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The ALFALFA Group HI Mass Function

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#HIStoryNU
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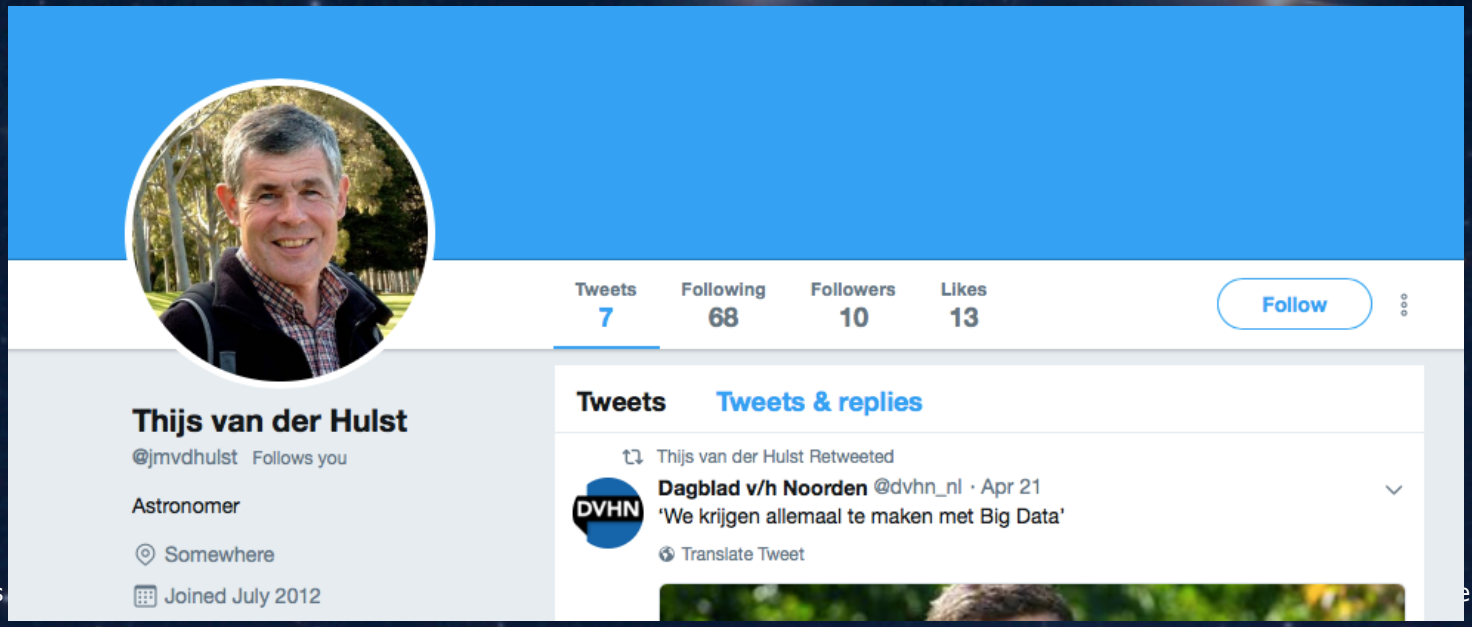

What is the HI Mass Function?

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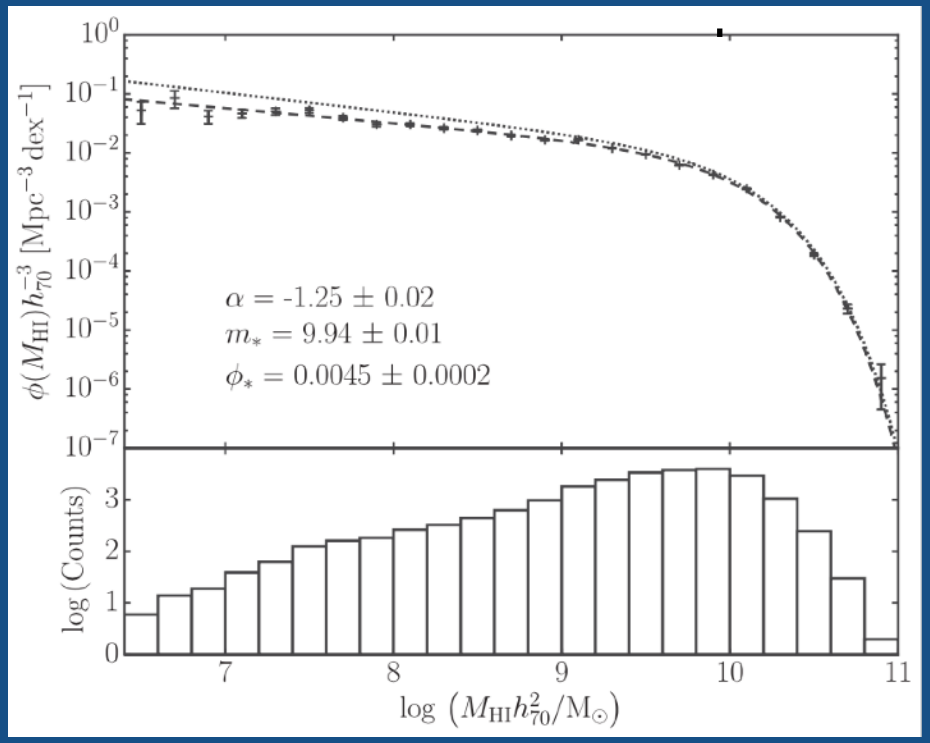
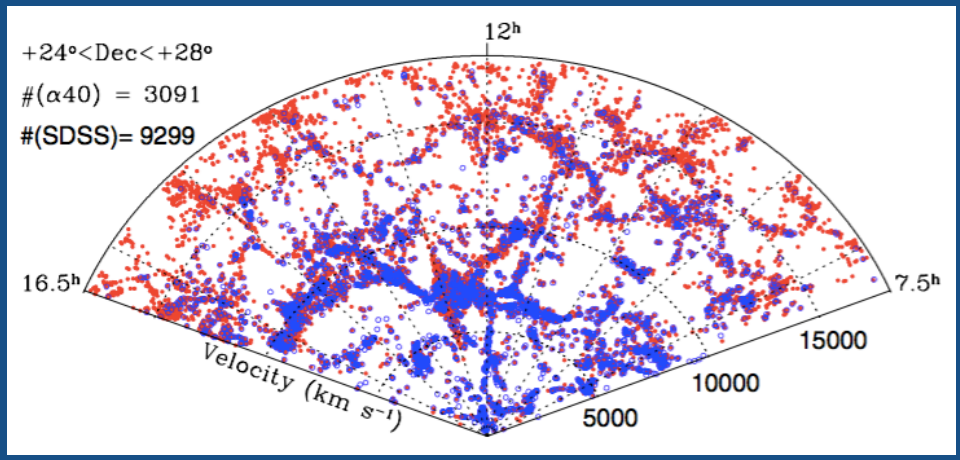
- Number density of galaxies in the Universe as a function of their HI mass.



ALFALFA (Jones et al 2018)



ALFALFA (Haynes et al 2011; 2018)

What is the HI Mass Function?

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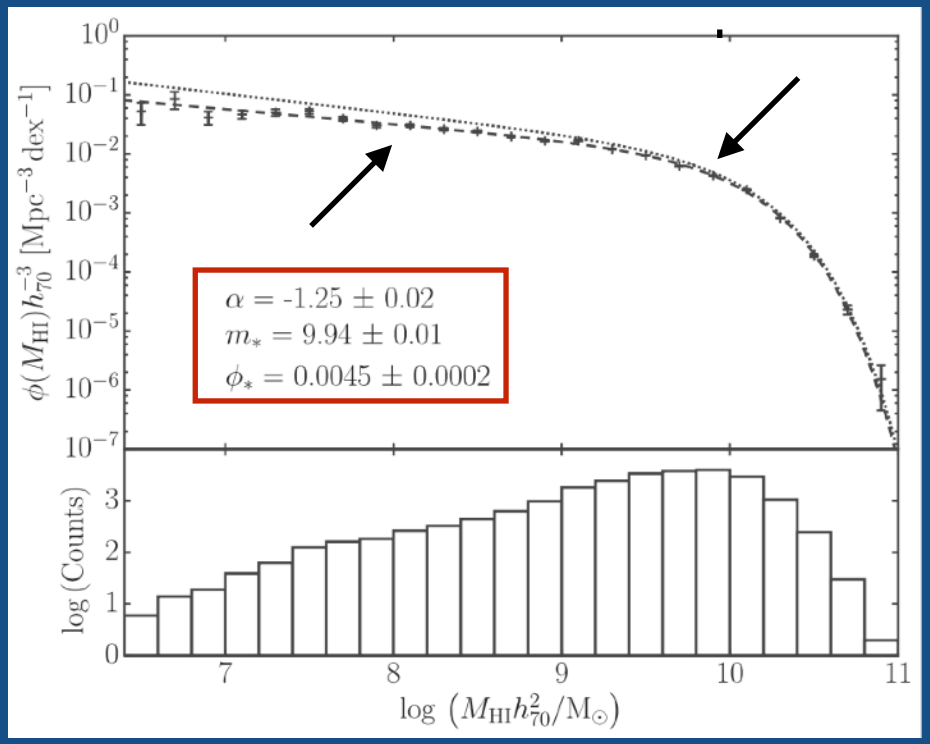

ALFALFA (Jones et al 2018)

Well fit by a Schechter Function:

$$\phi(M_{\rm HI}) = \ln(10)\,\phi_* \left(\frac{M_{\rm HI}}{M_*}\right)^{\alpha+1} e^{-\left(\frac{M_{\rm HI}}{M_*}\right)}$$

Slope

Knee

Why is the HI Mass Function important?

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- Number density of galaxies in the Universe as a function of their HI mass.

Well fit by a Schechter Function:

$$\phi(M_{\rm HI}) = \ln(10)\,\phi_* \left(\frac{M_{\rm HI}}{M_*}\right)^{\alpha+1} e^{-\left(\frac{M_{\rm HI}}{M_*}\right)}$$

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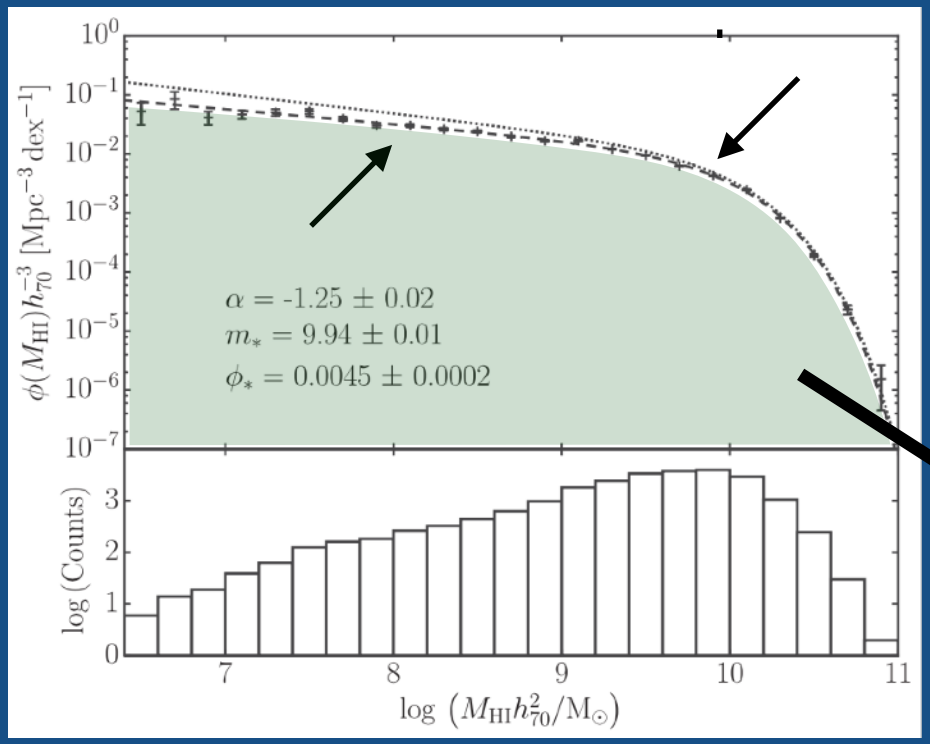
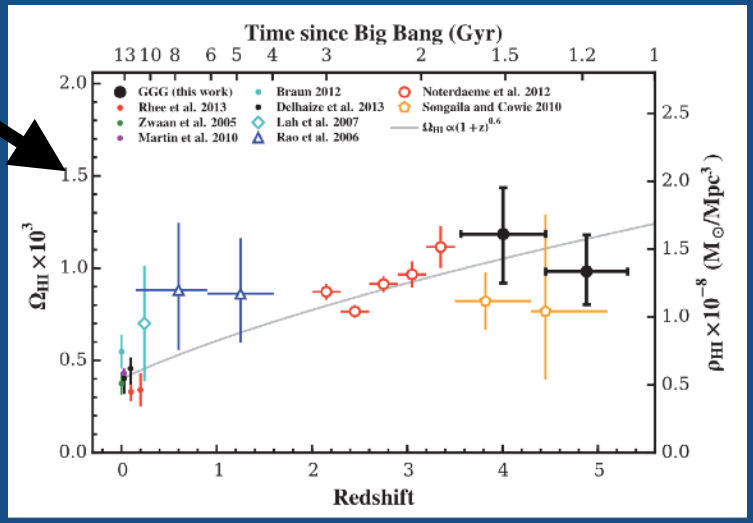


ALFALFA (Jones et al 2018)



Crighton et al (2015)

Environmental dependence on the HIMF?

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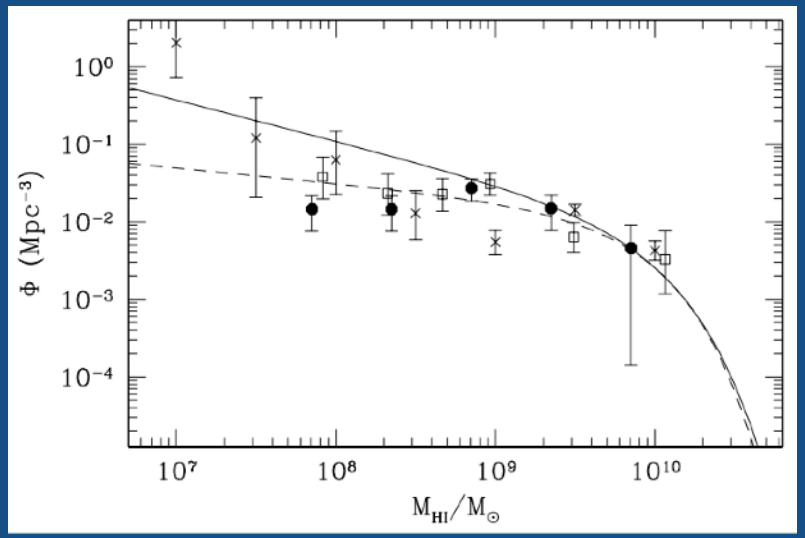
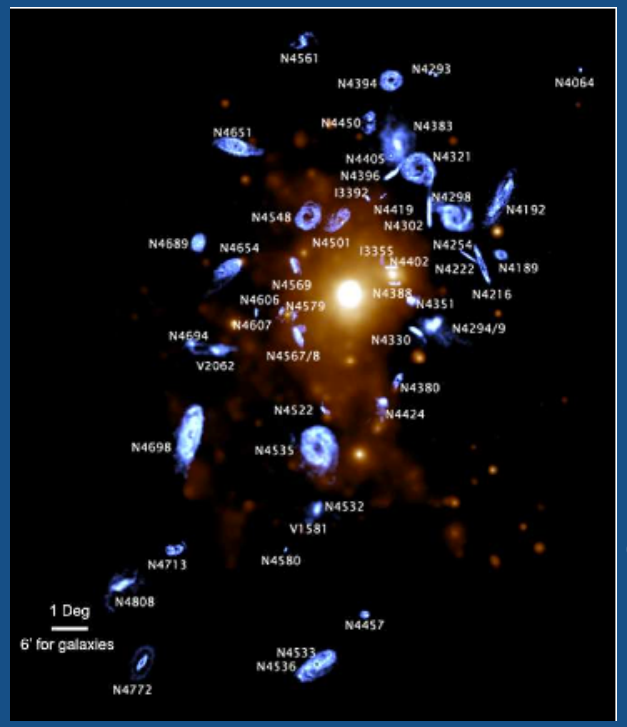
- Depends on your sample, definition of environment, and the scales which these probe. (e.g. Rosenberg & Schneider 2002; Zwaan et al 2005; Springob et al 2005; Moorman et al 2014; Jones et al 2016)
- Virgo Cluster HIMF apparently flattened compared to surroundings: gas processing?



Rosenberg & Schneider (2002)



VIVA; Chung et al (2009)

Galaxy groups: the primary site of galaxy evolution

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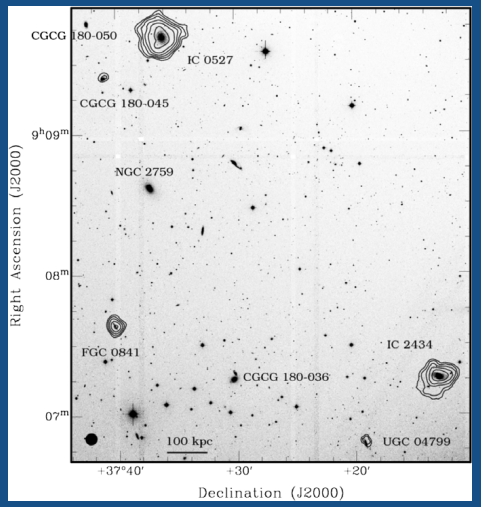
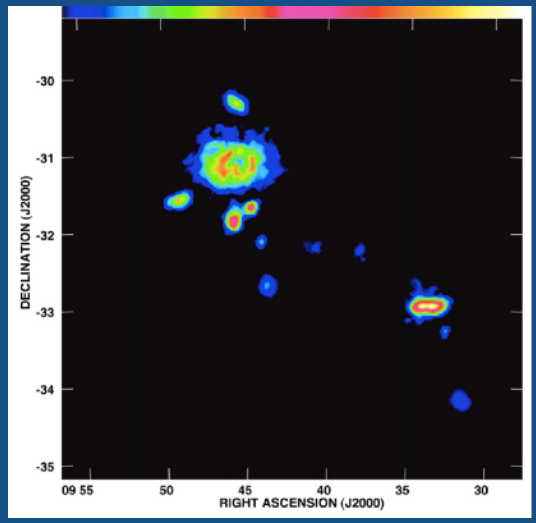
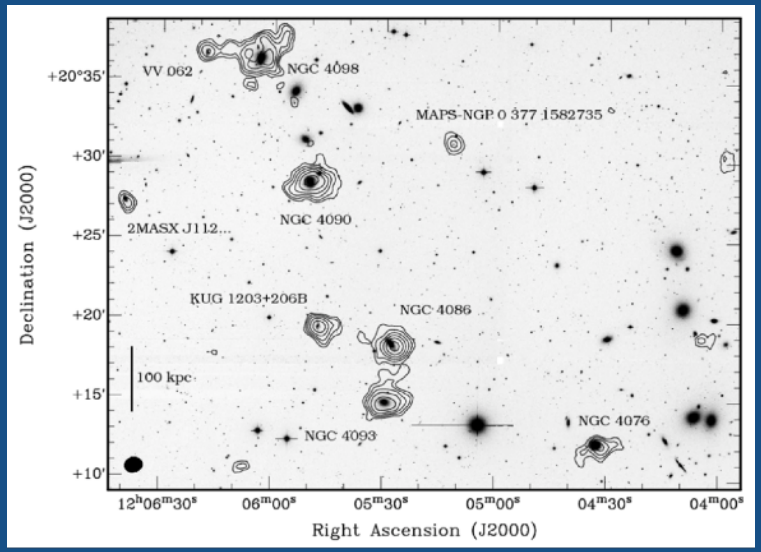
- 50-60% of galaxies live in group environment (Huchra & Geller, 1982; Crook et al 2004; Berlind et al 2006, 2009; Yang et al 2007, 2012; Tempel et al 2014; etc)
- Low velocity dispersion, high galaxy density —> opportunity for strong interactions and gas processing





Pisano et al (2011)



Freeland et al (2009)

Group HI Mass Function

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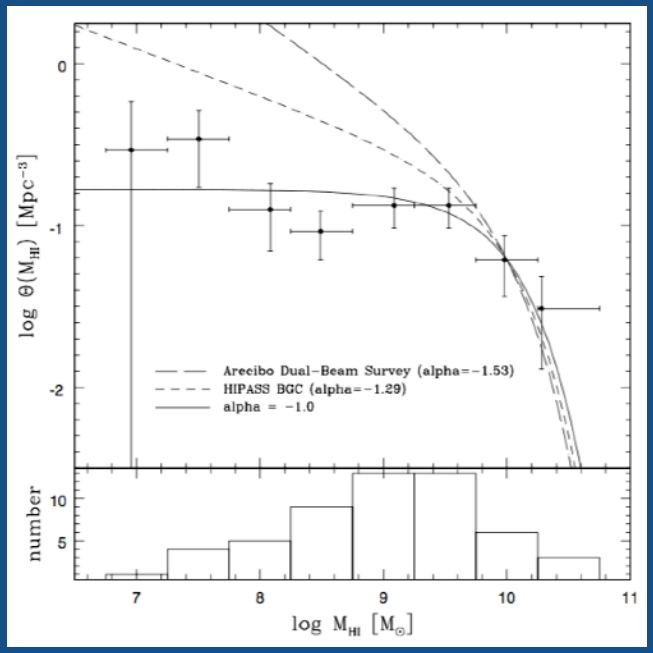
- Ursa Major; 32 HI detected galaxies (Verheijen et al 2001)
- Canes Venatici; 69 HI detected galaxies (Kovac et al 2005)
- 5 groups; 33 HI detected galaxies (Freeland et al 2009)
- 6 groups; 61 HI detected galaxies (Pisano et al 2011)



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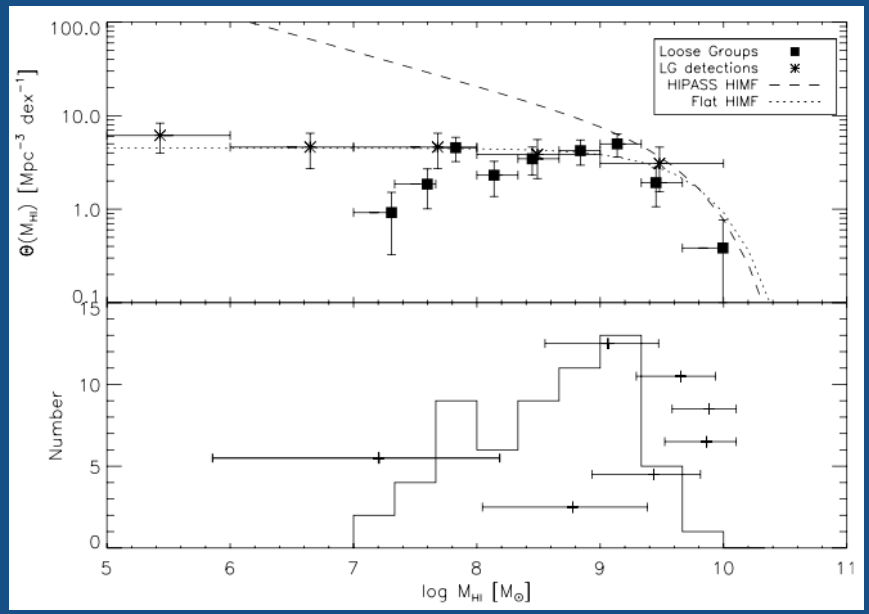

Pisano et al (2011)

SDSS Optical Group Catalogs (n≥3 members)

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Friends-of-Friends	Iterative Halo Finders
Berlind et al (2006, 2009) • SDSS DR7 • All M_r<-18 • Volume limited 0.02<z<0.42 • 1462 opt grps; 2346 HI gals	**Yang et al (2007, 2012)** • SDSS DR12 • Centrals M_r<-19.5 • Complete to z<0.08 • 2317 opt grps; 2753 HI gals
Tempel et al (2014) • SDSS DR10 • All M_r<-18 • Volume limited z<0.45 • 4023 opt grps; 1900 HI gals	**Lim et al (2017)** • SDSS DR13 • No mag limit • Complete z<0.05; $M_{grp}\sim10^{11.5}$ • 3770 opt grps; 2043 HI gals

Group HIMF Vmax Method

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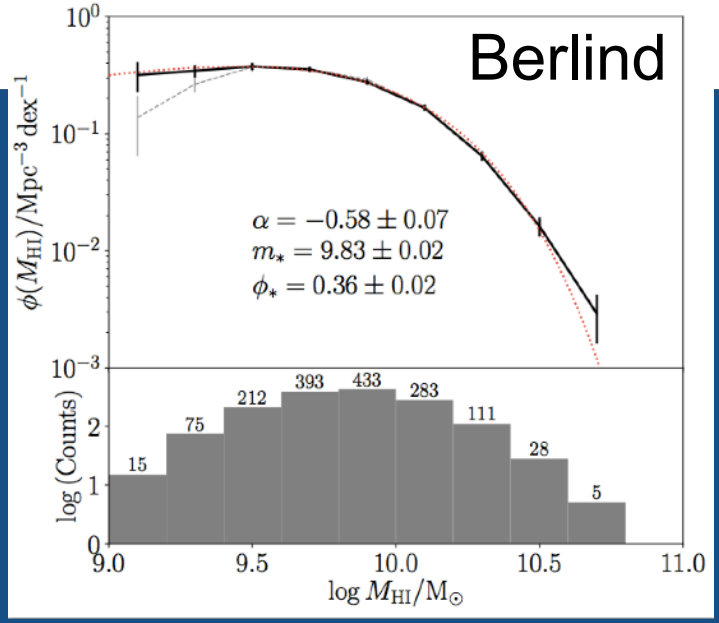

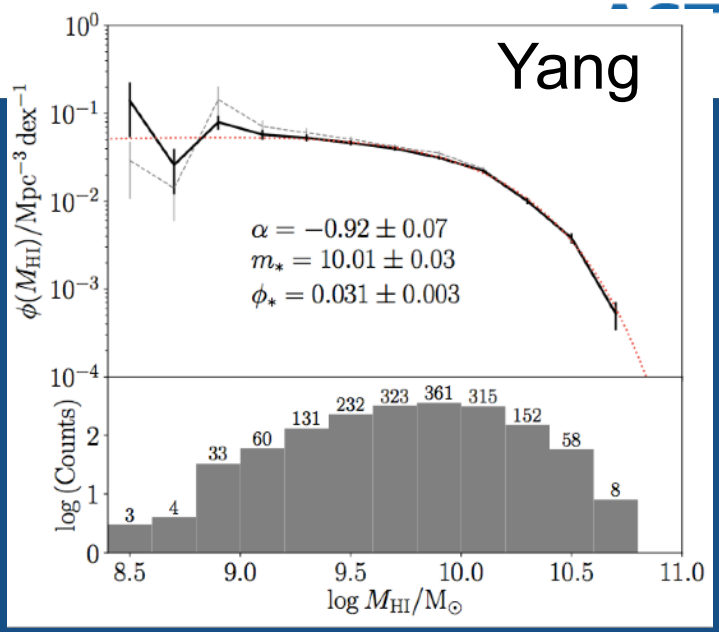

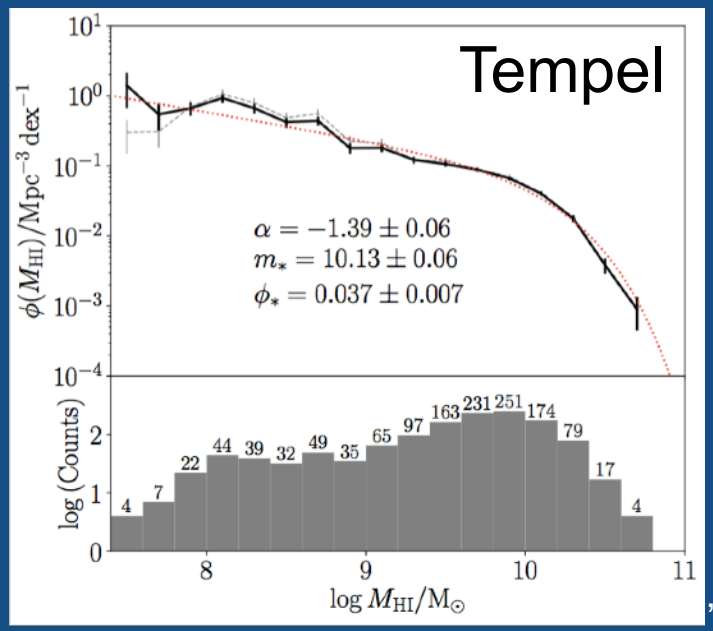

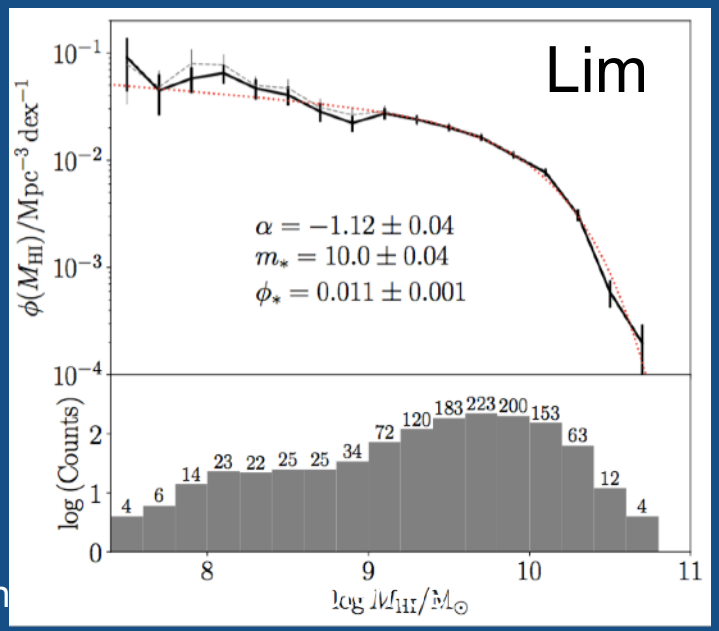

Details and corrections to the Group HIMF

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- Sensitivity to HI sources depend on both their flux and velocity width; broad sources are harder to detect.
  - Vmax & Veff methods correct for this if your sample extends to d=0 Mpc because it samples the full distribution of velocity widths at a given HI mass.
- Group catalog is a collection of galaxy subsamples: must correct for
- Large scale structure along the line of sight produces a bias

Vmax for Group Galaxies

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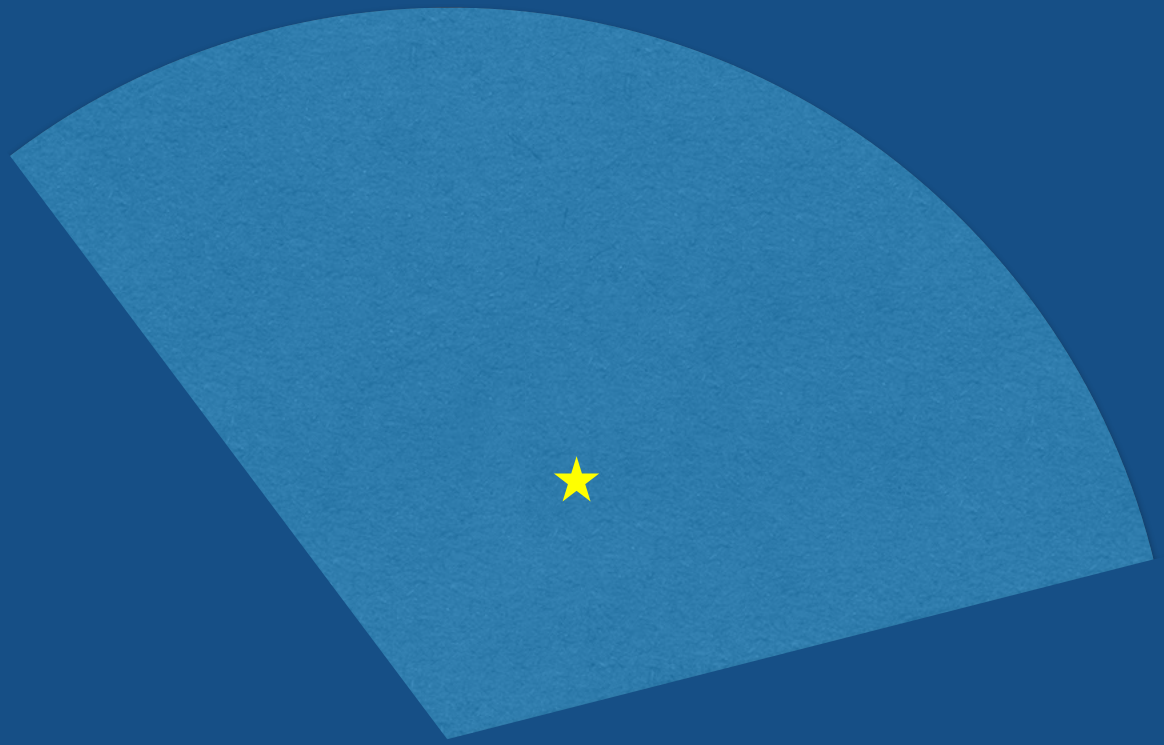
- Vmax - correct by the ratio of the volume in which a galaxy can be detected over the volume of the survey



Vmax for Group Galaxies

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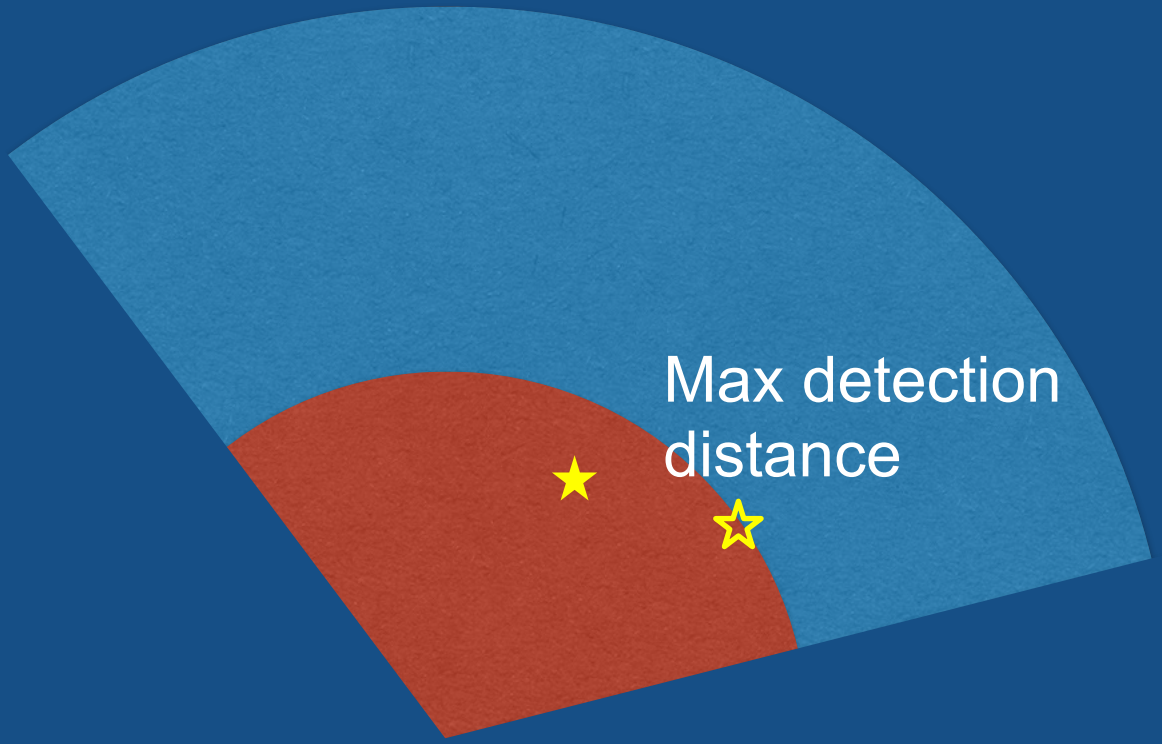

Vmax, velocity width correction for group galaxies

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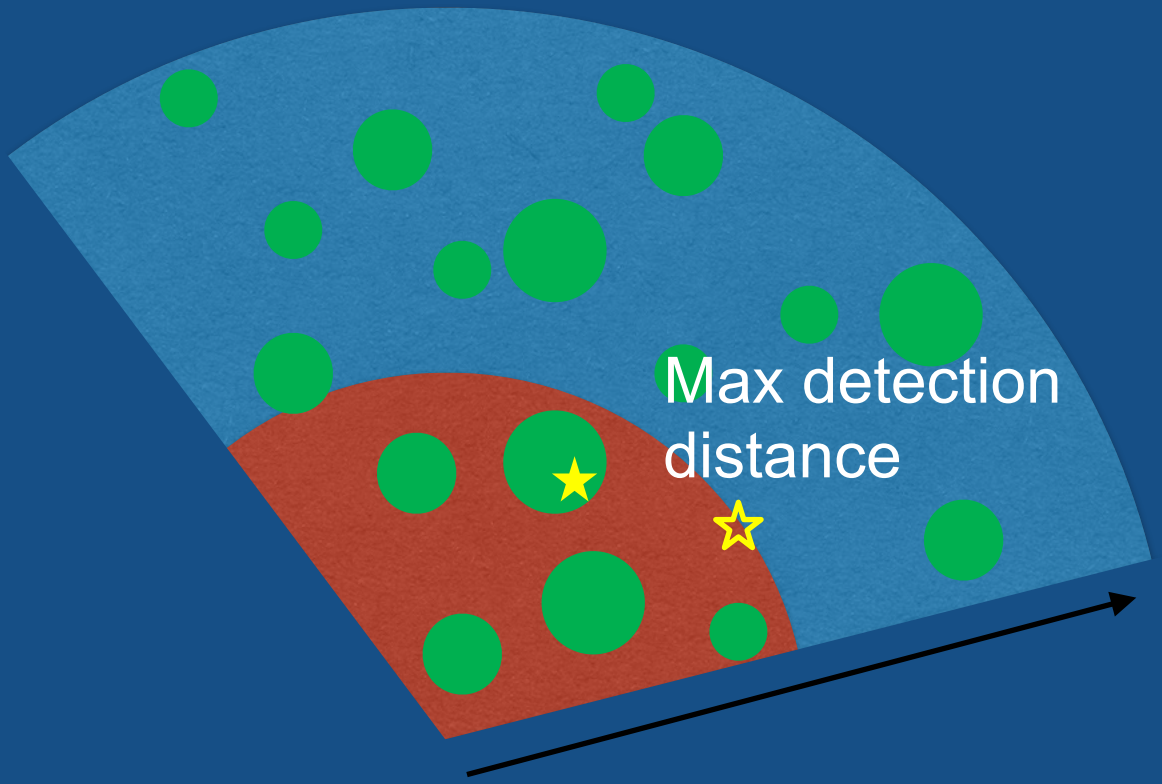
- Vmax - correct by the ratio of the volume in which a galaxy can be detected over the volume of the survey
- Velocity width - correct for not fully sampling mass-width distribution



Vmax, velocity width, LSS correction for group galaxies

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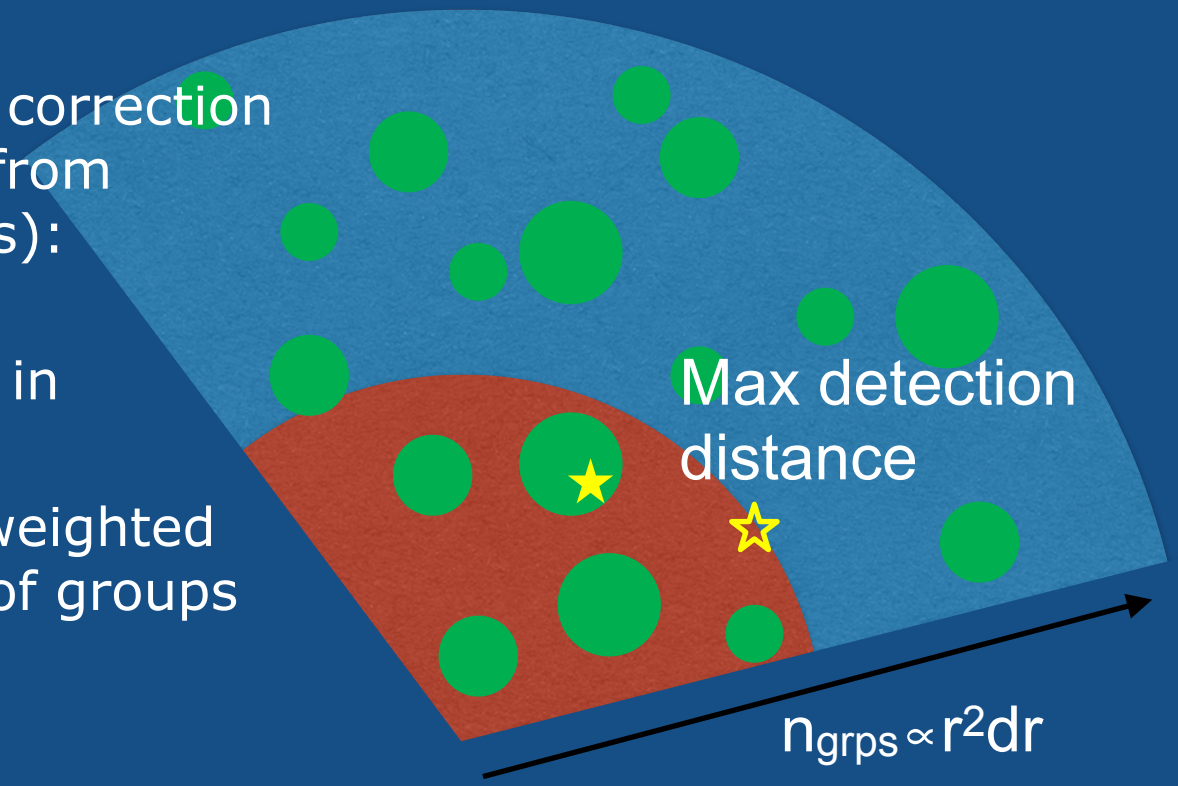
- Vmax - correct by the ratio of the volume in which a galaxy can be detected over the volume of the survey
- Velocity width - correct for not fully sampling mass-width distribution
- Large Scale Structure correction (a relative correction from the groups themselves):
  - Correct for over-density of groups in shells dr=4 Mpc
  - "Group volume" weighted average number of groups per bin



Group HIMF Vmax Method

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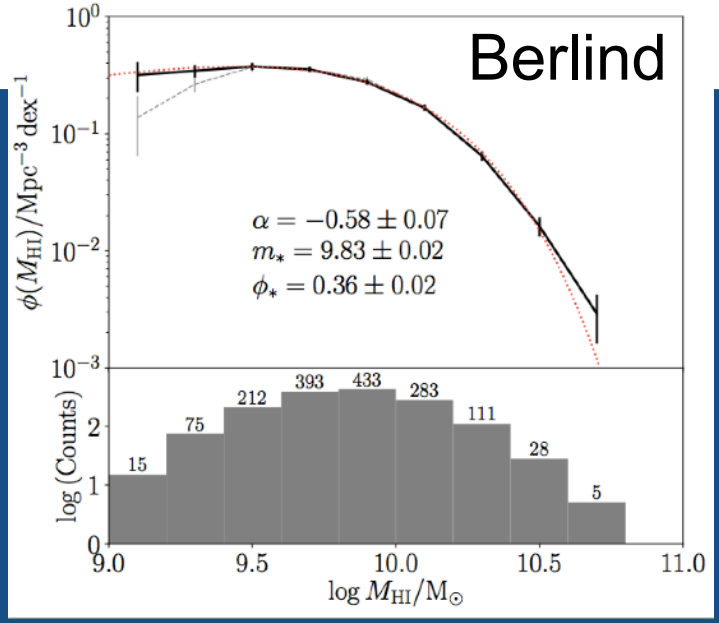

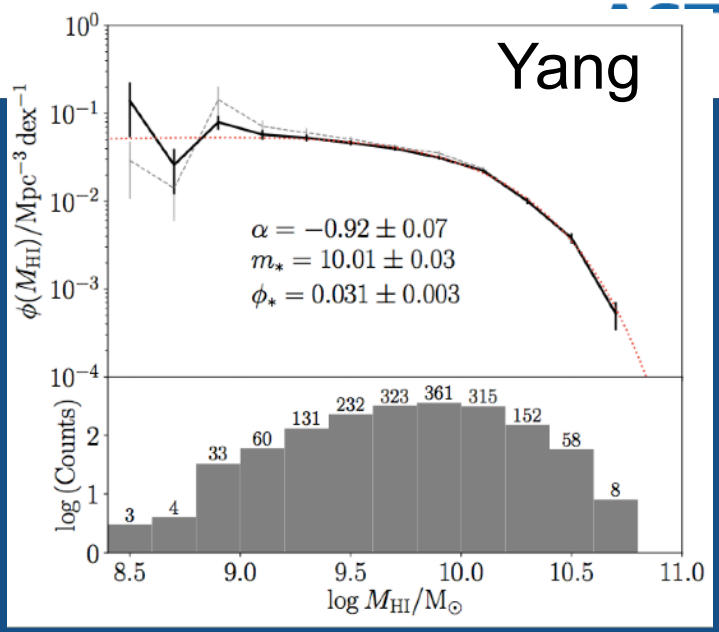

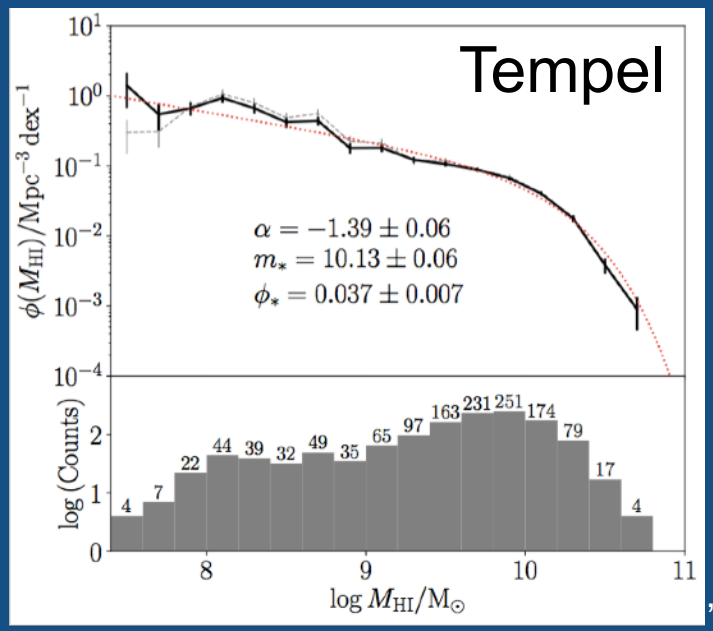

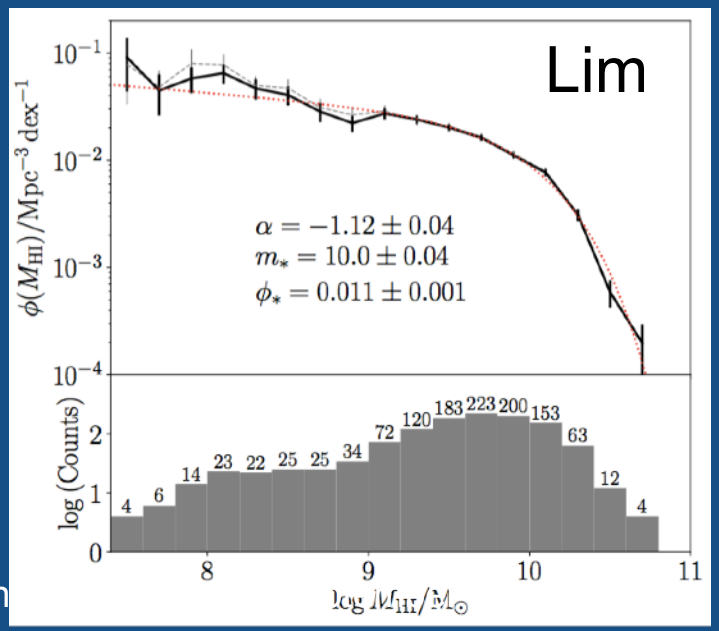

Large Scale Structure Correction

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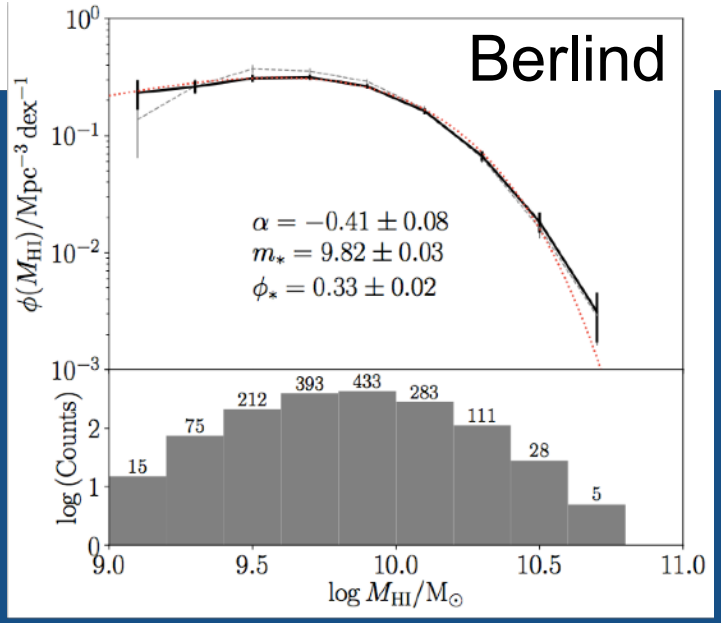

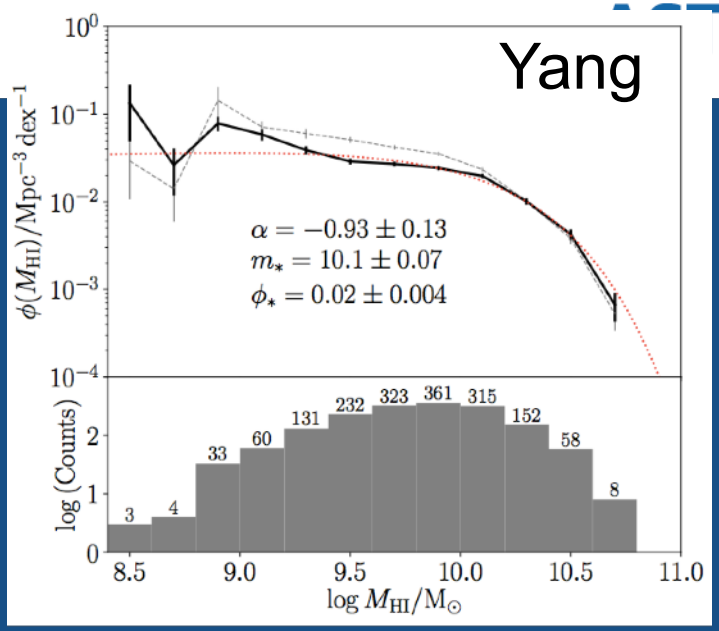

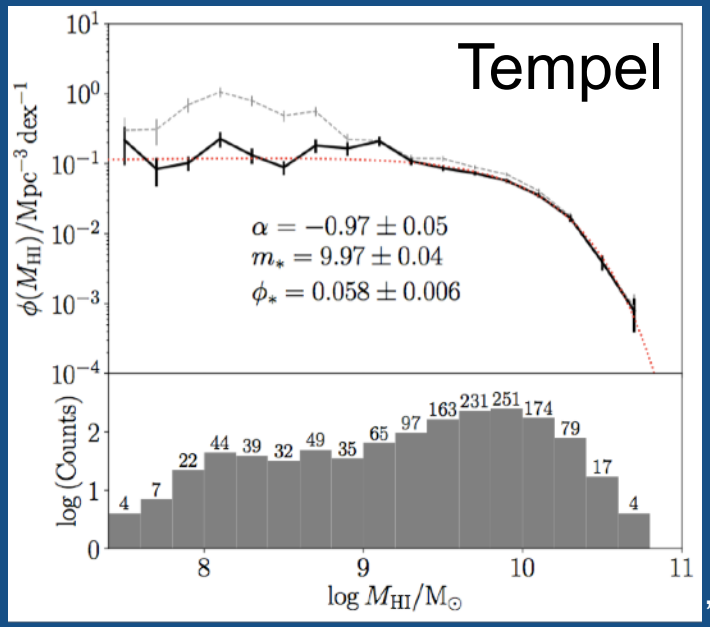

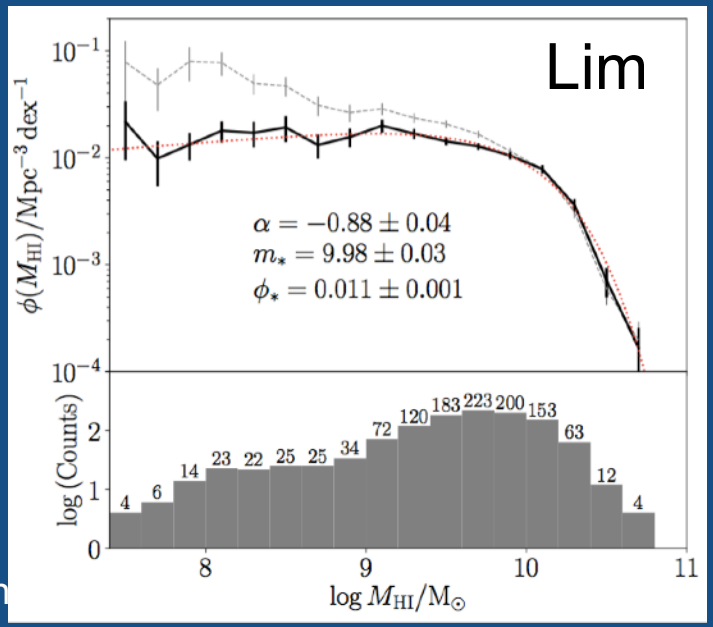

Group HIMF Vmax Method

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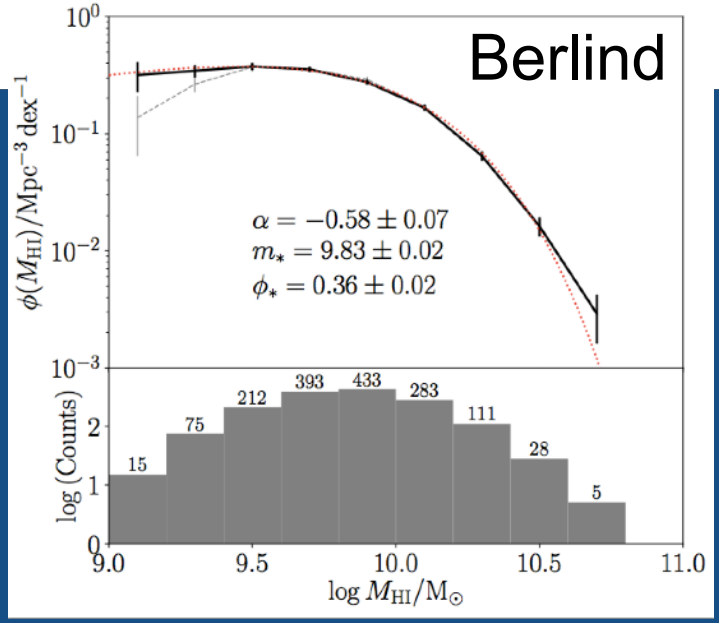

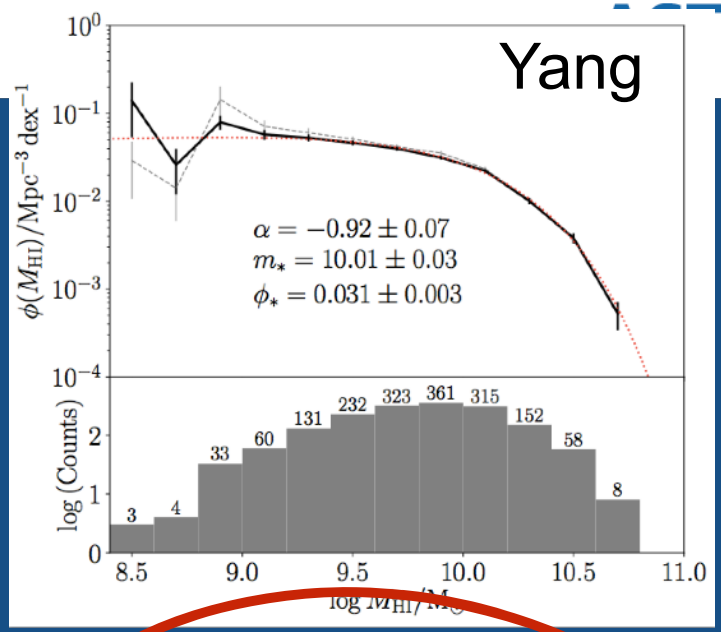

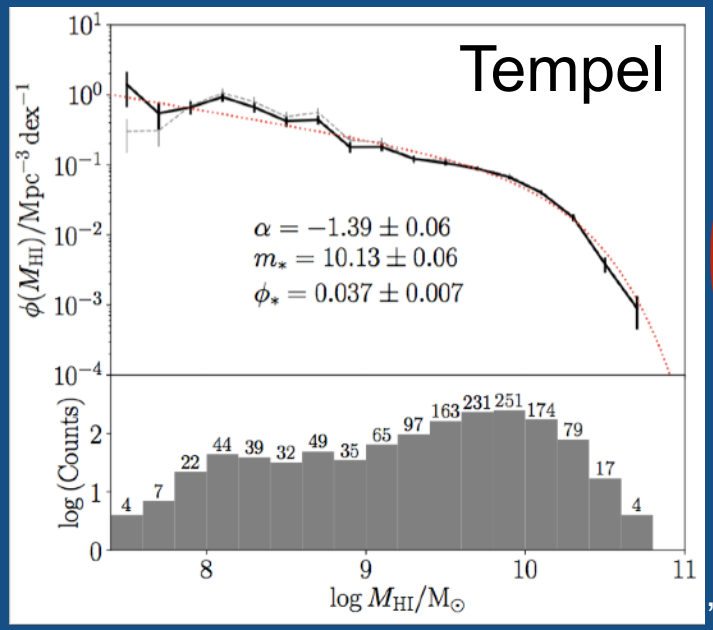

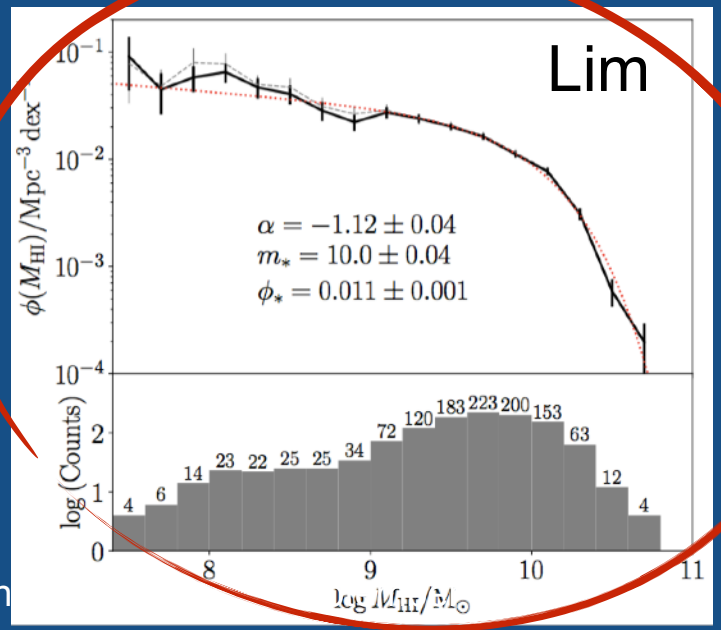

Lim Group HI Mass Function

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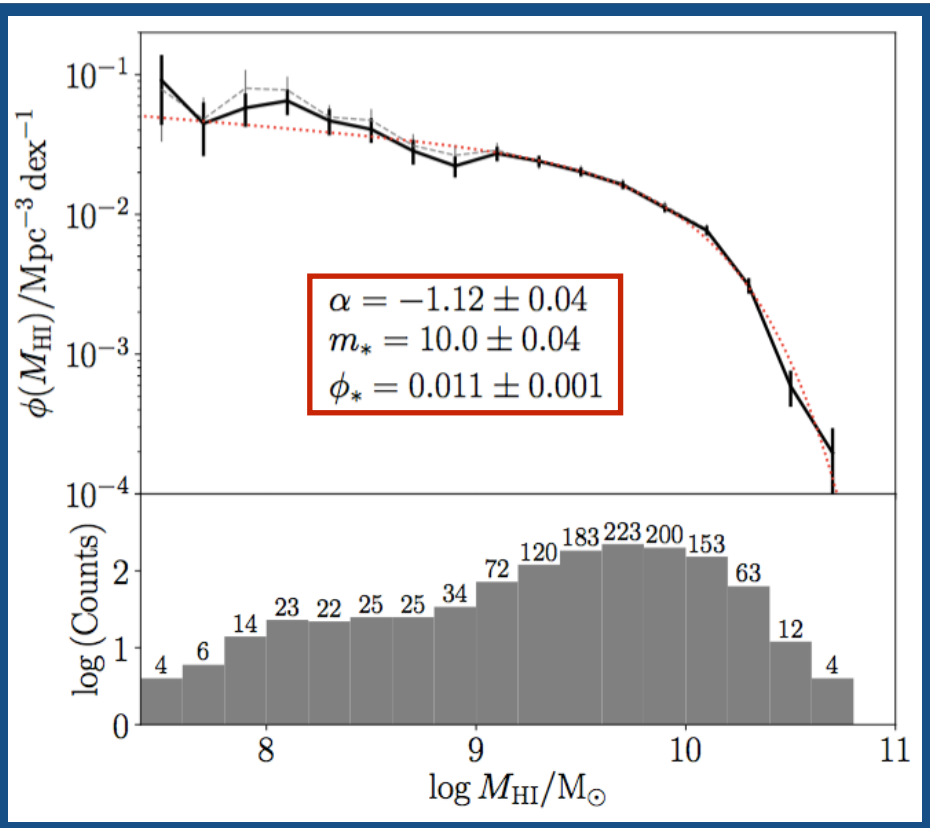

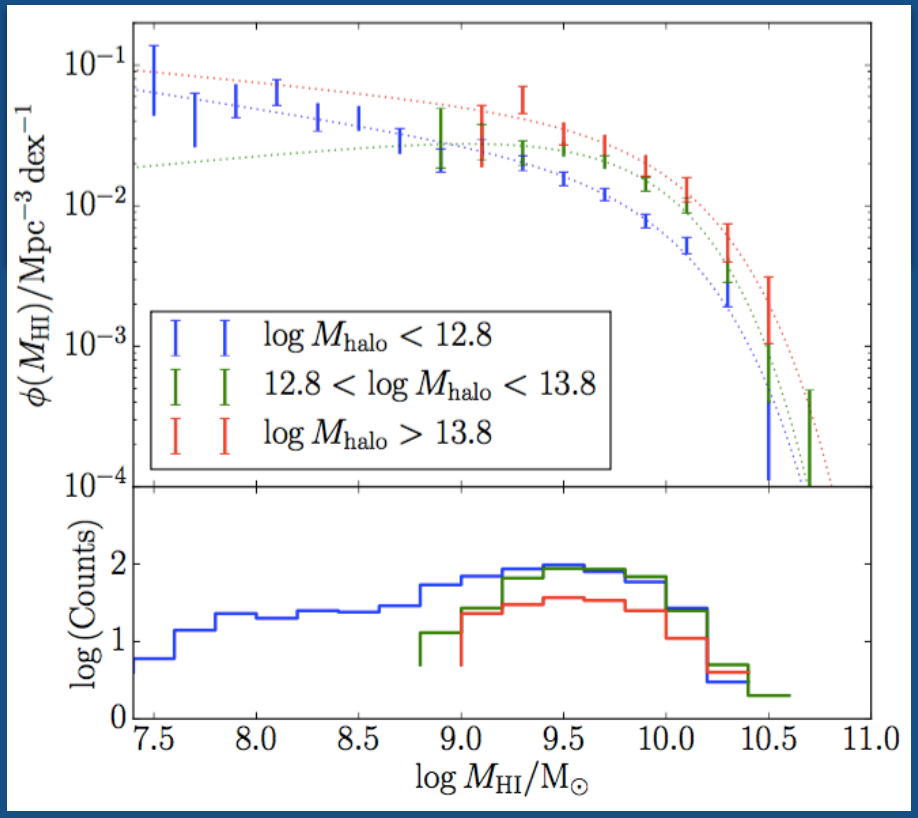

Group HIMF is the sum of groups of range of halo masses:

- High mass end is dominated by galaxies in more massive halos
- Low mass end is dominated by nearby low mass groups

Preliminary Results of the Group HI Mass Function

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- Investigating the HIMF in 4 different SDSS group catalogs.
  - Highlights differences between the group catalogs & their shortcomings.
- Number of groups and galaxies increased by ~2-3 orders of magnitude over previous studies.
  - 2000-3500 galaxy groups, with ~2000 HI galaxies.
- Group HIMF M* is dominated by galaxies that live in high mass groups.
- Low mass slope appears flatter than global HIMF.
  - Dominated by galaxies in low mass groups