

## The Evolving HI Universe with DINGO

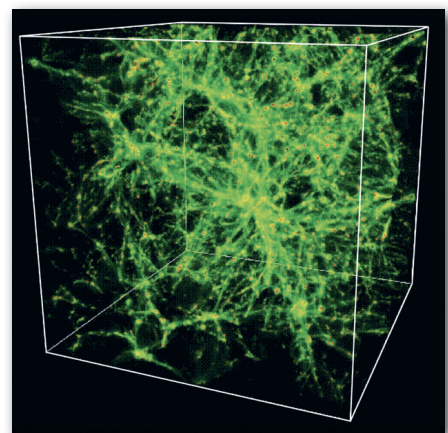


## The Evolving HI Universe



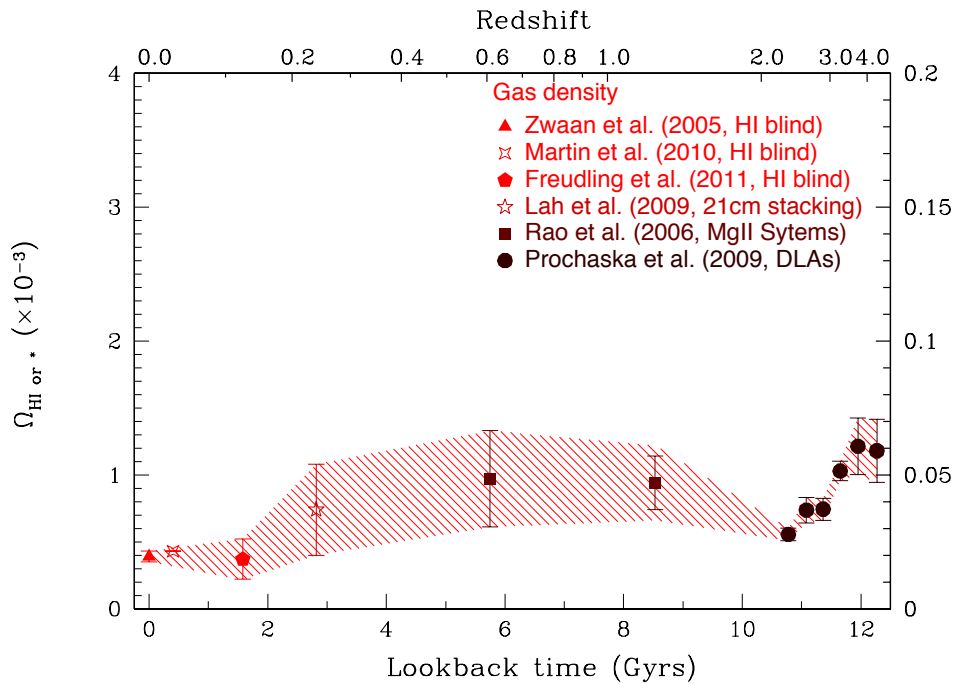
### From Dark Ages to present day:

- mass density evolution
- formation of cosmic web
- collapse into densest halos
- creation of galactic disks
- dense molecular clouds → star formation
- galactic evolution: accretion, feedback processes, role of environment.

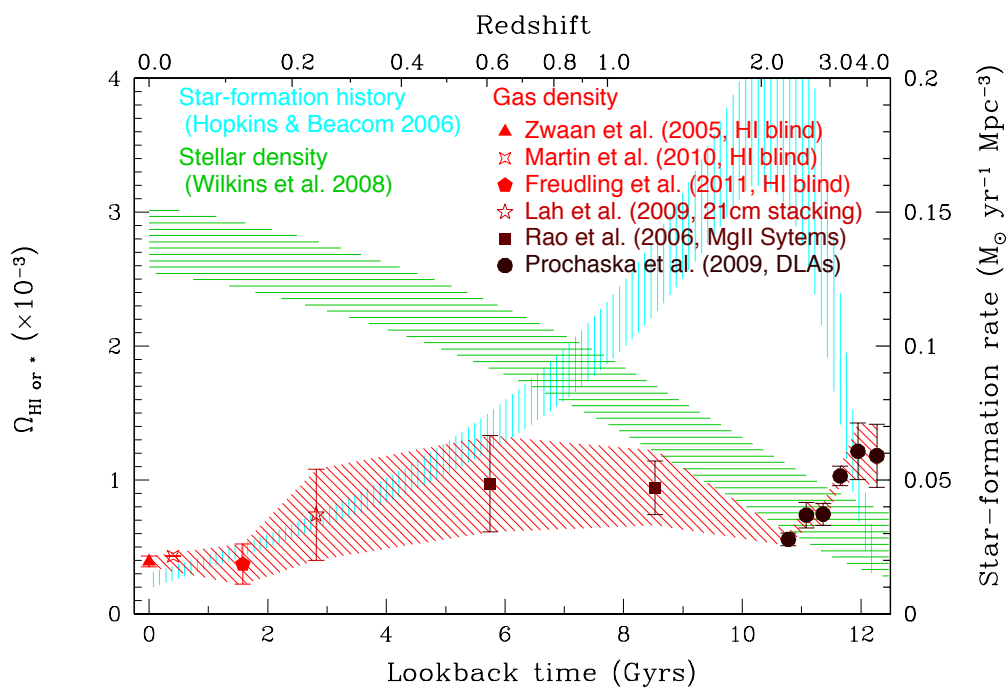


Cen & Ostriker, 2006

# Where Are We Now?



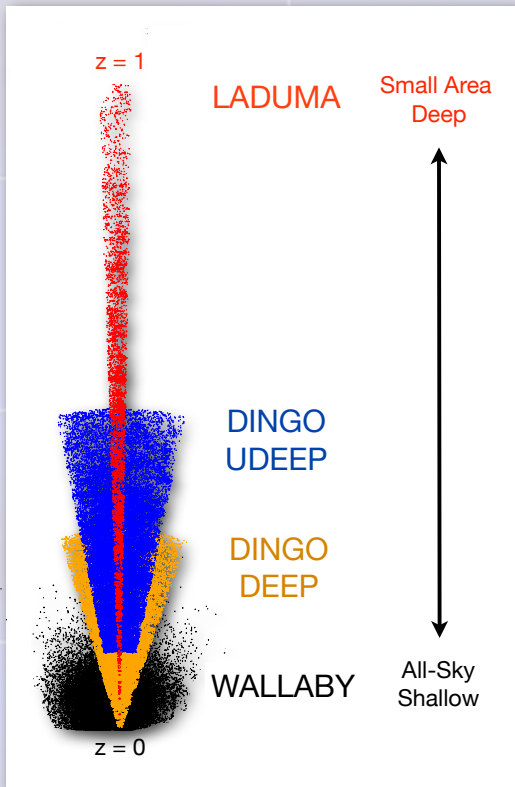
# Where Are We Now?





# DINGO & HI Pathfinder Surveys

ICRAR



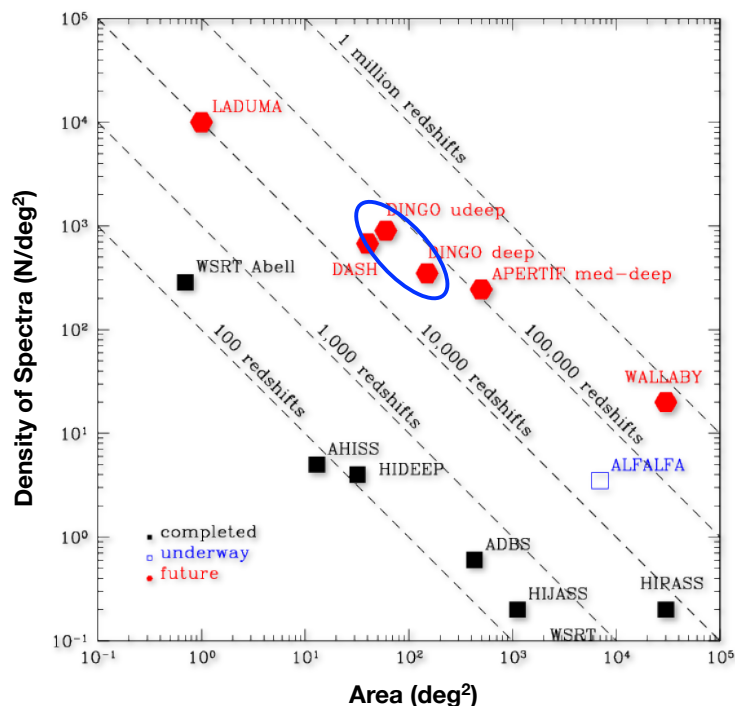
## Blind HI Surveys:

- LADUMA (MeerKAT):
  - 20k galaxies,  $1+ \text{ deg}^2$ ,  $z < 1.4$
- DINGO (ASKAP):
  - UDEEP: 50k gals,  $60 \text{ deg}^2$ ,  $0.1 < z < 0.43$   
2500 hours/pointing
  - DEEP: 50k gals,  $150 \text{ deg}^2$ ,  $z < 0.26$   
500 hours/pointing
- DASH (APERTIF):
  - 25k,  $40 \text{ deg}^2$ ,  $0.1 < z < 0.3$
- MED-DEEP (APERTIF):
  - 120k galaxies,  $500 \text{ deg}^2$ ,  $z < 0.26$
- WALLABY (ASKAP) + North (APERTIF):
  - 500k galaxies, all-sky,  $z < 0.26$



# Spectral Density

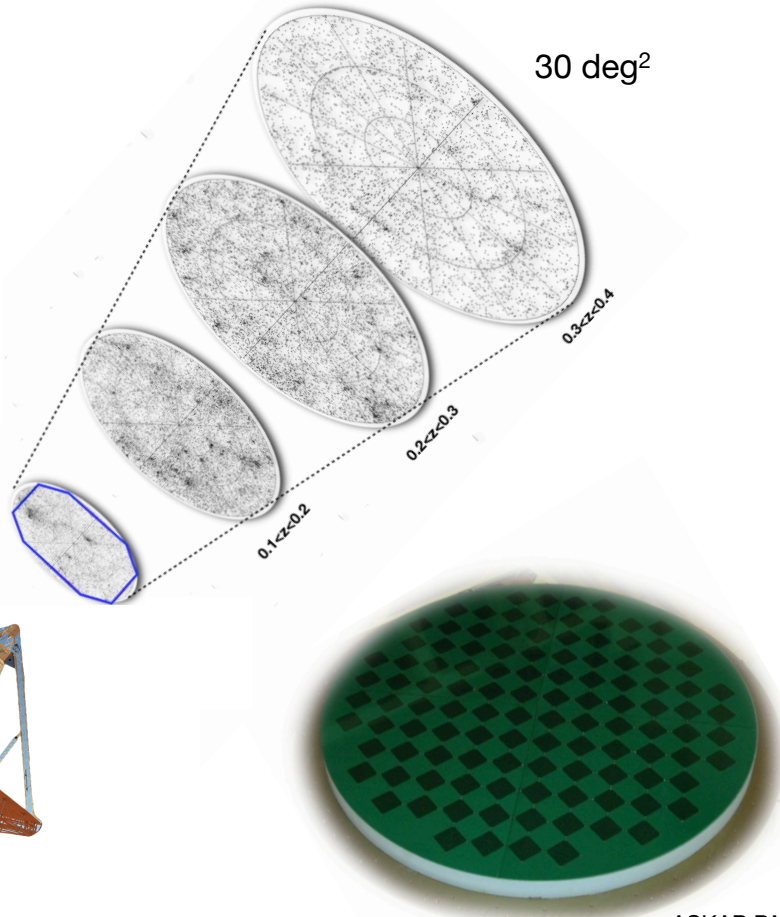
ICRAR



# DINGO:

Studying the Evolving HI Universe

over Cosmologically Representative Volumes

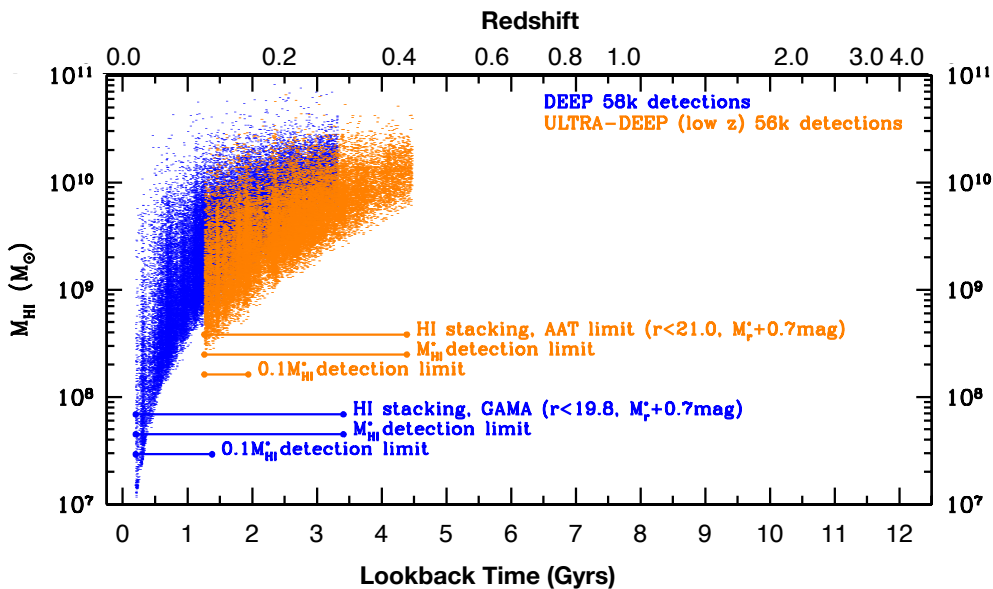


DINGO and ASKAP

# Mass Sensitivity

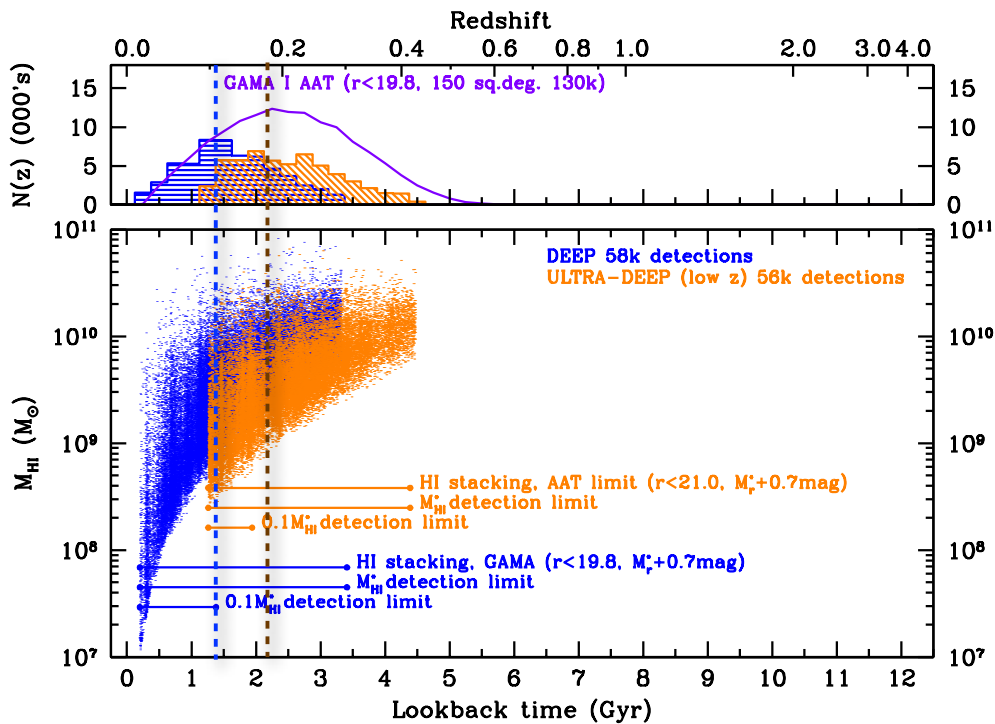


- **Deep:** 150 deg<sup>2</sup>, 0 < z < 0.26, 500 hours/pointing
- **Ultradeep:** 60 deg<sup>2</sup>, 0.1 < z < 0.43, 2500 hours/pointing





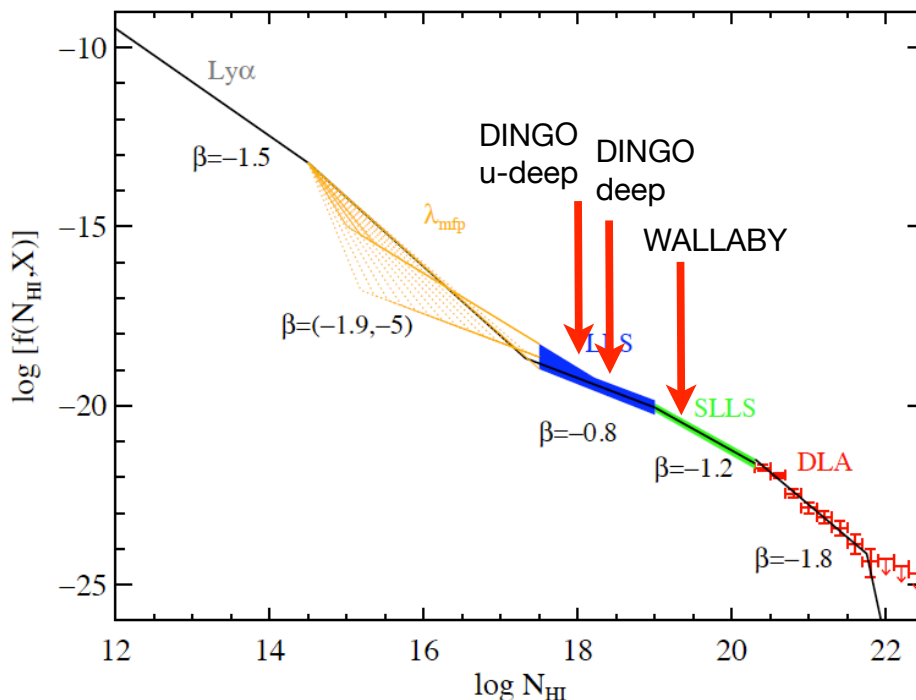
# DINGO Observations



# Column Density Sensitivity



HI Distribution Function:



Prochaska et al. 2010

WALLABY:  
 $N_{\text{HI}} \sim 2 \times 10^{19} \text{ cm}^{-2}$

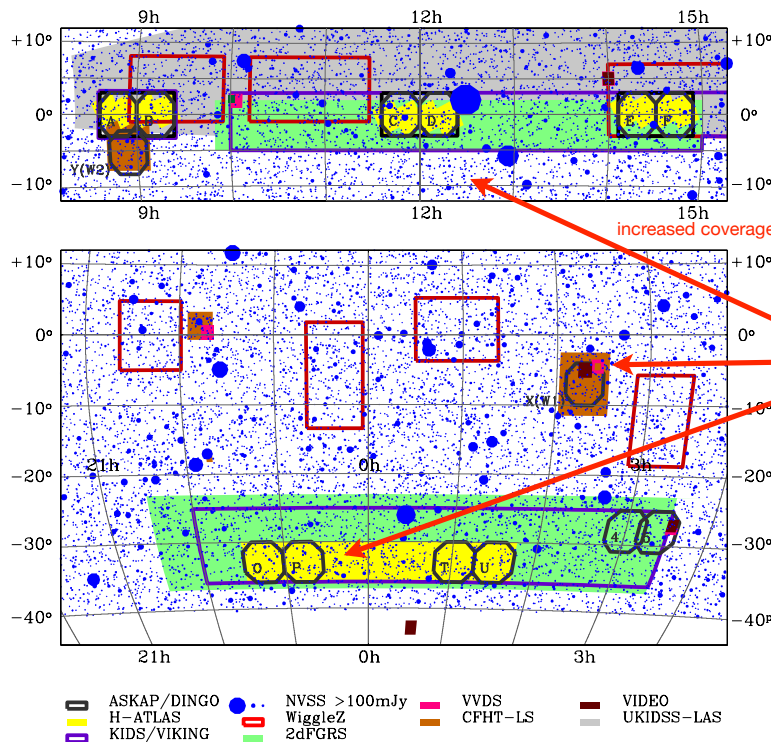
DINGO deep:  
 $N_{\text{HI}} \sim 2.6 \times 10^{18} \text{ cm}^{-2}$

DINGO u-deep:  
 $N_{\text{HI}} \sim 1.2 \times 10^{18} \text{ cm}^{-2}$

(30" beam, 20 km/s,  $1\sigma$ )



# DINGO Fields



← GAMA I complete

← increased coverage:  $5 \times 12 \text{ deg}^2$

GAMA II:  
24 nights 11A,  
on-going through 12B

- ASKAP/DINGO
- H-ATLAS
- KIDS/VIKING
- NVSS > 100mJy
- WiggleZ
- 2dFGRS
- VVDS
- CPHT-LS
- VIDEO
- UKIDSS-LAS

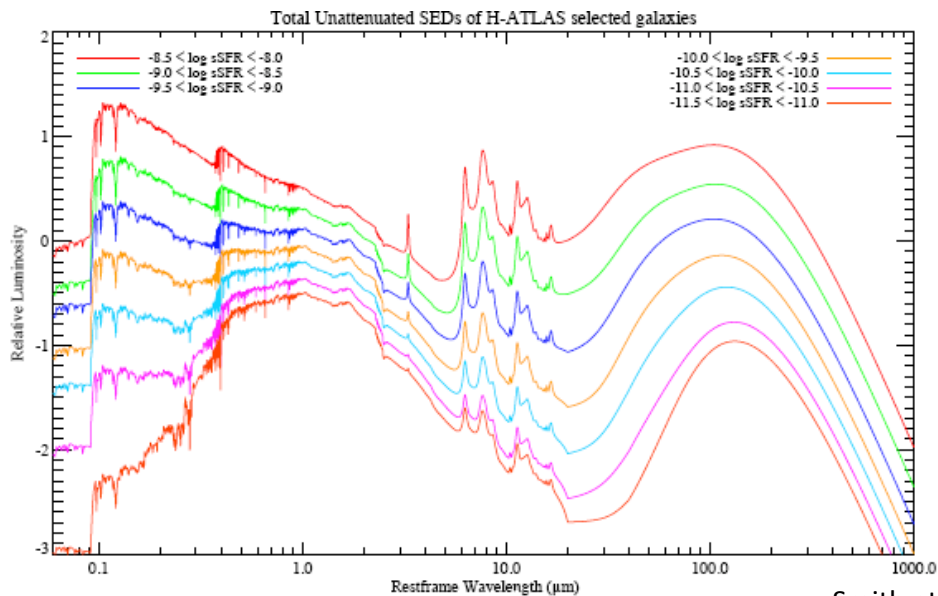


# Multiwavelength Advantage



FUV-far-IR samples the main energy output of galaxies from stars & dust

GALEX SFR	VST S.Pop	VISTA S.Mass	WISE pAH	HERSCHEL Dust
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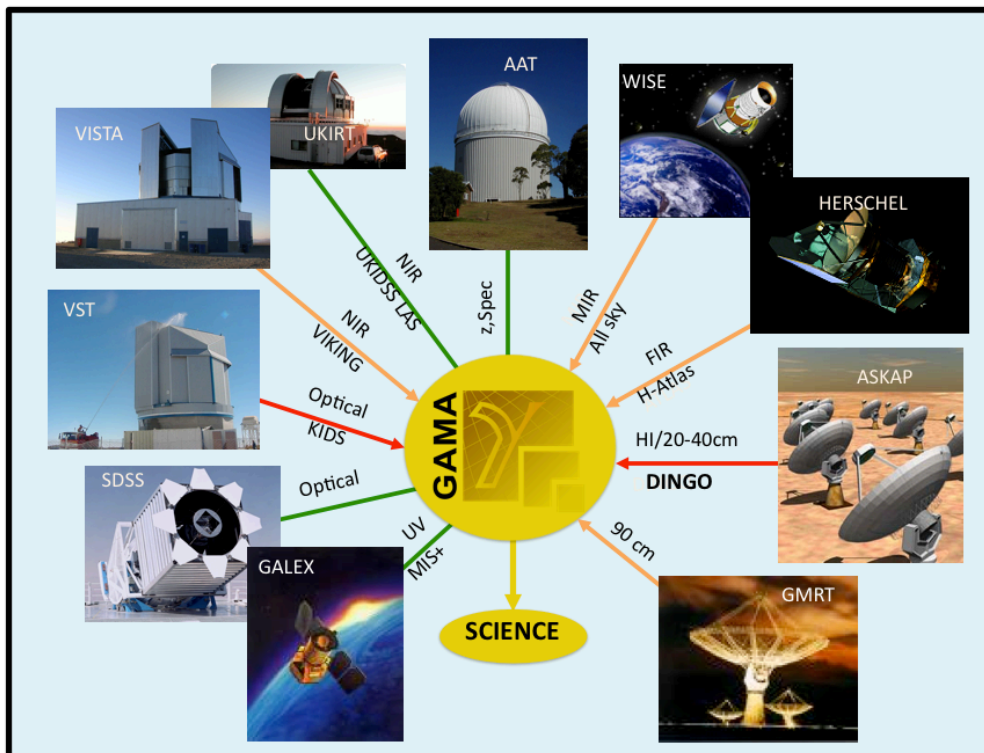


Smith et al





# Multiwavelength Advantage

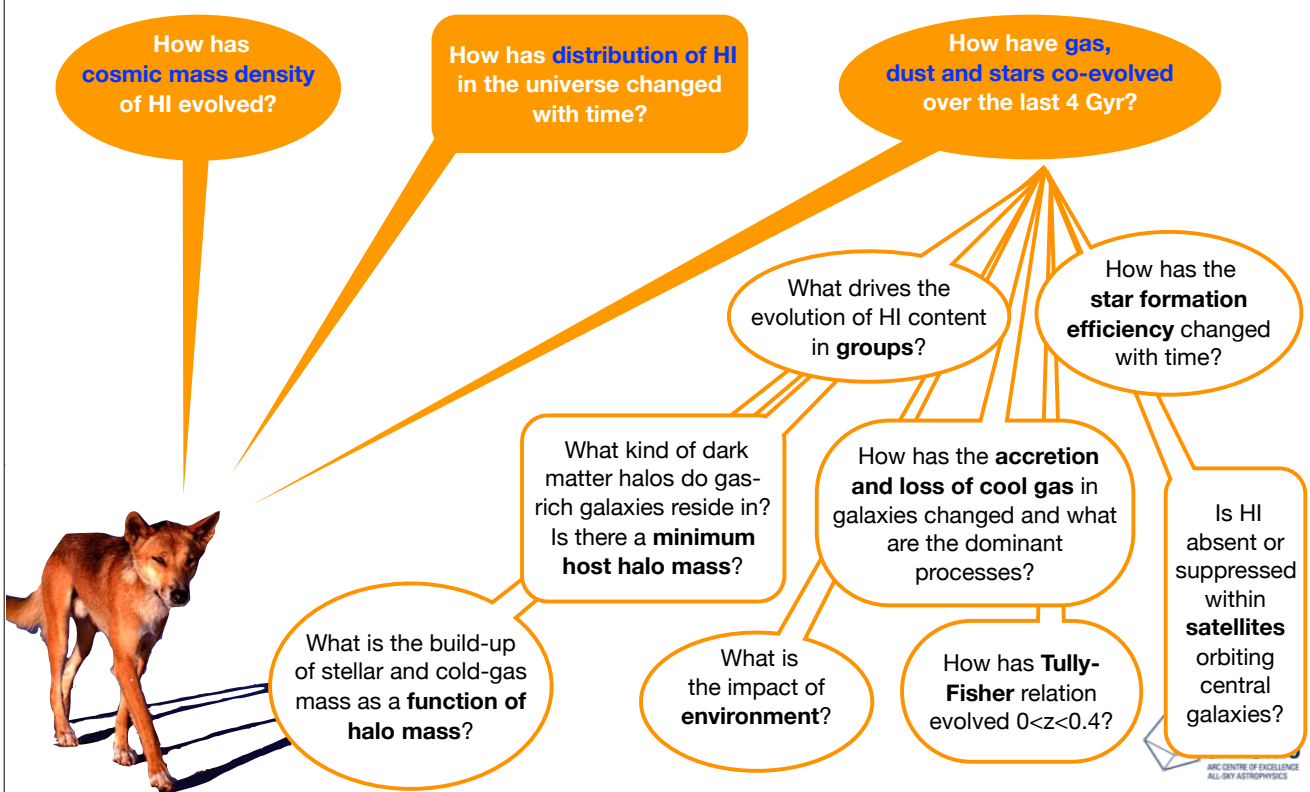
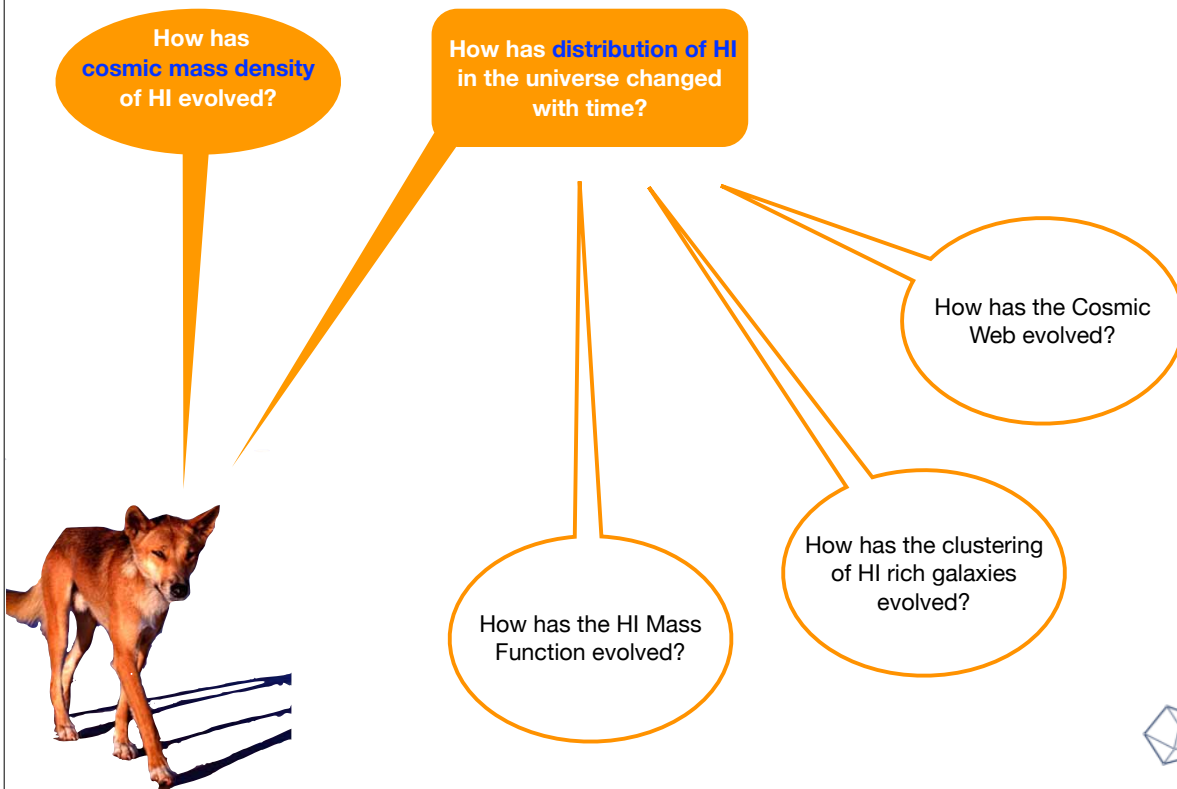


# DINGO Science



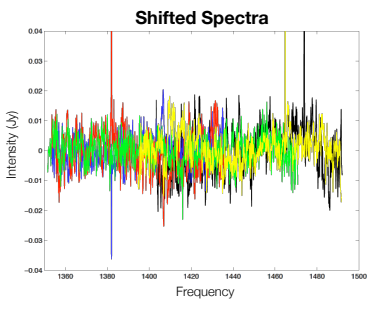
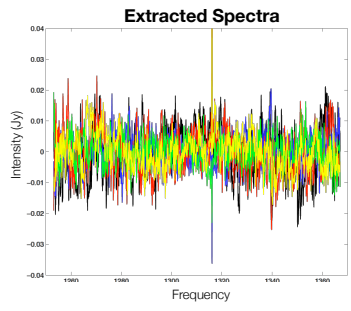
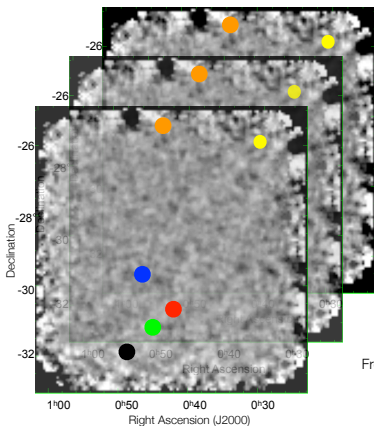
How has  
cosmic mass density  
of HI evolved?





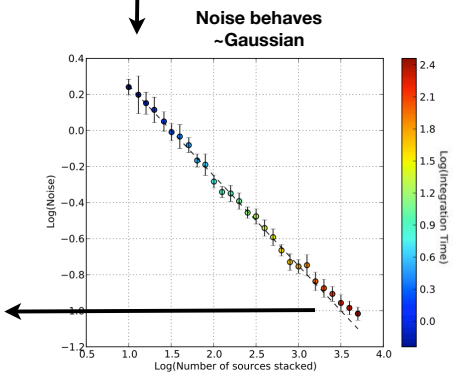
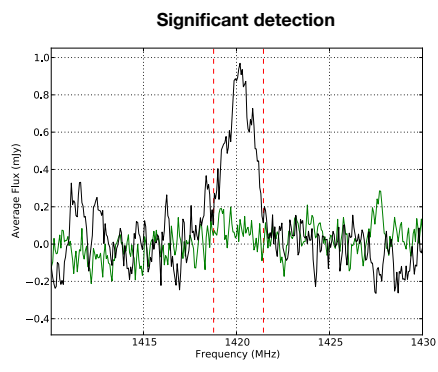


# HI Stacking

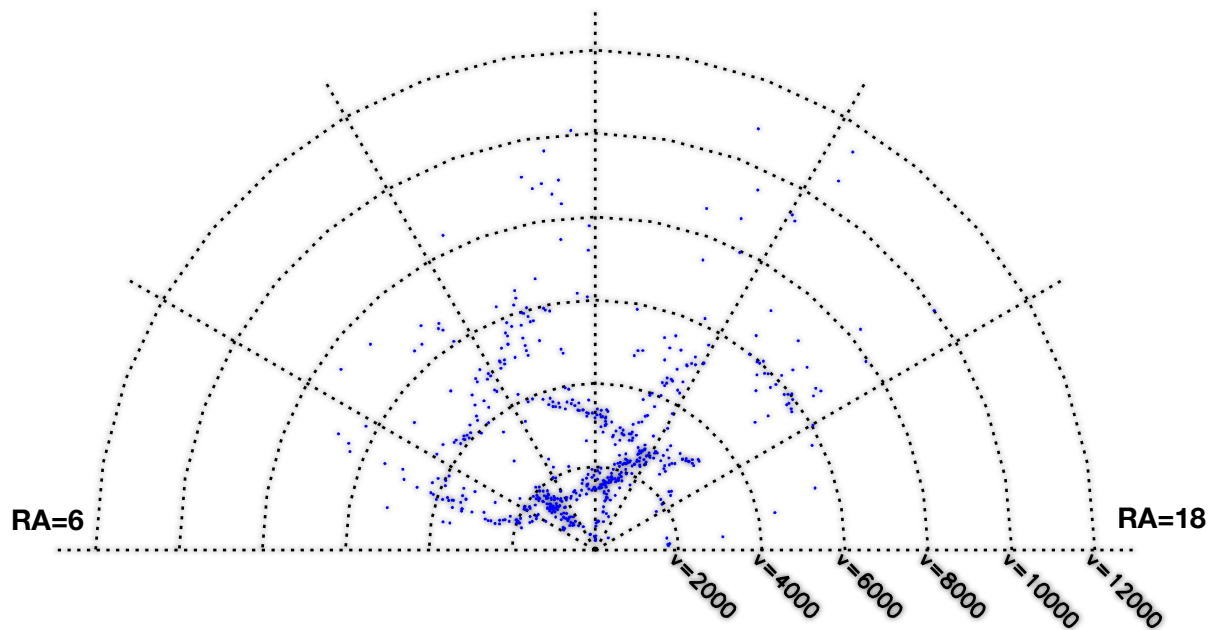


Jacinta Delhaize

Measure statistical properties of galaxies



# HI Stacking: HIPASS



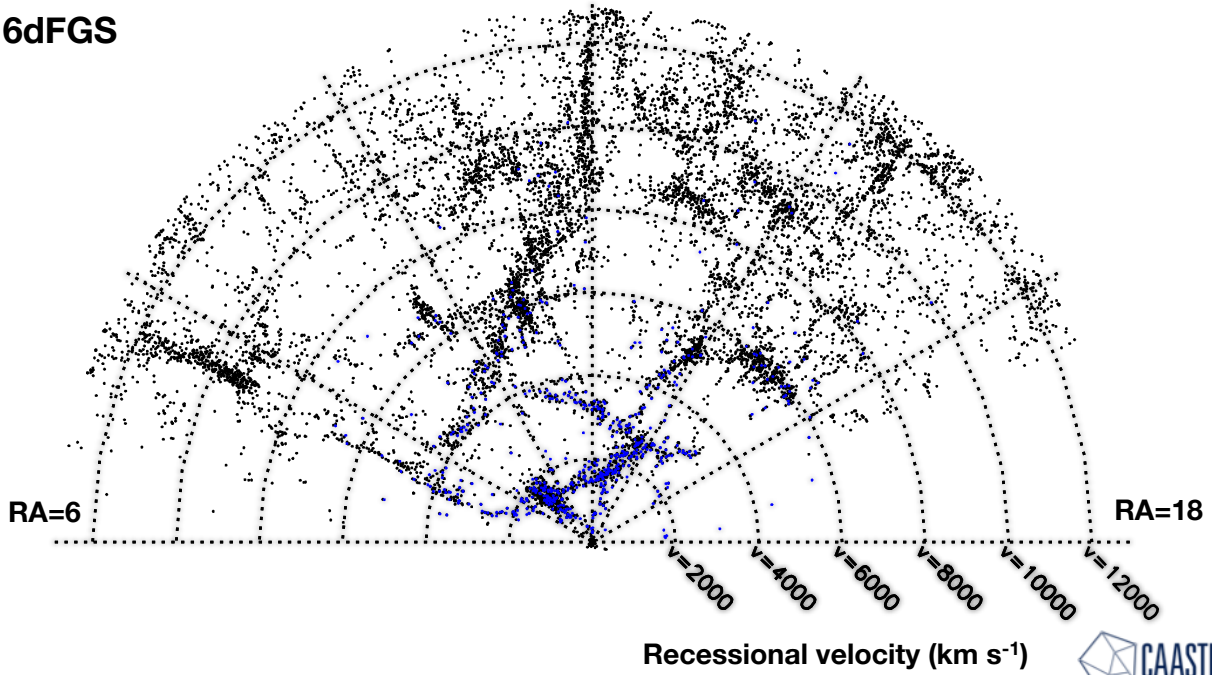
Recessional velocity ( $\text{km s}^{-1}$ )



# HI Stacking: HIPASS & 6dFGS

ICRAR

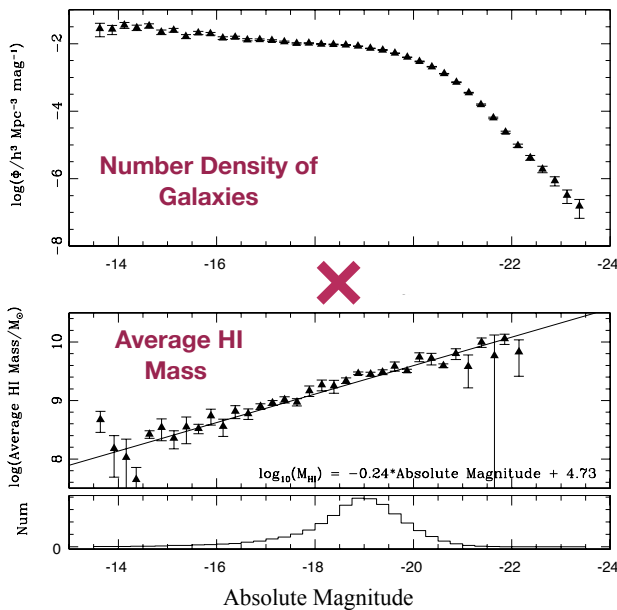
HICAT  
6dFGS



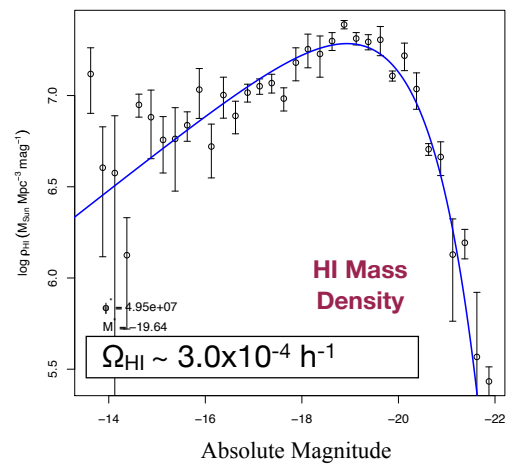
CAASTRO  
ARC CENTRE OF EXCELLENCE  
ALL SKY ASTRONOMY

# $\Omega_{\text{HI}}$ - HIPASS/6dF

ICRAR



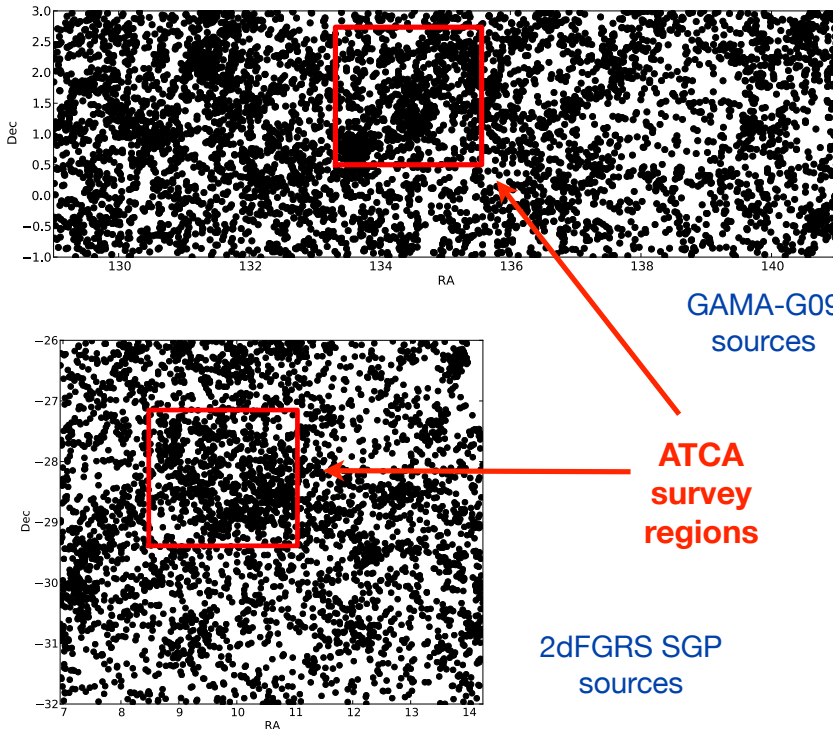
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CAASTRO  
ARC CENTRE OF EXCELLENCE  
ALL SKY ASTRONOMY



# HI Stacking with GAMA & 2dFGRS



Jacinta Delhaize using Parkes data:

$$\rho_{\text{HI}} = \frac{\langle M_{\text{HI}} \rangle}{\langle L \rangle} \times \rho_{\text{L}}$$

GAMA-G09 (u):

$$\Omega_{\text{HI}} = (3.9 \pm 0.4) \times 10^{-4} h^{-1}$$

GAMA-G09 (r):

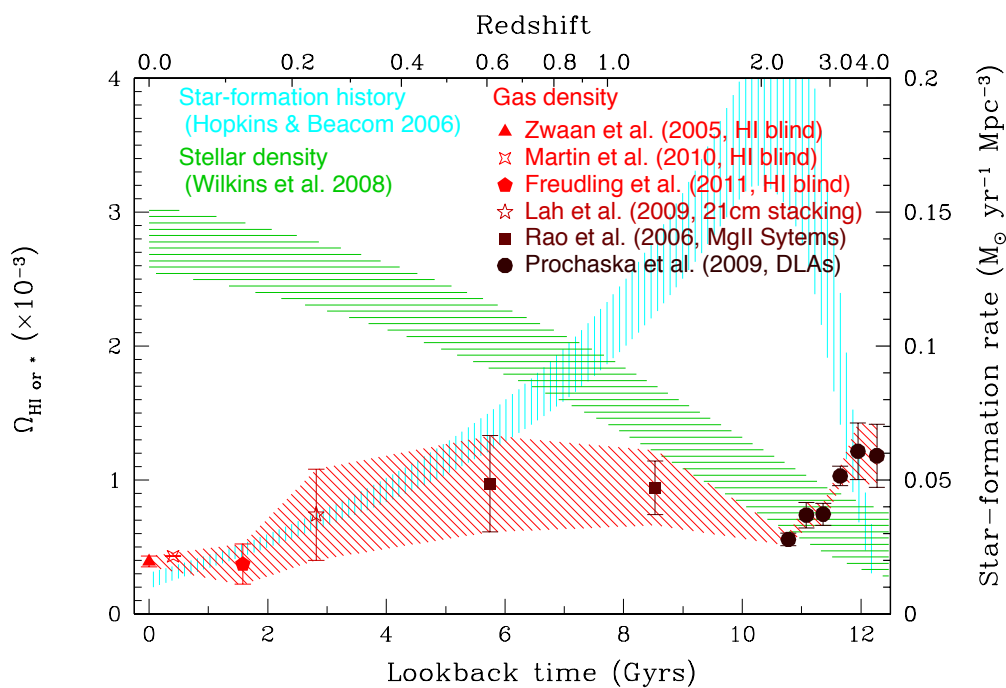
$$\Omega_{\text{HI}} = (4.8 \pm 0.5) \times 10^{-4} h^{-1}$$

2dFGRS SGP:

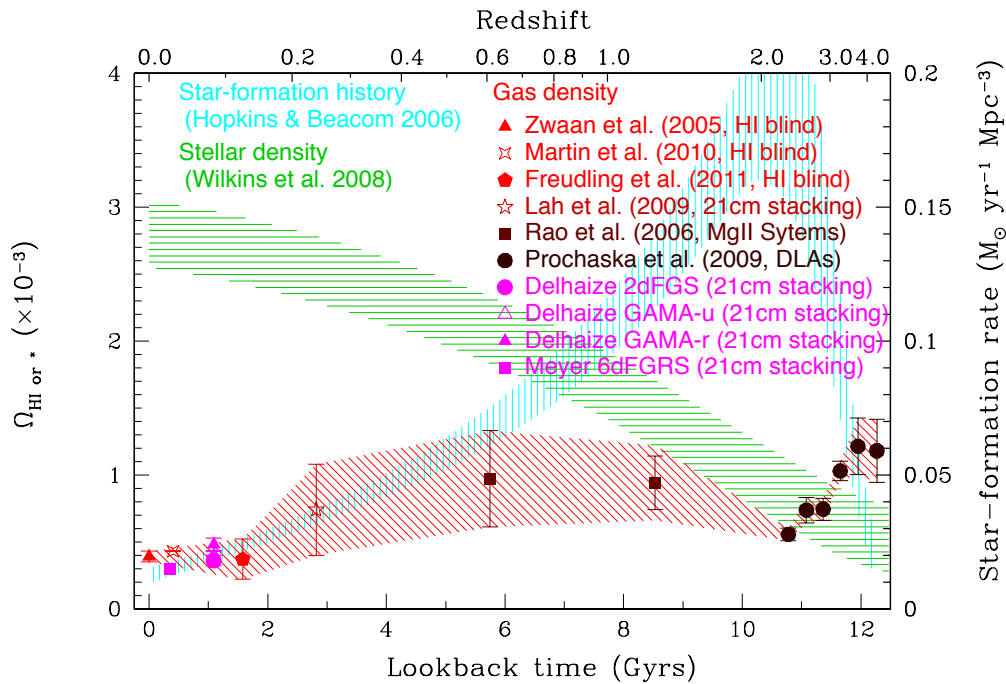
$$\Omega_{\text{HI}} = (3.6 \pm 0.4) \times 10^{-4} h^{-1}$$



# Where Are We Now?



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