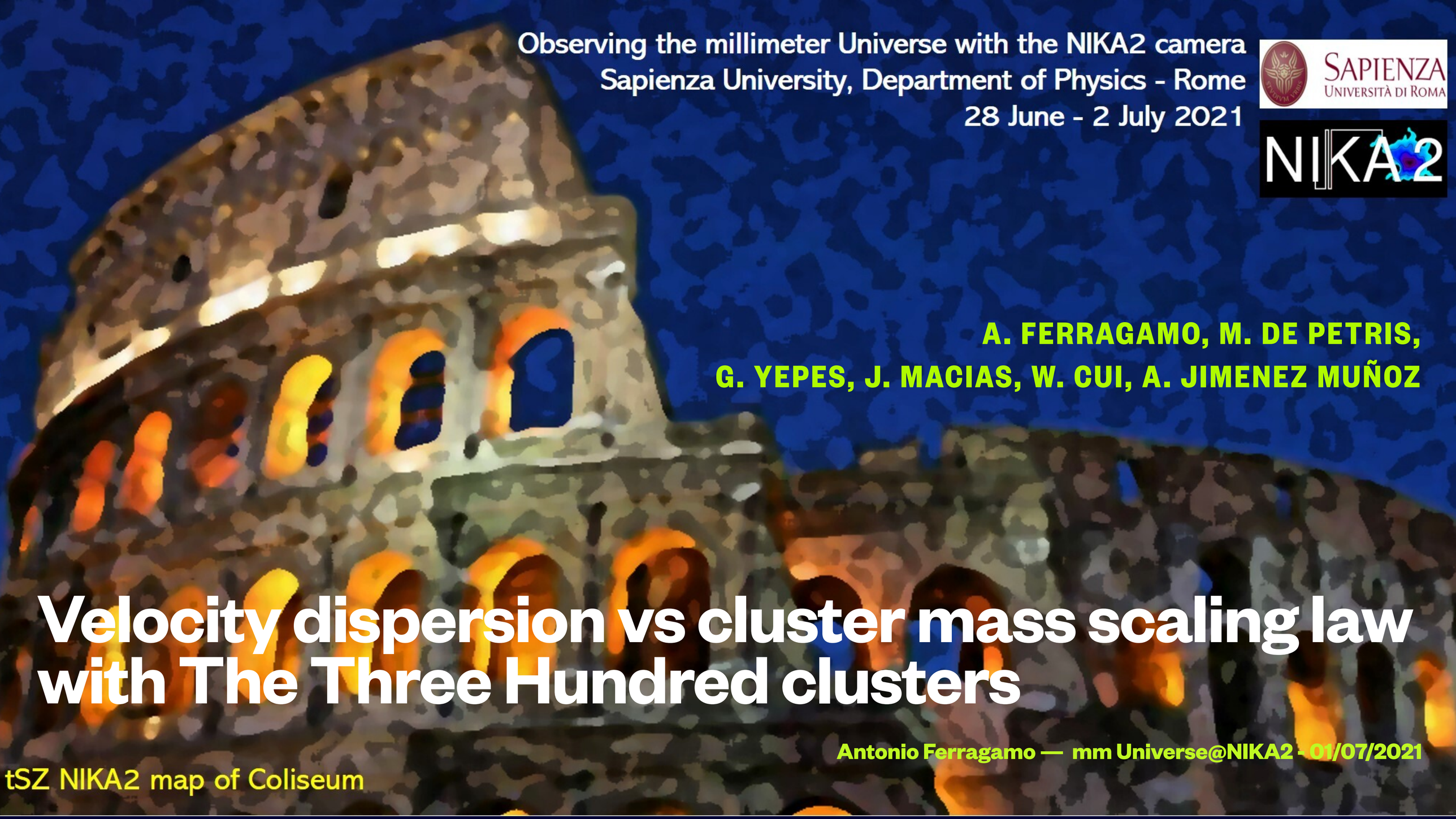
Observing the millimeter Universe with the NIKA2 camera
Sapienza University, Department of Physics - Rome
28 June - 2 July 2021



Velocity dispersion vs cluster mass scaling law with The Three Hundred clusters

A. FERRAGAMO, M. DE PETRIS,
G. YEPES, J. MACIAS, W. CUI, A. JIMENEZ MUÑOZ

tSZ NIKA2 map of Coliseum

The theoretical σ-M relations

from the virial theorem the relations between the velocity dispersion and the mass are given by

$$\frac{\sigma_{200}}{\mathrm{km\ s^{-1}}} = A \left[\frac{h(z)\ M_{200}}{10^{15} \mathrm{M}_{\odot}} \right]^{\frac{1}{3}}$$

A depends on the concentration parameter and the particular density profile

NFW profile

constant concentration c=5

$$A = 1040\text{–}1140$$ Munari et al. 2013

Simulations: DM particles in DM-Only

DM particles in DM-Only

Evrard et al. 2008

$$A = 1082 \pm 4.0$$
$$\alpha = 0.3361 \pm 0.0026$$

Ensemble of 11 DM-Only simulations

tracers: DM particles

Mass threshold: h(z) M_{200} > 1 x 10^{14} $M_\odot$

Trieste DM-Only simulation:

tracers: DM particles

Mass threshold: h(z) M_{200} > 1 x 10^{13} $M_\odot$

Munari et al. 2013

$$A = 1094 \pm 3.7$$
$$\alpha = 0.334 \pm 0.0014$$

(average of 8 redshifts from 0 to 2)

Numerical simulations: state of the art

Sub-haloes and Galaxies in Hydro

Munari et al. 2013

$$A = 1244 \pm 4.7$$
$$\alpha = 0.361 \pm 0.0027$$

Trieste DM-Only simulation:

tracers: Sub-haloes

Mass threshold: h(z) M_{200} > 1 x 10^{13}

Trieste Hydro simulation:

tracers: Sub-haloes

Mass threshold: h(z) M_{200} > 1 x 10^{13}

$$A = 1199 \pm 5.2$$
$$\alpha = 0.365 \pm 0.0017$$

$$A = 1177 \pm 4.2$$
$$\alpha = 0.364 \pm 0.0021$$

Trieste Hydro simulation:

tracers: Galaxies

Mass threshold: h(z) M_{200} > 1 x 10^{13}

(average of 8 redshifts from 0 to 2)

Simulations: runs

Spherical Zoomed regions of 15/h Mpc radius centred around the 324 most massive clusters of the Multidark-Planck simulation formed at z=0 (Mass: 3.2×10^{15} – 8×10^{14} M/h)

GADGET X

modern SPH

AGN feedback,
(Trieste Model)

DM ONLY HYDRO

GIZMO

modern SPH

AGN feedback
(Davé+19 Model)

Simulations: tracers

DM particles

single simulation element

Sub-haloes

structures of gravitationally bound DM particles

$N_{DM\_part} \geq 20$

$M_{star} \geq 10^9\ M_\odot$

Galaxies

structures of gravitationally bound DM and Gas particles

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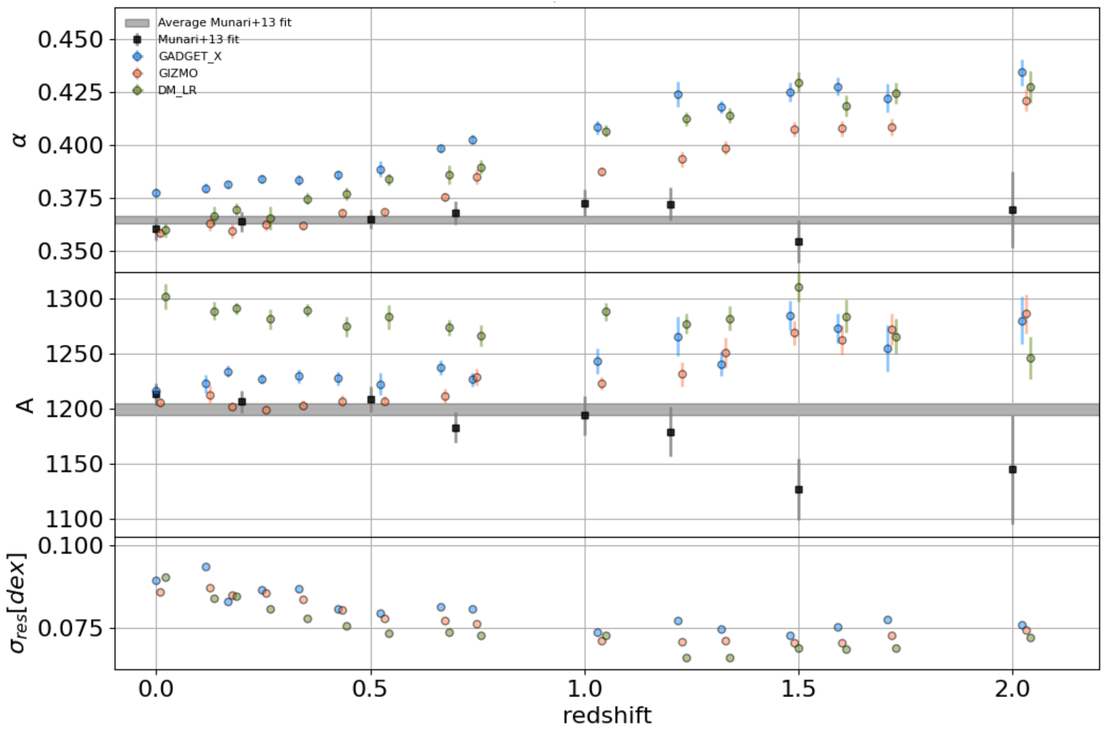
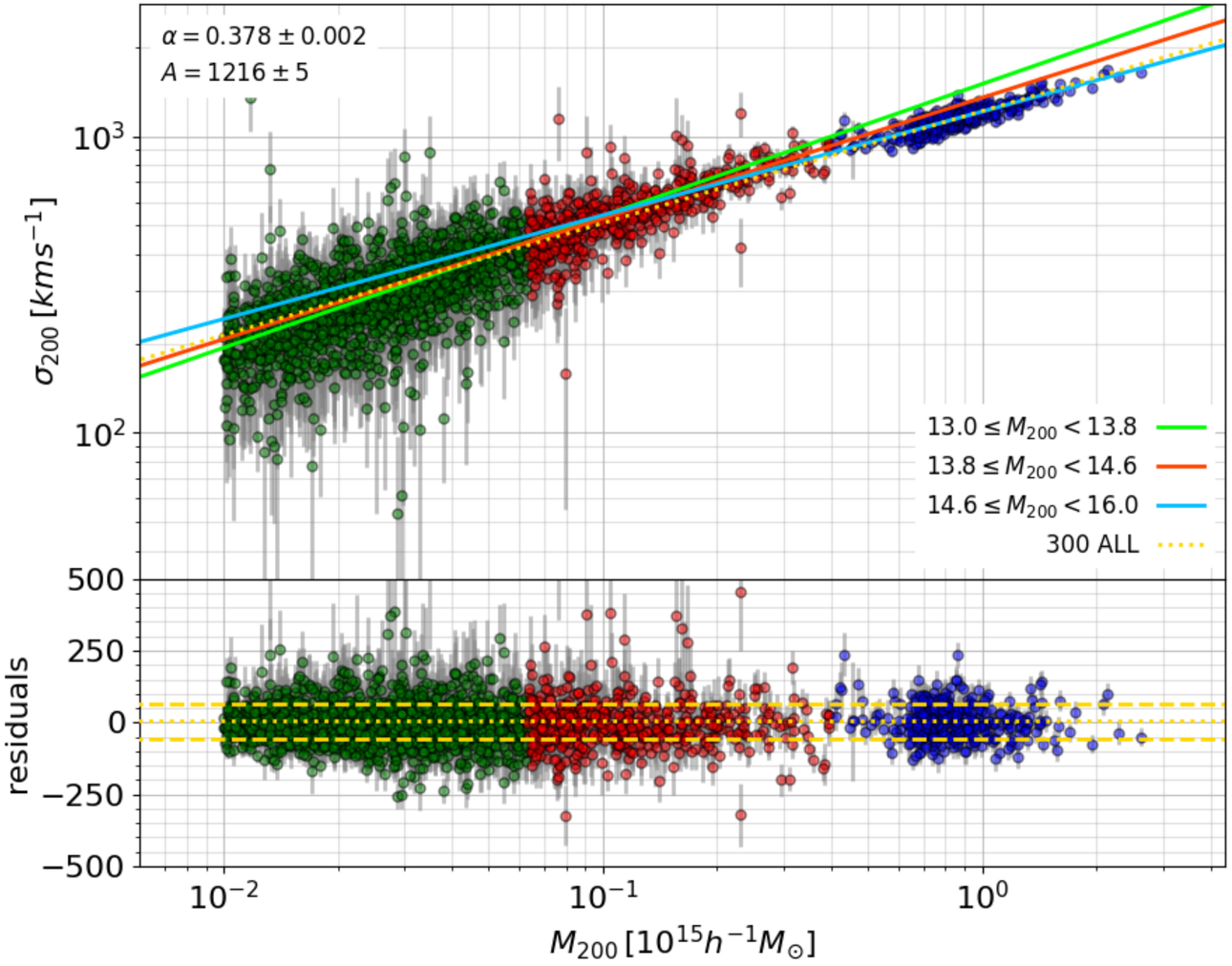
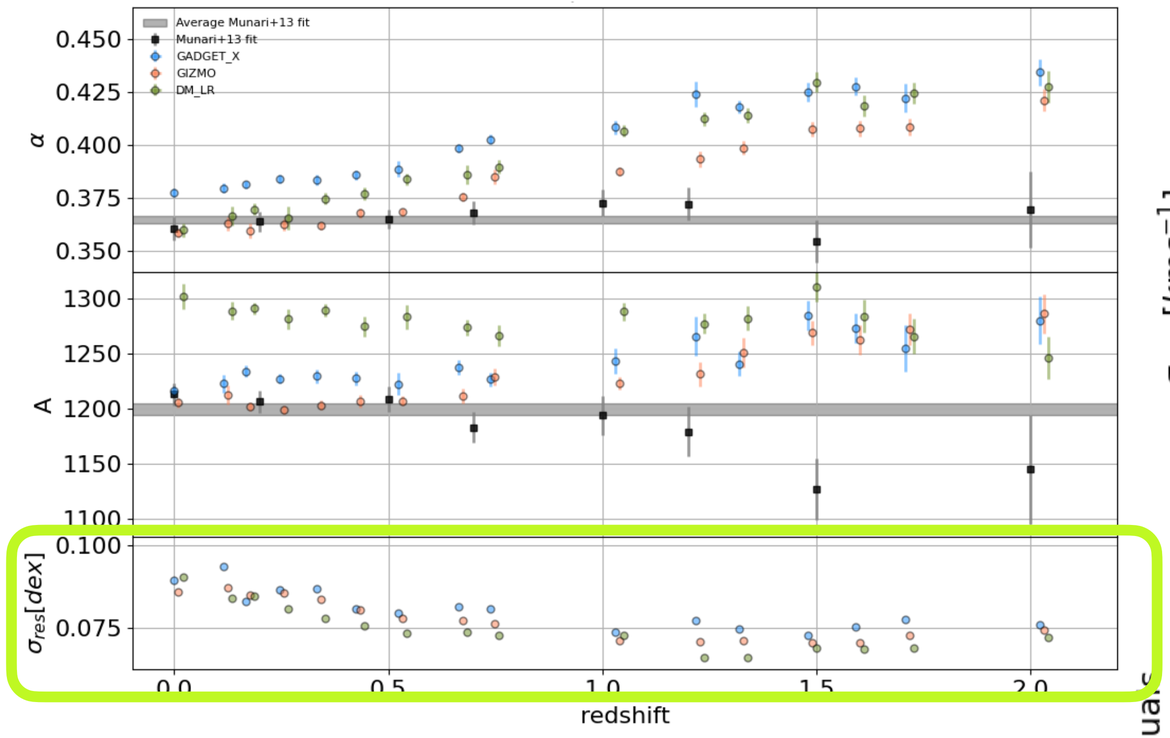
THE 300th: Sub-halos $N_{sh} \geq 5$

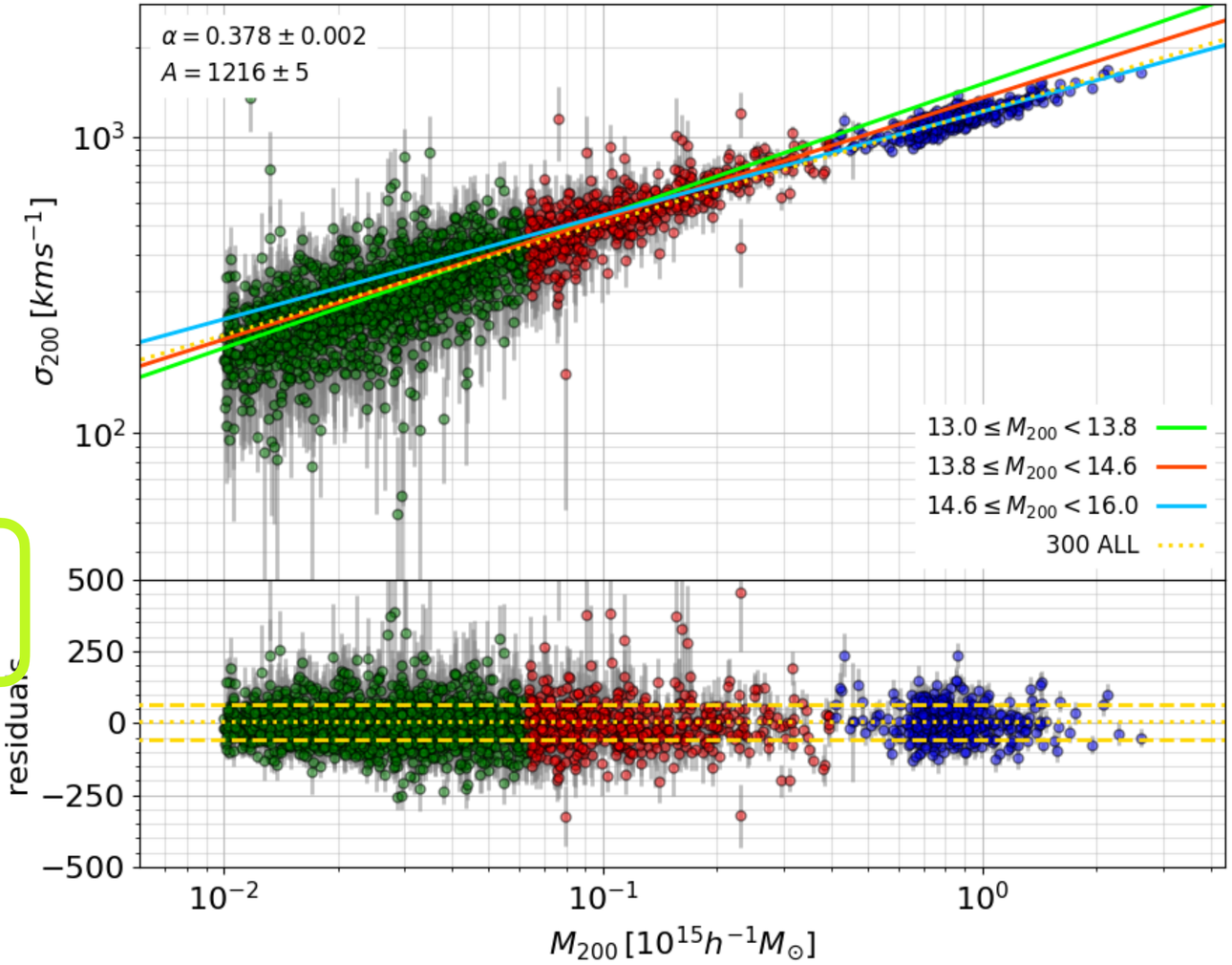


- the slope shows a redshift dependence
- the normalisation seems to be more stable



THE 300th: Sub-halos $N_{sh} \geq 5$





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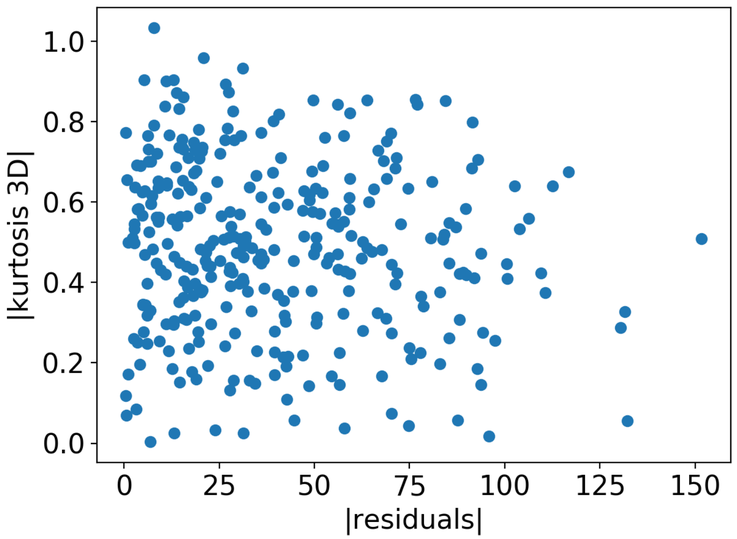
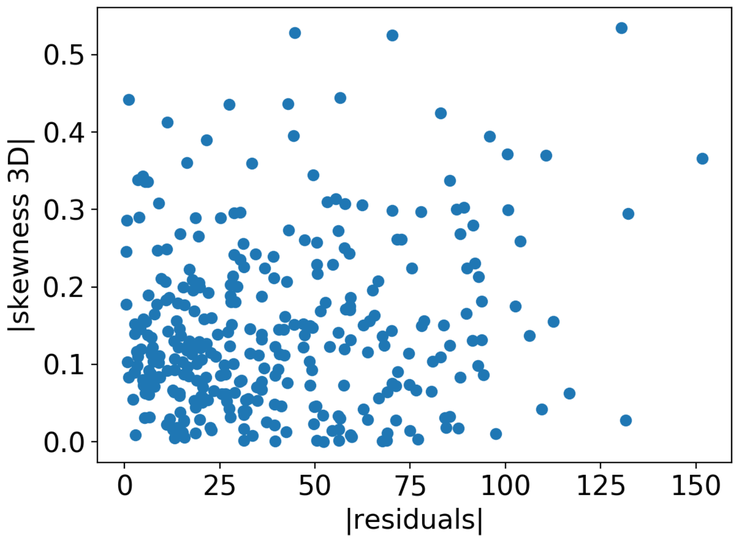
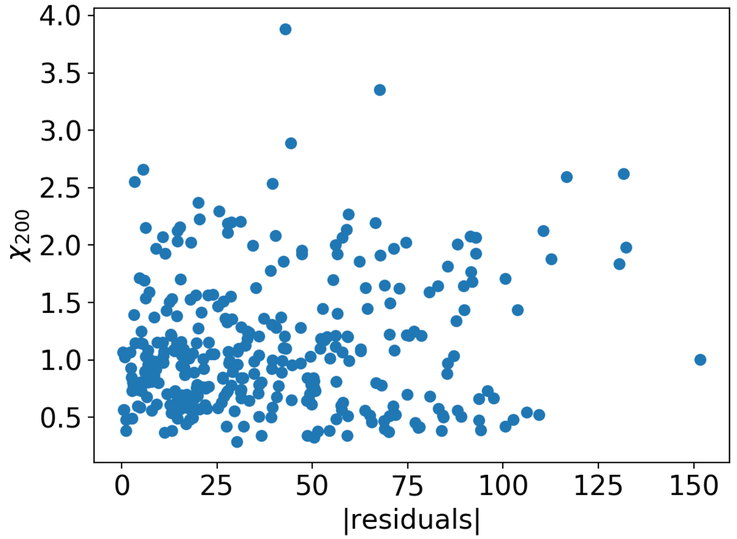
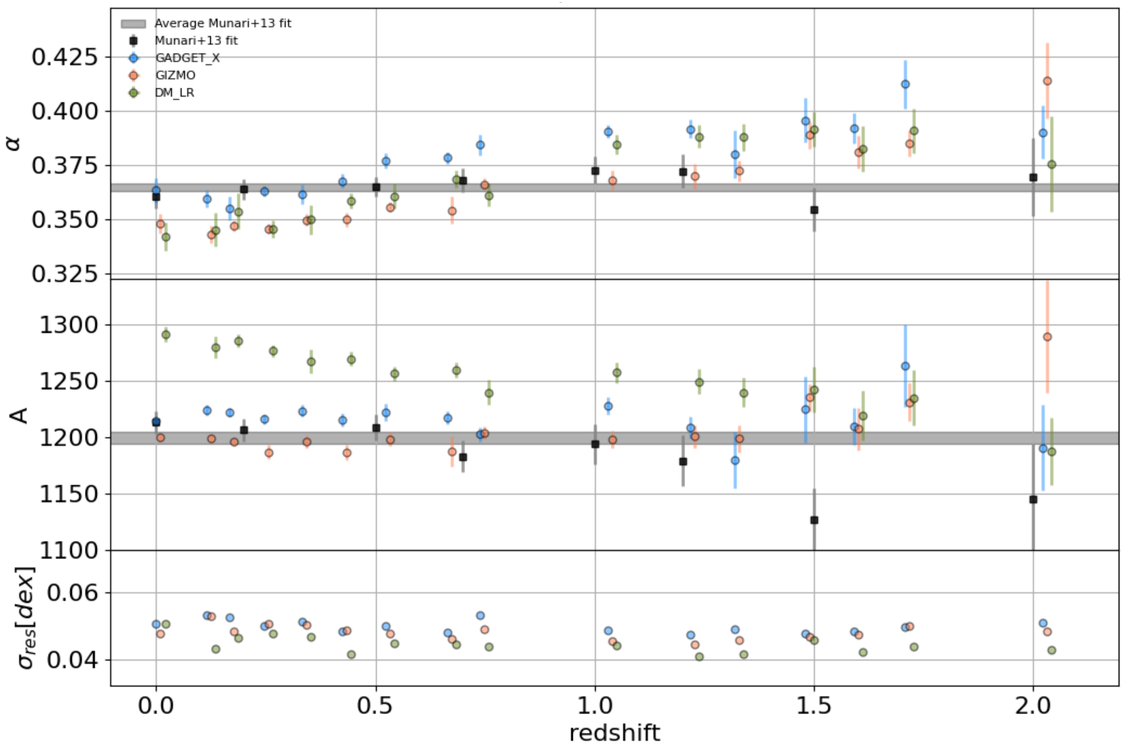




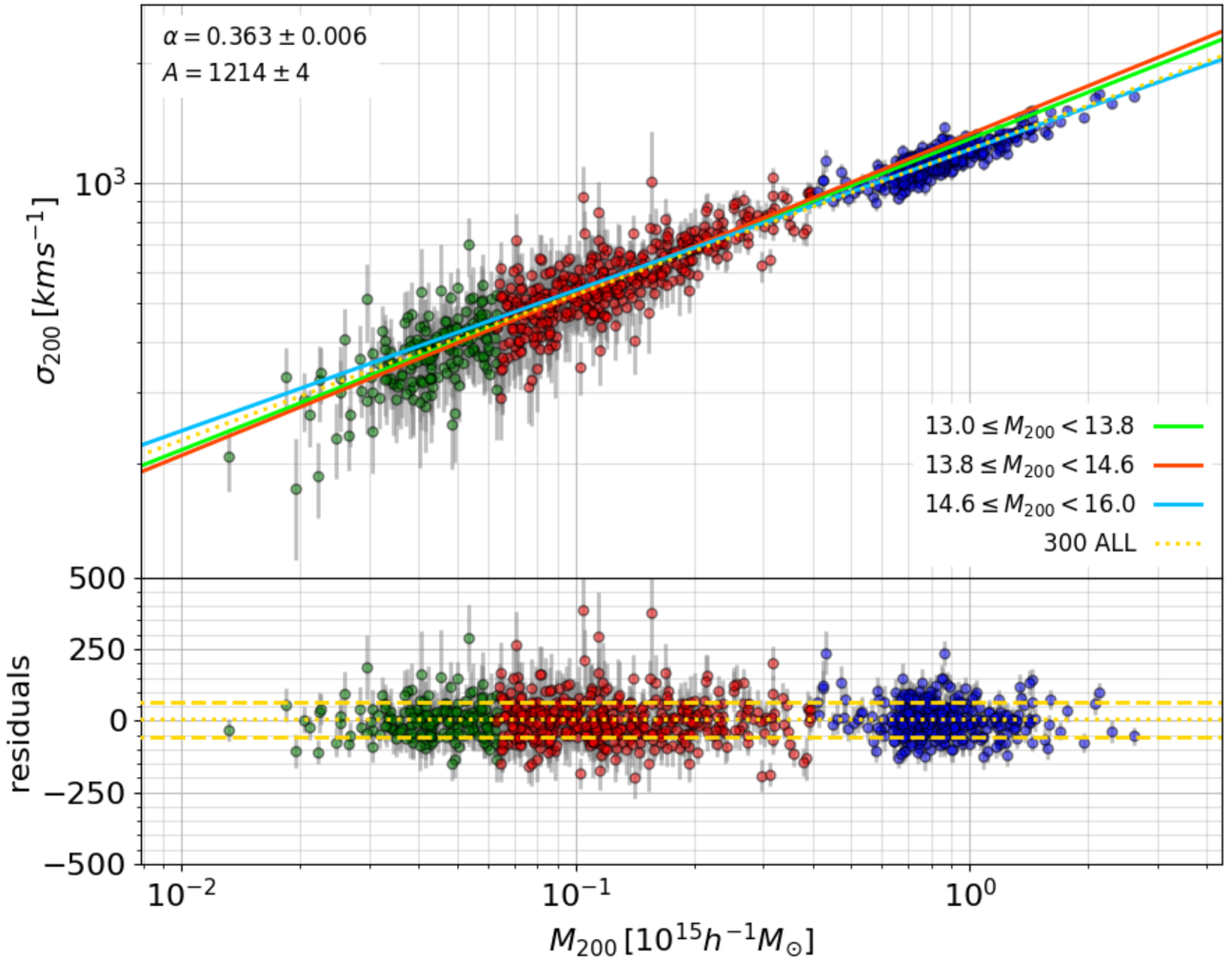


the scatter seems not to correlate neither with the shape of the velocity distribution nor with the parameter of the dynamic state.

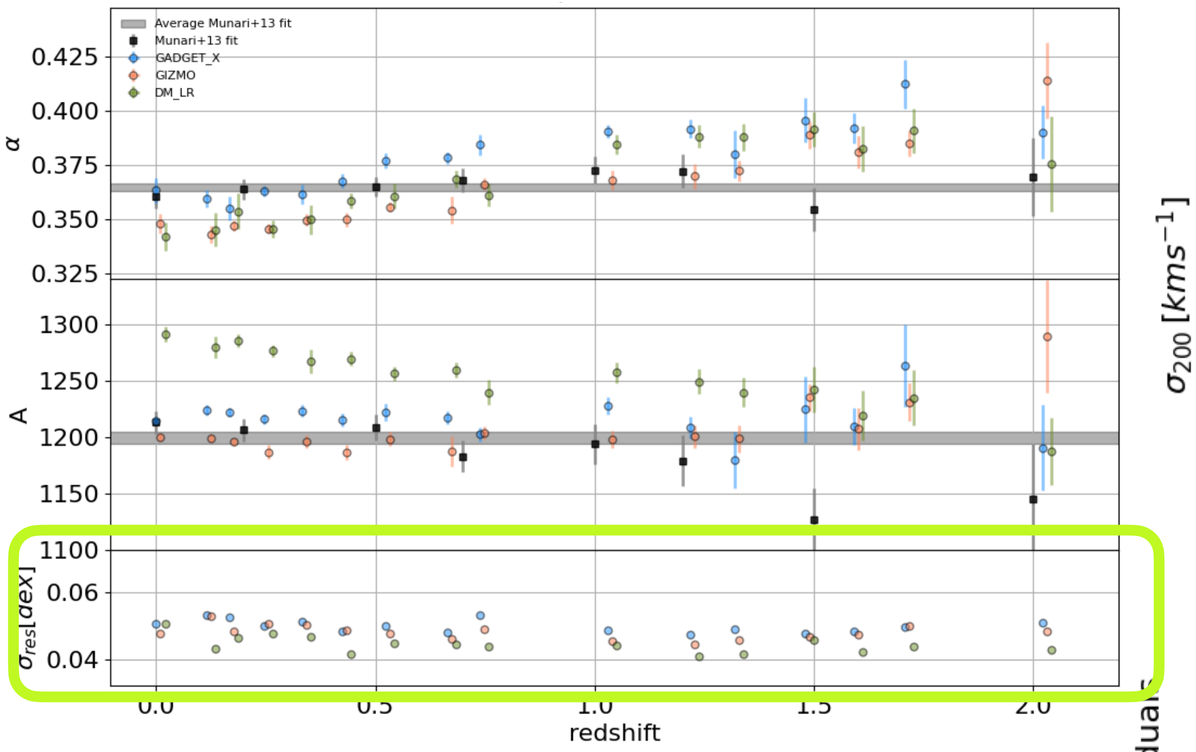
THE 300th: Sub-halos $N_{sh} \geq 10$



- the slope shows a redshift dependence
- the normalisation seems to be more stable



THE 300th: Sub-halos $N_{sh} \geq 10$



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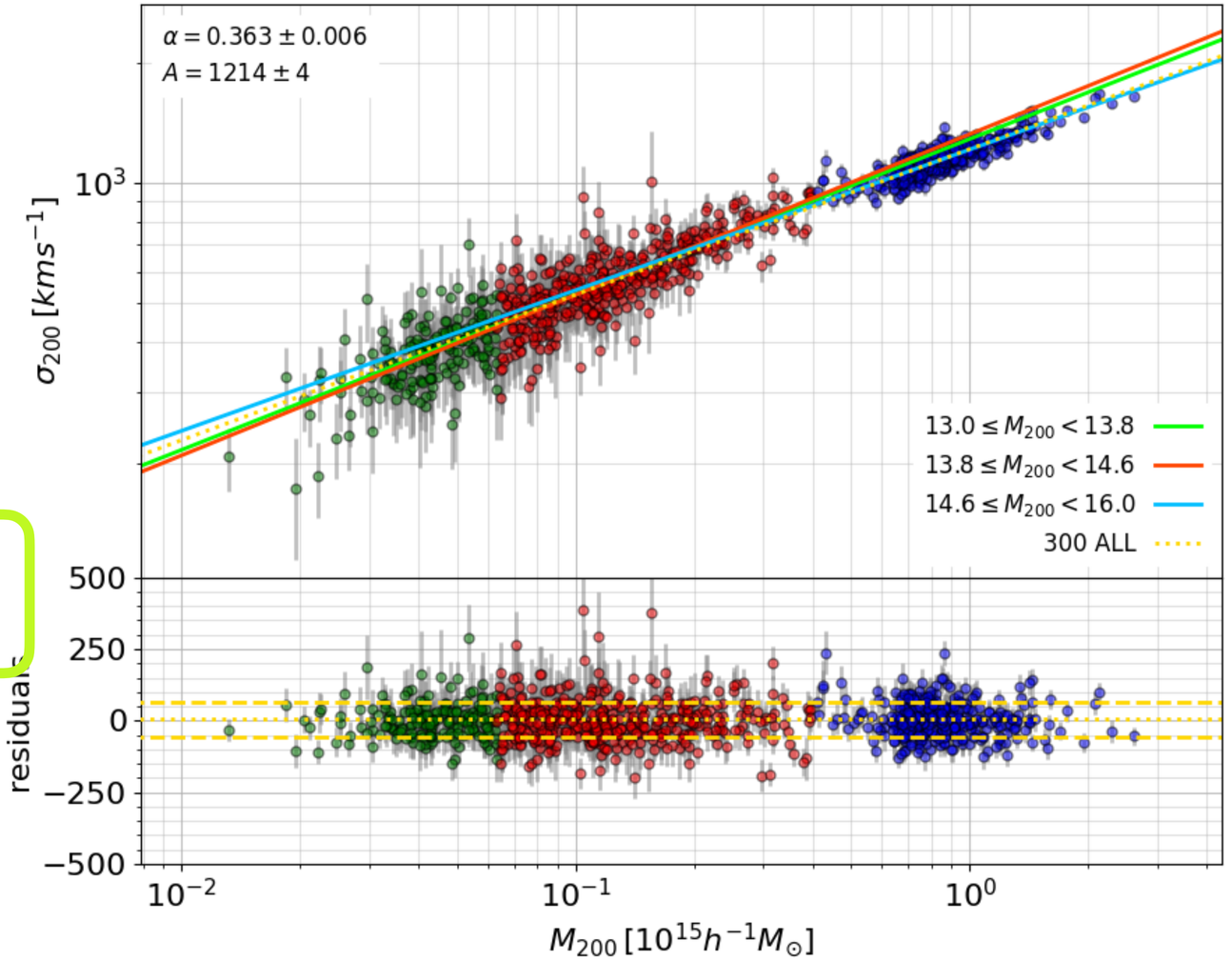
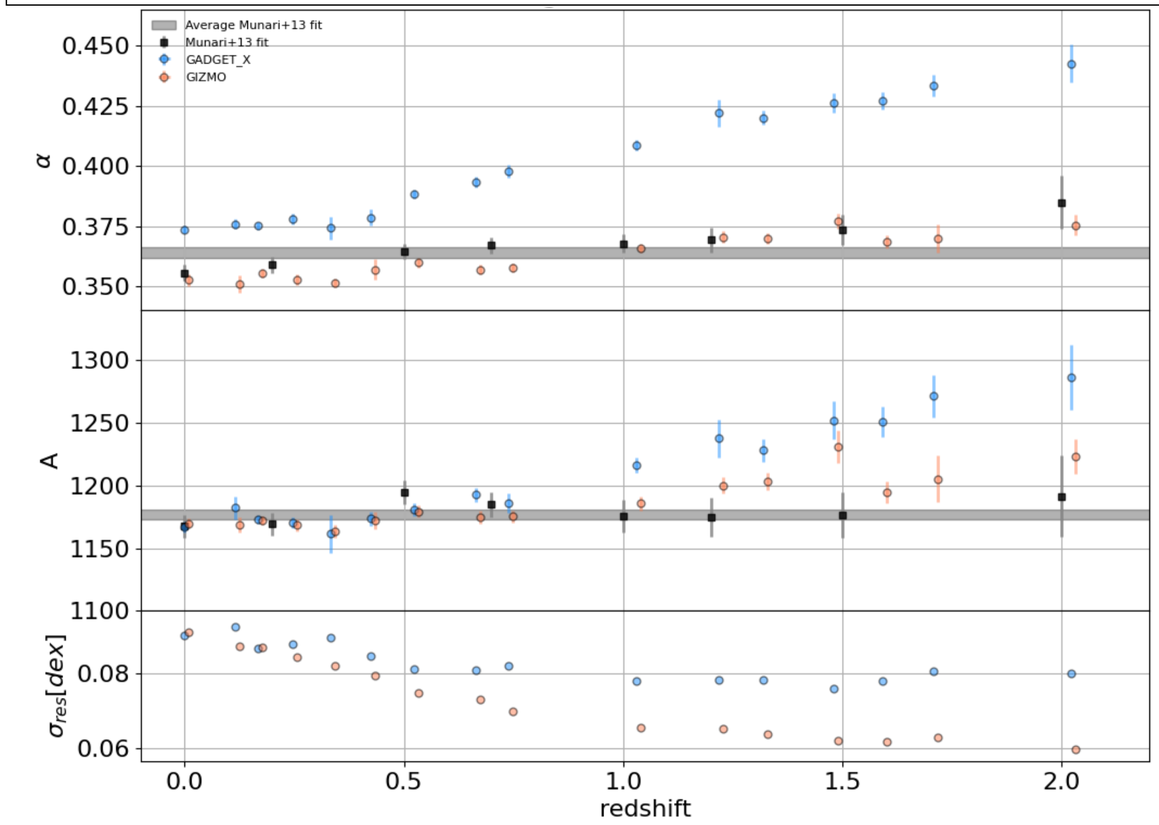
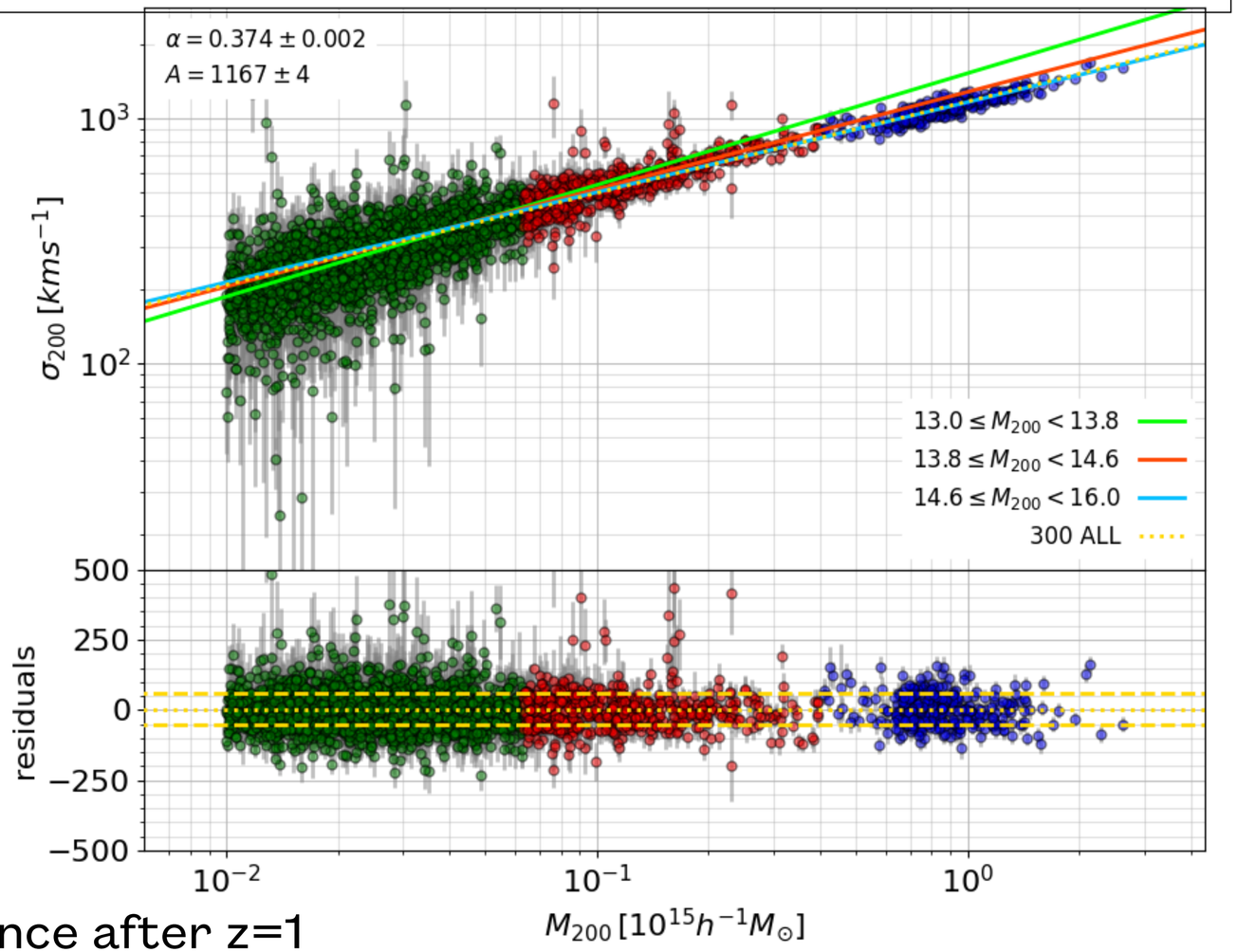
- the normalisation seems to be more stable



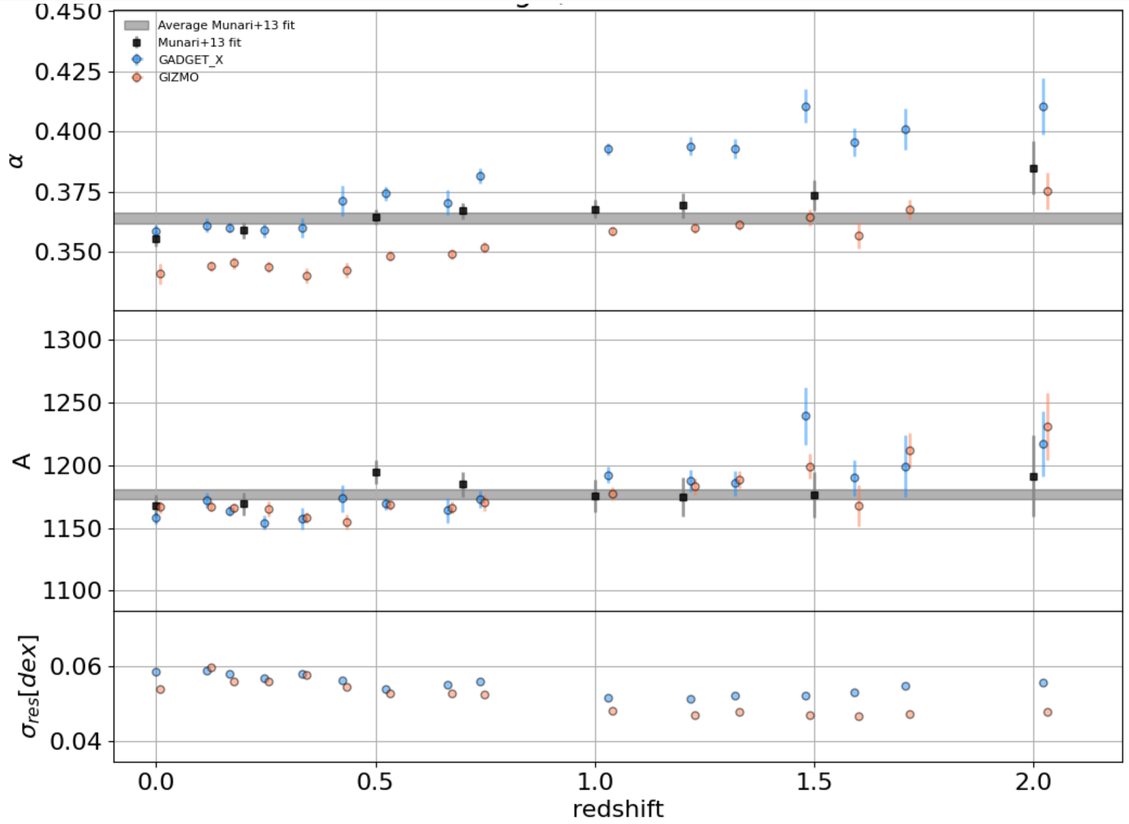
THE 300th: Galaxies $N_{gal} \geq 5$

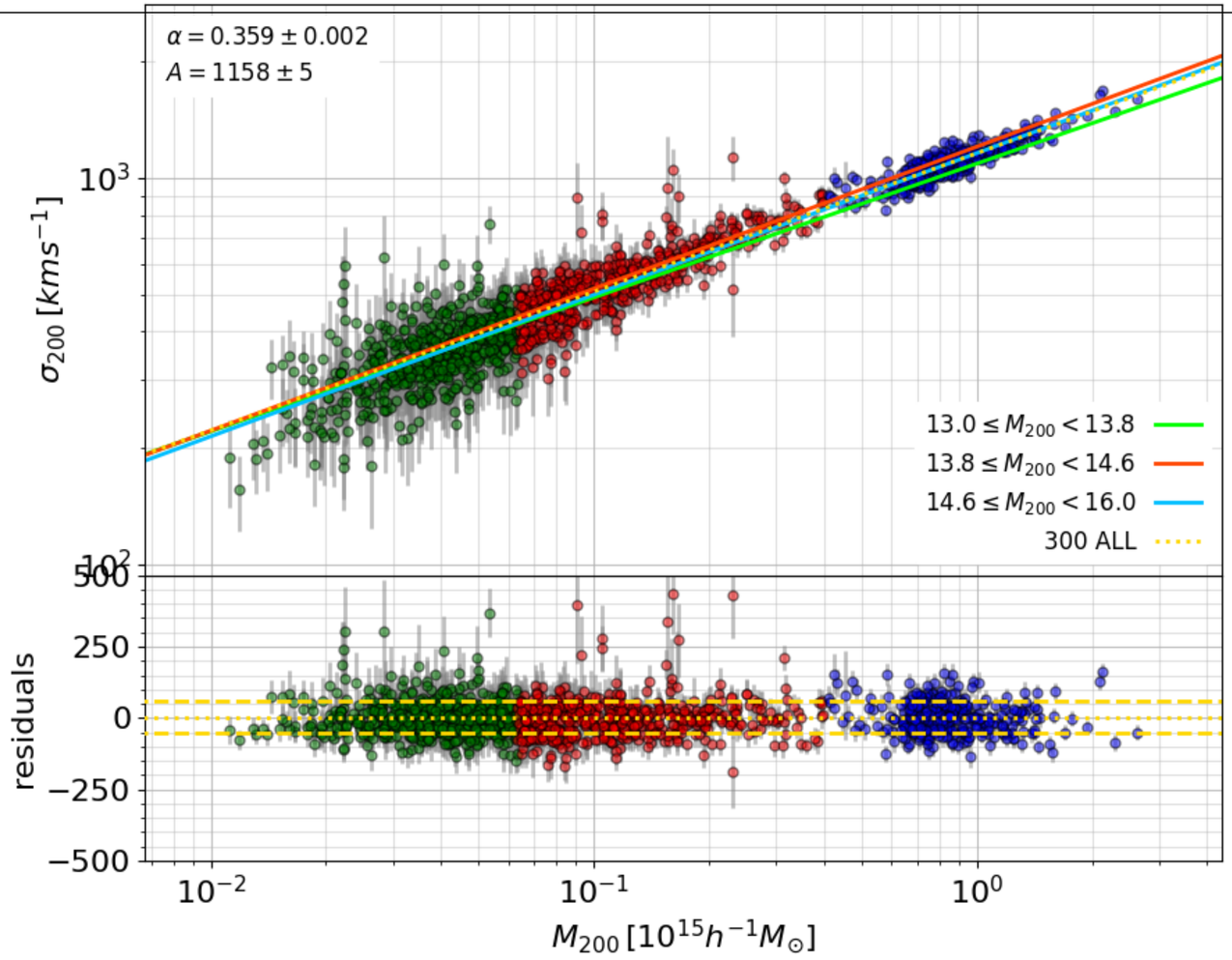




- the slope shows a redshift dependence
- the normalisation shows a redshift dependence after z=1

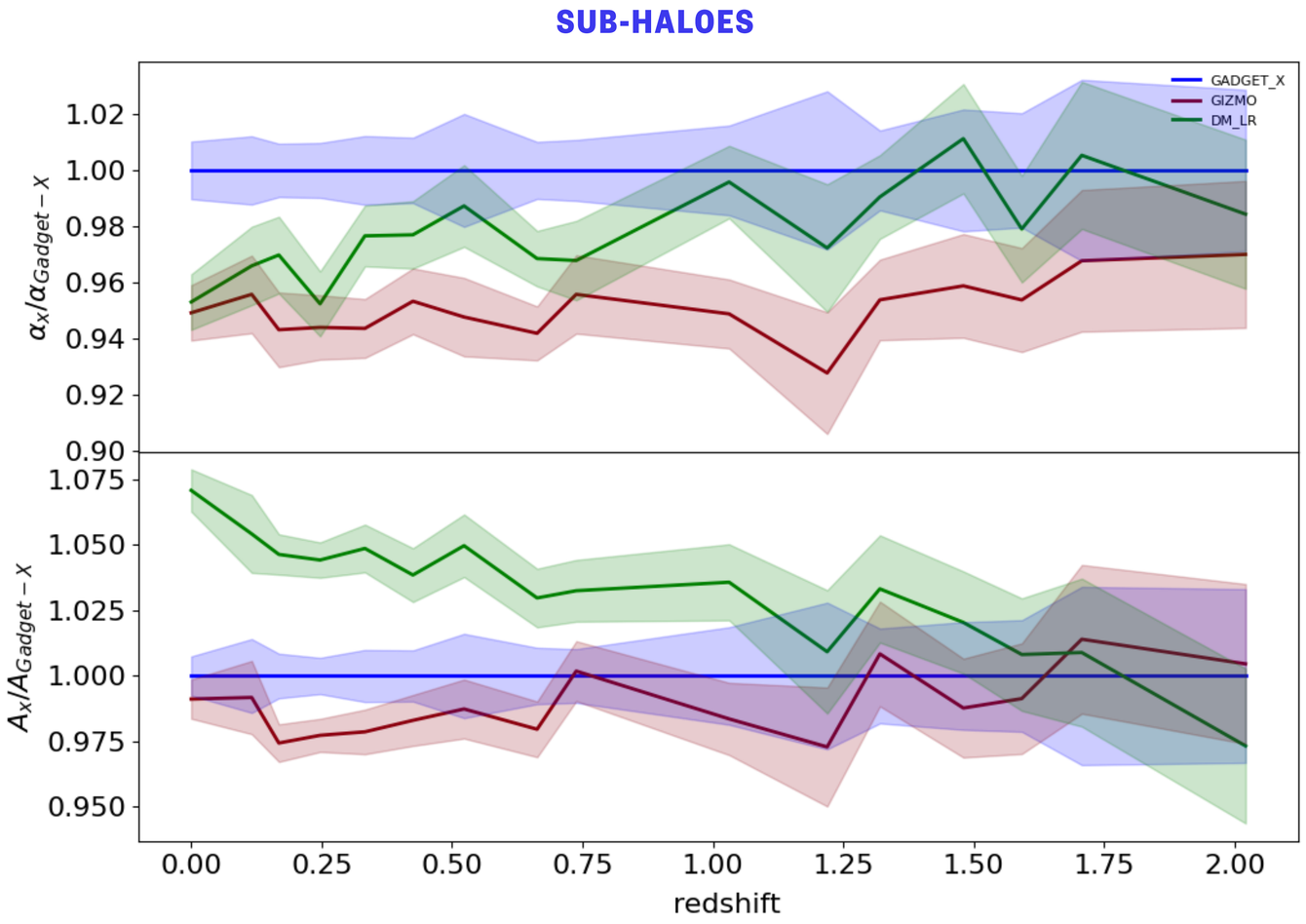
THE 300th: Galaxies $N_{gal} \geq 10$





- the slope shows a redshift dependence
- the normalisation is constant with redshift

THE 300th: GADGET-X vs GIZMO

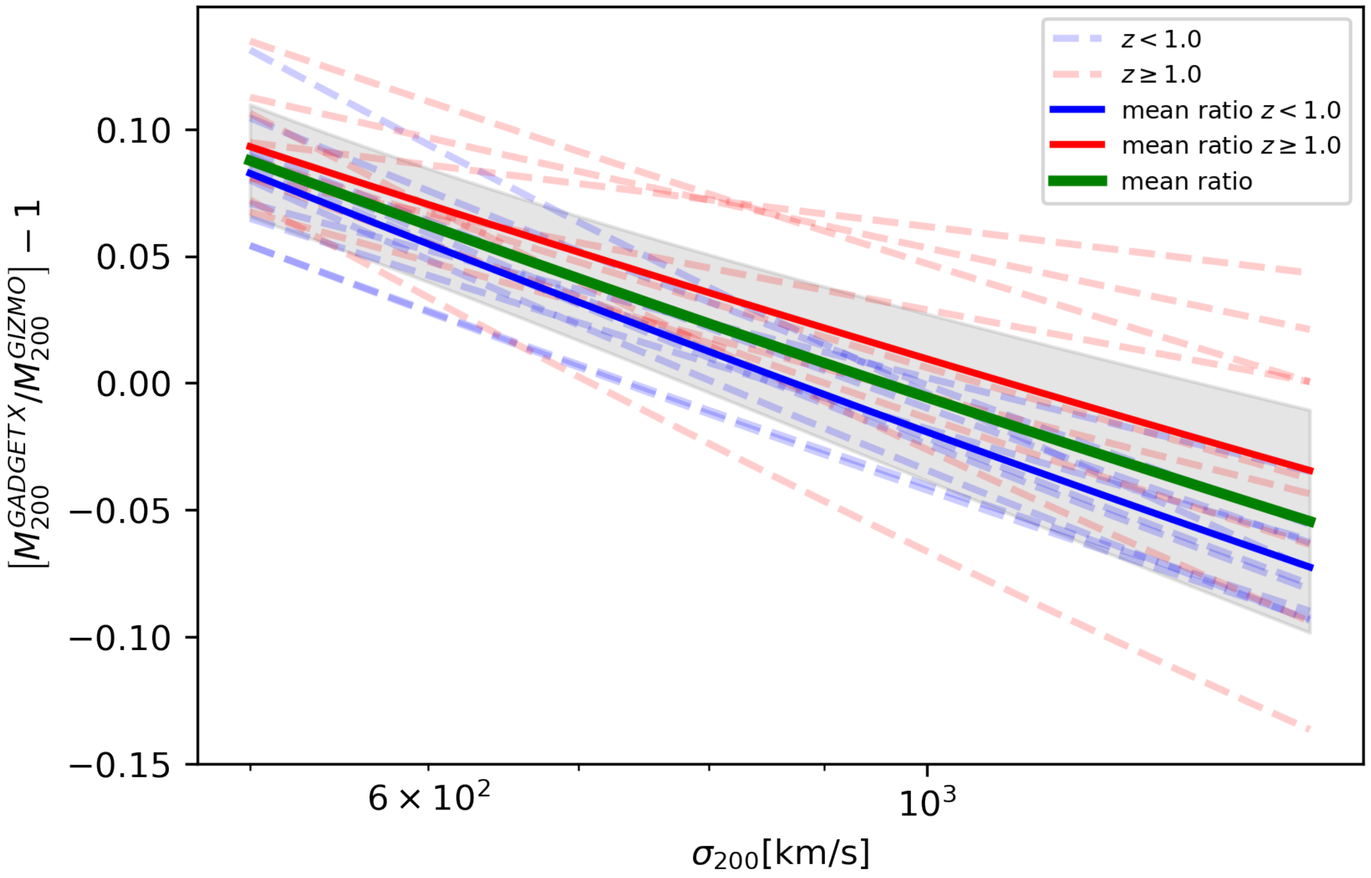


GIZMO parameter are lower than the GADGET-X ones, especially the slope

Effect of the differences in AGN feedback recipes

THE 300th: GADGET-X vs GIZMO

SUB-HALOES



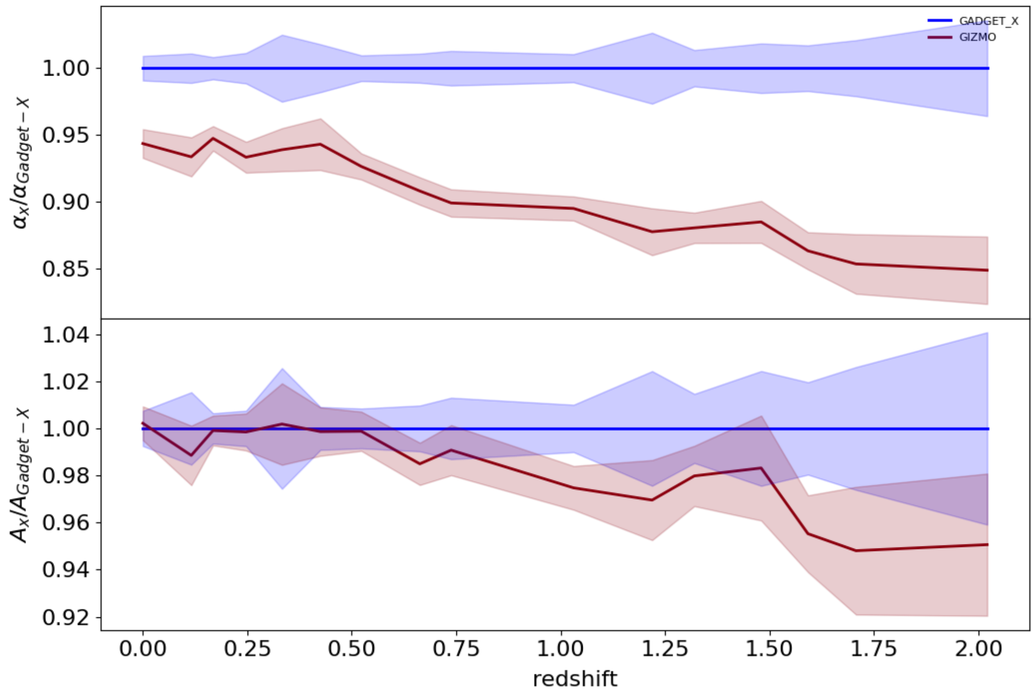
LOW MASS

$$\frac{M_{200}^{GADGET\,X}}{M_{200}^{GIZMO}} - 1 \sim 0.1$$

HIGH MASS

$$\frac{M_{200}^{GADGET\,X}}{M_{200}^{GIZMO}} - 1 \sim 0.05$$

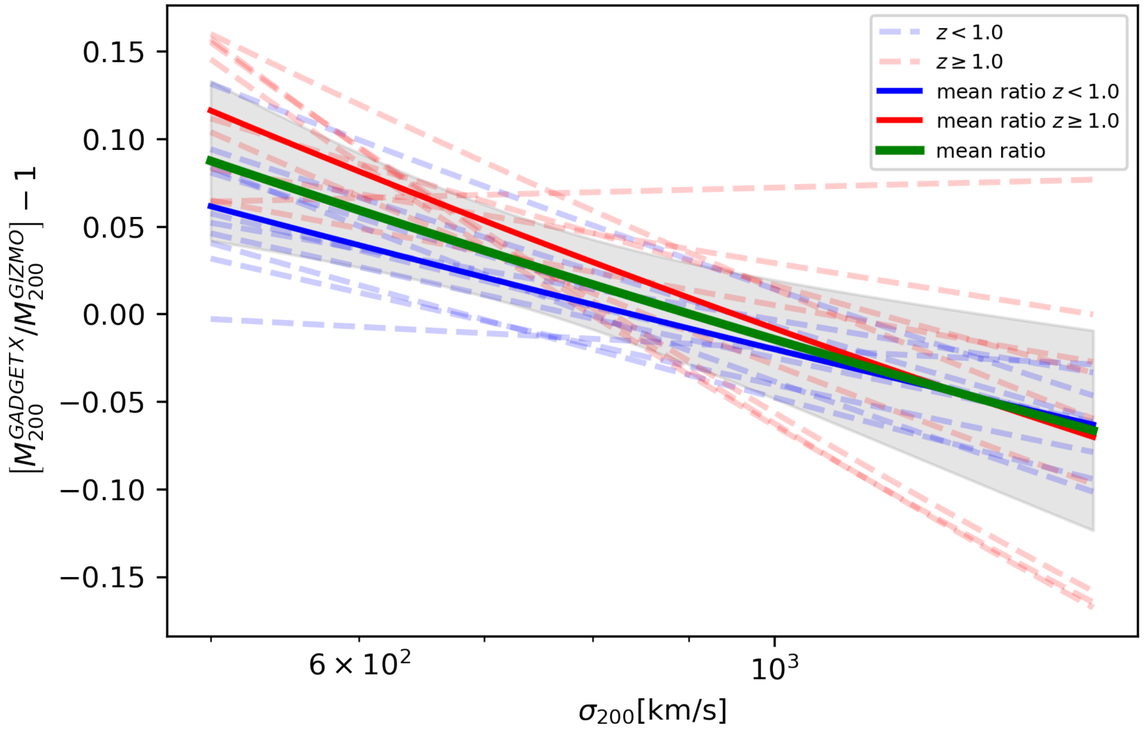
THE 300th: GADGET-X vs GIZMO



LOW MASS

$$\frac{M_{200}^{GADGET\ X}}{M_{200}^{GIZMO}} - 1 \sim 0.1$$

GALAXIES



HIGH MASS

$$\frac{M_{200}^{GADGET\ X}}{M_{200}^{GIZMO}} - 1 \sim 0.05$$

THE 300th: the scaling relation (PRELIMINARY)

$$\frac{\sigma_{200}}{\mathrm{km\ s^{-1}}} = A \left[\frac{h(z)\ M_{200}}{10^{15}\ \mathrm{M_\odot}} \right]^{\alpha+\beta z}$$

	GADGET X			GIZMO		
	A	α	β	A	α	β
sub-haloes	1216.2 ± 0.6	0.358 ± 0.002	0.027 ± 0.003	1198.8 ± 0.7	0.341 ± 0.002	0.026 ± 0.002
galaxies	1172.7 ± 0.8	0.357 ± 0.002	0.029 ± 0.002	1171.5 ± 0.6	0.340 ± 0.001	0.016 ± 0.001

THE 300th: star mass dependence

Galaxies

structures of
gravitationally bound DM
and Gas particles

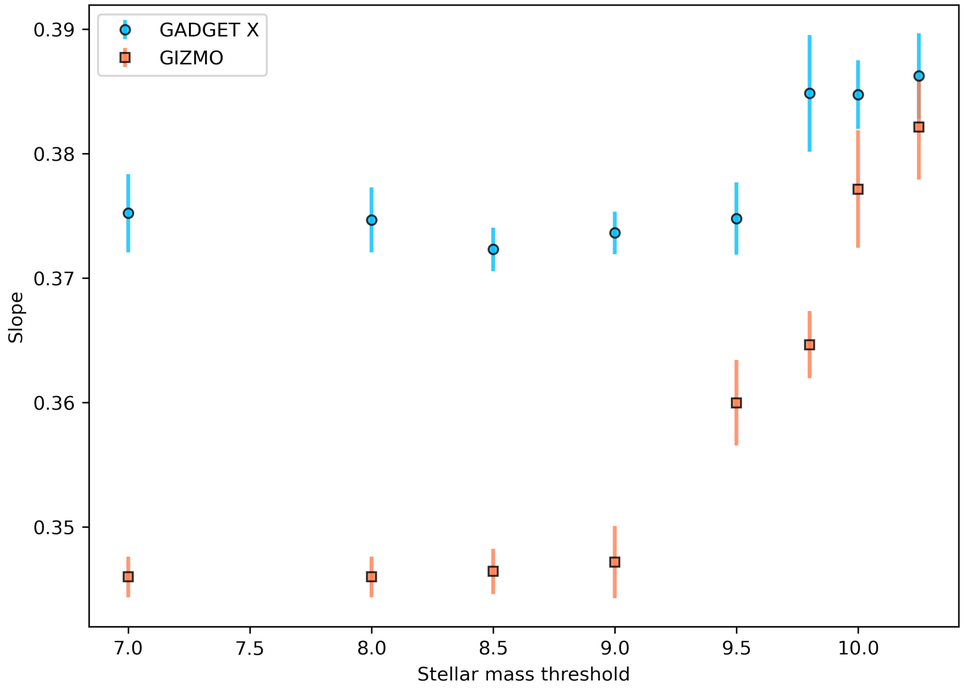
$N_{DM\_part} \geq 20$

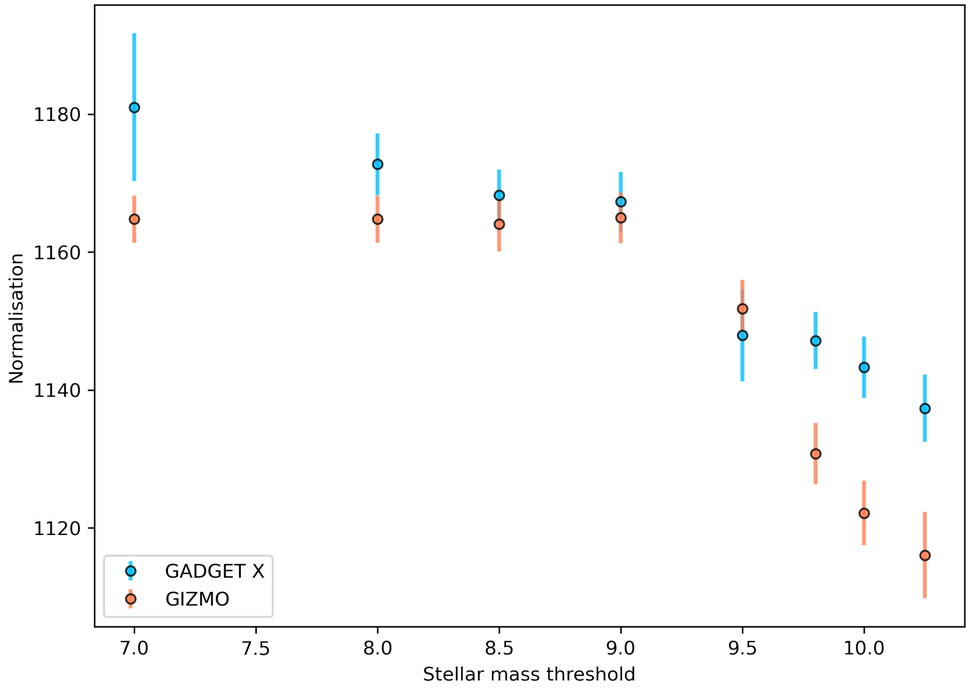
What happen if we increase the stellar mass of the galaxies we use to estimate the dispersion?

7 stellar mass thresholds from **7.0 dex** (1 stellar particle) to **10.25 dex**

THE 300th: star mass dependence

Z=0.0



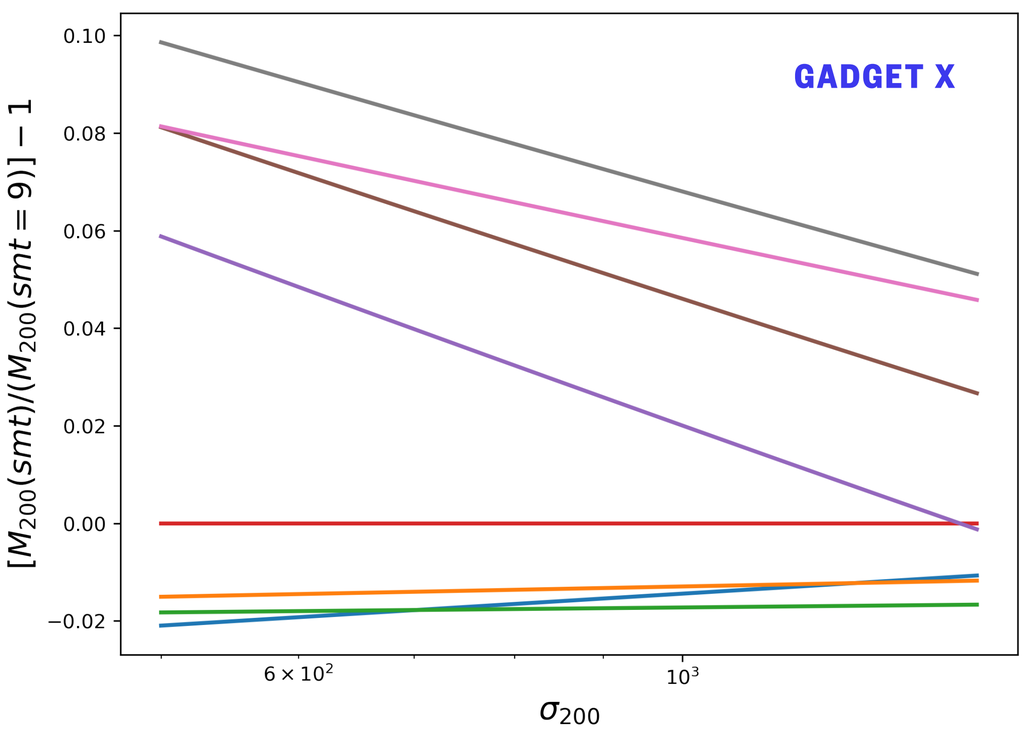


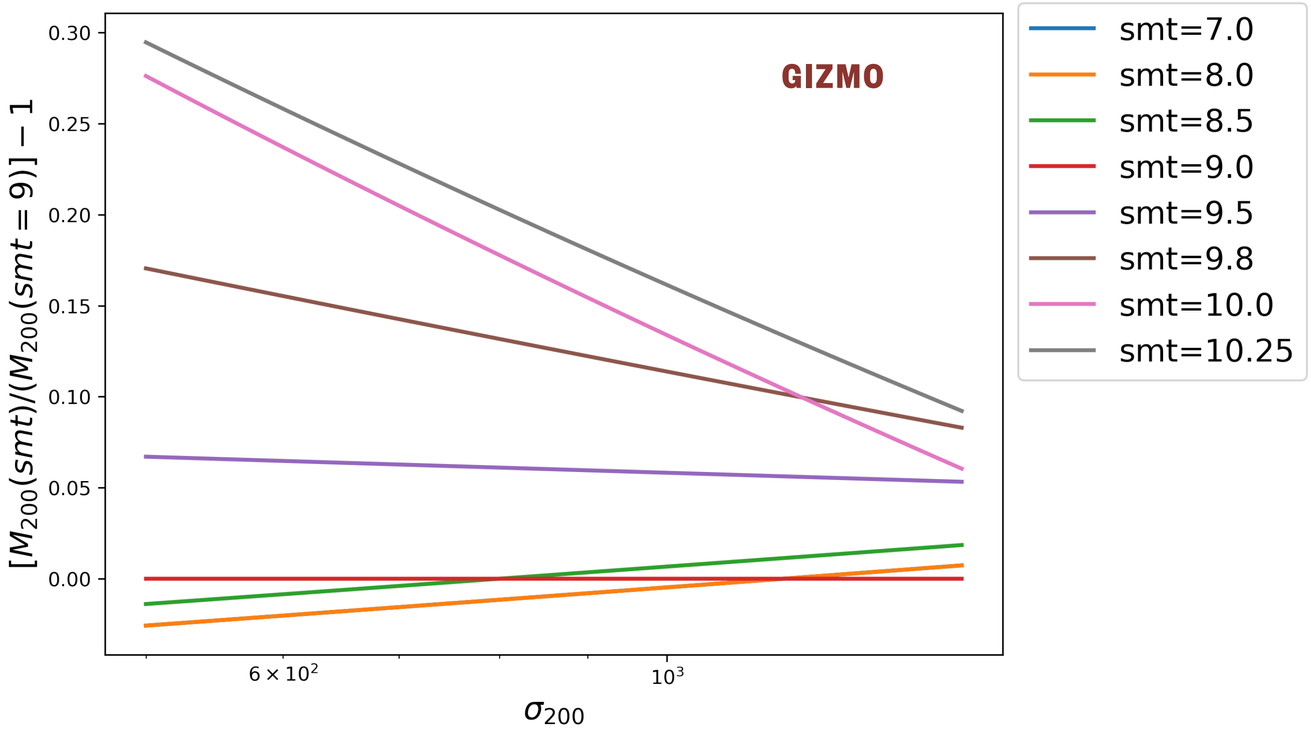
- Increasing stellar mass threshold

- Increasing slope
- Decreasing normalisation

THE 300th: star mass dependence

Z=0.0





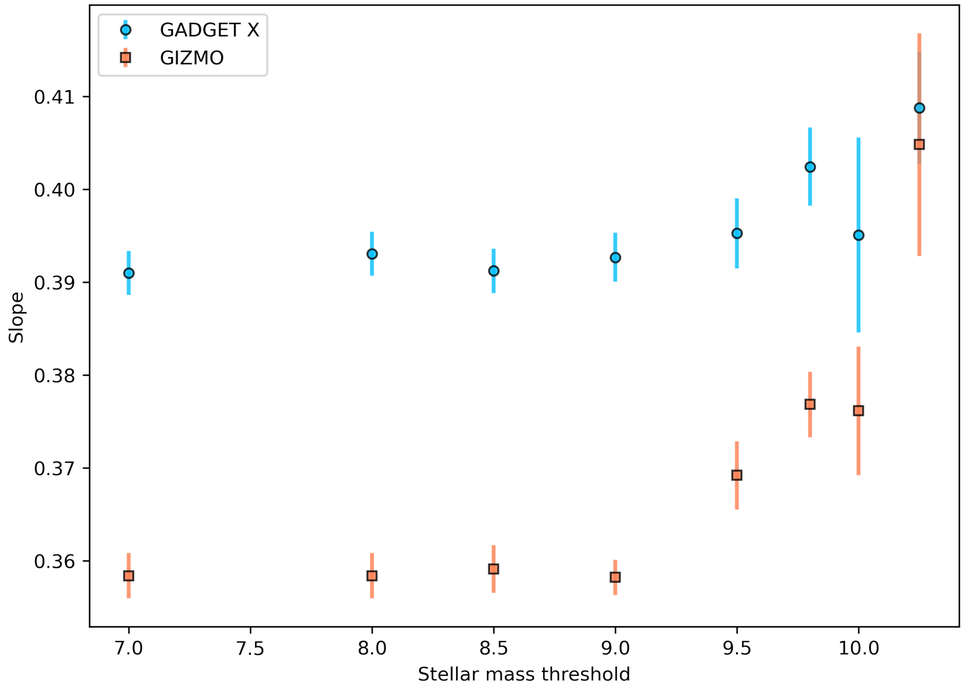
- Increasing stellar mass threshold

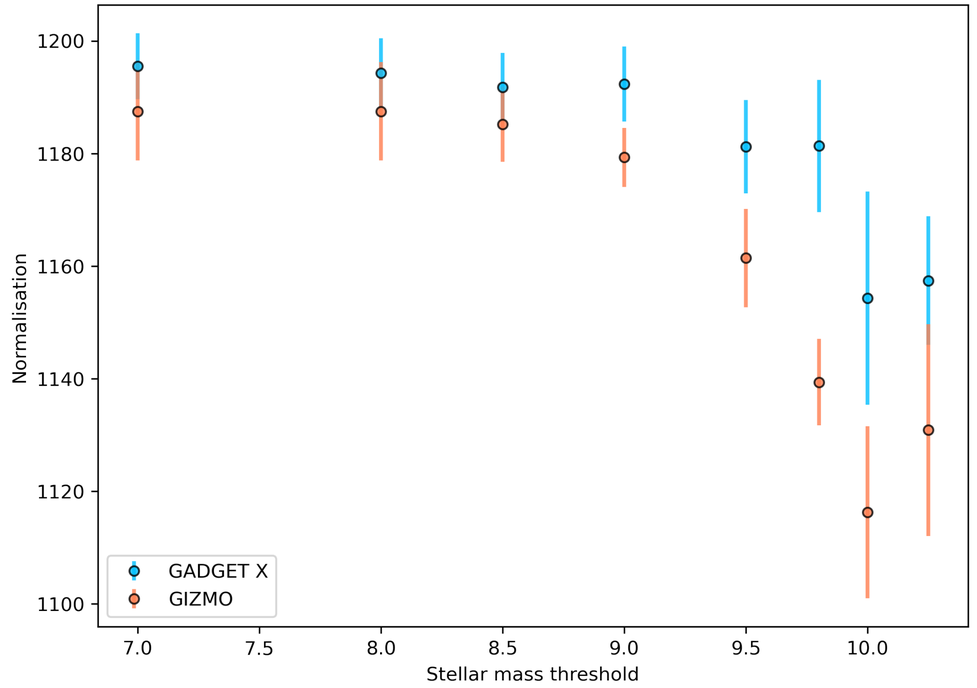
→

- Increasing slope
- Decreasing normalisation

THE 300th: star mass dependence

Z=1.031





the trend is present also at high redshift

- statistical effect
- physical effect

Conclusions (PRELIMINARY)

- **Relations σ_{200} - M_{200} for both Sub-haloes and Galaxies**
  - 19 redshifts from z=0 to z=2.16
    - 3 simulation flavours: GADGET-X, GIZMO, DM-Only Low-Resolution
      - halo mass thresholds: M≥13.0 [dex], M≥13.6 [dex], M≥14.0 [dex], M≥14.6 [dex]
      - halo mass bins: 13.0≤M≤13.8[dex], 13.8≤M≤14.6[dex], M≥14.6 [dex]
        - min number of sub-halos: 5, 10, 20
- **We observed a redshift dependence of the of the slope)**
- **We observed a differences due to the particular AGN feedback recipe**

next future

- We are investigating a dependence of the parameters with the stellar mass of the galaxy members

- Constrain the relations σ_{500} - M_{500} and σ_{200} - M_{500}