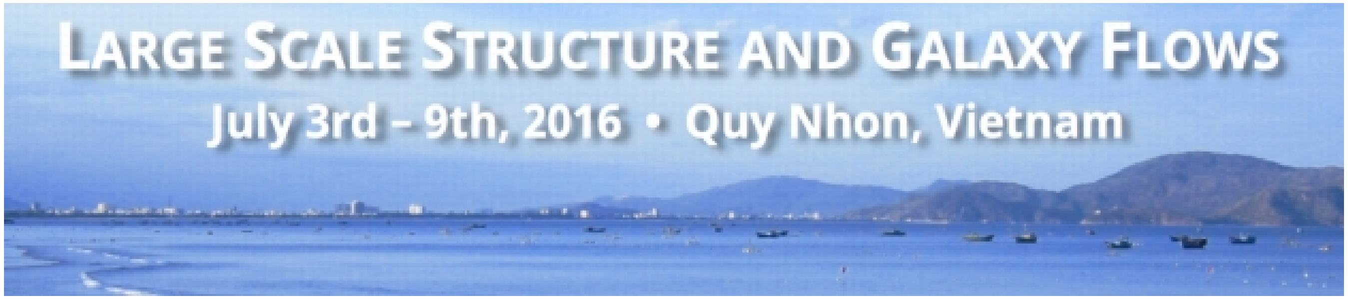
האוניברסיטה העברית בירושלים
The Hebrew University of Jerusalem



The Local Group Factory

Edoardo Carlesi

__EC__, J.G. Sorce, Y. Hoffman, S. Gottlöber, G. Yepes, N.I. Libeskind,S.V. Pilipenko, A. Knebe, H. Courtois, R.B. Tully, M. Steinmetz, ***MNRAS 458, 2016***

__EC__, Y. Hoffman, J.G. Sorce, S. Gottlöber, G. Yepes, H. Courtois, R.B. Tully, ***MNRAS 460, 2016***

Motivation

Study the LG in a **controlled environment:**

Is the LG a **typical** object?

Is it an **unlikely** product of ΛCDM?

Can we learn something on **cosmology**?

Large scales/small scales relation?

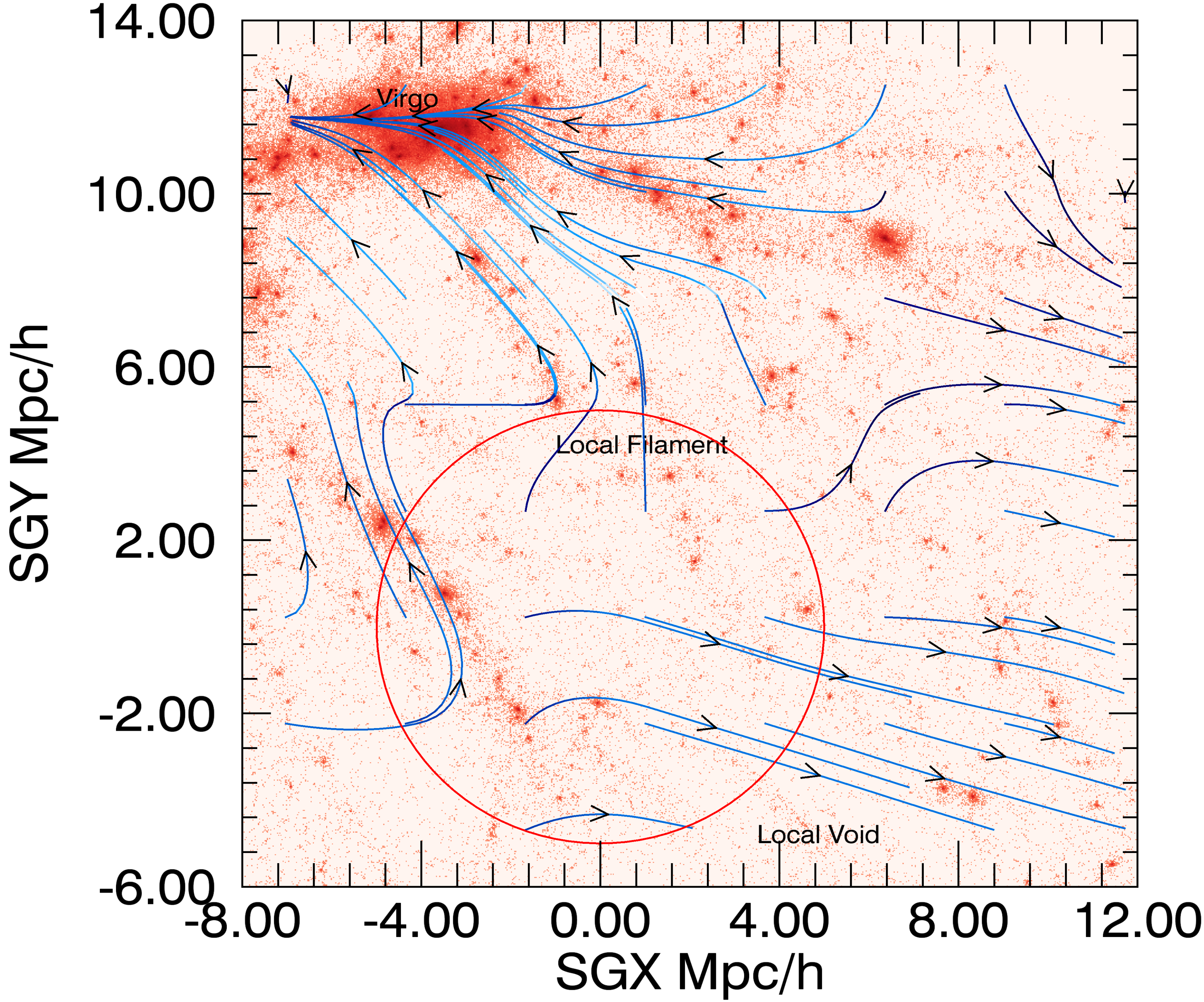
Algorithms & Data

Use peculiar velocities (Cosmic Flows 2, CF2) to constrain the ICs (WF/CR method)

Constrained Realisation: Random field + observational constraints

We generate **two** CR (large/small scales)

Each large scale realisation can be used with **different short wave** realisations.



14.00
10.00
6.00
2.00
-2.00
-6.00
SGY Mpc/h
-8.00
-4.00
0.00
4.00
8.00
12.00
SGX Mpc/h
Virgo
Local Filament
Local Void

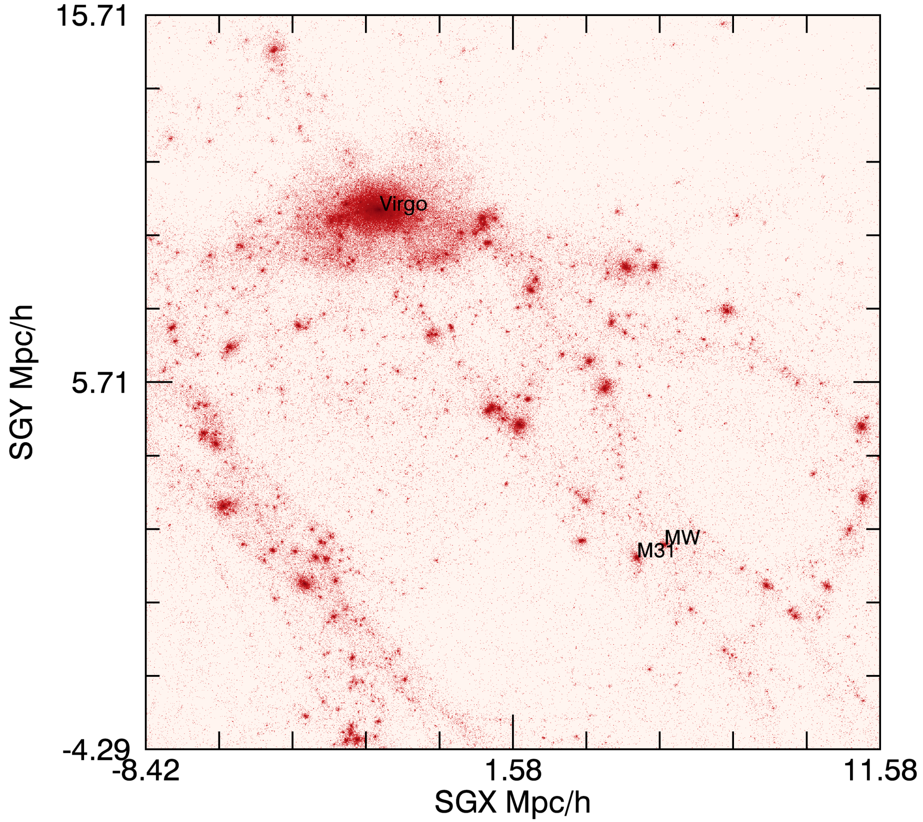
The Local Group Model

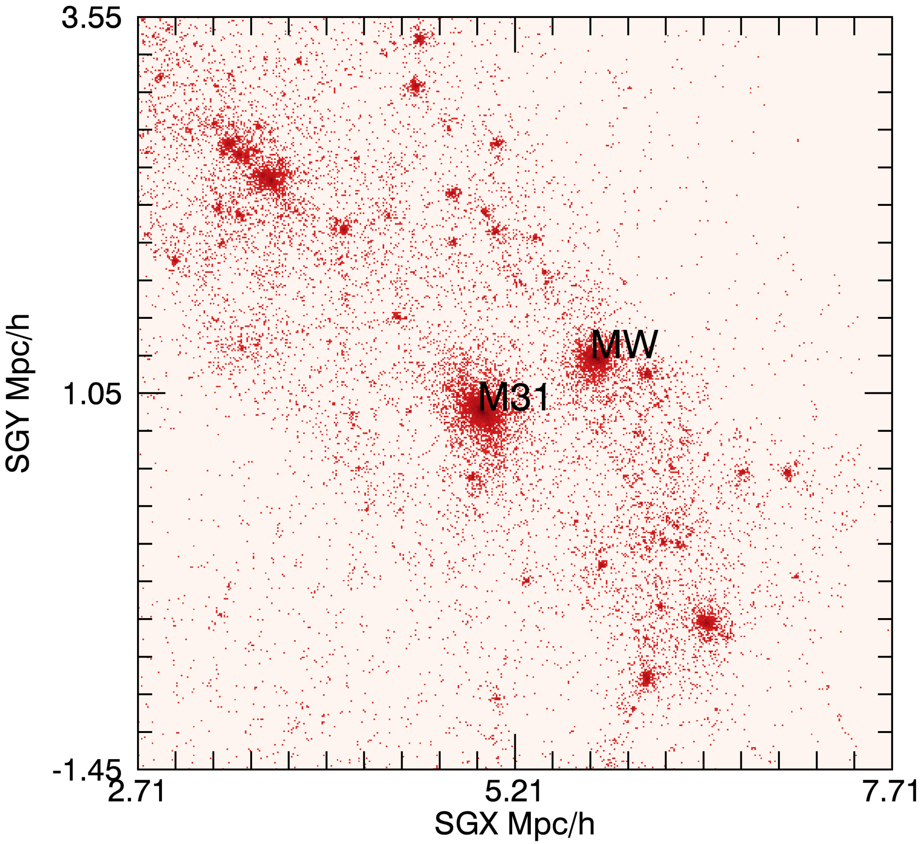
Question: How do we define a LG in simulations?

Example:

- 2 DM haloes
- Isolation: No third large halo $R<2.5\ h^{-1}$Mpc
- Separation: $(0.5 – 1.5)\ h^{-1}$ Mpc
- Tot.Mass: $(0.5 – 1.5) \times 10^{12}\ h^{-1}\ M_{su}$

Local Neighbourhood and Local Group Reconstruction





LG Factory Efficiency

Planck-I type of cosmology

512^3 particles 1-layer zoom simulations:

700 simulations, 80 LS realisations, 344 Type I LGs, 120 Type II LGs, 19 Type III LGs

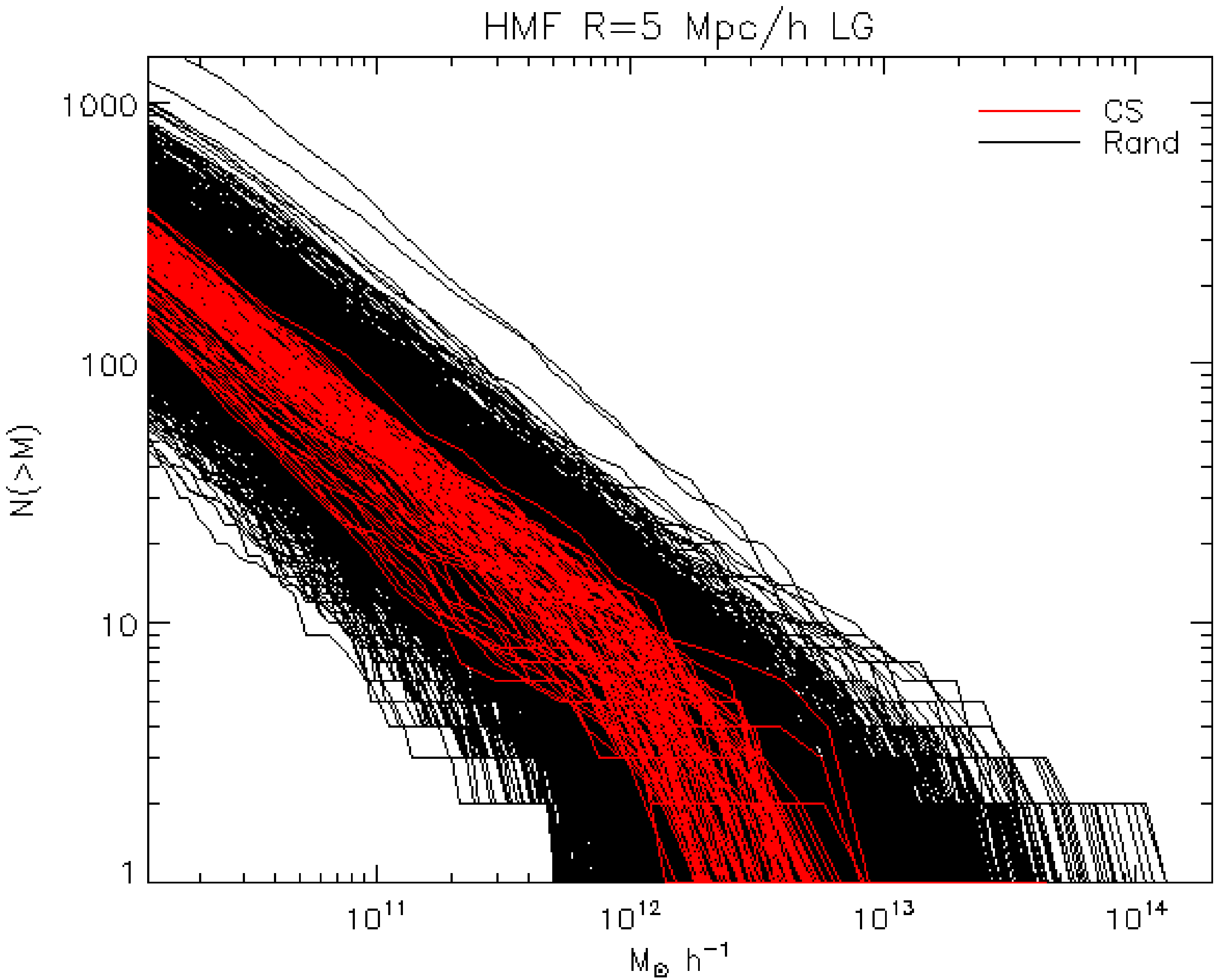
Resimulations:

1024^3 particles 2-layers zoom, 200 LGs

2048^3 particles 3-layers zoom, 16 LGs

4096^3 particles 4-layers zoom, 10 LGs

8192^3 particles 5-layers zoom, 1 LG


HMF R=5 Mpc/h LG
CS
Rand
1000
100
10
1
N(>M)
10^{11}
10^{12}
10^{13}
10^{14}
$M_{\odot}\ h^{-1}$

Application I:
Vtan of M31

Application I: V_{tan} of M31

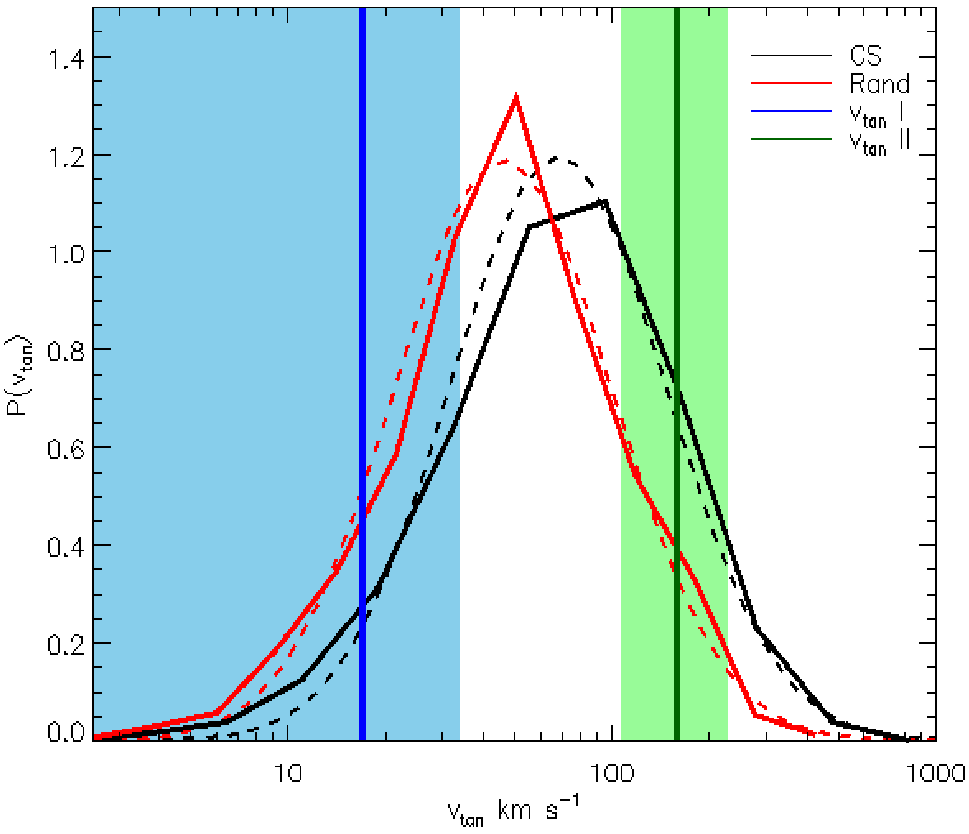
Use constrained simulations (CS) LG sample to study the distribution of M31's V_{tan}

Use standard Planck-I simulation (same LG model) as LG control sample (*Rand*)

Compare to *van der Marel et al. 2012* and *Salomon et al. 2016* estimates

V_{tan} of M31

	v	$v+\sigma_v$	$v-\sigma_v$
$v_{\rm tan}^{(I)}$	17	34	0
$v_{\rm tan}^{(II)}$	164	225	103
$v_{\rm tan}{}^{CS}$	78	168	36
$v_{\rm tan}{}^{Rand}$	51	109	24

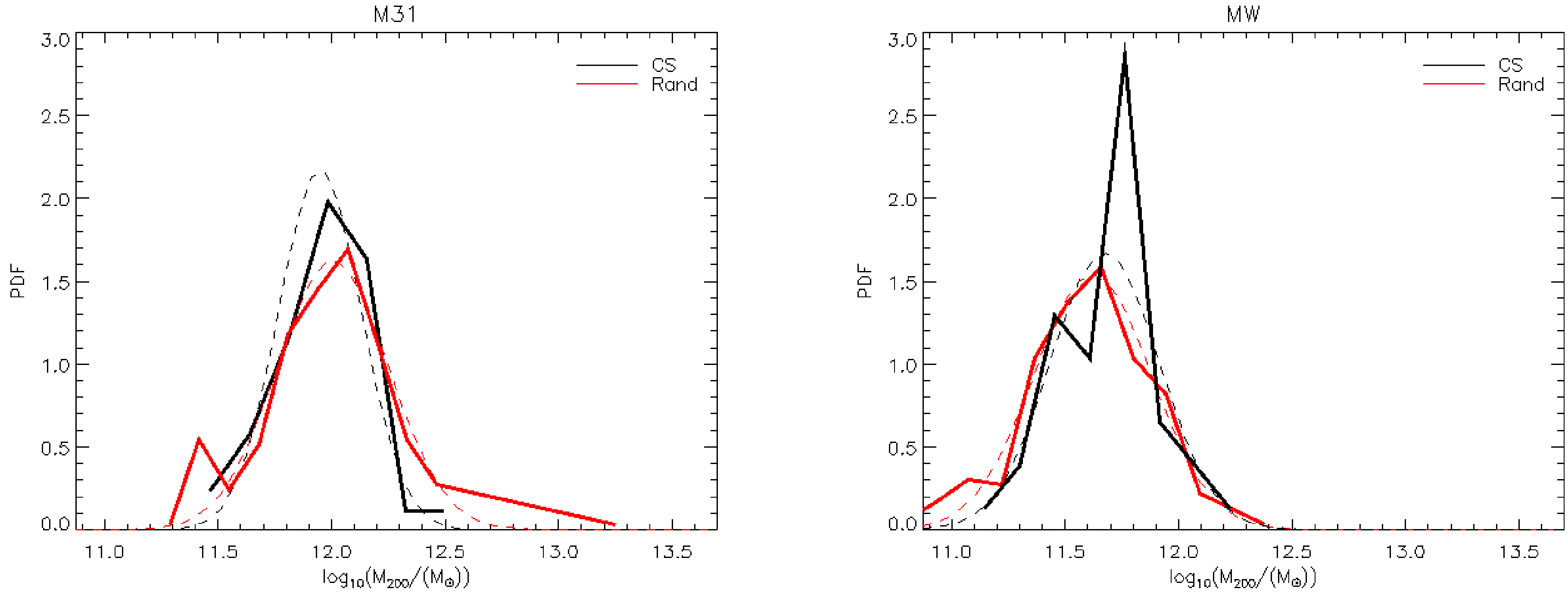


Probabilities of the different samples for the CS and Rand simulations:

Sample	P_I^A	P_{II}^A
CS	0.14	0.28
Rand	0.29	0.16

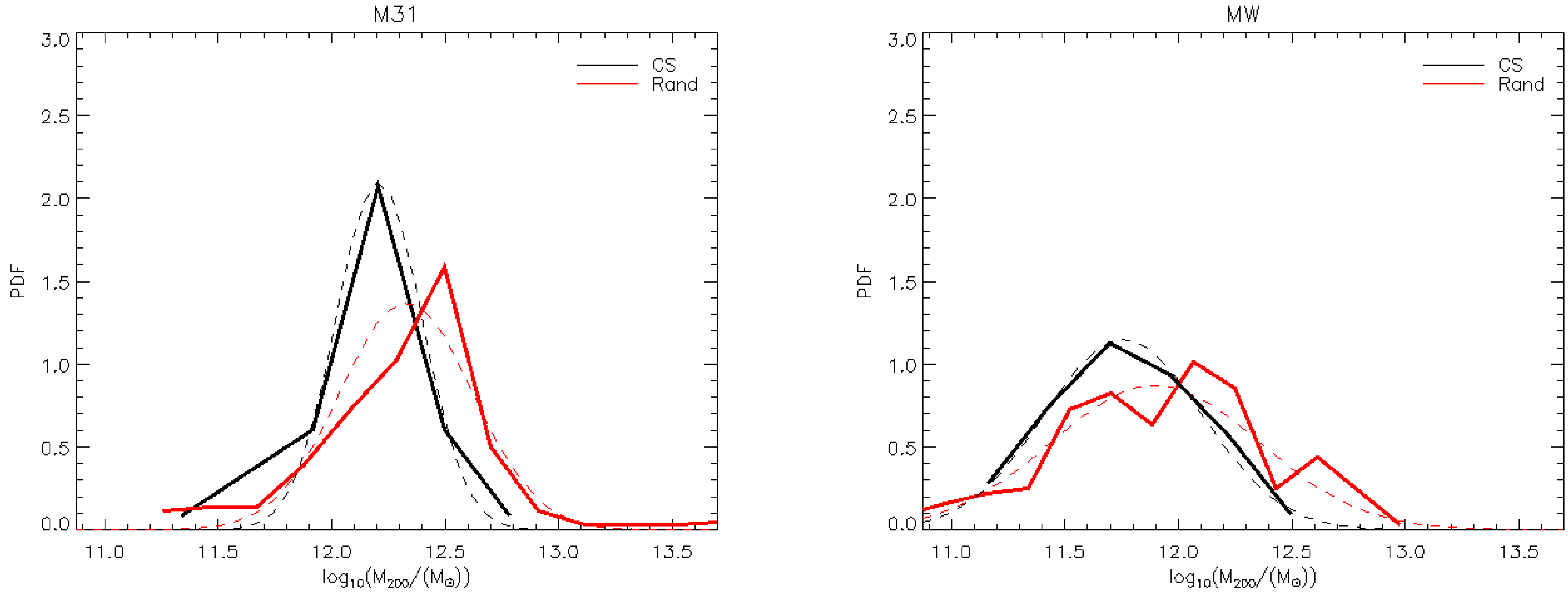
Application II:
MLG (M31 & MW)

M_{LG} : V_{tan}=17±17 km/s (Sohn et al. 2012)



M_{200}	Mean	Std.dev	μ	σ
$M_{M31,CS}$	12.04	0.22	11.93	0.21
$M_{M31,Rand}$	12.04	0.27	12.00	0.25
$M_{MW,CS}$	11.75	0.19	11.69	0.19
$M_{MW,Rand}$	11.66	0.28	11.62	0.26
$M_{MLG,CS}$	12.23	0.19	12.20	0.14
$M_{MLG,Rand}$	12.21	0.23	12.15	0.20

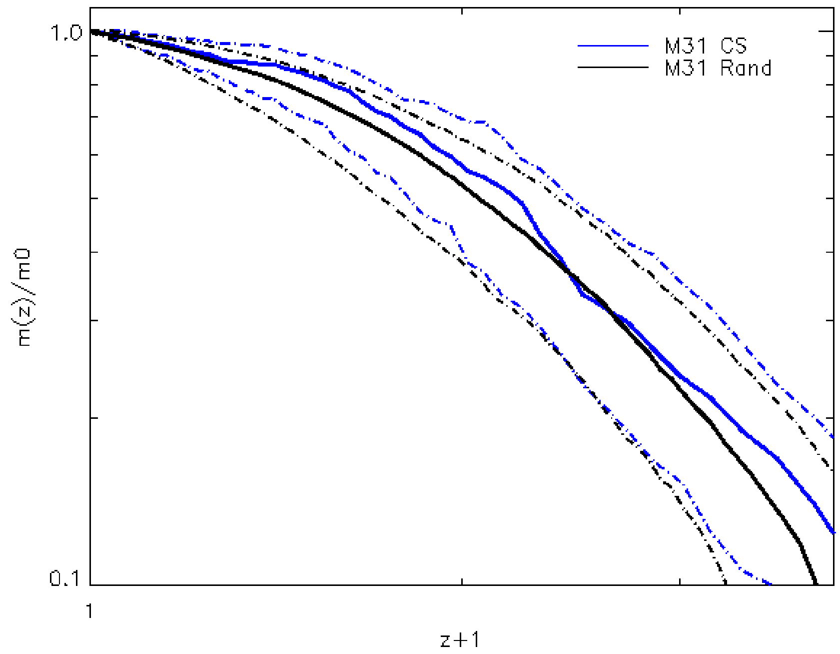
M_{LG} : V_{tan}=168±61 km/s (Salomon et al. 2016)

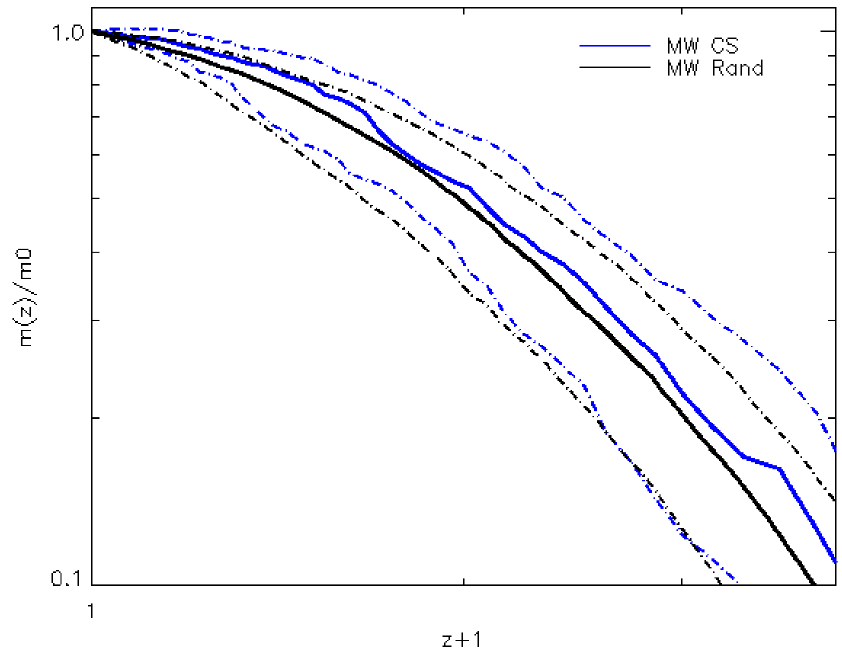


M_{200}	Mean	Std.dev	μ	σ
$M_{M31,CS}$	12.40	0.25	12.21	0.19
$M_{M31,Rand}$	12.47	0.39	12.33	0.29
$M_{MW,CS}$	11.91	0.33	11.76	0.35
$M_{MW,Rand}$	12.03	0.43	11.90	0.46
$M_{MLG,CS}$	12.54	0.23	12.41	0.16
$M_{MLG,Rand}$	12.62	0.36	12.52	0.27

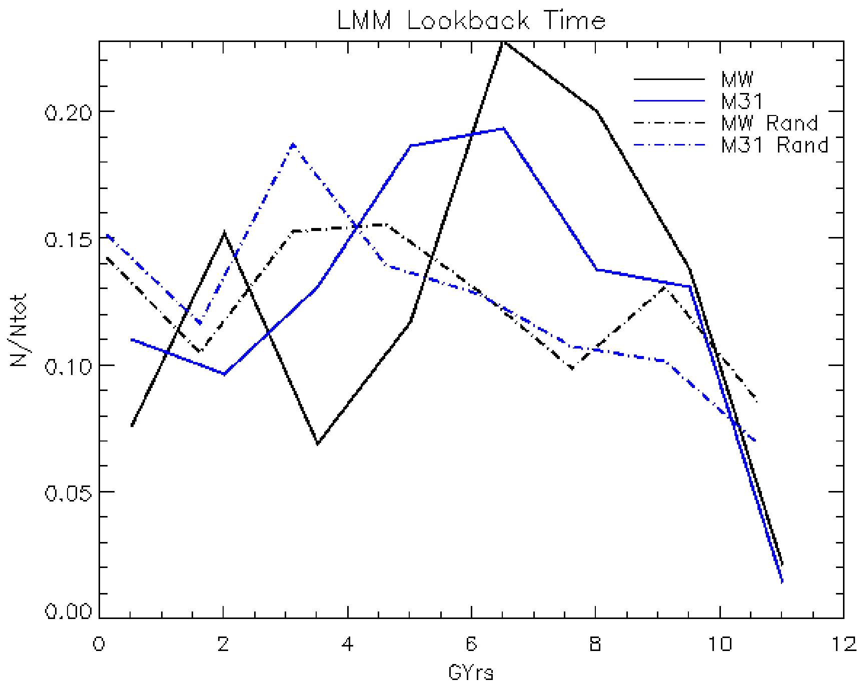
Application III: Mass Assembly History

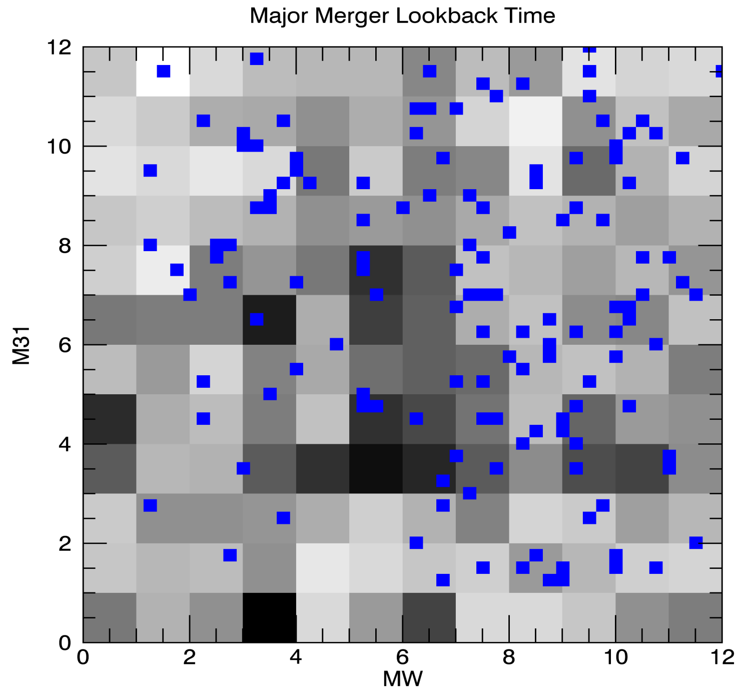
MAHs





Major Merger Times





Conclusions

LG Factory: Efficient pipeline to simulate LGs in real environment, study LG properties & cosmology

Applications: V_{tan} M31, M_{LG} , MAH

Future projects: Full hydro, local volume, satellites (abundance & anisotropy), SMBHs...