playing with HALO

ABUNDANCE MATCHING

Andrey Kravtsov

10 April 2012, KITP

playing with HALO ABUNDANCE MATCHING

Andrey Kravtsov

10 April 2012, KITP

$$n(>V_{\rm max,acc})=n(>L) \quad \text{or} \quad n(>M_{\rm halo})=n(>M_*) \quad \text{or} \quad \ldots.$$

- *No environmental dependence in L-Mhalo or M*-Mhalo relation, although sometimes Mhalo or Vmax for subhalos is taken at the time of accretion, while isolated halos use current value*

- *Redshift evolution of these relations is accounted for by matching of appropriate mass functions and luminosity functions at different redshifts*

[4] Giving new meaning to its abbreviation, SHAM, for SubHalo Abundance Matching, a term often used informally by its practitioners.

a SHAM practitioner?

sha·man *noun* \ˈshä-mən, ˈshā- *also* shə-ˈmän\

plural **shamans**

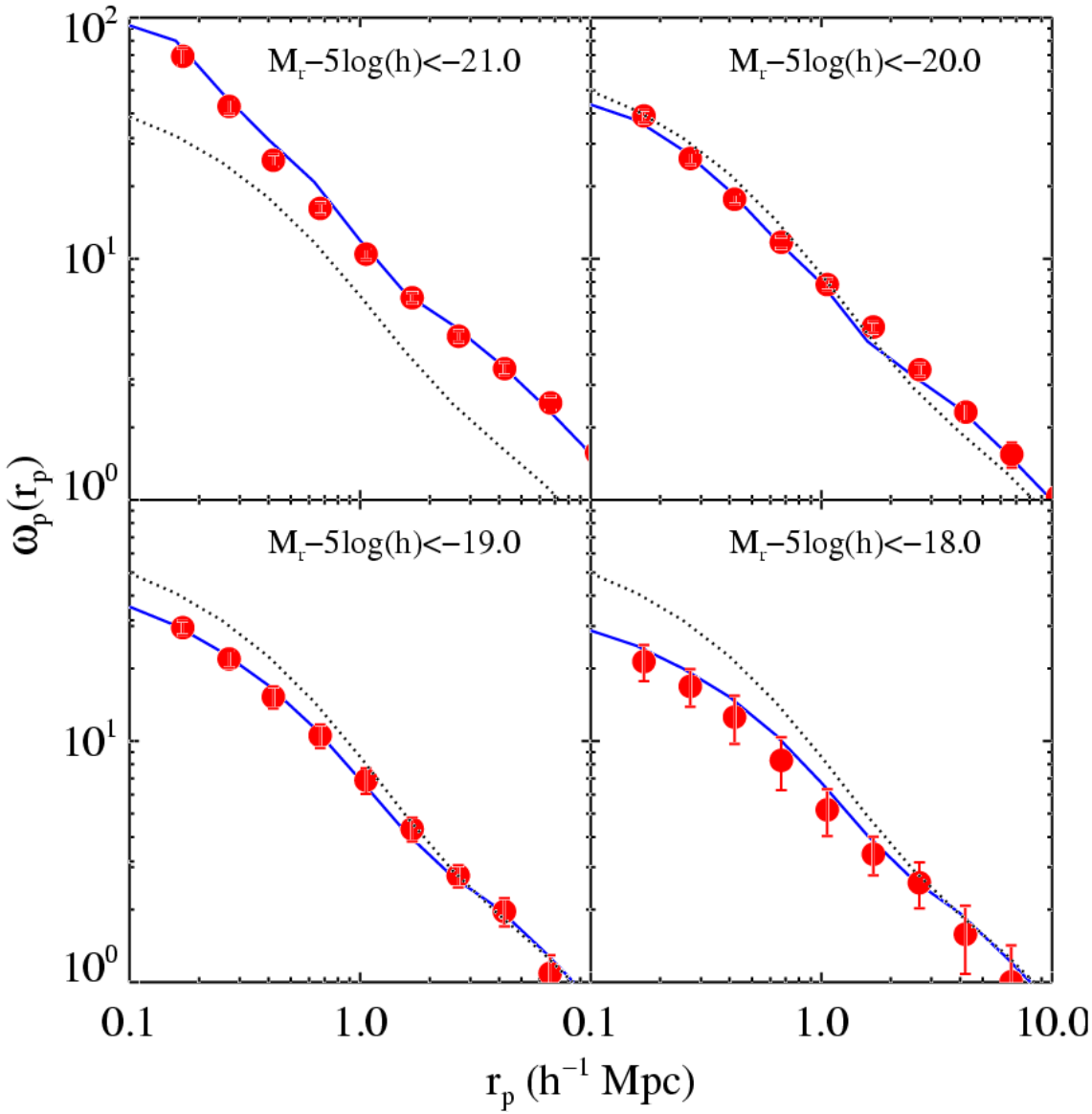
Definition of SHAMAN

1 : a priest or priestess who uses magic for the purpose of curing the sick, divining the hidden, and controlling events

We presented a first application of the abundance matching technique to current infrared data. Our exercise turned out to be surprisingly elucidating (Bethernim et al. 2012, AA 537, L5)

Galaxy clustering in SDSS at z~0 is well reproduced by simulations

projected 2-point correlation function



$n(>V_{max,acc})=n(>L)$

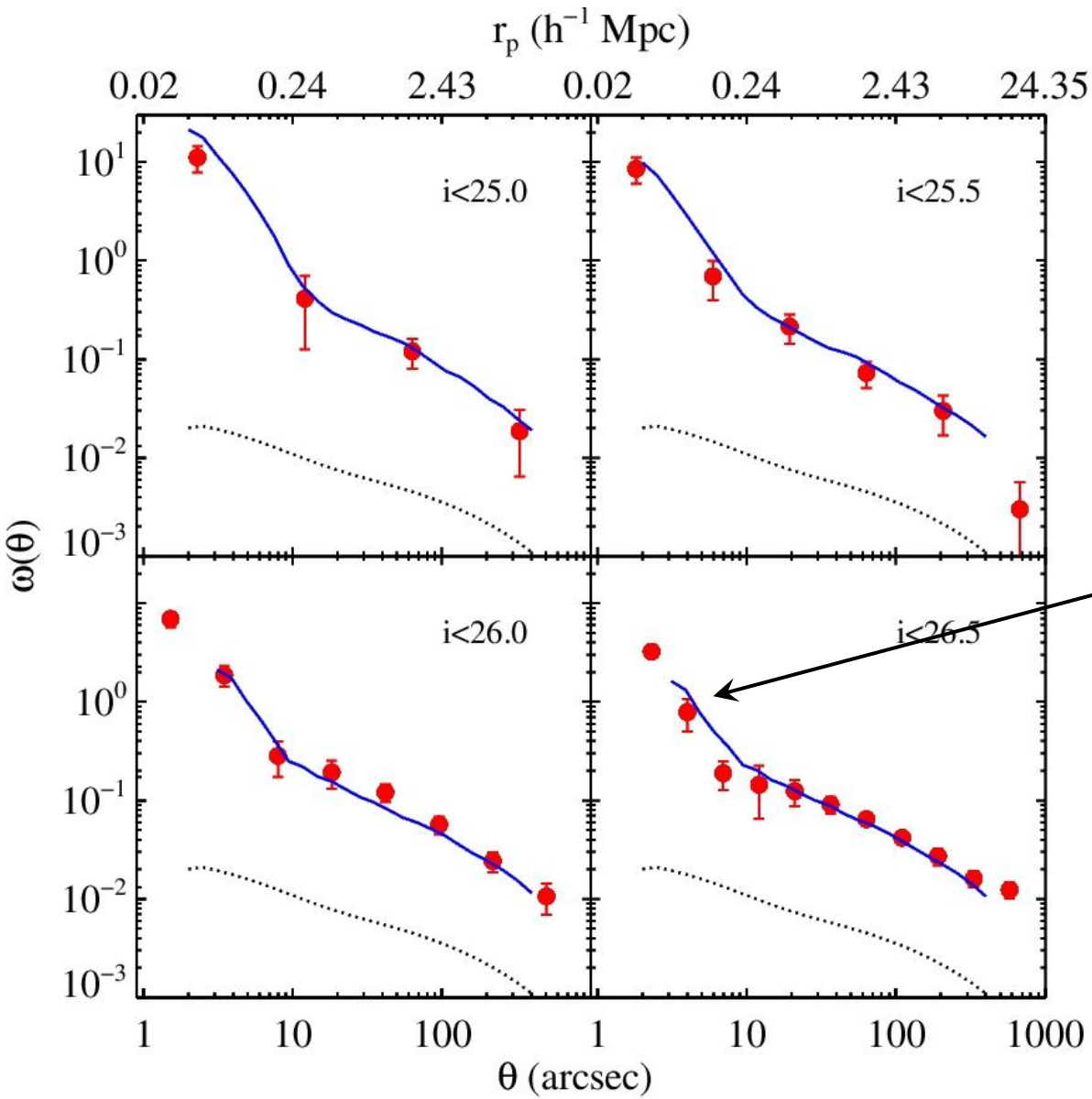
Conroy Wechsler, Kravtsov 2006

projected separation (chimps)

halo clustering vs Subaru Deep Field (z~4)

angular 2-pt correlation function

Conroy, Wechsler & Kravtsov 2006



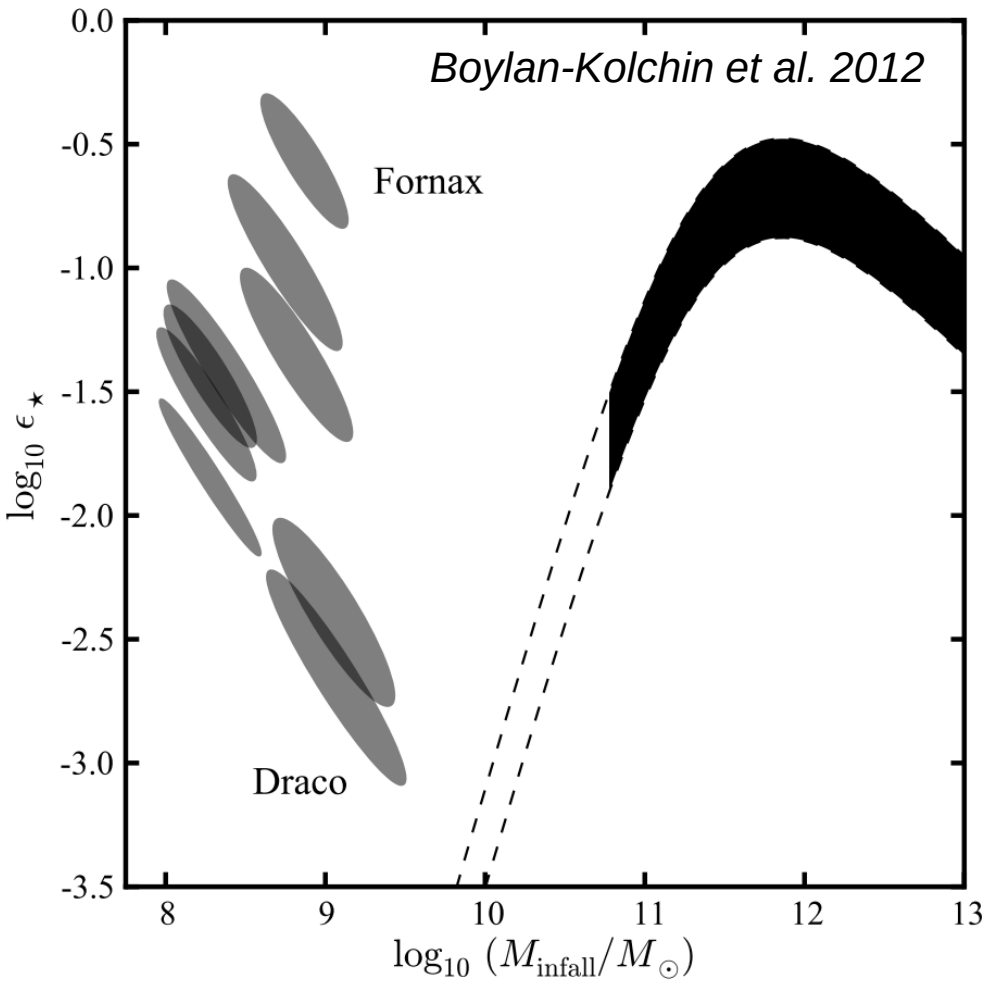
angular separation (arcsec)

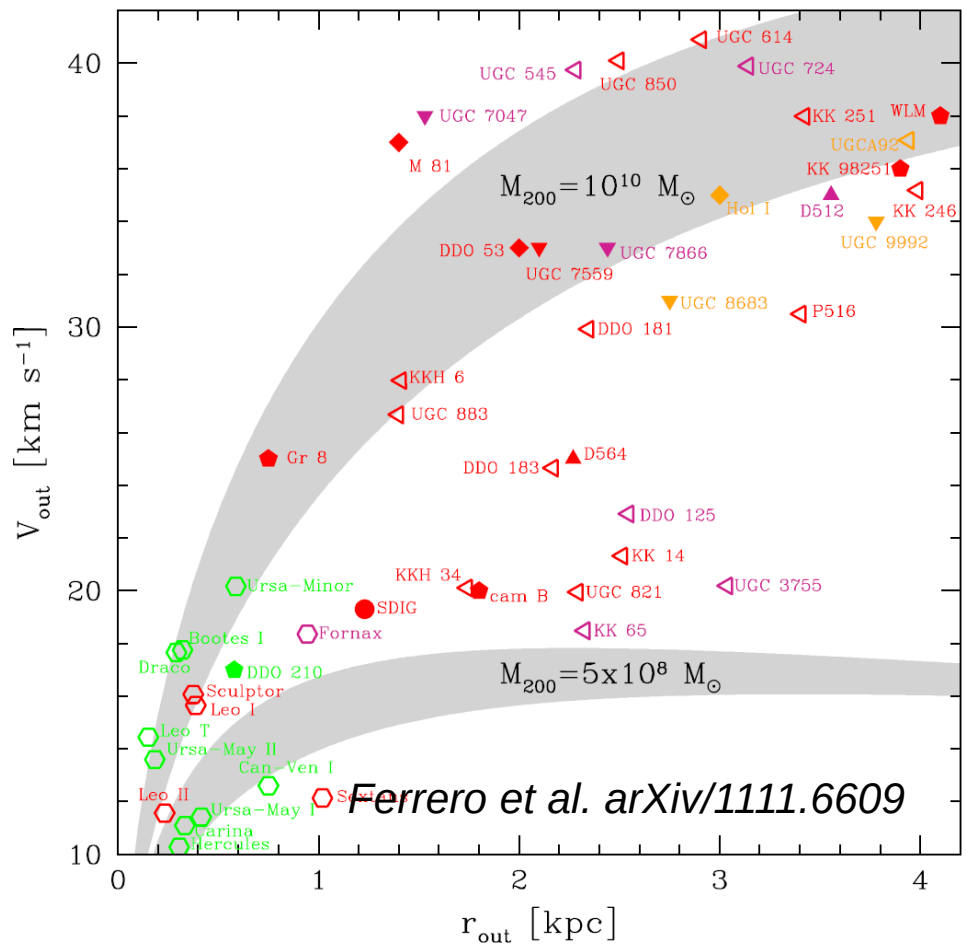
dotted line: dm
solid lines: halos
circles: Subaru data (Ouchi et al. 2005; Kashikawa et al. 2005)

strong deviation from power law at rp~0.3h^{-1} Mpc at z~3 was *predicted* by simulations

(Zheng 2004; Kravtsov et al. 2004)

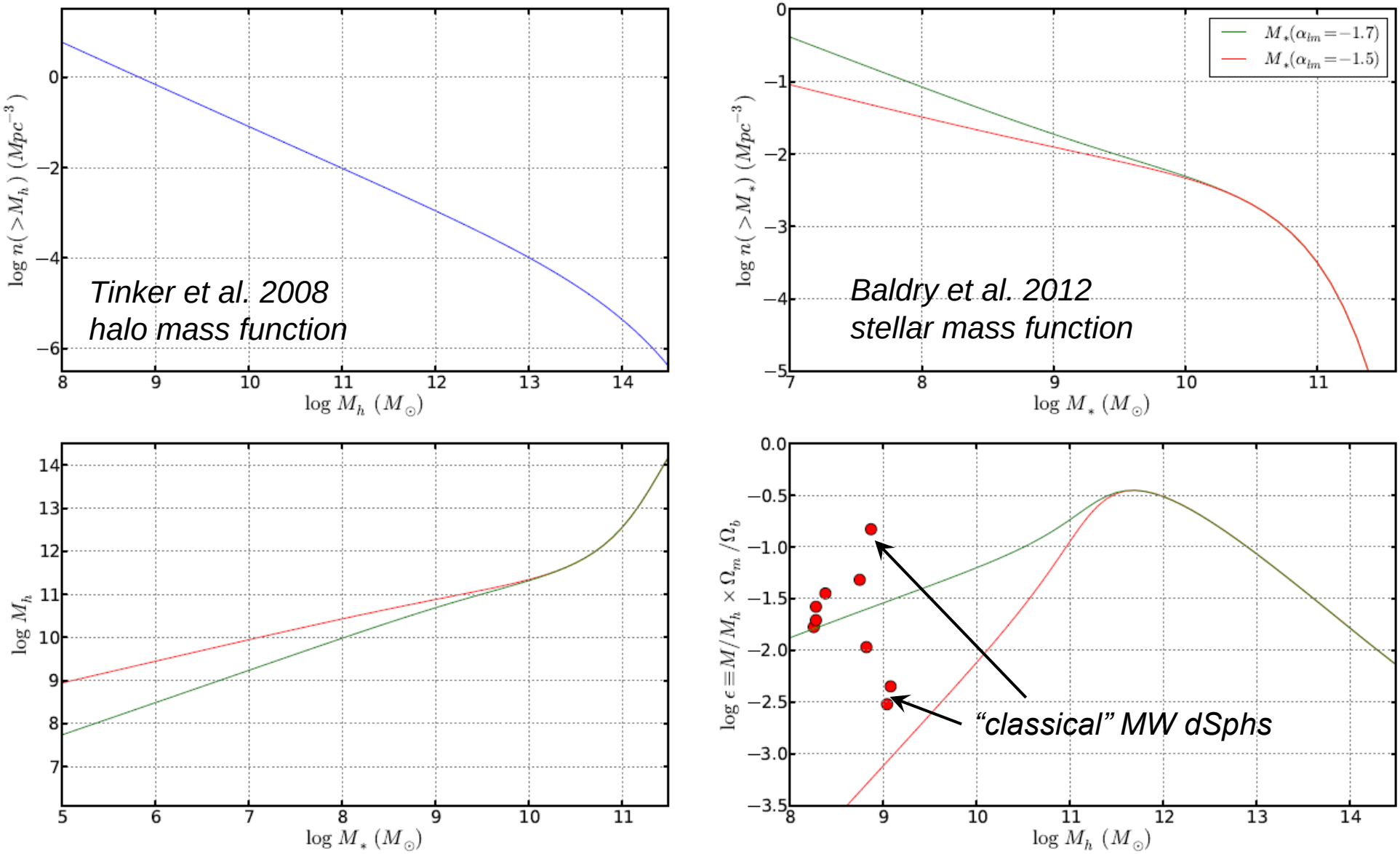
Abundance matching and dwarf galaxies: Indications of puzzles/problems



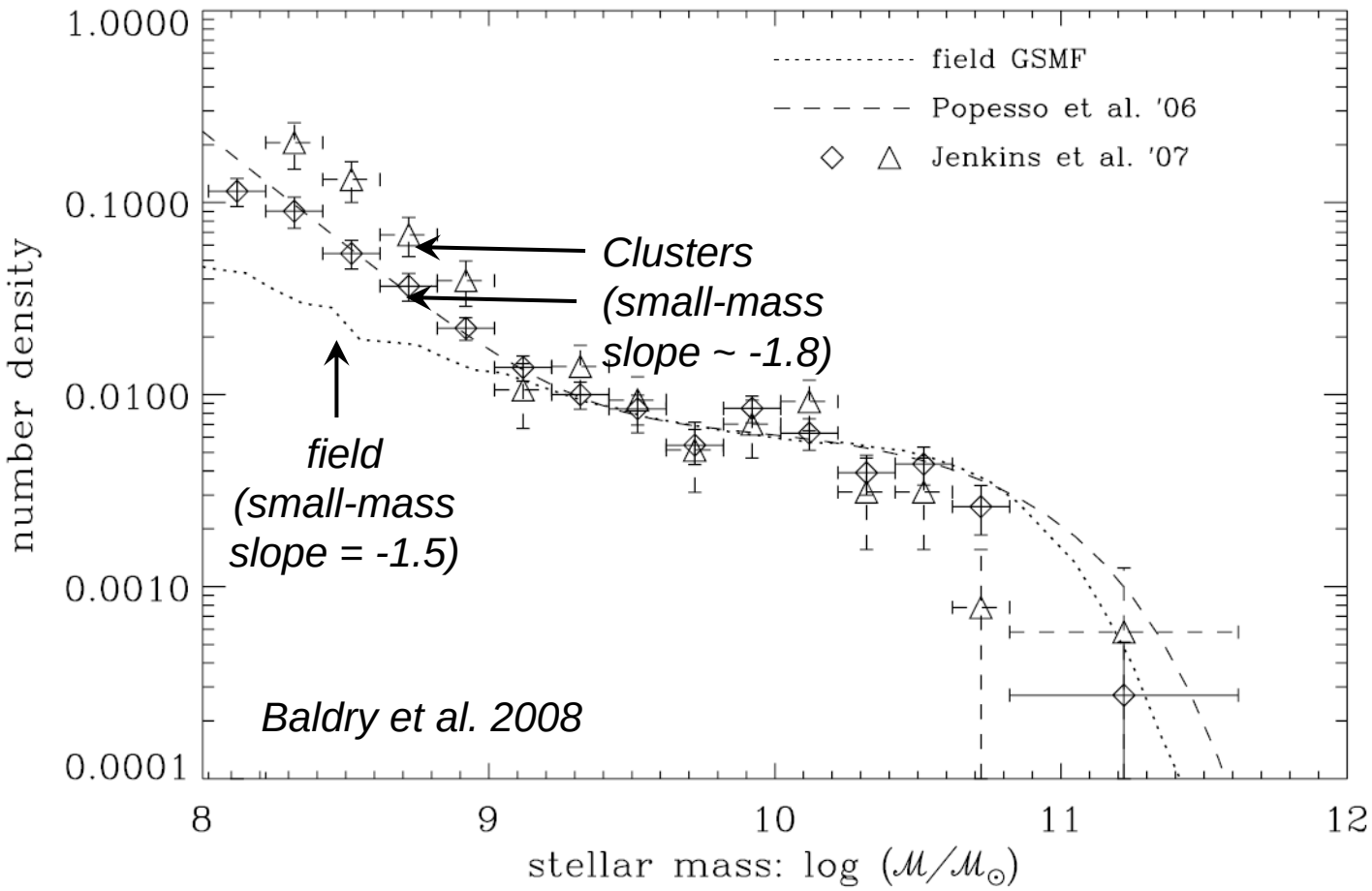


Abundance matching for MW dSph

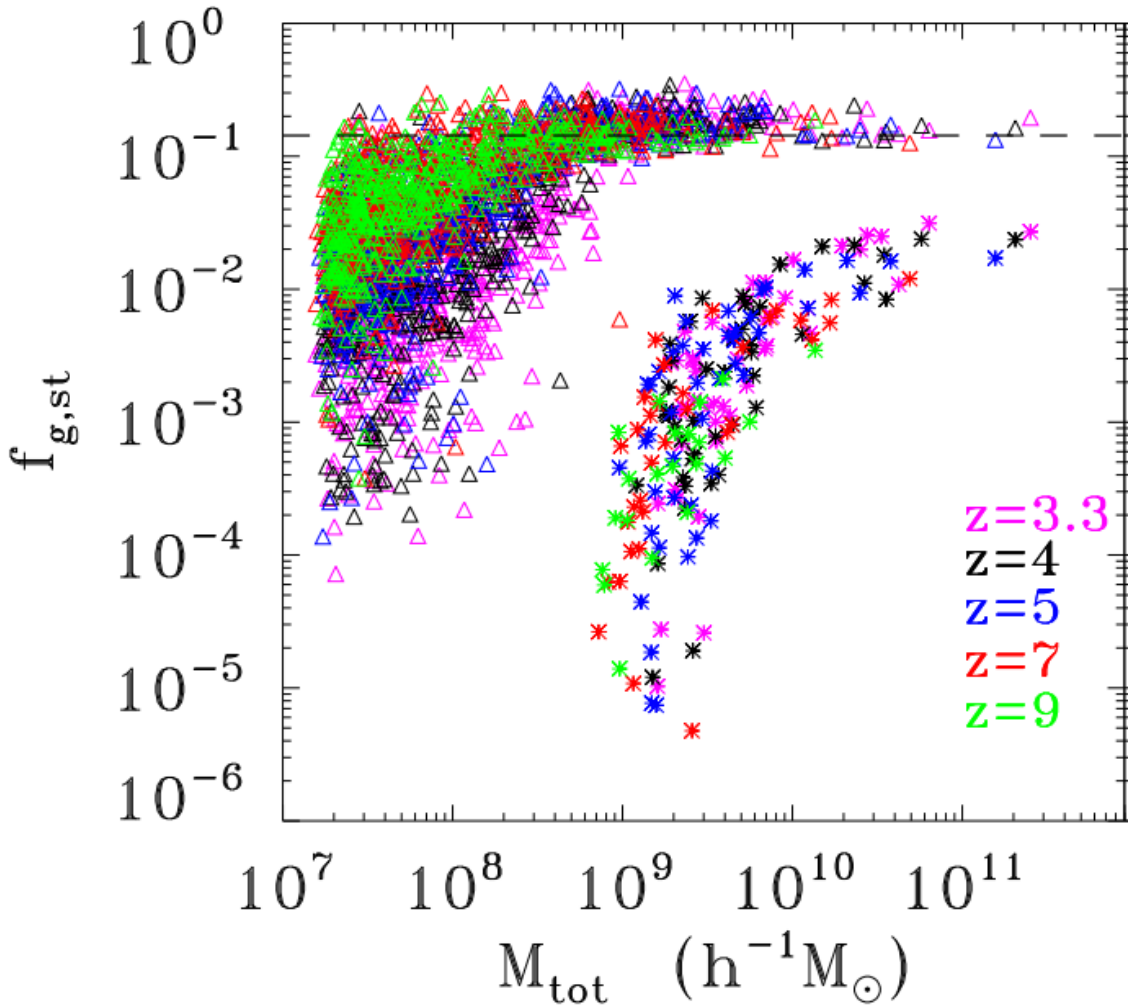
$$n(>M_{\rm halo})=n(>M_*)$$



Stellar mass function at dwarf masses may depend on environment



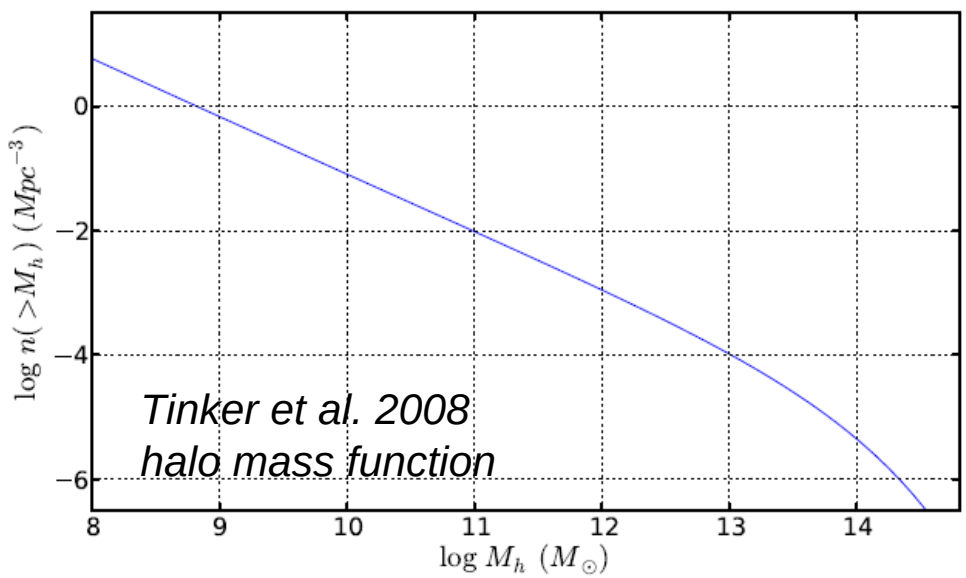
Stochasticity of star conversion efficiency often arises naturally in galaxy formation models

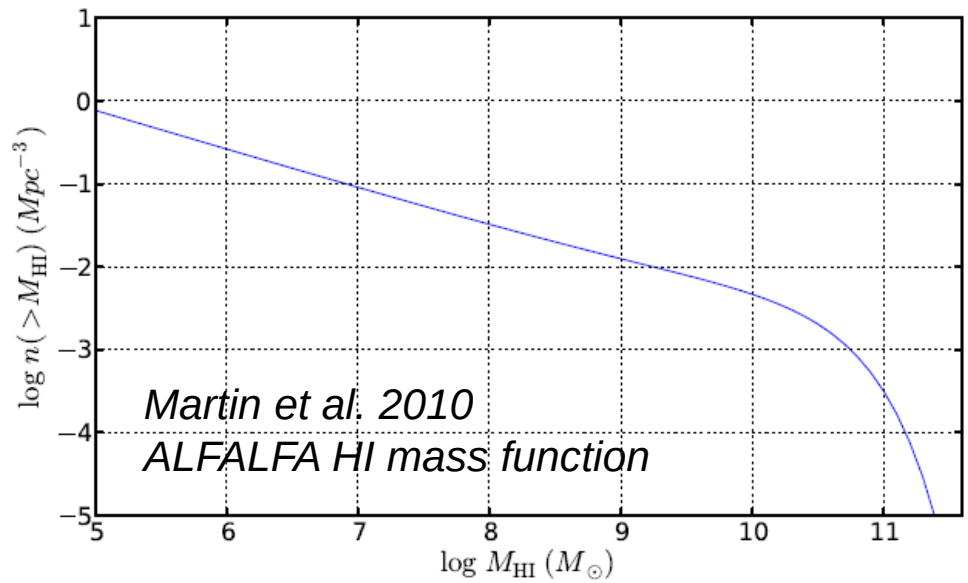


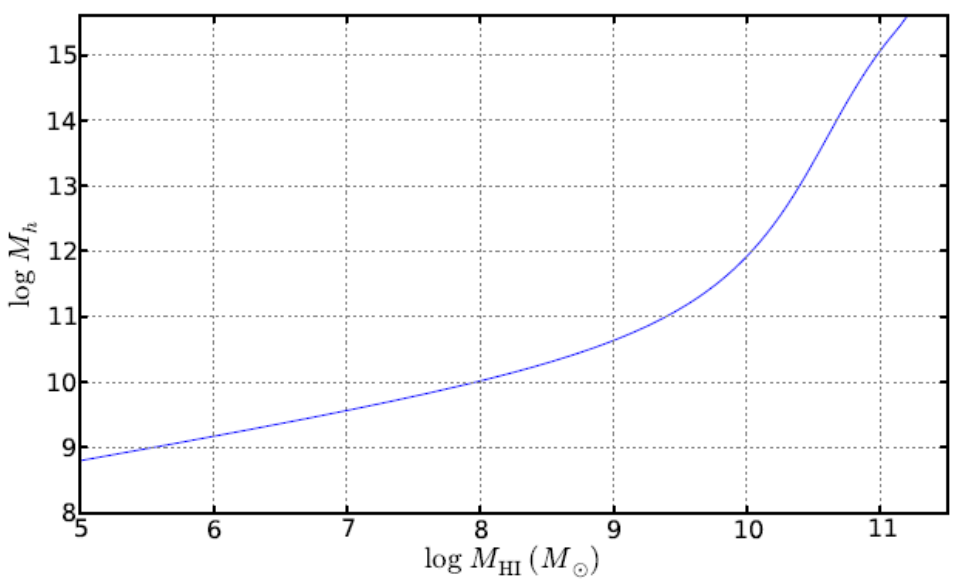
Tassis, Kravtsov & Gnedin 2008
(cf. also Ricotti et al. 2008; Kuhlen et al. 2012, etc…)

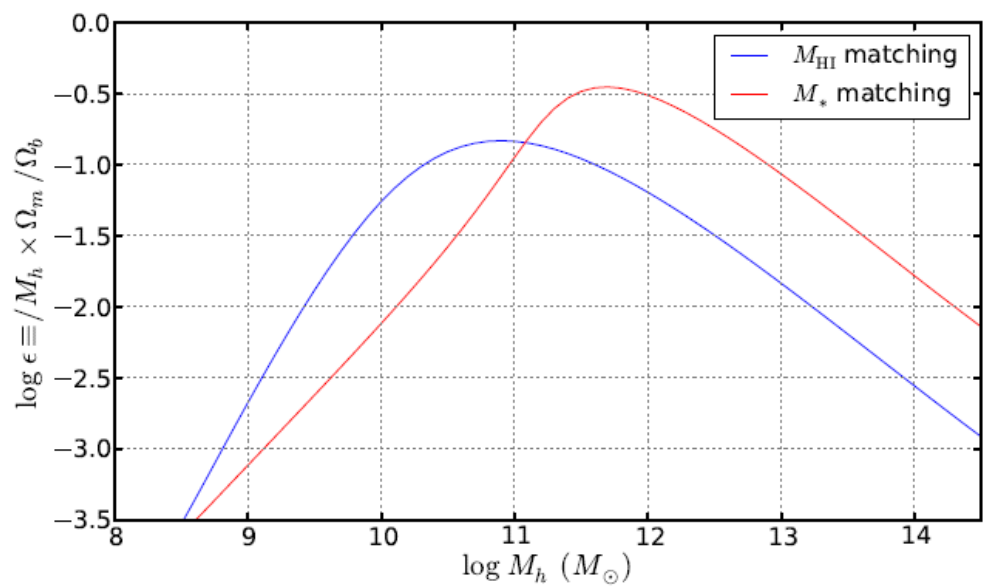
Abundance matching for using HI mass function

$$n(>M_{\rm halo})=n(>M_{\rm HI})$$

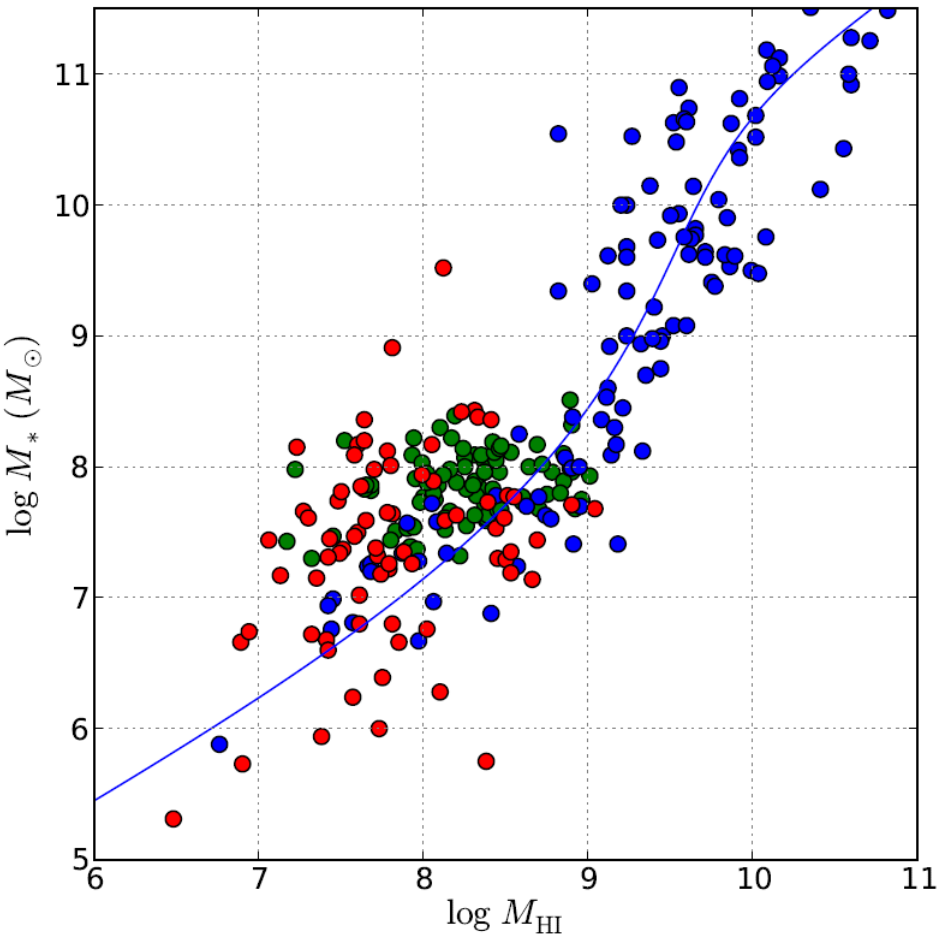


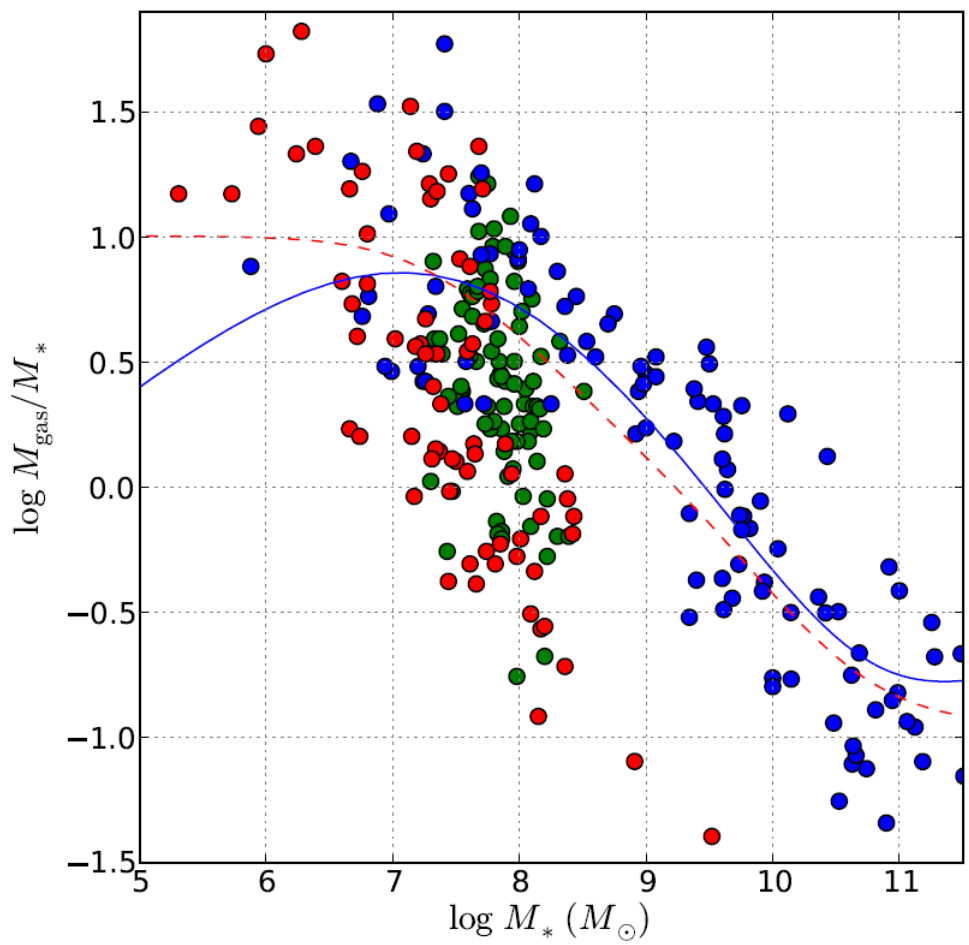






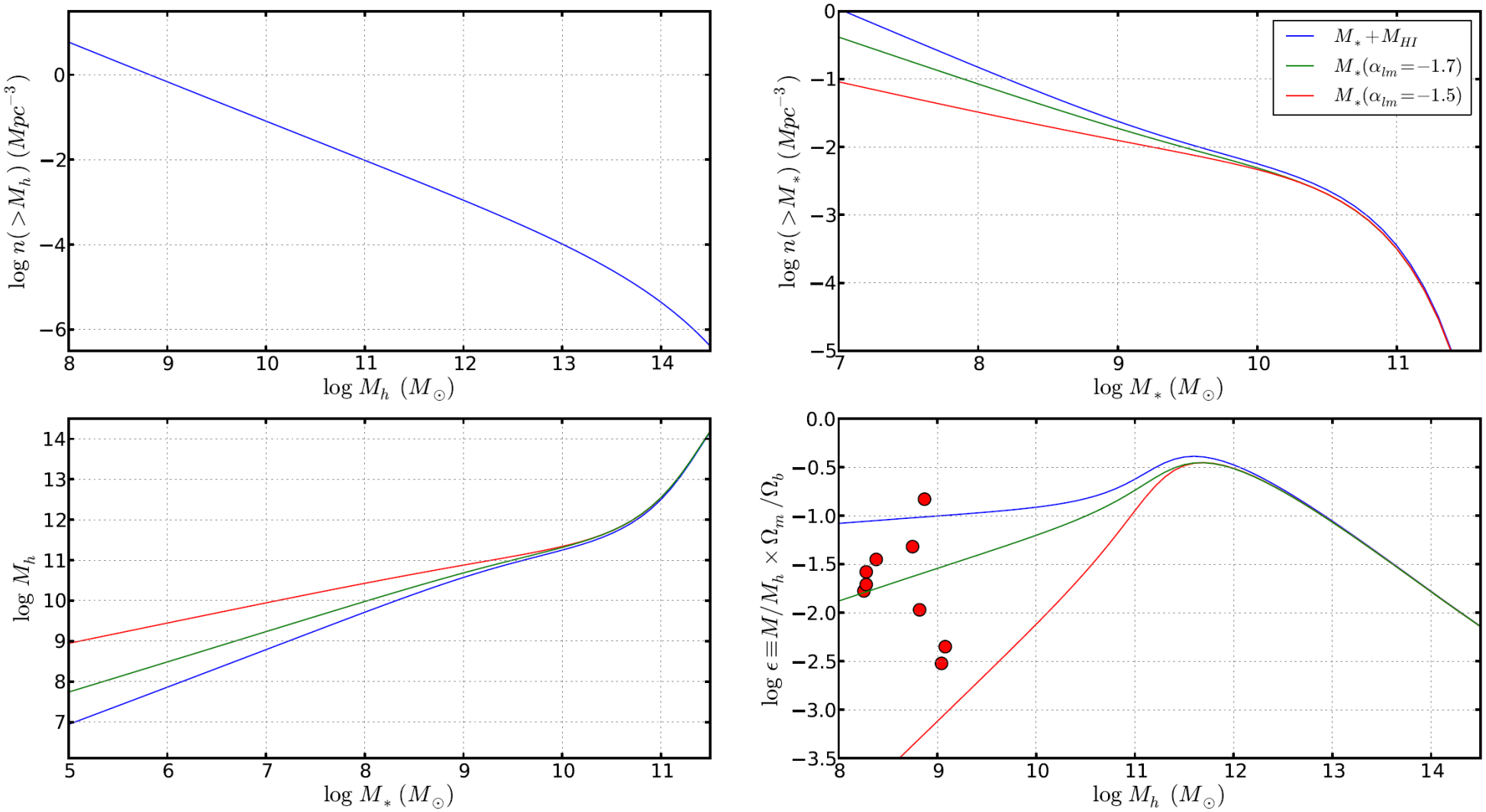
Stellar to HI mass function abundance matching works but quite a bit of scatter





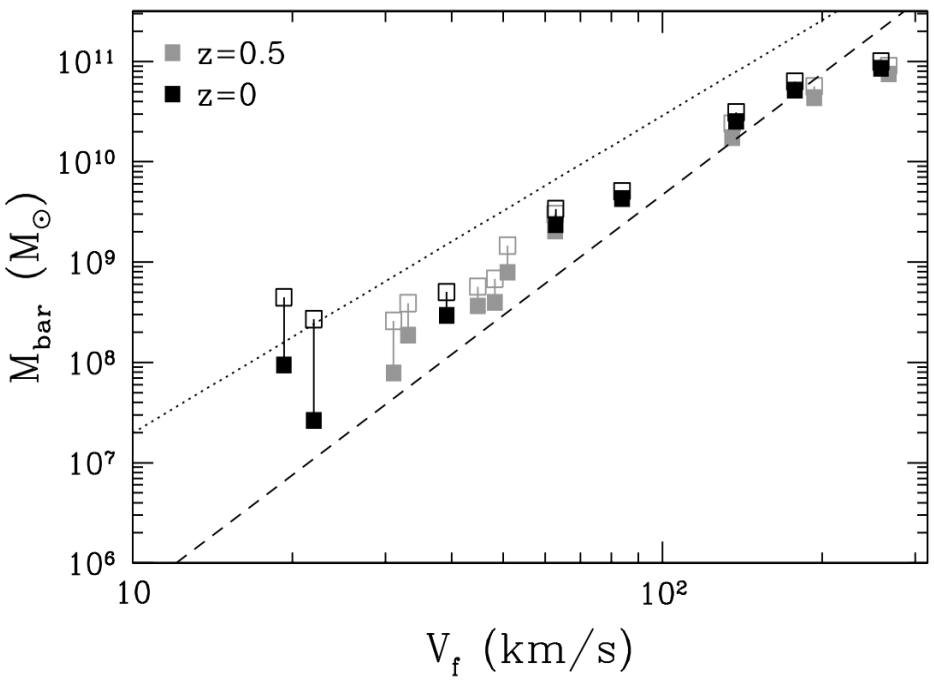
Abundance matching using $M_* + M_{HI}$ (aka "baryon") mass function

$$n(>M_{\rm halo}) = n(>M_*) \quad \text{and} \quad n(>M_{\rm halo}) = n(>M_{*+\rm HI})$$

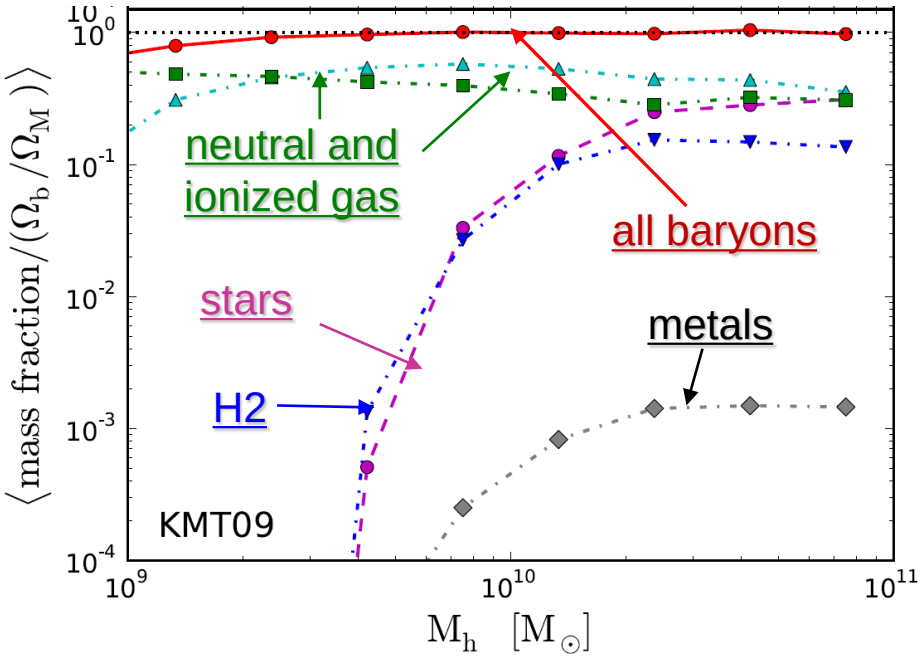


The "baryon" fraction problem: hidden repository of ionized gas?

Gnedin N. 2012
arXiv/1108.2271

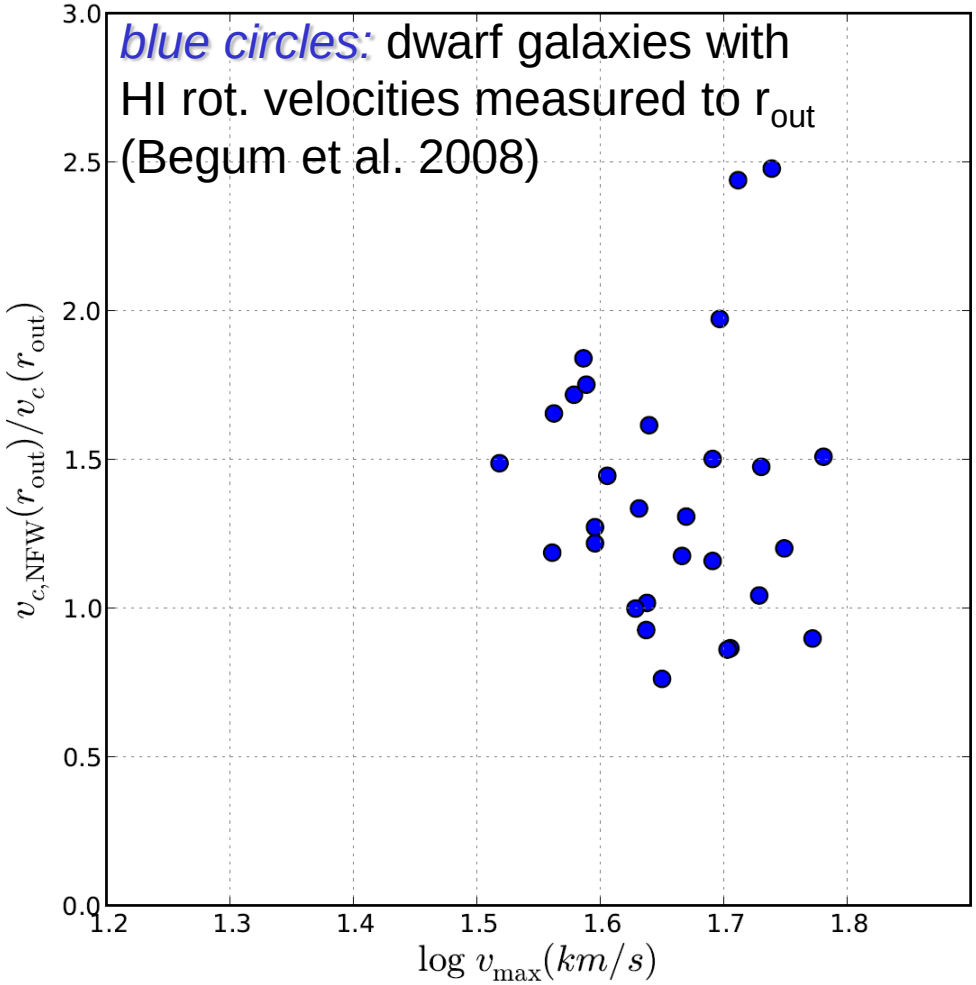


Kuhlen et al. 2012
arXiv/1105.2376



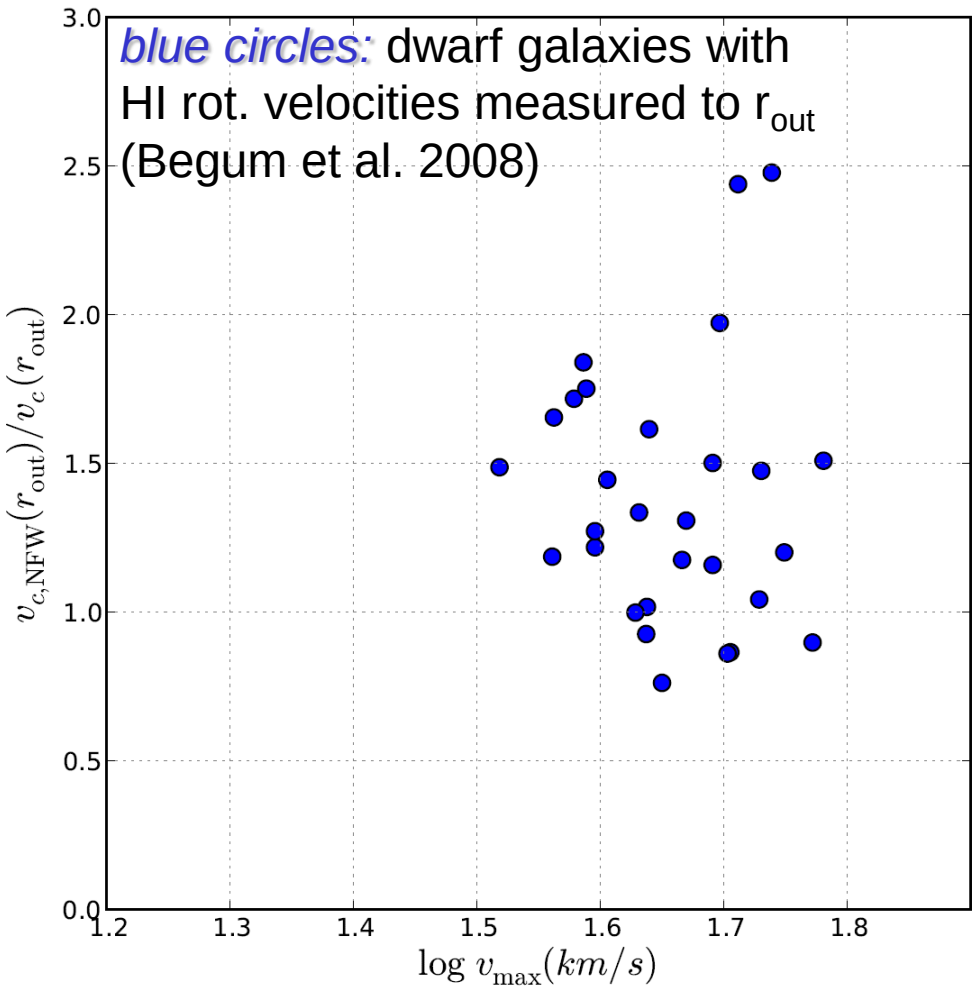
"To big too fail" problem for field dwarfs?

$$n(>M_{\rm halo})=n(>M_*)$$

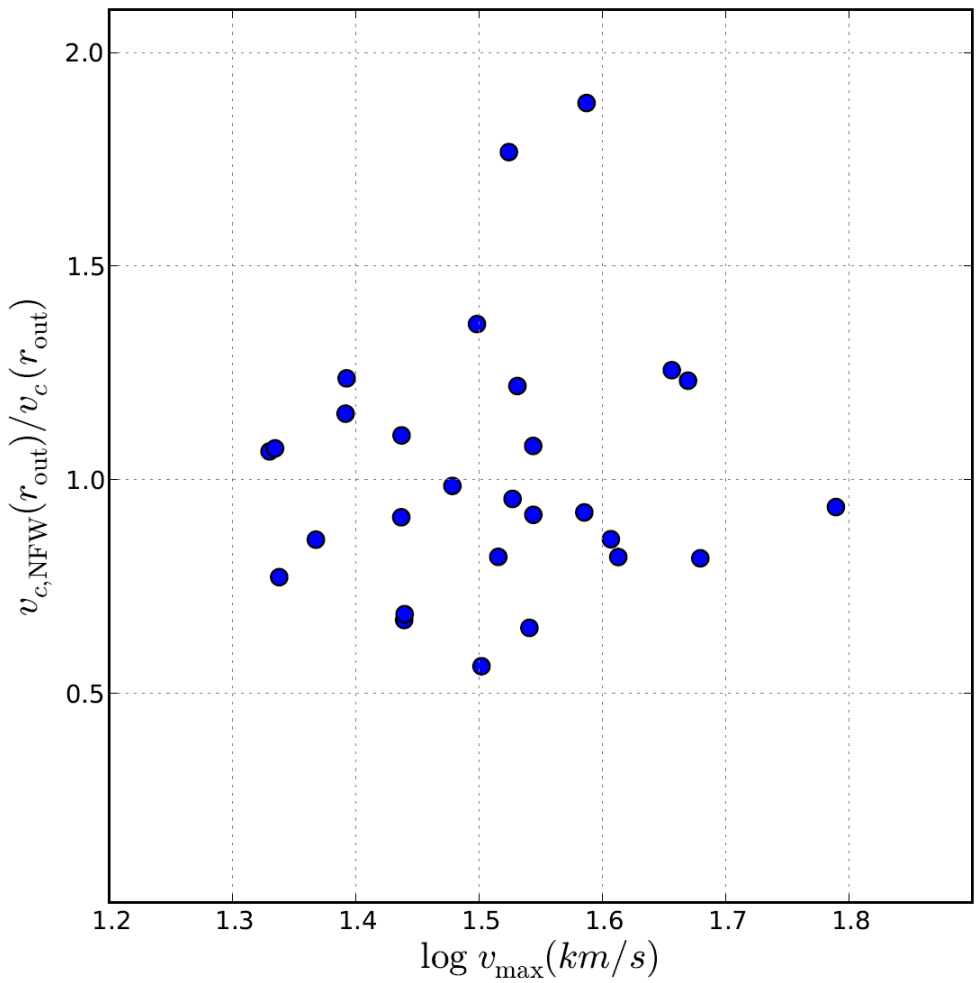


No problem if abundance matching is done on the MHI+M* (aka "baryonic") mass function

$n(>M_{\rm halo})=n(>M_*)$



$n(>M_{\rm halo})=n(>M_{*+\rm HI})$



$$y_{\rm eff} = \frac{Z}{\ln(1/f_{\rm gas})}$$

Gnedin N. 2012
arXiv/1108.2271