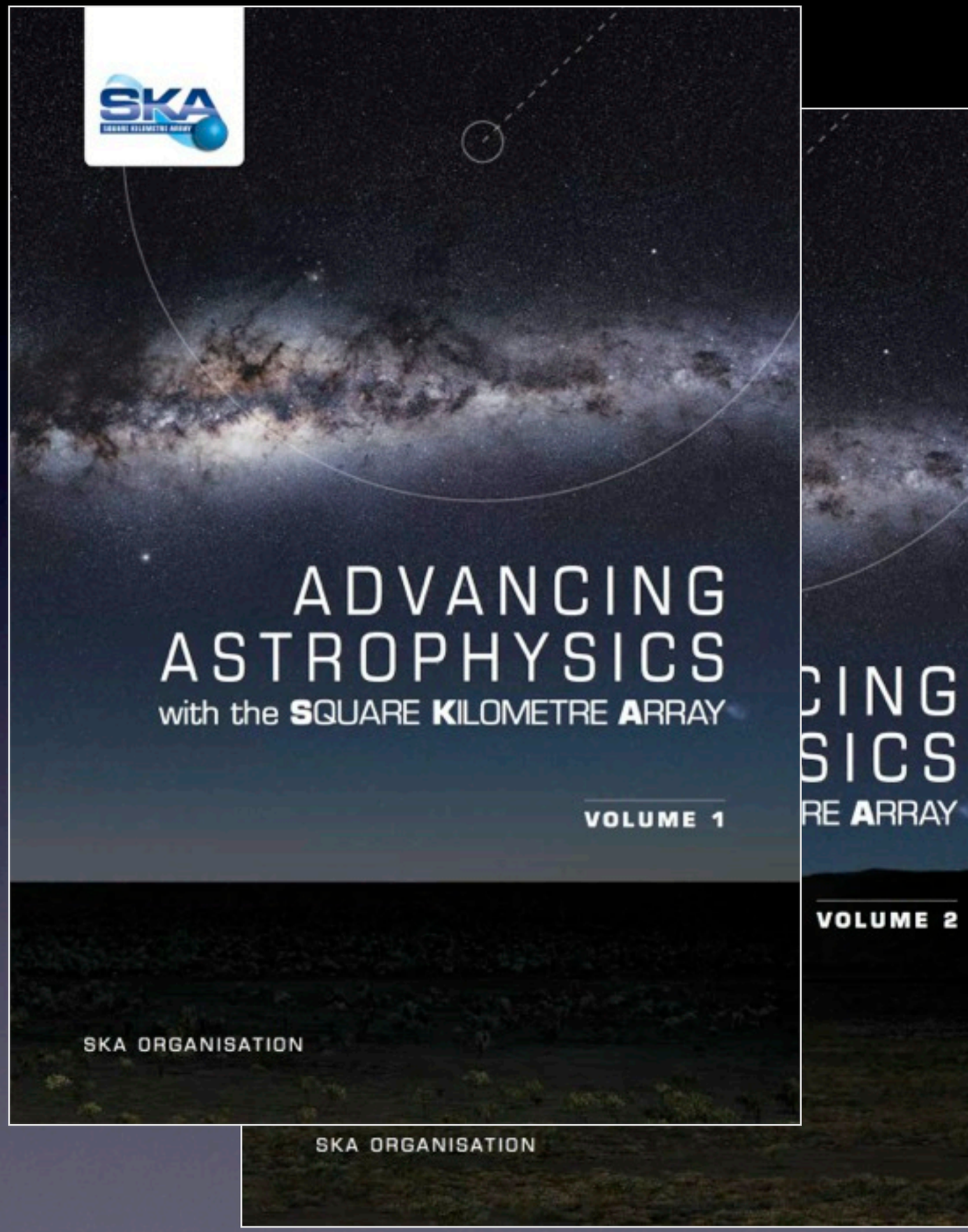
Commensal observing: HI science with MIGHTEE

Natasha Maddox
Postdoctoral Fellow at
ASTRON

Image credit: SKA Organization

- 135 science chapters
- 10 HI chapters
- 24 hours in a day

➡ Time oversubscription



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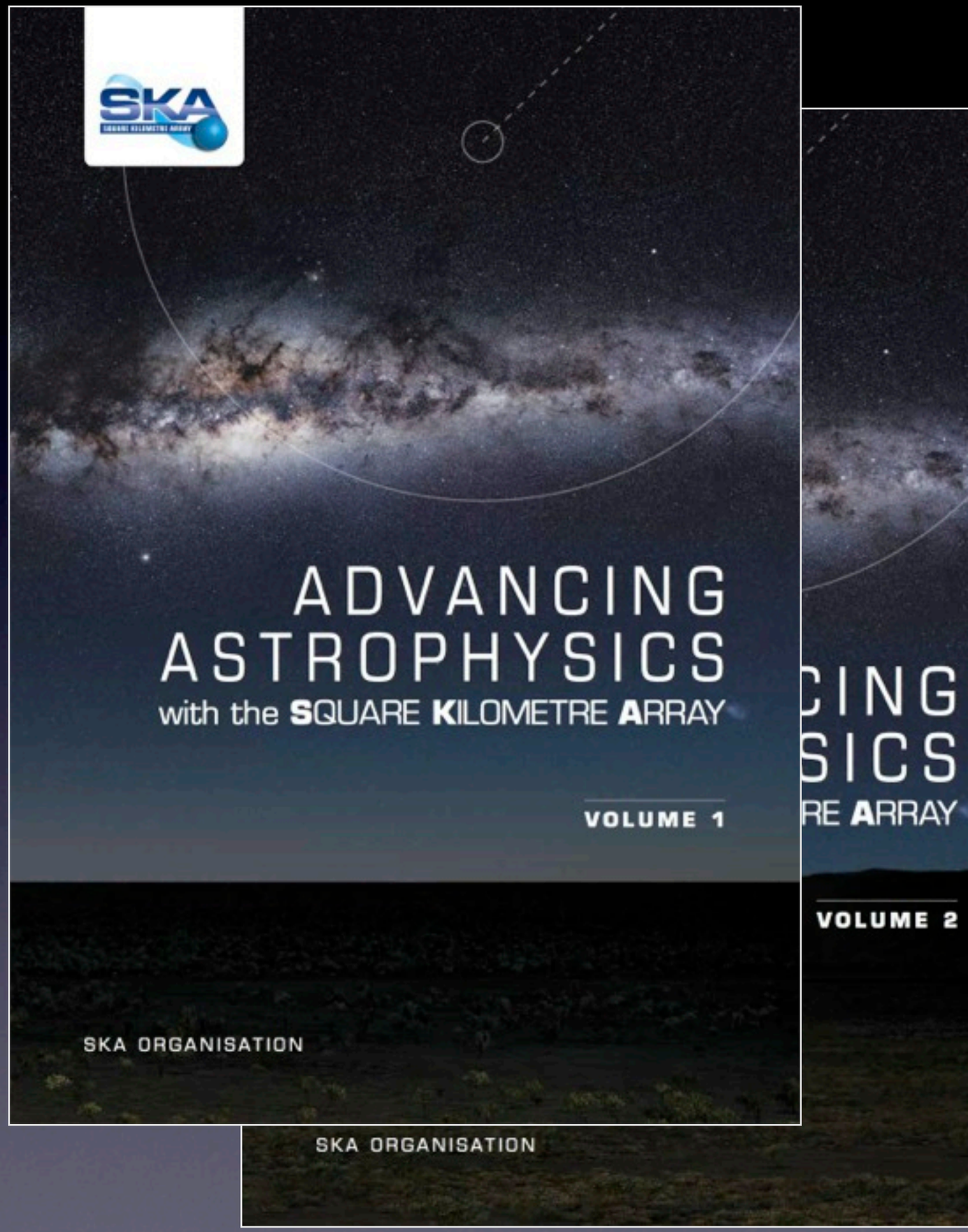
➡ Alleviate oversubscription by observing *commensally*

- Observe HI (spectra) and radio continuum (imaging) at the same time *(and absorption and transients and magnetism...)*



LADUMA

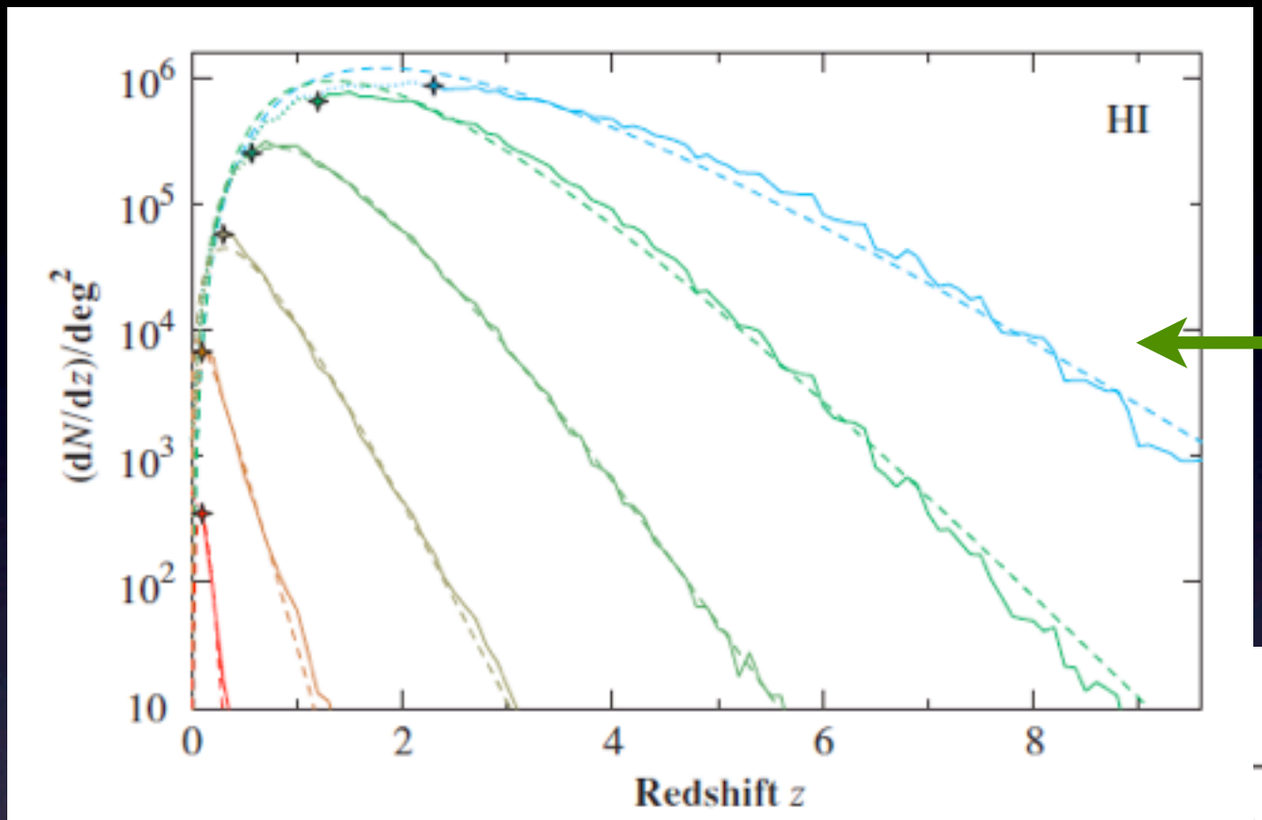
- Looking At the Distant Universe with the MeerKAT Array
- Deep HI survey with MeerKAT
- 5000 hours of a single pointing
- HI detections to z<=0.6, stacked detections to z>1

MIGHTEE

- MeerKAT International Giga-Hertz Tiered Extragalactic Exploration
- *Continuum* (imaging) survey
- 35 deg^2, 50 hours per pointing
- ➡ *Data taken in spectral line (HI) mode*

SKA South Africa

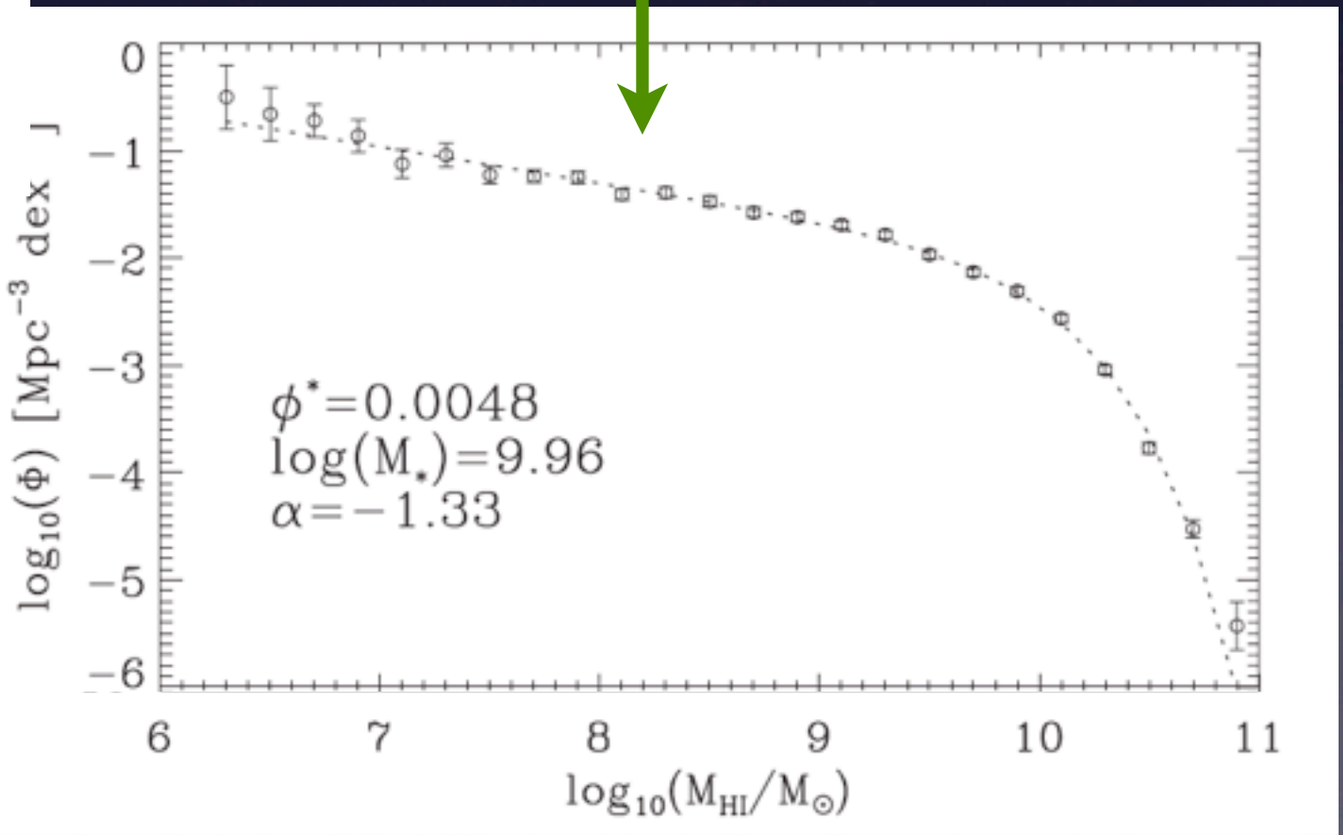
Predict what a given survey will see in HI:



Obreschkow et al. 2009

dN/dz from SKA Simulated Skies (S^3) simulations +

HI mass function from data



Martin et al. 2010

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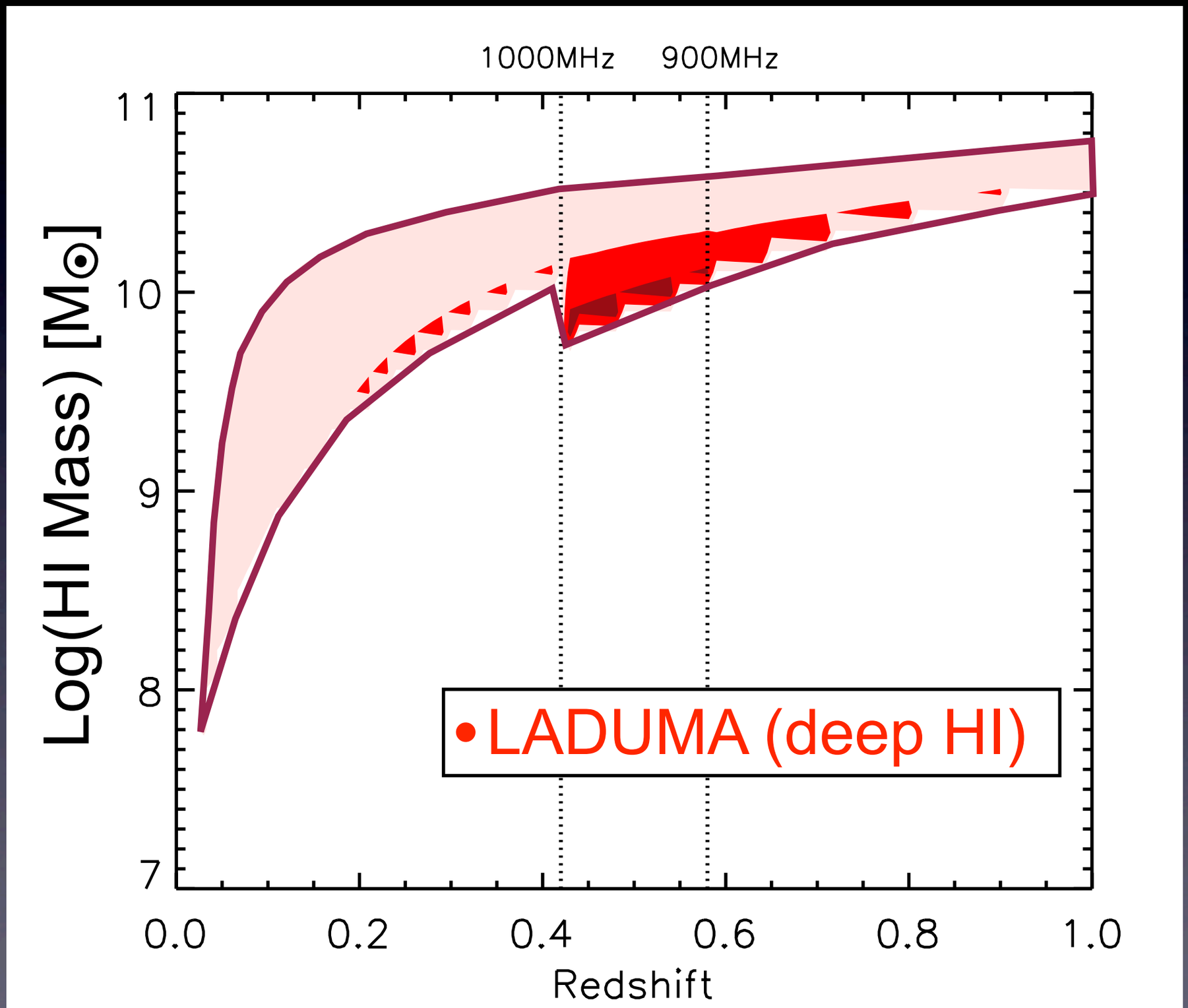

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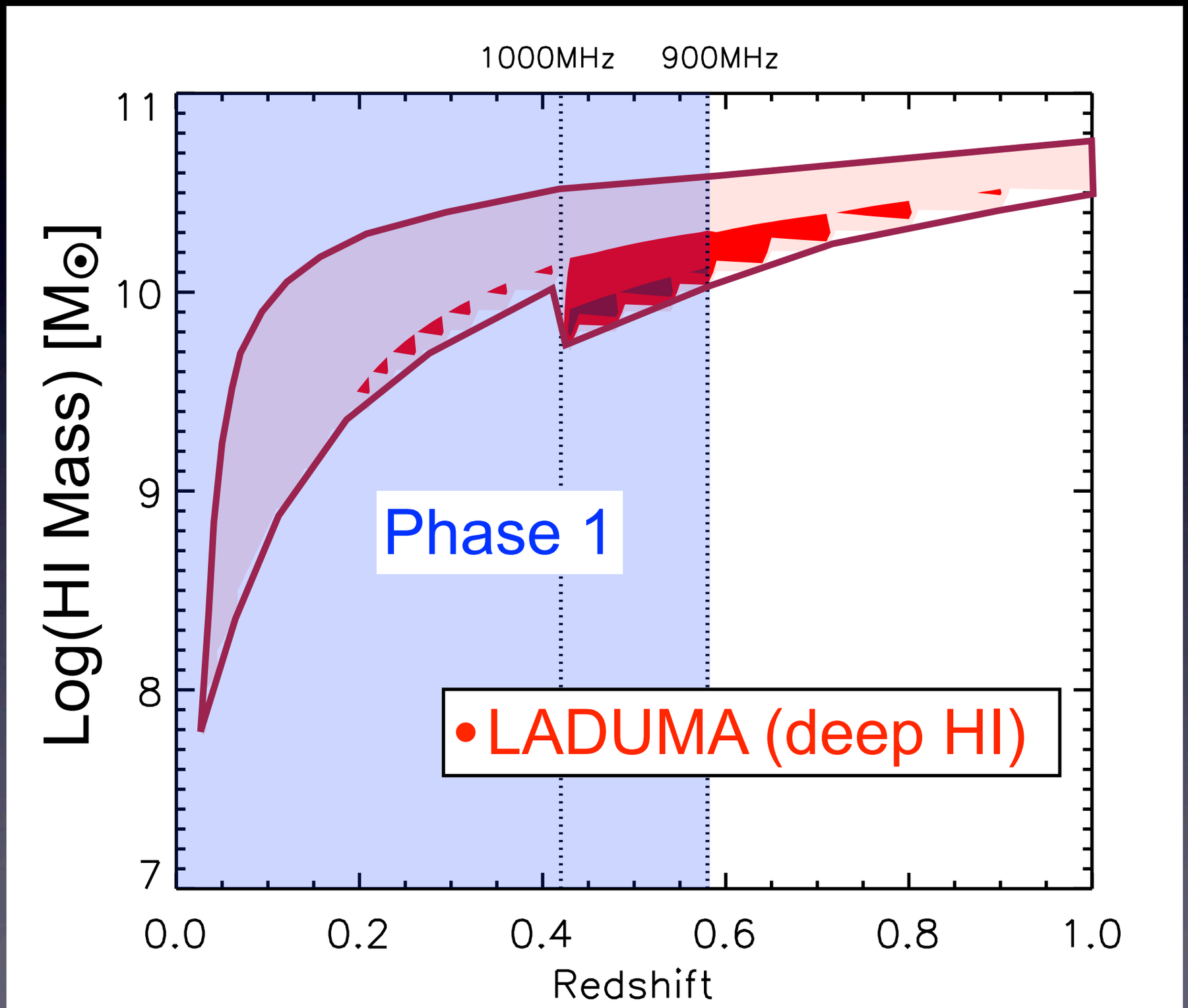

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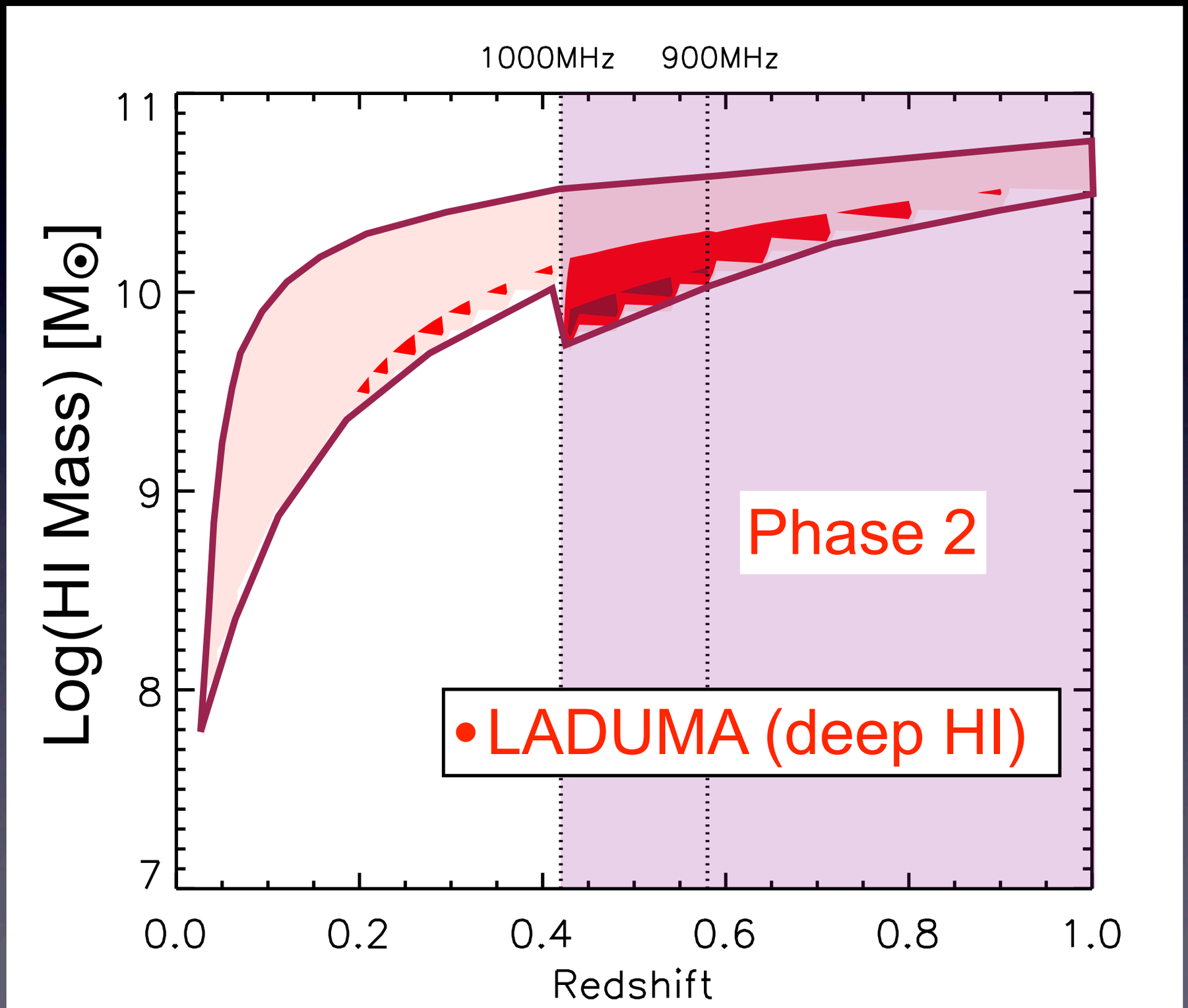

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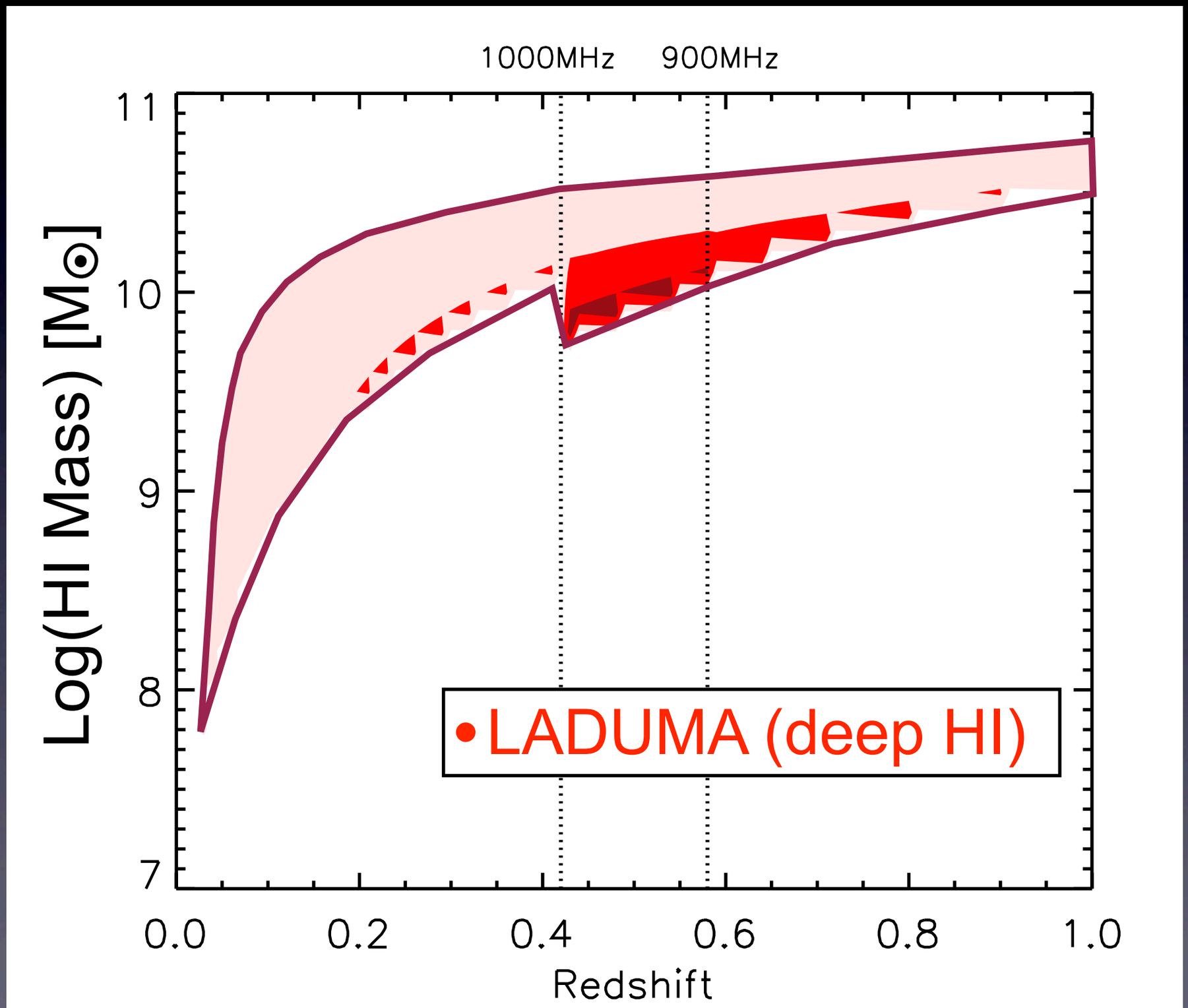

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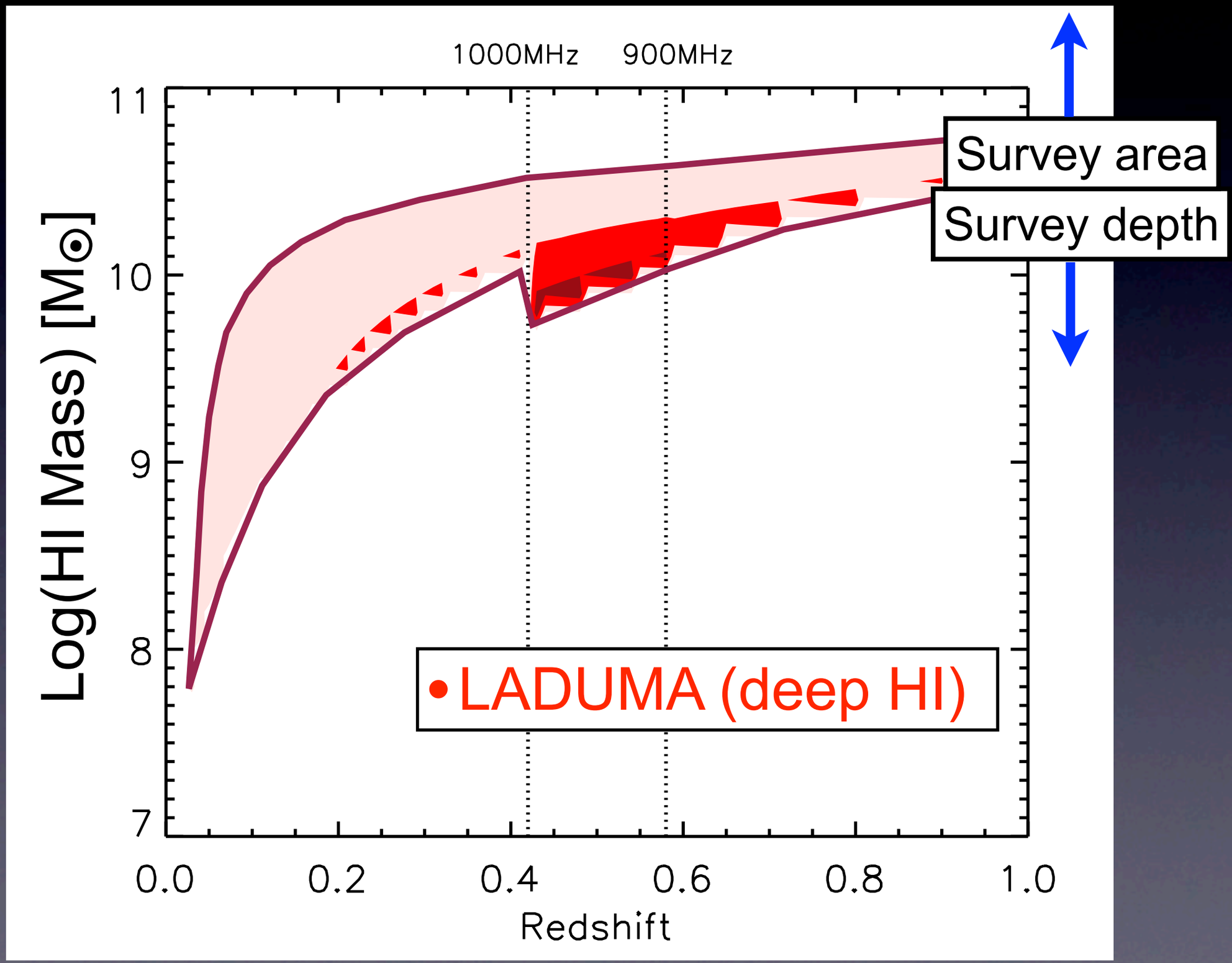

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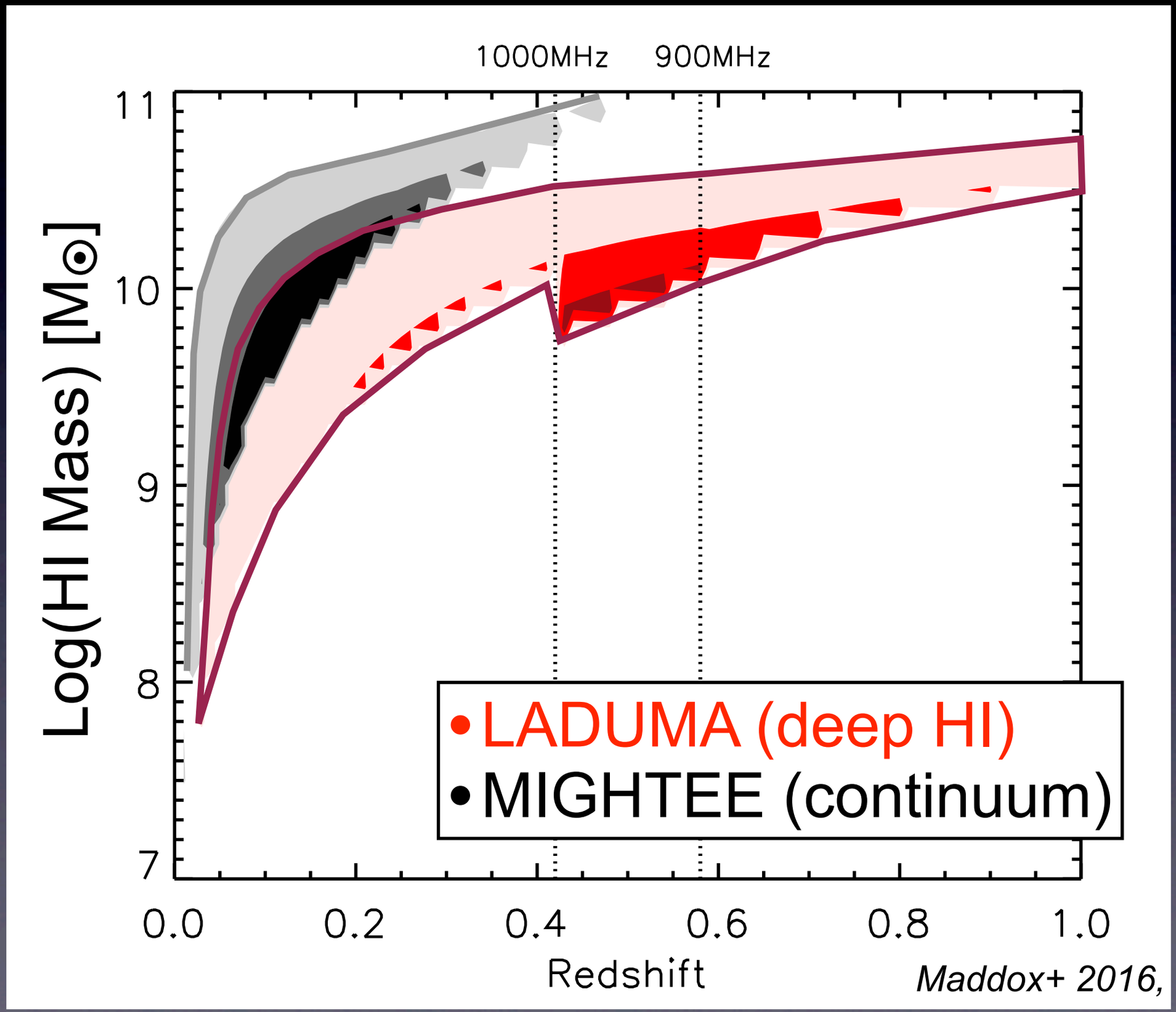
SKA South Africa

- Adding in HI data from the MIGHTEE fills parameter space not accessible to LADUMA



Maddox+ 2016, submitted

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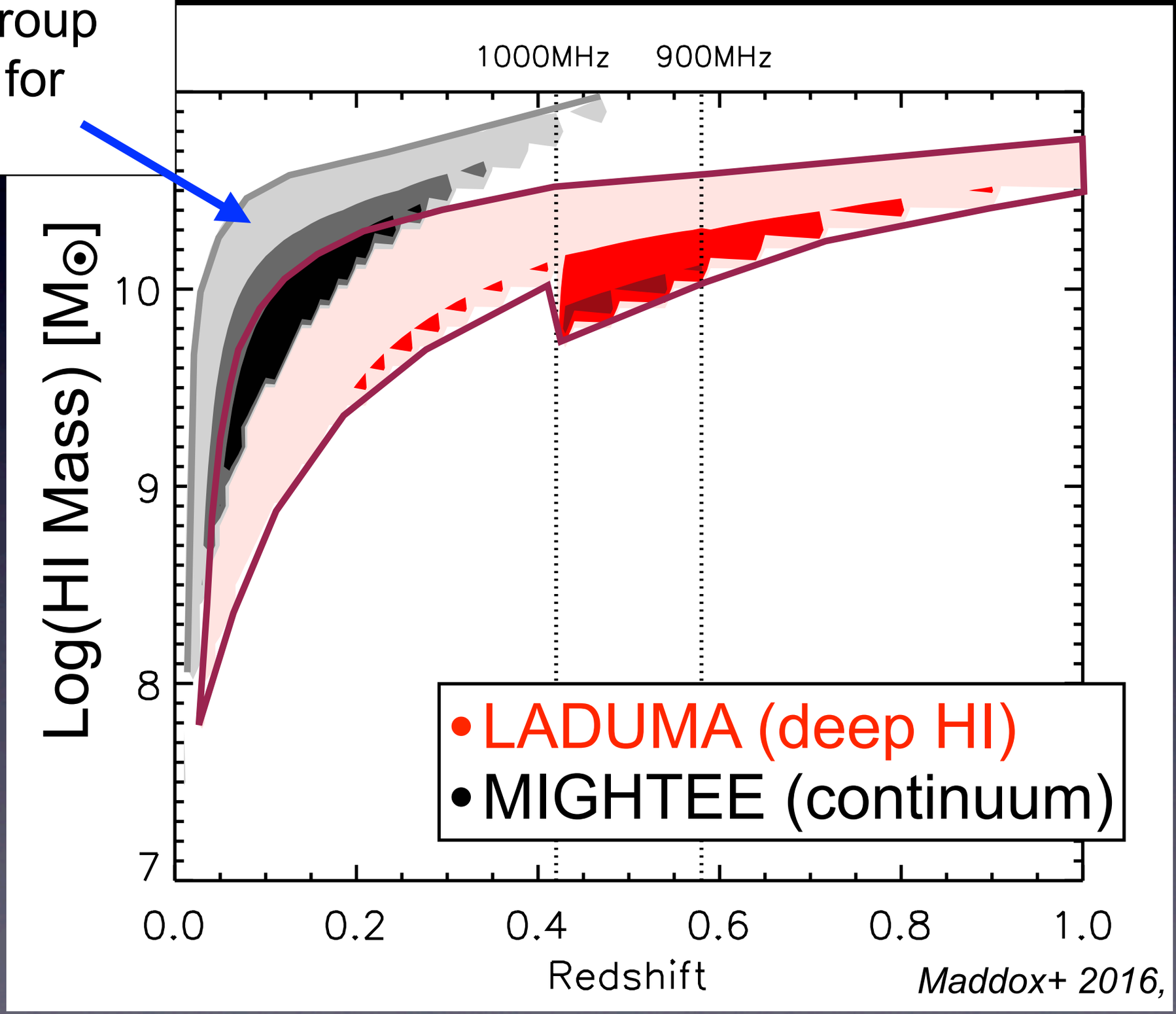
The HI group gets this for "free"



Maddox+ 2016, submitted

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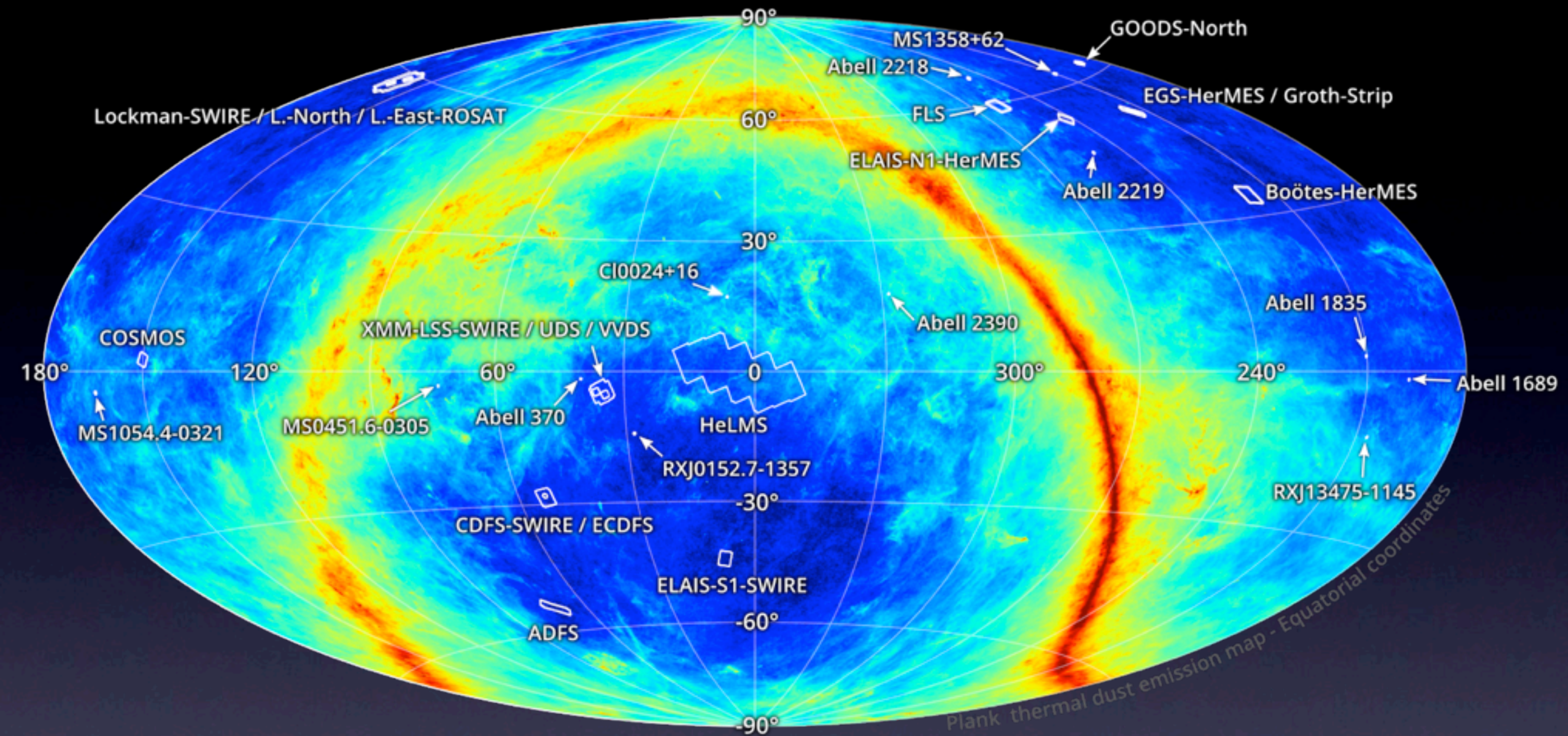
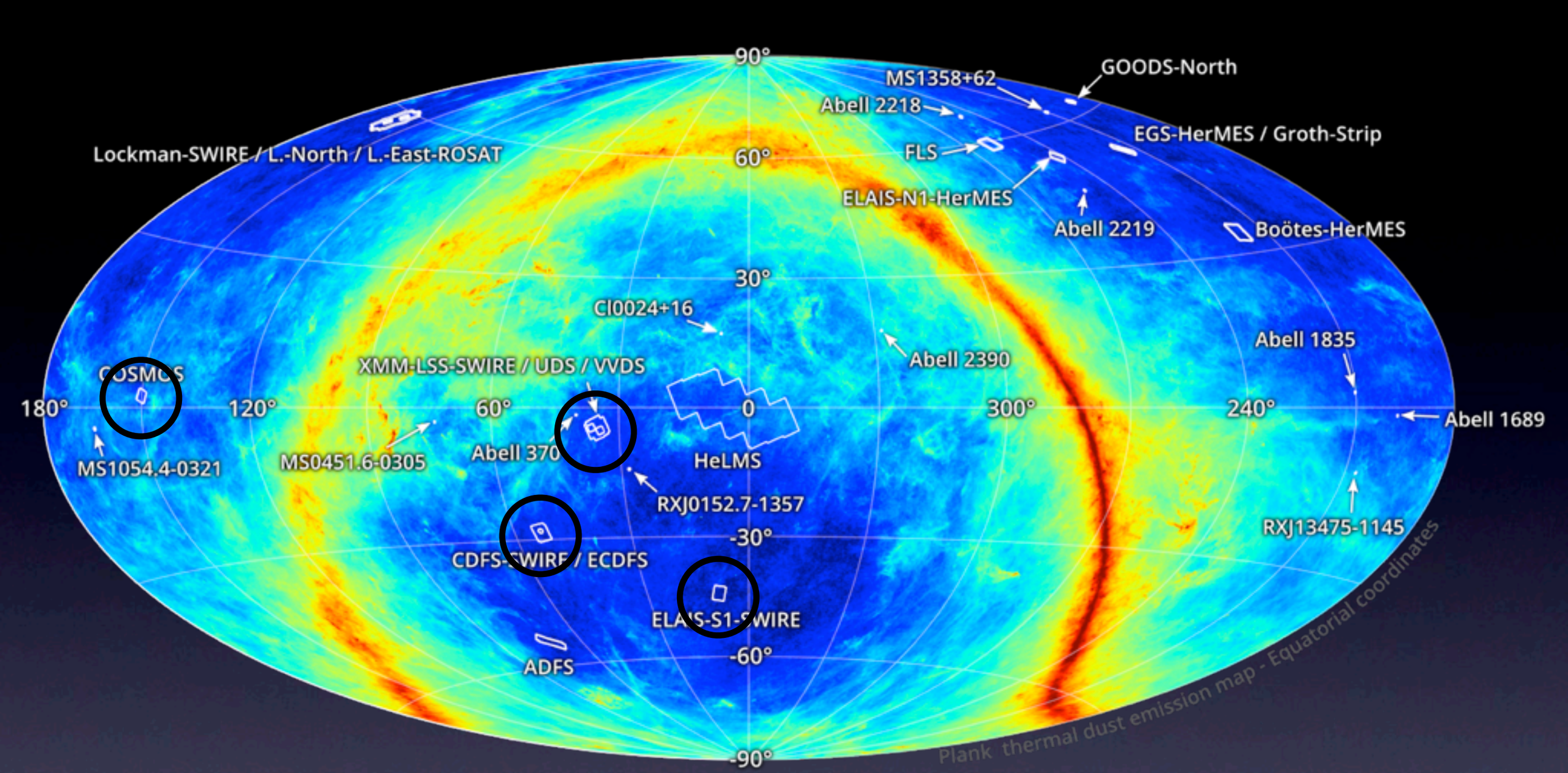
SKA South Africa



http://hedam.lam.fr/HerMES/index/survey



- COSMOS (also the CHILES field)
- XMM-LSS
- ECDFS (also the LADUMA field)
- ELAIS S1

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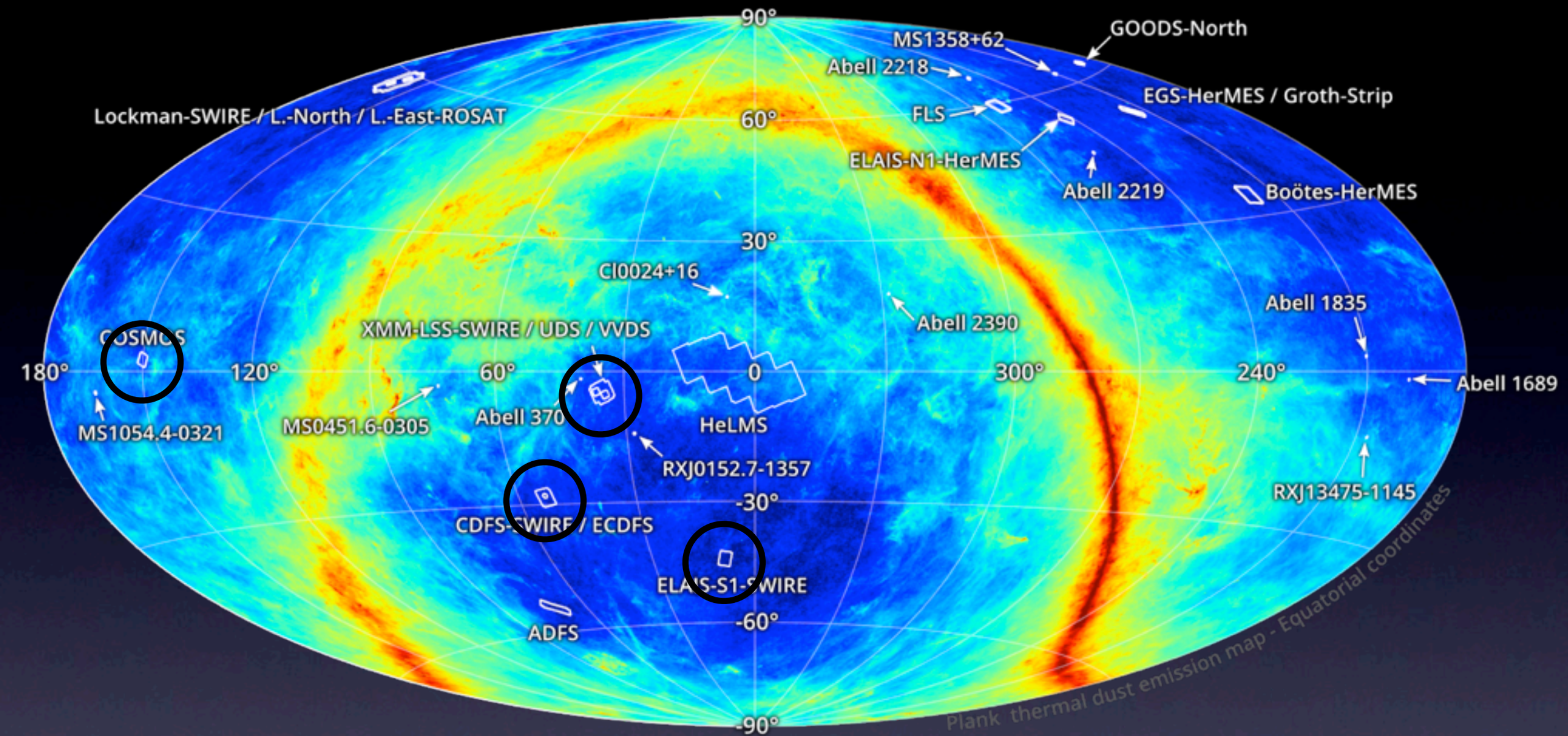

- Extensive multi-wavelength ancillary data
- Optical, NIR (VISTA), IR (Spitzer), FIR (Herschel)
- Falls within Mattia Vaccari's *HELP* infrastructure

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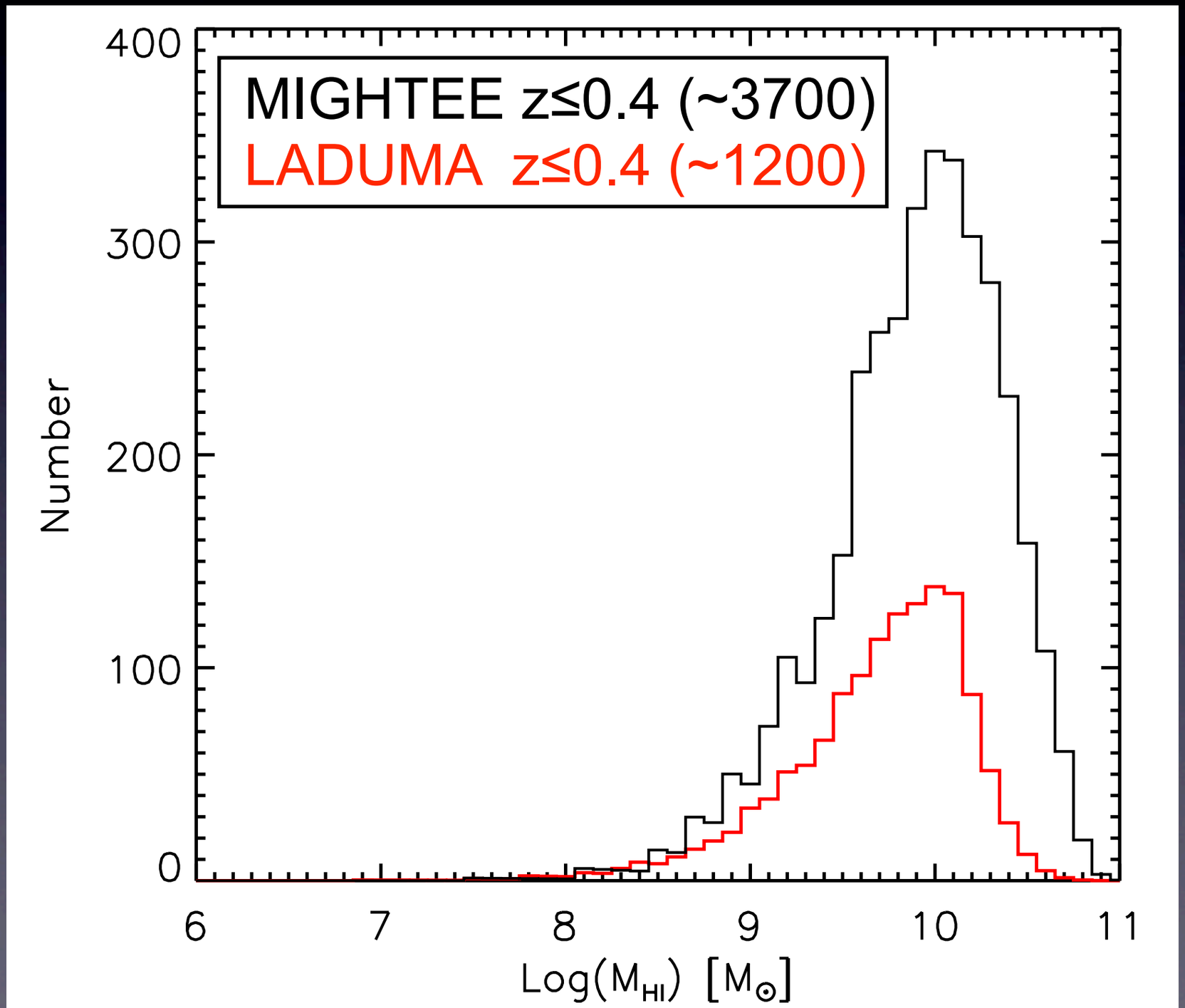
What use is a (relatively) shallow HI survey?

- Explore the high mass end of the HI mass function
- Predicted to have many more detections, improved population statistics



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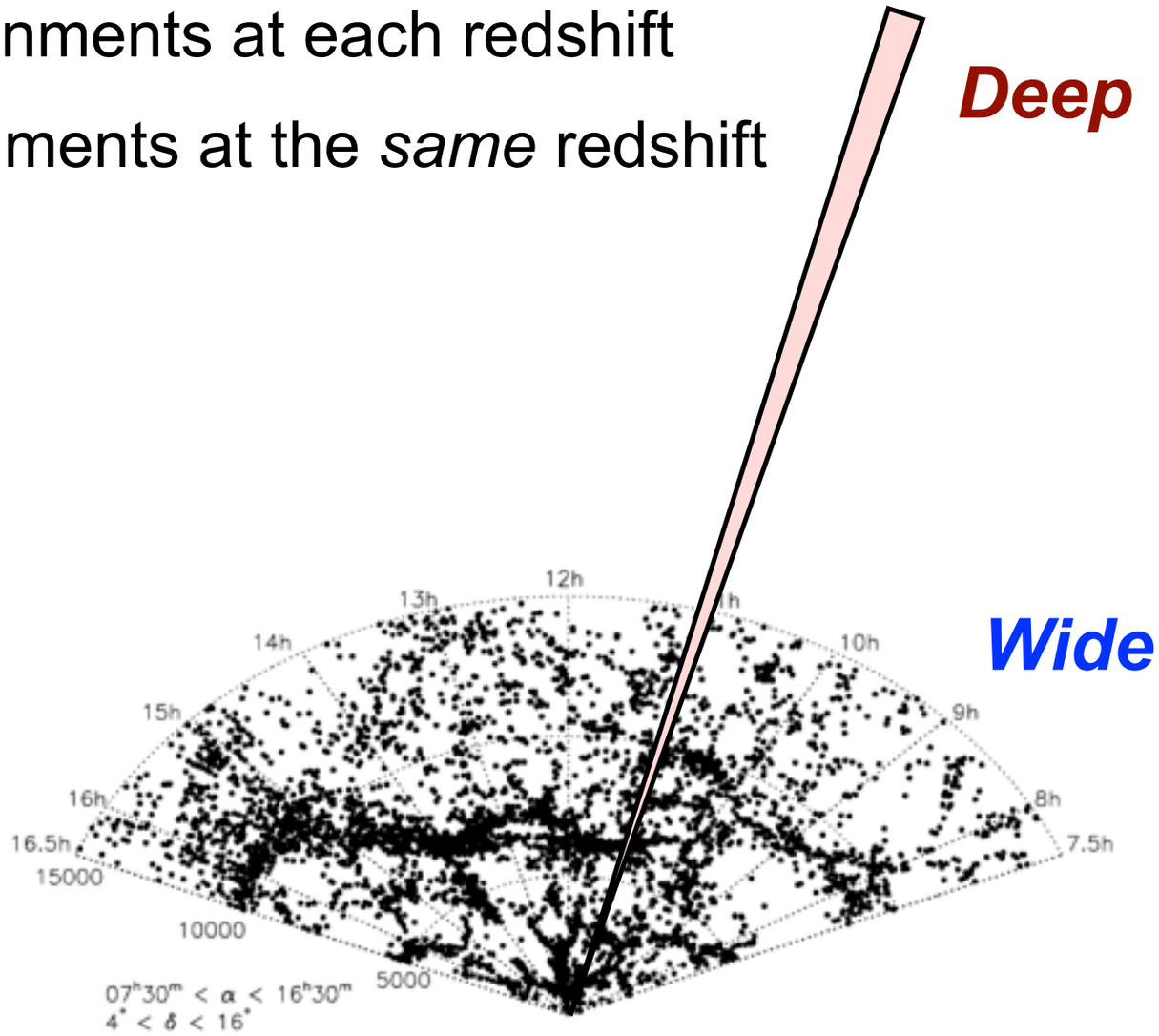
- Explore a wider variety of environments than available in the deep fields (clusters, groups, filaments, voids, field)

Deep: Different environments at each redshift

Wide: Various environments at the *same* redshift



***not to scale*

Observing HI and continuum at the same time:

- Clearly, this is efficient in terms of observing strategy
- What does it mean, observationally/scientifically?

➡ We have three options to pursue

Case 1:	Case 2:	Case 3:
HI groups steal the data taken for continuum surveys	Continuum groups steal the data taken for HI surveys	Combine the data taken from all surveys
→ see above	→ not straightforward, but still useful	→ see below

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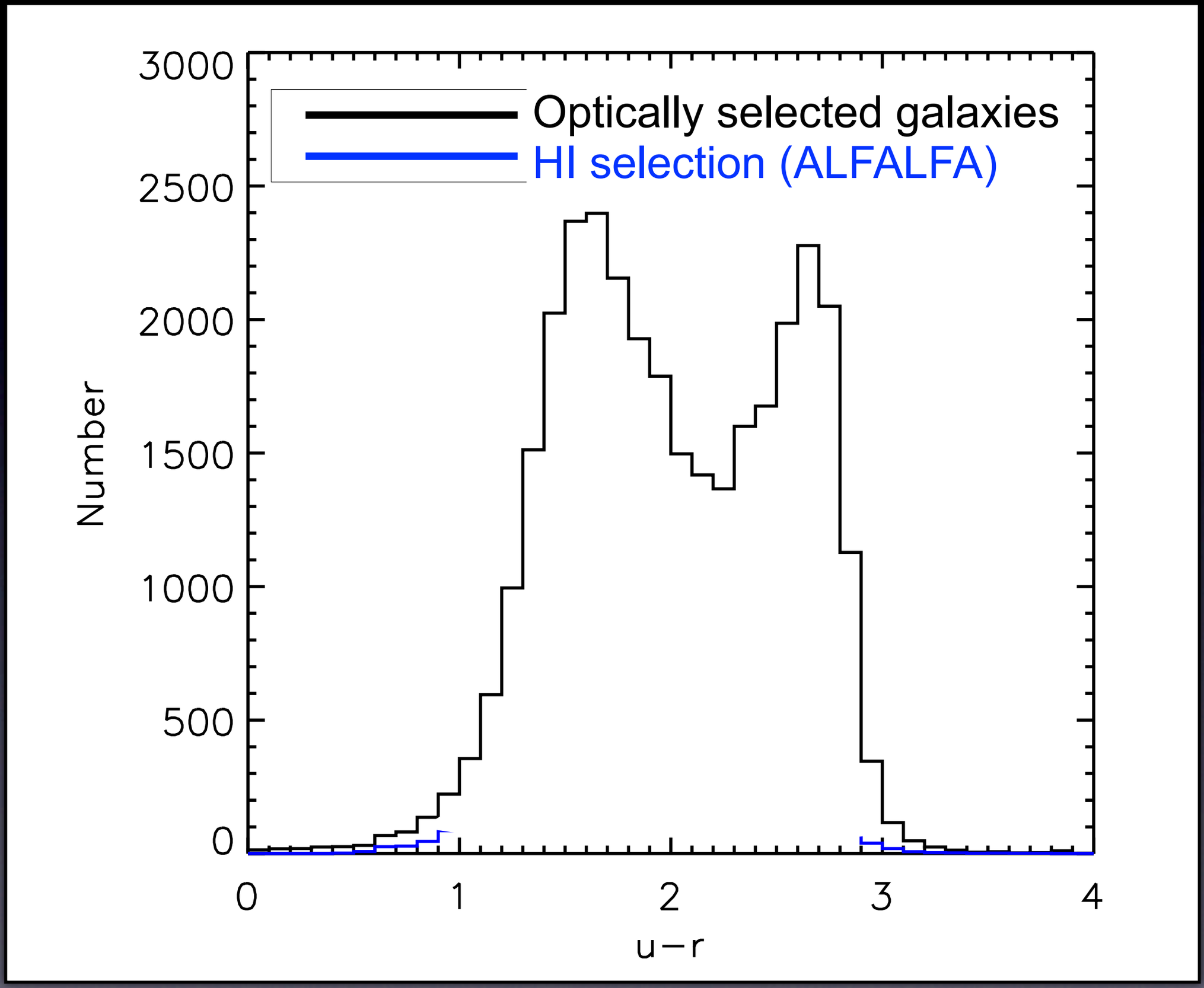

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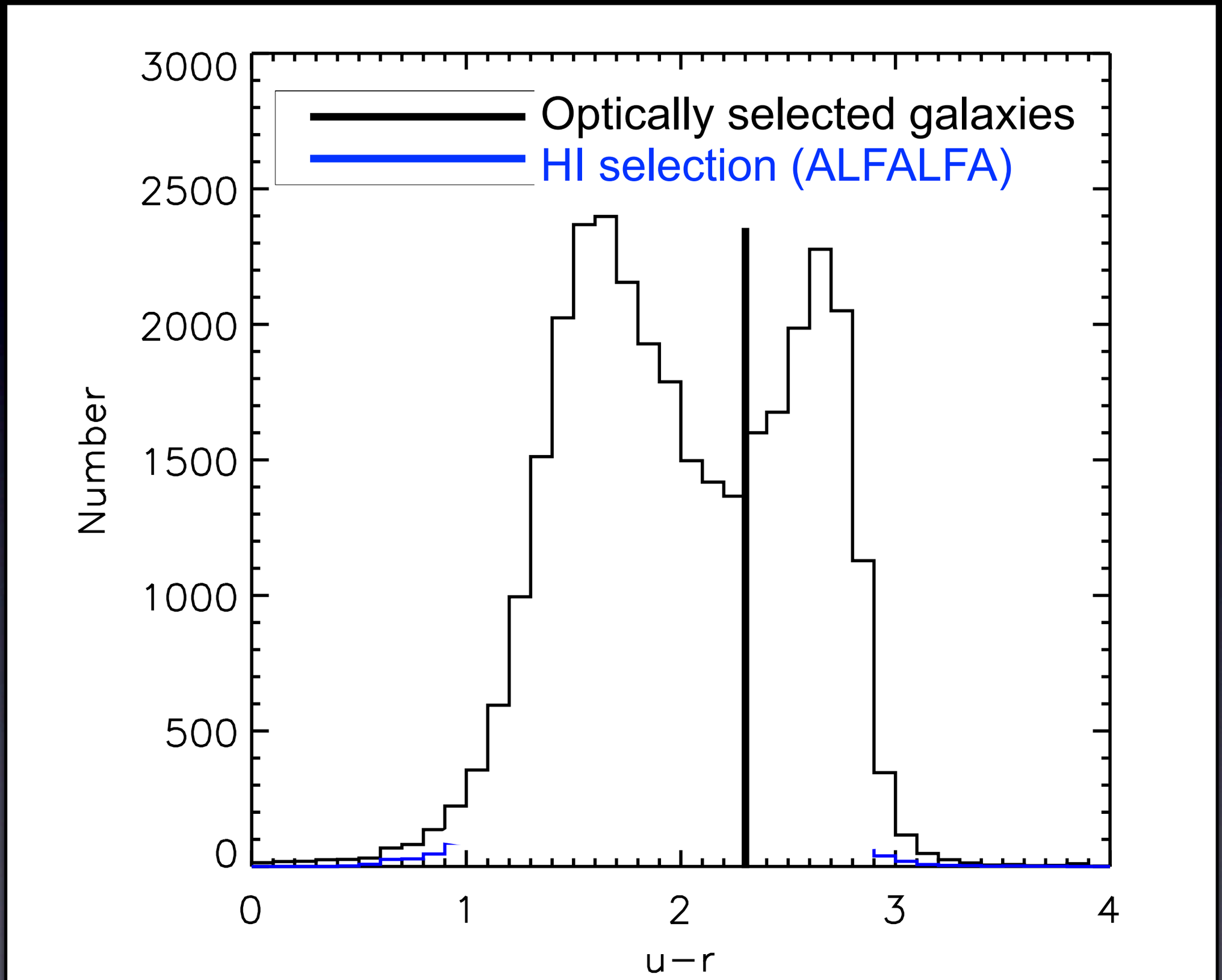

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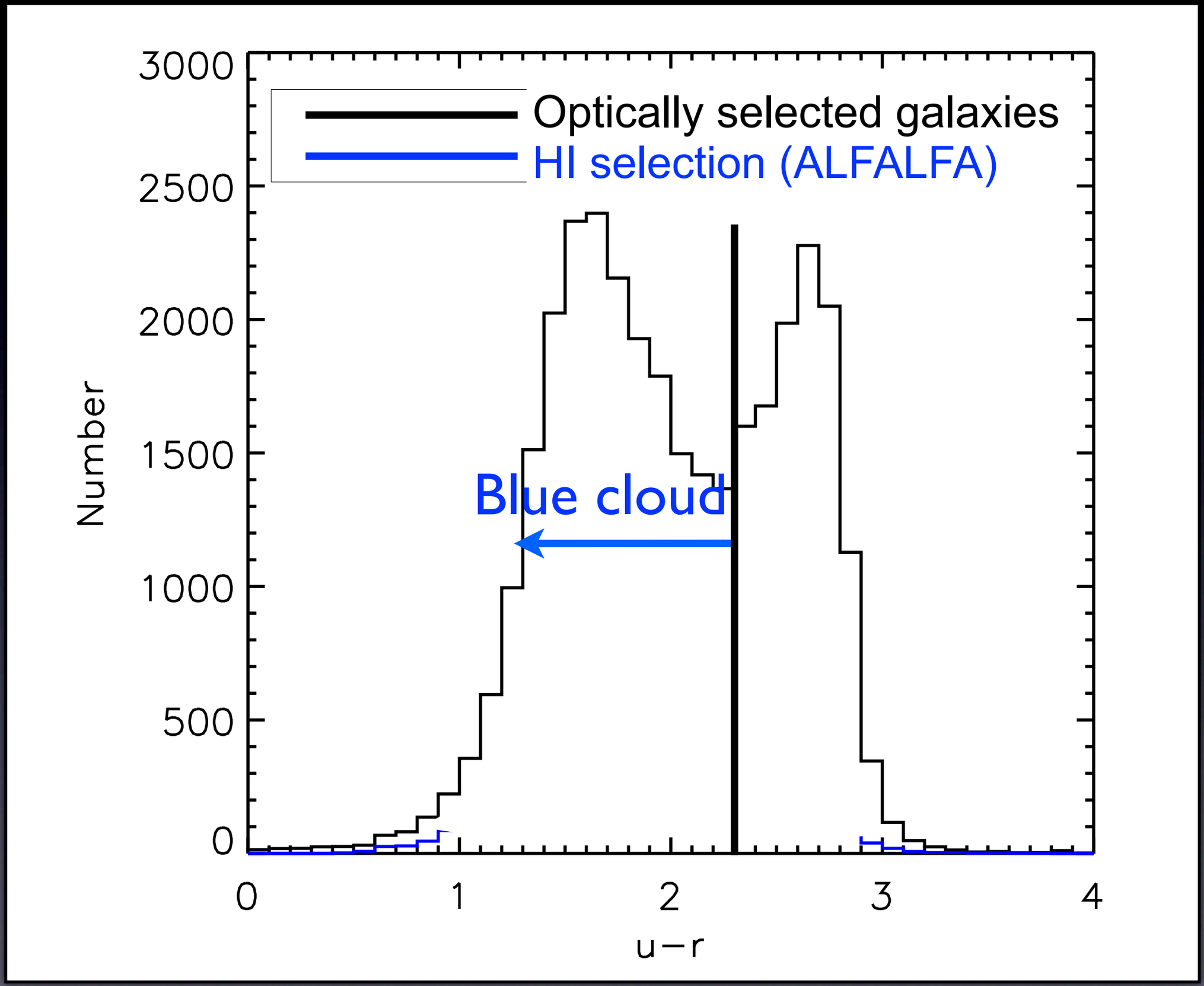

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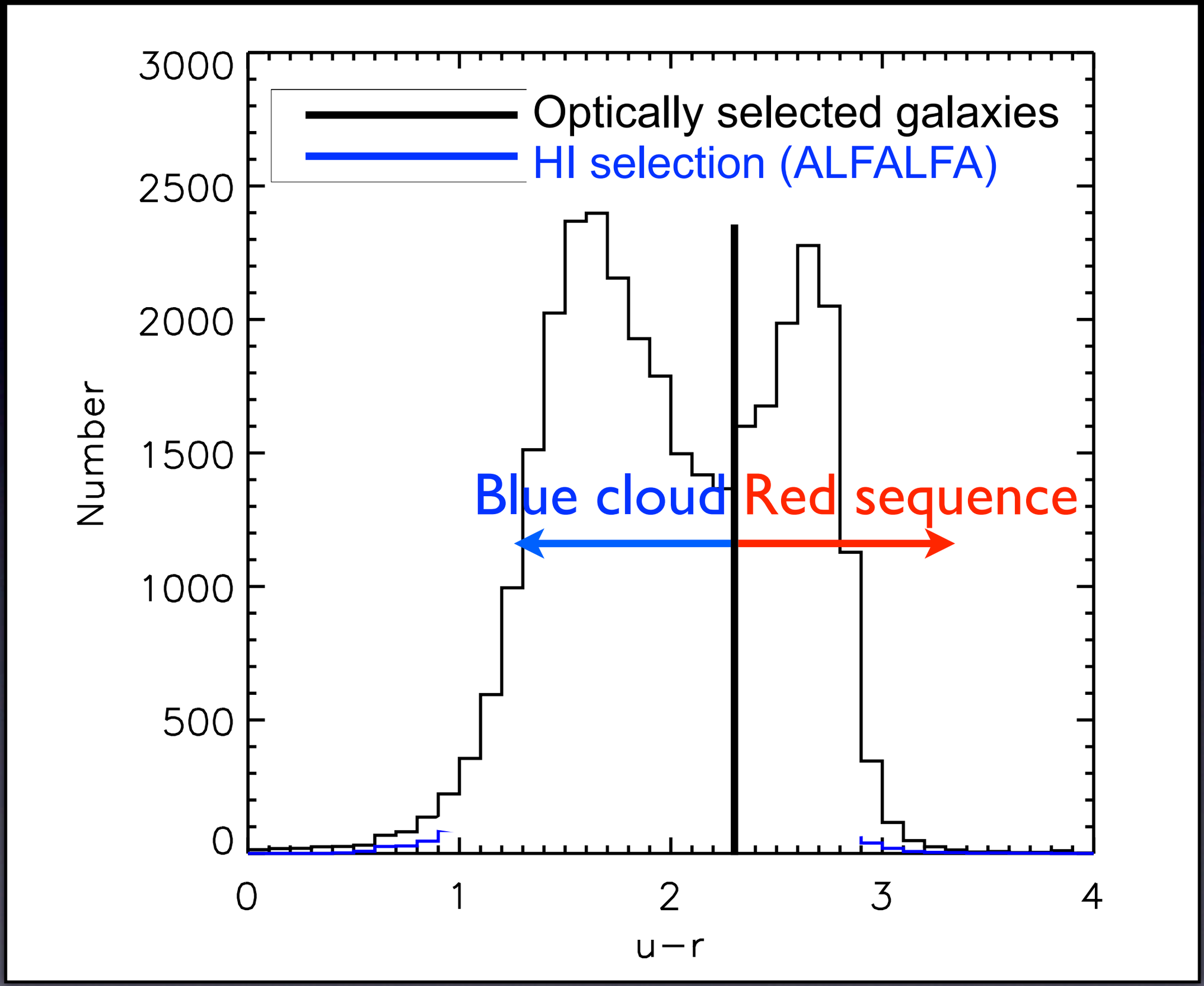

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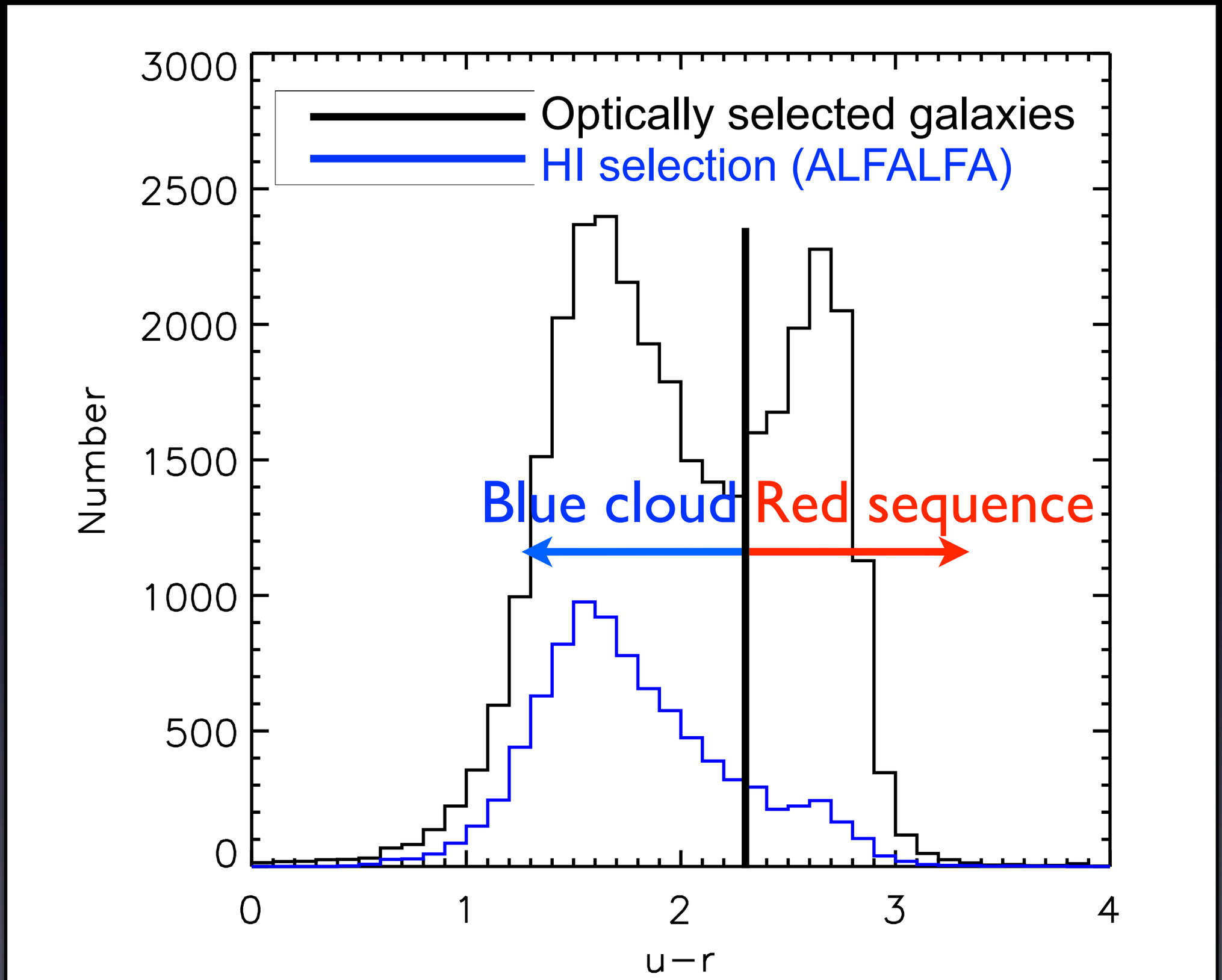

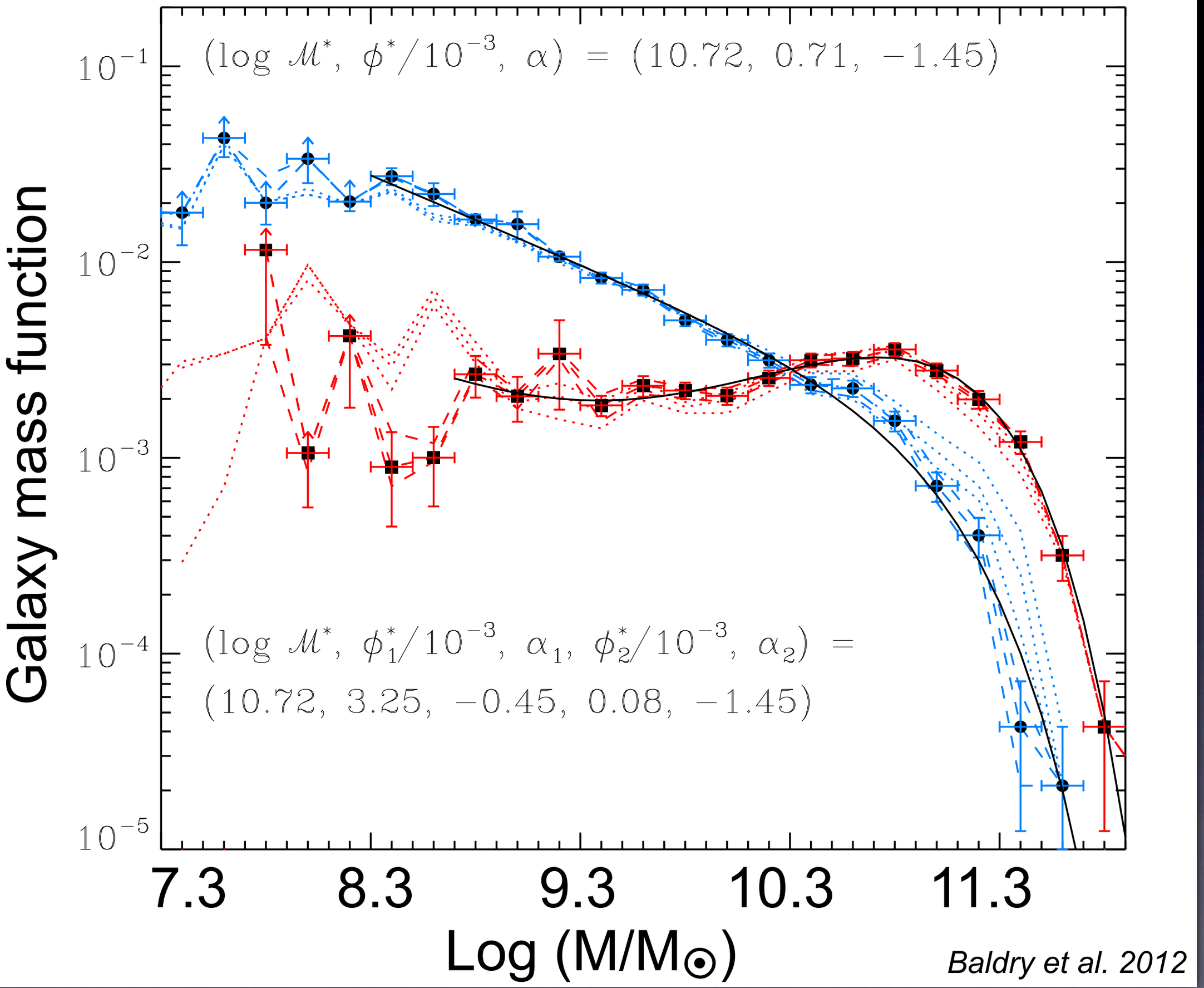
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$(10.72,\ 3.25,\ -0.45,\ 0.08,\ -1.45)$
Galaxy mass function
10^{-1}
10^{-2}
10^{-3}
10^{-4}
10^{-5}
7.3
8.3
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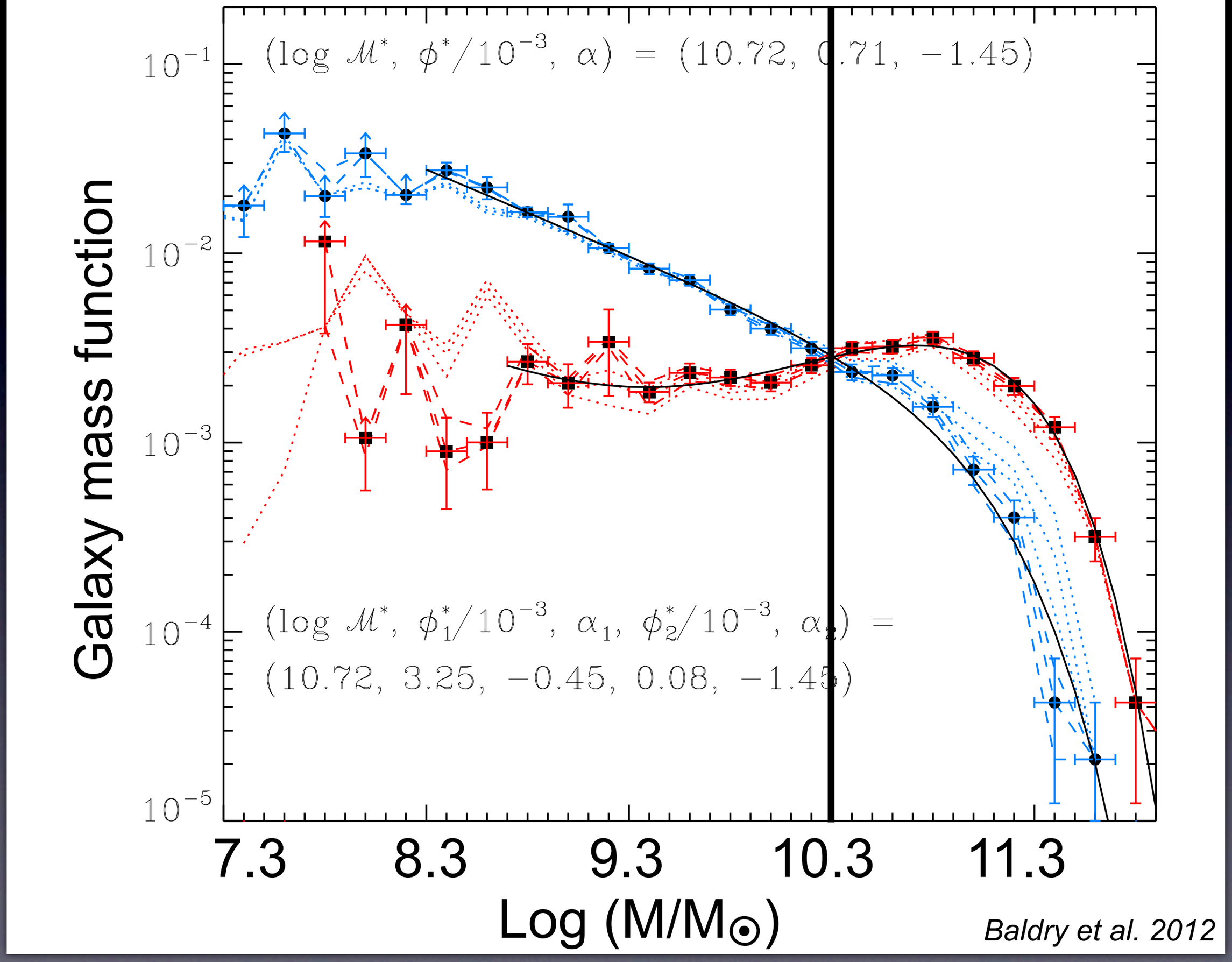
Log (M/M⊙)
Baldry et al. 2012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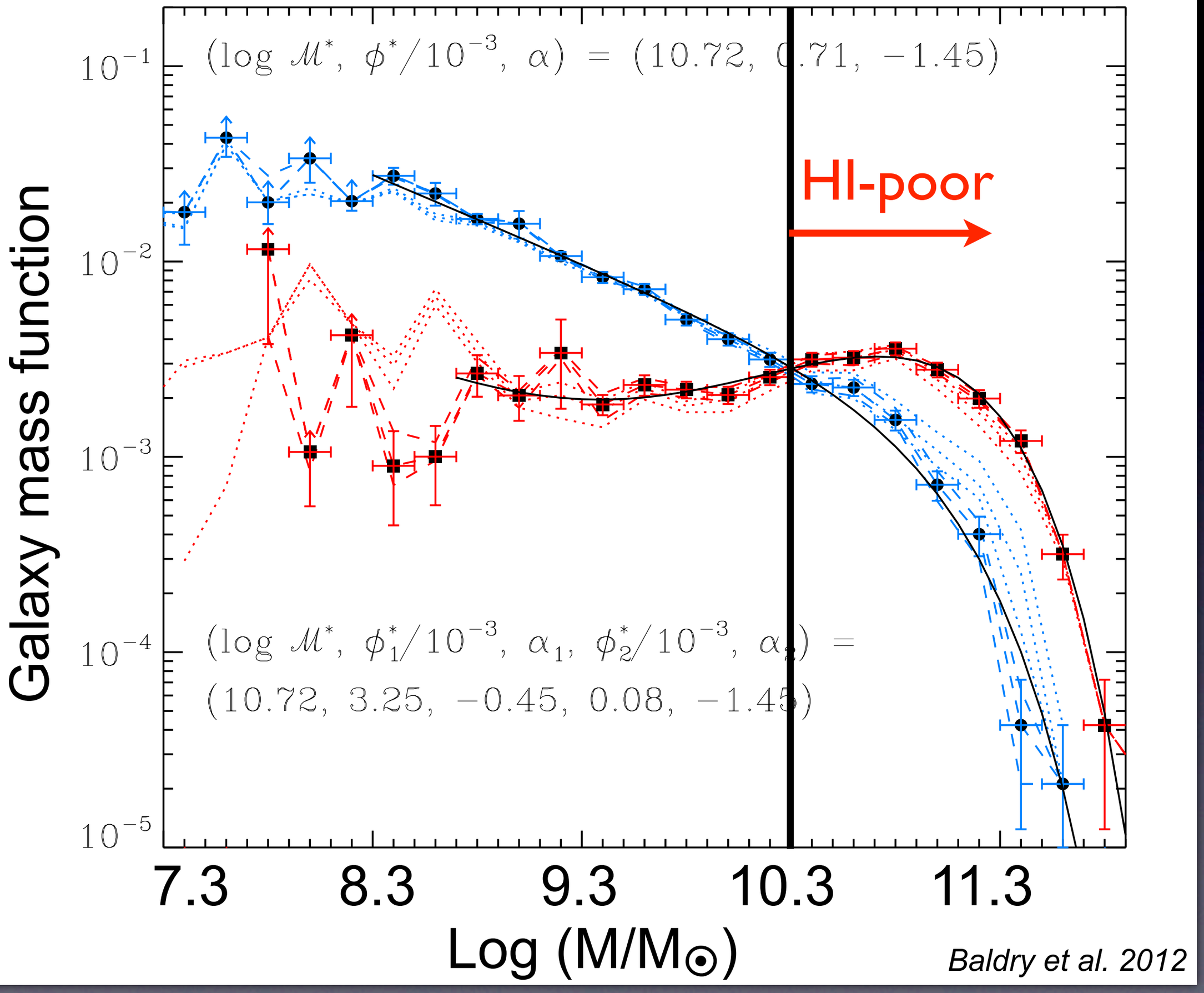

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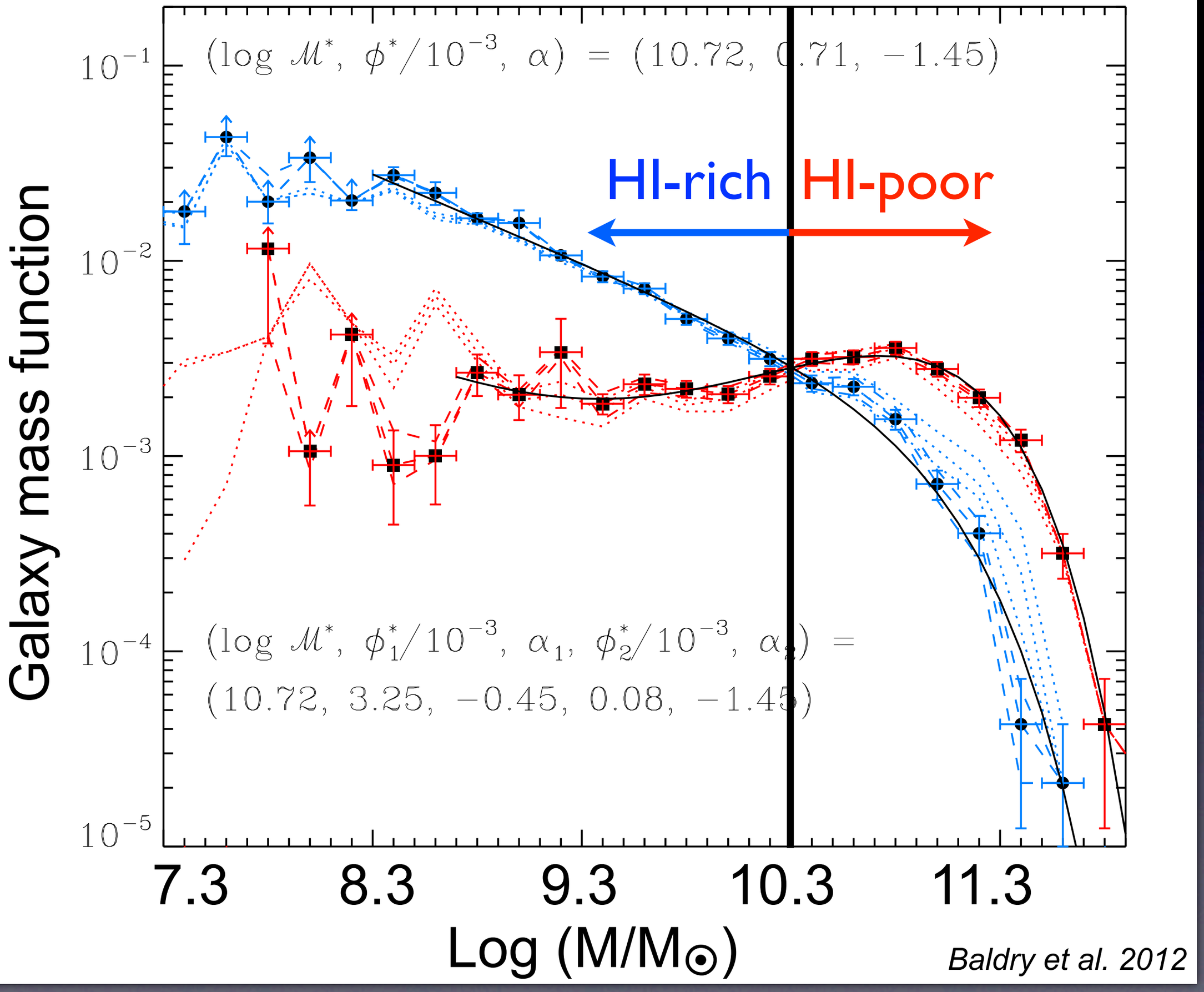

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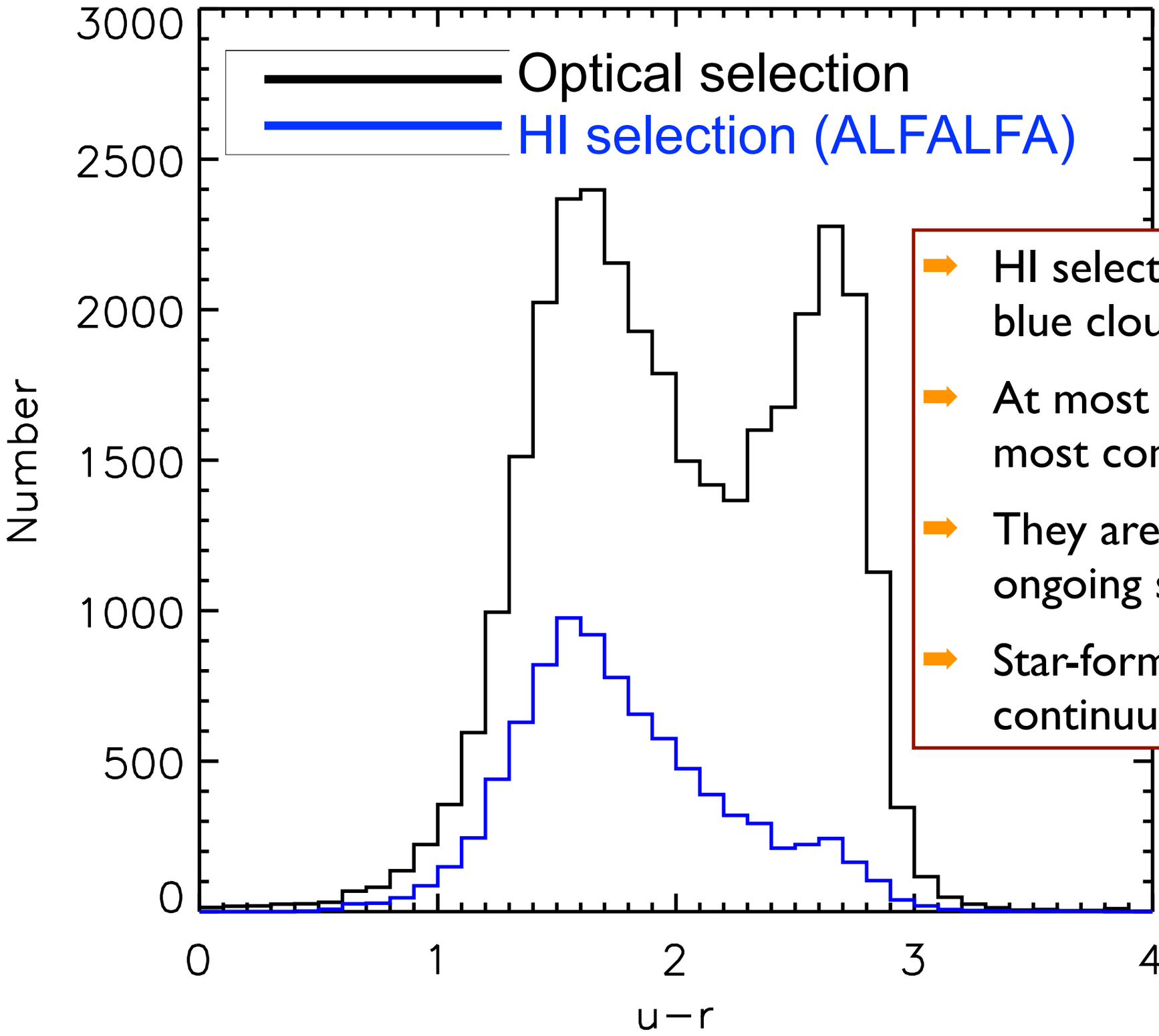


- HI selection preferentially selects blue cloud galaxies
- At most masses, these are the most common galaxies
- They are also the galaxies with ongoing star formation
- Star-forming galaxies dominate continuum surveys at faint fluxes

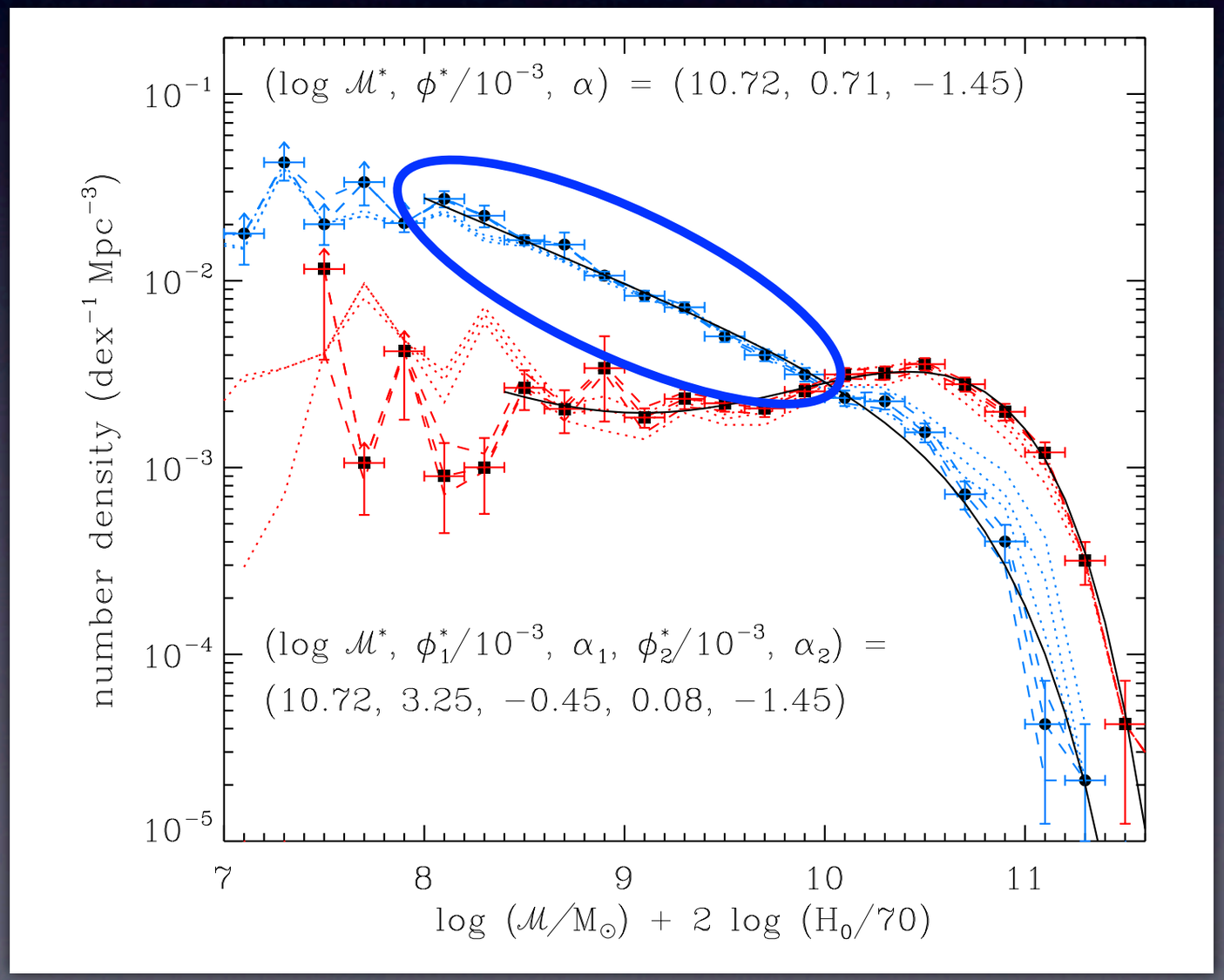
Observing HI and continuum at the same time:

- HI measures neutral gas reservoir, or fuel for *future star formation*
- Radio continuum measures *current star formation*

➡ With the same observations, we can measure both the potential for star formation (HI), and the ongoing star formation (continuum), in the same galaxies, over a range of redshift

Spectroscopy

- Redshifts are essential for many scientific goals, either photometric or spectroscopic
- From the shape of the galaxy mass function, most of the galaxies will have $M_{stellar} \sim 10^9\, M_\odot$, are blue and diffuse, very difficult to get an optical spectrum



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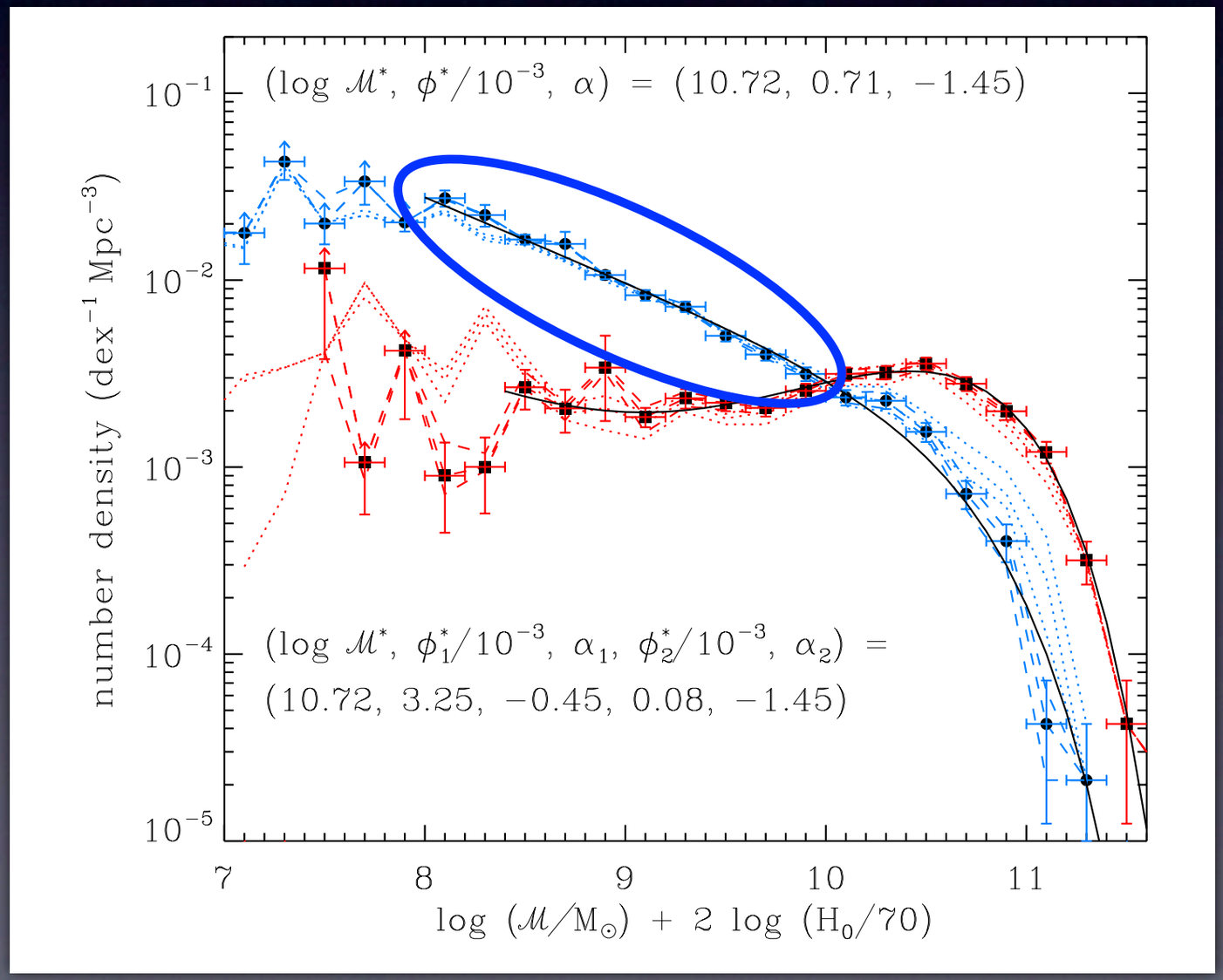


Who is going to do the work?

- MIGHTEE was set up as a *continuum* survey
- Splinter session Friday afternoon to discuss
- If you're interested, contact the PIs of MIGHTEE:
  - Kurt van der Heyden
  - Matt Jarvis
- Splinter session coordinators:
  - Sarah Blyth
  - Brad Frank
  - Natasha Maddox (me)

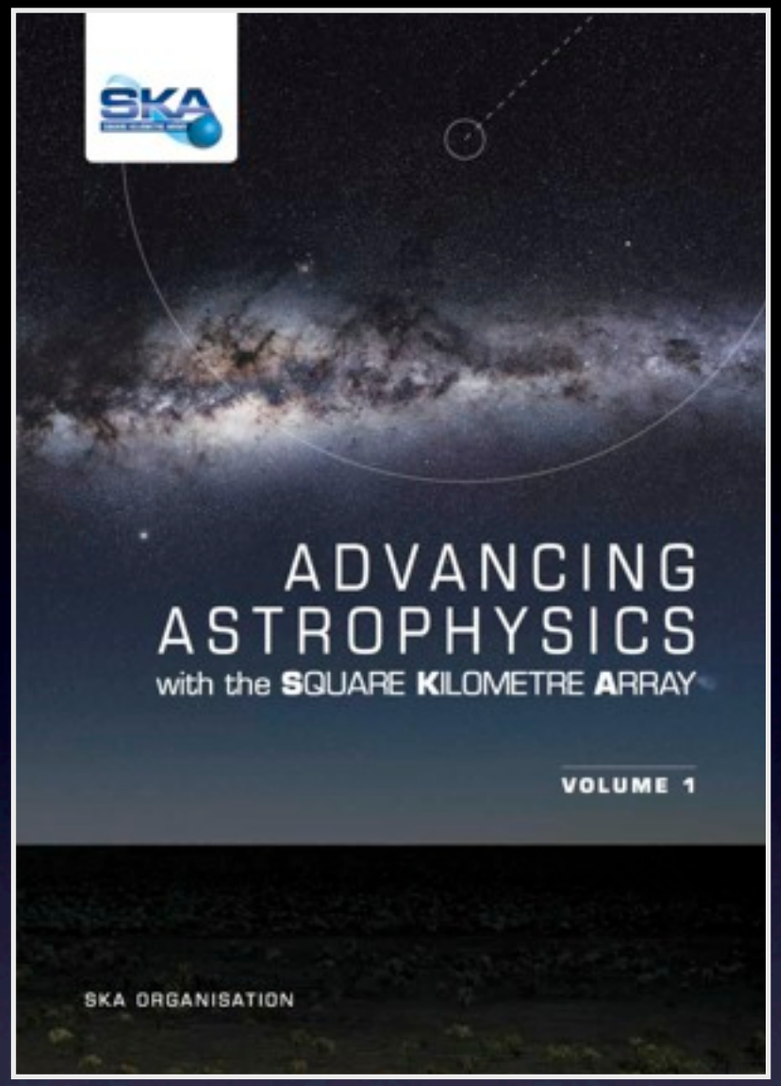
Summary:

- Commensal observing is efficient use of telescope time, and will become more common in SKA era

- MIGHTEE is an excellent *HI* survey

- Large area explores high HI masses and different environment

- Register interest or come to the splinter session



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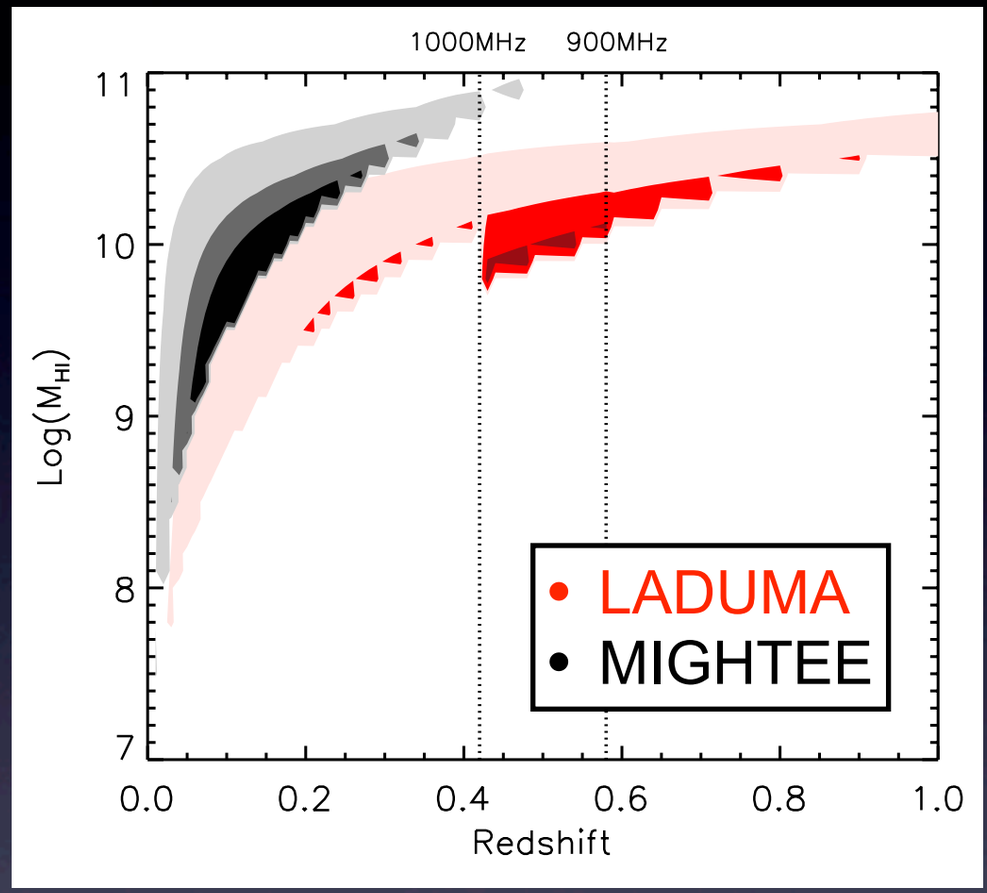

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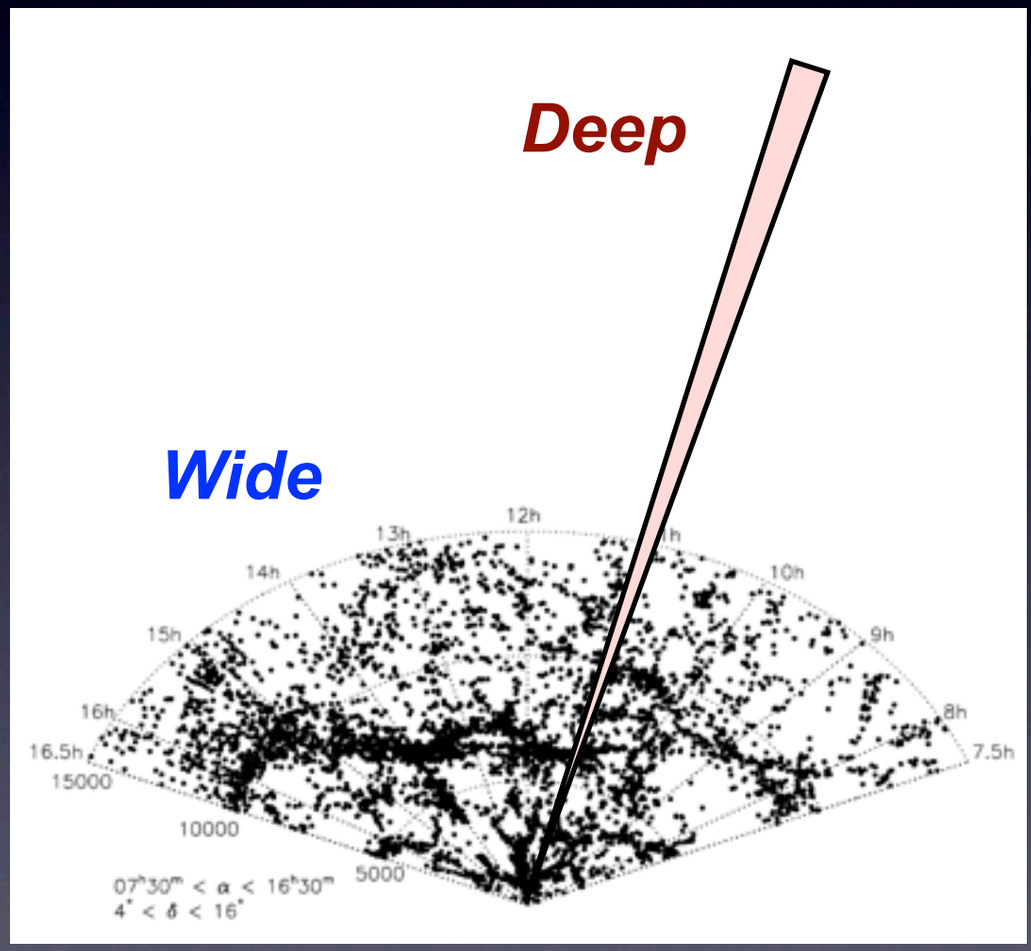

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