On the inside-out reionization of the MW satellite system

Reionization at galaxy-scale

P. Ocvirk, D. Aubert
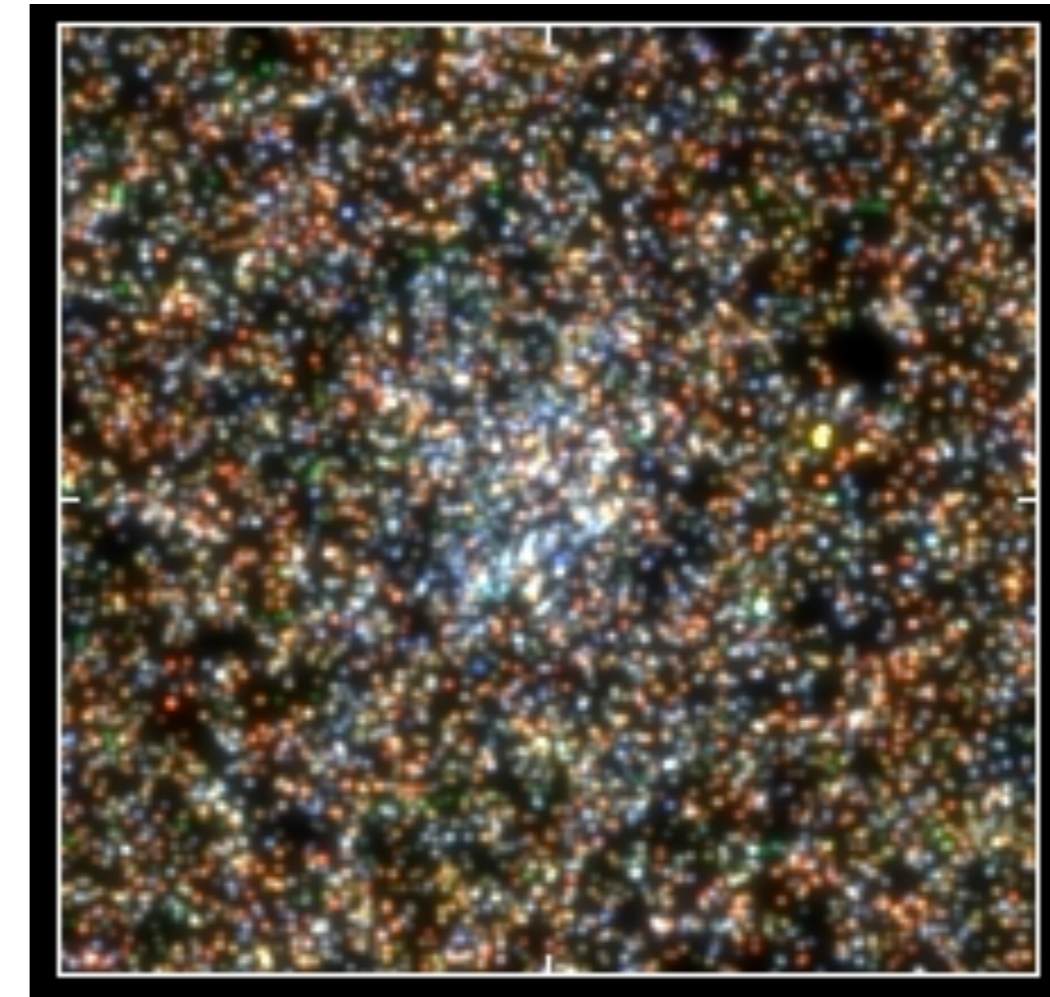Observatoire astronomique de Strasbourg

Observatoire astronomique
de Strasbourg

○ Impact of radiation field structure on the Galaxy

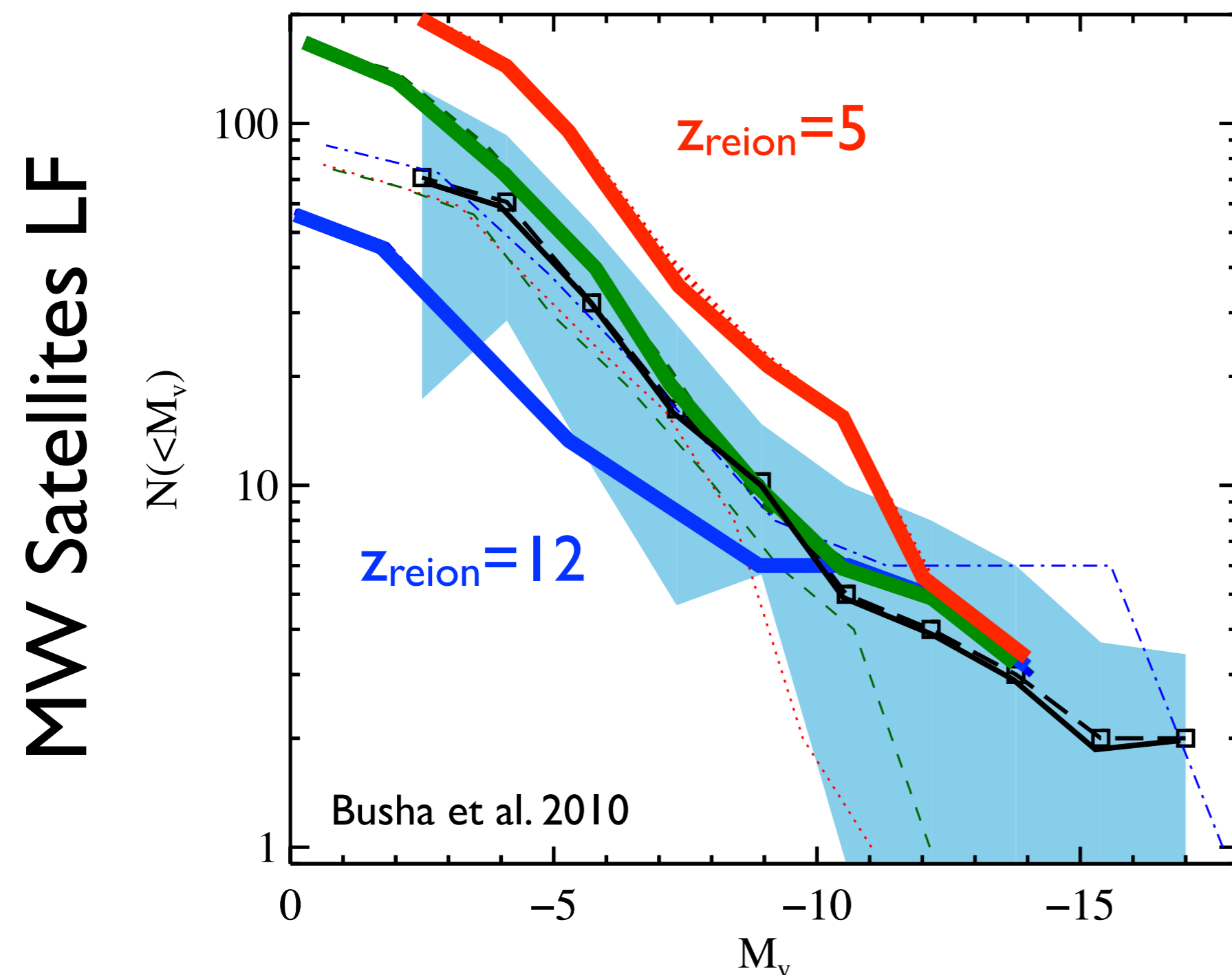○ RT simulations, reionization history of the MW satellites

Reionization & the Milky Way

○ UV background

○ => gas photo-evaporation

○ => suppression of low-mass galaxies

○ => satellite galaxies, ultra-faint dwarfs

Bootes
D = 60 kpc
r_h = 220 pc
M_v = -5.8 mag

Courtesy V. Belokurov
and SDSS collaboration

z_{reion}=5

z_{reion}=12

$N(<M_v)$

MW Satellites LF
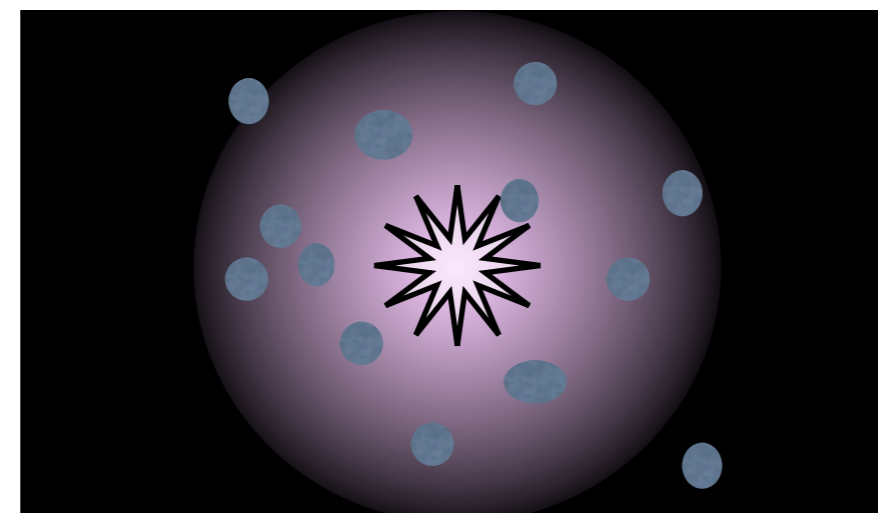
Busha et al. 2010

M_v

○ Semi-analytical models

○ Satellite SF stops at z_{reion}

○ => sats = reionization fossils

○ reionization uniform & instantaneous

Impact of local structure of UV field at reionization on MW satellite pop
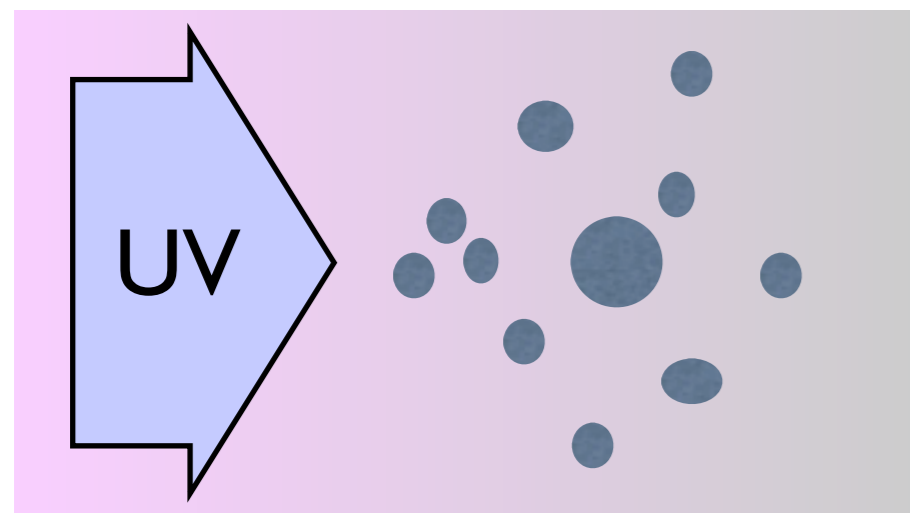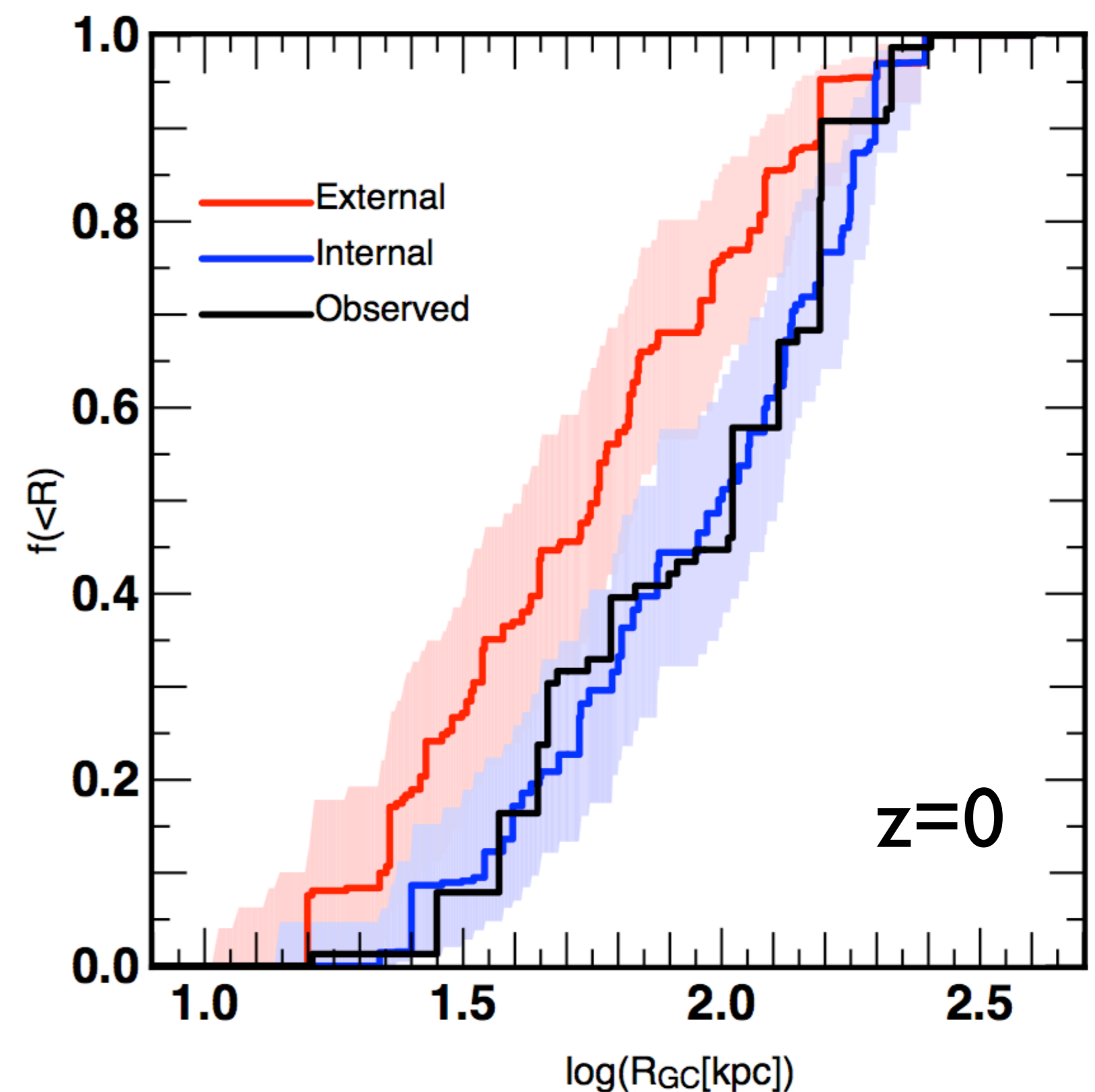

External, uniform BG

Internal, inside-out

○ SAM based on Via Lactea II

○ photo-evaporation recipes from Iliev et al. 2006

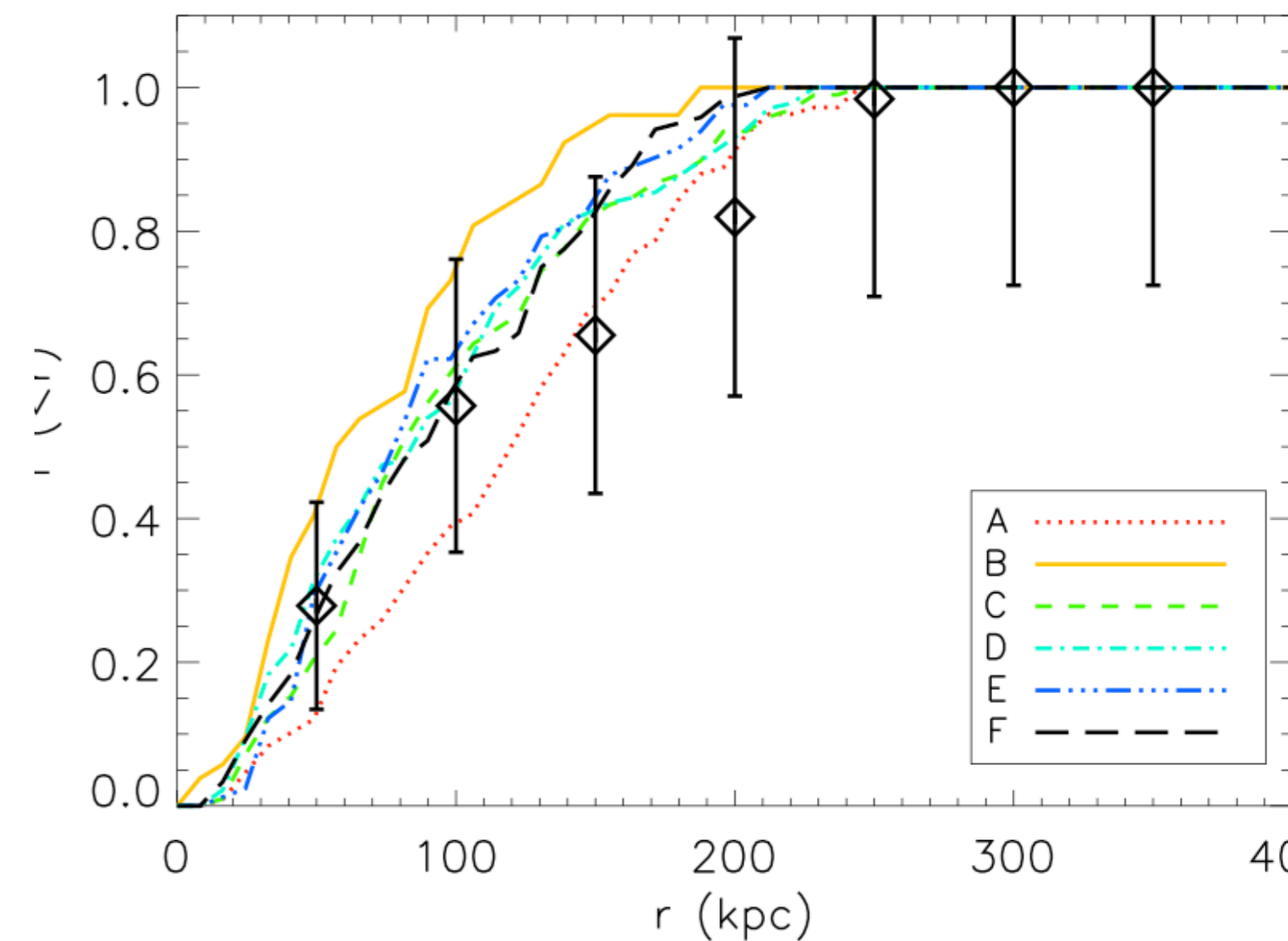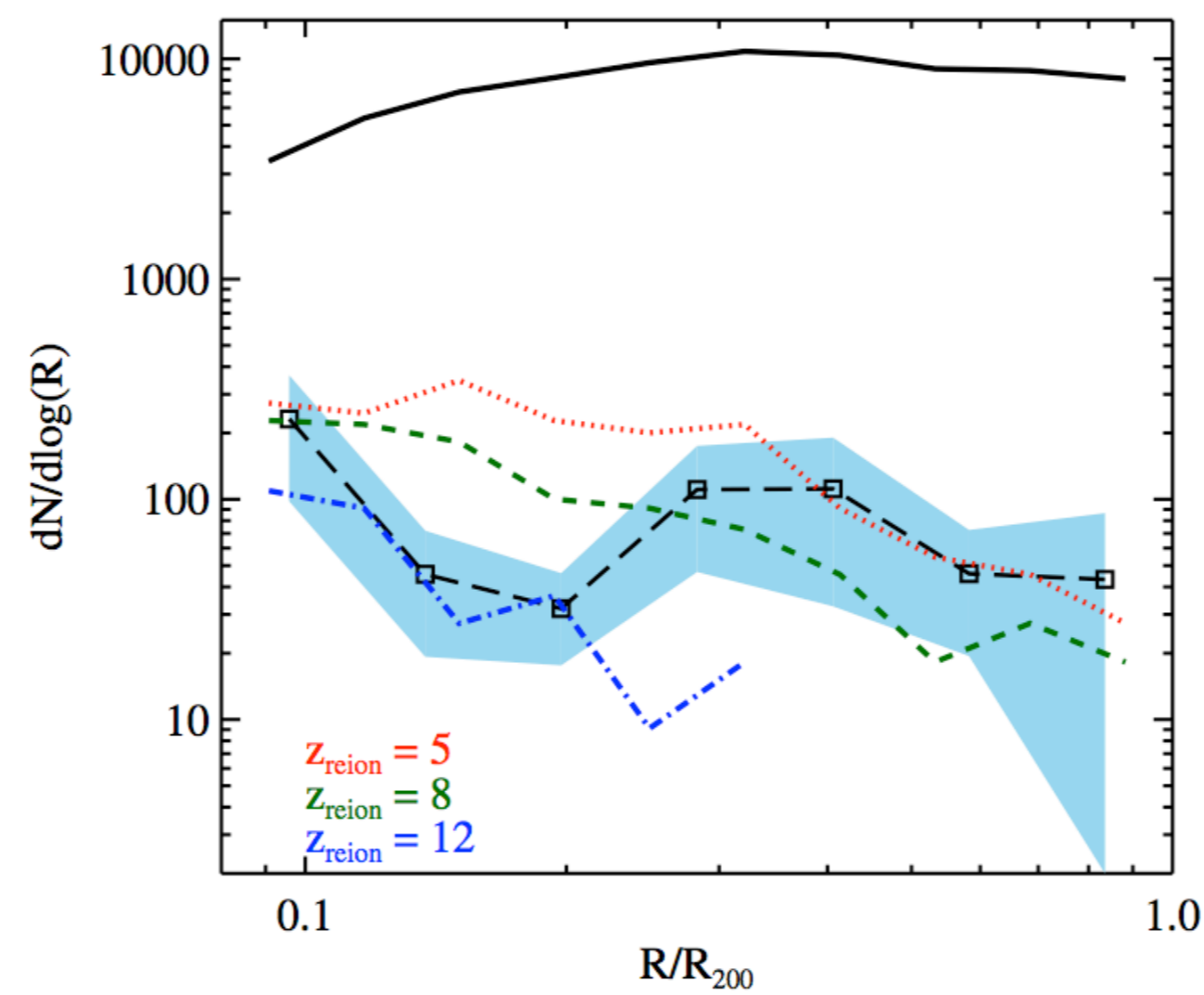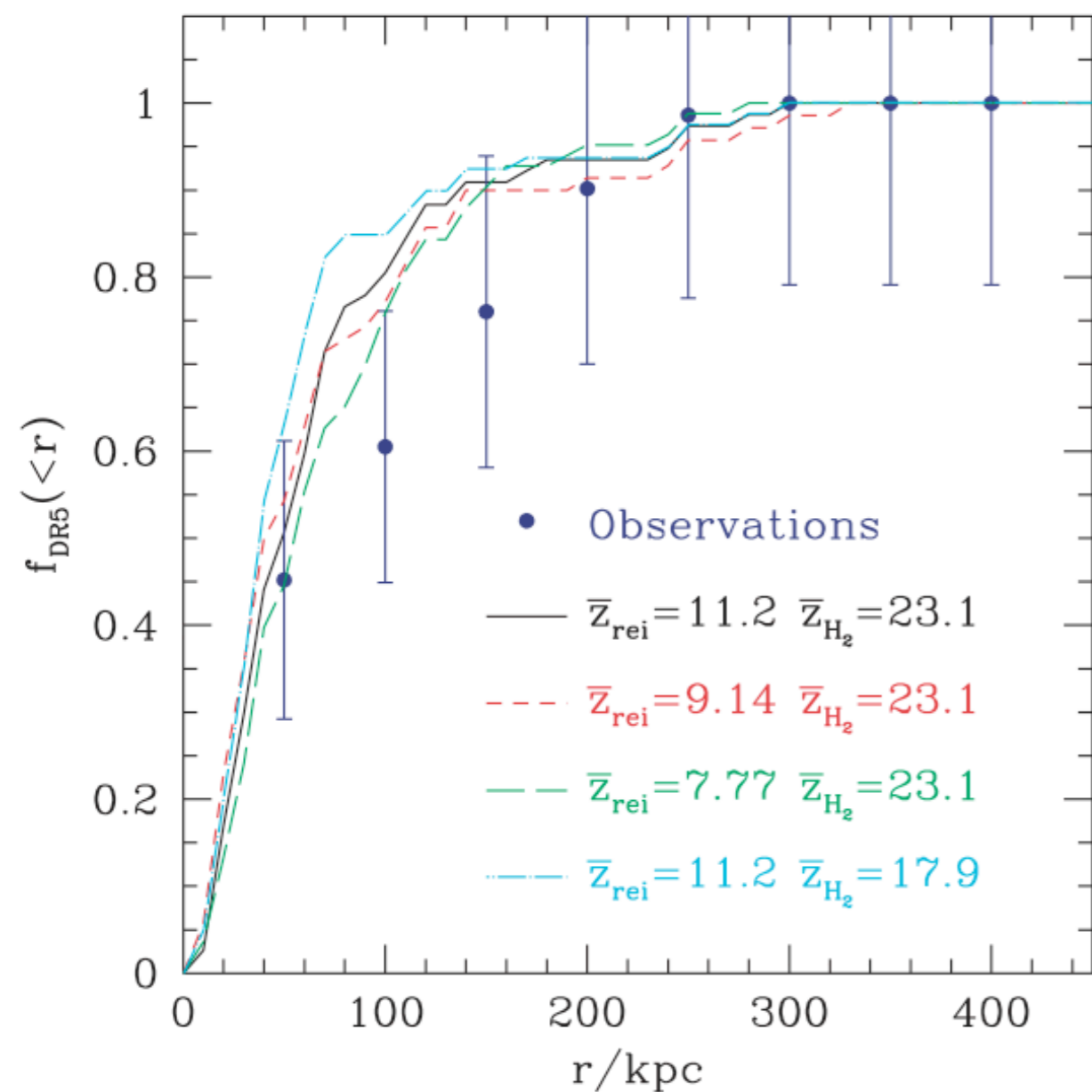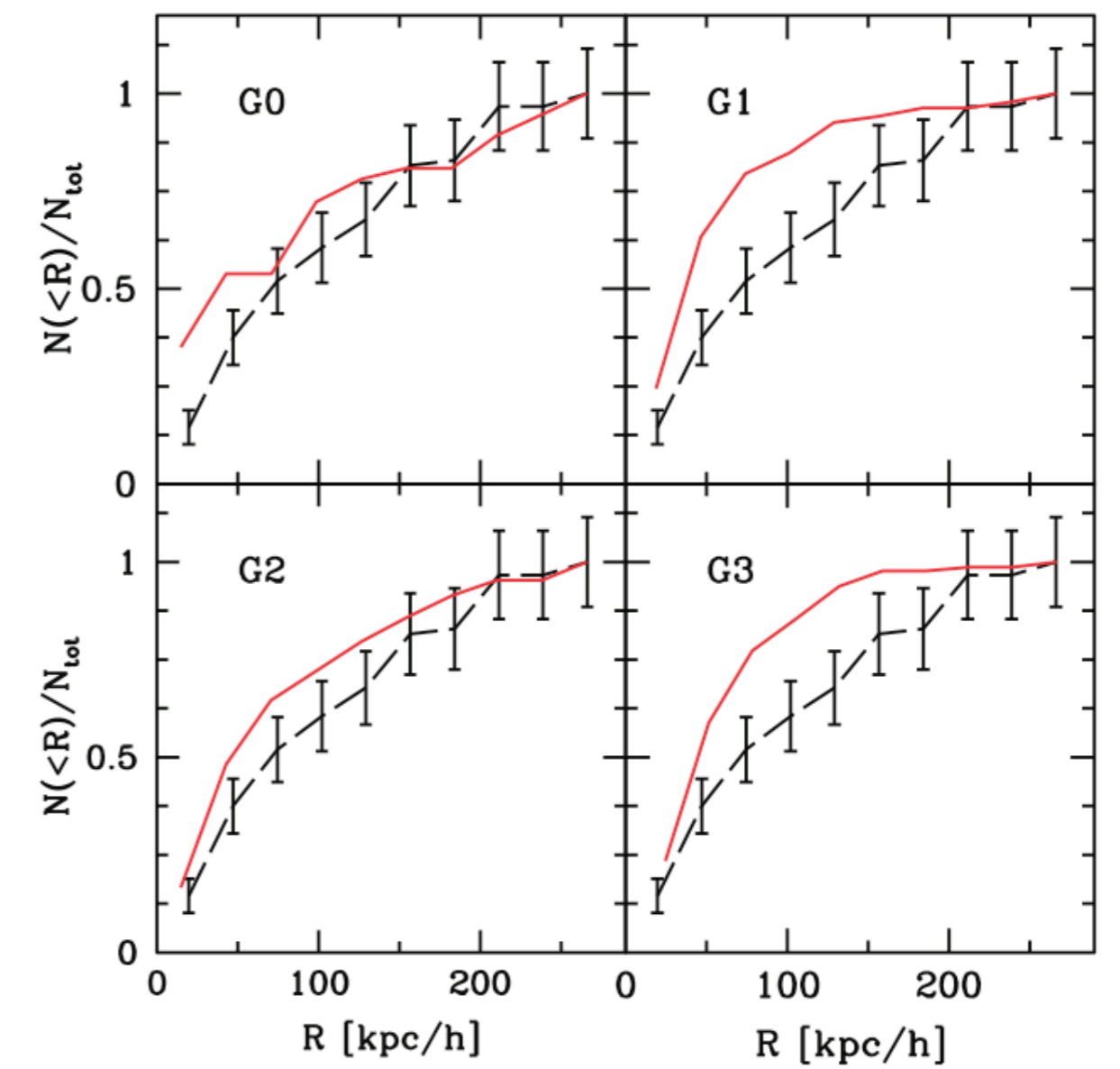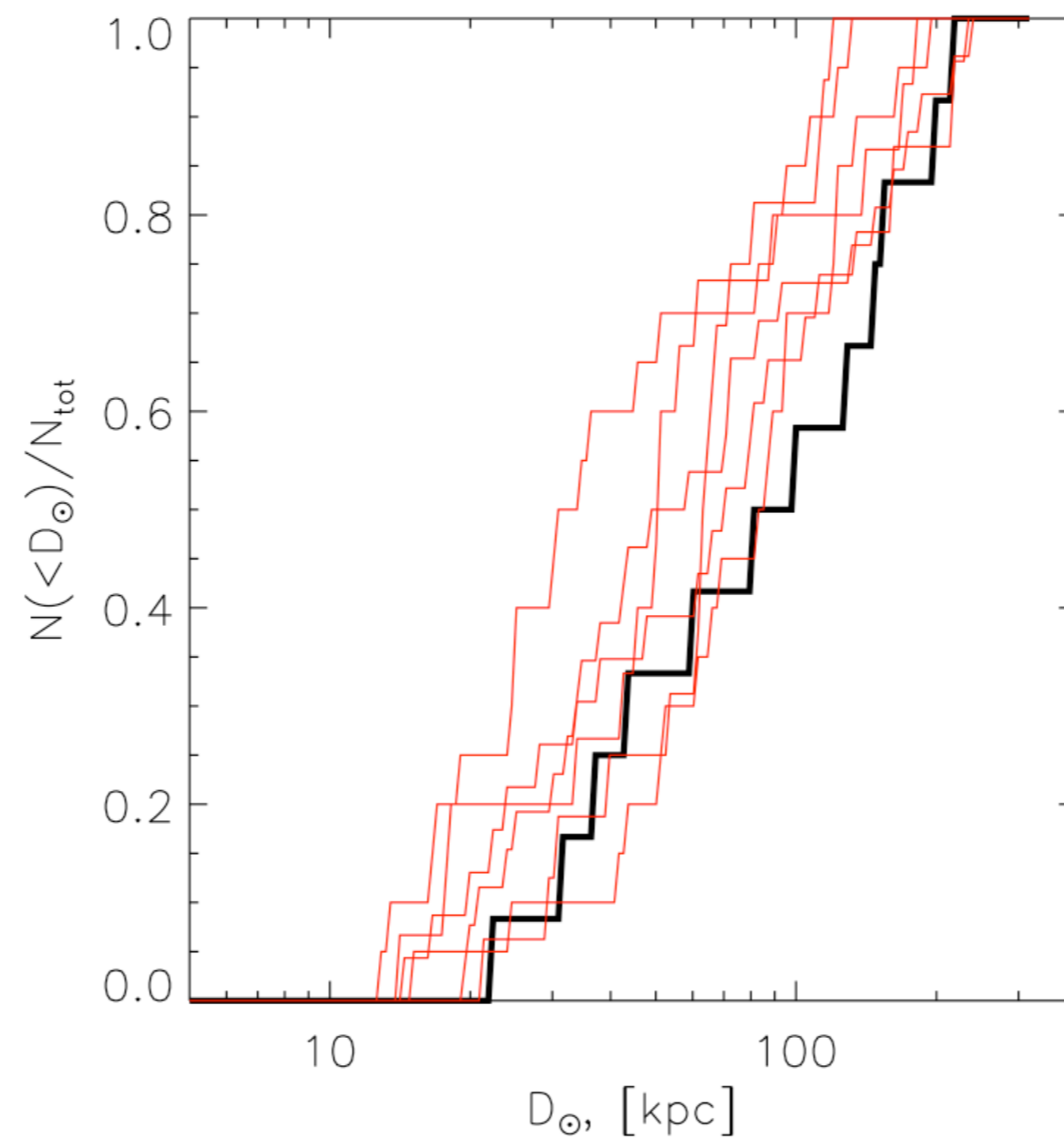○ => Signature of reionisation geometry survives down to z=0
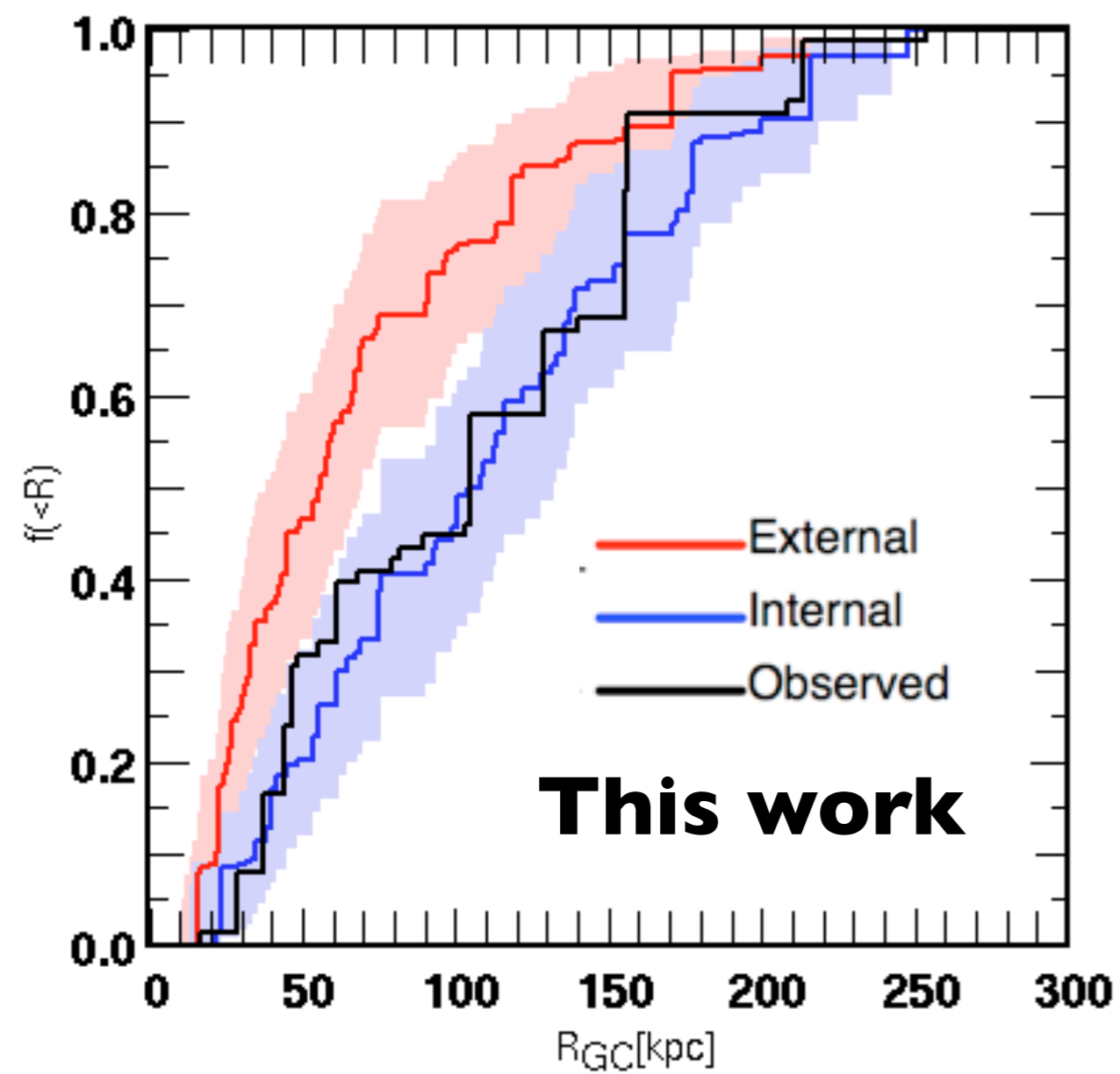
○ Simplification: unique central UV source   -_-

cumulative normalized radial distribution of Milky Way satellites

Ocvirk & Aubert 2011

Comparing with literature

This work

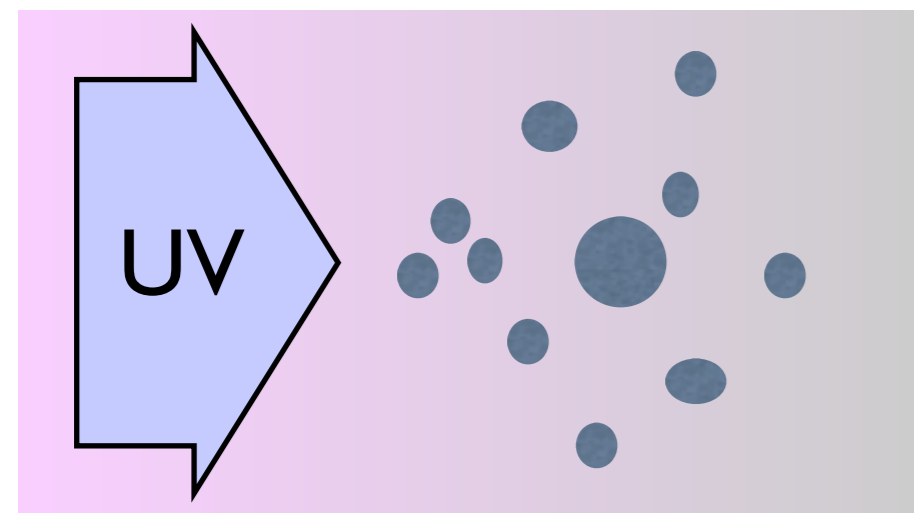Koposov et al. 2009

Maccio et al. 2010

Munoz et al. 2009

Busha et al. 2010

Lunnan et al. 2011, "self-consistent" reionisation

Impact of local structure of UV field at reionization on MW satellite pop
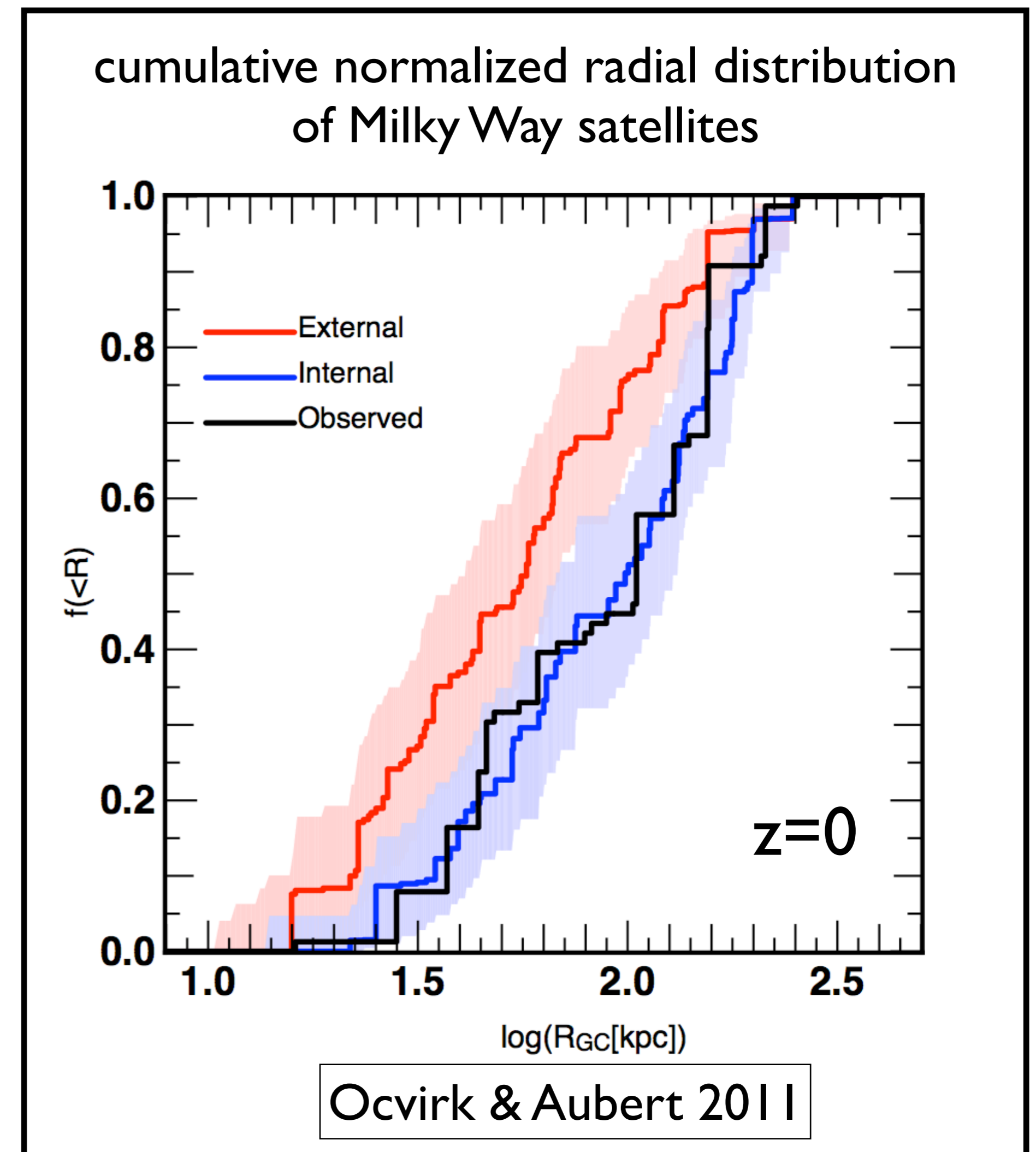

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cumulative normalized radial distribution of Milky Way satellites

z=0

Ocvirk & Aubert 2011
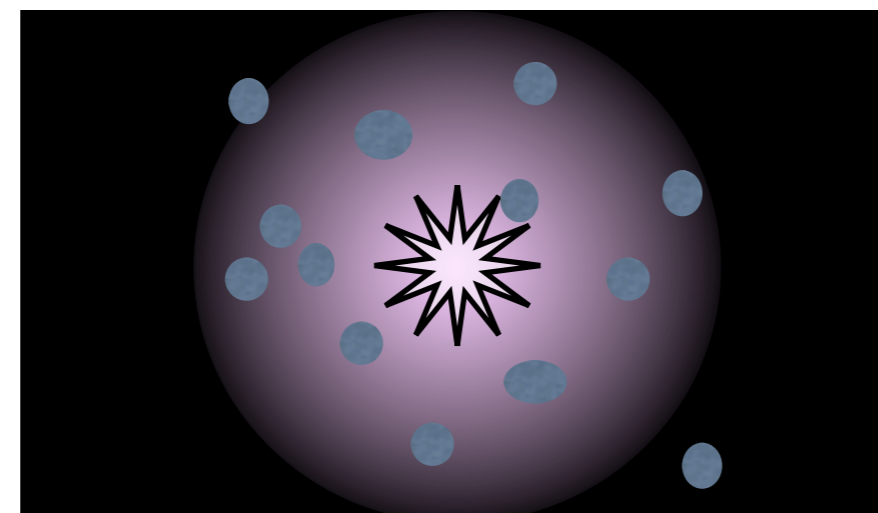
PICON

PICON: **P**hoto-**I**onization of **CON**strained realizations of the local group

Radiative post-processing of high-res hydro simulation of local group formation

HYDRO SIMULATION

- CLUES[1]

- Gottloeber et al. 2010

- GADGET 2, WMAP3 (no live RT)

- produces realistic MW+M31+M33

- $M_{part}=2.10^5$ $M_\odot$ (in HR region)

[1]CLUES: Constrained Local UniversE Simulations
Y. Hoffman (Racah Institute of Physics)
G. Yepes (Universidad Autonoma de Madrid)
S. Gottloeber (Leibnitz Institut fuer Astrophysik Potsdam)

RADIATIVE TRANSFER

- ATON (Aubert & Teyssier 2008)

- grid-based method

- multi-GPU: CUDATON

- Stellar sources T=50000 K, f_{esc}=0.2

- H only chemistry, 1 photon group

- ~20 h^{-1} kpc resolution, 512^3, 11 $^{h-1}$Mpc box

- No photo-evaporation/feedback!!

- No external source (Virgo)

Post-processing of the CLUES simulation with ATON

Setup geometry

- Low res region => $\rho = 10^{-2}\,\rho_c$
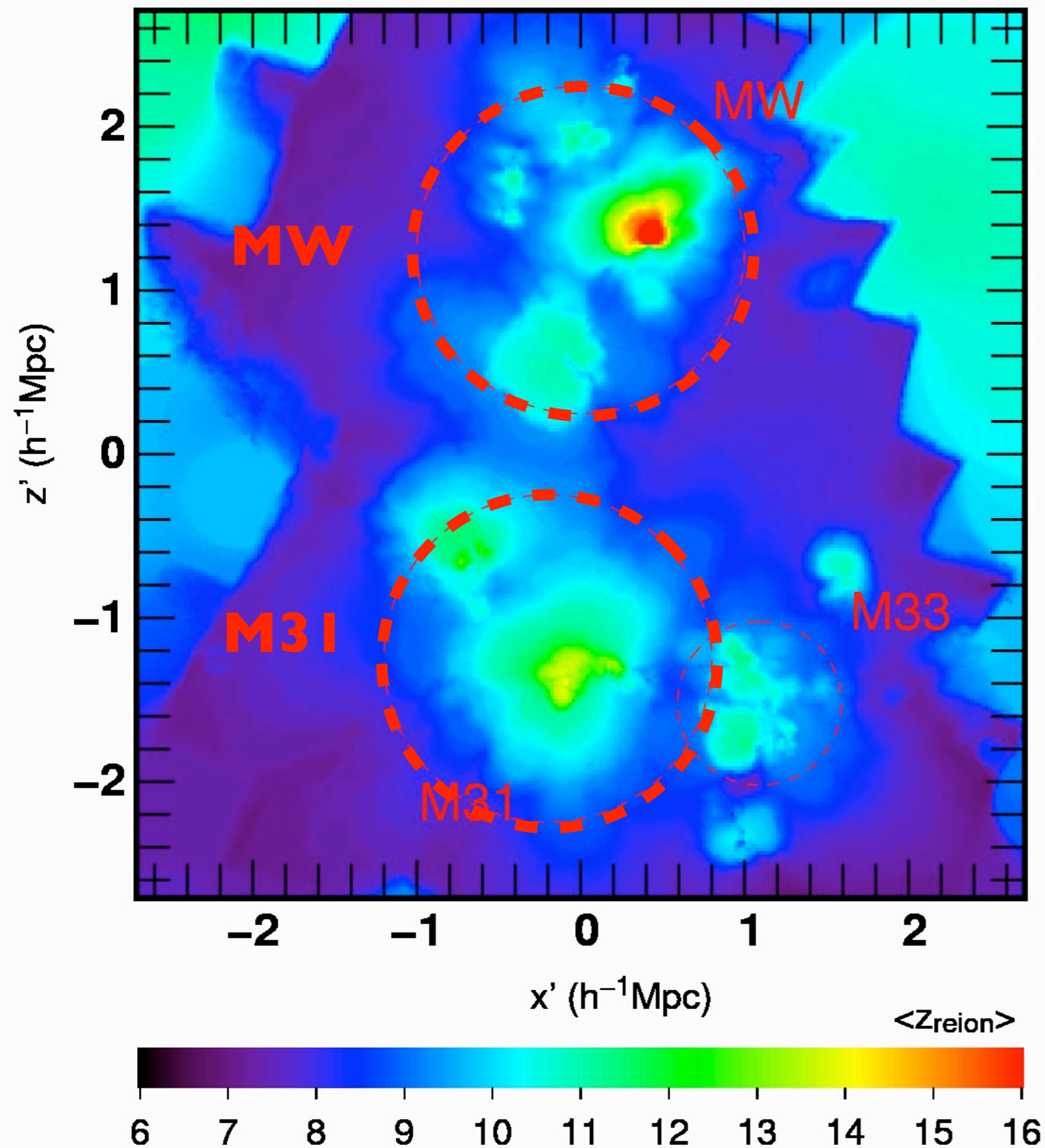- Box : 11 h^{-1} Mpc @512^3
- => ~20 h^{-1} kpc resolution

Boundary conditions

- Transmissive (photons get out)
- No external source (internal reionization)

$\langle x_{neutral}\rangle_\rho$ at z=9

MW

M31

M33

11 h^{-1} Mpc
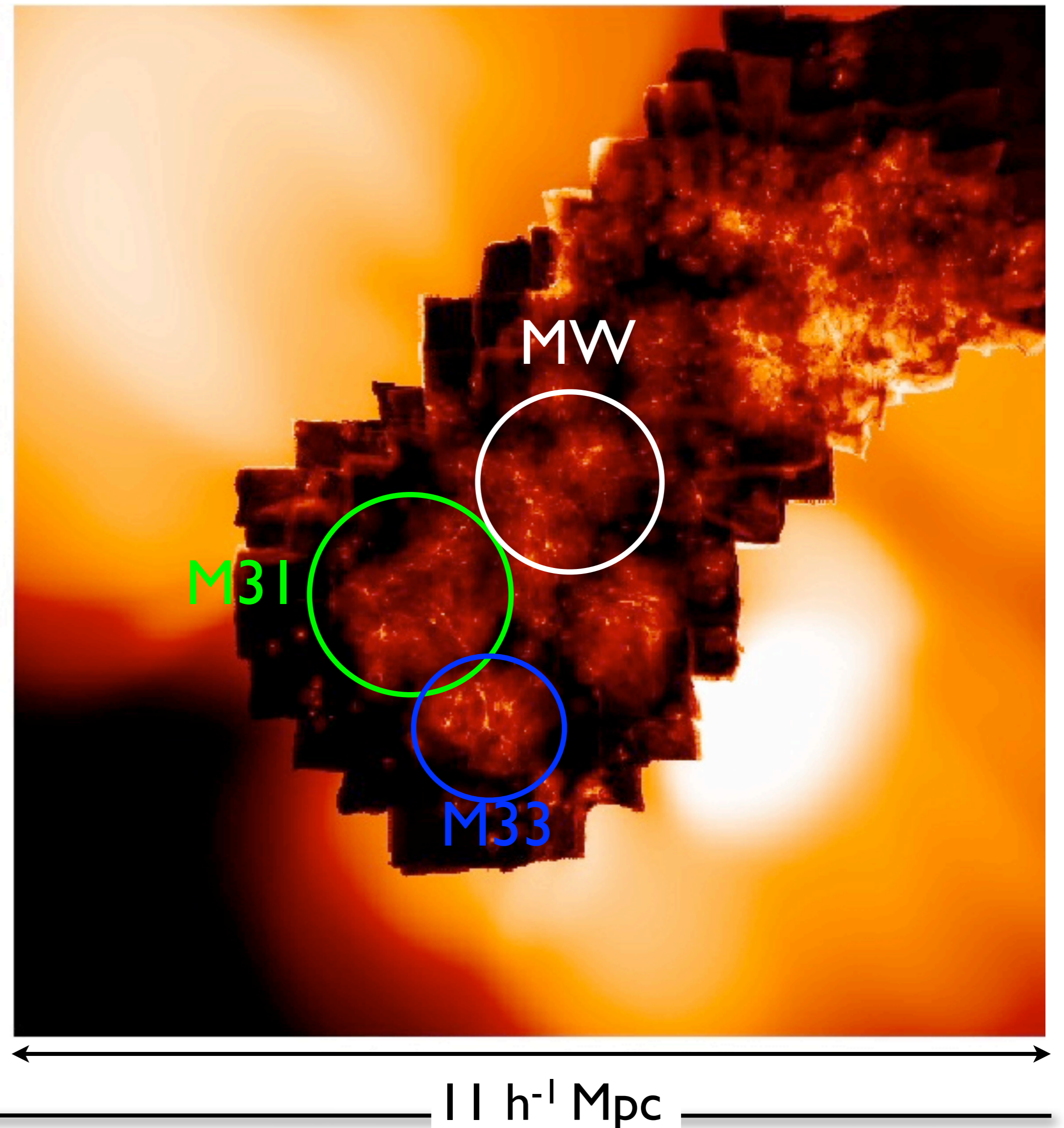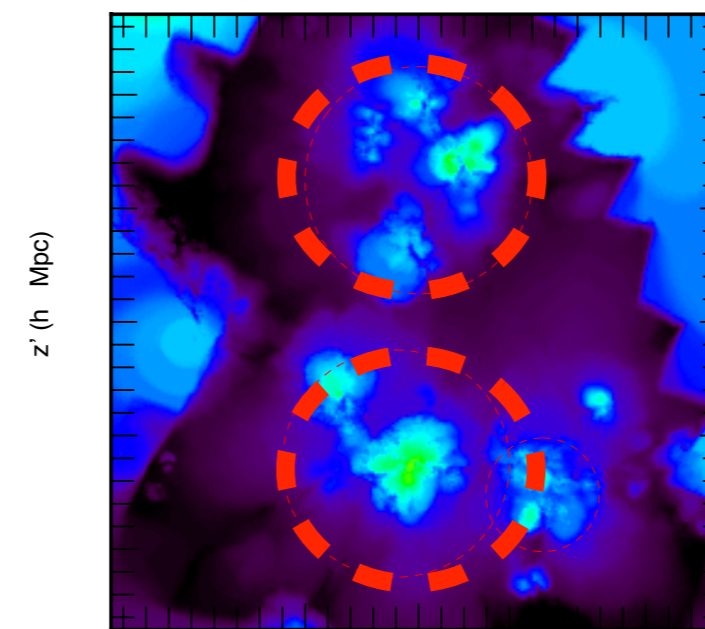
Local group reionization map

- Slice through MW-M31-M33 plane 200kpc thickness

- 2-4 major patches

- patches more or less structured

- each galaxy reionizes in isolation
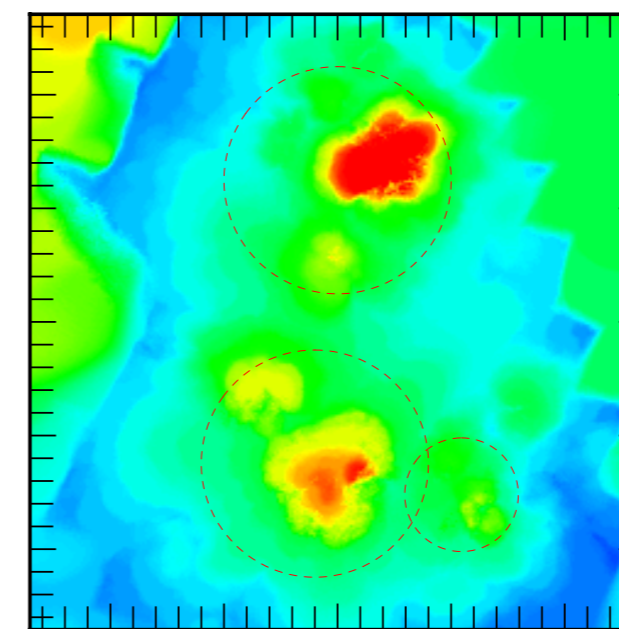
- Is that always so?

Ocvirk et al. 2012, submitted
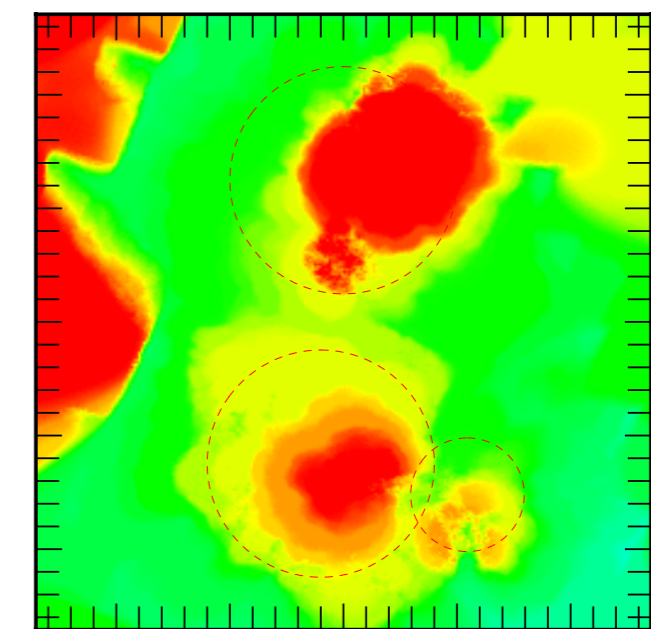
Impact of source modelling

Increasing emissivity

Increasing feedback strength

$M_t = 5.10^6 M_\odot$ (halo detection limit)	No feedback
$T_{vir} \sim 10^4 K$ $M_t \sim 1.10^8 M_\odot$ (z-dependent)	Lyman-Werner suppression of H_2 formation (Shapiro et al.)
$M_t = 1.10^9 M_\odot$	Strong SN feedback (ref?)

running   todo   todo

todo

z_{reion}

6 7 8 9 10 11 12 13 14 15 16

Conclusions 1
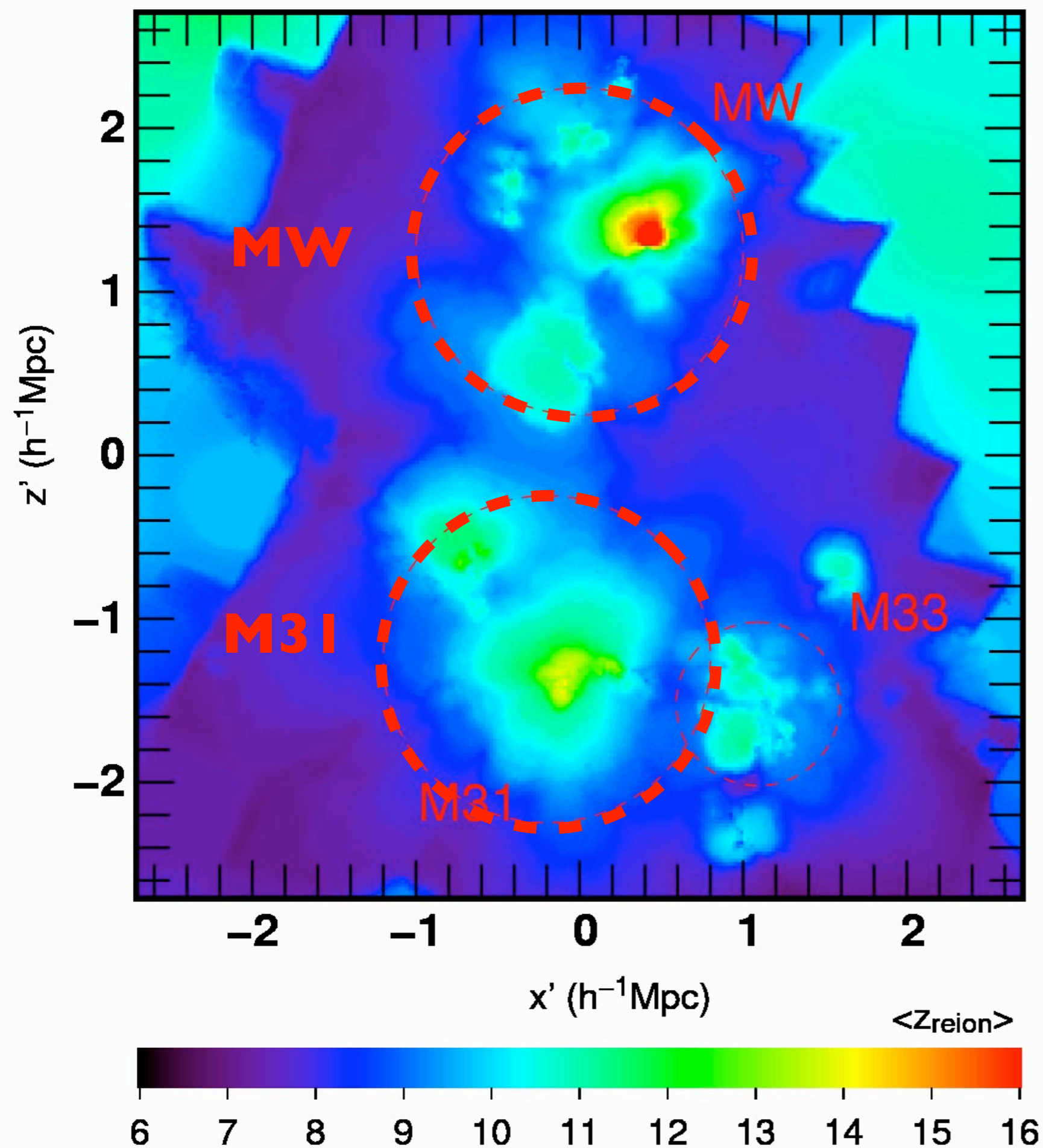
- MW and M31 reionize in isolation except in the most extreme models (Strong SN feedback + high emissivity)

- => modelling isolated MWs should be mostly ok in SAMs (cf Griffen et al. 2012)

- low emissivity models => large Δz_{reion}

- => effect on global satellite reionization history?

- Effect of > 12.7 Gyr dynamical evolution?