The Galaxy Velocity Function Since z=1.5 in DEEP2

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What is a Galaxy Velocity Function?

In analogy with the galaxy luminosity function, or the galaxy stellar mass function...

the galaxy velocity function is the *number density of galaxies as a function of their internal velocities*.

Major goals = study galaxy assembly and trace dark halos.

(Also a probe of cosmology, e.g., Newman & Davis 00,02).

Why Study the Galaxy Velocity Function?

It's not straightforward to relate galaxy L's or even M_*'s to the dark halos in which they reside.

- Significant errors in M_*'s (*at least* factor of 2-3)

- The galaxy property a dark halo velocity most directly compares to is galaxy velocity (Navarro & Steinmetz 97; Klypin et al. 02).

- Dark halo masses most directly traced by V_c

Data for the Galaxy Velocity Function

- Need a large redshift survey with high enough spectral resolution to measure internal kinematics

  => DEEP2 Survey

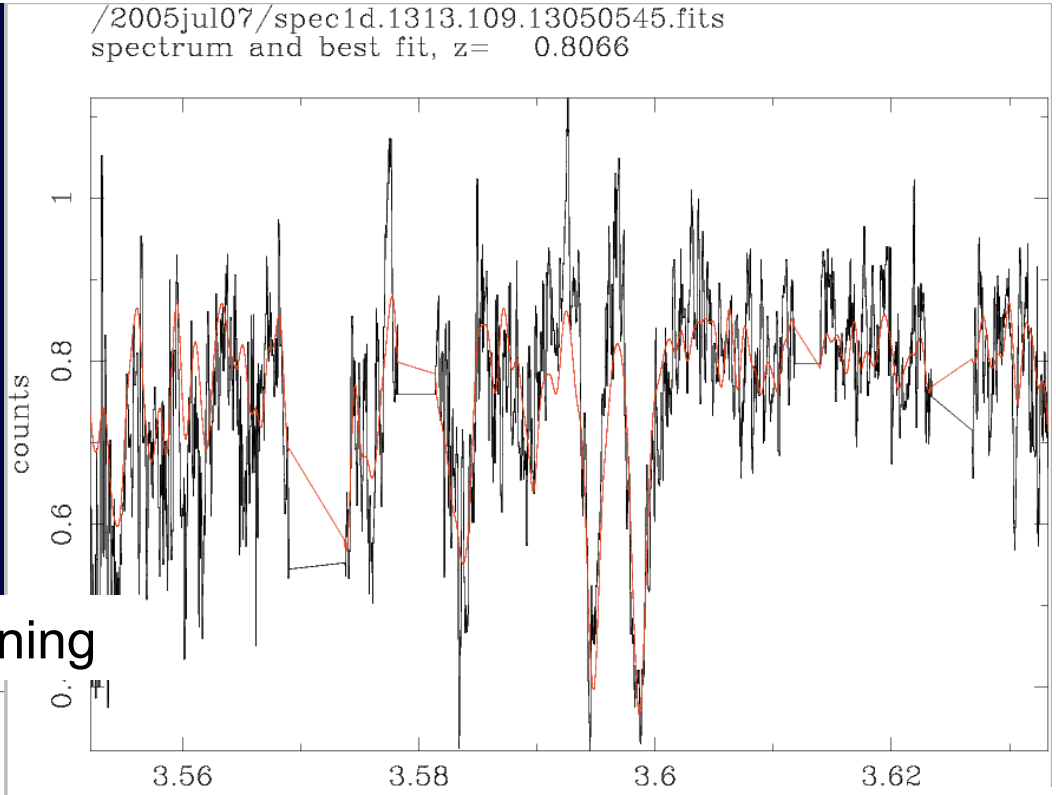
- ~50,000 spectra

- ~30,000 spectra with successful measurements of emission linewidths or absorption line velocity dispersions

Galaxy σ Measurements

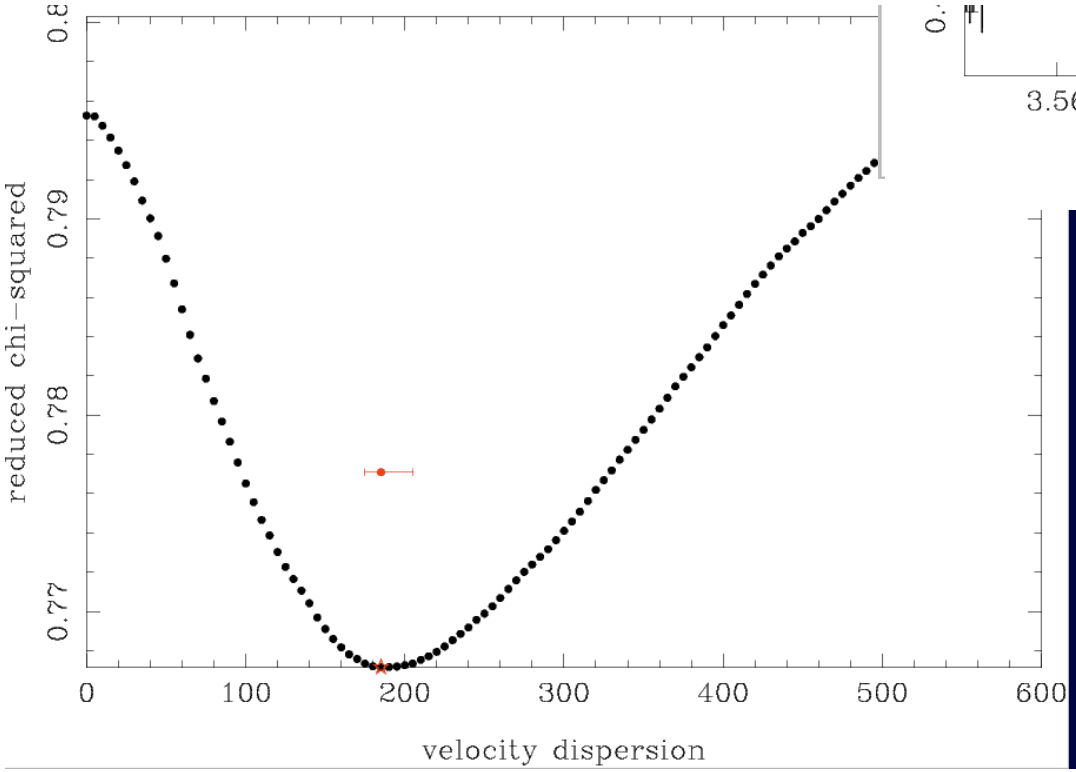
- **Absorption line σ's** measure the velocity dispersion of early type galaxies within the effective radius (Gebhardt et al. 2003)
- Emission line σ's
  - For rotation dominated systems, they measure 0.6Vrot (Rix et al. 1997, Weiner et al. 2006a)
  - For disturbed systems, they sum all disordered motions beneath the seeing limit (Weiner et al. 2006a)
- Automated programs:
  - FITDISP performs least squares fits to absorption line spectra with a linear combination of broadened stellar templates, fits for broadening
  - LINEFIT performs a least-squares fit to the emission lines, fits for linewidth

Example FITDISP output: Fitting to Ca HK lines for a Galaxy at z=0.8



log rest wavelength

Chi squared as a function of broadening



Least squares fit to spectrum with a linear combination of broadened stellar templates from MILES.

For each spectrum, 50 Monte Carlo realizations are simulated and re-fit to get error on sigma.

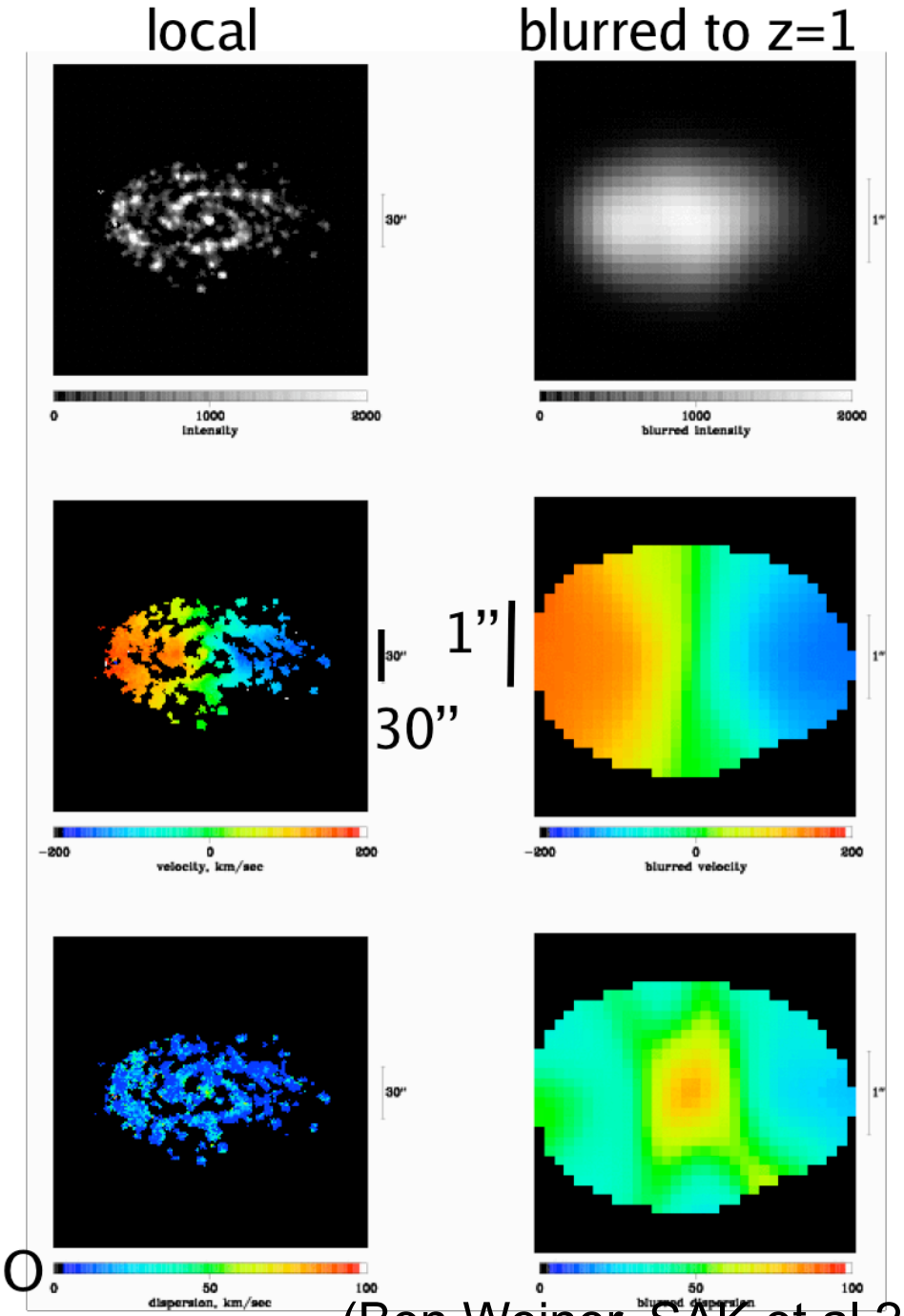
What normal disk kinematics would look like at z=1

intensity

velocity

Seeing blurs velocity into "dispersion" - model this when fitting the data.

dispersion

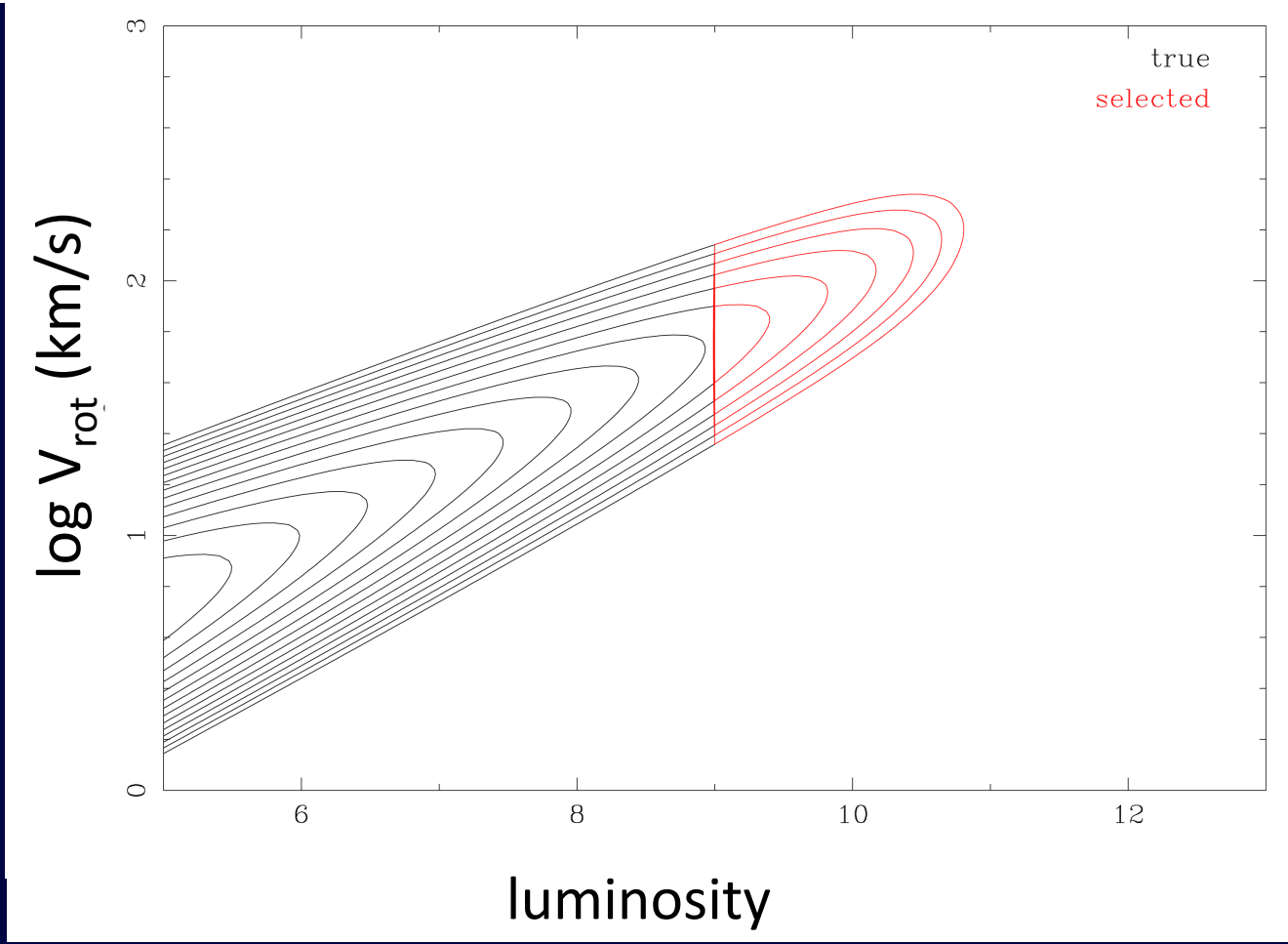


H-alpha vel field of NGC 7171, from Rutgers Fabry-Perot at CTIO

(Ben Weiner, SAK et al 2006)

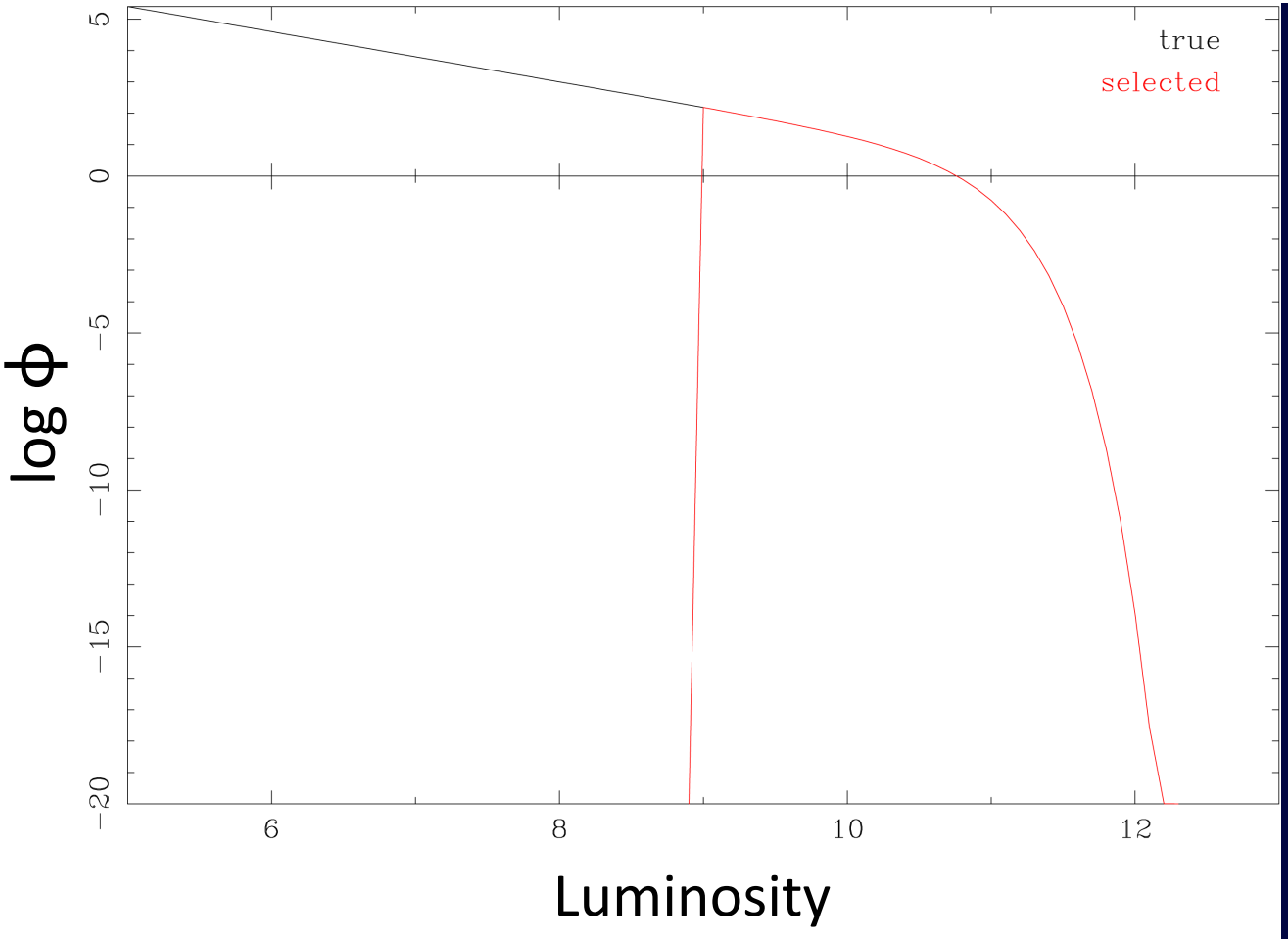
Incompleteness in the Velocity Function

Given a Tully-Fisher Relation, Make Luminosity Selection



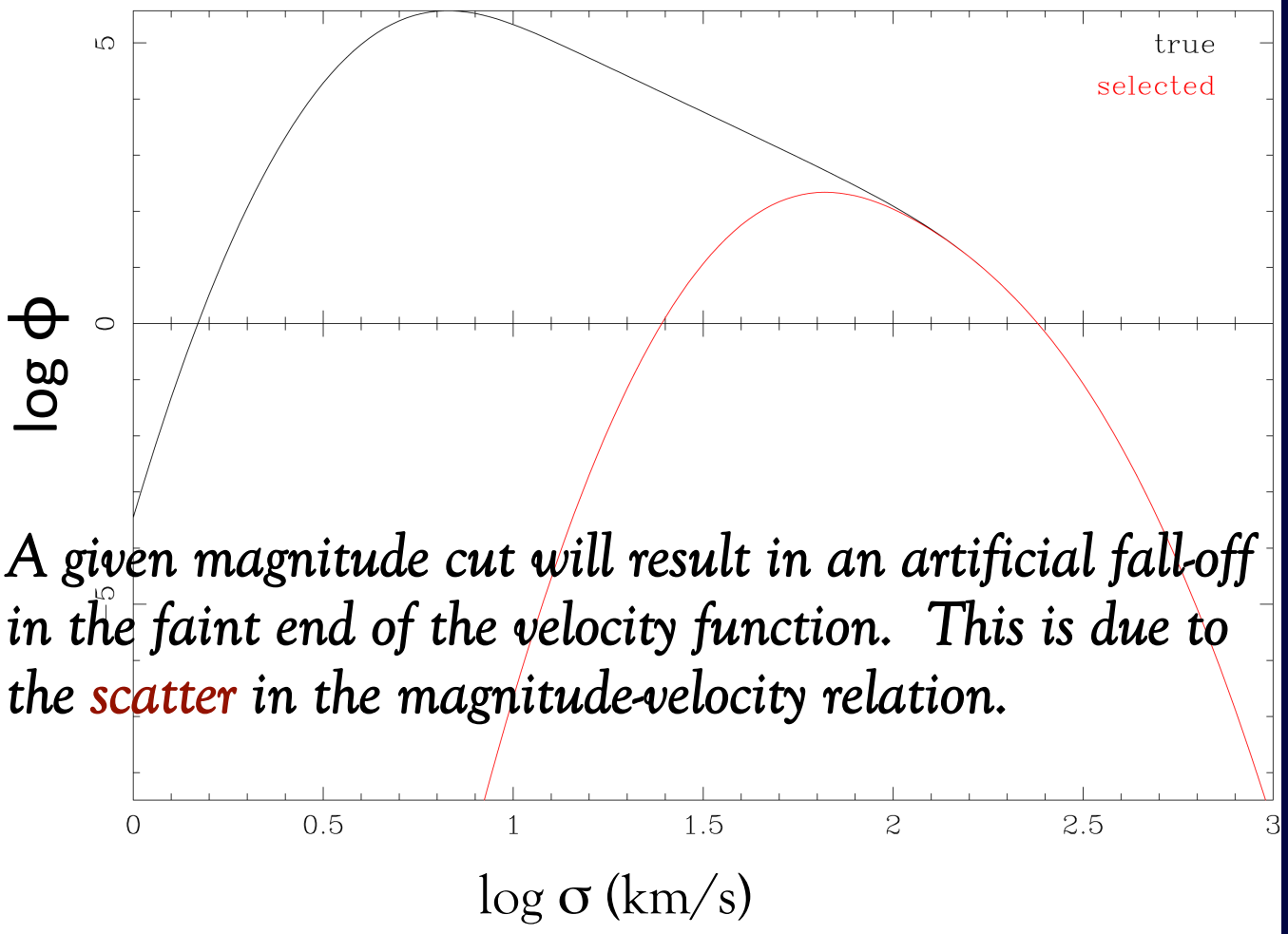
Incompleteness in the Velocity Function

Luminosity Selection in a Luminosity Function



Incompleteness in the Velocity Function

Magnitude Selection in a Velocity Function

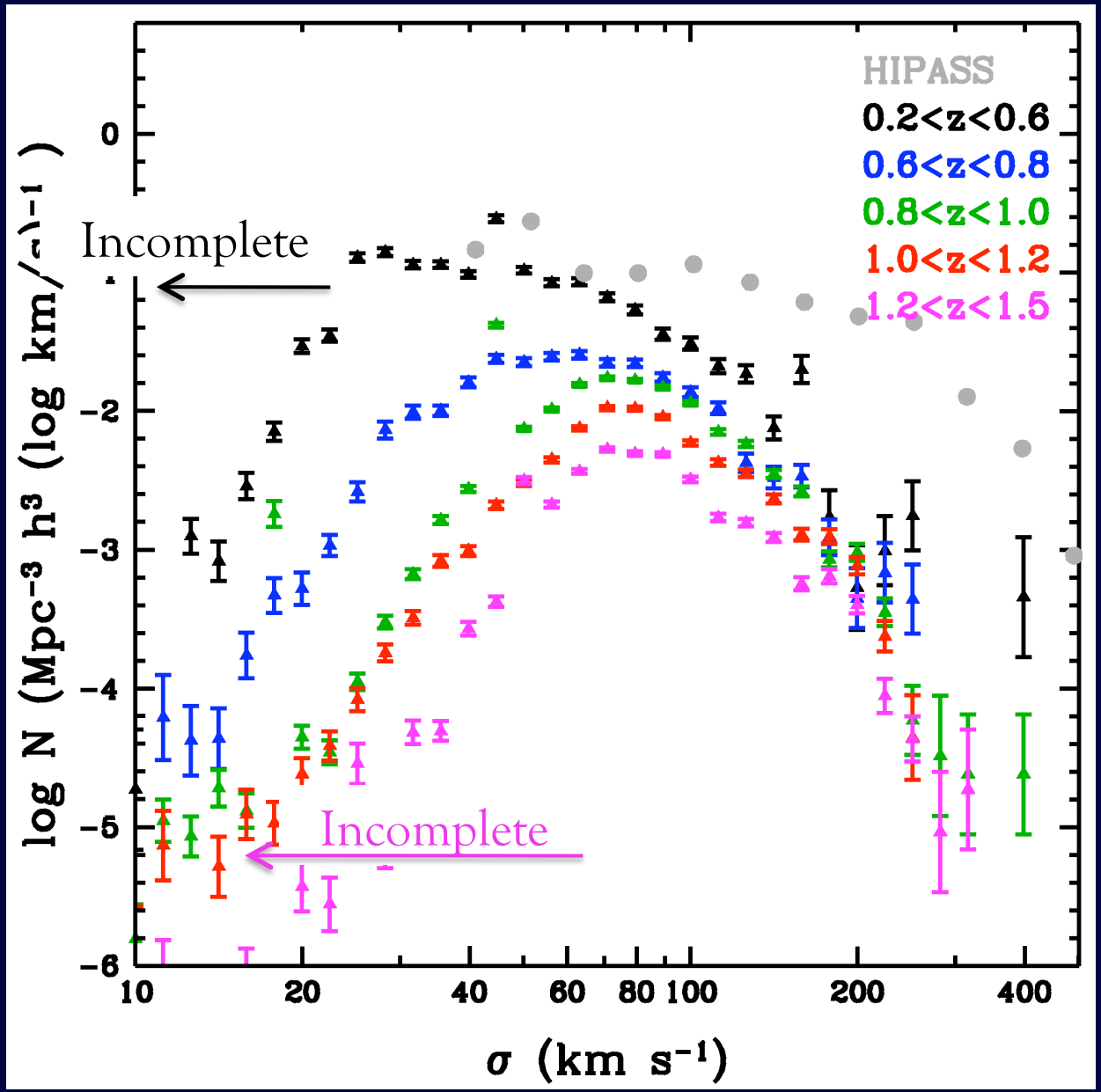


A given magnitude cut will result in an artificial fall-off in the faint end of the velocity function. This is due to the scatter in the magnitude-velocity relation.

Velocity Function for *Emission Line* Galaxies

Emission line widths sum rotation and random motions beneath seeing limit (Weiner et al. 2006a)

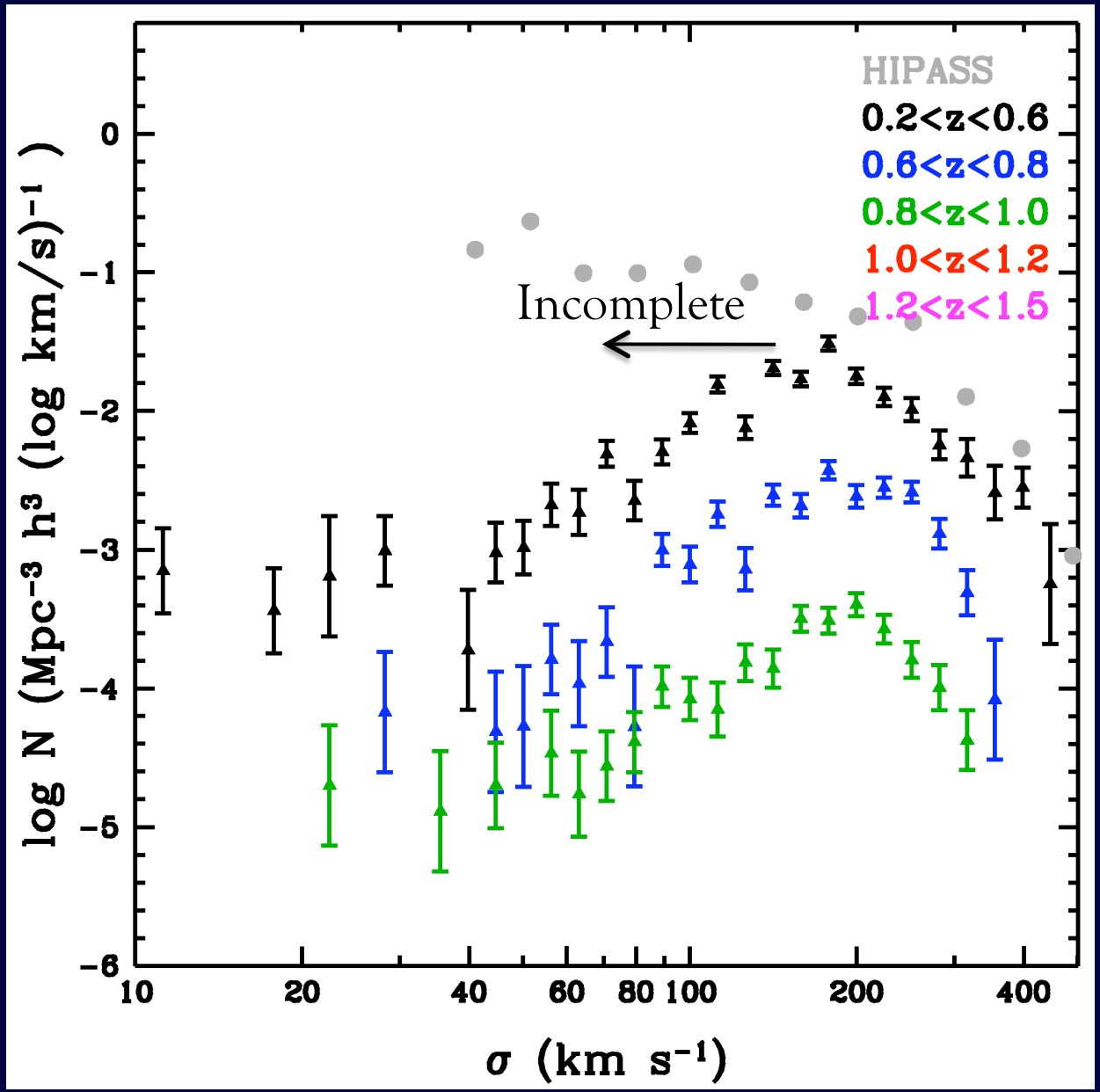
Increase in σ over 0.2<z<1.5 by a factor of ~1.5-2, perhaps also some σ^* evolution



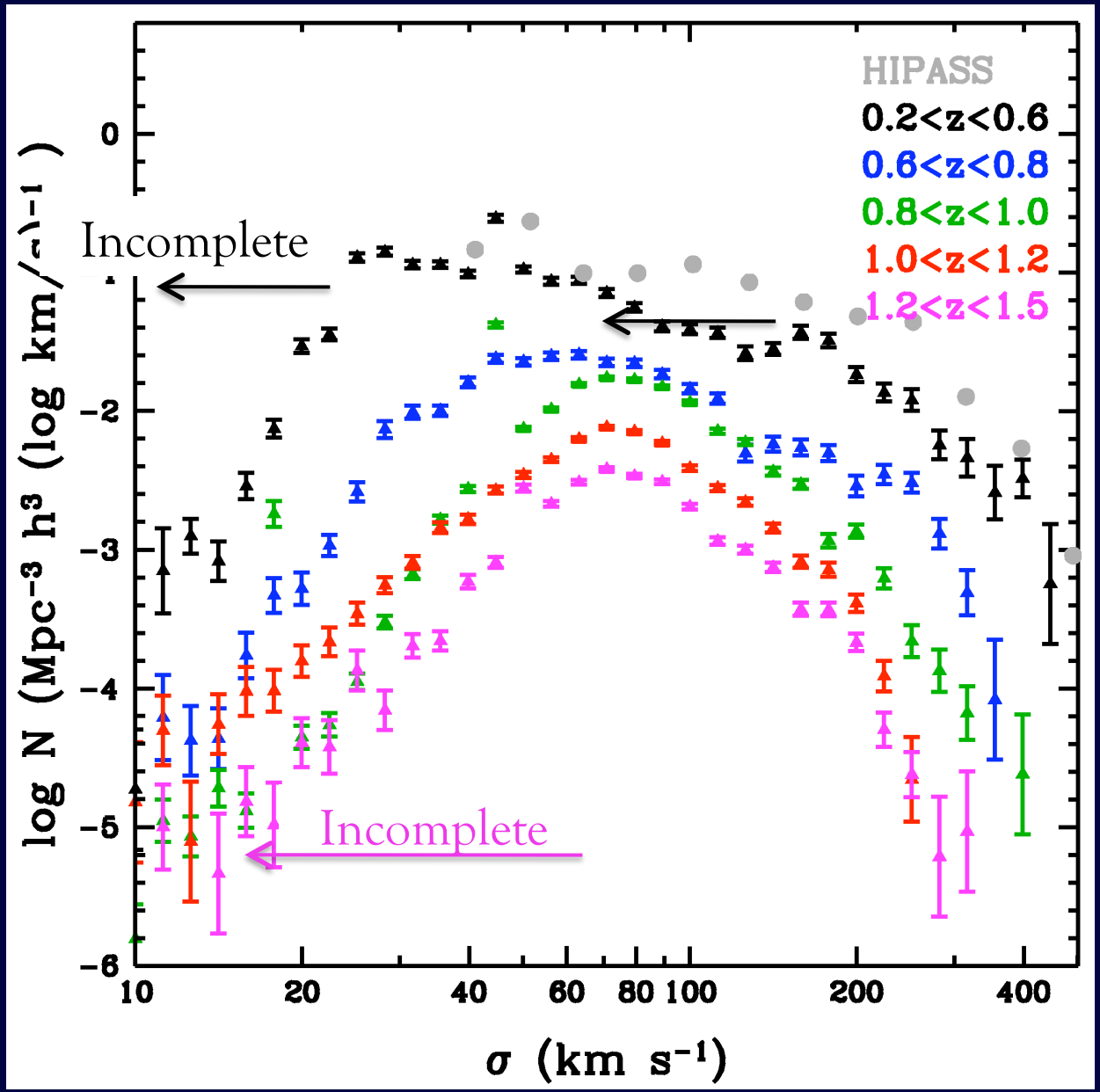
Velocity Function for *Absorption Line* Galaxies

Absorption line widths measure velocity dispersion within the effective radius (Gebhardt et al. 2003)

Evolution in σ^*, magnitude of which TBD



Velocity Function for *Emission and Absorption Line* Galaxies

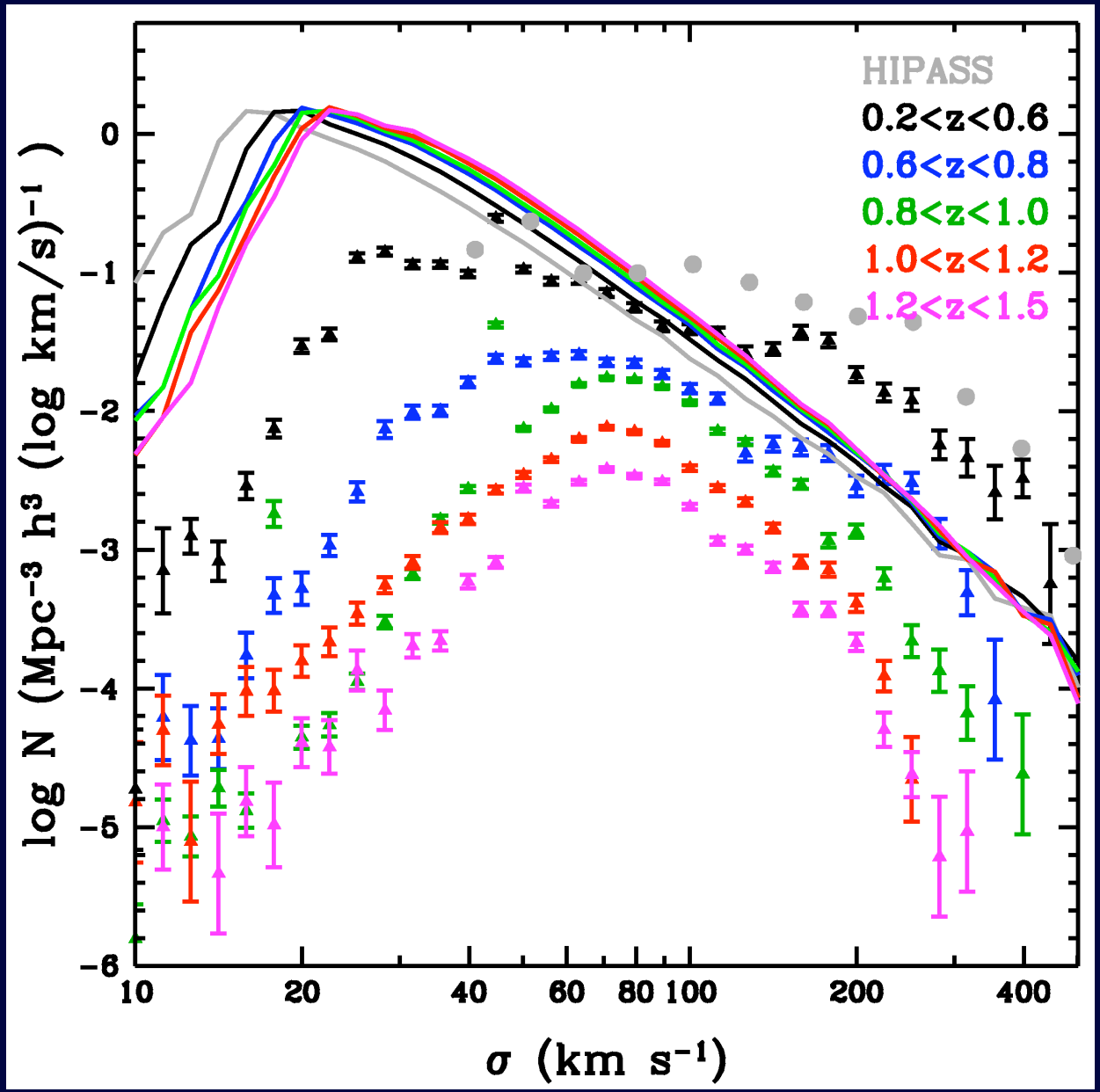


Velocity Function for *Emission and Absorption Line* Galaxies

Need SAMS
(and cosmolgical hydro simulations)

Vvir for dark matter halos from N-body simulation plotted as solid lines (Project Horizon, Julien Devriendt)

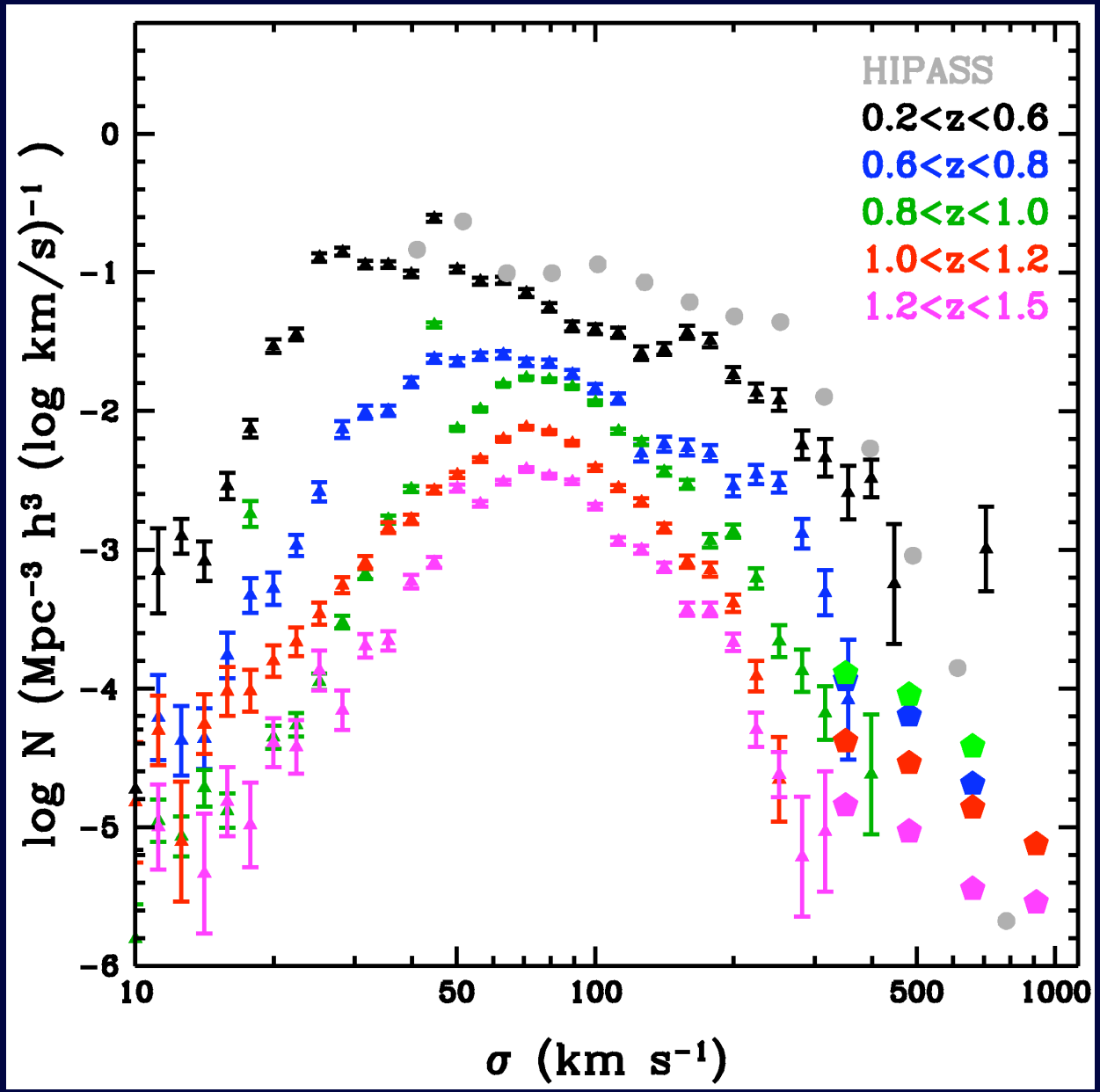
Much less evolution found for simulated halos, and in opposite sense



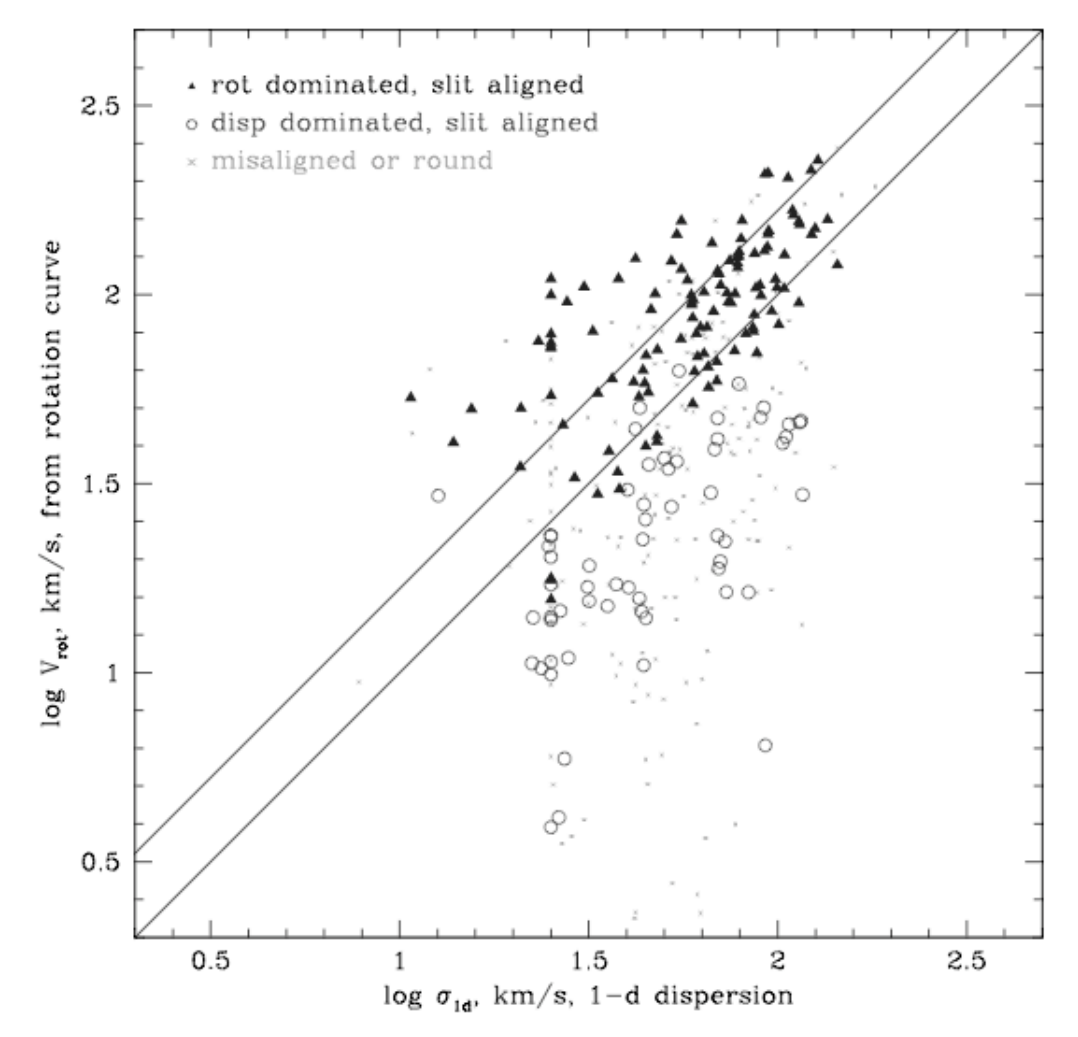
Velocity Function for *Emission and Absorption Line* Galaxies and *Groups*

Note change in velocity scale from previous plot

Group measurements in DEEP2 from Brian Gerke



V_{rot} versus σ for Emission Line Galaxies



The lines plotted are the 1:1 line and V=0.6sigma (Rix et al. 1997).

Sigma captures the velocity scale for rotation and dispersion dominated galaxies, while Vrot only works for rotation dominated galaxies.

From Weiner, SAK et al. 2006a