MIGHTEE and CHILES Team Up: new constraints on the evolution of the MHI-M^* scaling relation
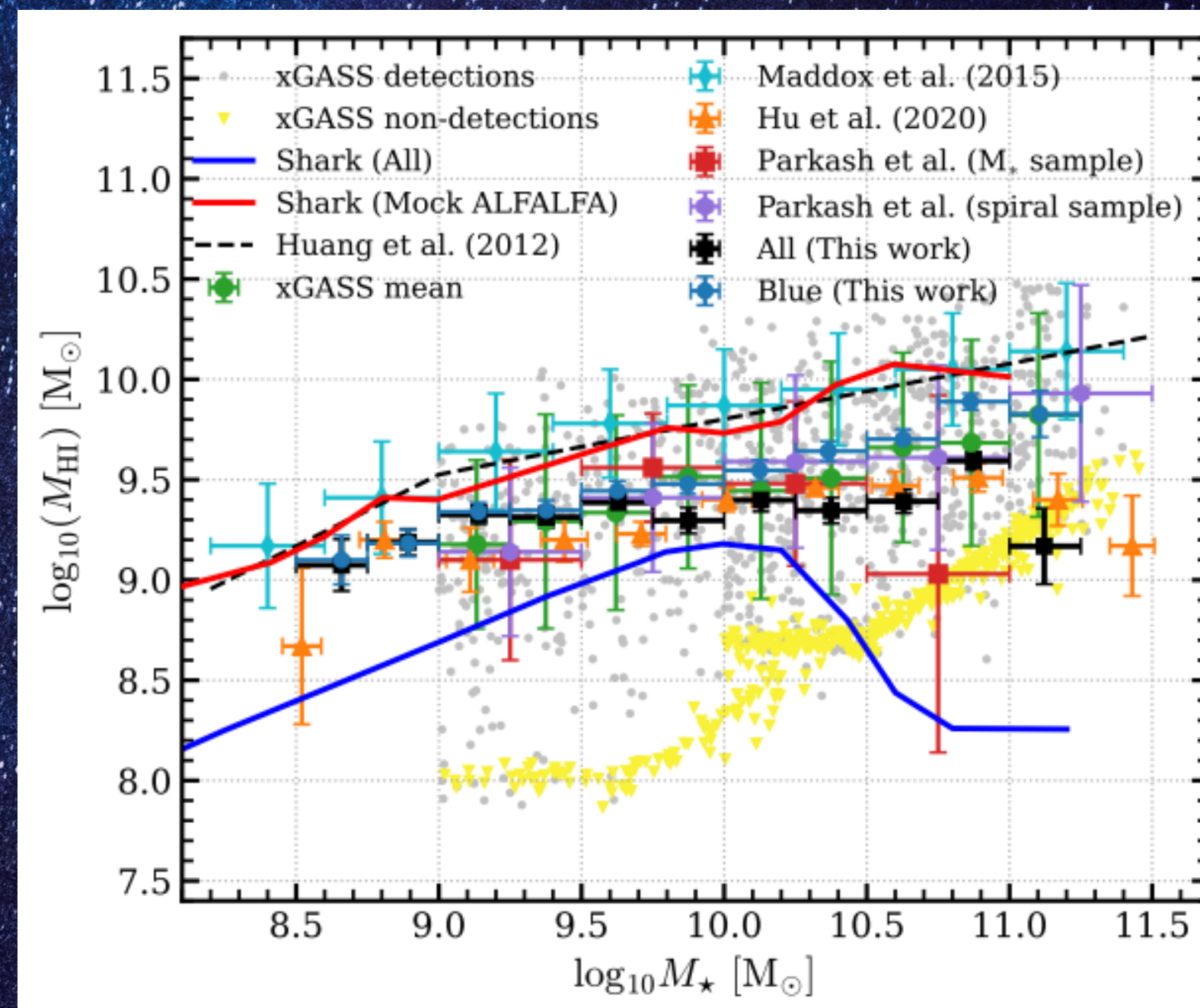
ALESSANDRO
BIANCHETTI

SUPERVISORS:
GIULIA RODIGHIERO, ED ELSON

with FRANCESCO
SINIGAGLIA, MATTIA
VACCARI, DJ PISANO
MIGHTEE & CHILES
collaborations

INAF
ISTITUTO NAZIONALE
DI ASTROFISICA

University of Cape Town · iYunivesithi yaseKapa · Universiteit van Kaapstad
SPES BONA

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MCCXXII

UNIVERSITY *of the*
WESTERN CAPE
RESPICE PROSPICE
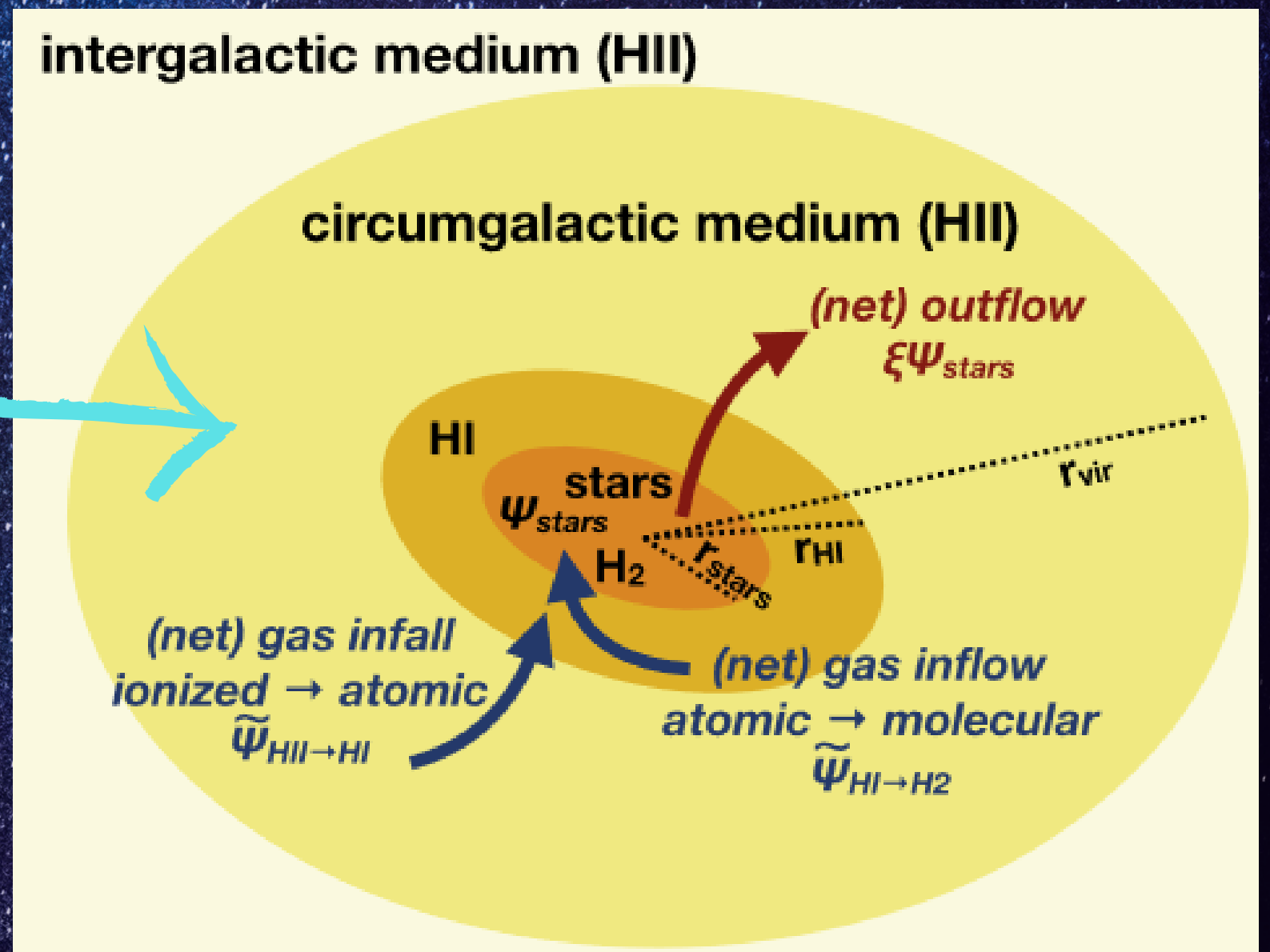

Rhee+22

WHY HI?
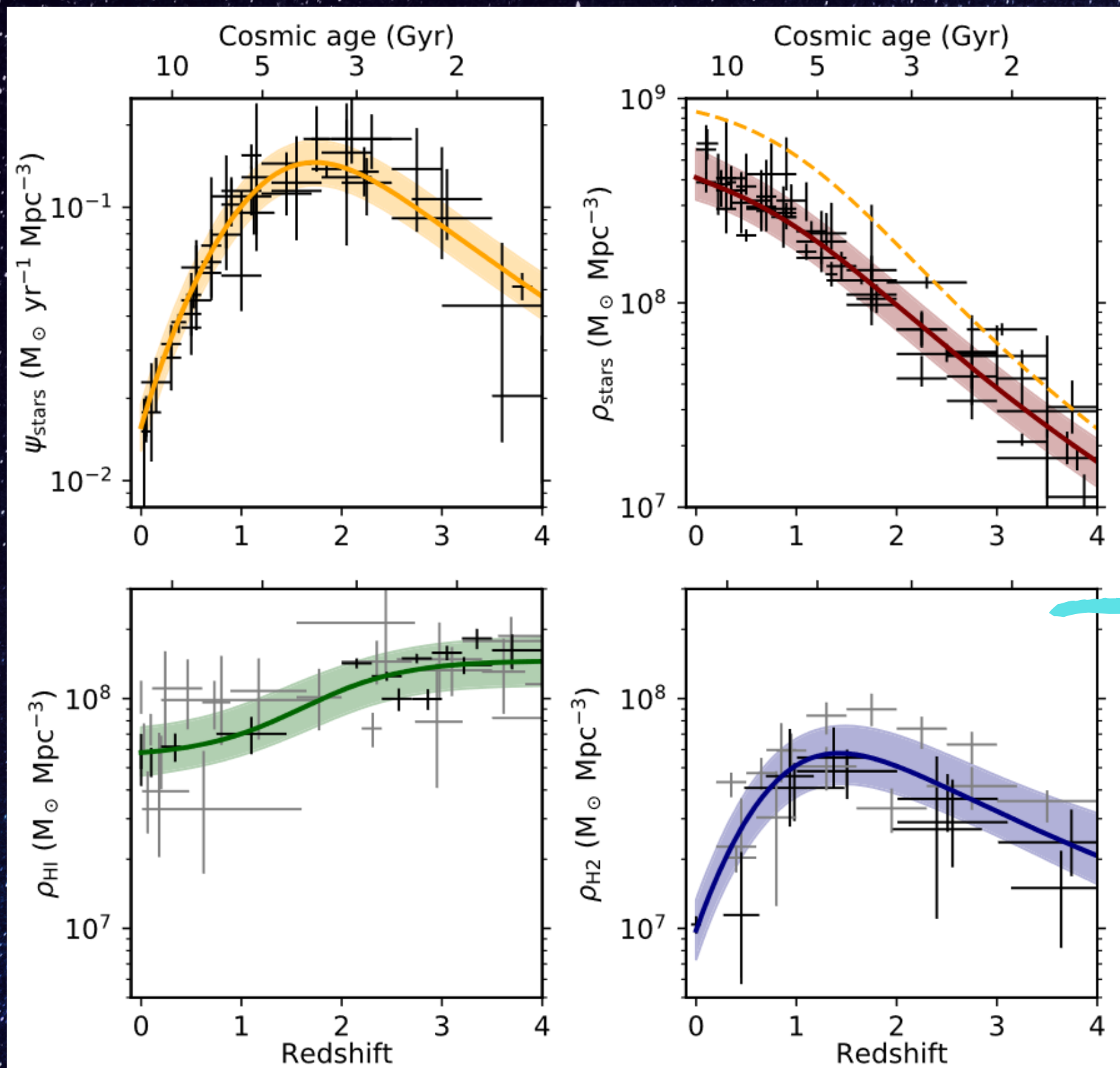
Walter et al, 2020

- peak of SFR at z ~ 1-2
- no evolution of HI mass?
- H2 density follows the SFR profile
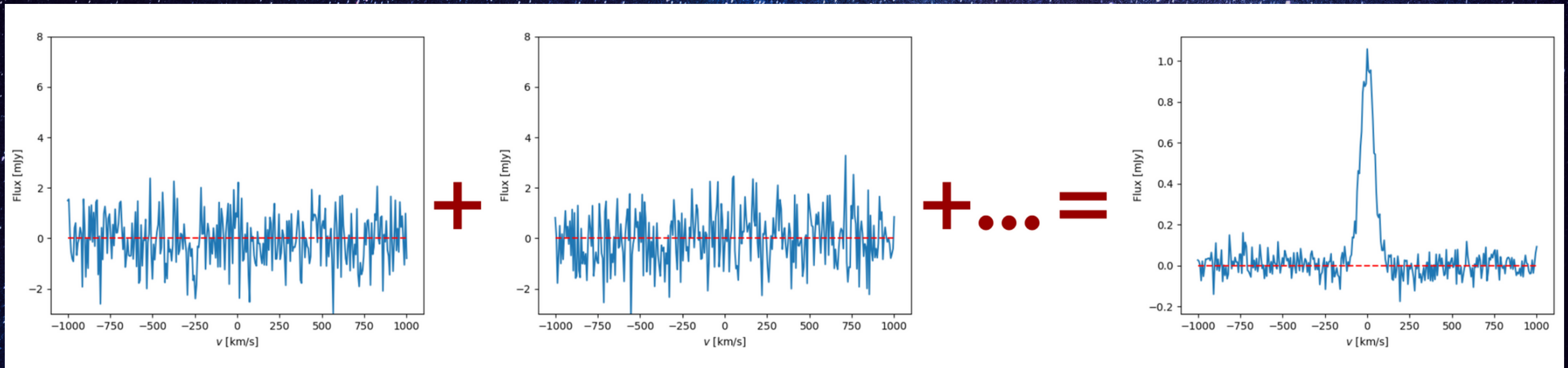- stellar mass density > total gas density after z~1.5

Walter et al, 2020

STACKING

Long term goal: using **stacking** to study the evolution of the scaling relation: **galaxy evolution** - **baryon cycle** - understanding SF efficiency connection with HI budget evolution

At z>0.1 direct detection of the HI emission line is hardly possible: use spectral stacking

HI SURVEYS

Long term goal: using **stacking** to study the evolution of the scaling relation: **galaxy evolution** - **baryon cycle** - understanding SF efficiency connection with HI budget evolution

MIGHTEE HI
(Early Science Data)
3x16 hrs

- $0 < z < 0.58$
- 900-1420 MHz
- beam~12" (60 kpc at z=0.4)
- spectral resolution 200 kHz
- COSMOS,XMMLSS,ECDFS

CHILES
(VLA)
1000 hrs

- $0 < z < 0.5$
- 946–1420 MHz
- beam~6" (30 kpc at z=0.4)
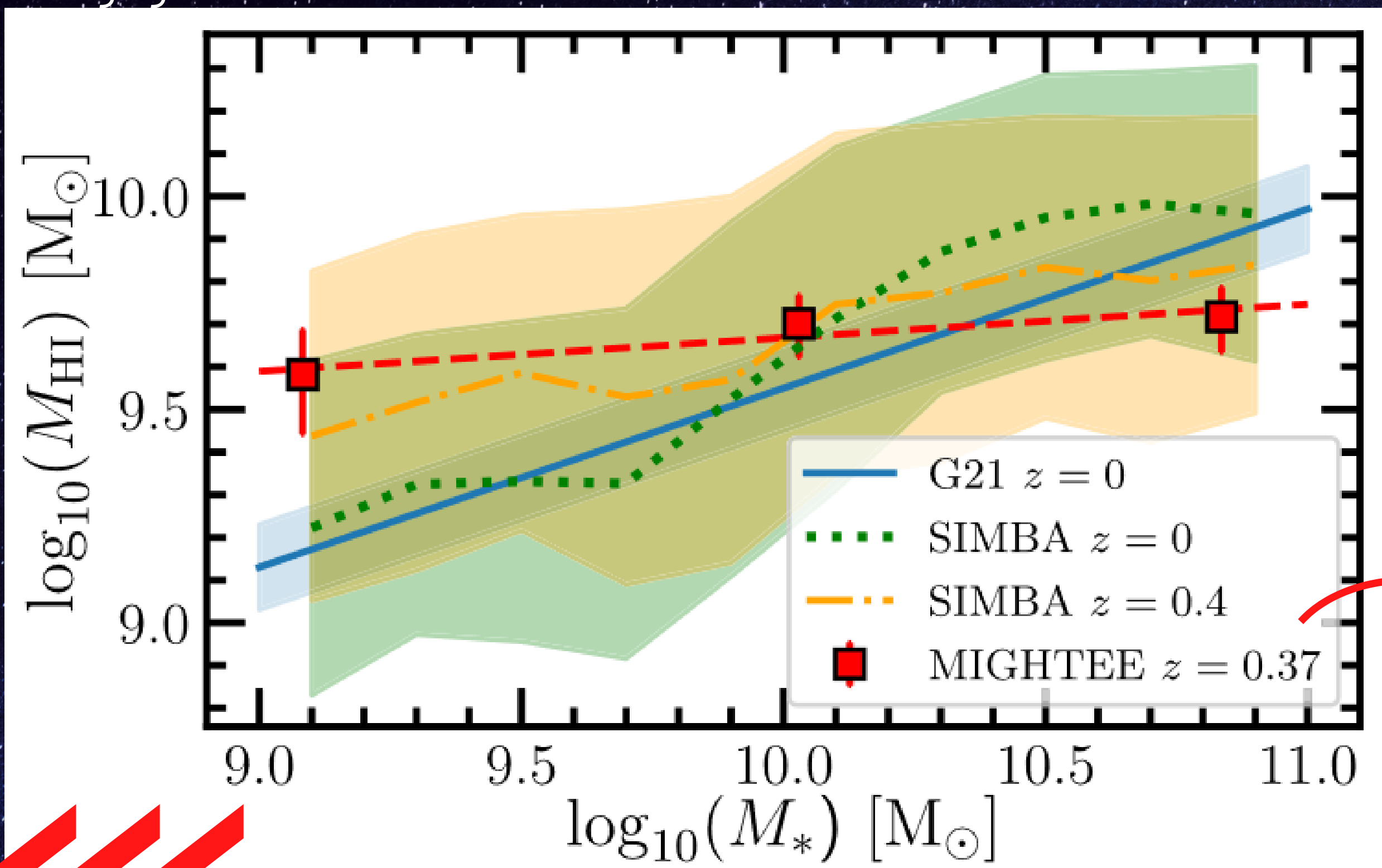- spectral resolution 125 kHz
- COSMOS subregion

SUPERMIGHTEE
(MeerKat+uGMRT)

- up to z~1
- 250-2500 MHz
- in agenda (2024)

HTTPS://WWW.MIGHTEESURVEY.ORG/
MADDOX ET AL 2021
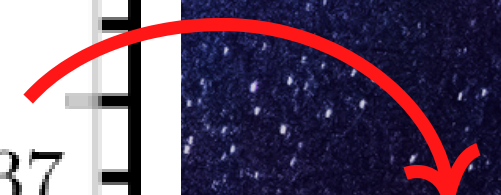
HTTP://CHILES.ASTRO.COLUMBIA.EDU

Sinigaglia et al. 2022: what can we work on?

increased statistics to make a finer stellar mass grid
CHILES

can we go to higher redshift?
SUPERMIGHTEE

HI SURVEYS

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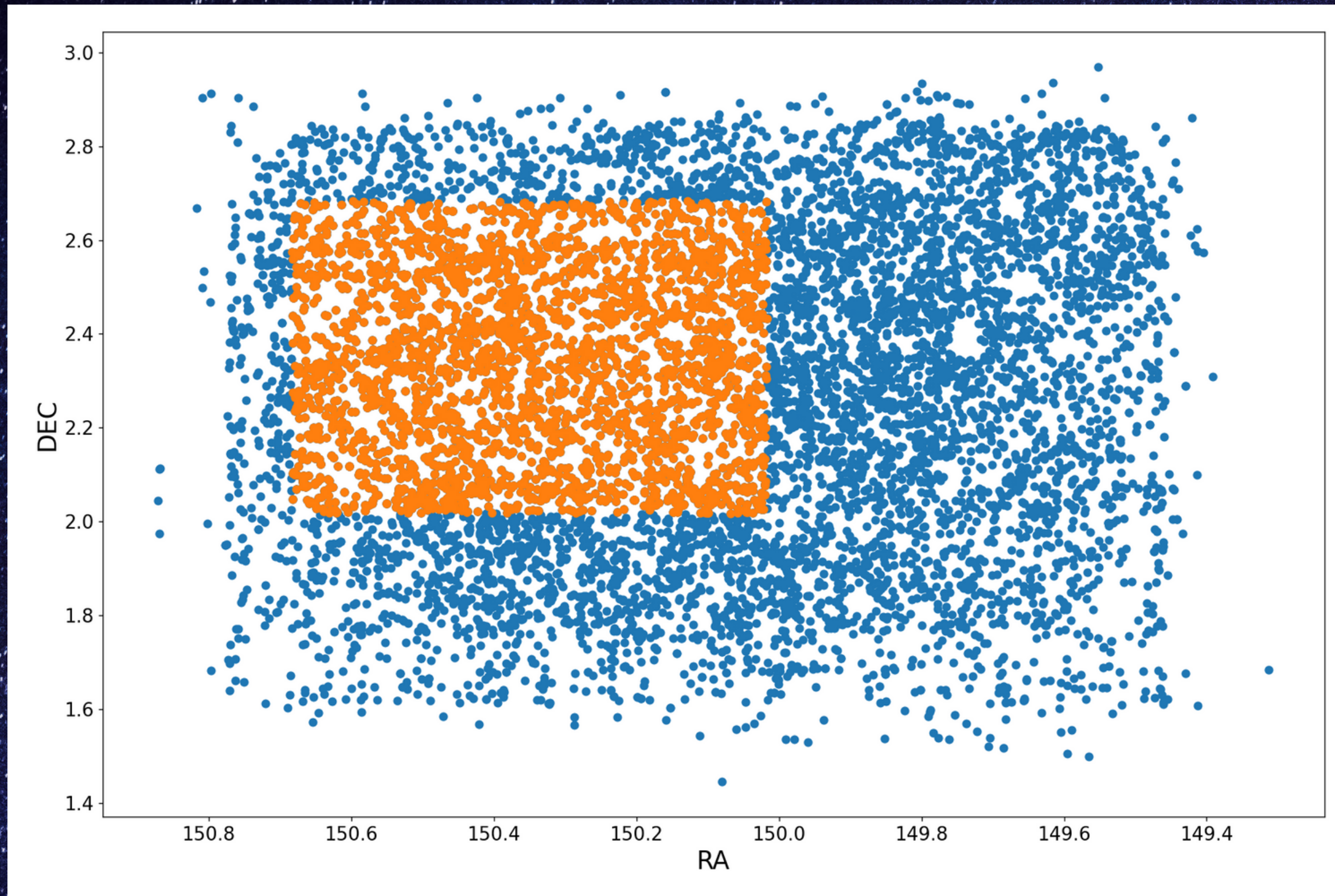HTTP://CHILES.ASTRO.COLUMBIA.EDU

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INPUT CATALOGUE

- spectroscopic redshift catalogue *[UPDATE JUNE 2023, Khostovan et al, in prep.] + DEVILS + DESI*
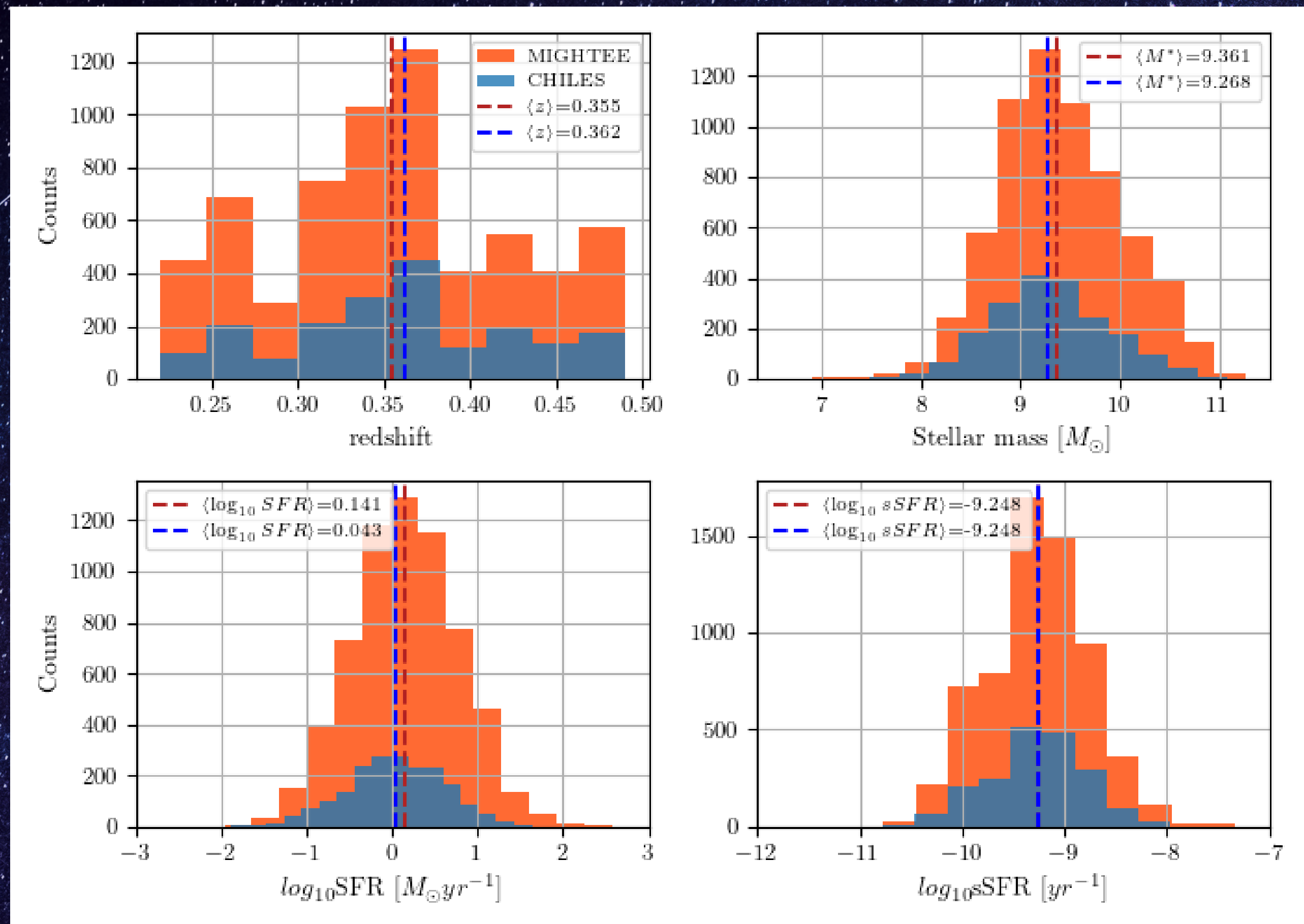- photometry: COSMOS2015 -> 2020

Selection criteria:
- removed photometric outliers (specz-photoz)<0.15*(1+specz)
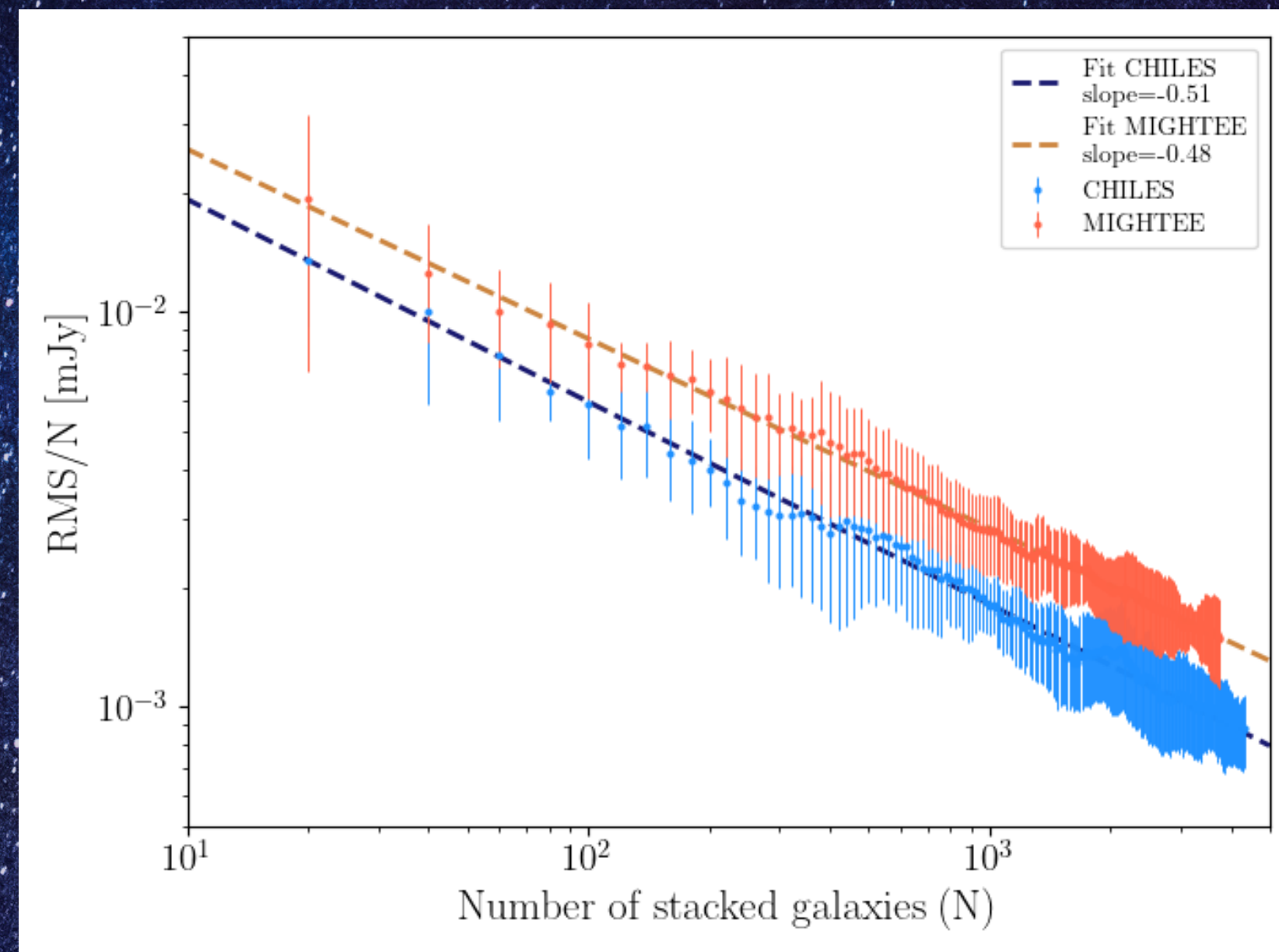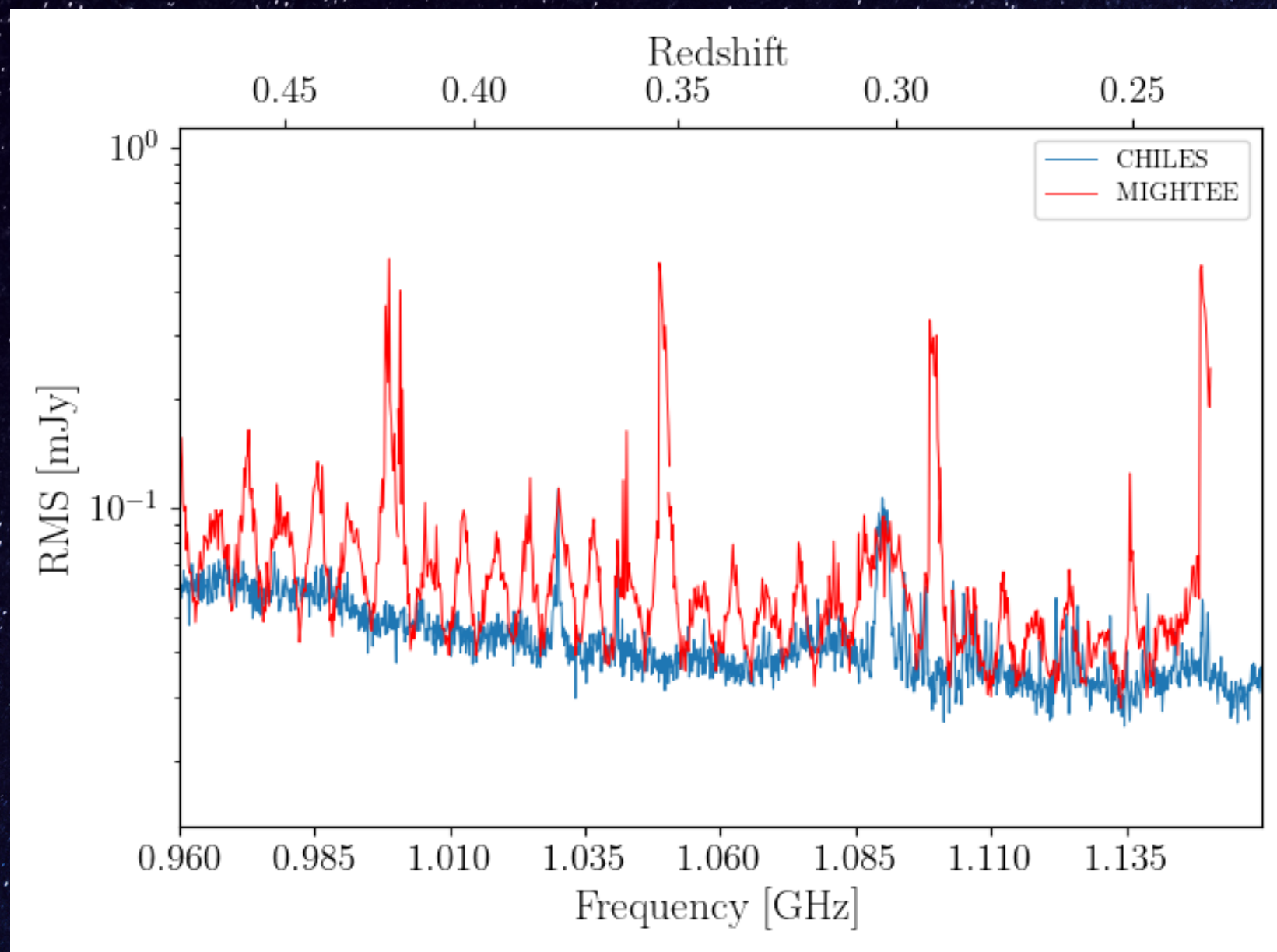- 0.22 < specz < 0.5
- star-forming galaxies

INPUT CATALOGUE
CHILES VS MIGHTEE

Are we drawing from the same galaxy population? Is there a bias in the physical properties of galaxies between CHILES and MIGHTEE?

CHILES VS MIGHTEE
SANITY CHECKS AND NOISE DIAGNOSTICS


CHILES and MIGHTEE noise patterns match, **but**:
- obs_time ~ 10^1 hrs for MIGHTEE
- obs_time ~ 10^3 hrs for CHILES

RMS ~ sqrt(N)

RMS/N ~ 1/sqrt(N)

COMBINED STACKS

✓ robust S/N everywhere

✓ removed issue of the alleged velocity bias of the peak (updated redshift collection)

✓ absence of remarkable features outside the central signal

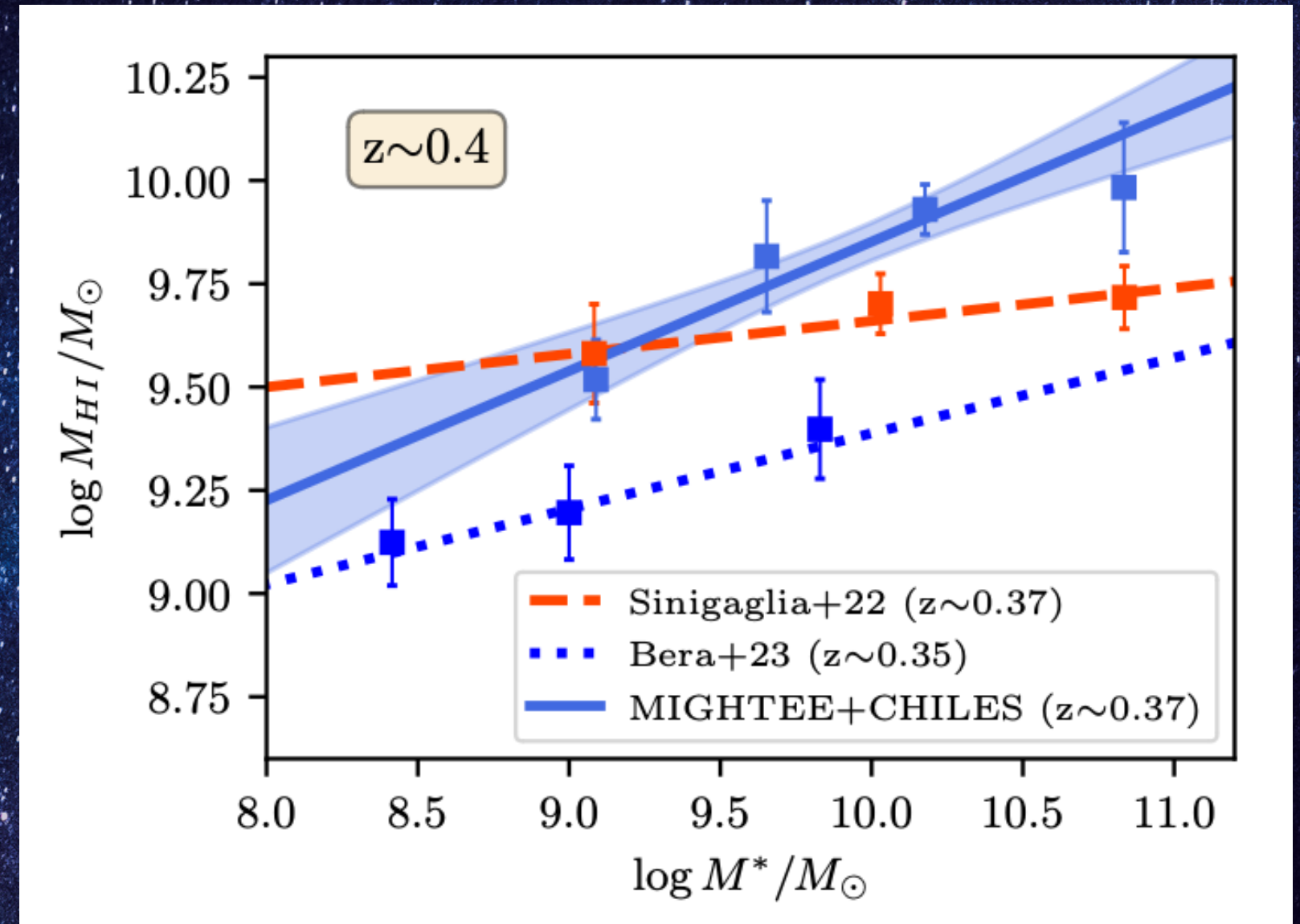✓ no asymmetry in the continuum

⚠ continuum slightly negative?
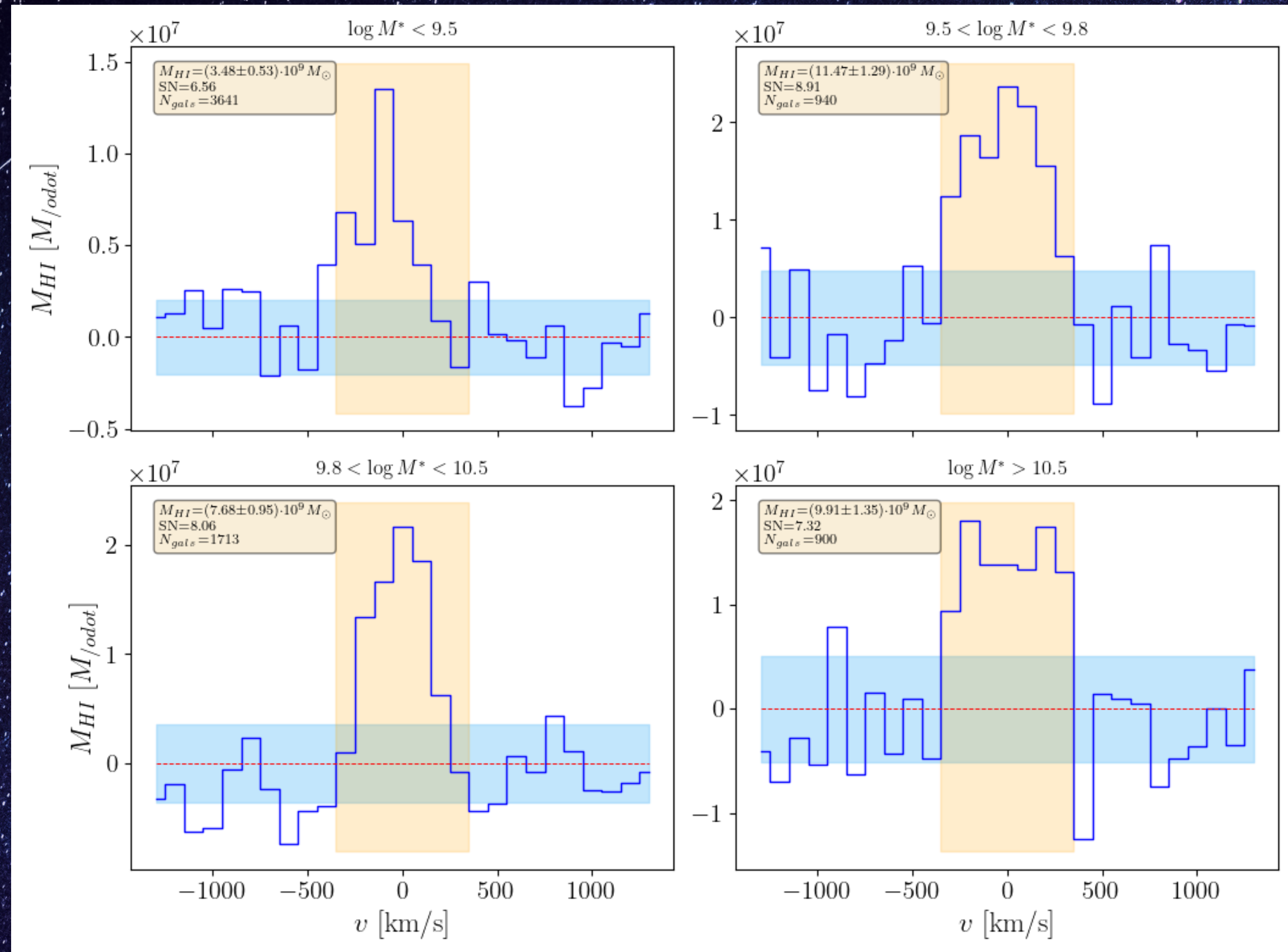
RESULTS

- **blue squares: combined stack, MIGHTEE+CHILES (z=0.37)**

- **stacks on CHILES only, two redshift bins**
  - ○ 0<z<0.1   <z>=0.05
  - ○ 0.1<z<0.22.   <z>=0.18
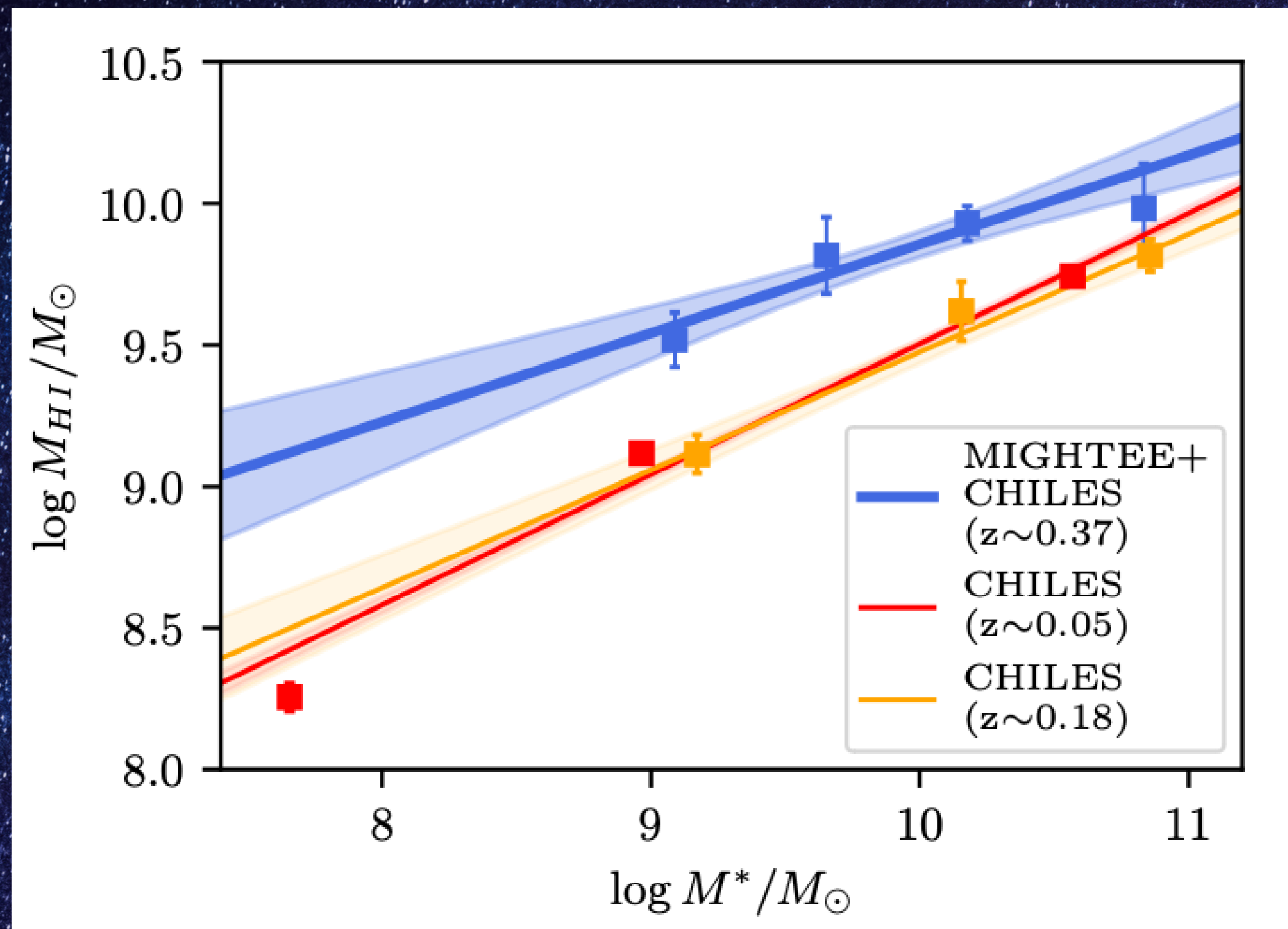
STATE OF THE ART

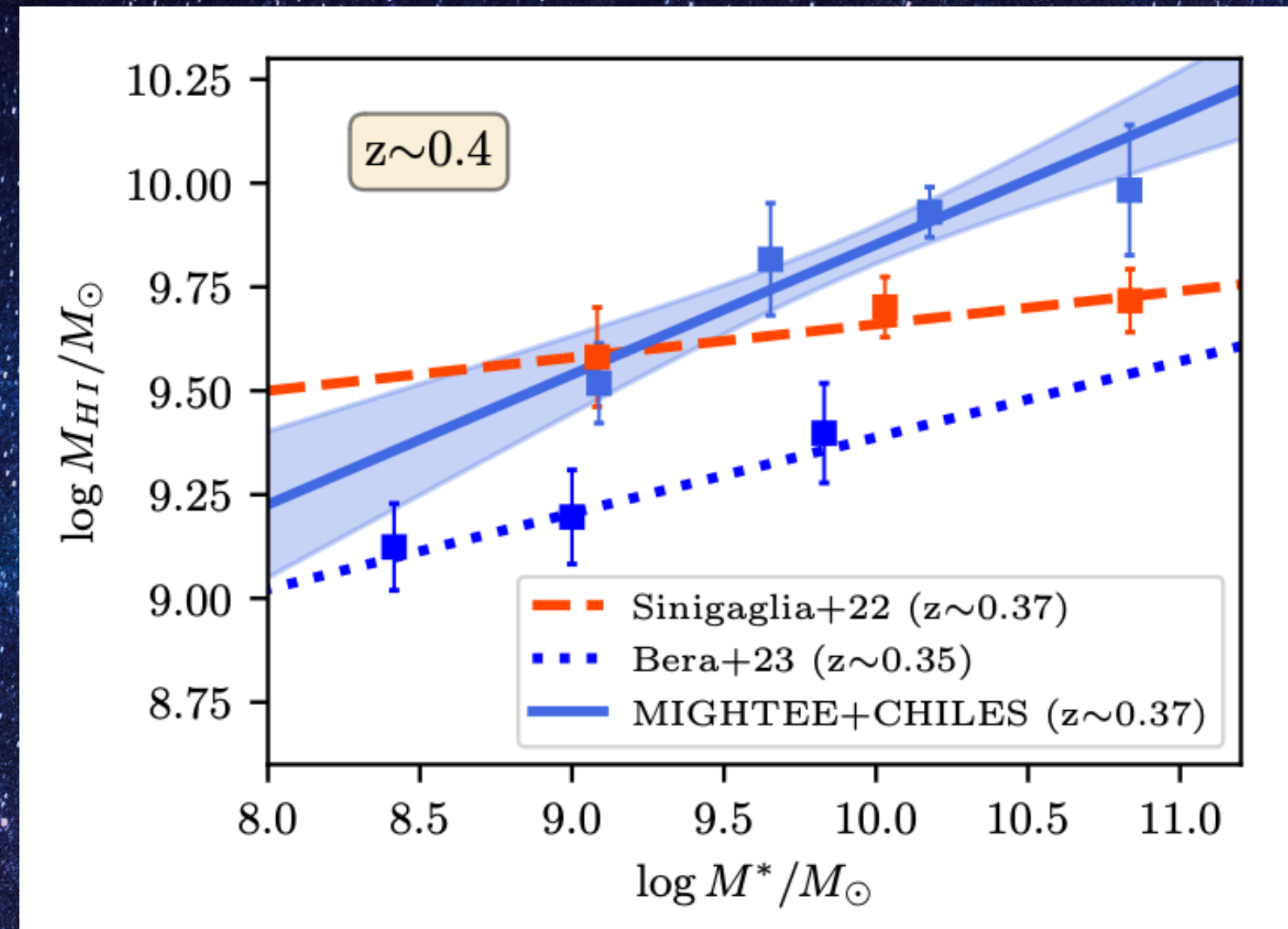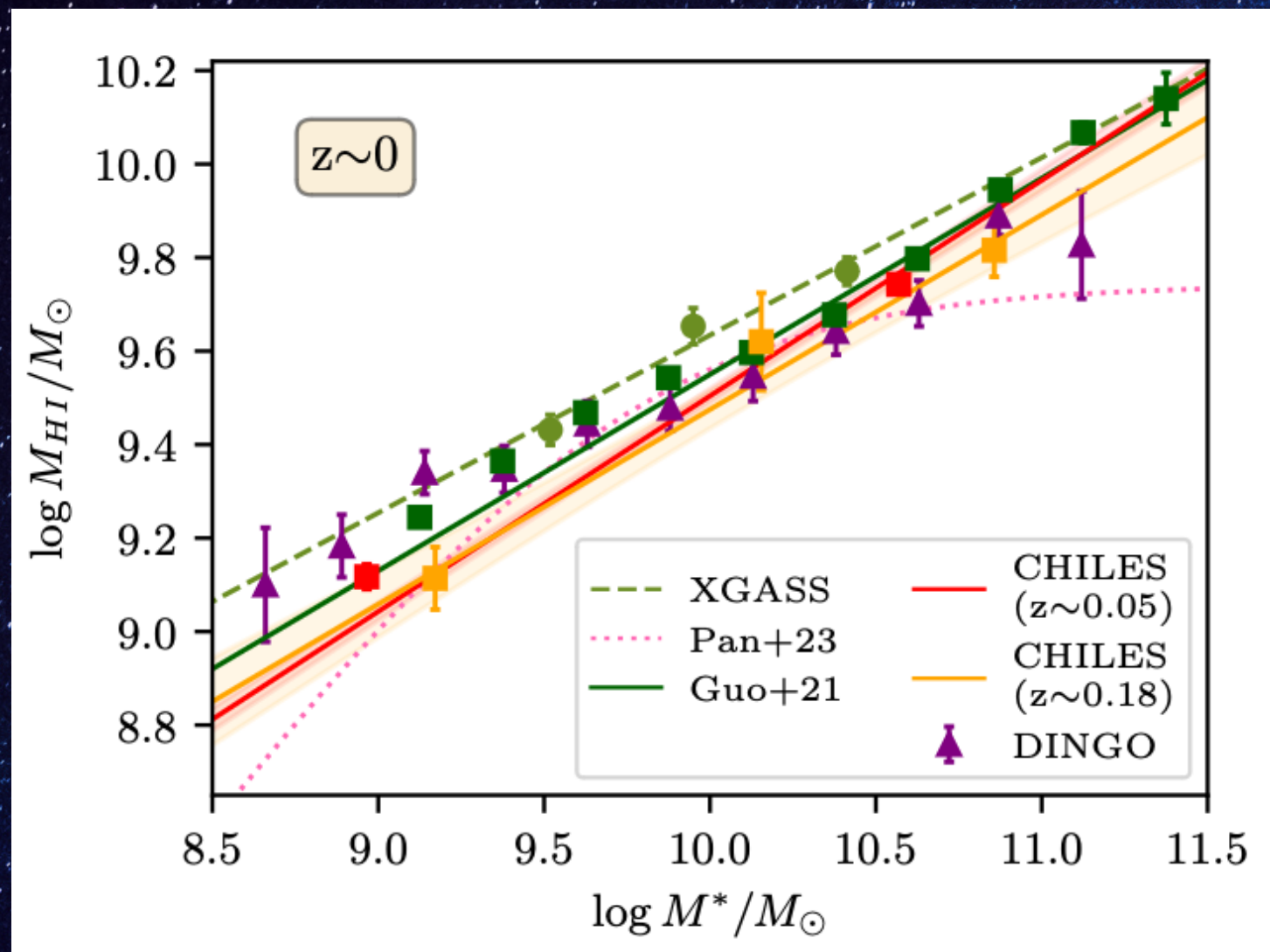**scaling relations at z=0.4**
- change in tilt wrt previous MIGHTEE result slope independent on redshift
- need for a bent model?

STATE OF THE ART

scaling relations in the local Universe
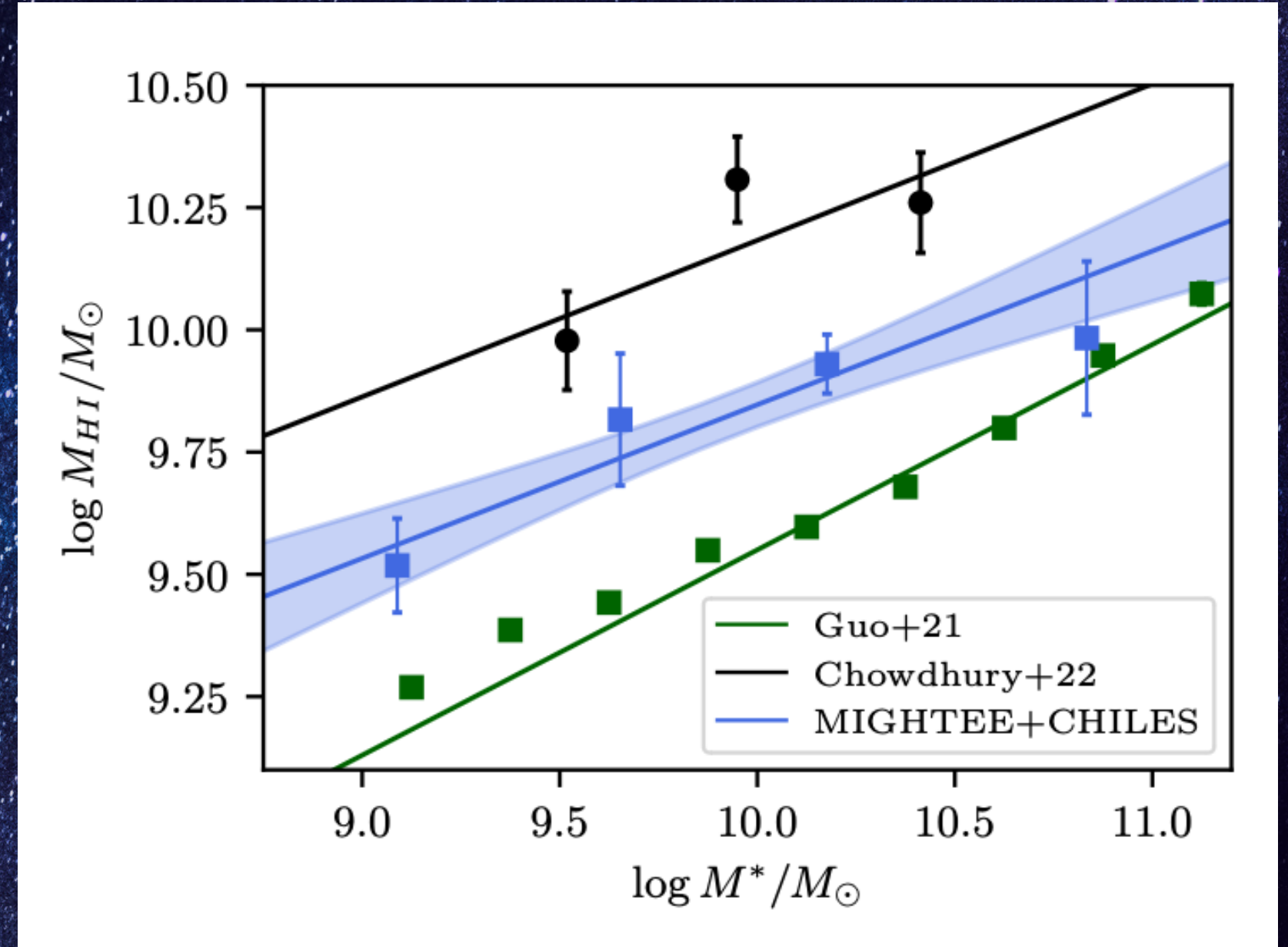- the two low-z CHILES scaling relations seem compatible
- little to no evolution until z=0.2
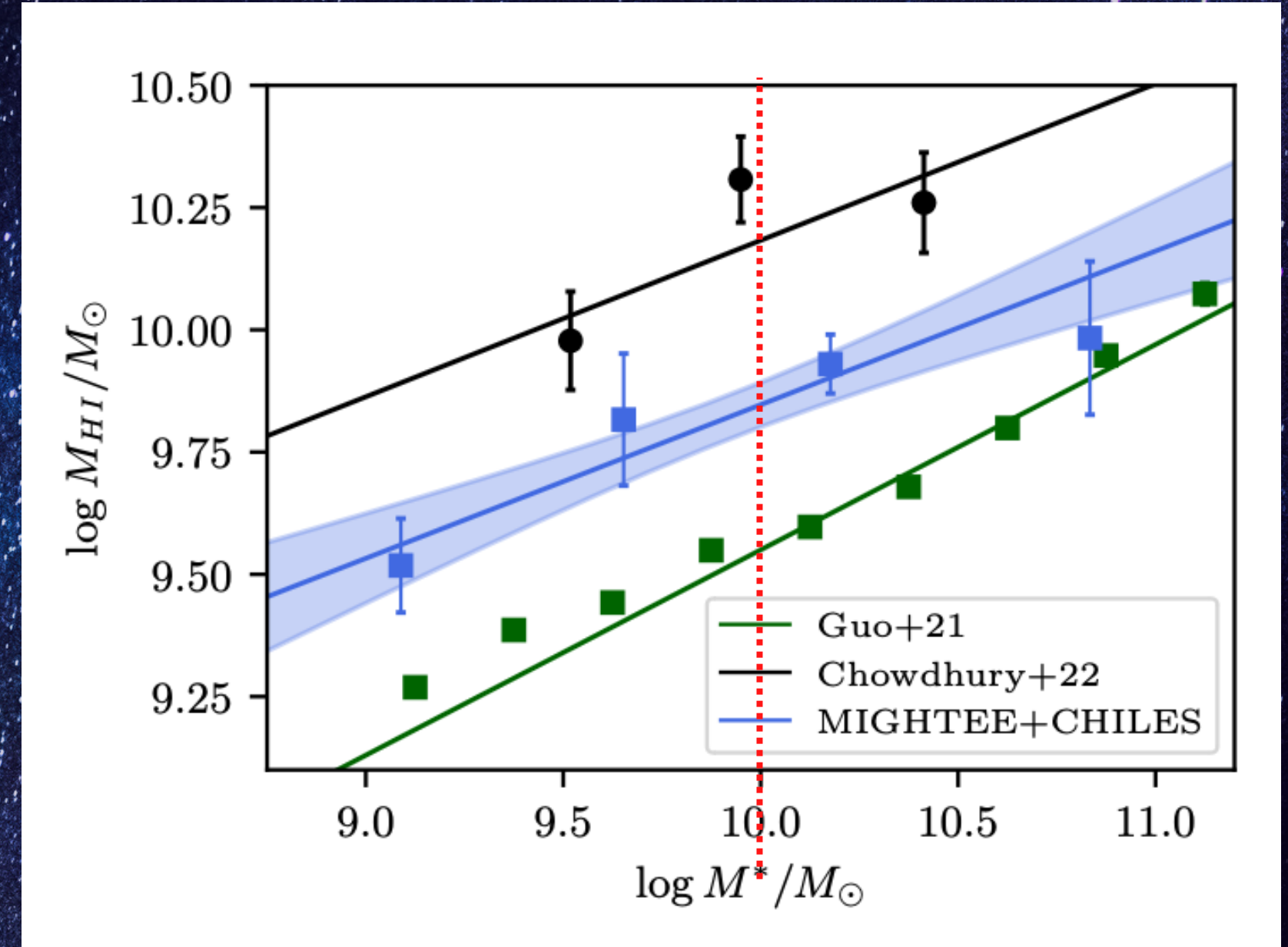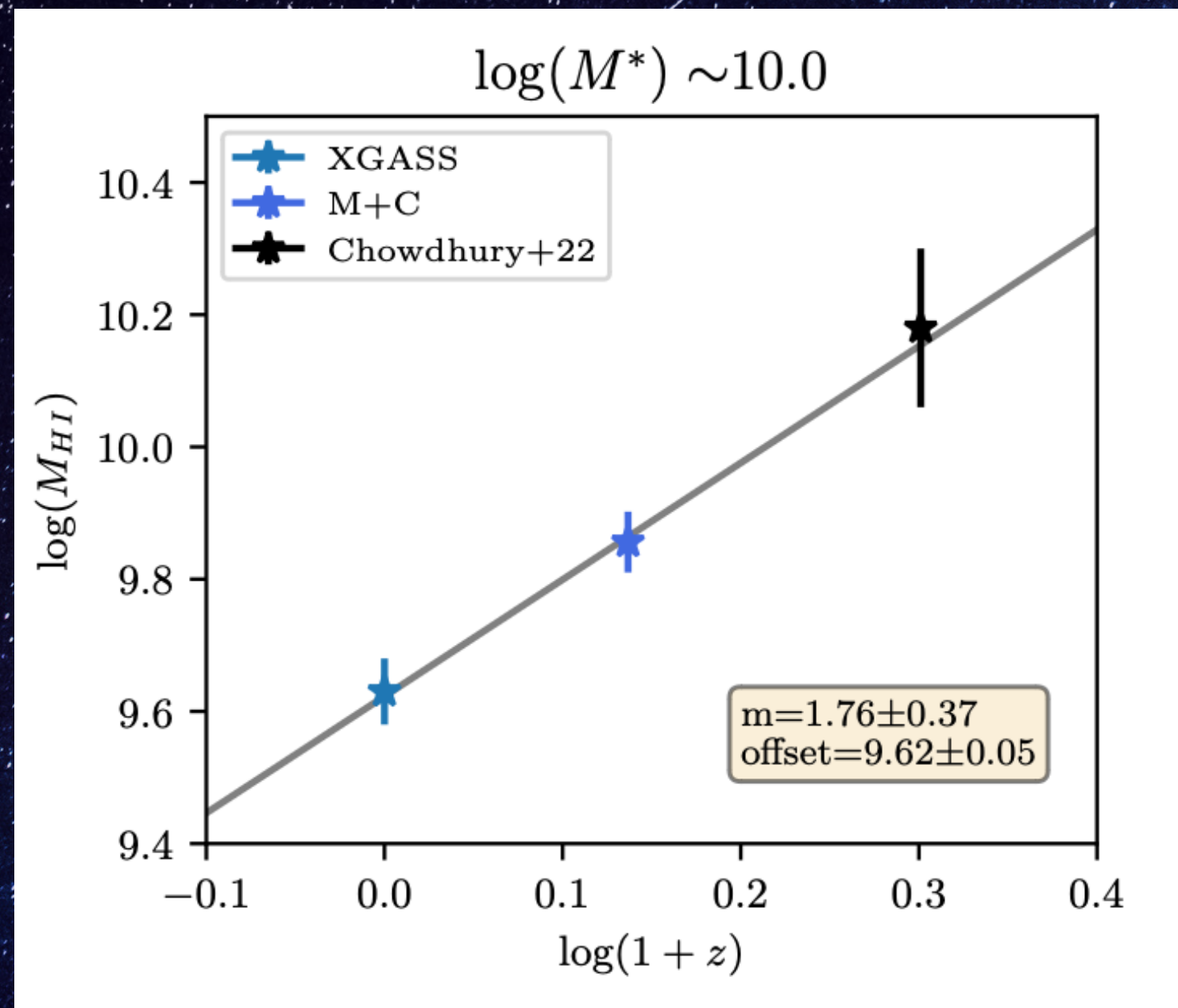

scaling relations at z=0.4
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SCALING RELATION EVOLUTION

- slope constant thought redshift
- HI removal/replenishment mechanisms do not vary across stellar mass (at least until logM*10)

SCALING RELATION EVOLUTION

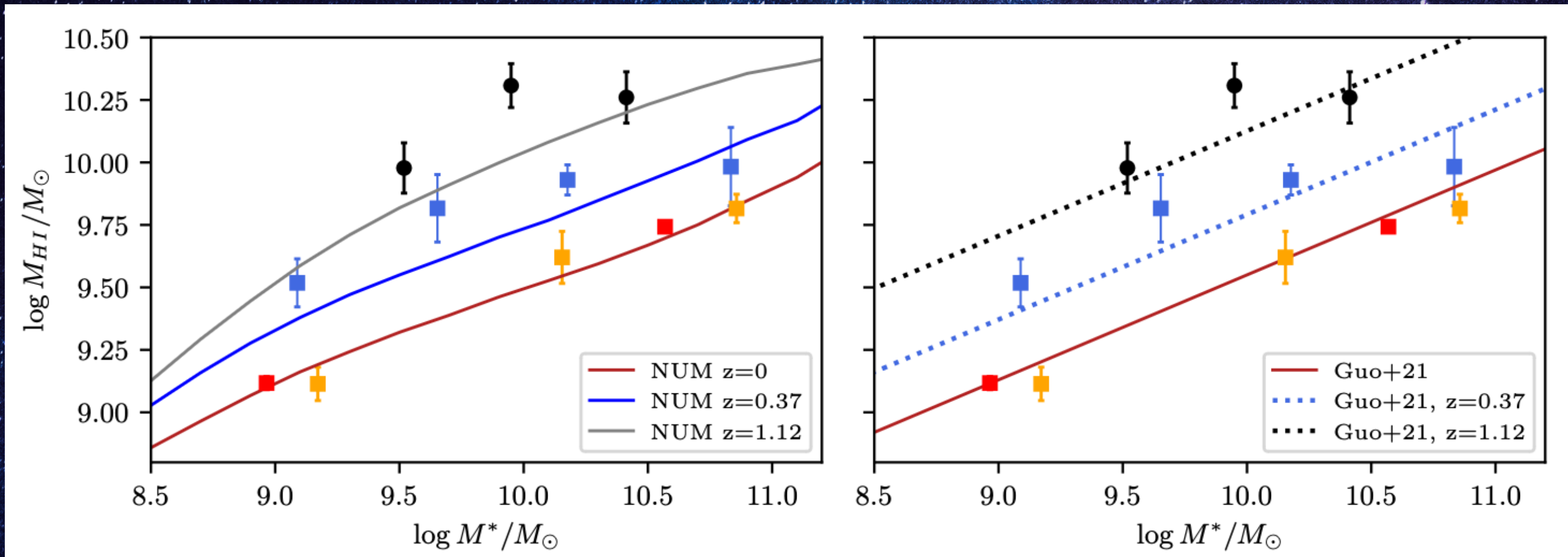- slope constant thought redshift
- HI removal/replenishment mechanisms do not vary across stellar mass (at least until logM*10)
- quantify evolution of MHI as a function of redshift at fixed stellar mass (logM*=10)

SCALING RELATION EVOLUTION

comparing with simulations
- NeutralUniverseMachine underpredict HI content
- re-scaling Local Universe scaling relation at z=0 provides good match with observations

TOWARDS SKA

WHAT'S NEW, WHAT'S NEXT

- stacking technical achievements:
  - MIGHTEE and CHILES stacks generally agree very well
  - the combination of the two ensure great statistics, great for stacking
  - refined RFI masking removed most of the unexplained features
- science questions:
  - do massive galaxies have very efficient Hi replenishment mechanism?
    Worth investigating the bent model
- paper in preparation!
- **SUPERMIGHTEE**: pushing our stacking project to z~1

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SARAO and UCT are offering a postdoctoral position, mixed MeerKat science operations support and personal research
https://jobregister.aas.org/ad/de59ca7f

Attention To: Prof. D.J. Pisano
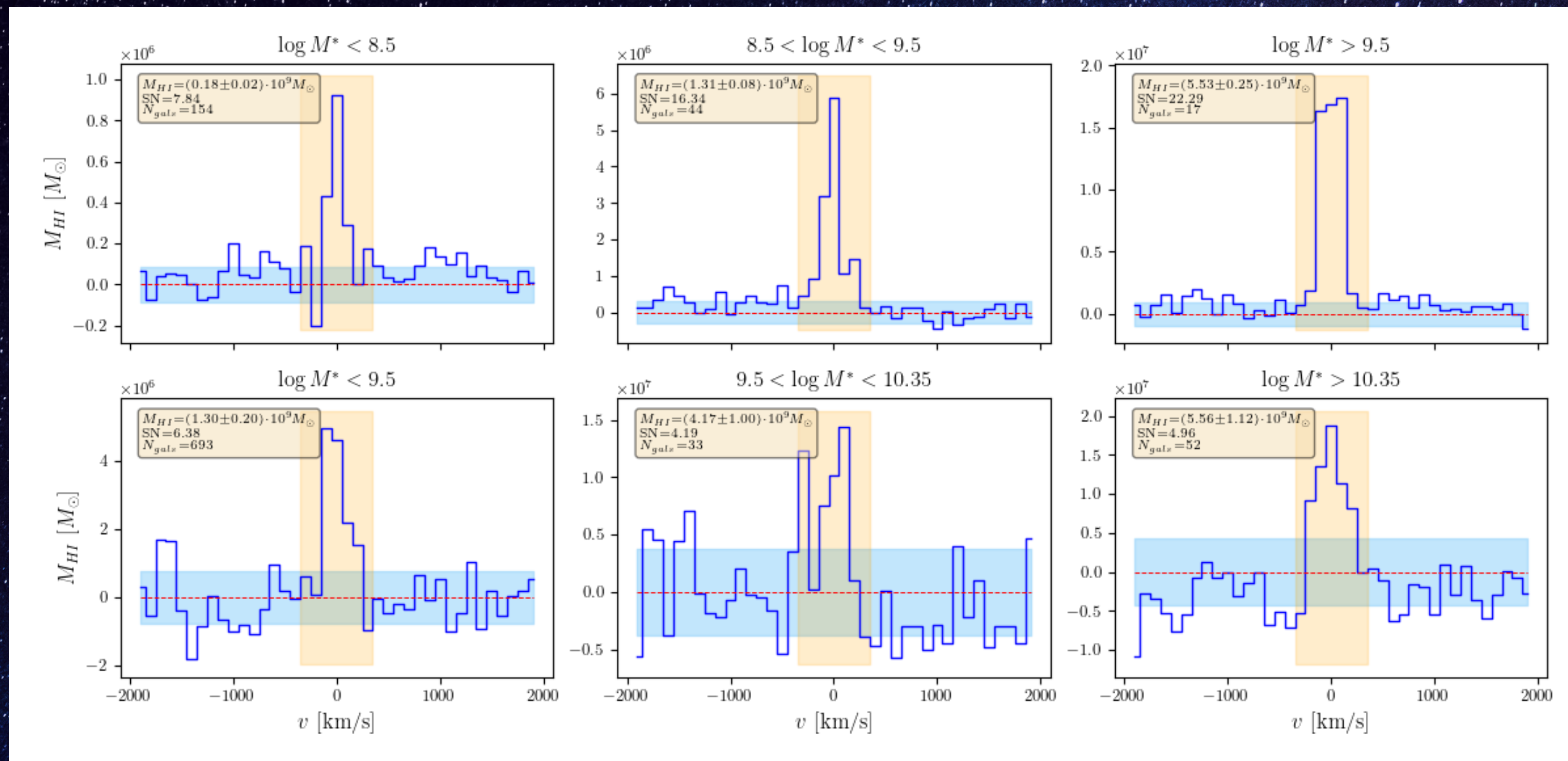Subject: SARAO-UCT Postdoctoral Fellowship
Email: **postdoc_applications@ast.uct.ac.za**
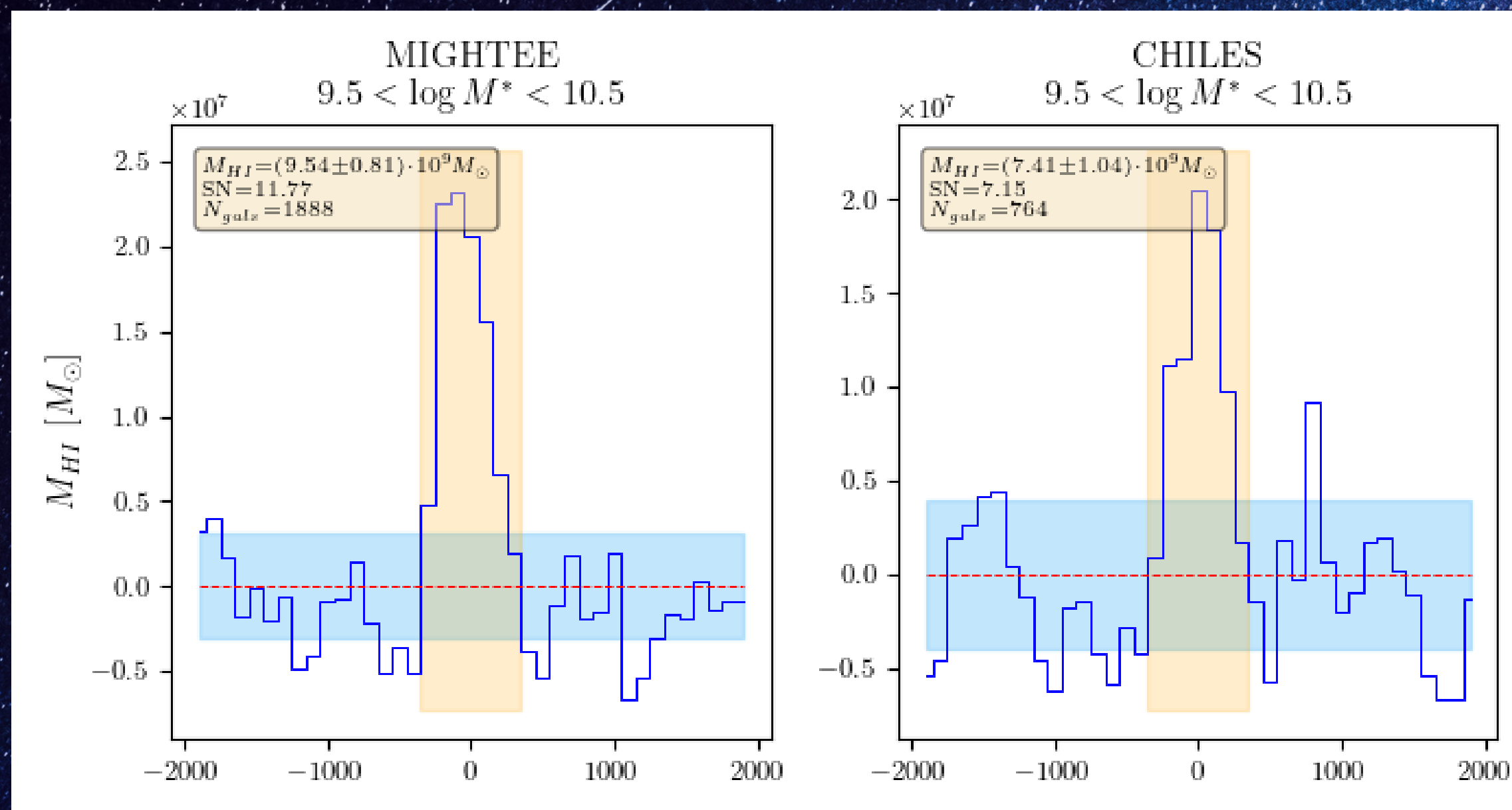or contact: **dj.pisano@uct.ac.za - mattia.vaccari@uct.ac.za - lucia.marchetti@uct.ac.za**

Deadline: January 15th, 2024

BACKUP: CHILES LOW-Z STACKS

BACKUP: MIGHTEE-CHILES COMPATIBILITY

Stacking setup

- RFI masking

- weighting scheme

- extracting aperture = 3xbeam

BACKUP: MIGHTEE-CHILES COMPATIBILITY