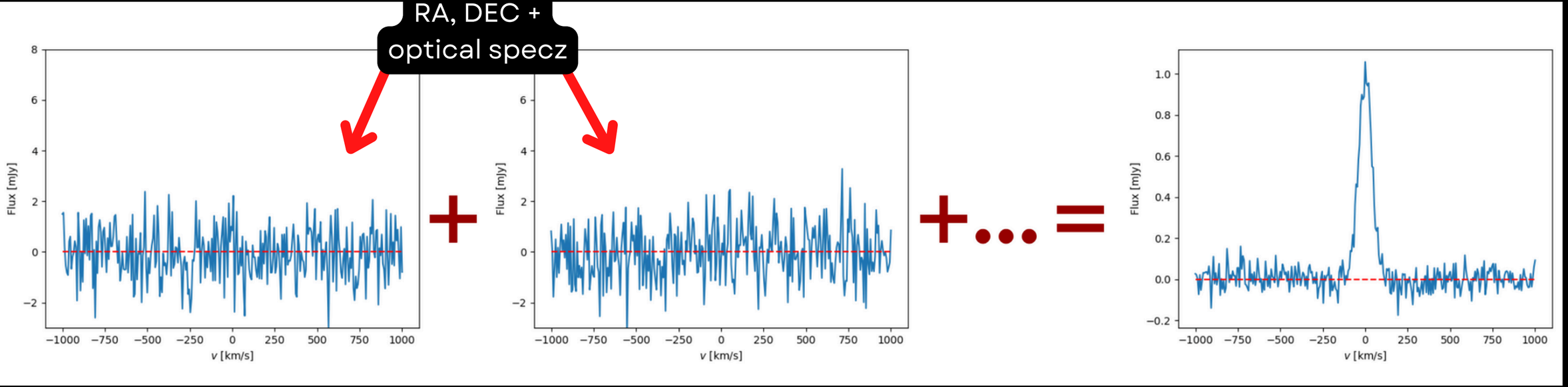
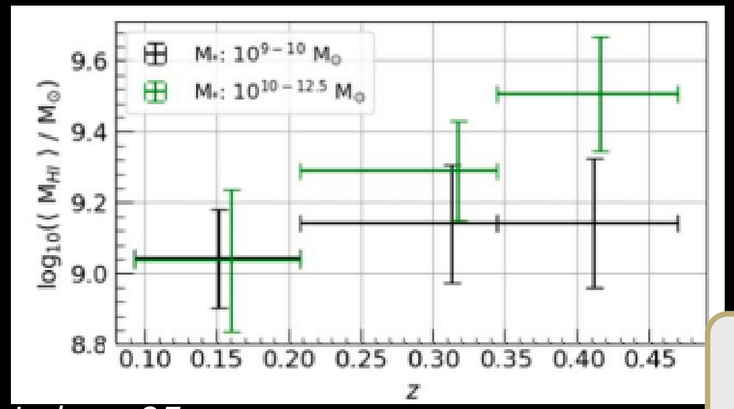


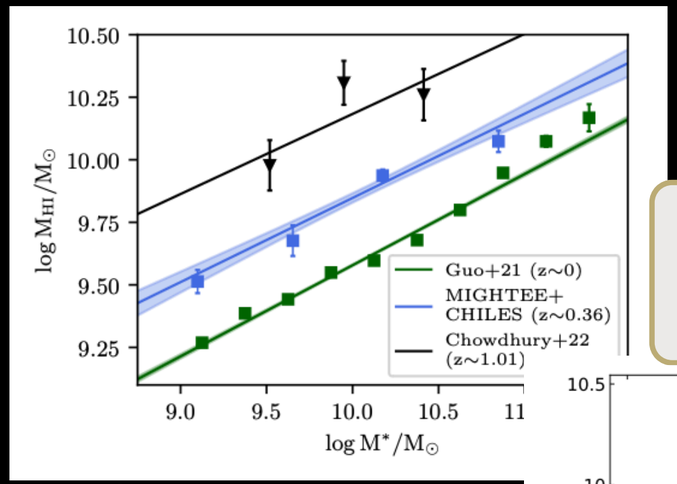
HI in starforming galaxies at z=0.4

the MHI-M* scaling relation



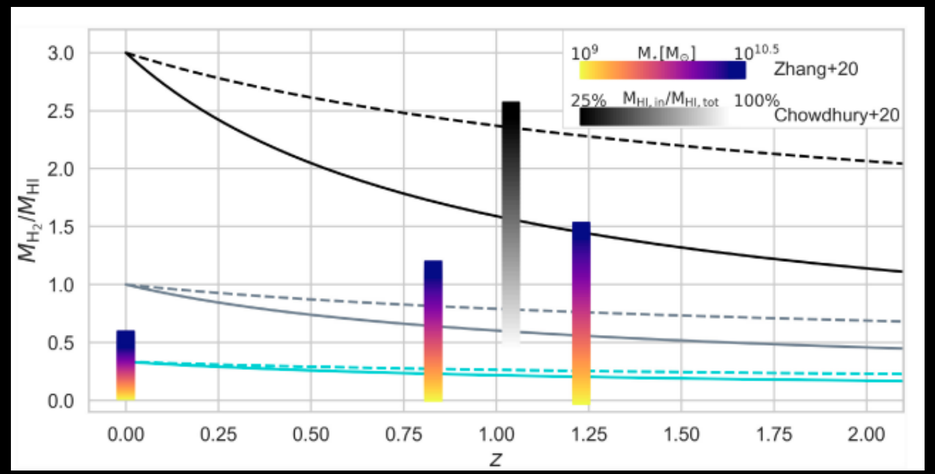
Luber+25

neutral atomic hydrogen and redshift
→shallow dependence?



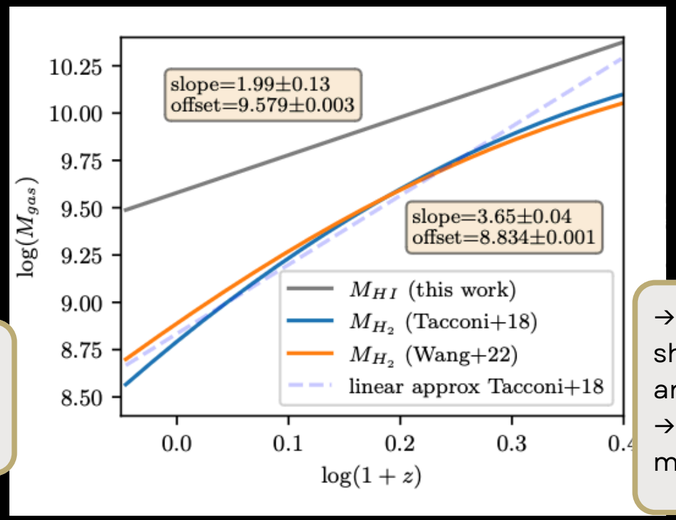
Bianchetti+25a

instances of MHI-M* relation at z=0, 0.4, 1
→do slope and norm change over cosmic time?

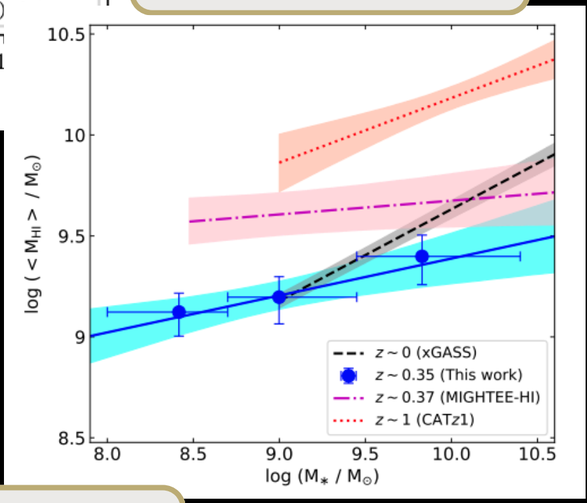


Morselli+21

molecular and atomic hydrogen
→how do they talk to each other in the frame of galaxy evolution?

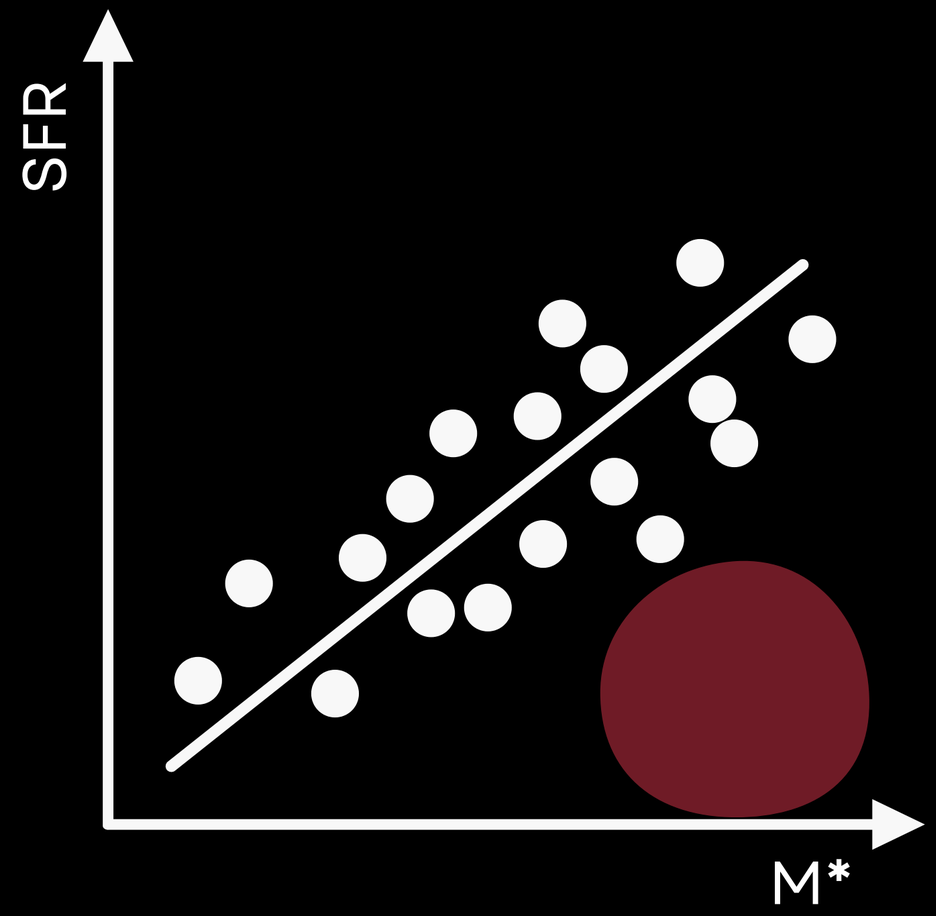


→ HI consumption rate is shallower than molecular and SFR
→ bottleneck in atomic to molecular gas conversion



Bera+23

what about HI in galaxies below the Main Sequence?

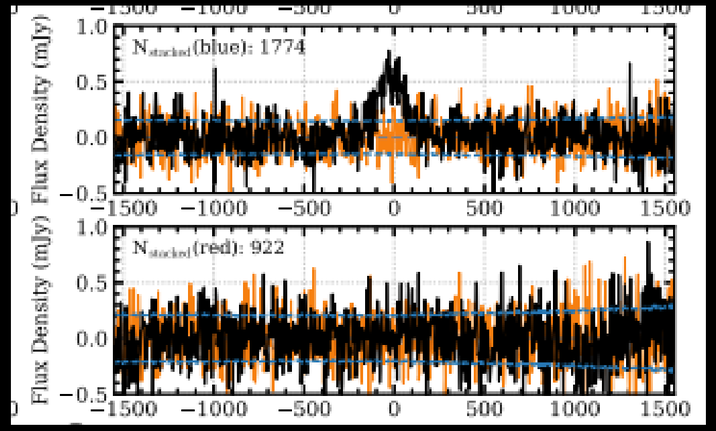


HI in passive galaxies

state-of-the-art

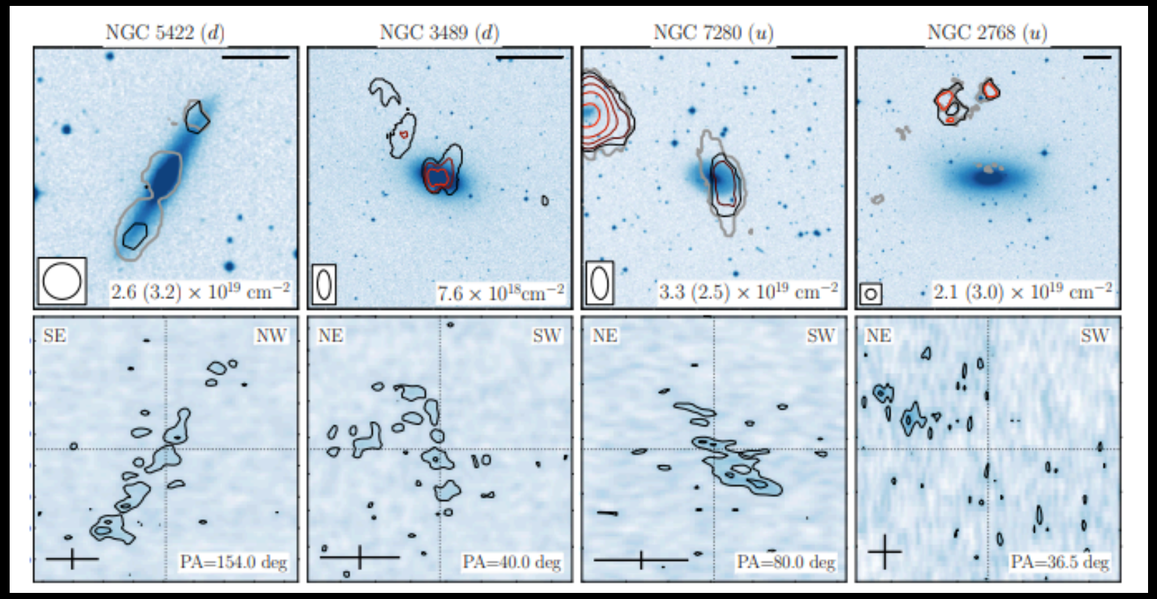
Serra+11, Cappellari+11, Maccagni+17
ATLAS3D Survey

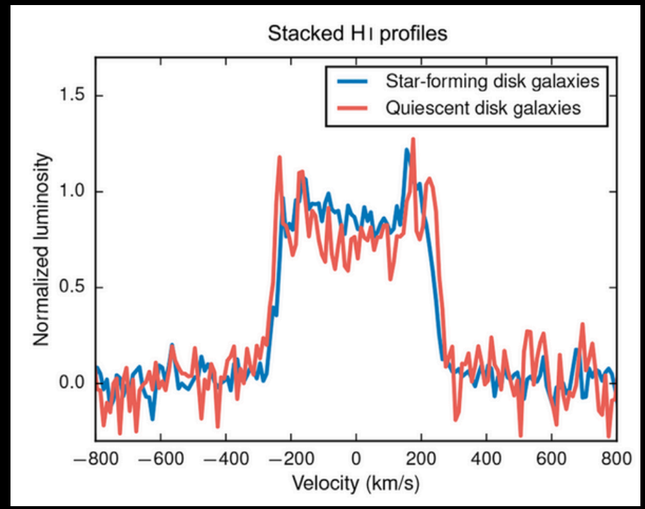
found HI in ETGs, likely environmental dependence
- 40% of galaxies inside Vurgo yield HI detection
- 10% of galaxies outside



Rhee+23 - DINGO survey
stack of red galaxies in GAMA yields no detection

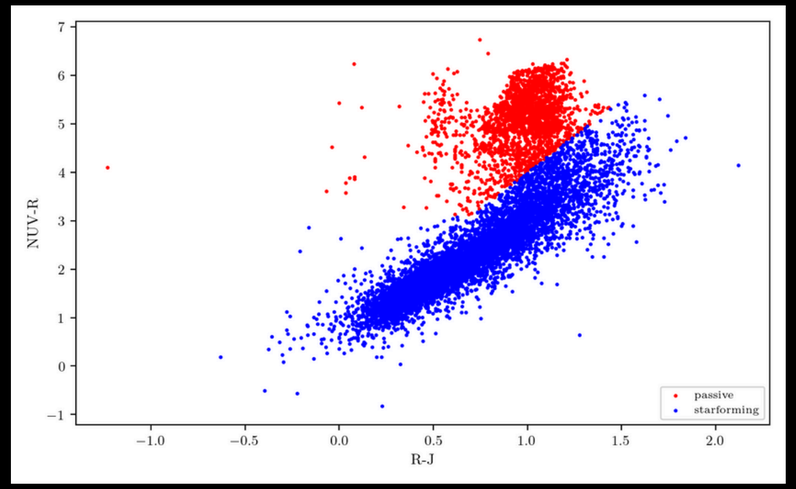
Zhang+19 -
quiescent disk galaxies are as HI-rich as active disks

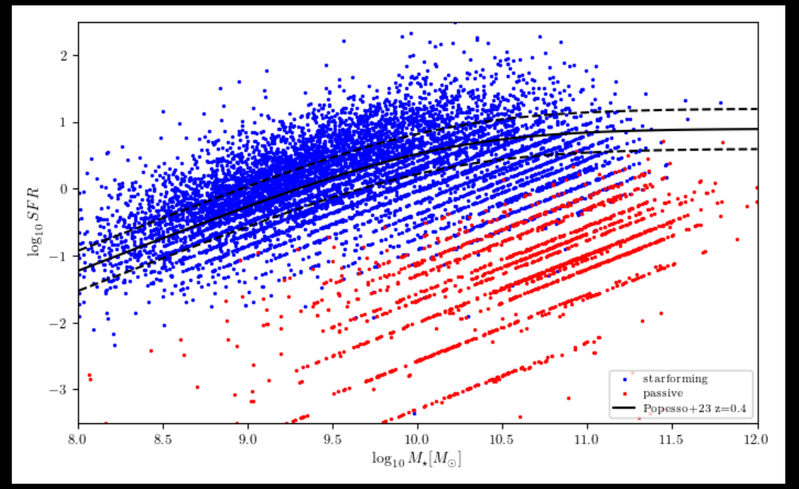




Cortese+20
Gereb+13, +16
HI can be found in passive discs, but it is an exceptional occurrence

HI in passive galaxies



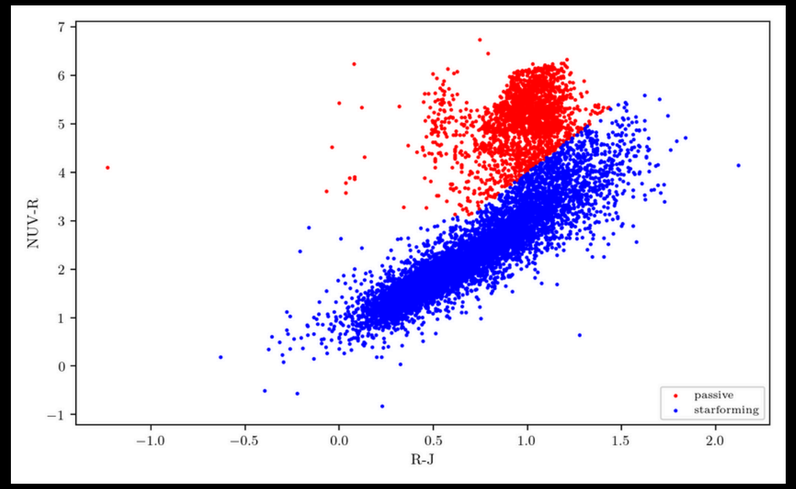


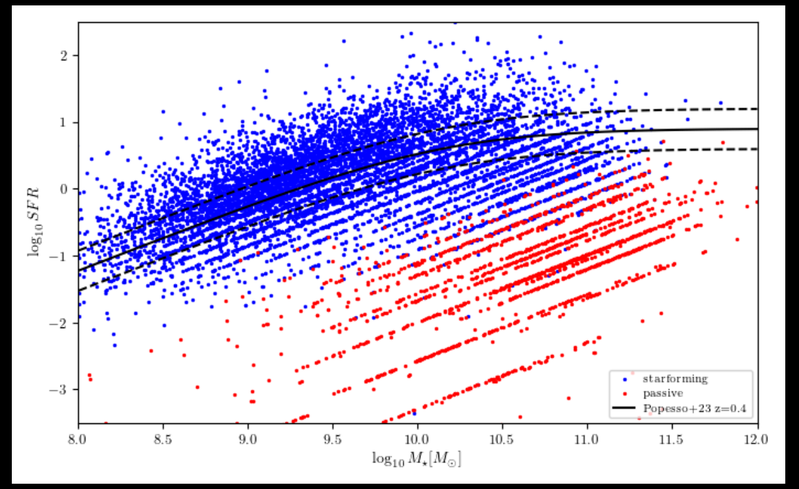
color-selected sample
complementary to the one used for *Bianchetti+25*

double color-selection criterion minimizes contamination from starforming galaxies

and we stack

HI in passive galaxies

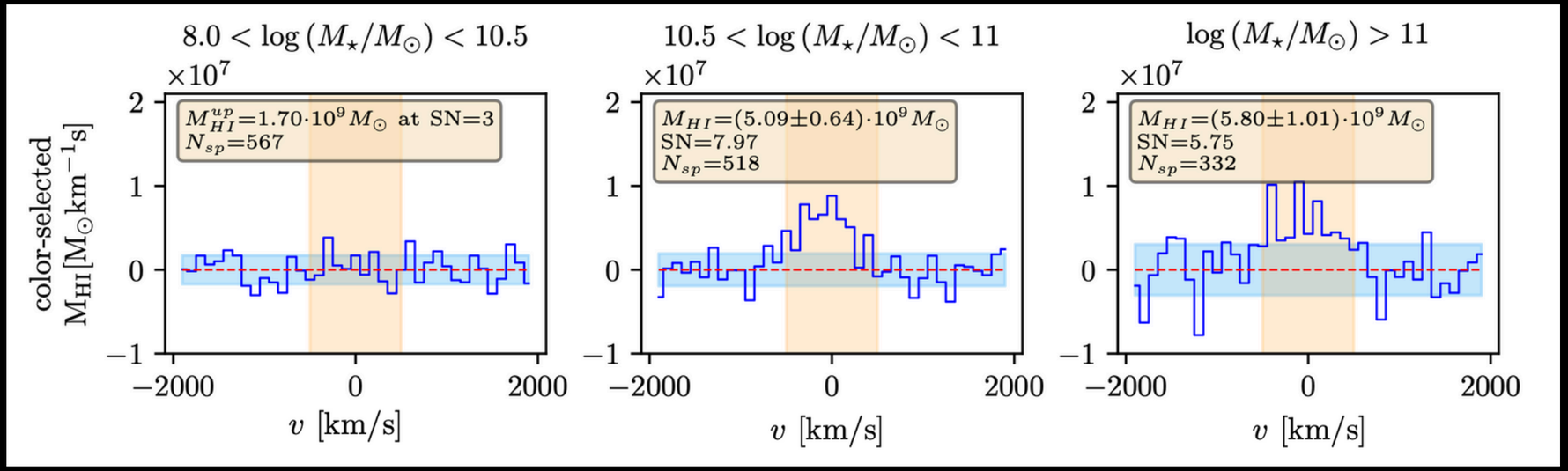




color-selected sample complementary to the one used for *Bianchetti+25a*

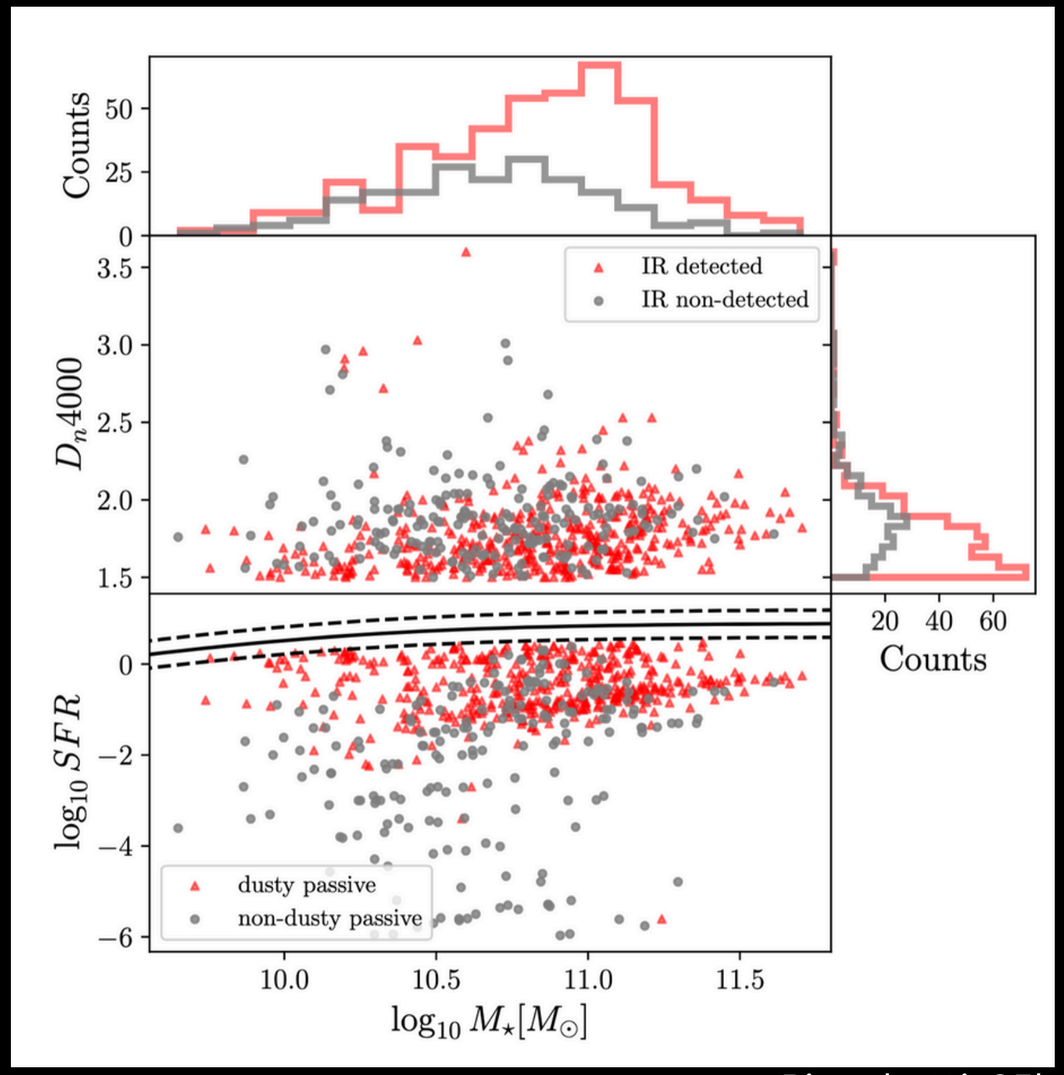
double color-selection criterion minimizes contamination from starforming galaxies

only galaxies with logM*>10.5 yield detection



Bianchetti+25b

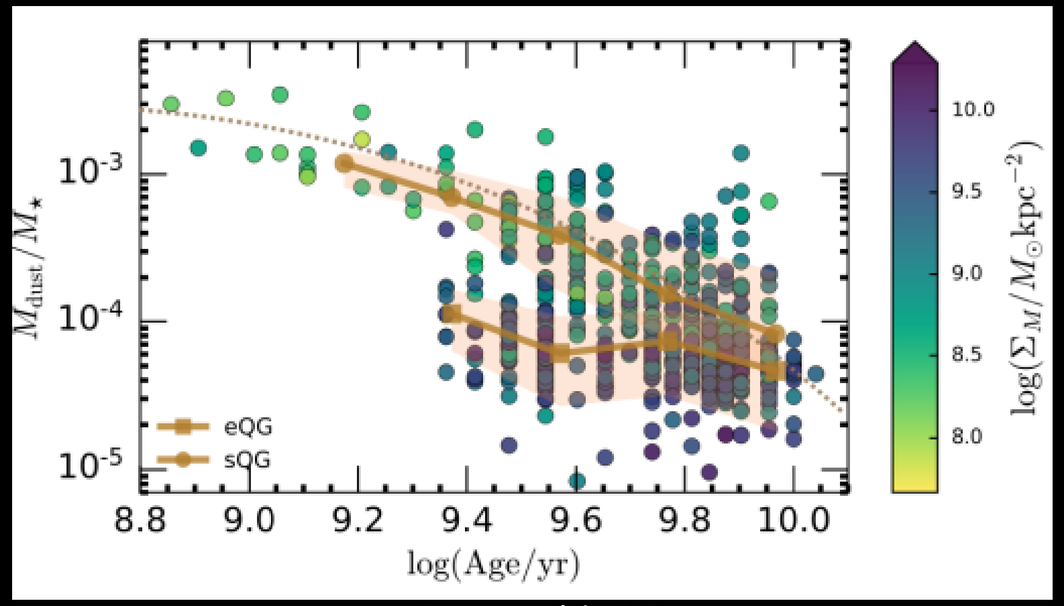
HI in passive galaxies



Bianchetti+25b

spectroscopically selected sample from *Donevski+2023*

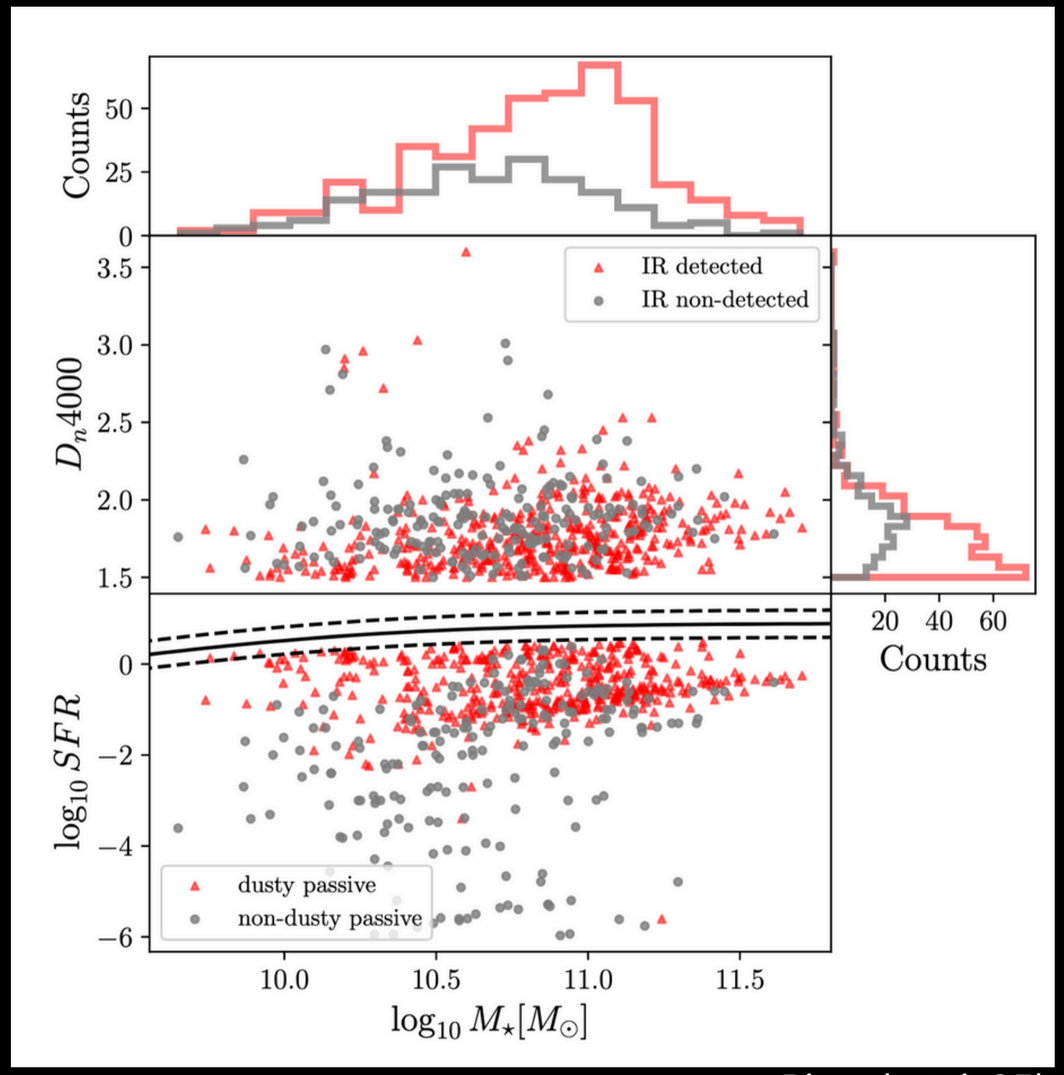
- IR flag (dusty vs non-dusty)
- morphology indicator (spirals/spheroids)
- density value (appendend from Darvish+2017)



Donevski+23

and we stack

HI in passive galaxies



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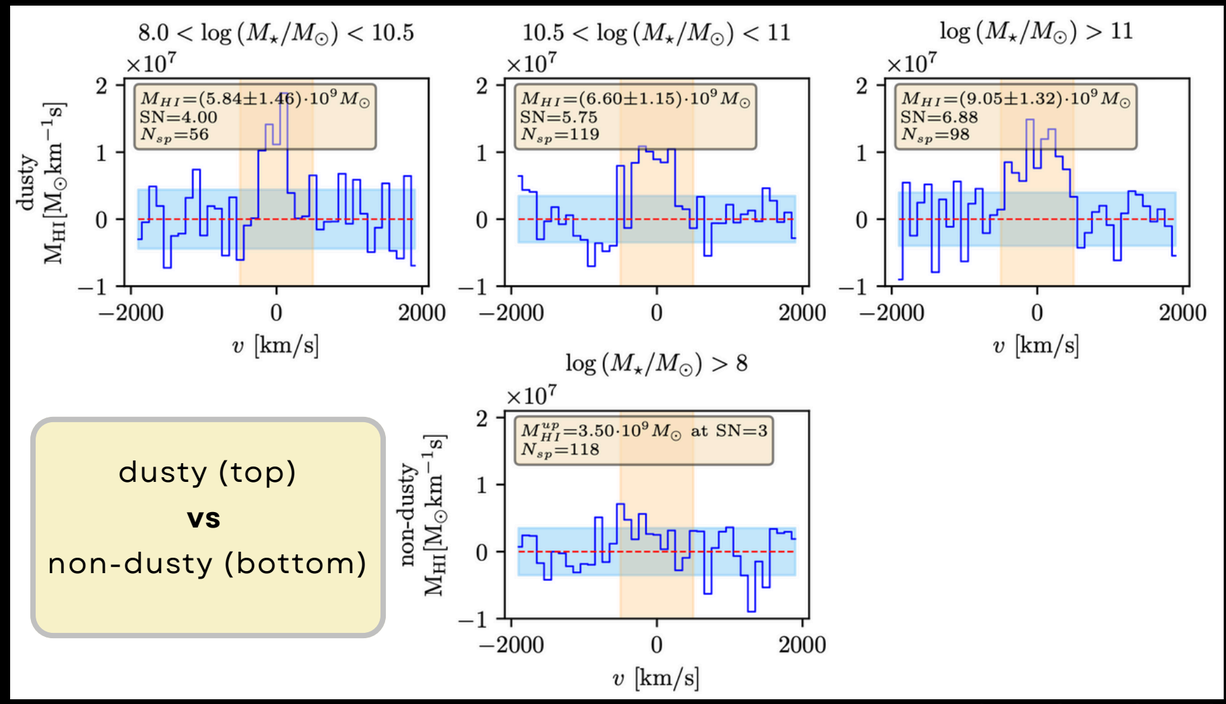
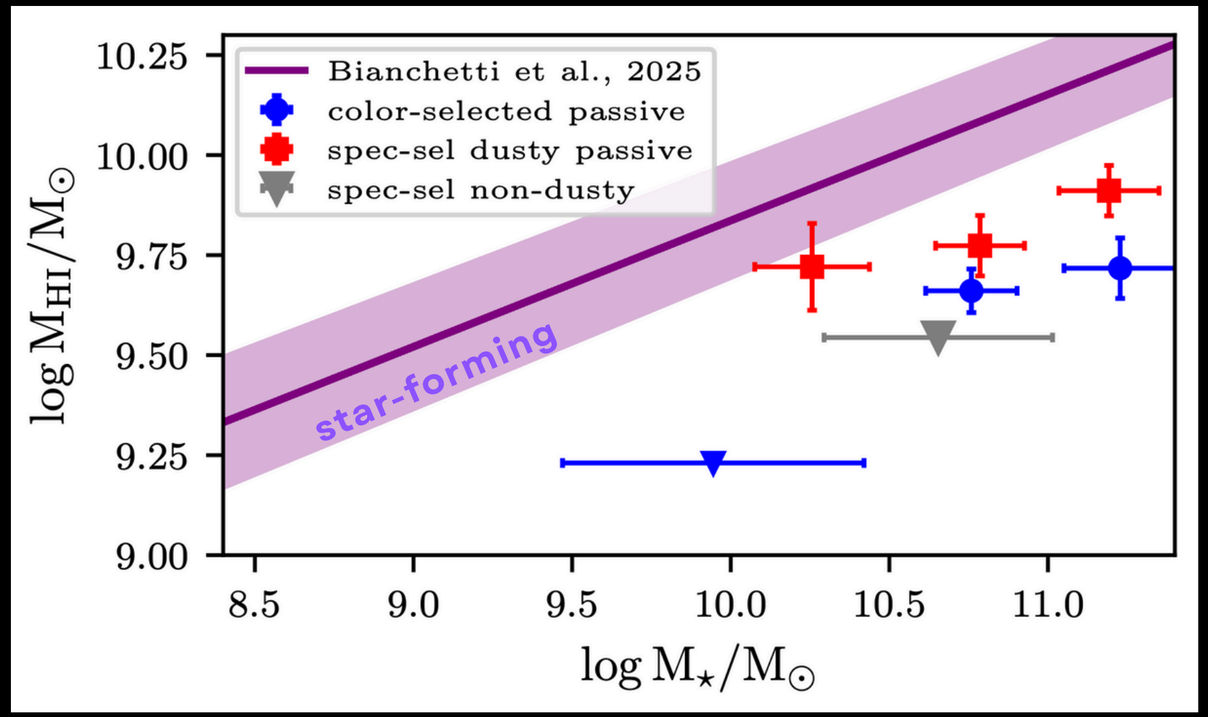


dusty (top)
vs
non-dusty (bottom)

Bianchetti+25b

HI in passive galaxies

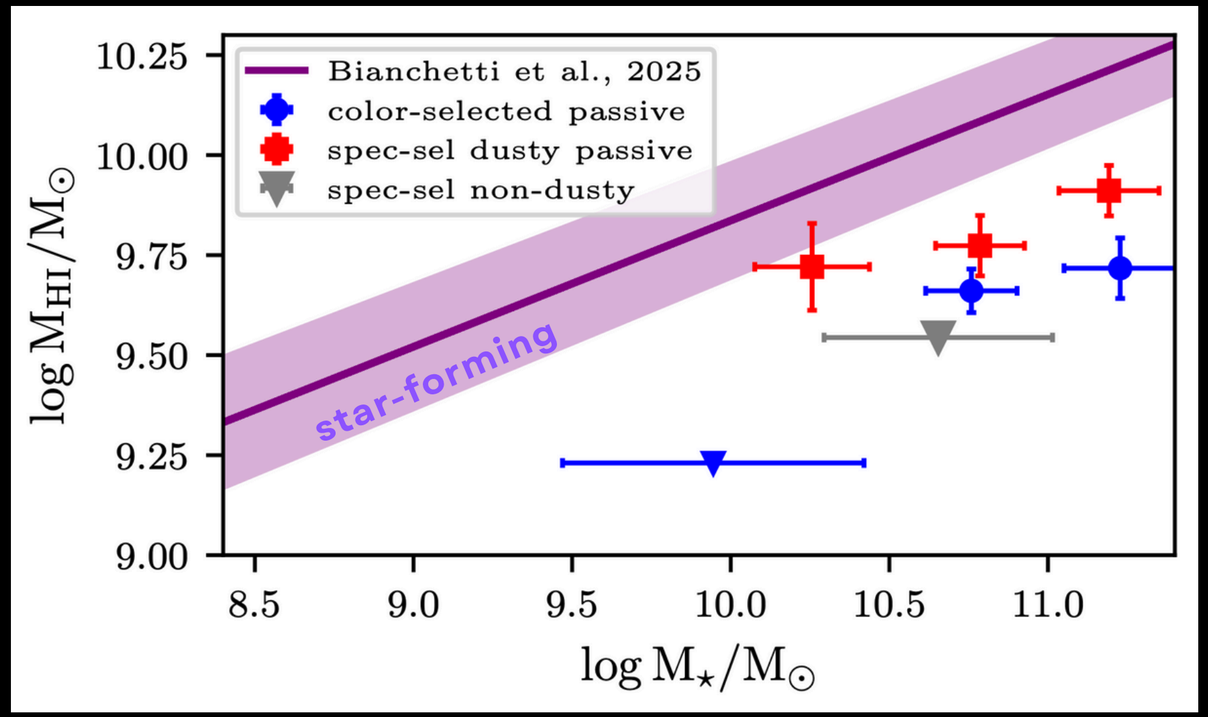


- massive dusty QGs yield more HI, 40% less than SFGs?
- non-dusty QGs yield no detection
- color-selected QGs also show low HI content (~3× lower than SFGs), likely due to being a mix of dusty and non-dusty galaxies

↓

dust-HI correlation: hydrogen possibly provides shielding from UV radiation and favours dust regrowth

HI in passive galaxies



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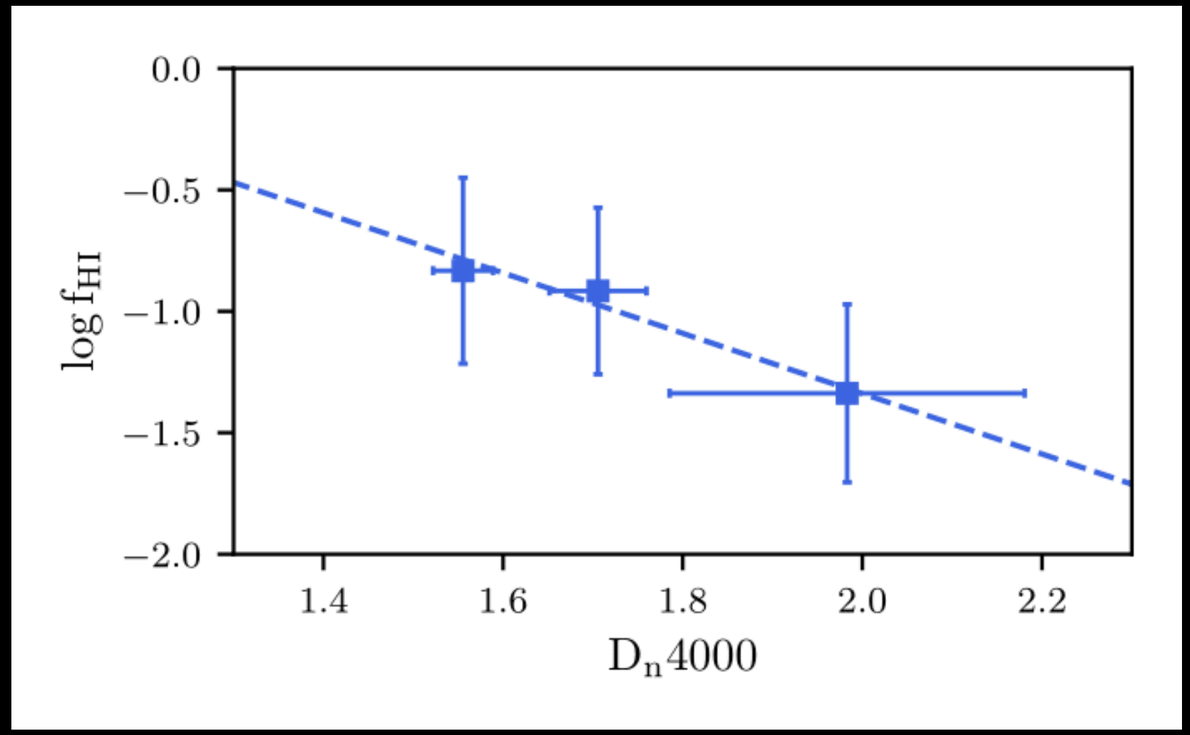
what drives HI content?

- age?
- environment?
- morphology?

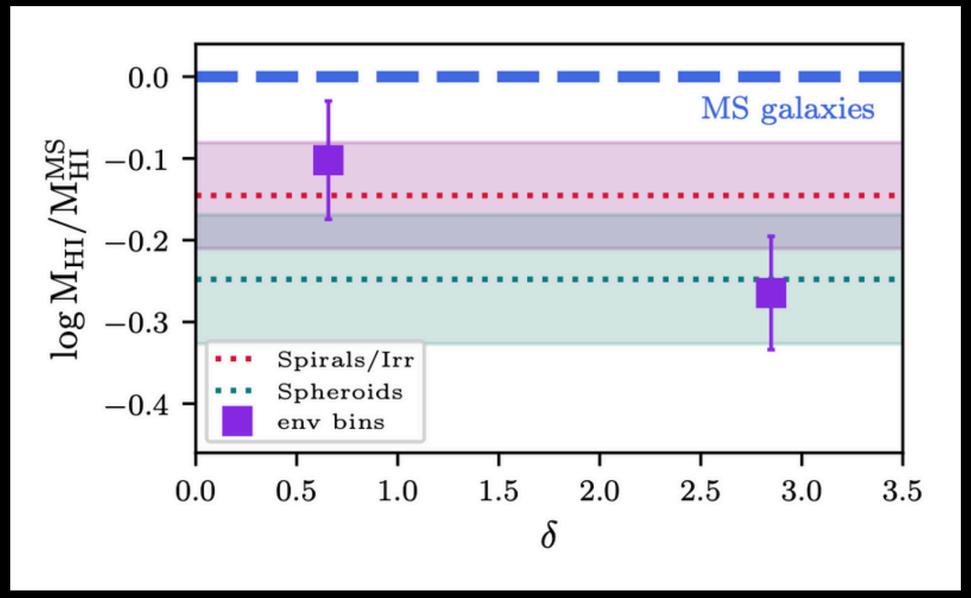
HI in passive galaxies



younger QGs (lower Dn4000) have higher HI content
➔ recent quenching or reaccretion of gas

HI in passive galaxies

morphology VS **environment**

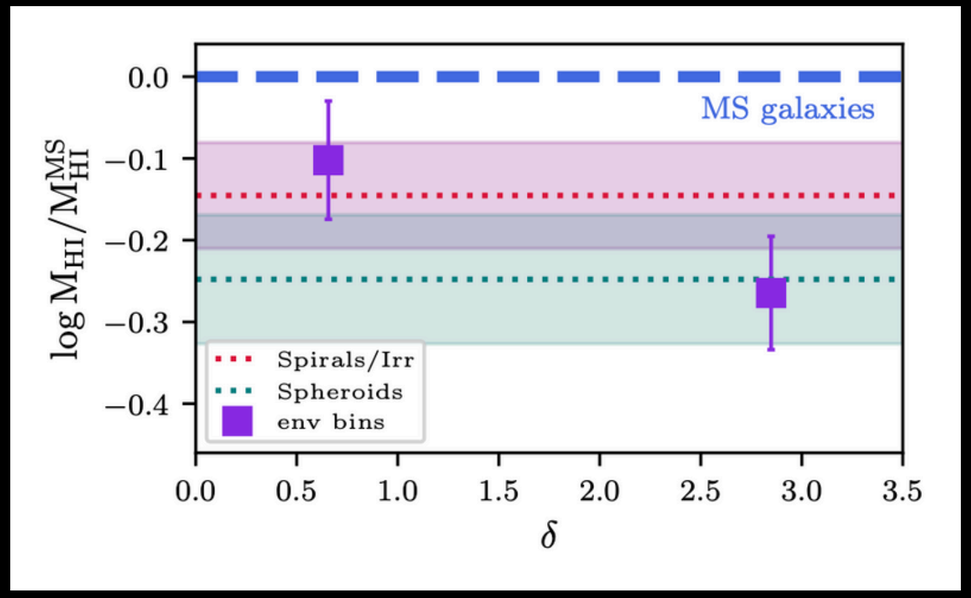


inverse HI content/env correlation? ➔ dense env promotes starvation/stripping

more HI in spirals than in spheroids ➔ morphology affecting HI retention

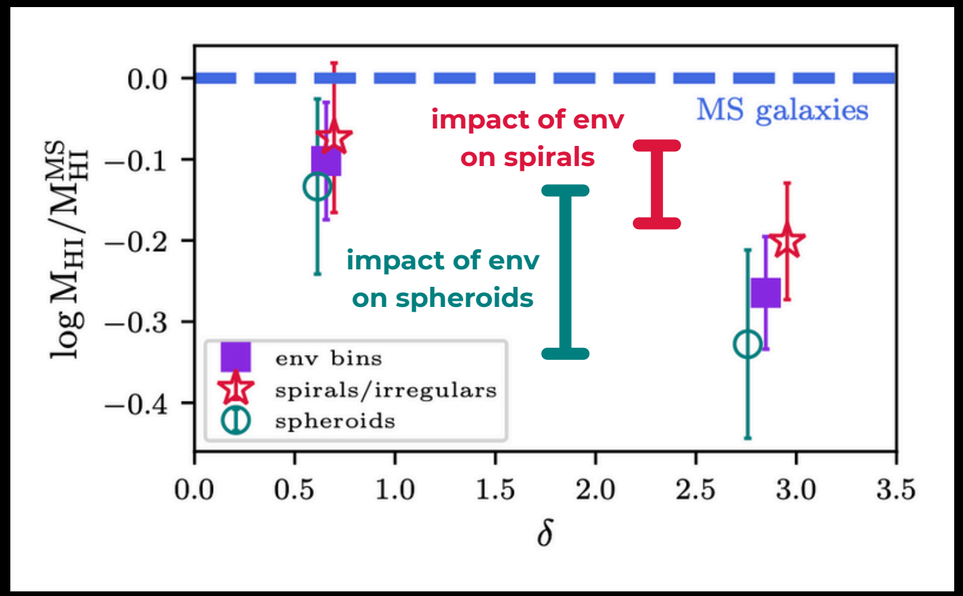
HI in passive galaxies

morphology VS **environment**



passive discs likely in lulling phase, or mini-quenching (Dome+24, Looser+25), less affected by environment

spheroids are more subject to environment and maybe drawing gas supplies through accretion/mergers



inverse HI content/env correlation? ➔ dense env promotes starvation/stripping

more HI in spirals than in spheroids ➔ morphology affecting HI retention

HI in passive galaxies

🔍 atomic gas evolution in QGs

plenty of scattered works on selected bias make an apple-to-apple comparison **hard**

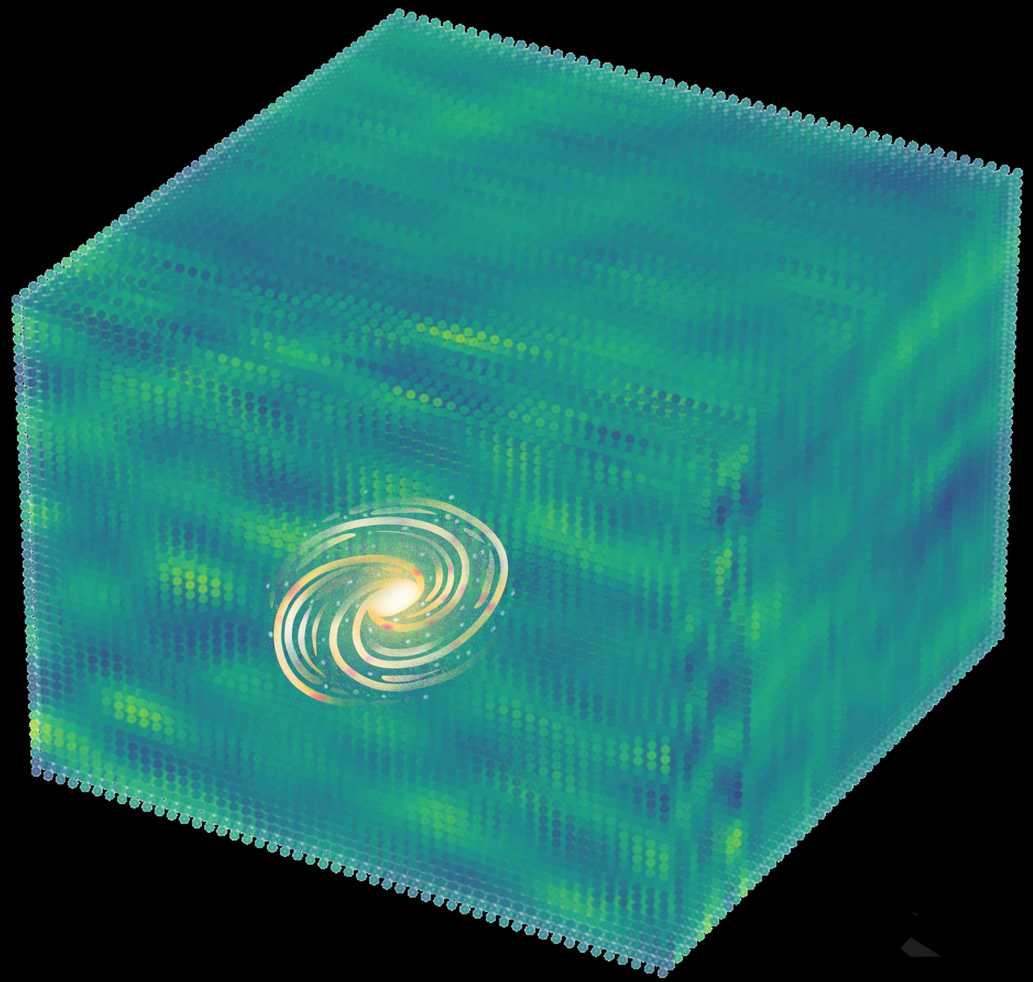
need for more detections/ larger specz samples

➔ **EDFS MeerKAT:** deploying MeerKAT+Euclid synergy
Euclid specz collection will bring 10^3 new elements
→ factor ≈300 improvement in stacked SNR

➔ **SKA sensitivity:** AA* vs this data (MIGHTEE-HI) → factor ≈100 improvement in noise and stacked SNR

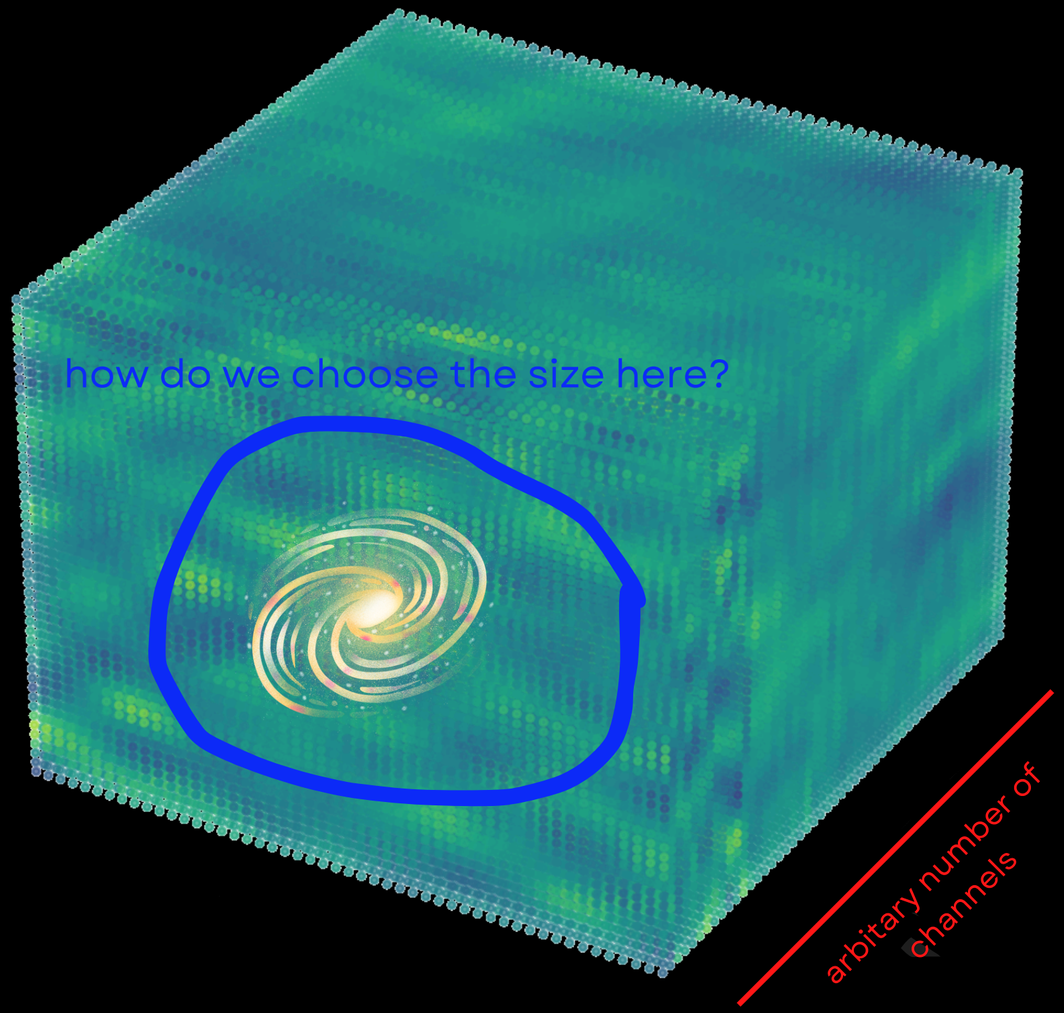
EXTRA MATERIAL

spectral stacking



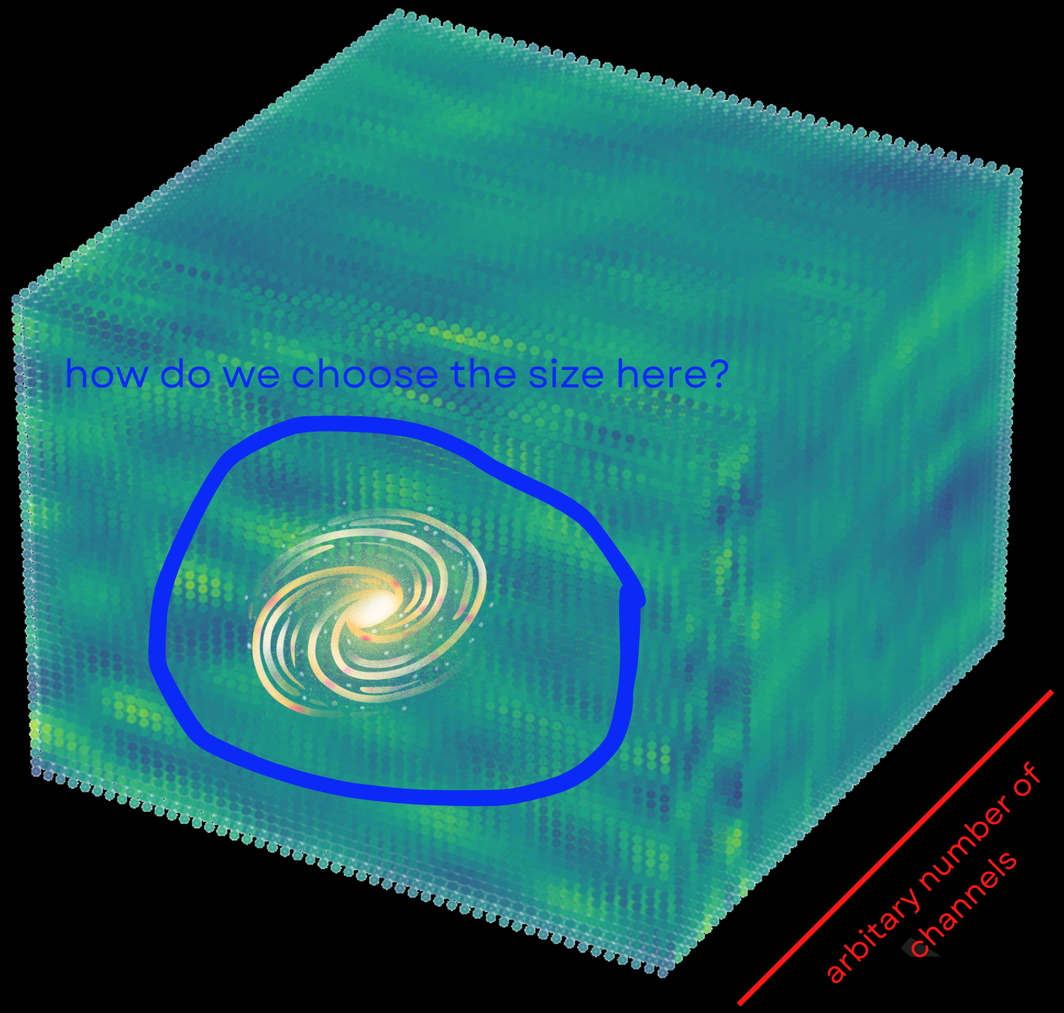
optically-detected galaxy
with accurate spectroscopic redshift

spectral stacking

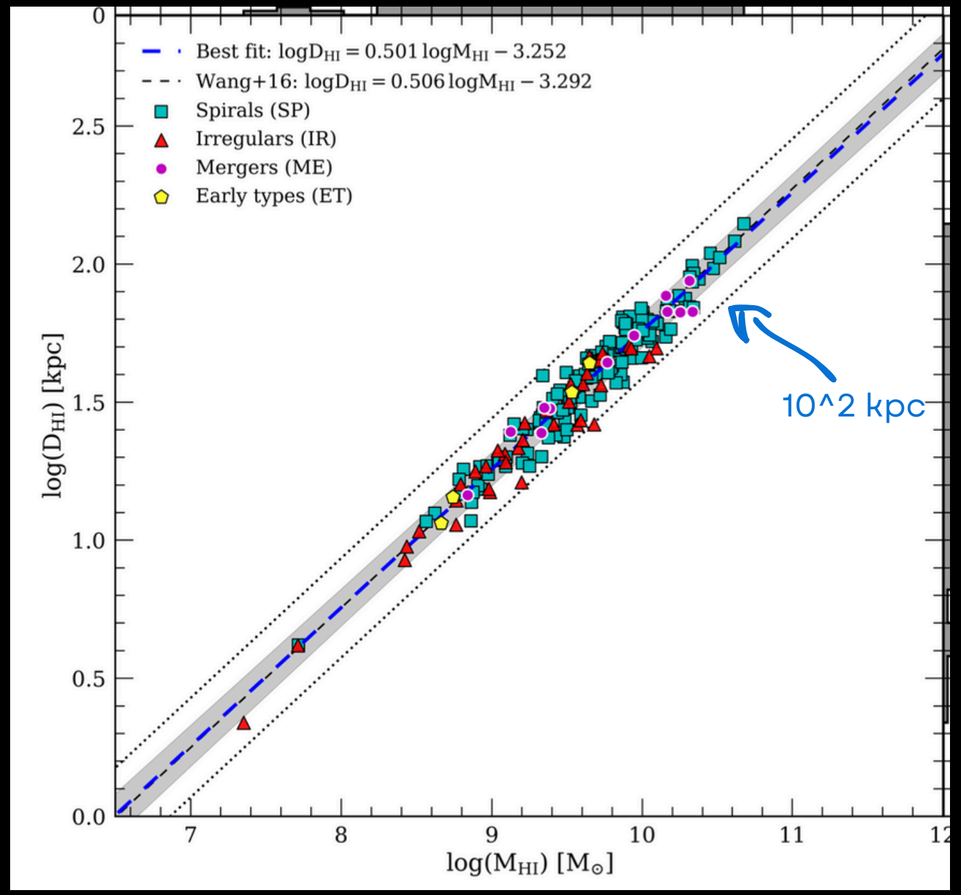


Rajohnson+22

spectral stacking



how big should the aperture be?



Rajohnson+22

spectral stacking