Evolution of the HI properties of galaxies out to z=3

A novel modeling approach

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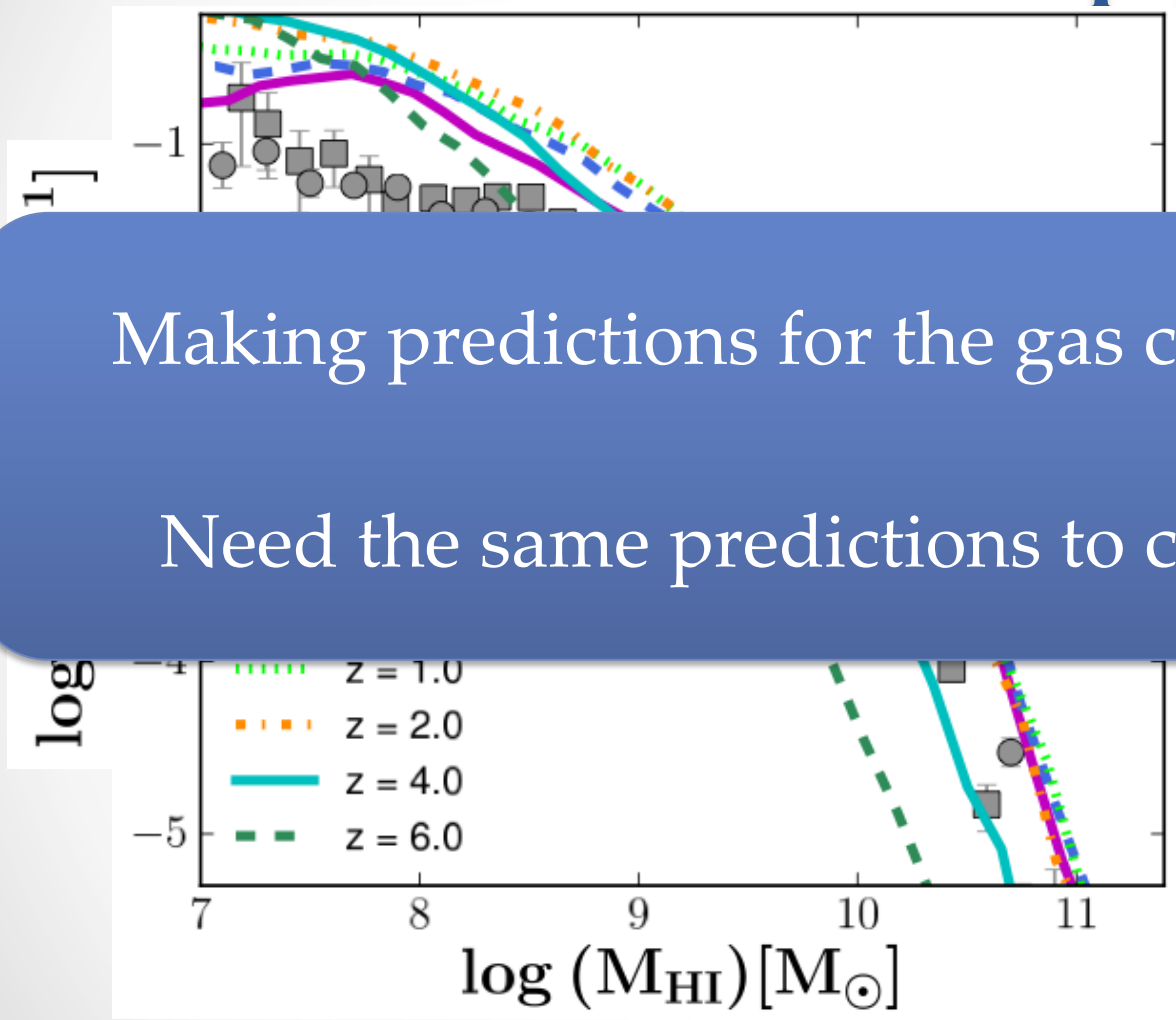
Gas is key!

- Knowledge about the gas content of galaxies and its partitioning into HI and H_2 helps to understand:
  - How much gas is there to drive star formation?
  - What fraction of the cold gas in a galaxy is available for star formation?
  - Which galaxies are most efficient in attaining their cold gas?
  - How do feedback processes affect this?
  - When do they kick in?

Theoretical approach

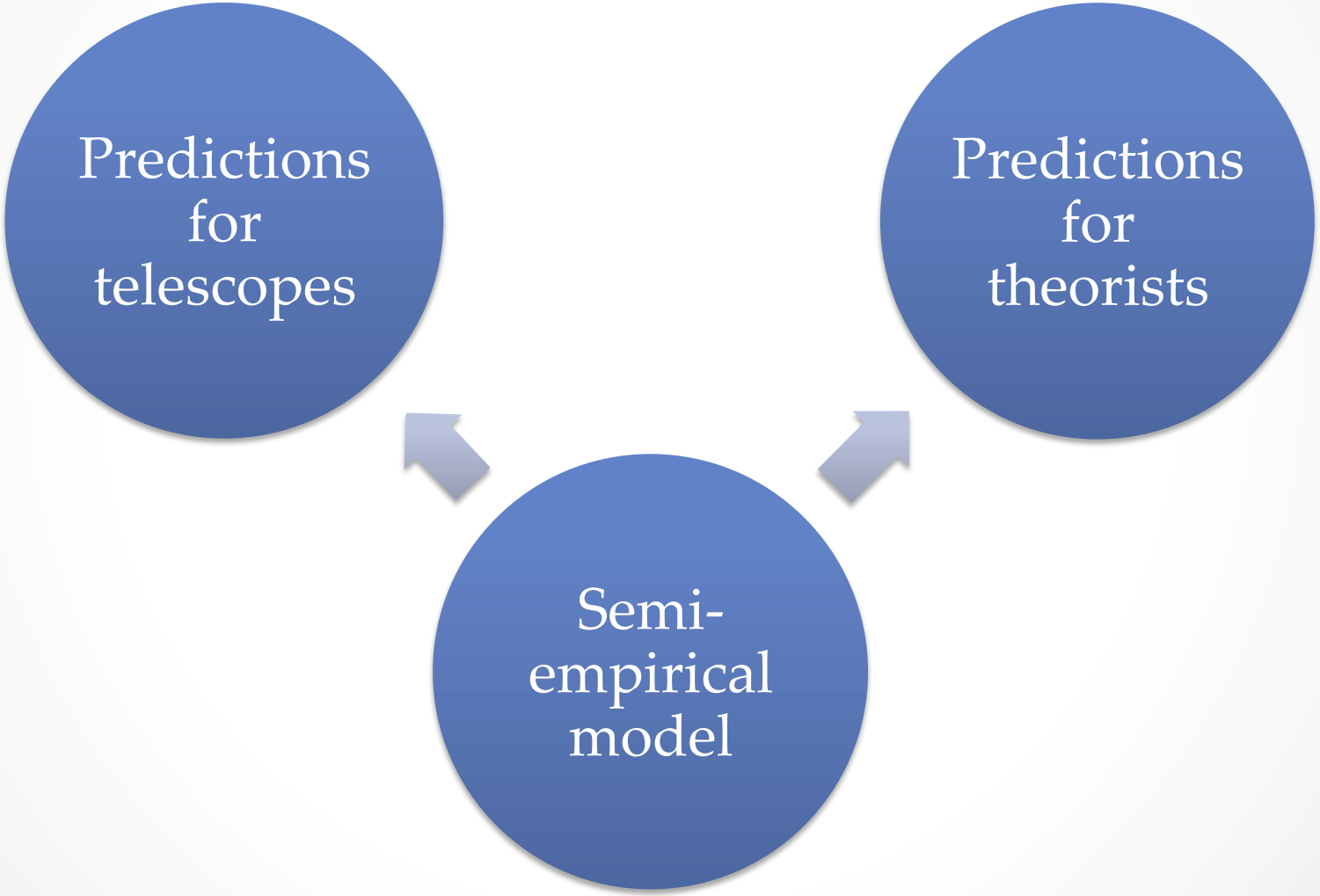


Making predictions for the gas content of galaxies

Need the same predictions to constrain models

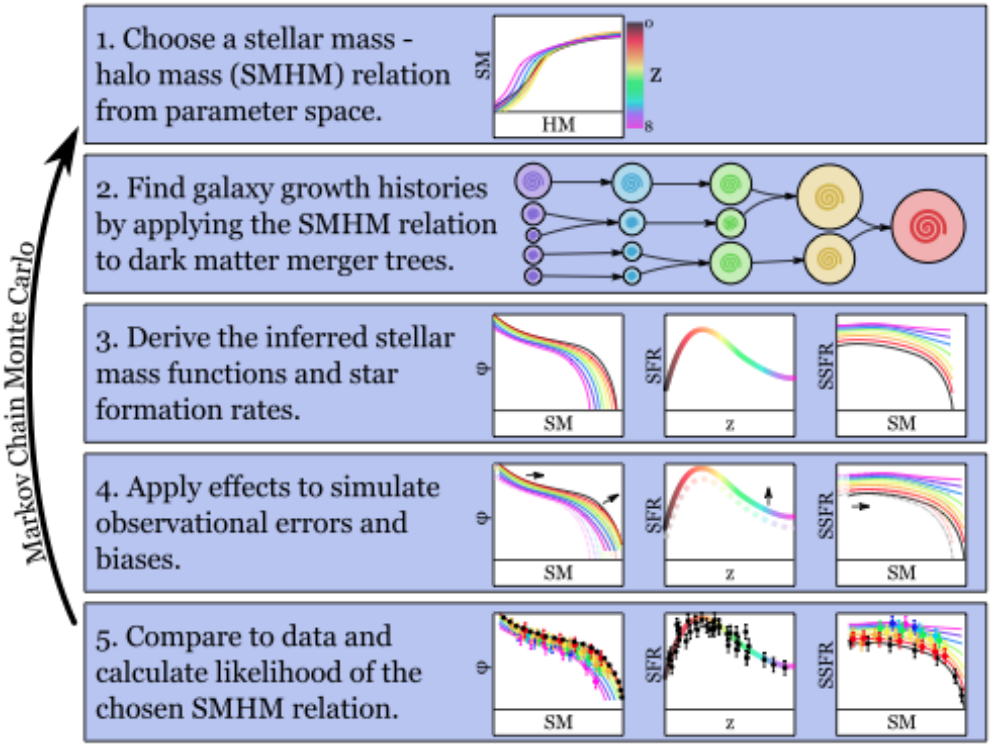
Popping, Somerville, Trager 2013

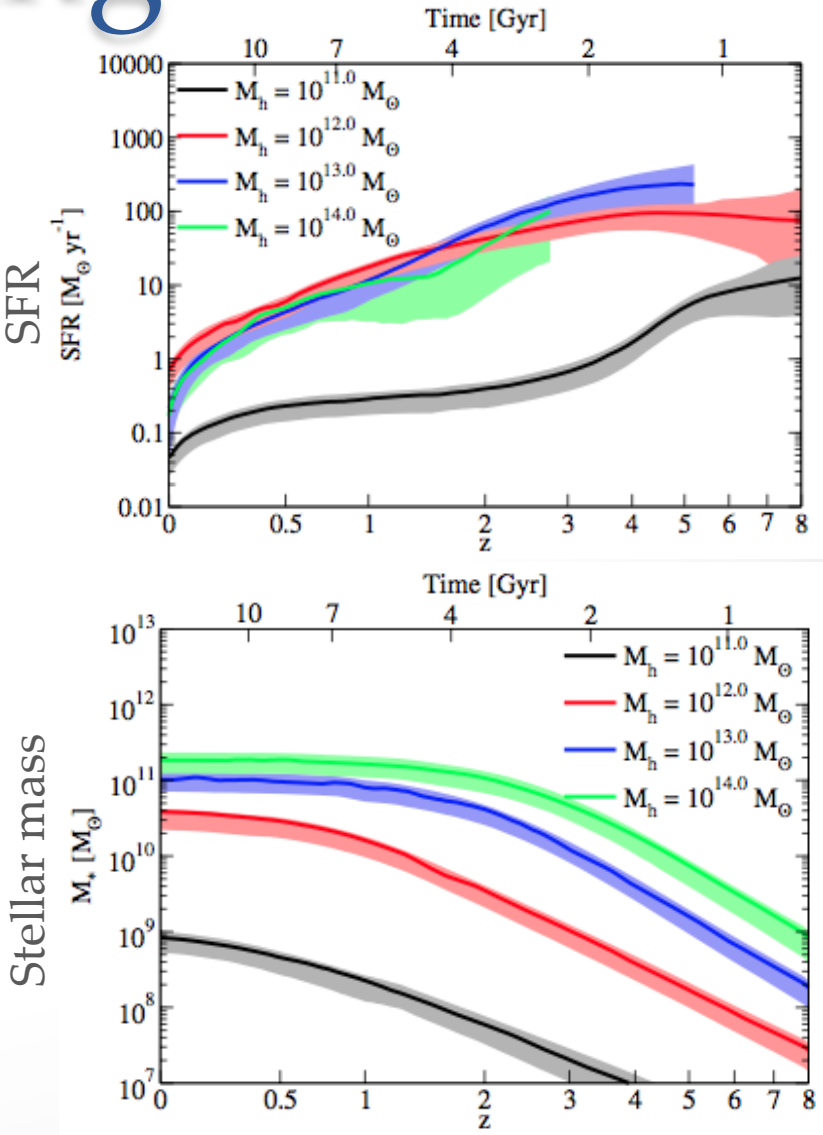
A novel approach



Sub-halo abundance matching

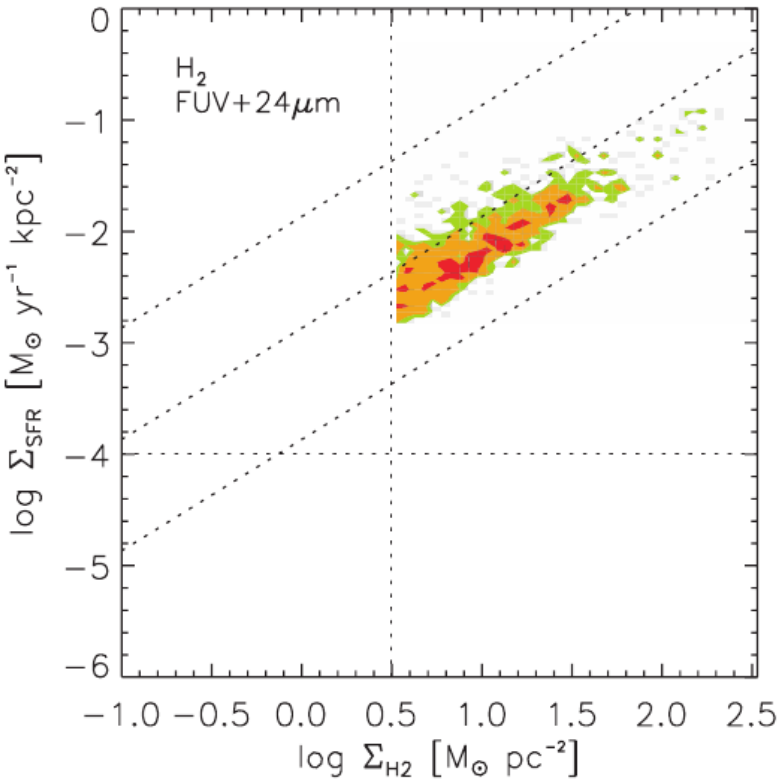
Match most massive galaxy to most massive halo





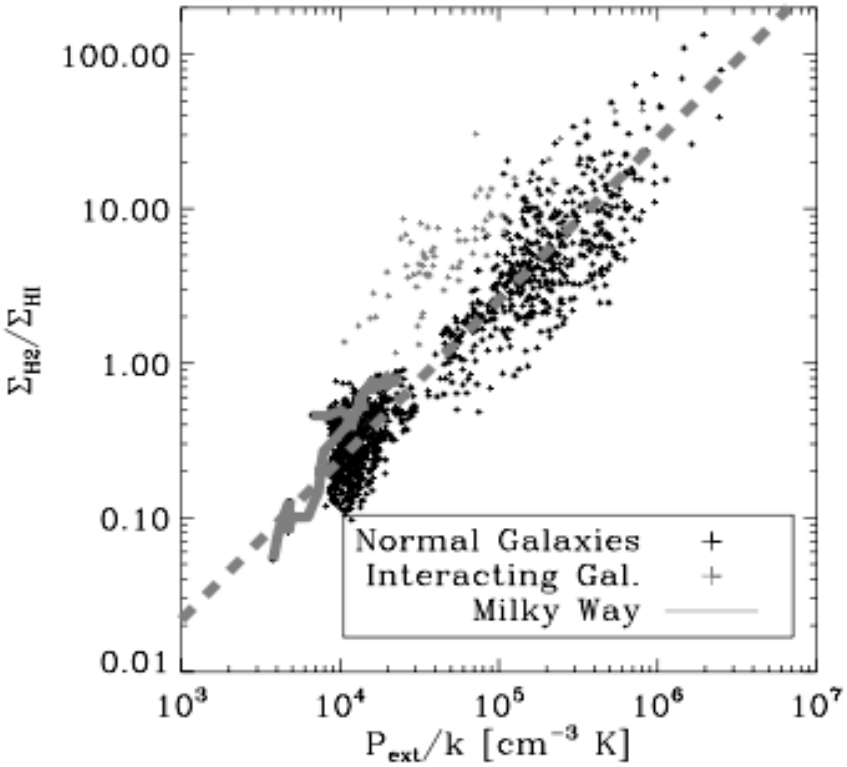
Behroozi+ 2013

Indirect gas estimates



$$\Sigma_{\rm SFR} = \frac{A_{\rm SF}}{10}\left(1+\frac{\Sigma_{\rm gas}}{\Sigma_{\rm crit}}\right)^{N_{\rm SF}} f_{H2}\,\Sigma_{\rm gas}$$

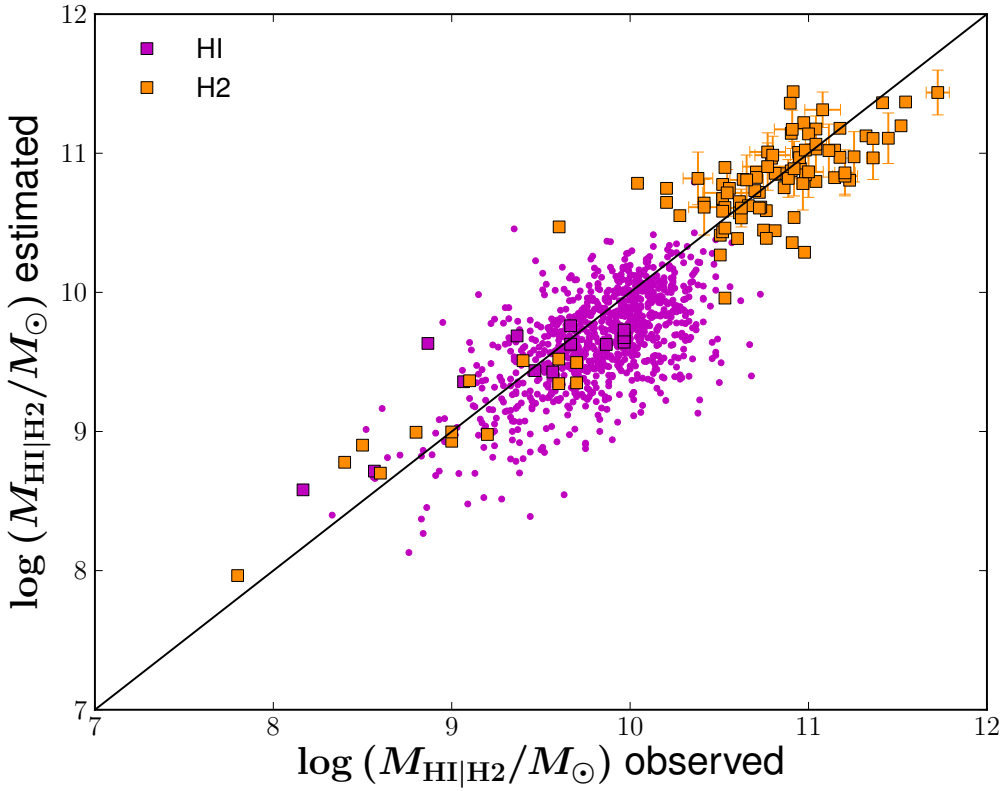
Bigiel+ 2008



$$P_m \sim \frac{\pi}{2} G\,\Sigma_{\rm gas}\left(\Sigma_{\rm gas} + \Sigma_* \frac{\sigma_{\rm gas}}{\sigma_*}\right)$$

Blitz & Rosolowsky 2006

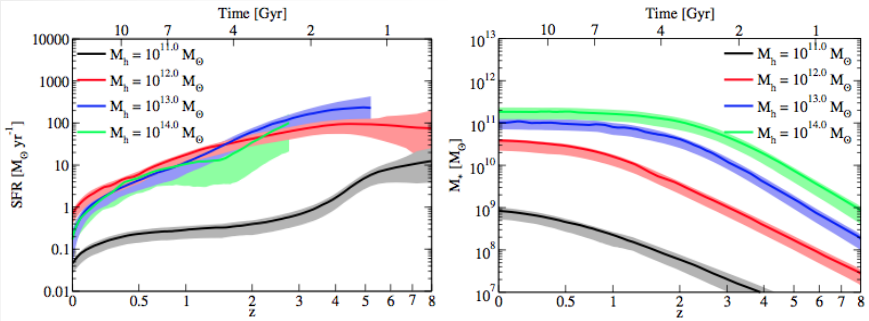
Indirect gas estimates

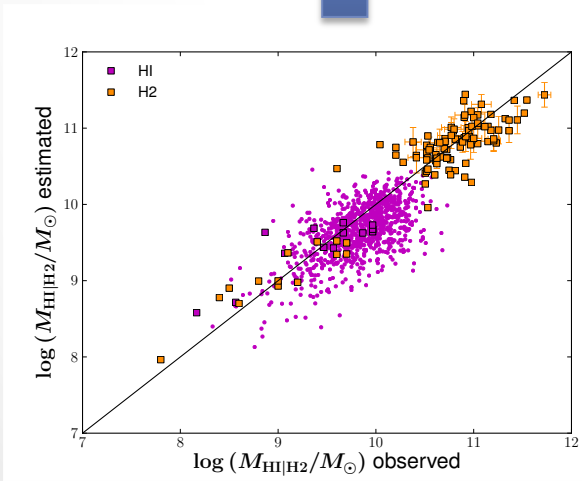


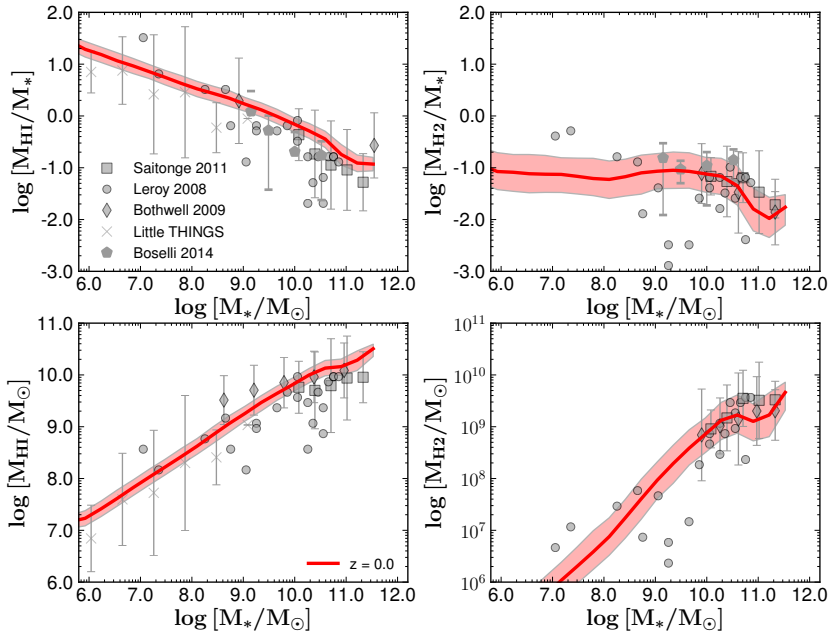
$$M_{gas}, f_{H2} = f(M_*, SFR, R_*)$$

Popping+ 2012
Popping+ 2014 in prep

A novel approach



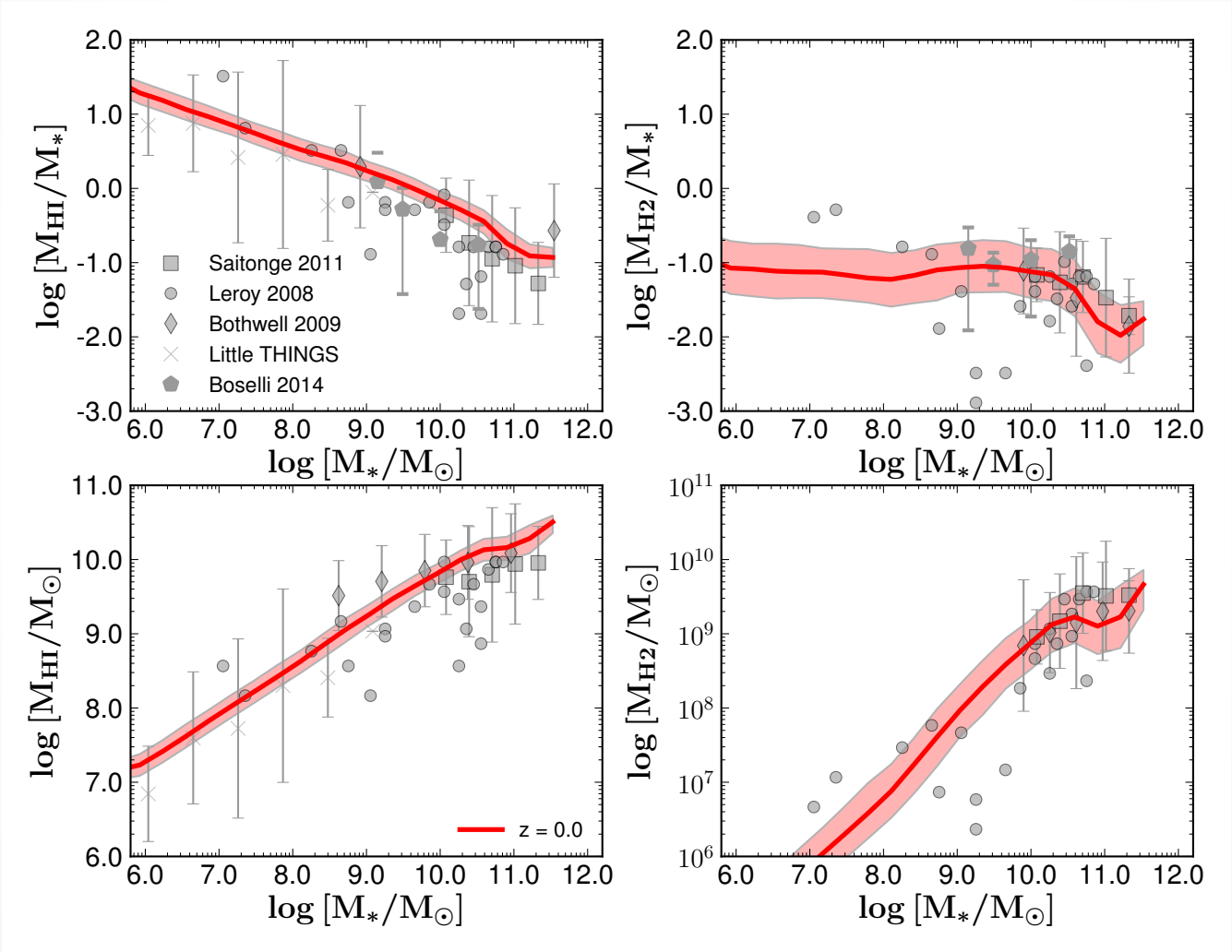




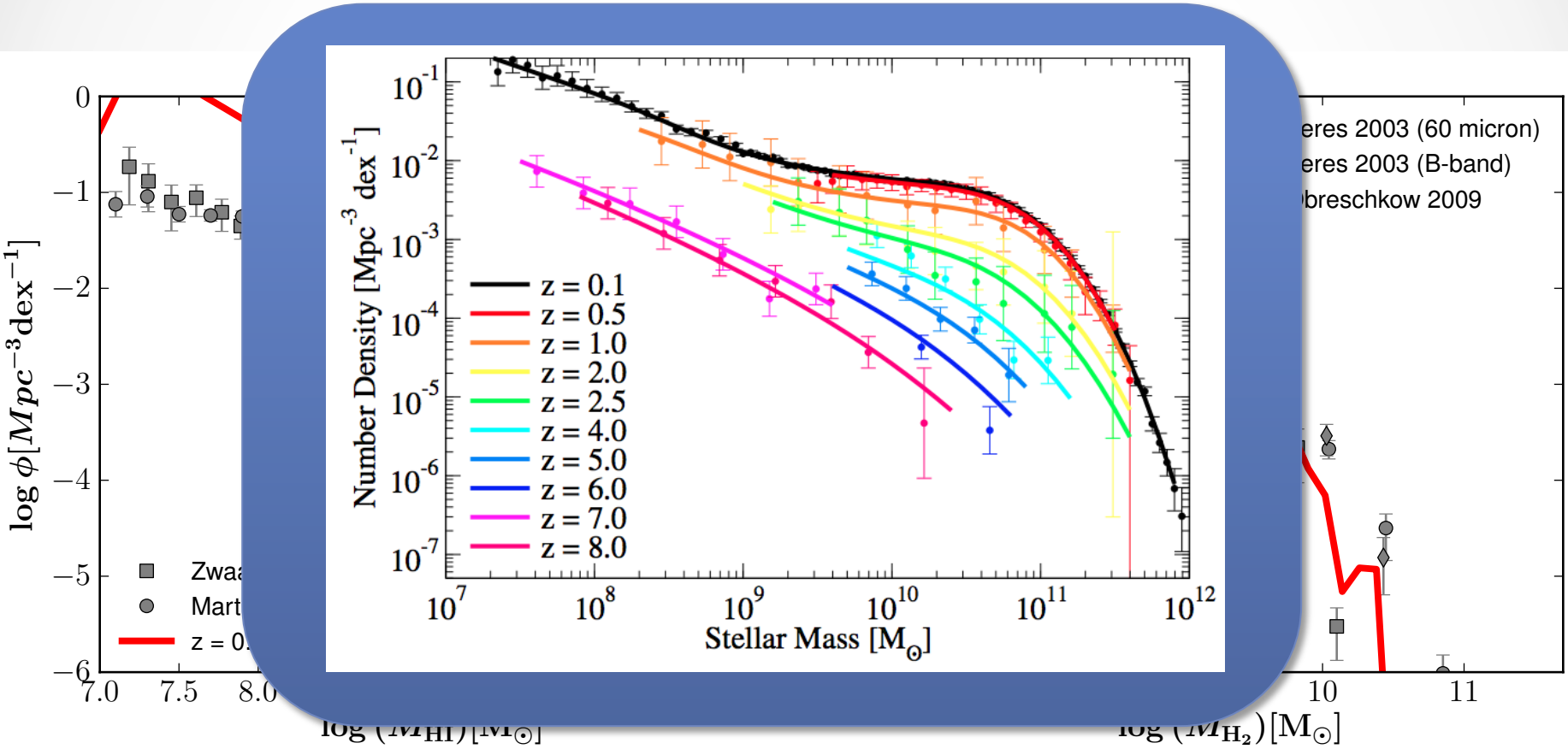
Local scaling relations

Gas ratio

Gas content



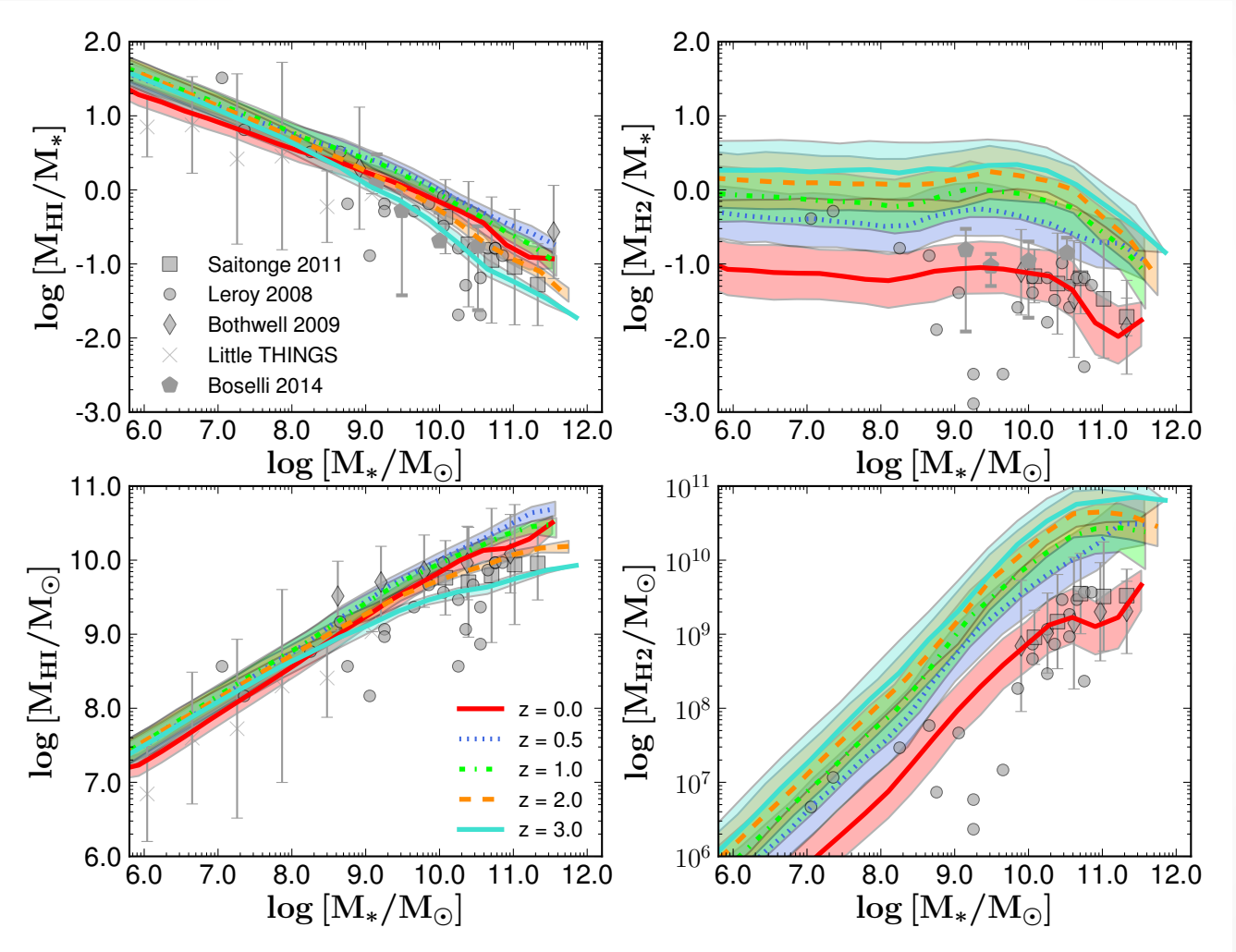
Local Mass Functions



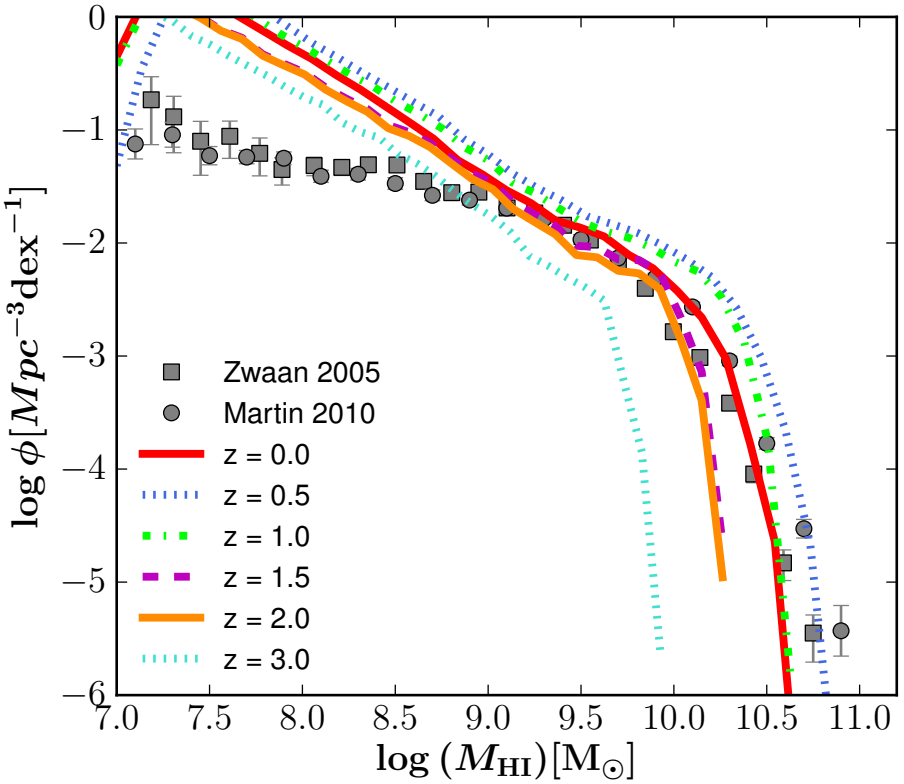
High-z scaling relations

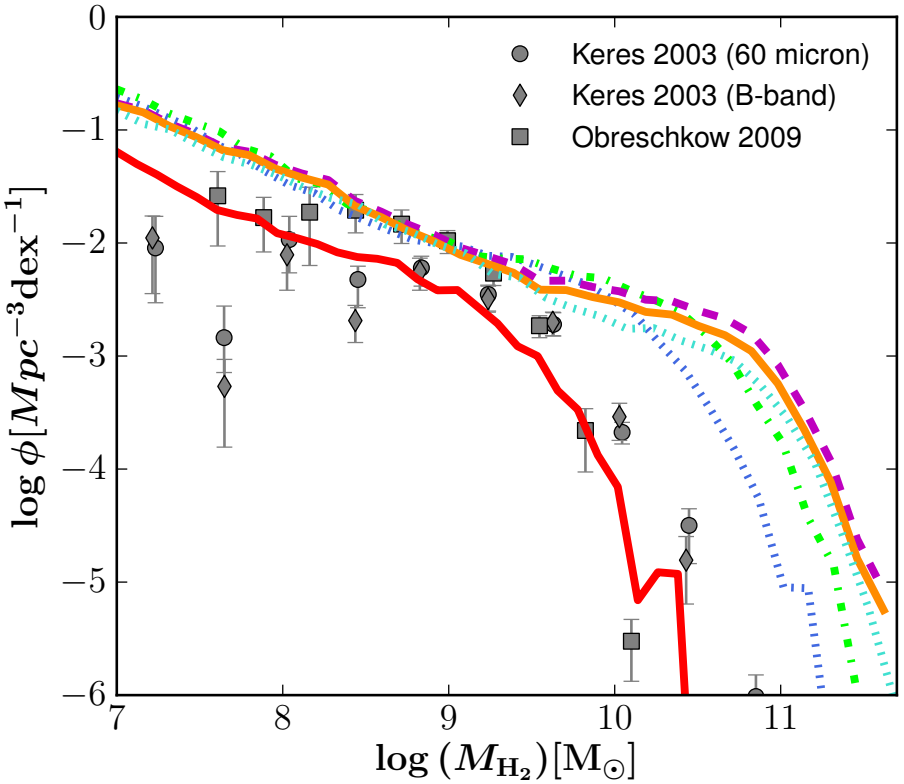
Gas ratio

Gas content

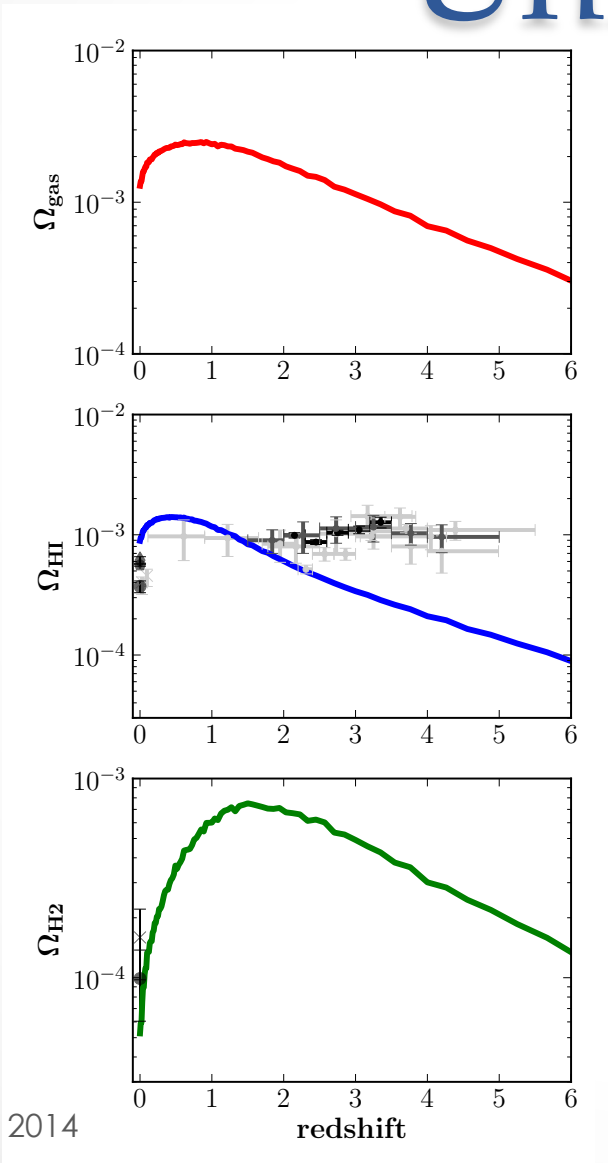


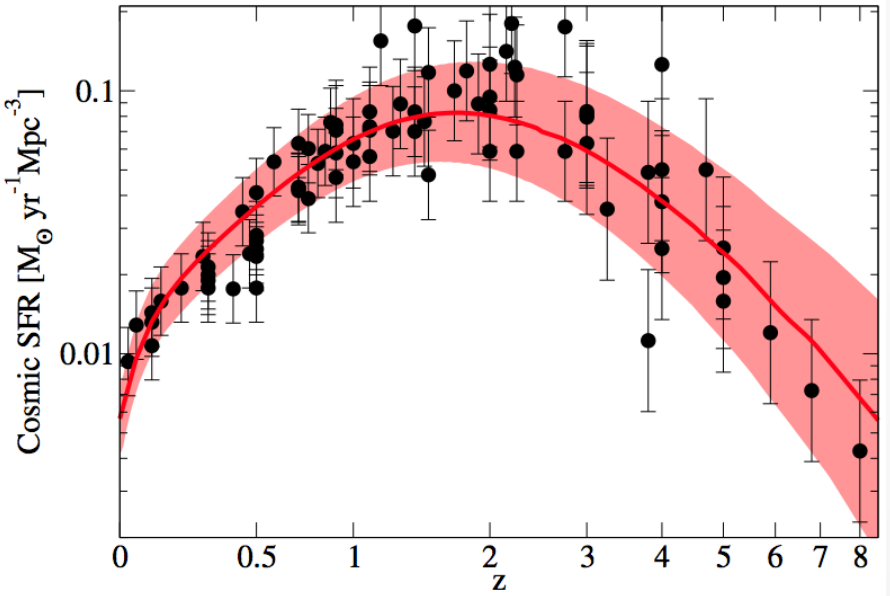
High-z Mass functions





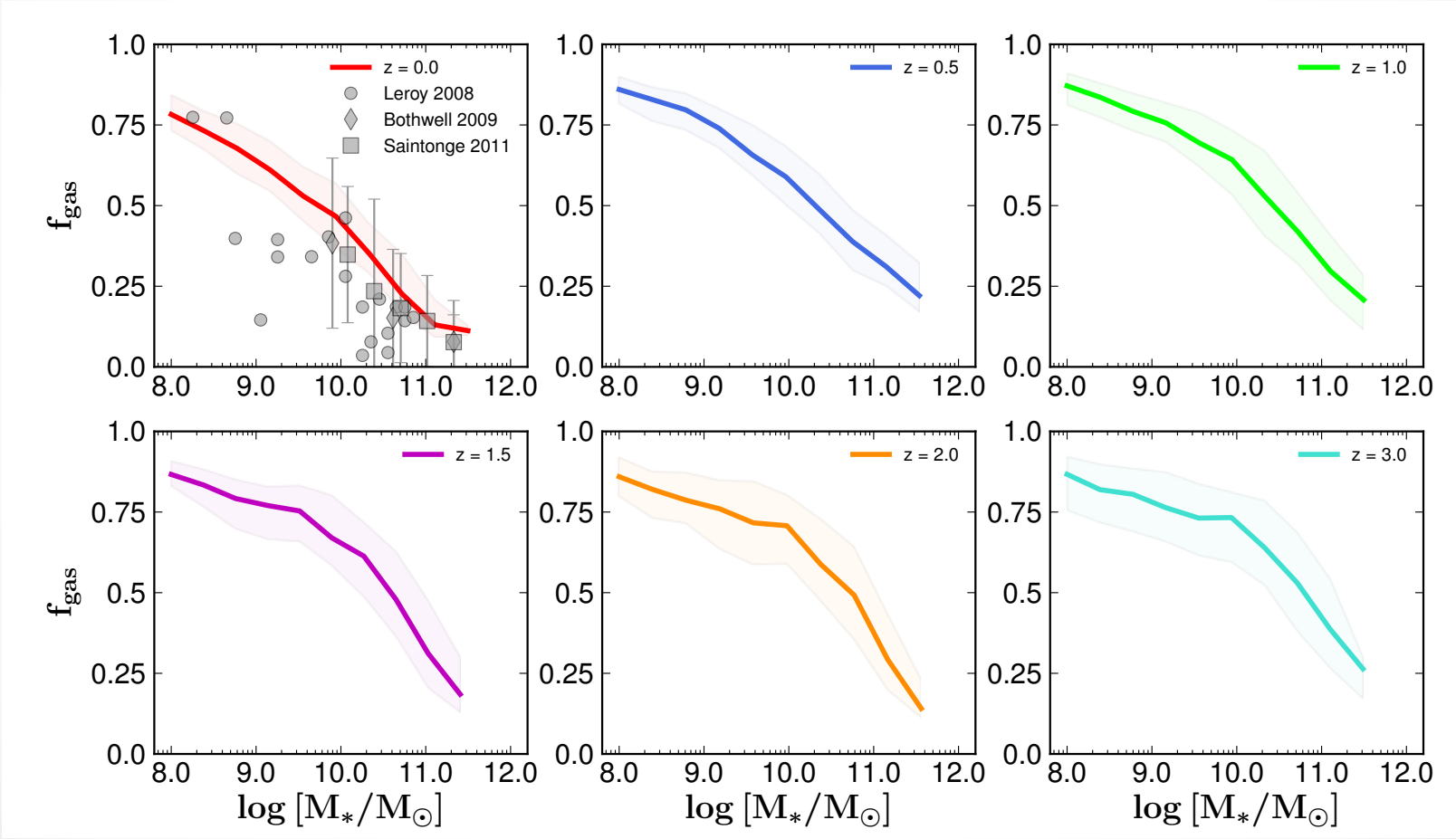
Gas density of the Universe





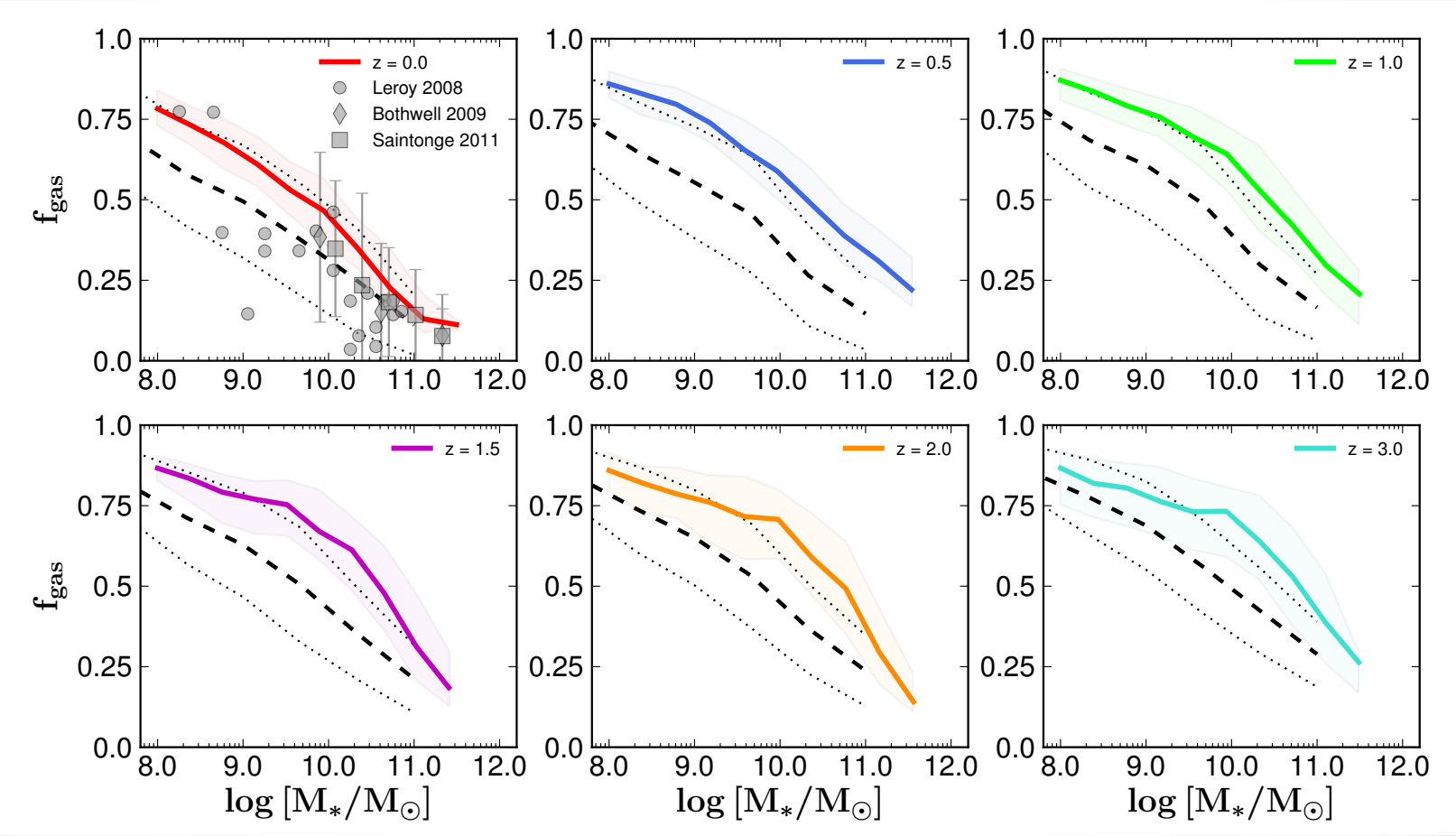
Behroozi+ 2013

Galaxy gas fractions

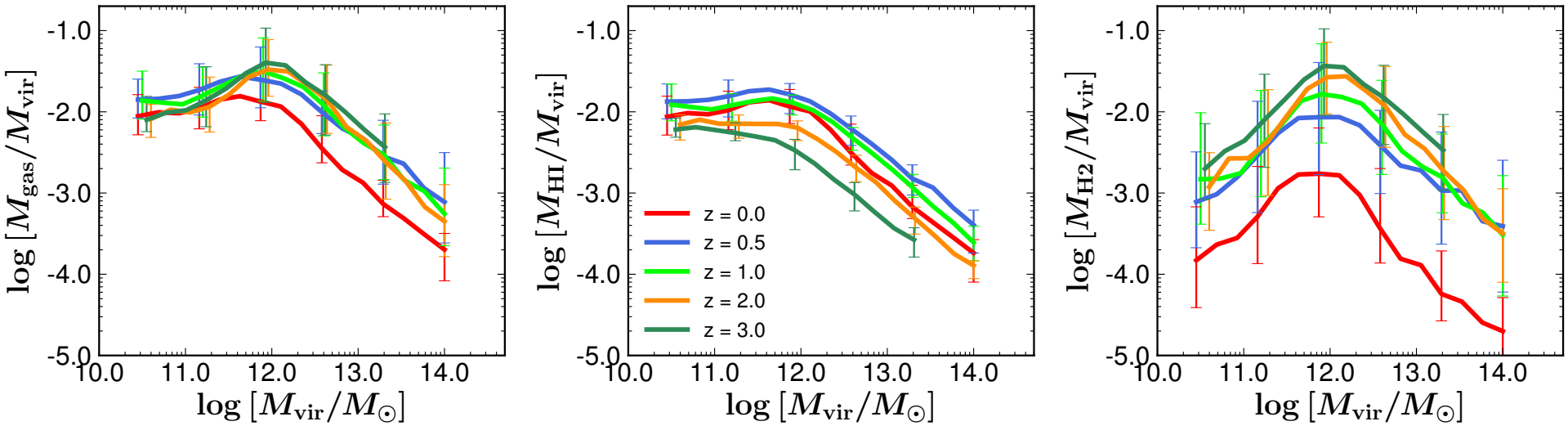


Confronting models

- SAM predicted galaxy gas fractions



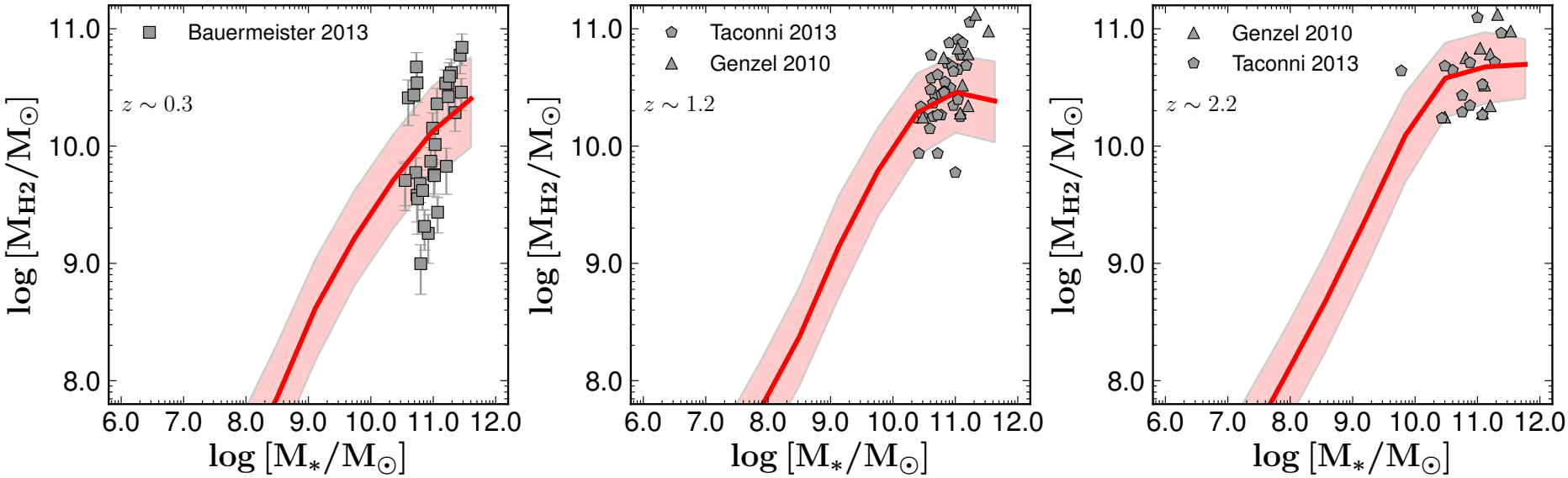
Gas content of halos



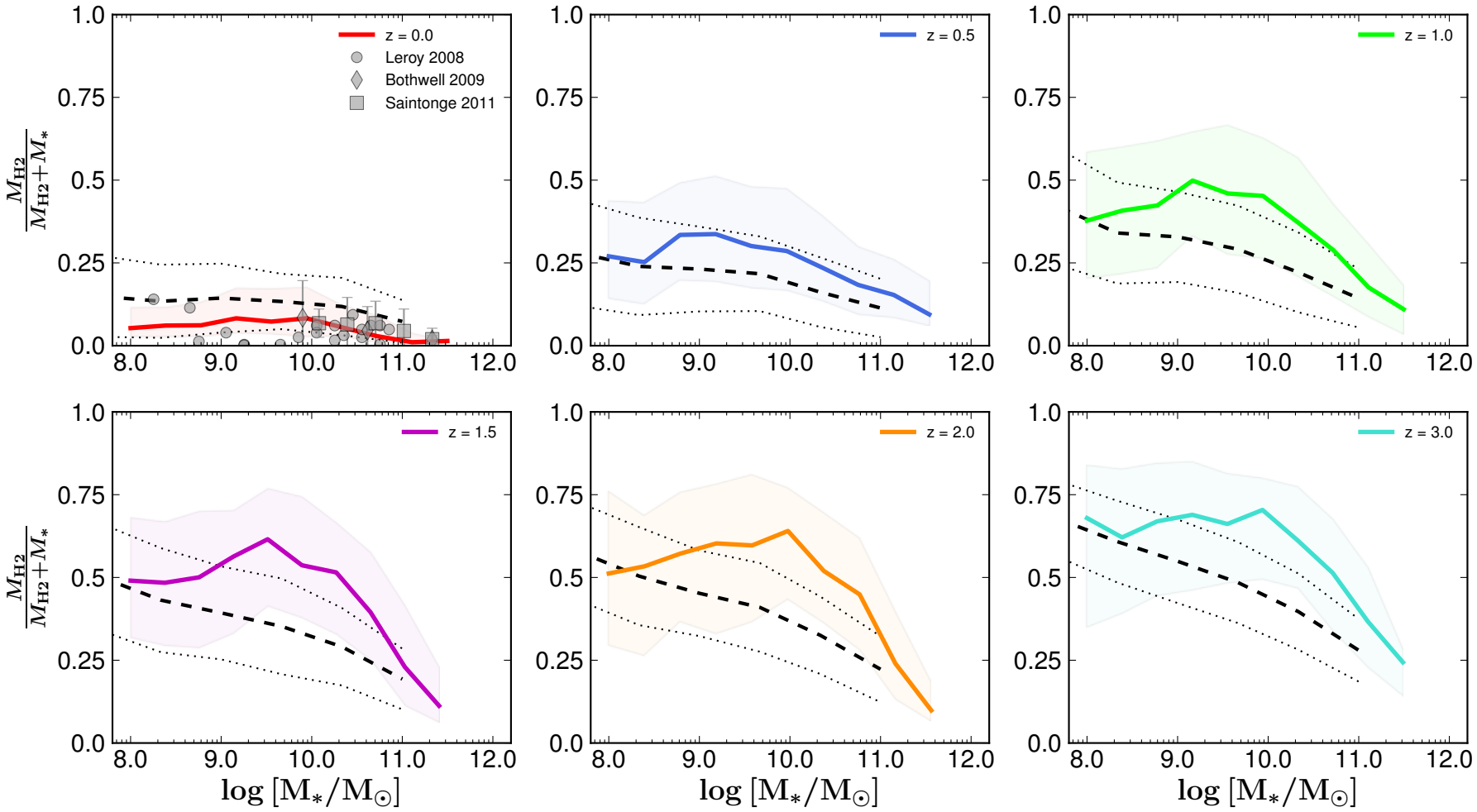
Take home points

- Semi-empirical model is data driven, free of unknown feedback recipes and provides predictions for the gas content of galaxies.
- New approach properly reproduces the gas content of galaxies and the number of gas-massive objects
- Weak evolution in HI content of galaxies at $z<1.0$. Some self-regulated equilibrium process occurs
- Good predictive power for observations *and* models

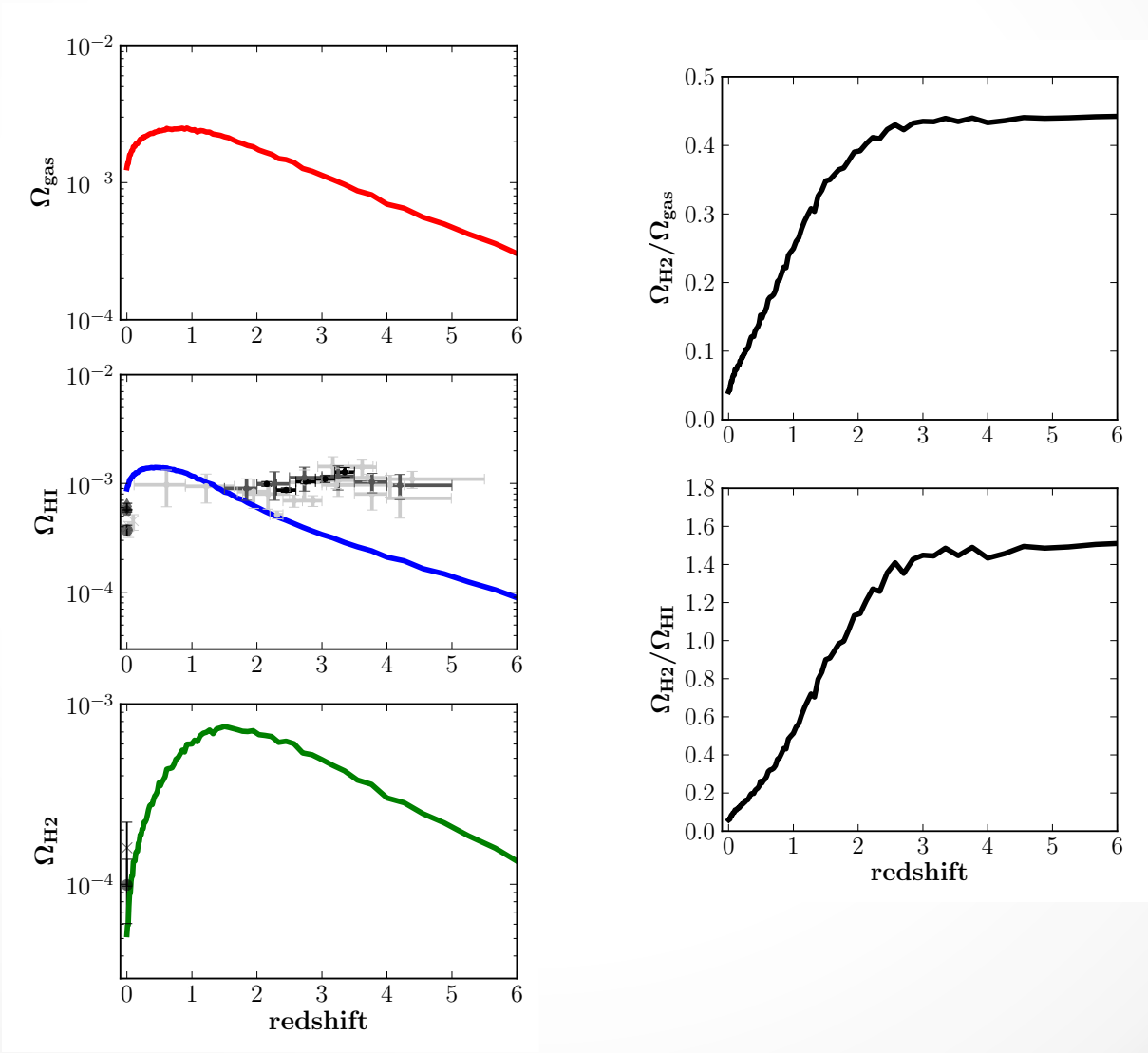
High-z constraints



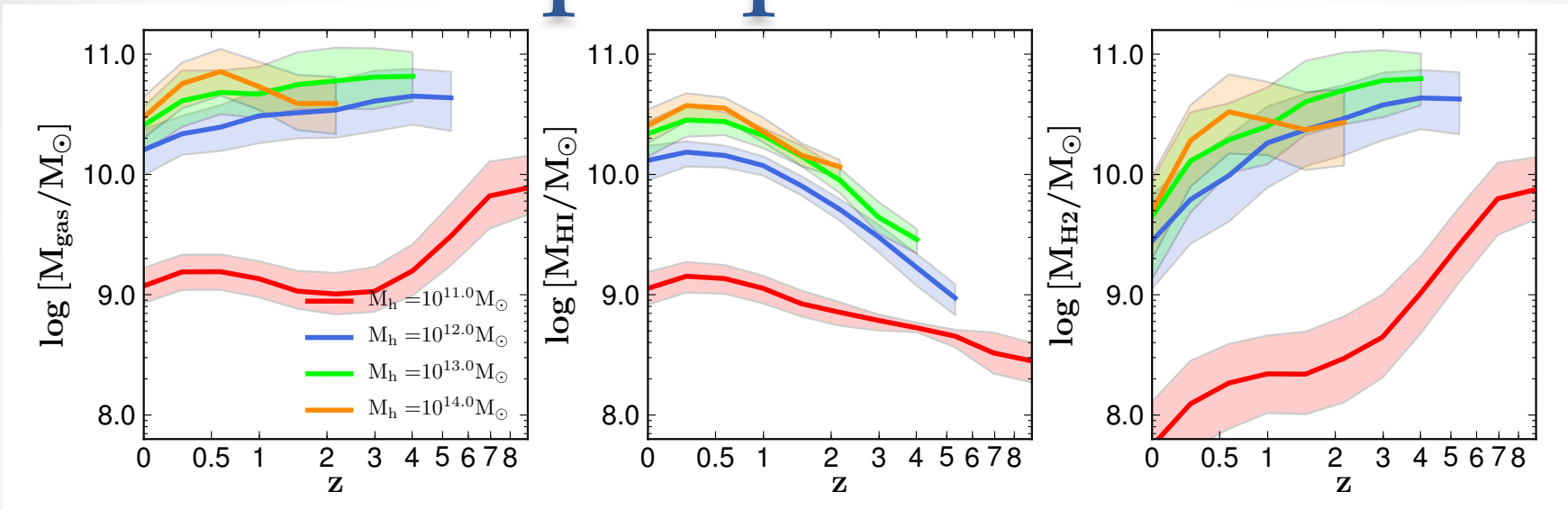
Relative H2 content

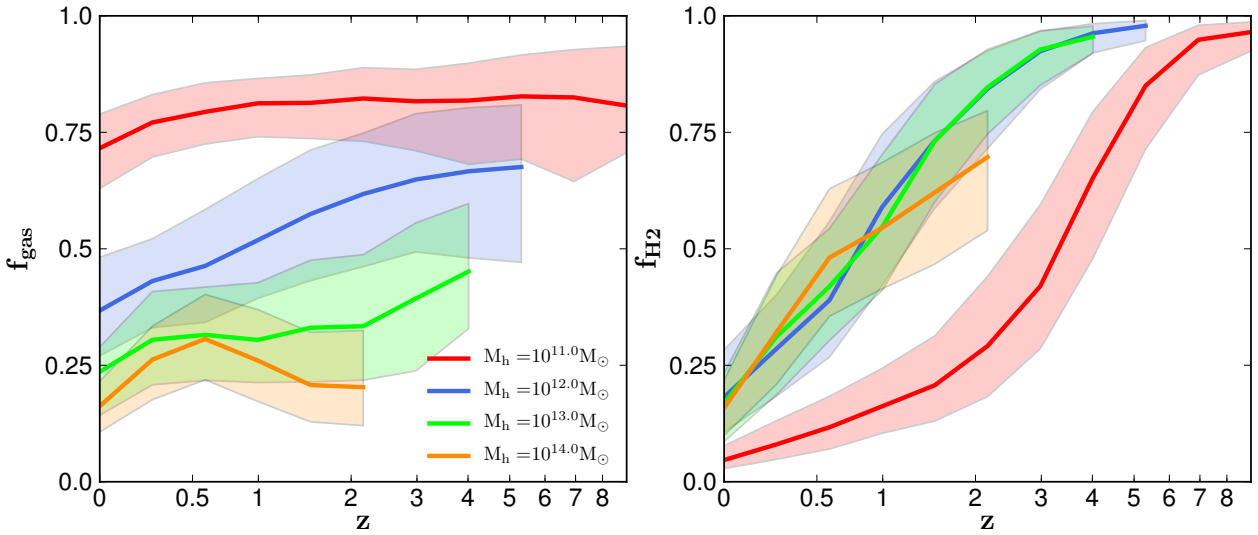


Gas density of the Universe



Time evolution of gas properties





Gas mass function