DEUS SIMULATIONS: IMPRINTS OF DARK ENERGY ON THE PROFILE OF DARK MATTER HALOS

Irène BALMÈS
part of the DEUS team including Jean-Michel ALIMI, Pier-Stefano CORASANITI, Yann RASERA, Vincent BOUILLOT, Vincent REVERDY, Linda BLOT...

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Balmès, Rasera, Corasaniti & Alimi, arXiv:1307.2922

NAVARRO, FRENK AND WHITE PROFILE

Phenomenological density profile from the simulations

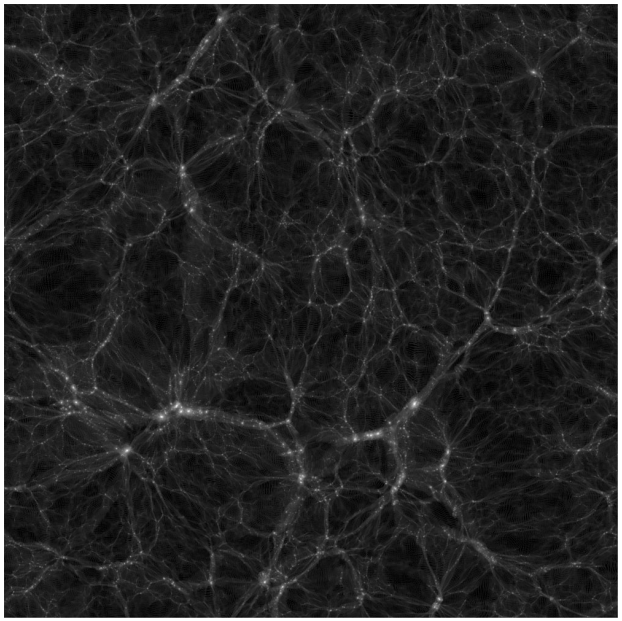
$$\rho(r) = \frac{\rho_s}{\frac{r}{r_s}(1+\frac{r}{r_s})^2}$$

concentration: $c = \frac{r_{200}}{r_s}$

How does c evolve with mass?

VAST LITERATURE

Navarro et al. 1997, Bullock et al. 2001, Zhao et al. 2003, 2009, Dolag et al. 2004....



DEUS SIMULATIONS

- multiple box-sizes and resolutions
- large mass range
- several cosmological models

see www.deus-consortium.org

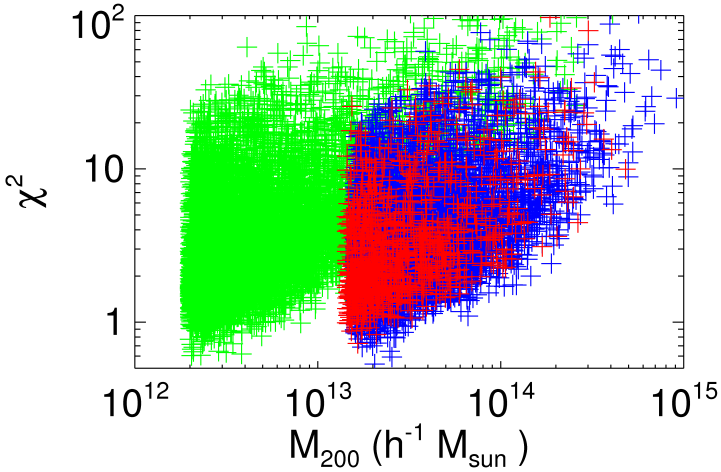
Ideal set-up to study imprints of cosmology on non-linear structure formation, and in particular on halo profiles.

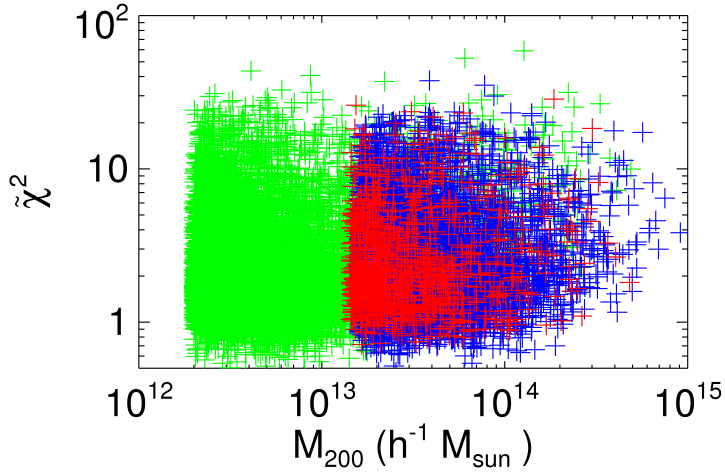
In this study, (mostly) box of 162 Mpc and $N_{part} = 512^3$.

HALO FINDER

Spherical OverDensity (SOD)
Friend of Friend (FoF)

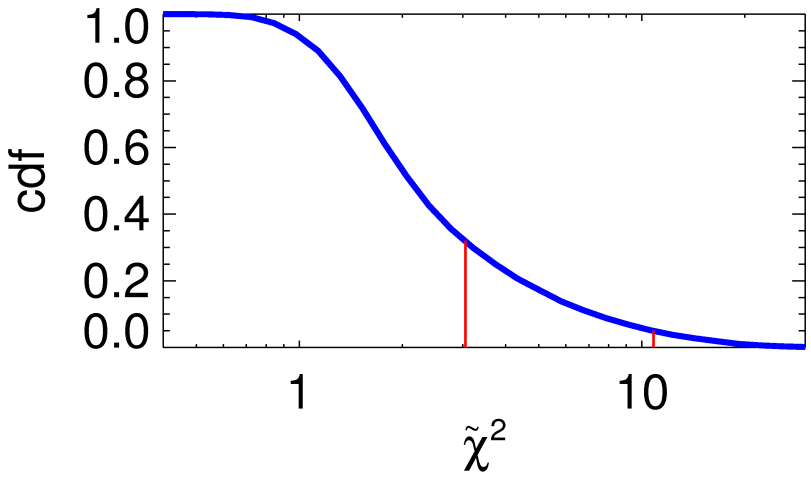
For each halo we obtain: M_{200}, r_{200}, c, χ^2





NUMERICAL EFFECTS ON χ^2

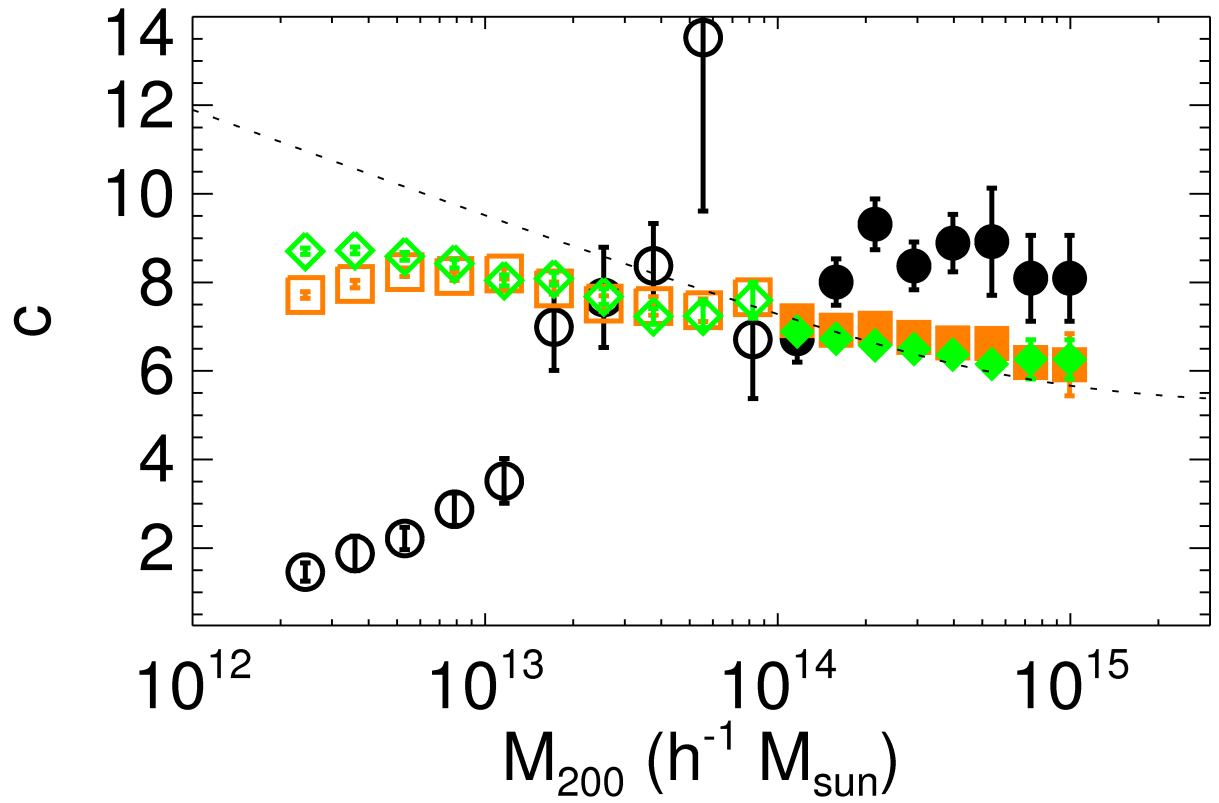
Renormalization: $\tilde{\chi}^2 = \chi^2/\sqrt{n_{part}}$
$\tilde{\chi}^2$ independent of the resolution



3 HALO GROUPS

- Halos fitted to within 1σ: 68 %
- Halos fitted to within 2σ: 95 %
- Halos ill-fitted: 5%

$\tilde{\chi}^2$ limits vary with cosmology and redshift.

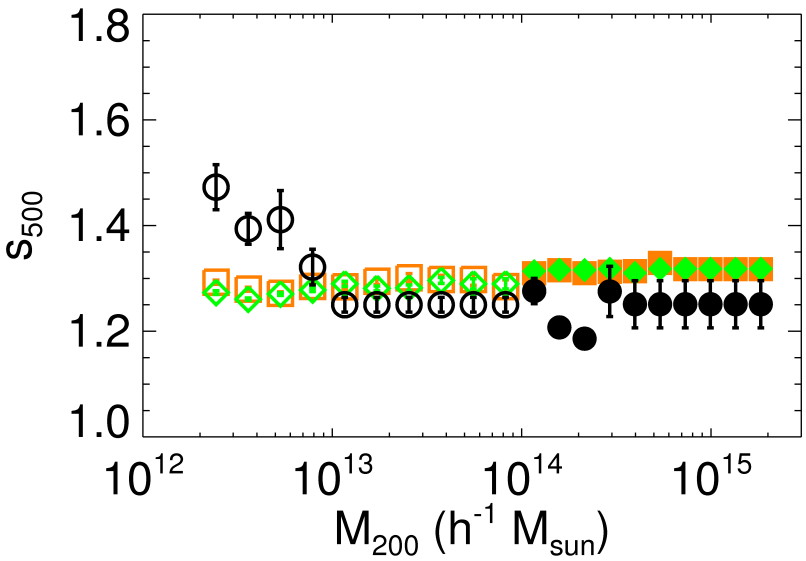


Great variations among the different groups. Find a more stable parameter?

SPARSITY

$$s_\Delta = \frac{M_{200}}{M_\Delta}$$

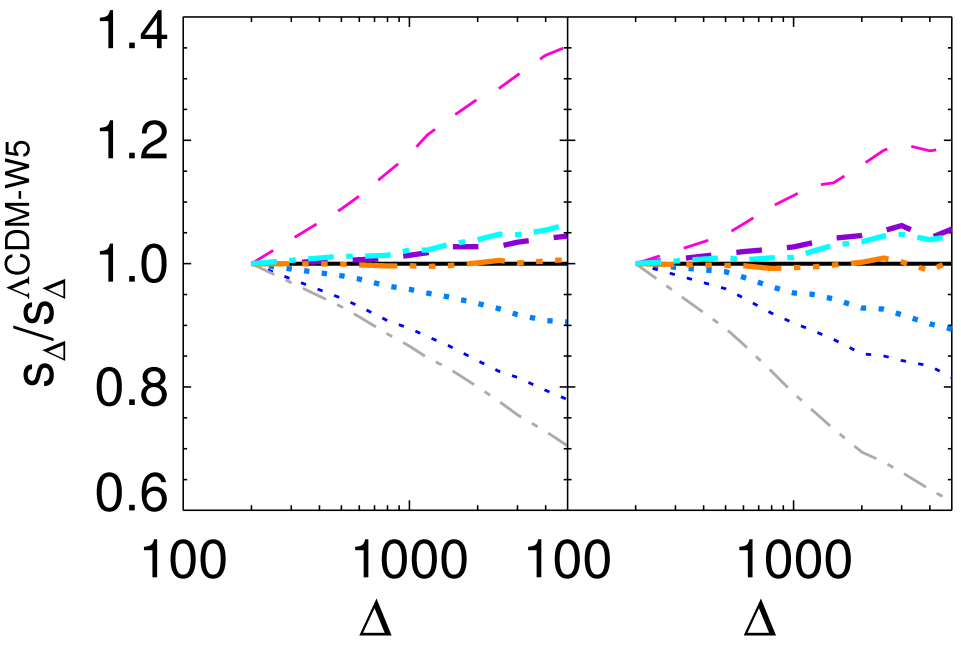
- no fitting required
- (nearly) independent of the halo mass



$\Rightarrow$ Consistency relation between s_Δ and the mass functions

$$\int \frac{1}{M_\Delta}\frac{dn}{d\ln M_\Delta} d\ln M_\Delta = s_\Delta \int \frac{1}{M_{200}}\frac{dn}{d\ln M_{200}} d\ln M_{200}$$

VARIATION WITH THE COSMOLOGY OF s_Δ



pink: $\Omega_\Lambda = 0$
blue: $\Omega_\Lambda = 0.9$
grey: toy-model Ratra-Peebles
cyan: realistic Ratra-Peebles
violet: ΛCDM-WMAP3
orange: SuperGravity

Cosmological variations linked to σ_8 and D_+

- the higher D_+, the lower s_Δ
- the higher σ_8, the lower s_Δ

- confrontation to observations
- 2D sparsity
- DEUS FUR data

LARGE SET OF UNIVERSE VOLUMES (+ 25 SIMULATIONS)

HIGH SPATIAL RESOLUTION AND MASS: 2.5 h^{-1} kpc to 10.4 h^{-1} Gpc, 2.5 10^{8} h^{-1} $M_\odot$ to 10^{16} $h^{-1}M_\odot$

INITIAL REDSHIFT DEEP IN LINEAR REGIME

Box Size	Force Resolution	Mass Resolution	Number of Particles	Initial Redshift	Cosmological Models	Supercomputer (Nb of Proc)
162 h^{-1} Mpc	2.5 h^{-1} kpc	~2. 10^{9} h^{-1} $M_\odot$	512^3	~90	ΛCDM, SUCDM, RPCDM	Titane (64)
162 h^{-1} Mpc	2.5 h^{-1} kpc	~2.5 10^{8} h^{-1} $M_\odot$	1024^3	~130	ΛCDM, SUCDM, RPCDM	Blue Gene/P(4096)
648 h^{-1} Mpc	20 h^{-1} kpc	~1.5 10^{11} h^{-1} $M_\odot$	512^3	~55	ΛCDM, SUCDM, RPCDM	-
648 h^{-1} Mpc	10 h^{-1} kpc	~1.75 10^{10} h^{-1} $M_\odot$	1024^3	~90	ΛCDM, SUCDM, RPCDM	Blue Gene/P(4096)
648 h^{-1} Mpc	5 h^{-1} kpc	~2. 10^{9} h^{-1} $M_\odot$	2048^3	~90	ΛCDM, RPCDM	Blue Gene/P(32768)
1296 h^{-1} Mpc	40 h^{-1} kpc	~1. 10^{12} h^{-1} $M_\odot$	512^3	~40	ΛCDM, SUCDM, RPCDM	-
2592 h^{-1} Mpc	40 h^{-1} kpc	~1. 10^{12} h^{-1} $M_\odot$	1024^3	~55	ΛCDM, SUCDM, RPCDM	Blue Gene/P(4096)
2592 h^{-1} Mpc	20 h^{-1} kpc	~1.5 10^{11} h^{-1} $M_\odot$	2048^3	~55	ΛCDM, RPCDM	Blue Gene/P(24576)
5184 h^{-1} Mpc	40 h^{-1} kpc	~1. 10^{12} h^{-1} $M_\odot$	2048^3	~40	ΛCDM, RPCDM	Blue Gene/P(24576)
10368 h^{-1} Mpc	40 h^{-1} kpc	~1. 10^{12} h^{-1} $M_\odot$	4096^3	~40	ΛCDM	Curie Fat Nodes (9728)