Abundance of Field Galaxies

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Abundance of Field Galaxies

Klypin, Karachentsev, Makarov 2014

Goals:

Observational measurements of Galaxy velocity function for a sample, which is not HI-selected and includes all types of galaxies

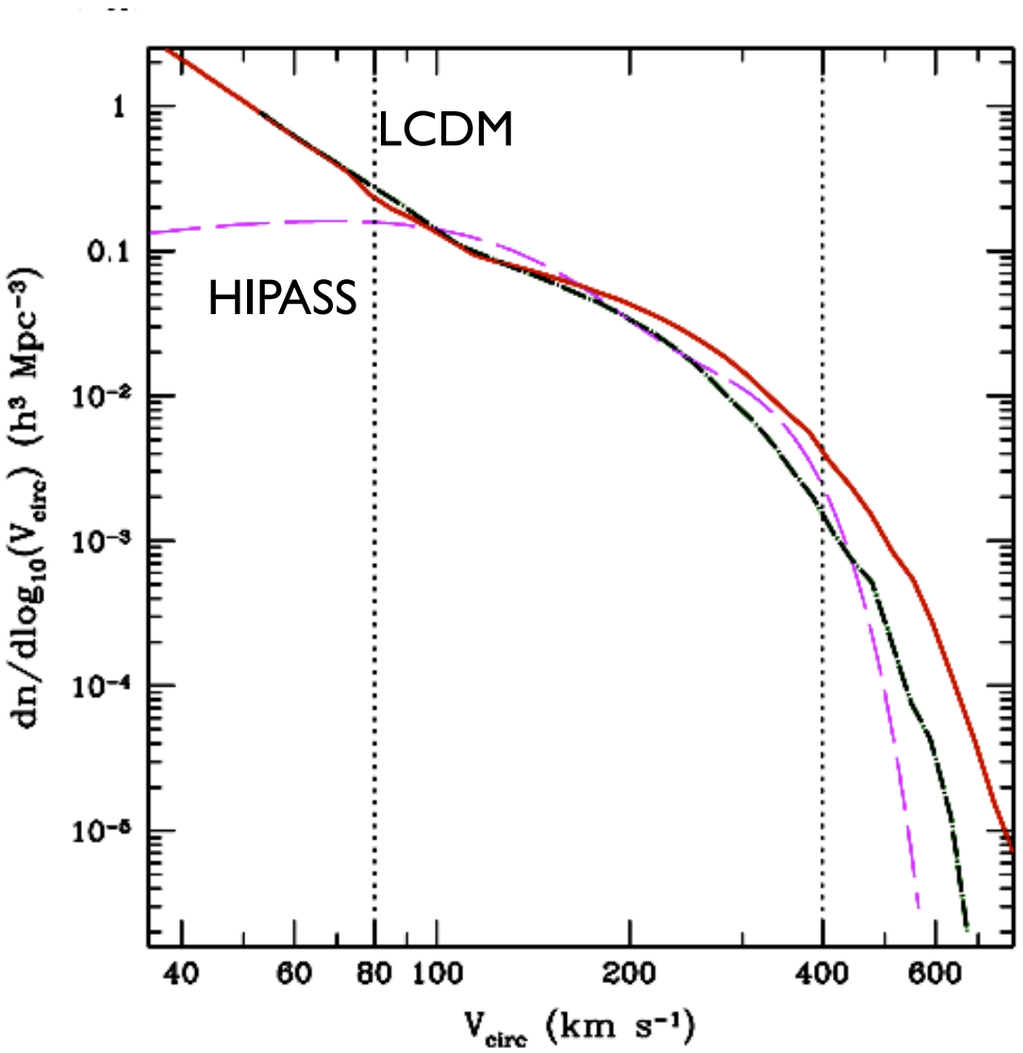
Local Volume:

600 dwarf galaxies

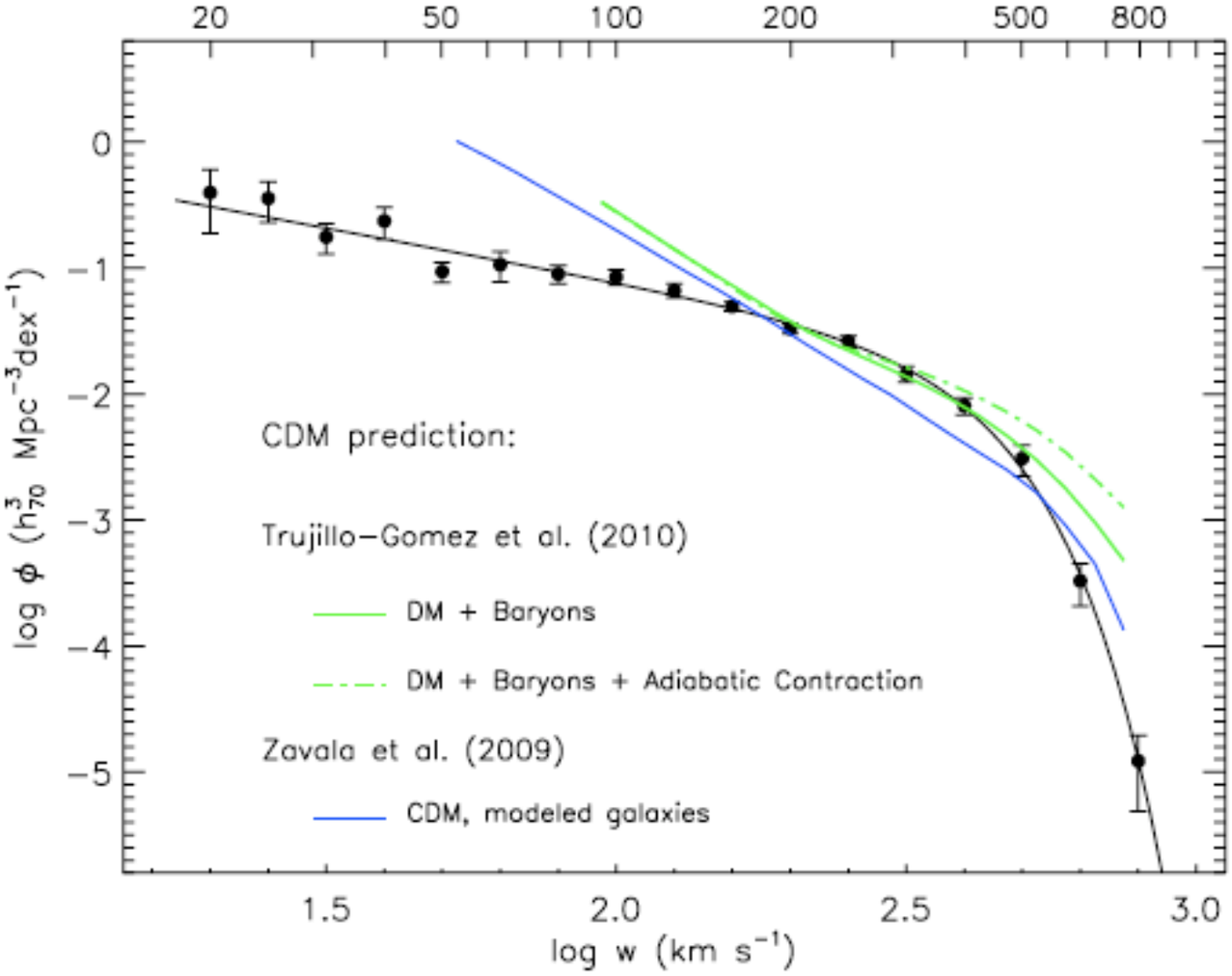
- most are not satellites
- early and late types
- HI line widths and vel. dispersions.
- D< 10 Mpc

Abundance of Field Galaxies

Trujillo-Gomez et al 2011



Papastergis et al 2011



Klypin, Karachentsev, Makarov 2014

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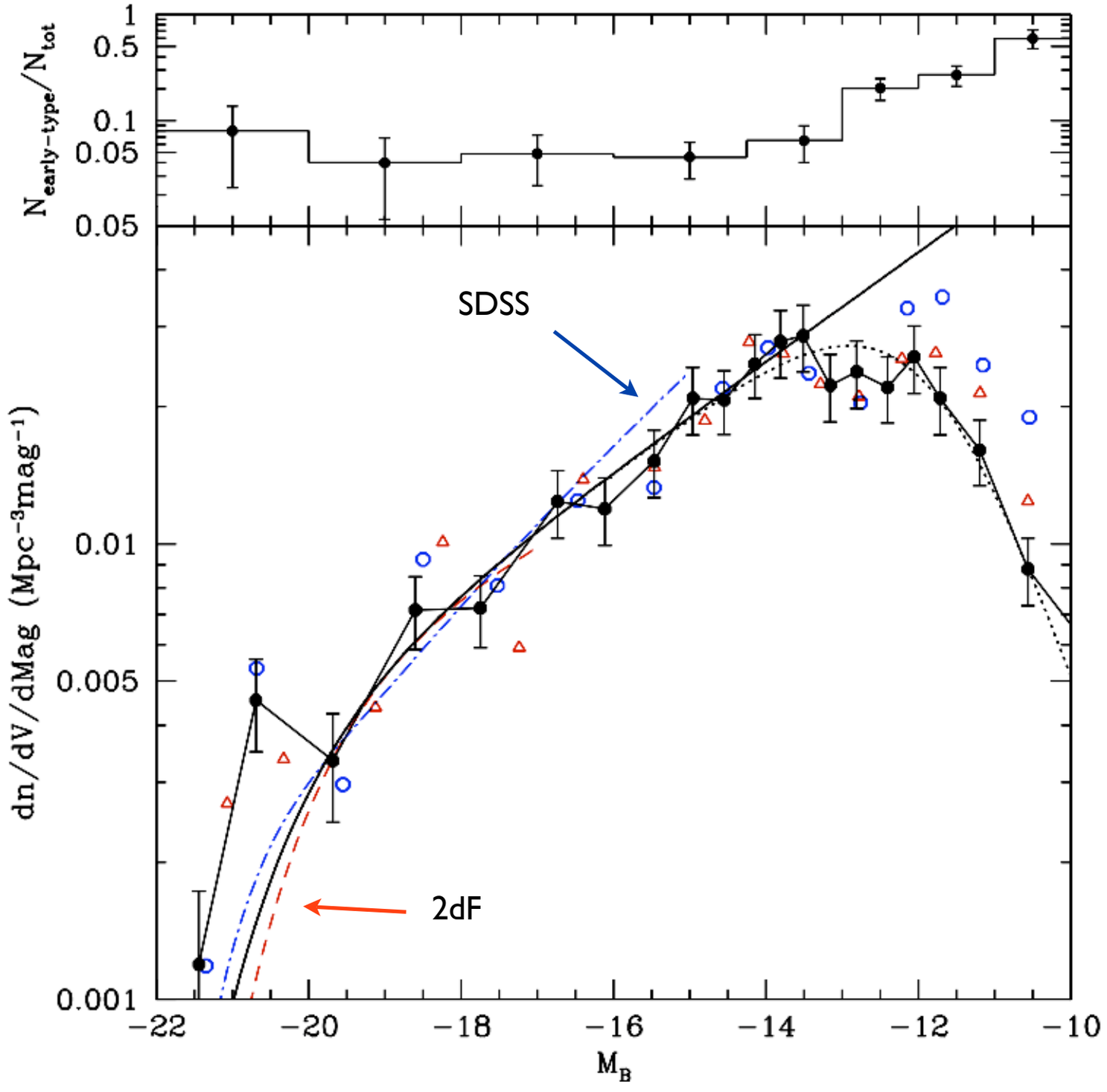


Early type galaxies

No dSph in the field

Most of early-types dwarfs are satellites within ~200kpc from their parents

dIrr => dSph is environmental effect

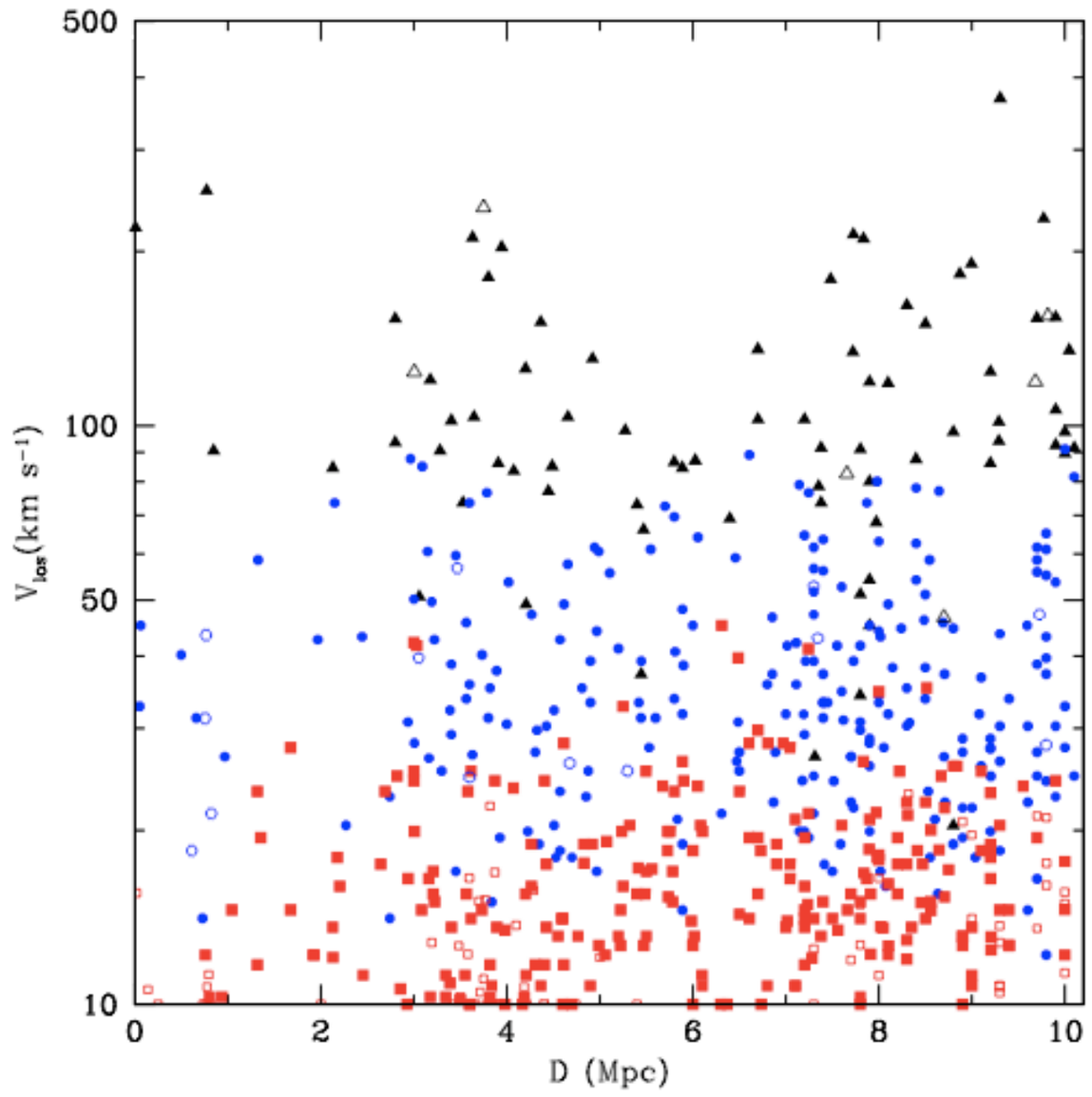
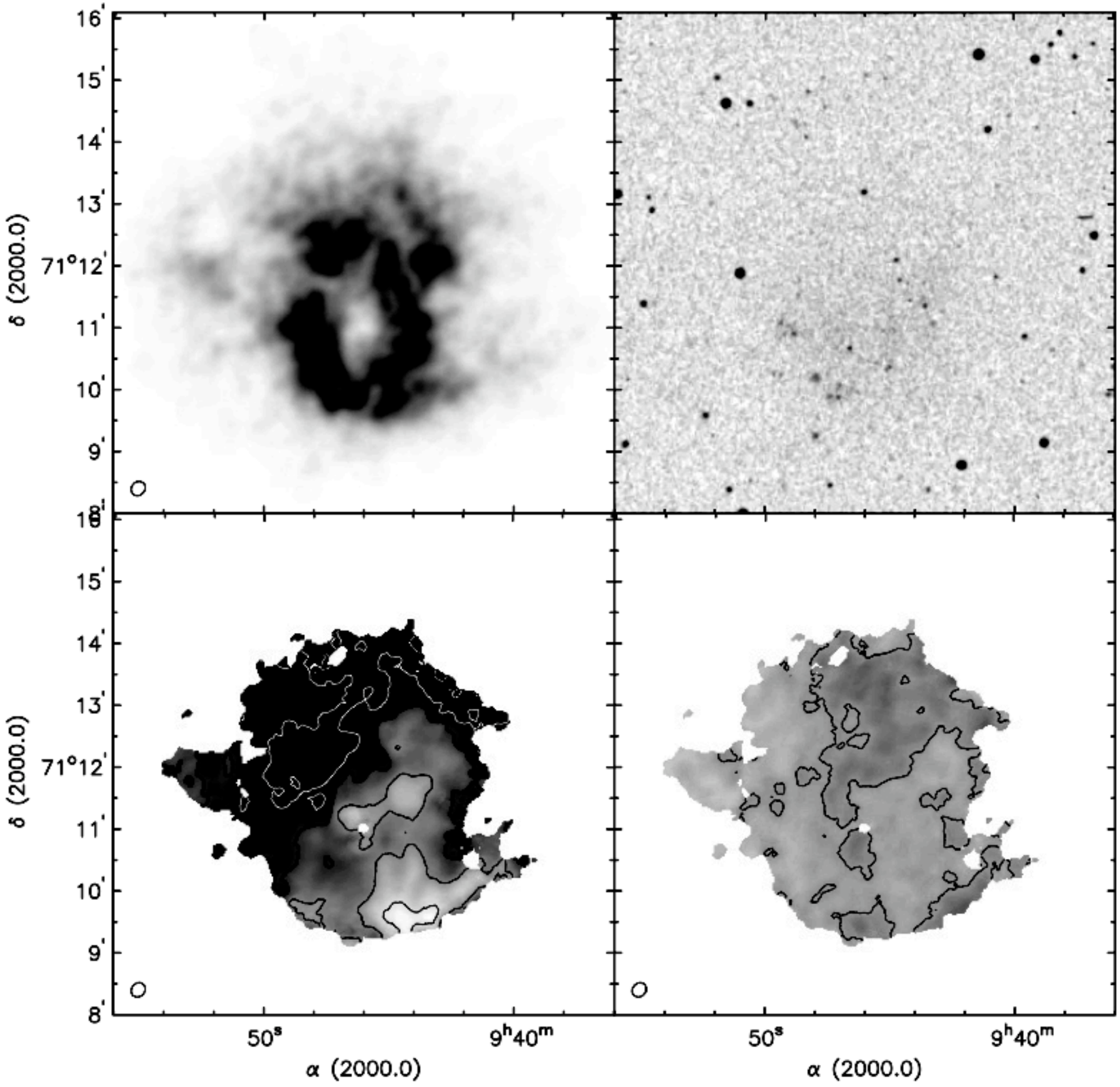


Figure 3. Distribution of line-widths $V_{\rm los}$ of galaxies in observations as the function of distance from the Milky Way. Empty (filled) circles are for early (late) type galaxies. Colors code bright (black, $M_B > -18$), intermediate (blue , $-14 > M_B > -18$), and dwarf (red, $M_B > -14$) galaxies. The enhancement of the number of galaxies at the distance $D \approx 3.5 - 4\,$Mpc is due to large groups with central galaxies NGC5128, M81, and IC342.



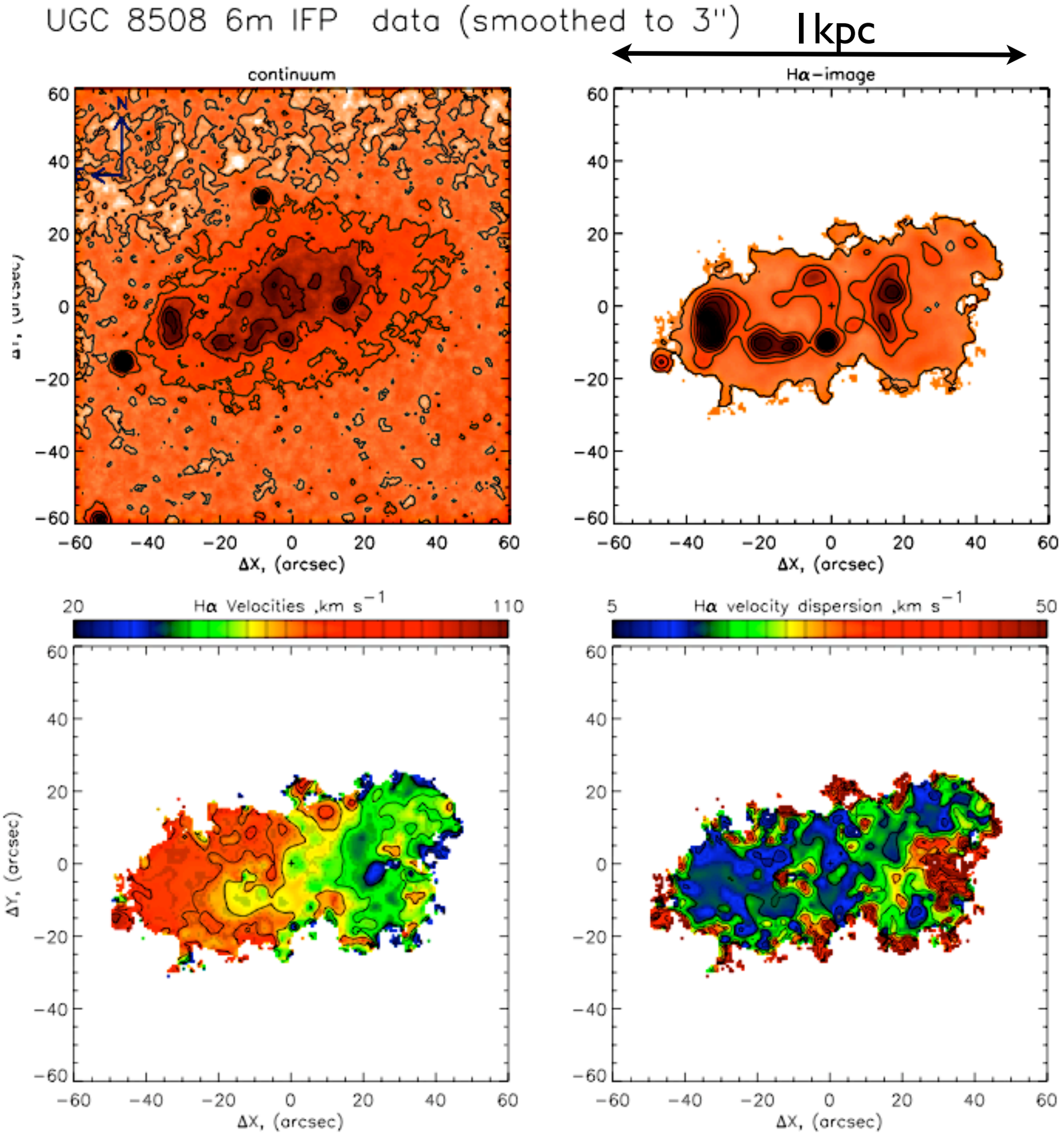
M_B =-14.8 inclination =12deg

Example: UGC8508

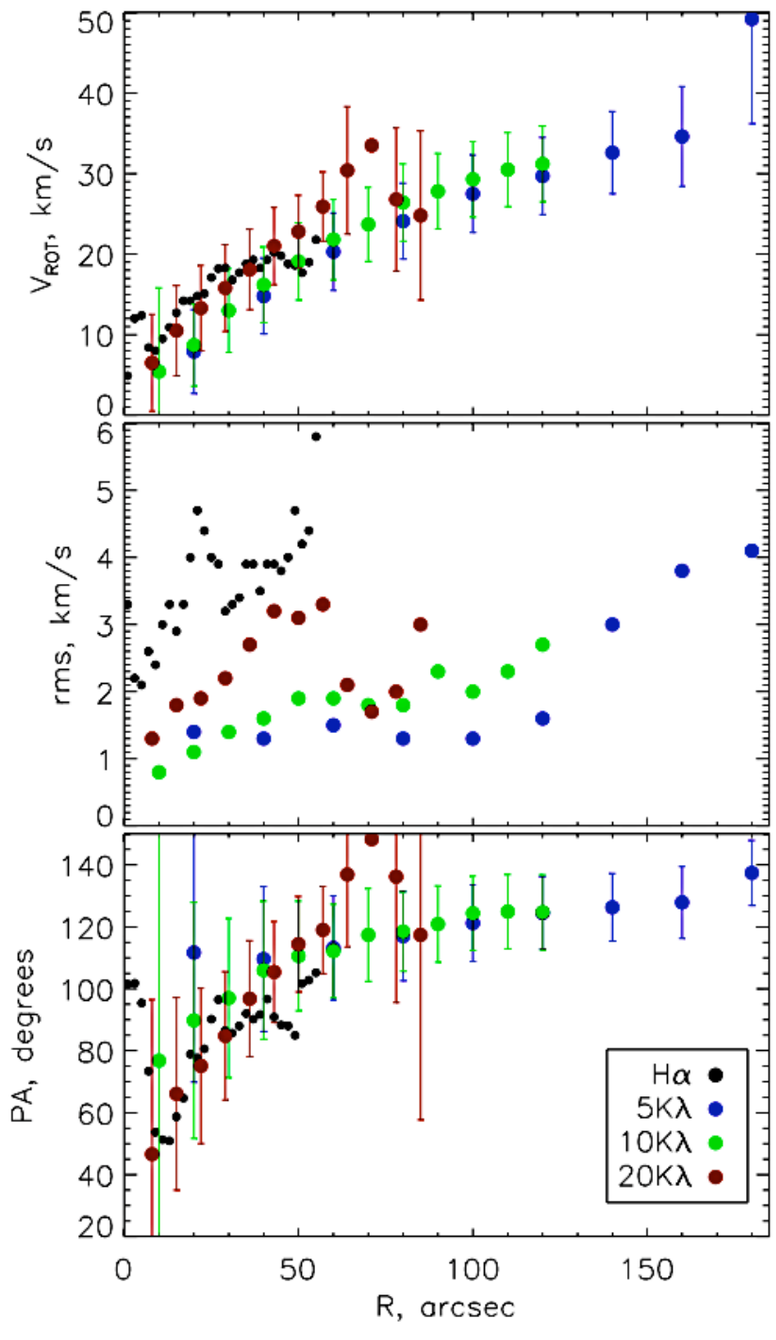
Distance 2.5 Mpc

M_B =-12.9

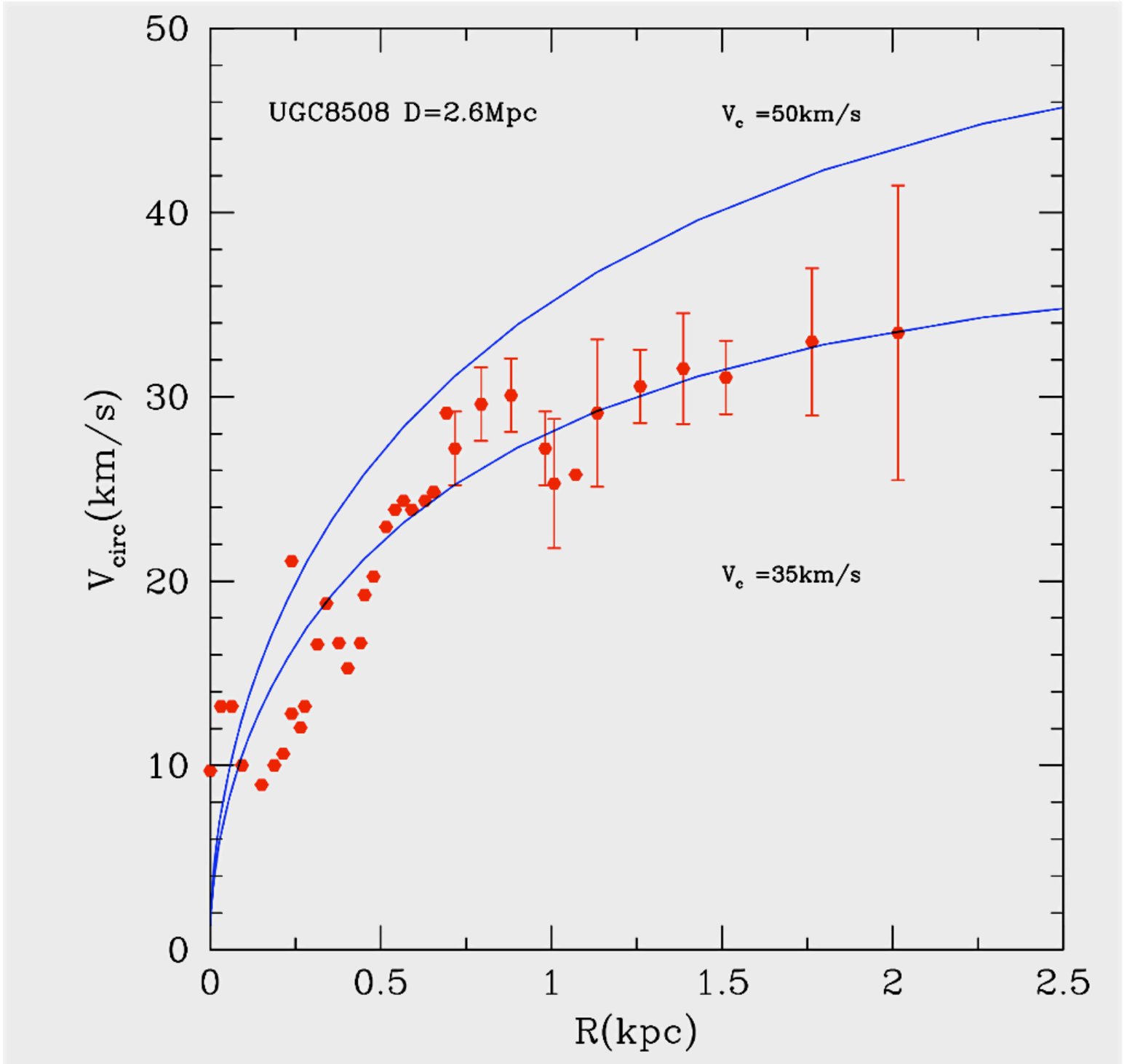
Russian 6m telescope



Velocity of rotation:
Observed: 25-30 km/s
Theory: 50 km/s



Theory predicts too large circular velocity



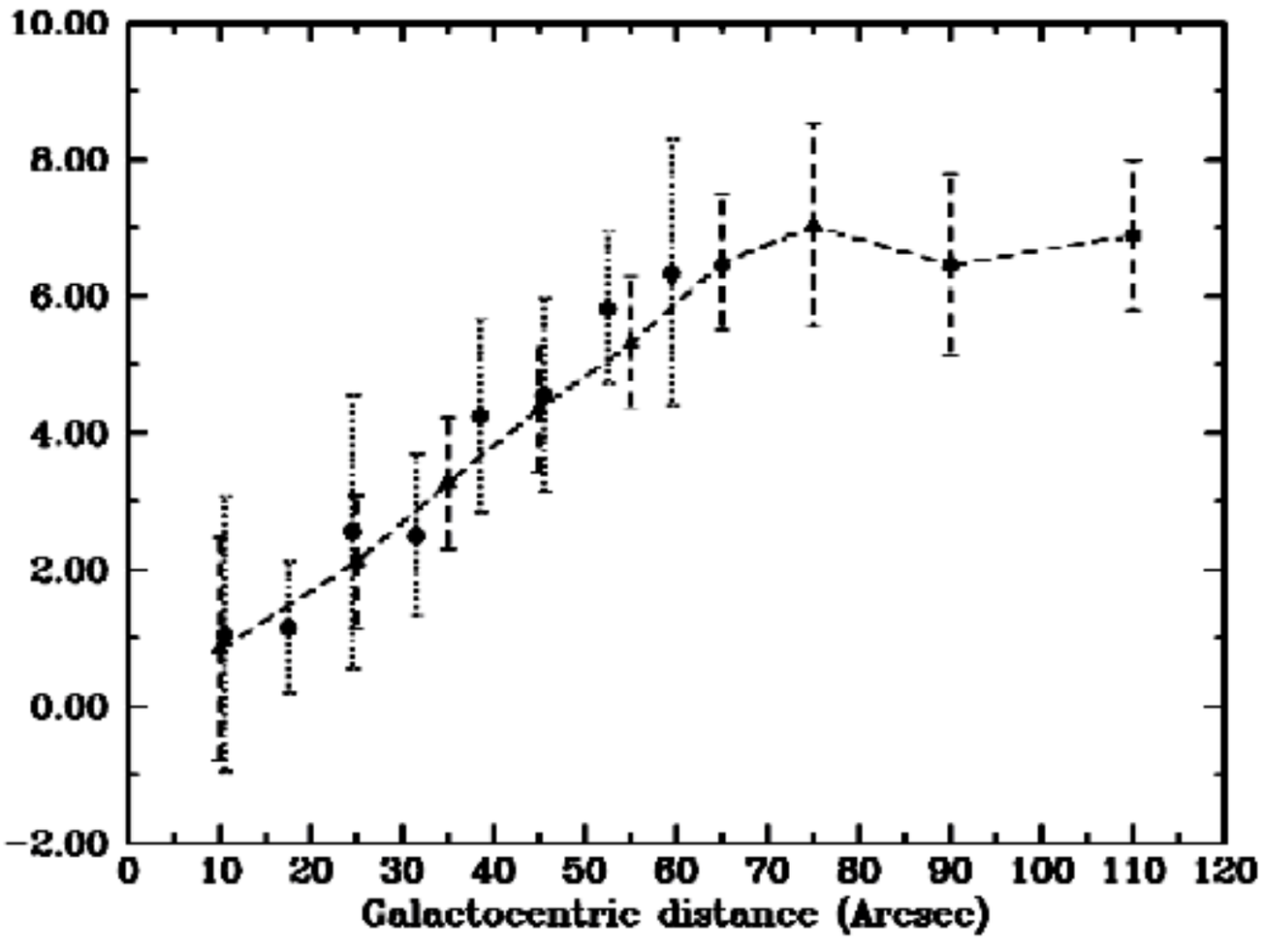
Galaxy, which should not exist:

Cam B (Begum et al 2003)

$V_{rot+rms}$ = 10km/s

M_B = -12.3

D = 3.5 Mpc



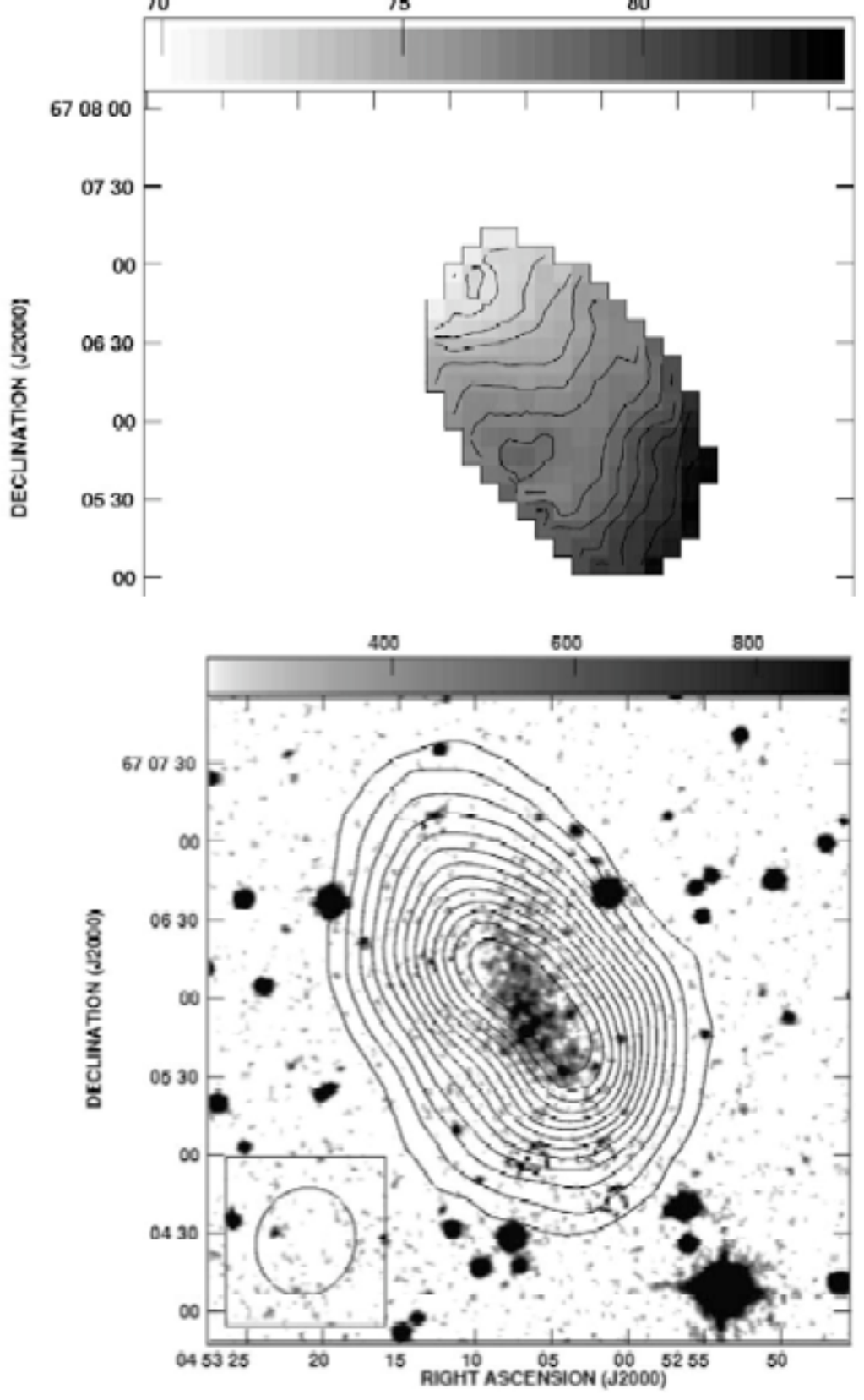


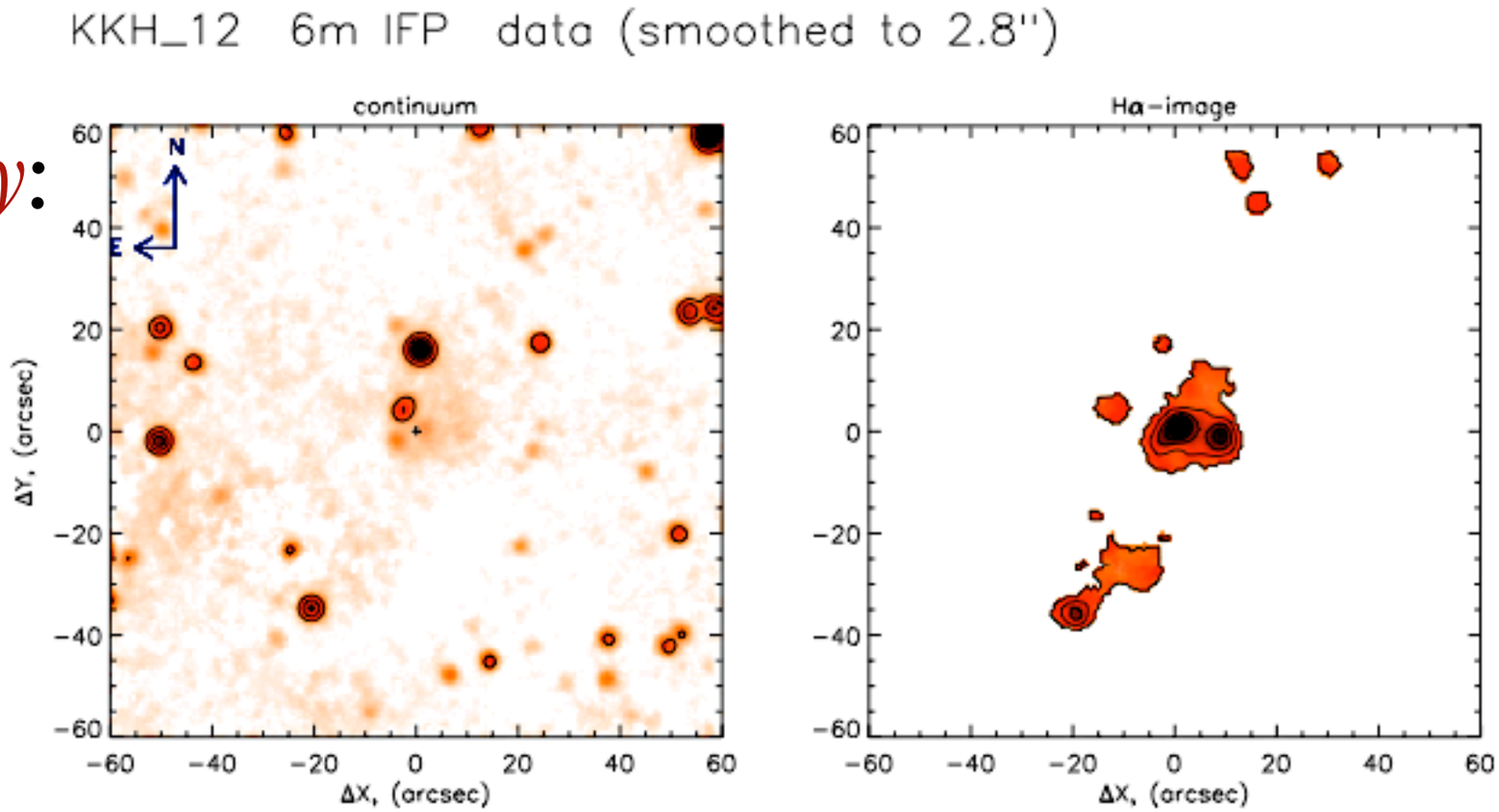
Fig. 3. The digitized Palomar Sky Survey image of Cam B with the GMRT 40″×38″ resolution integrated HI emission (moment 0) map overlayed. The contour levels are 3.7, 8.8, 19.1, 24.3, 29.4, 34.6, 39.8, 44.9, 50.1, 55.2, 60.4, 65.5 and 70.7×10^{19} atoms cm^{-2}.

Another *pigmy galaxy*:
5km/s rotation
200-500 pc across

- Isolated galaxy
- Low density environment
- It forms stars in the way normal galaxies do

How this thing can possibly exist?

Limit on galaxies must be very small: Vcrit <10km/s



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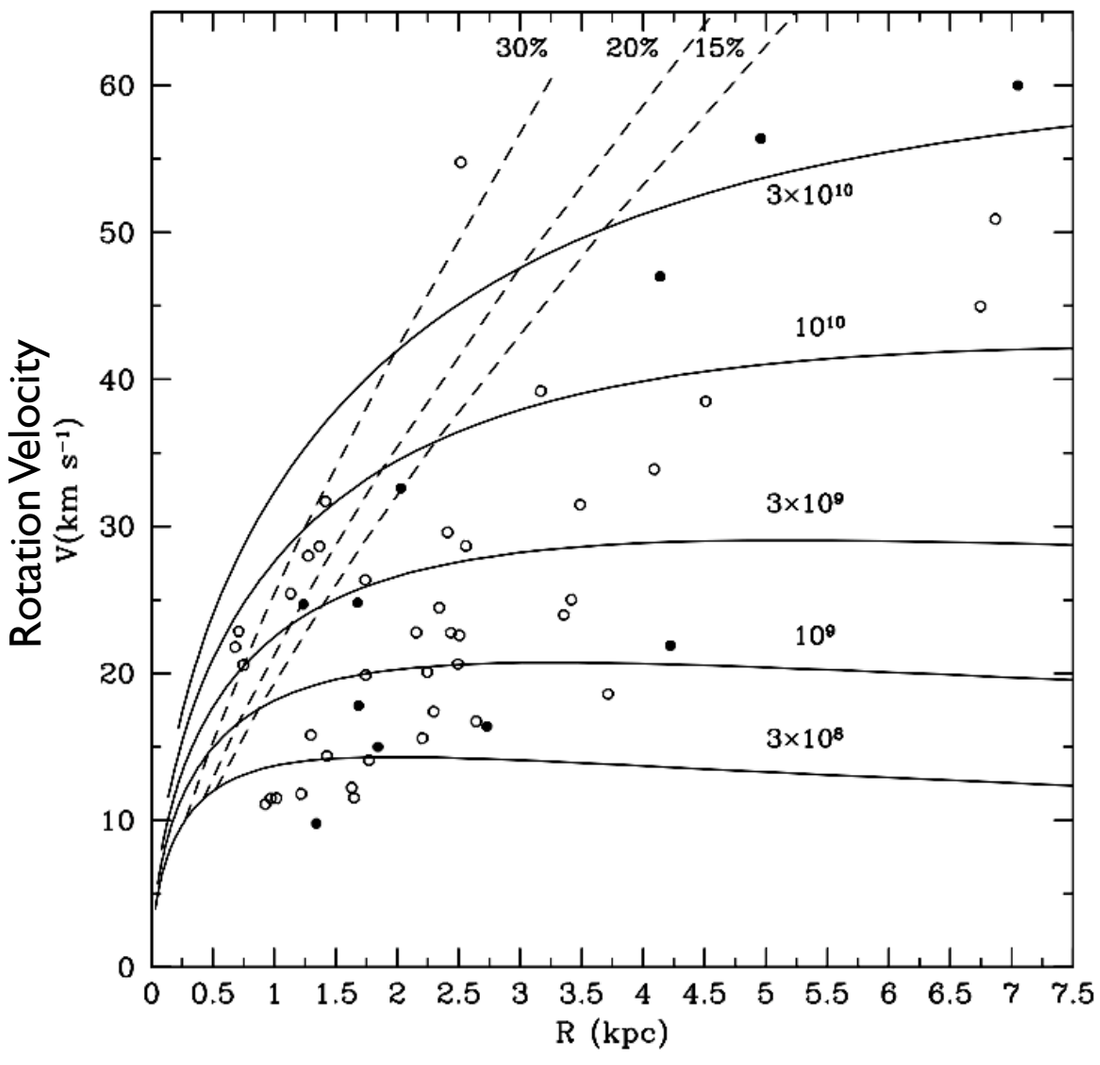
No dSph in the field: only star-forming dIrr

No HI-only galaxies: every galaxy has stars

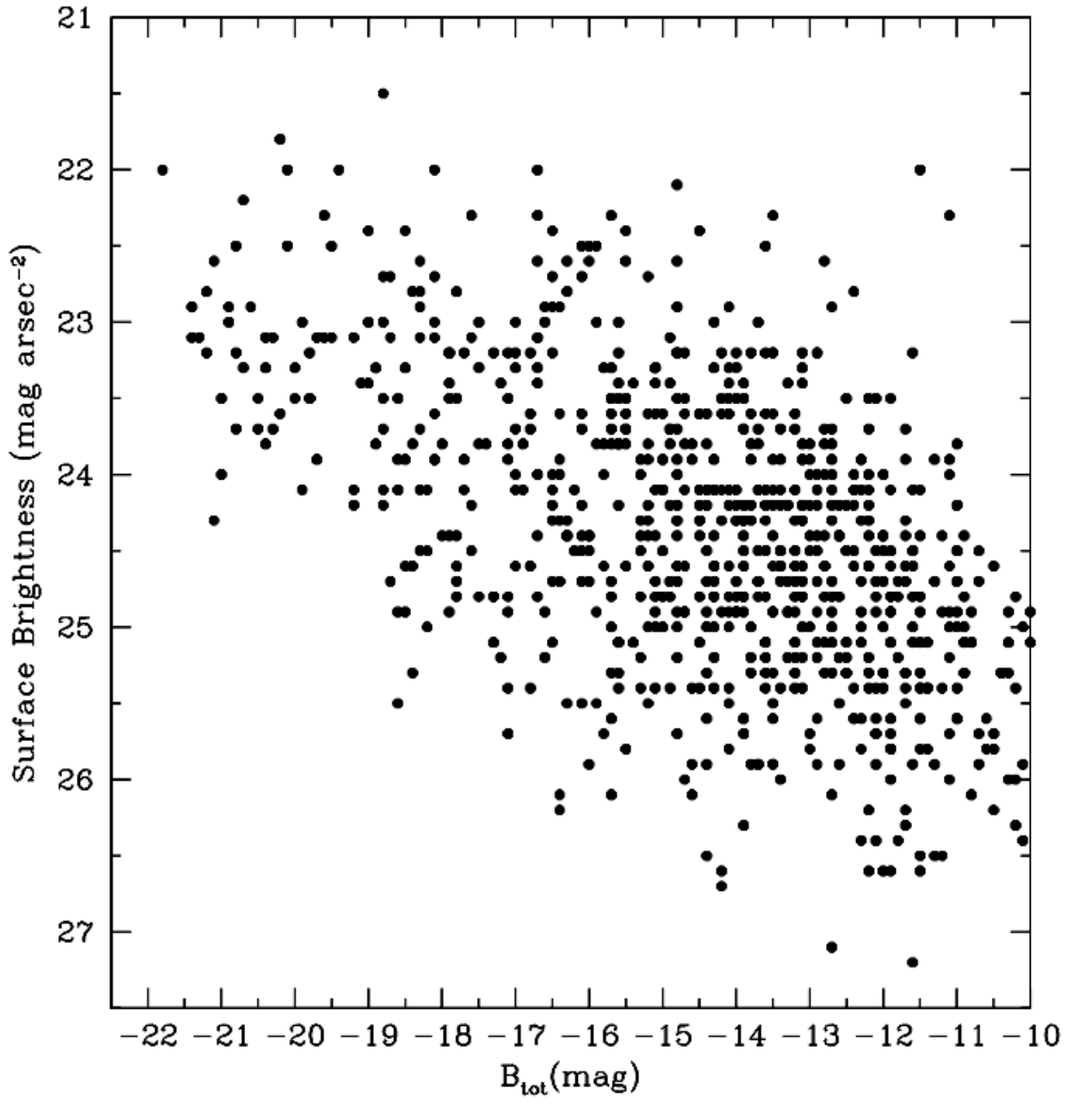
HI gas extends far enough to measure Vmax



NFW

HI extent

No indication that very low surface brightness galaxies are missed



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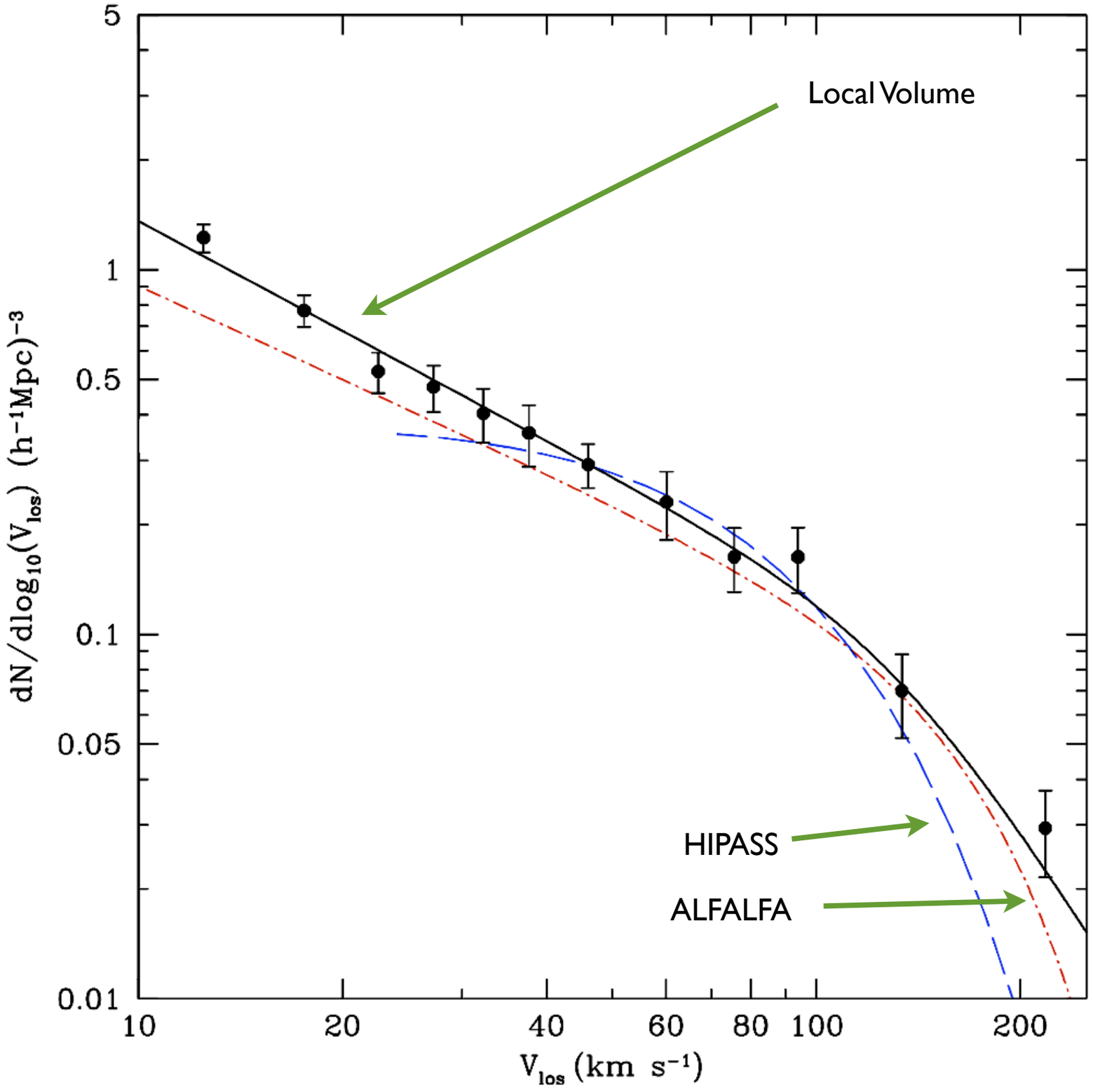
Abundance of Field Galaxies

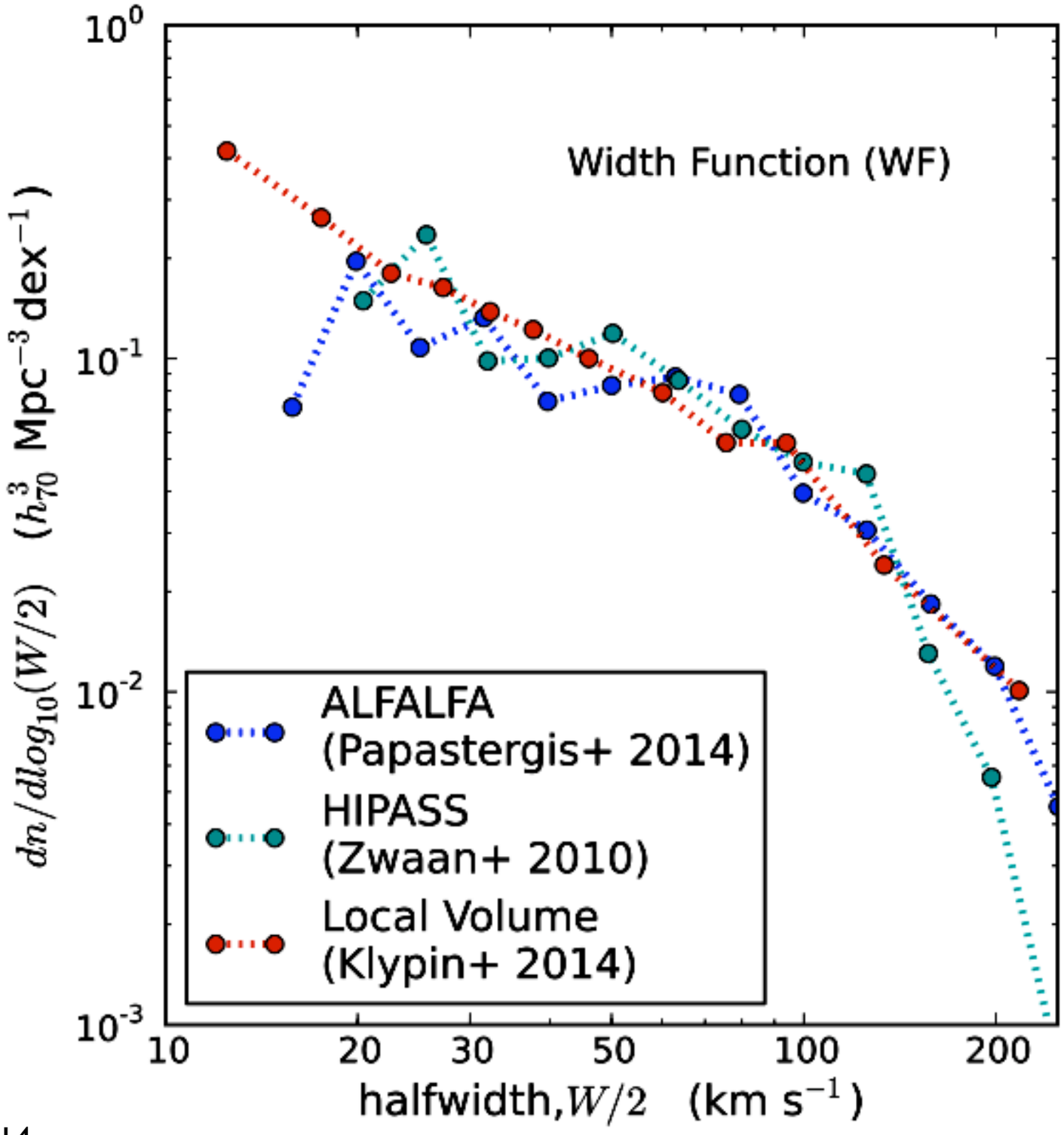
Local Volume: Not corrected for inclination

600 dwarf galaxies
- most are not satellites
- early and late types
- HI line widths and vel. dispersions.
- D< 10 Mpc

Consistent results:
Local Volume is 10% above HI surveys because it has early type galaxies



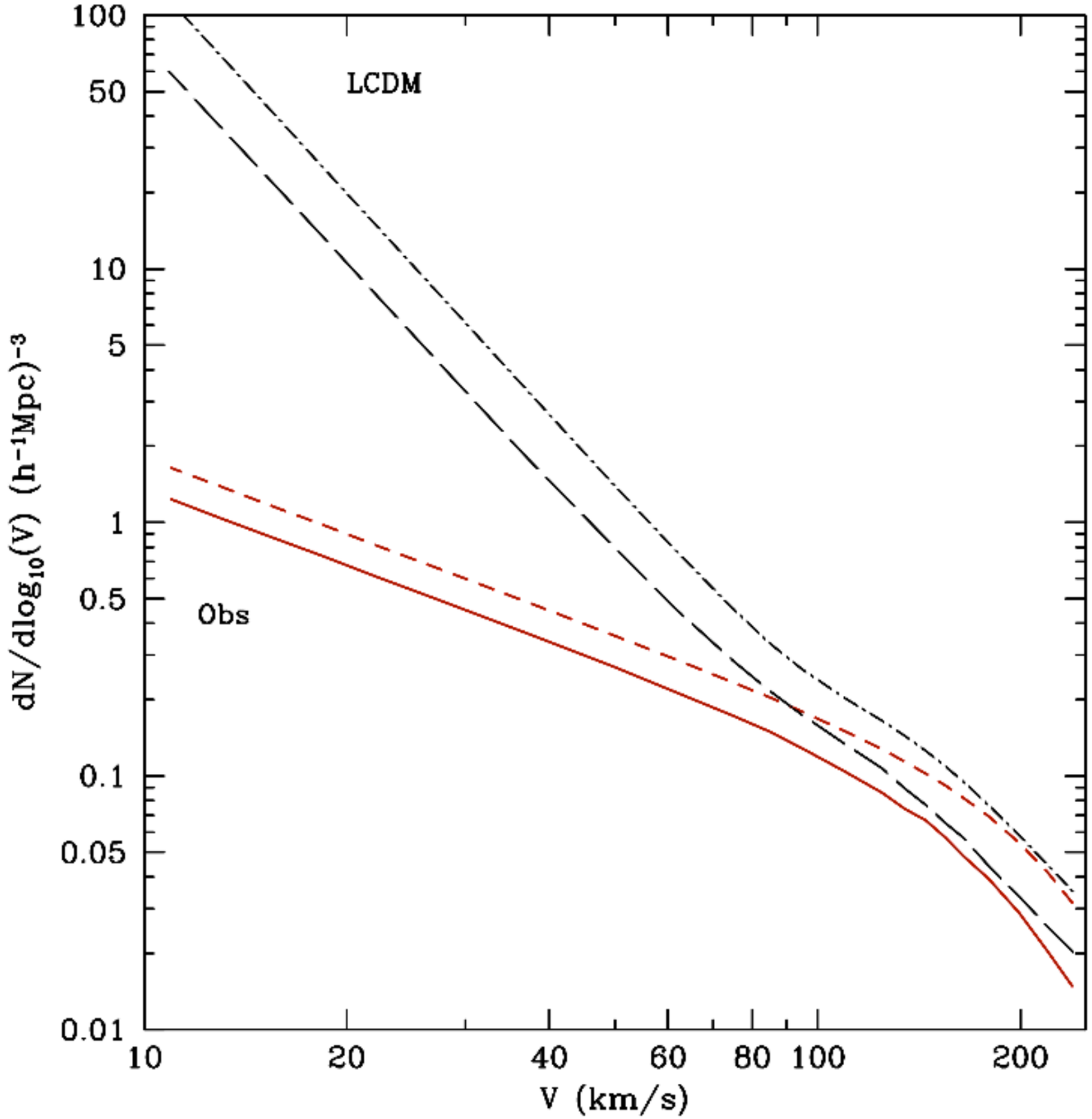
Comparison with HI surveys



M. Papastergis (private comm) 2014

Velocity functions:

True (VF) and projected (VW/2, not corrected by inclination.



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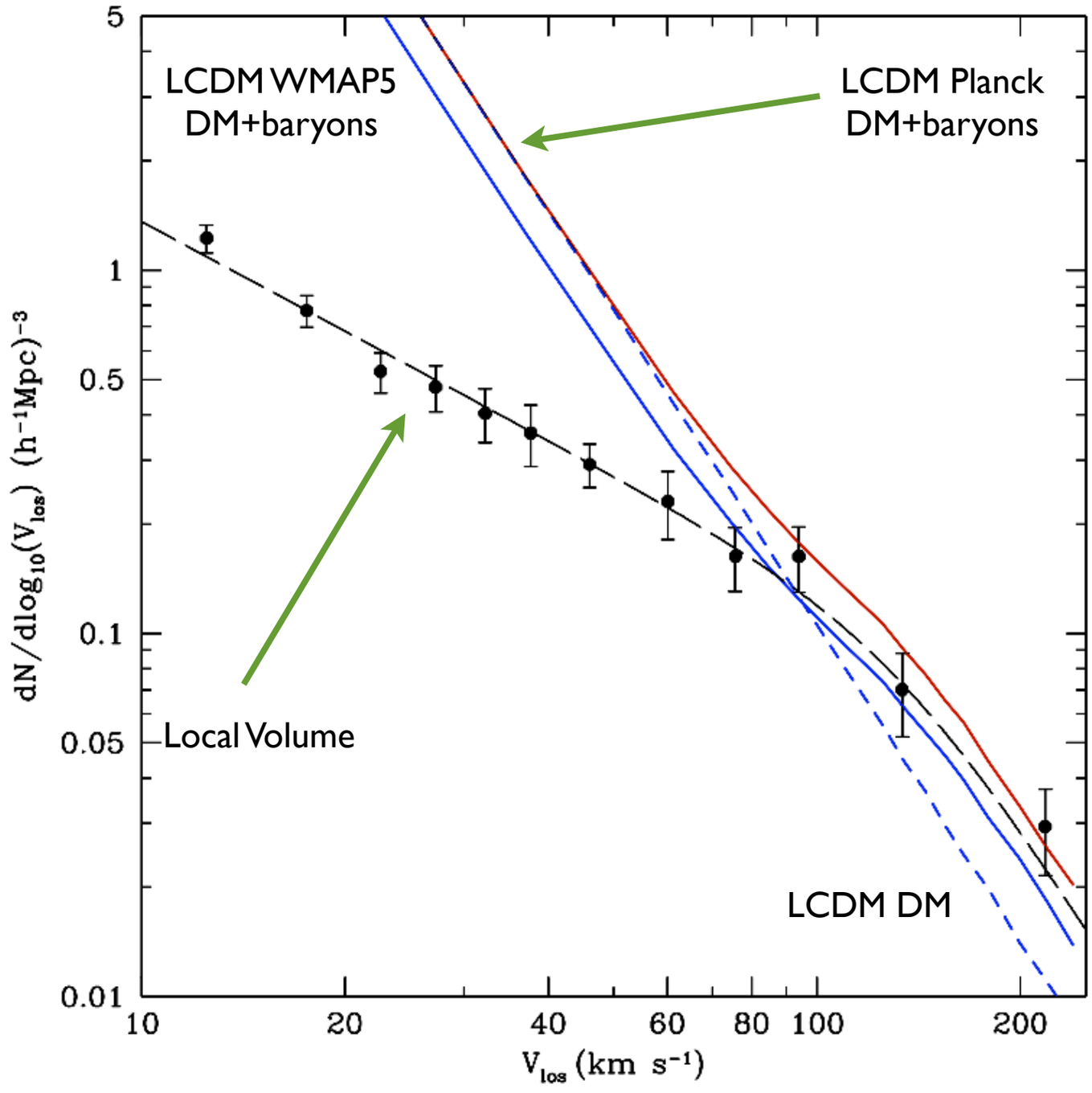
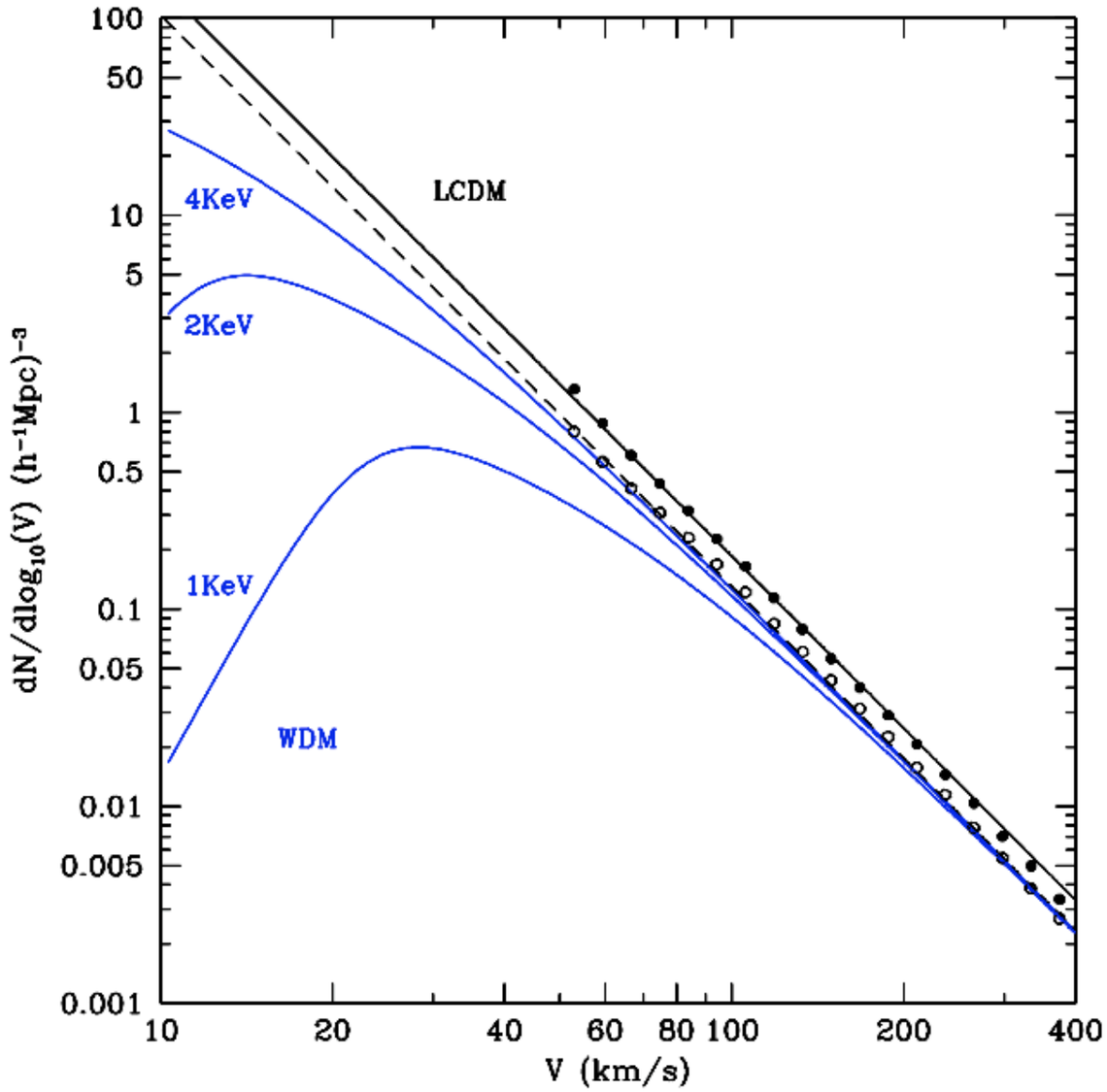
LCDM: - Planck cosmology
- halos + subhalos
- corrected for baryons
- random disk orientation

Good fit to galaxies with V>60km/s



Disagreement 3-5 times for V =30-40km/s

WDM VF (Schneider et al 2013)



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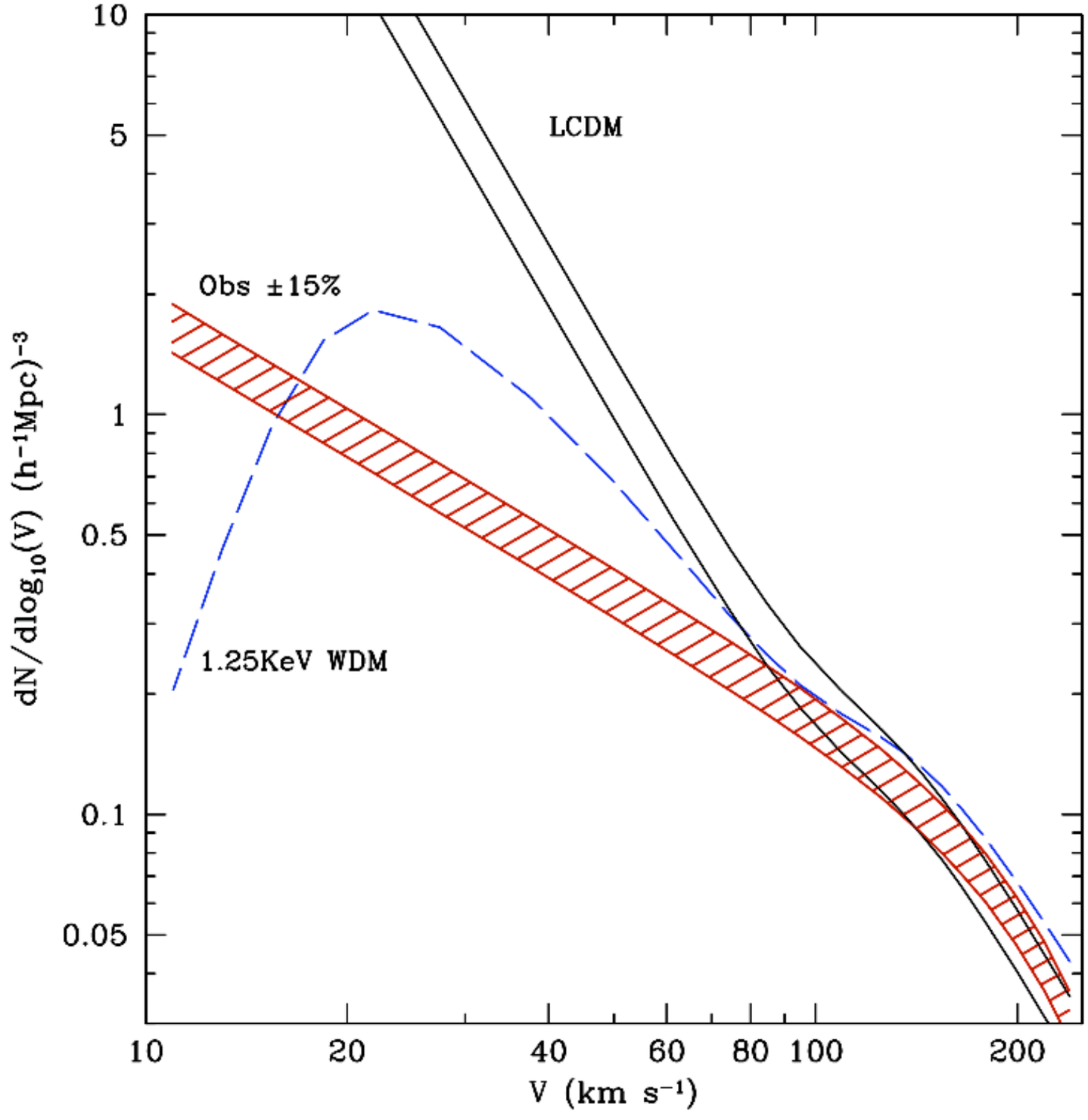
WDM: - Scheneider, Dutton&Maccio

used mass function and concentrations for WDM
- Planck cosmology
- halos + subhalos
- corrected for baryons
- random disk orientation

No neutrino mass solves the problem



Field Dwarfs problem vs Local Group

Kravtsov 2010

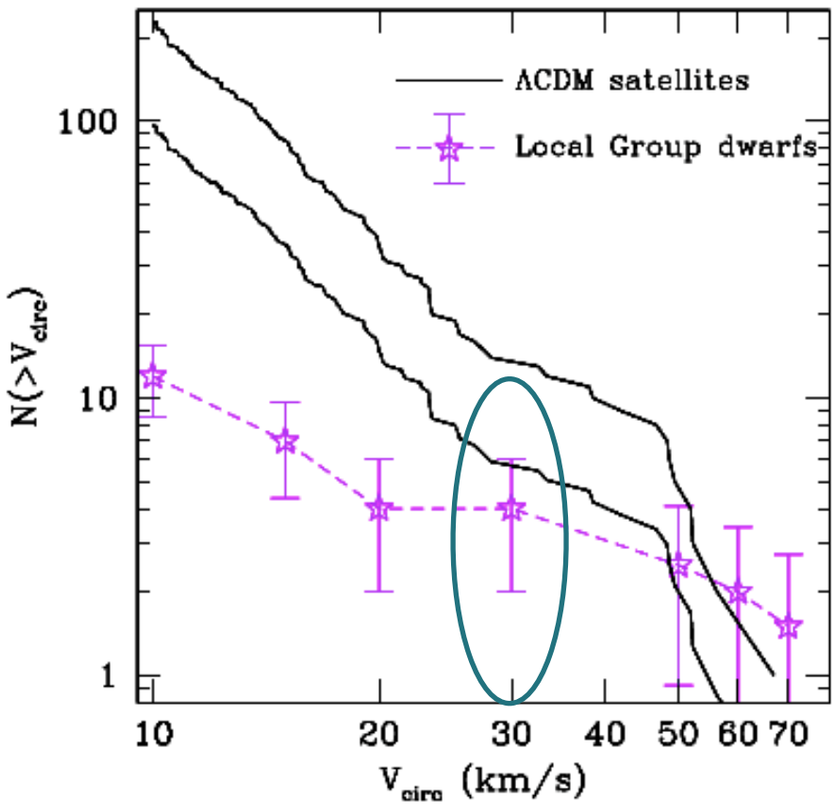


Fig. 7— Comparison of the cumulative circular velocity functions, $N(> V_{max})$, of subhalos and dwarf satellites of the Milky Way within the radius of 286 kpc (this radius is chosen to match the maximum distance to observed satellites in the sample and is smaller than the virial radius of the simulated halo, $R_{337} = 326$ kpc). The subhalo VFs are plotted for the host halos with max. circular velocities of 160 km/s and 208 km/s that should bracket the V_{max} of the actual Milky Way halo. The VF for the observed satellites was constructed using circular velocities estimated from the line-of-sight velocity dispersions as

Klypin et al 2011

KLYPIN, TRUJILLO-GOMEZ, & PRIMACK

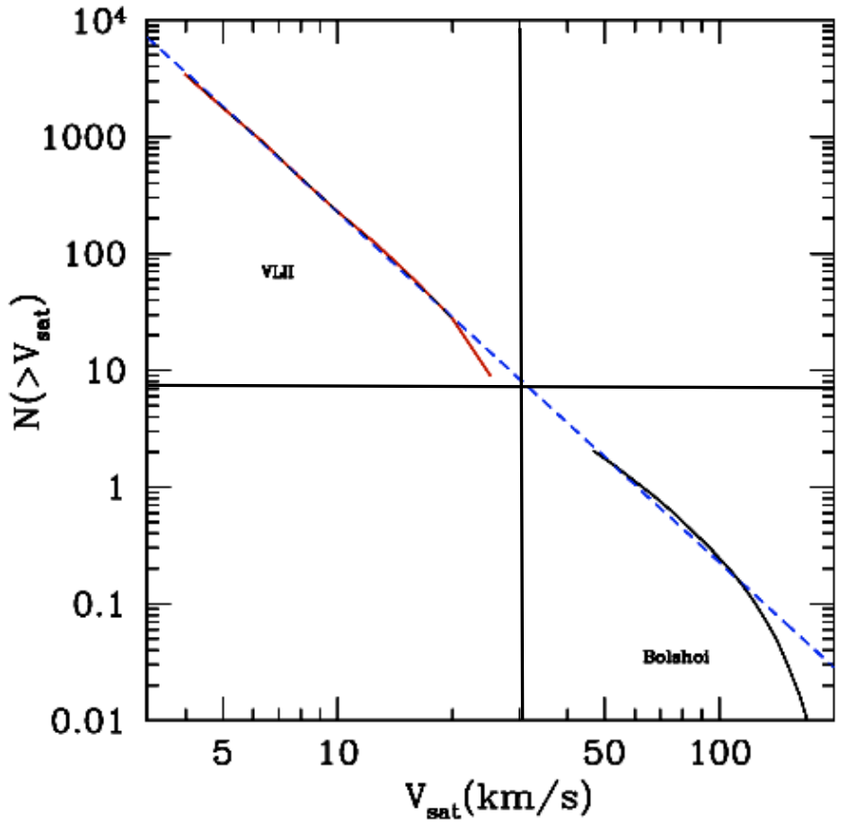
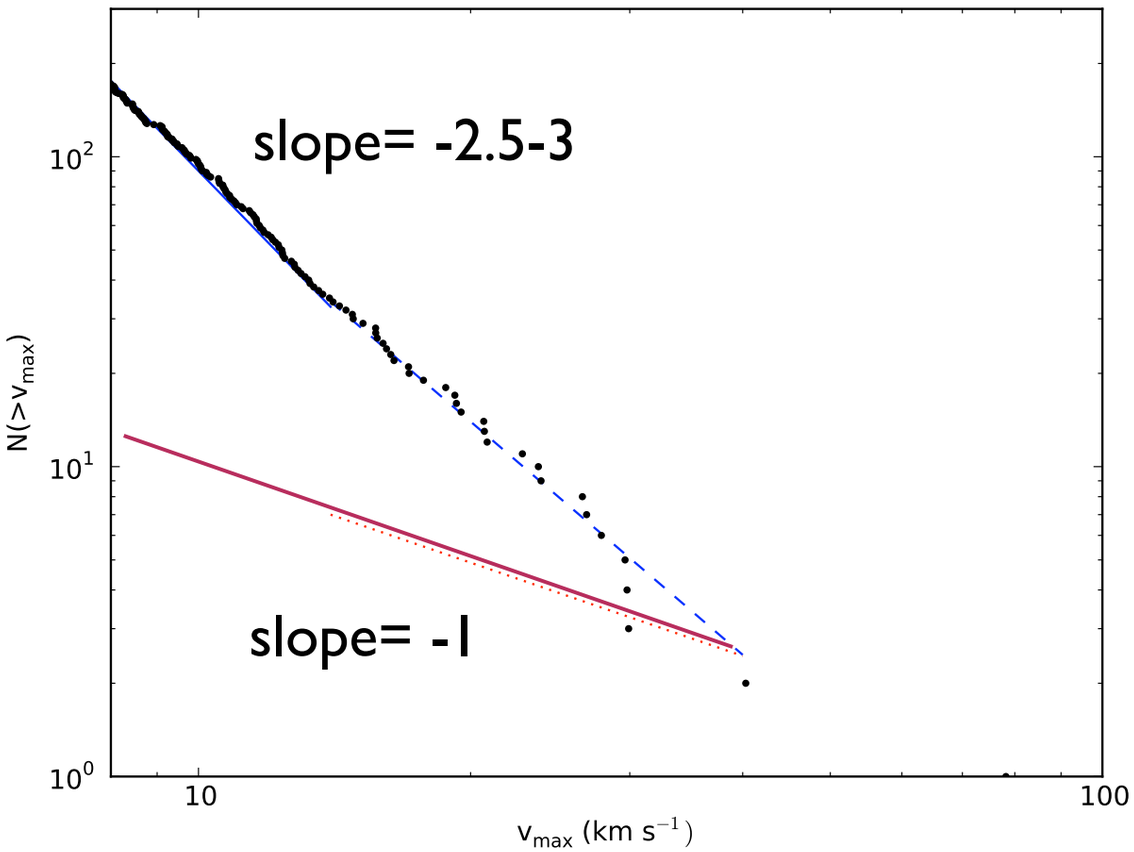
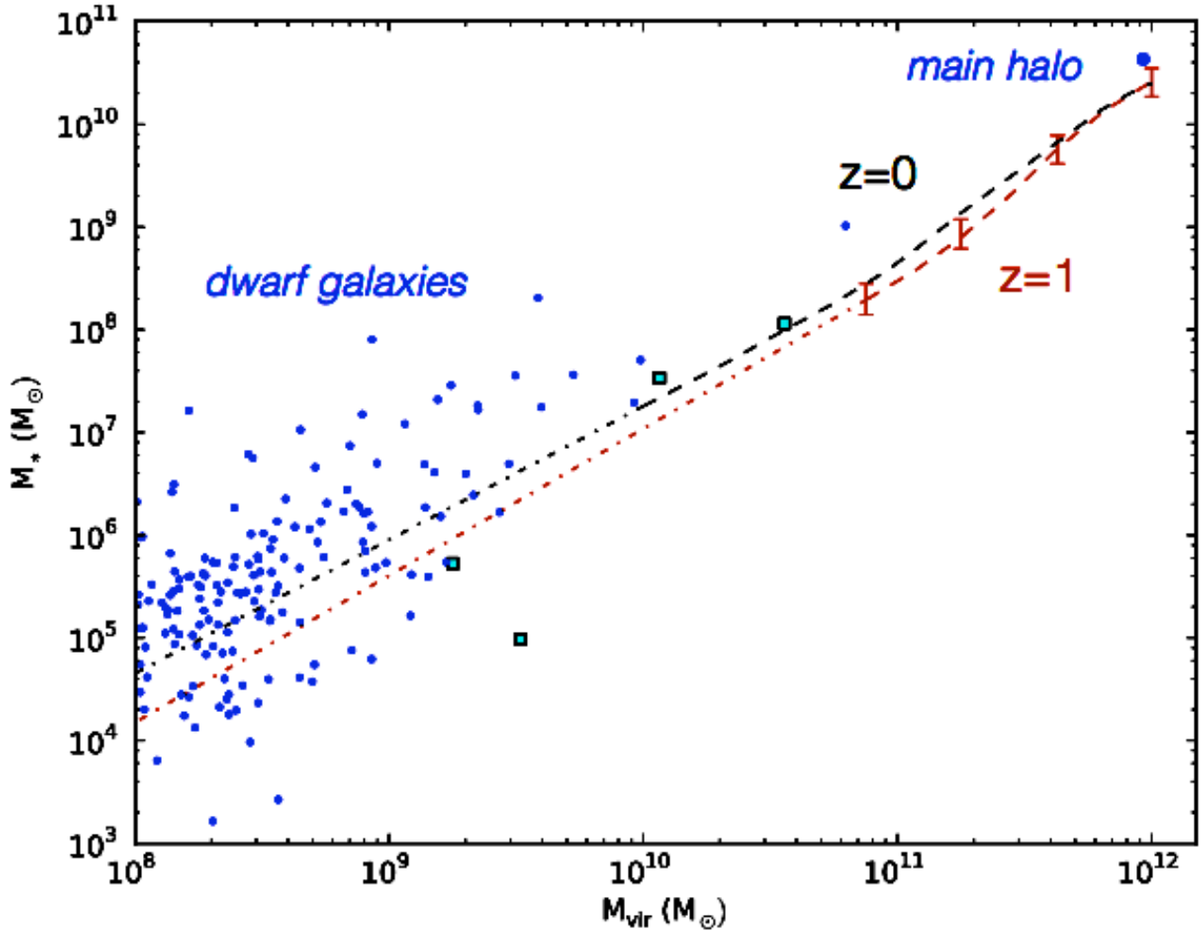


Figure 14. Comparison of satellite velocity functions in the Via Lactea-II and Bolshoi simulations for host halos with $V_{circ} = 200$ km s^{-1} and $M_{vir} \approx 1.3 \times 10^{12}\, h^{-1}\, M_{\odot}$. The dashed line is a power law with slope −3,

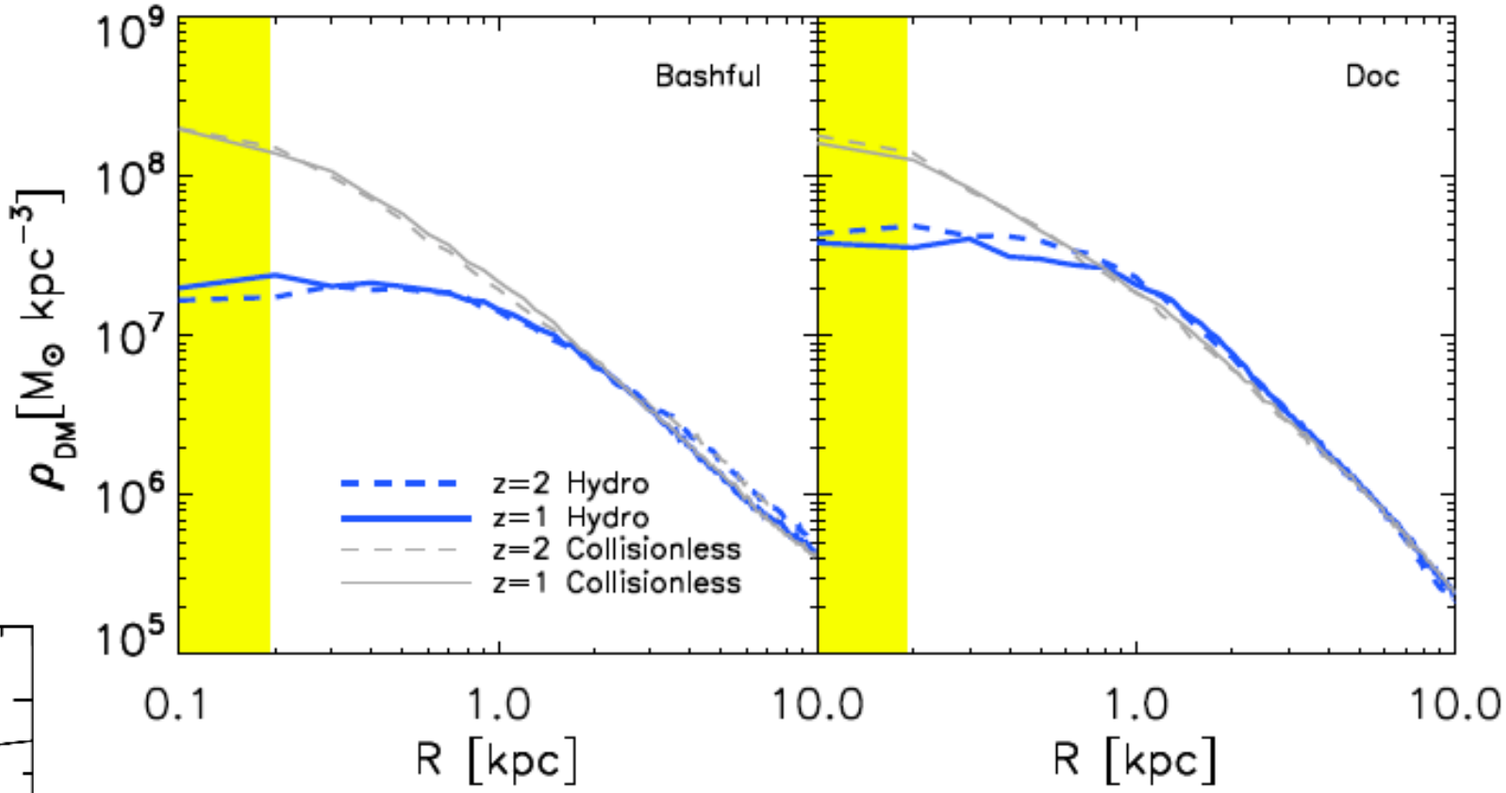
Satellites in hydro runs

Arraki et al 2014: too many satellites:
reionization does not kill satellites - only suppresses SFR

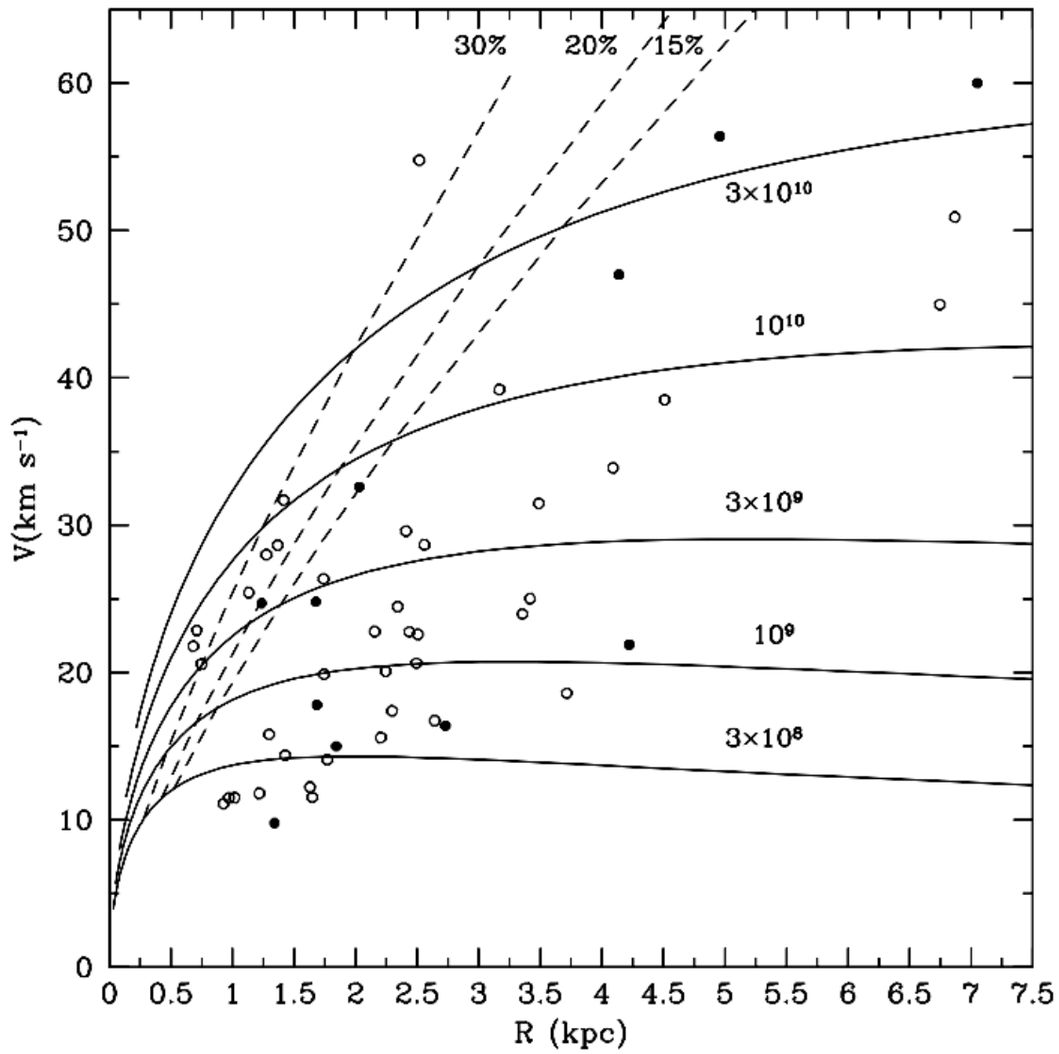




Can cores help?



Madau, Shen, Governato 2014



Gas extends to very large distances of 2-5 kpc
This is where W50 is measured.

Cores do not help.

To 'solve' the Field Abundance problem with stellar feedback, mass of 30 km/s galaxy must be reduced 5 times in the inner 3 kpc radius.

Difficult, but may be possible.

Too-big-to-fail : structural problems of satellites (too dense) with V=20-30km/s

-- can be solved with ram pressure/tidal stripping (Arakki 2013, Zolotov 2013)

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There is no Too-Big-to-Fail Problem

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There is no Too-Big-to-Fail Problem

Problem: there is no failed galaxy:

- re-ionization does not kill galaxies.
- SN feedback does not kill galaxies

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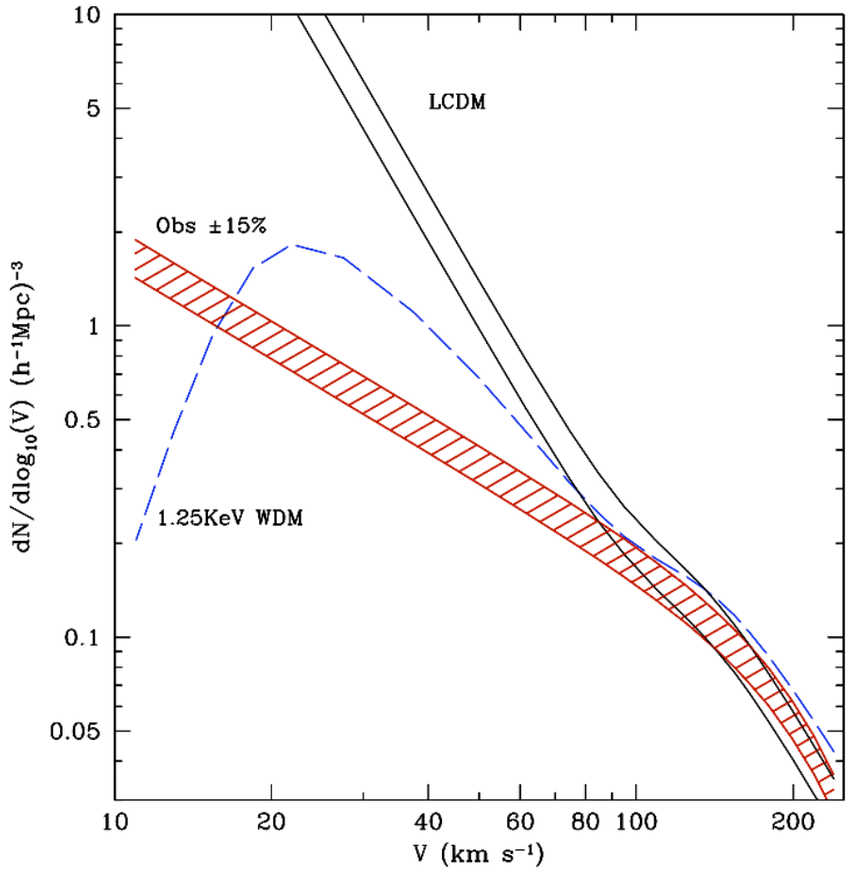

This is a new problem:

- not overabundance of satellites
- not Too-Big-To-Fail

Too-big-to-fail : structural problems of satellites (too dense) with V=20-30km/s

-- can be solved with ram pressure/tidal stripping (Arakki 2013, Zolotov 2013)

What <u>cannot</u> help:
- SNII feedback (not enough SNs)
- turn dIrr to dSph : no dSph in the field
- no star formation at all (HI will be observed)

What can help:
- large population of very low SB
- very efficient stellar feedback
- lack of self-shielding for some dwarfs