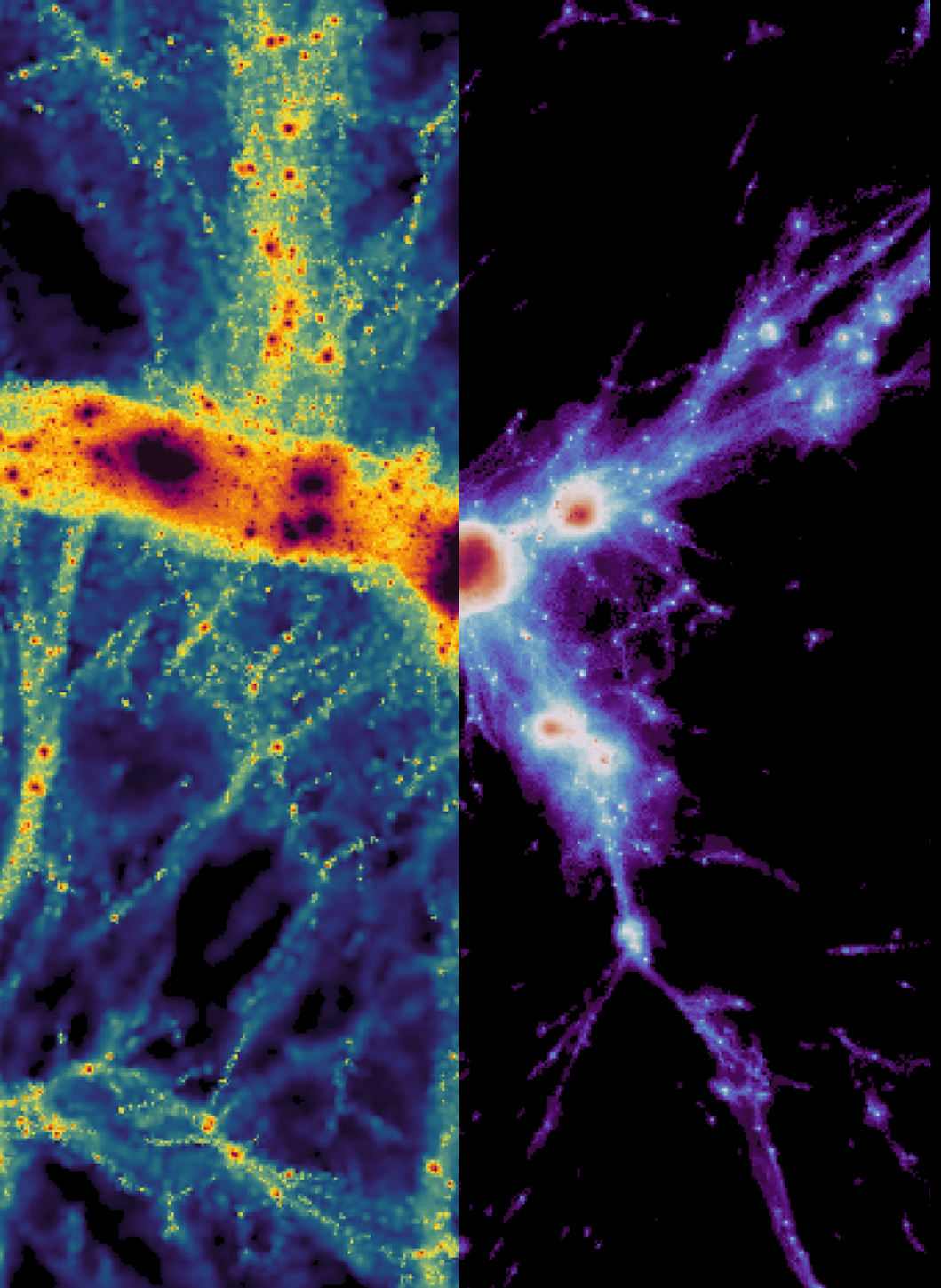
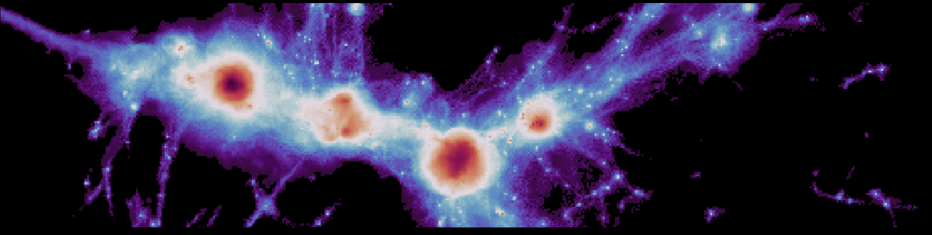


COSMOLOGICAL SIMULATIONS OF SIDM WITH THE TNG MODEL

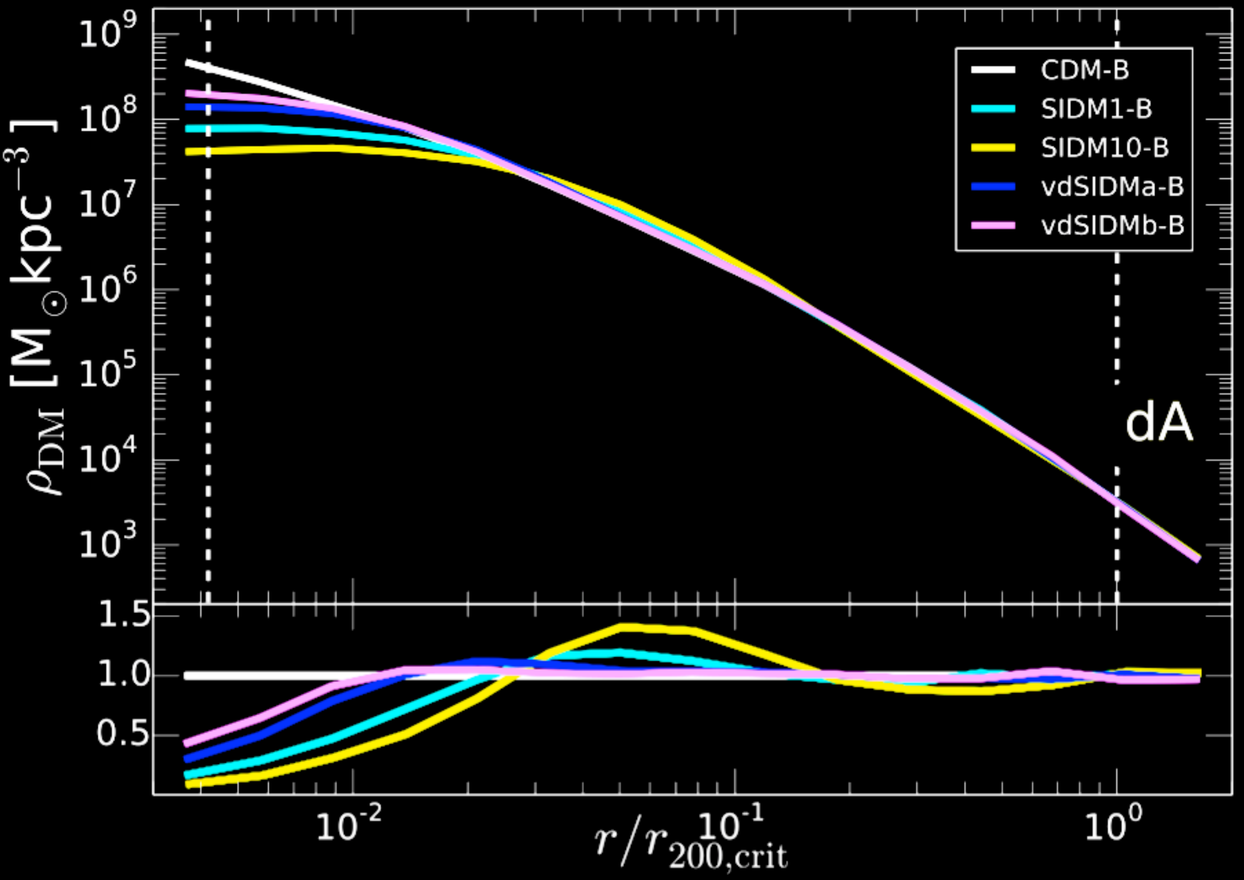
Giulia Despali

University of Bologna

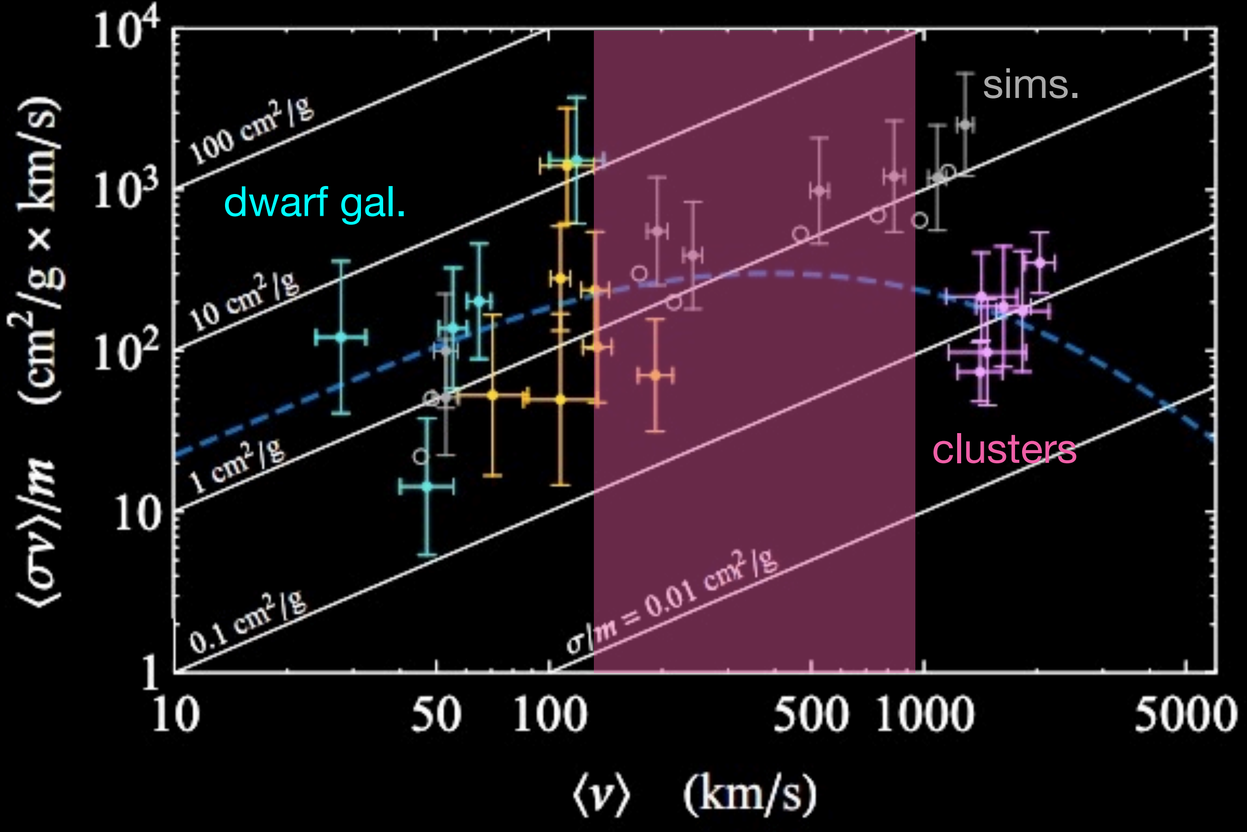
Simona Vegetti, Mark Vogelsberger, Lauro Moscardini, Massimo Meneghetti, Annalisa Pillepich, Dylan Nelson, Claudio Mastromarino



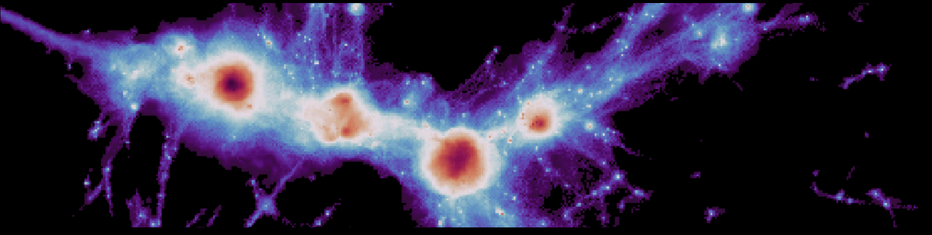
SELF-INTERACTING DARK MATTER



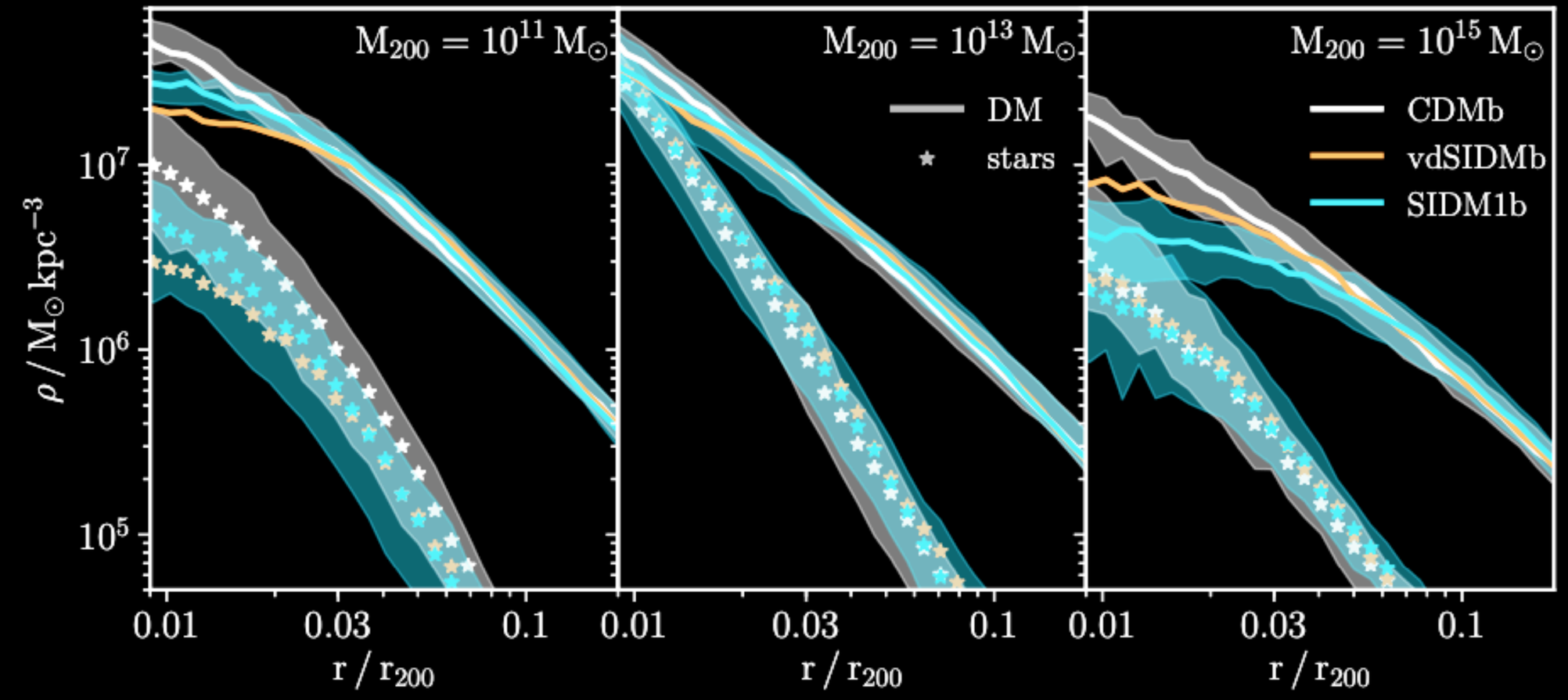
(Vogelsberger et al. 2016)



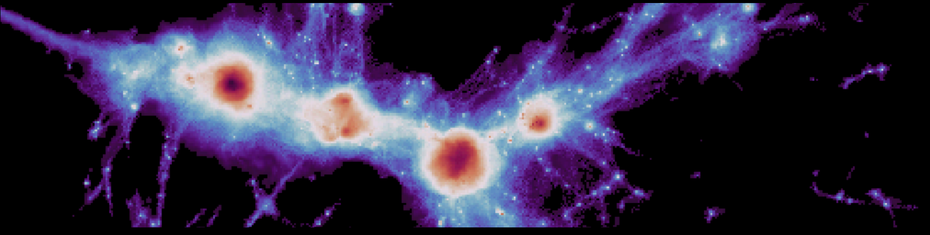
(Kalpinghat et al. 2015)



SIDM HYDRO SIMULATIONS



(Robertson et al. 2021)

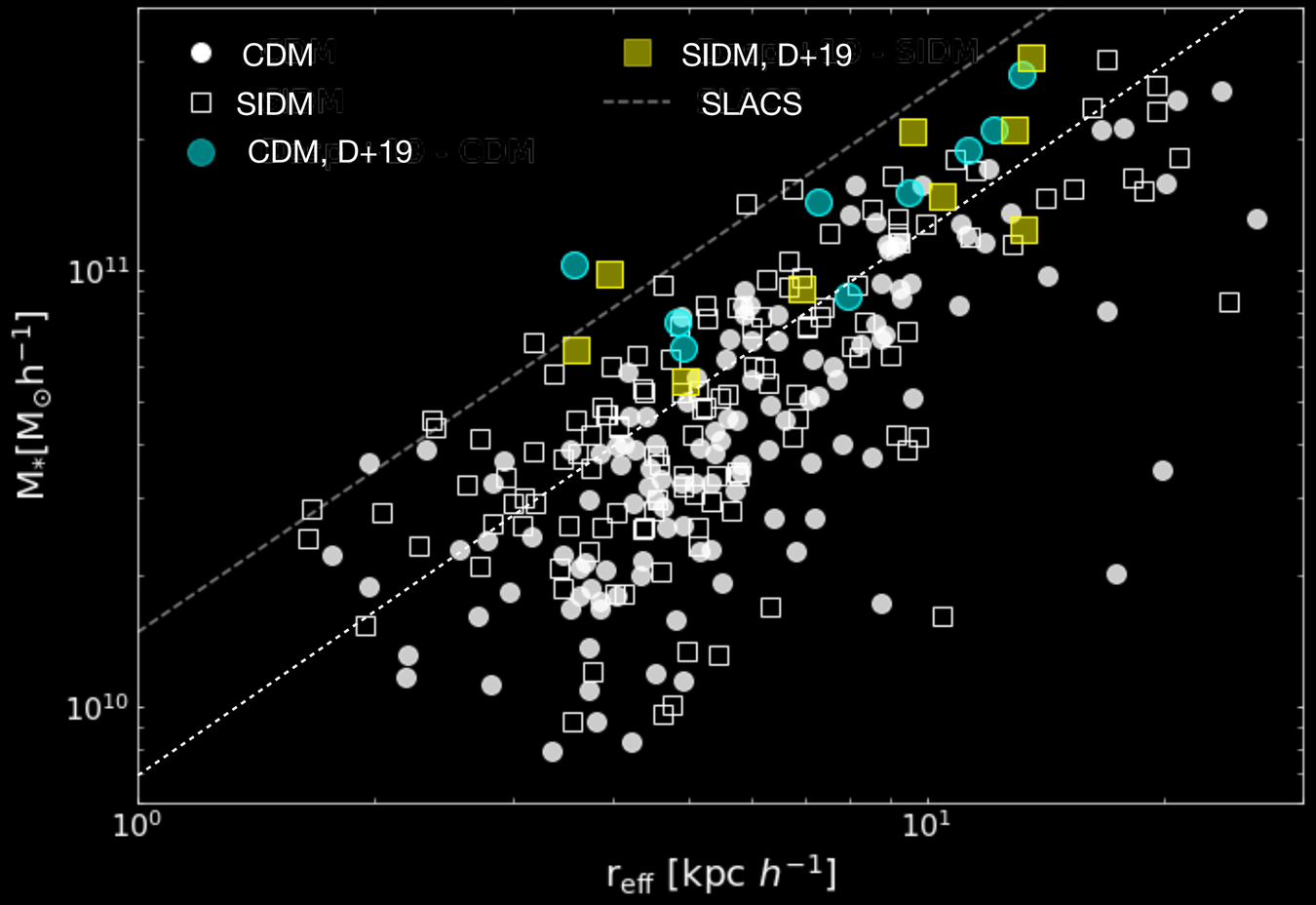


SIDM HYDRO SIMULATIONS

- constant cross section σ=1 cm²/g

Selection:

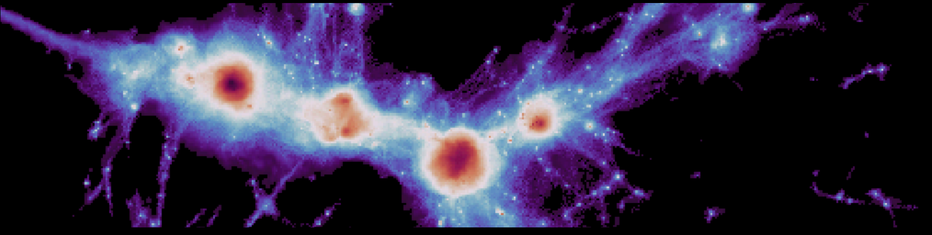
- elliptical galaxies log(M) ~12.5-13.4 Msun
- analogues of lens galaxies
- redshift z = 0.2, 0.5, 1



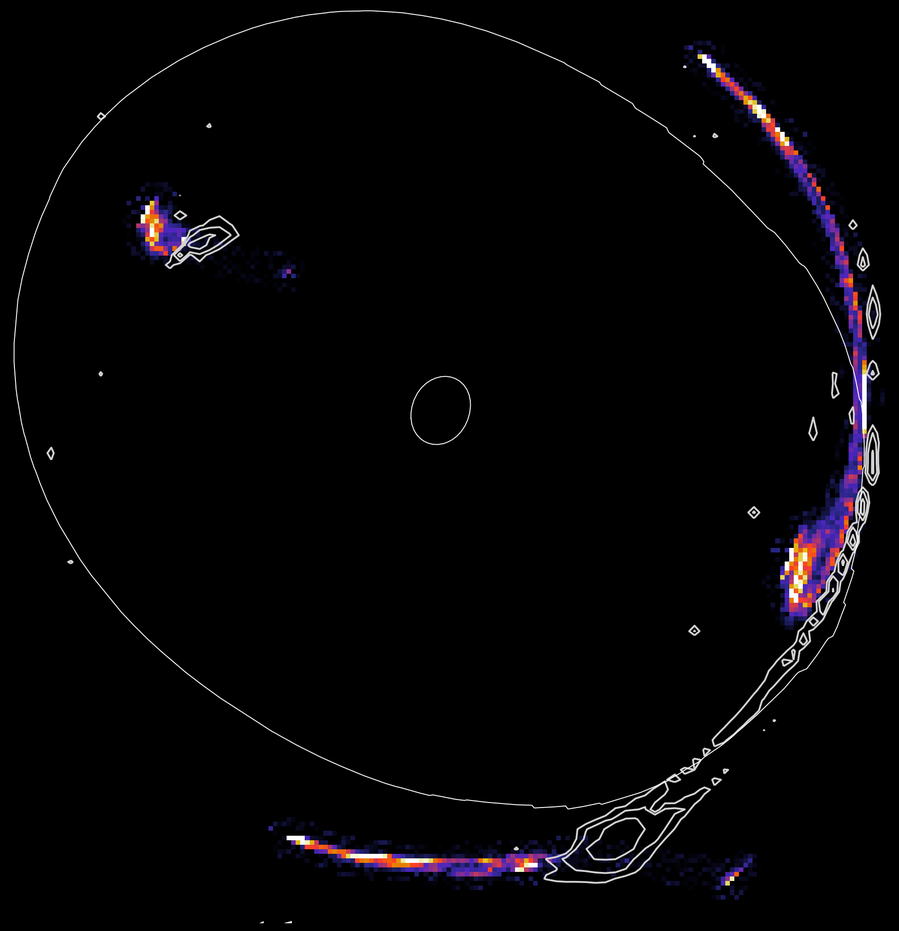
Eagle50 SIDM (Robertson+20)

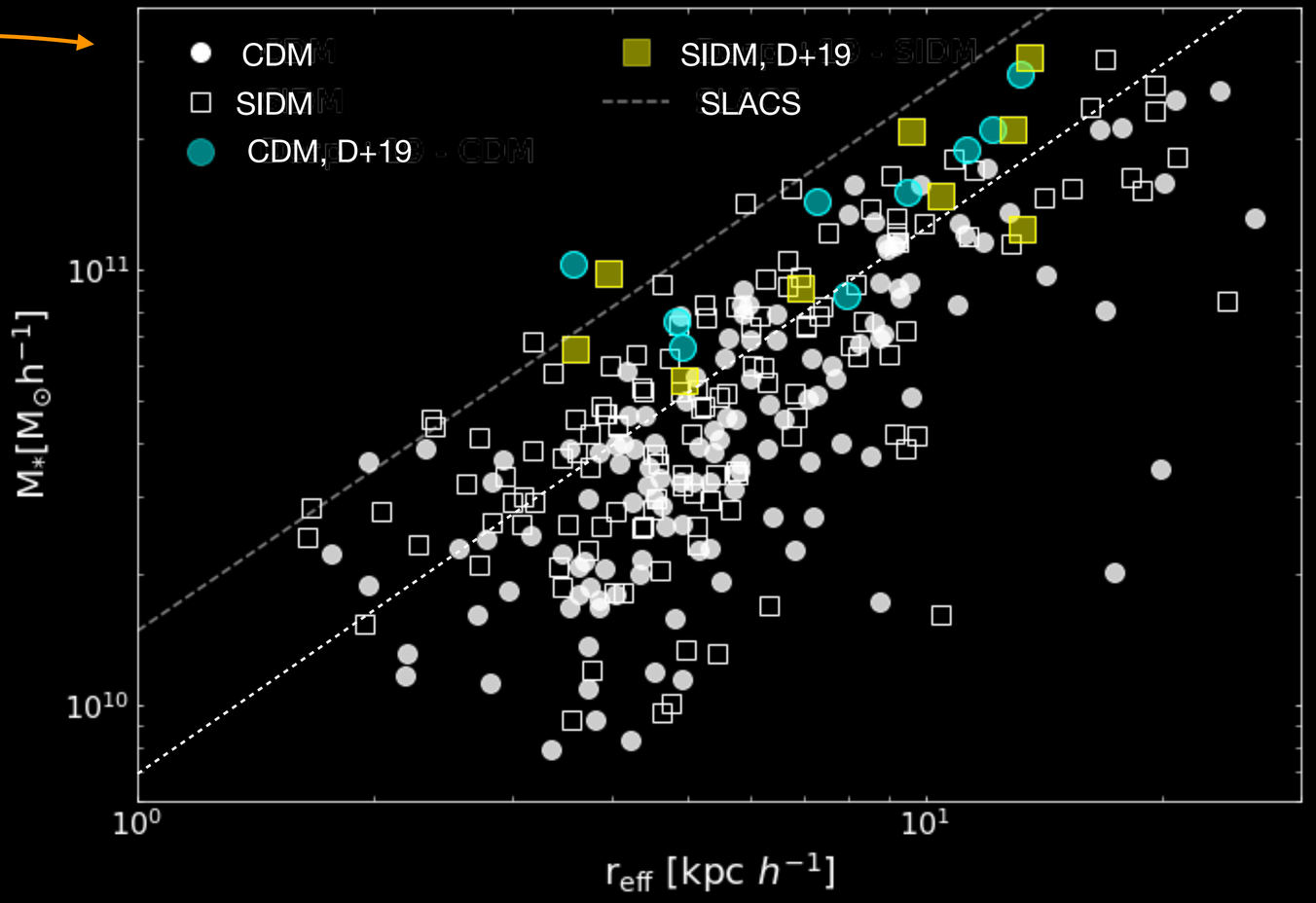
Zoom-in TNG+SIDM (Despali+19,22)

SIDM HYDRO SIMULATIONS



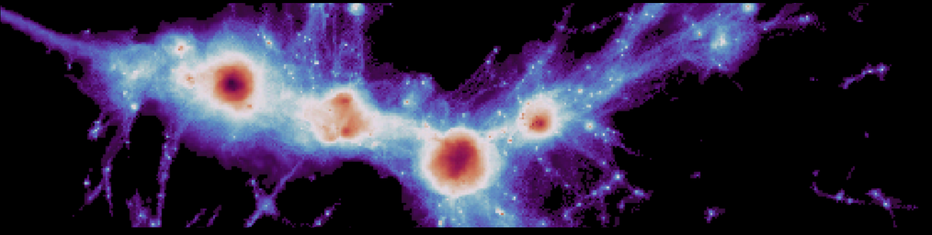
Elliptical (lens) galaxies





Eagle50 SIDM (Robertson+20)

Zoom-in TNG+SIDM (Despali+19,22)

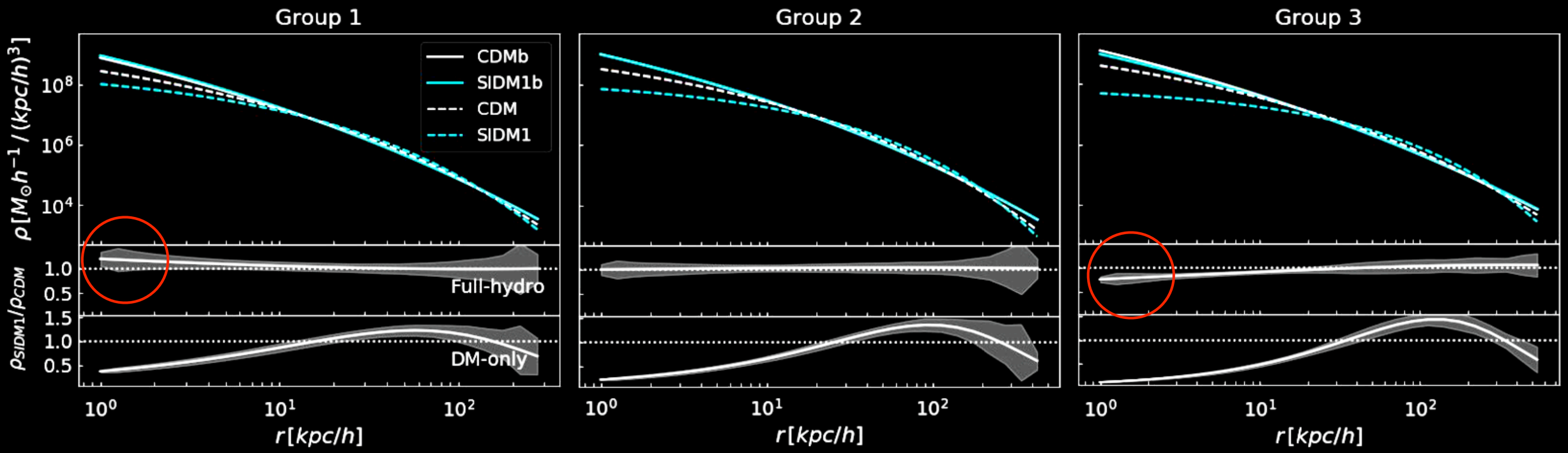


SIDM HYDRO SIMULATIONS

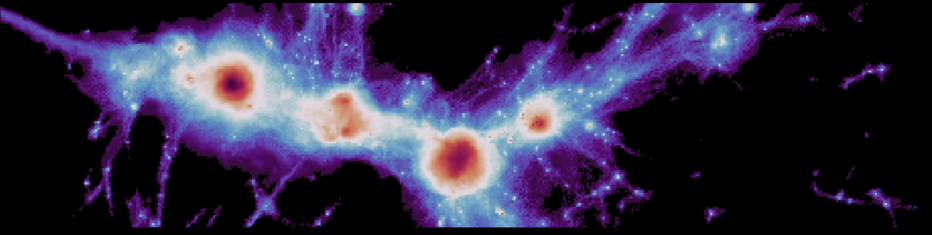
log(M)~12-12.5

log(M)~12.5-13

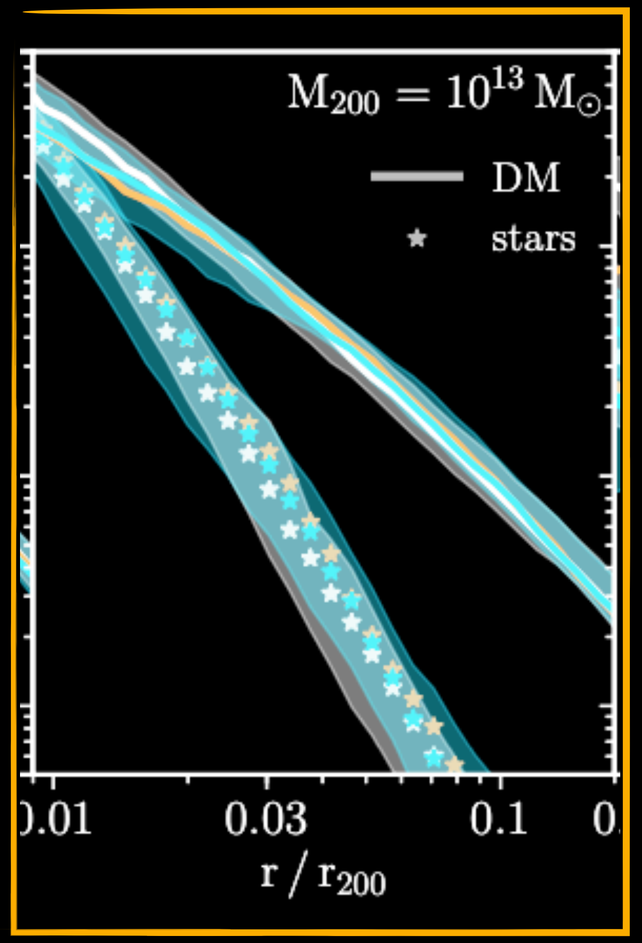
log(M)~13-13.5



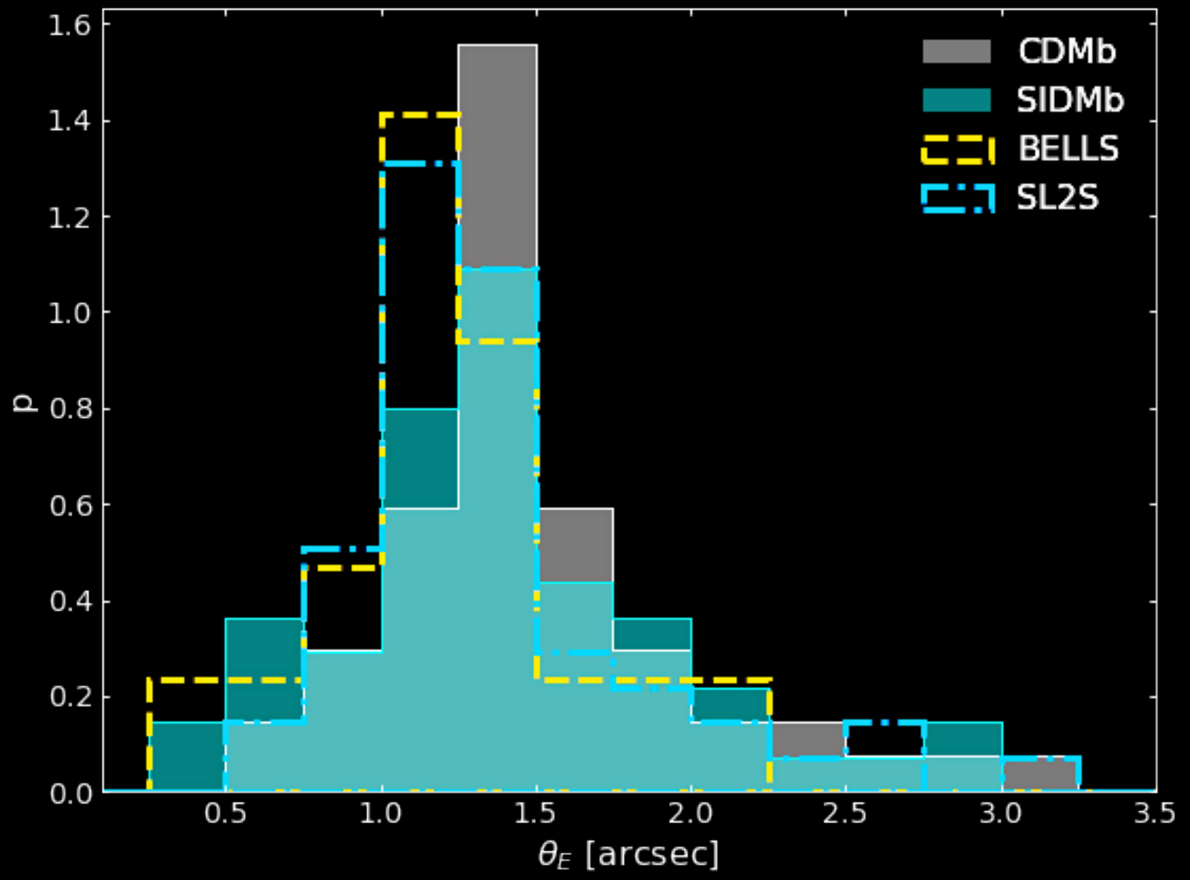
(Mastromarino, Despali et al. 2023)



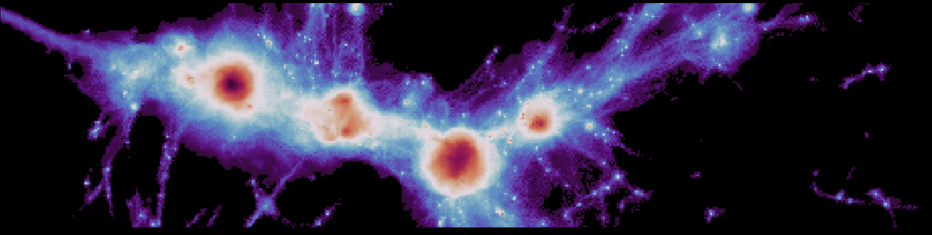
SIDM + BARYONS: LENSING EFFECT



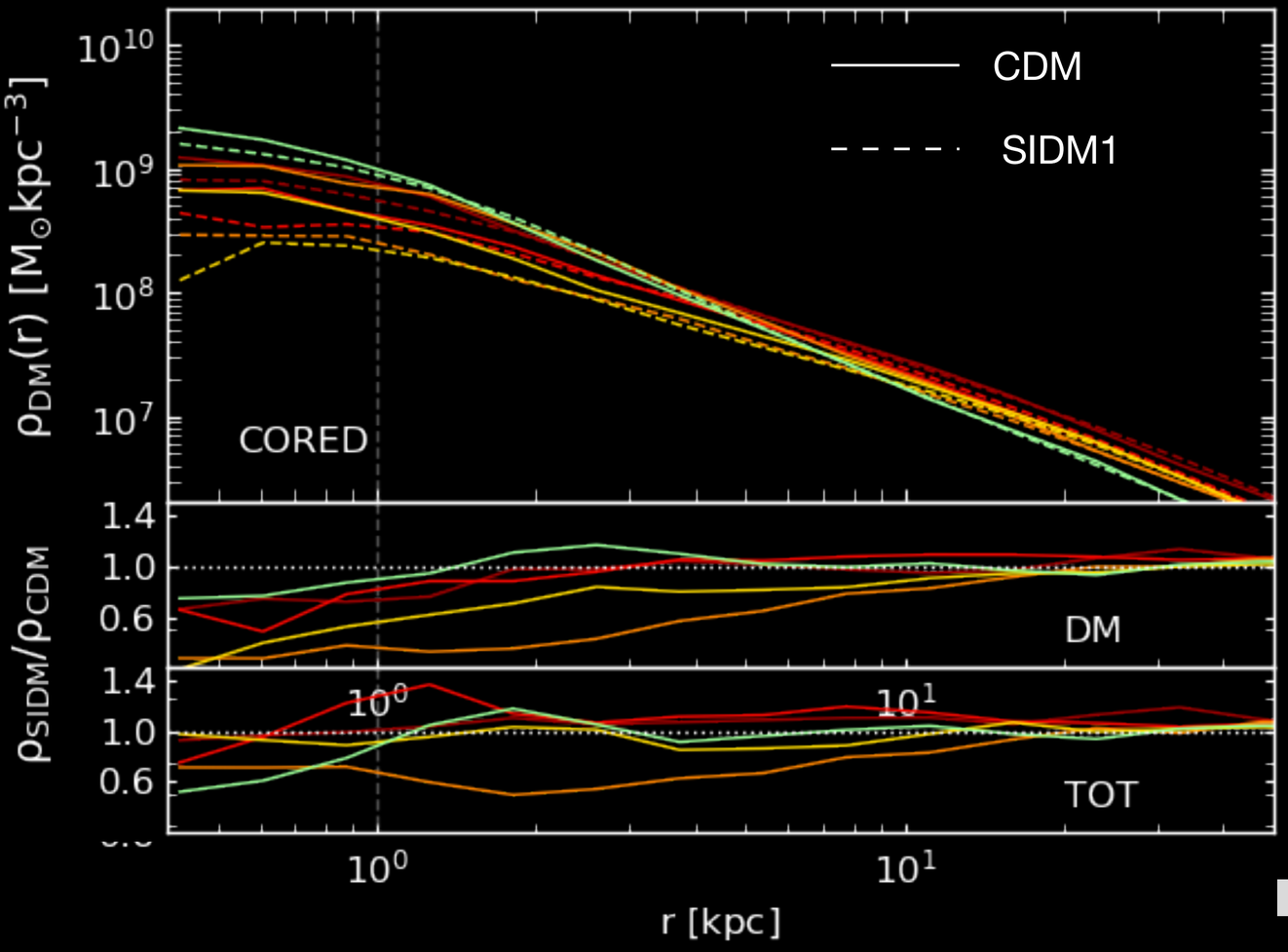
similar distribution of Einstein radii

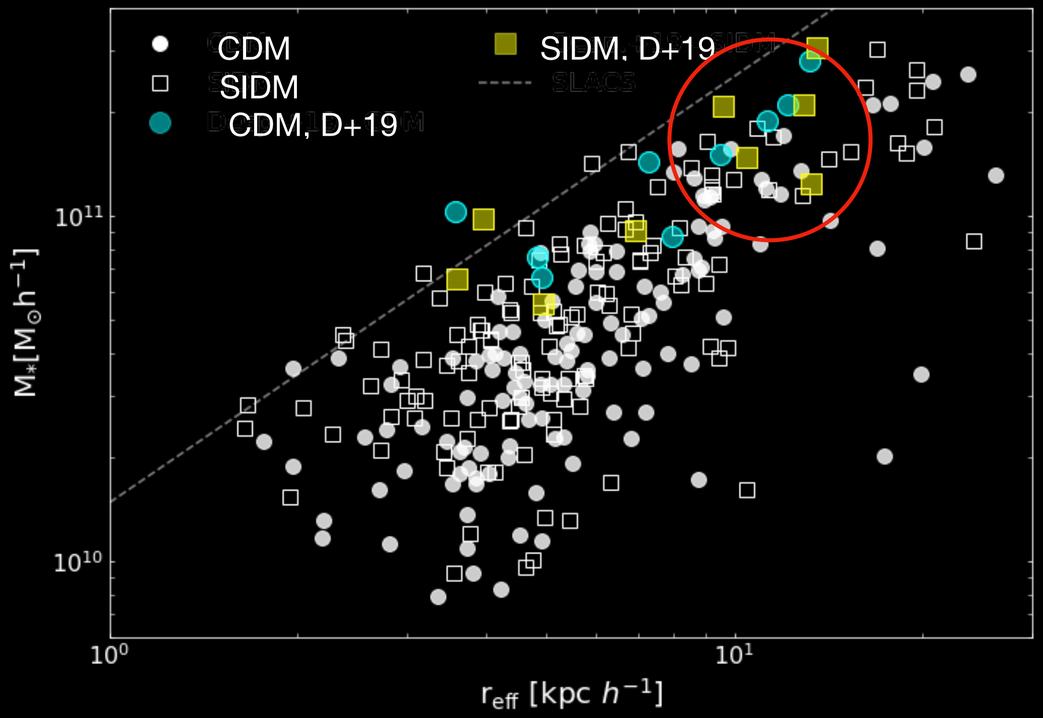


(Mastromarino, Despali et al. 2023)



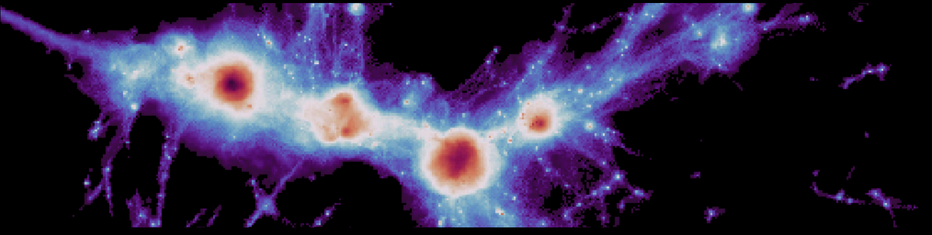
SIDM HYDRO SIMULATIONS



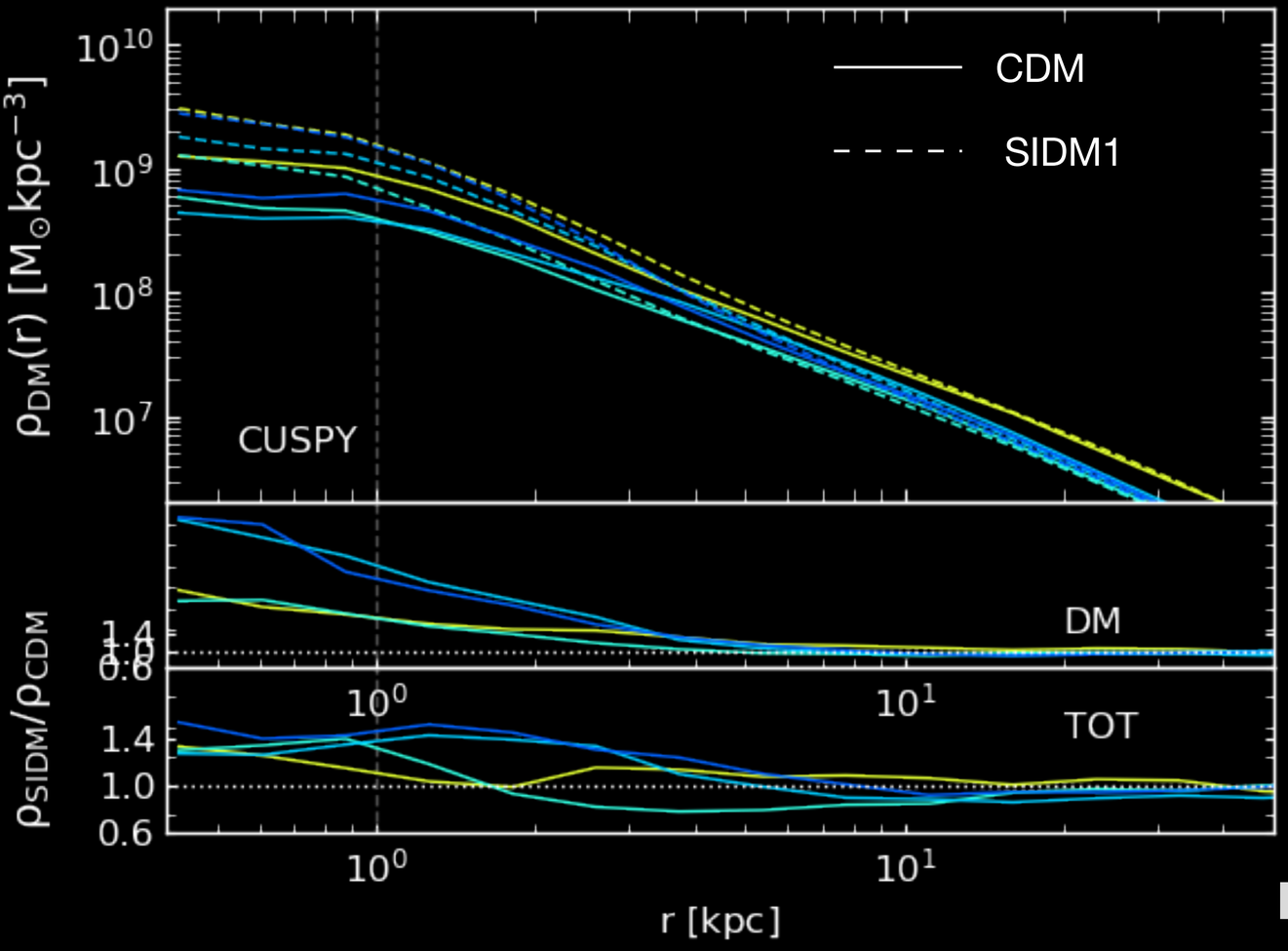


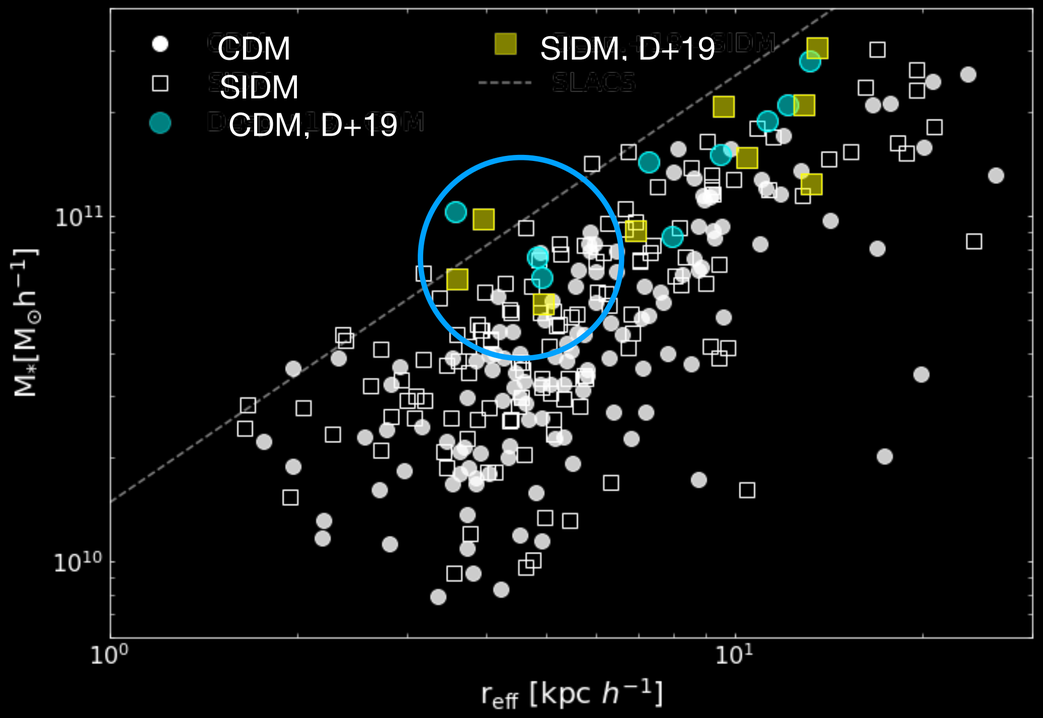
Eagle50 SIDM (Robertson+20)

Zoom-in TNG+SIDM (Despali+19,22)



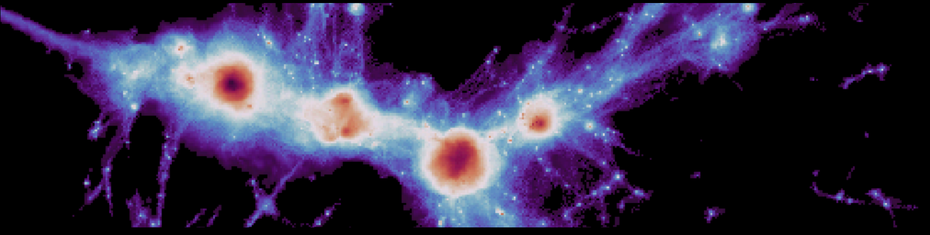
SIDM HYDRO SIMULATIONS



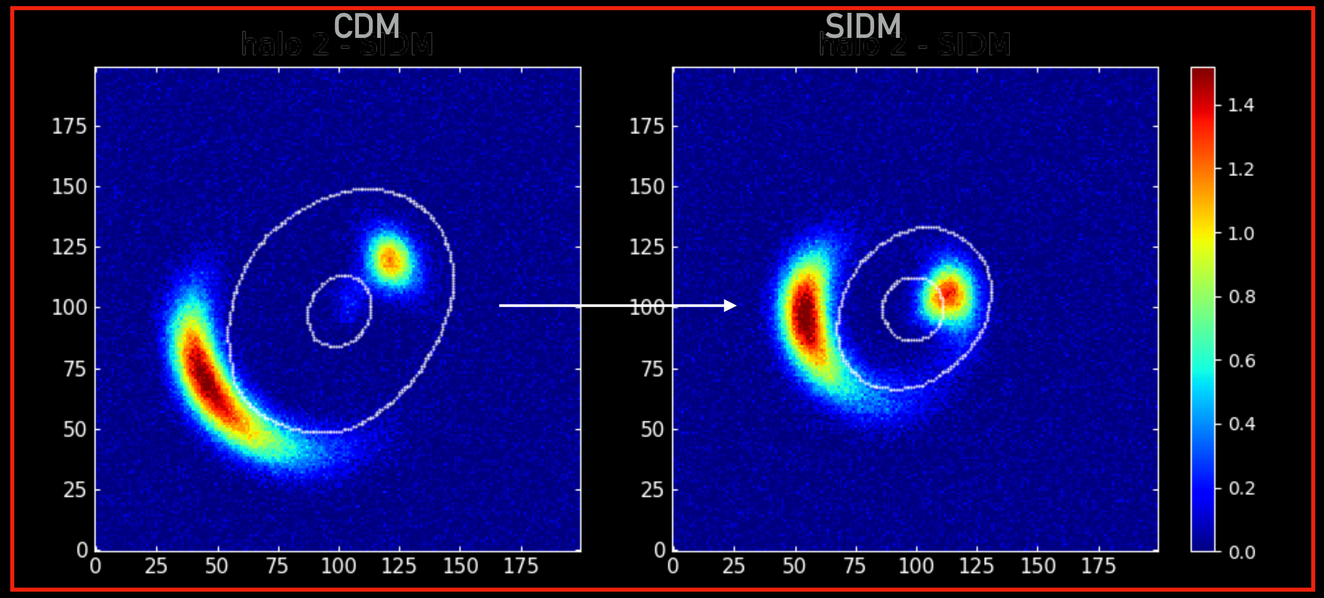


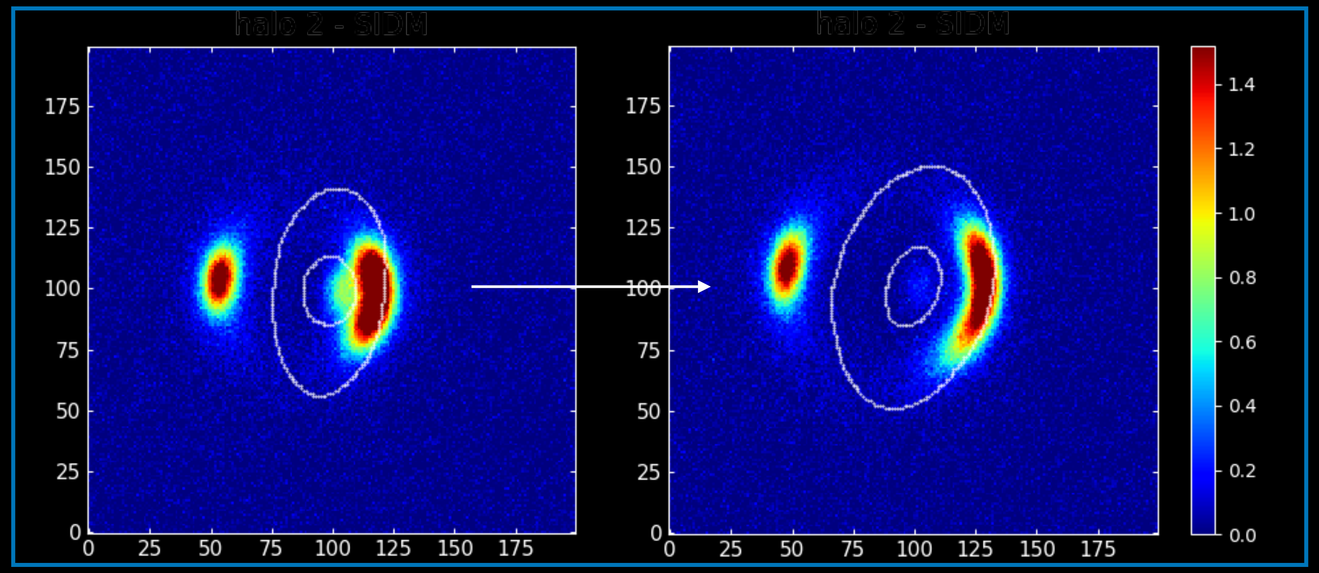
Eagle50 SIDM (Robertson+20)

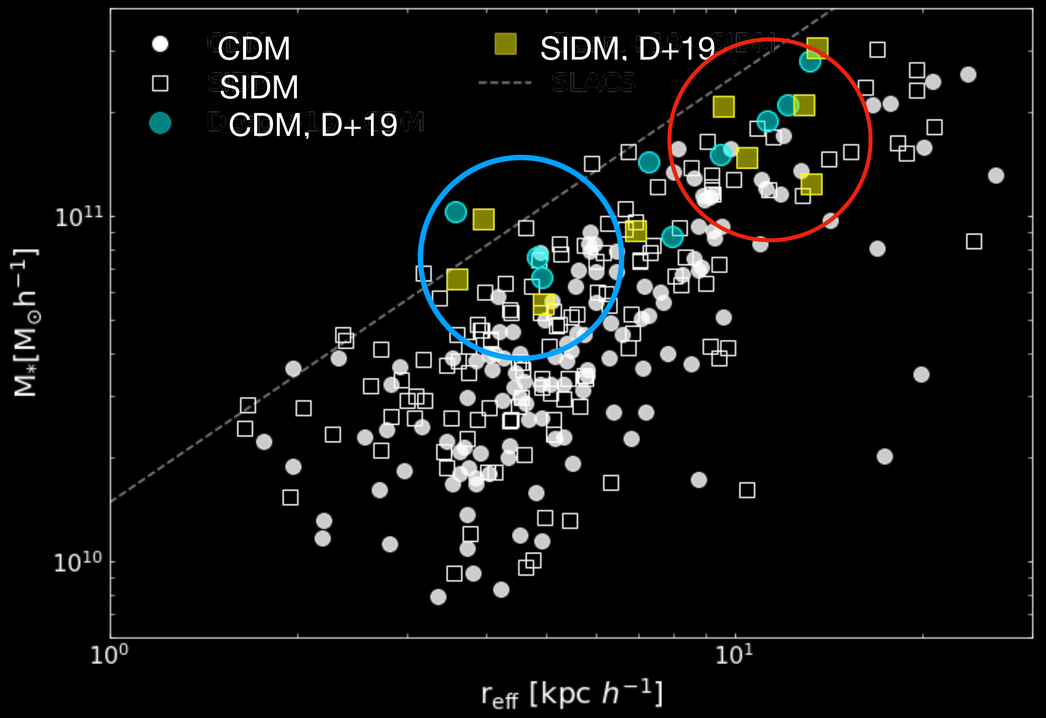
Zoom-in TNG+SIDM (Despali+19,22)



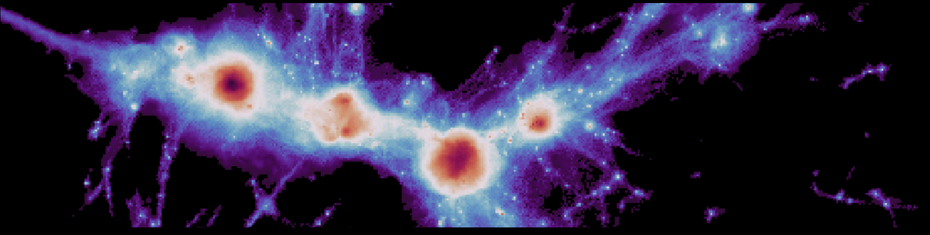
LENSING EFFECT



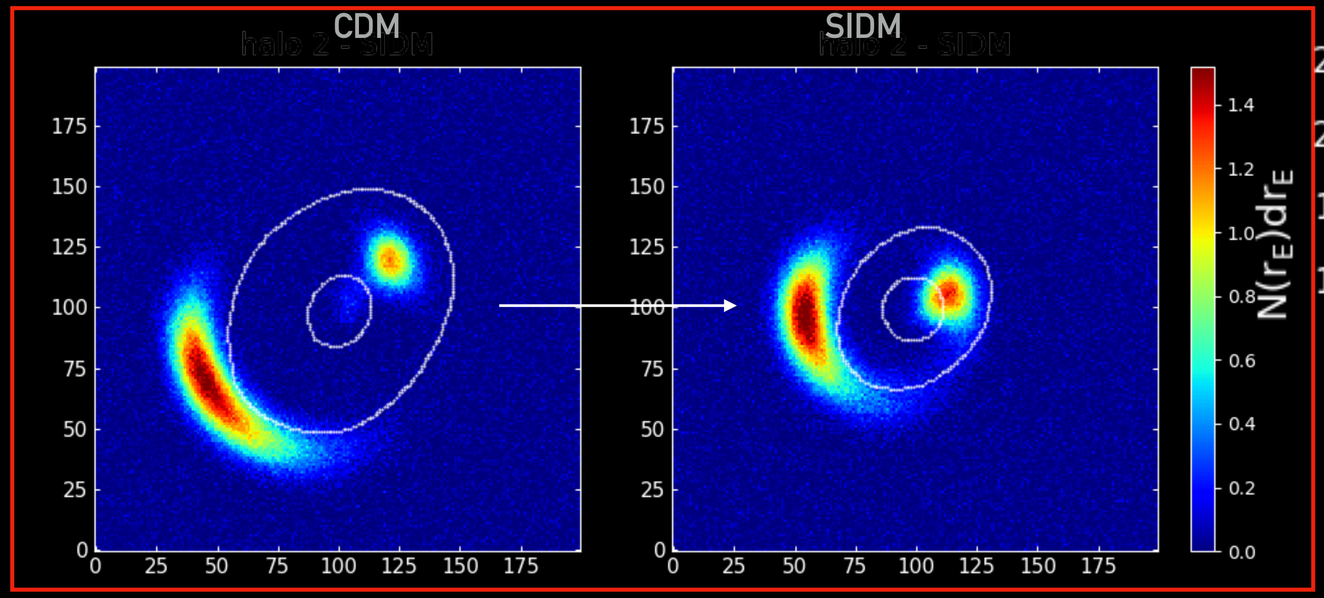


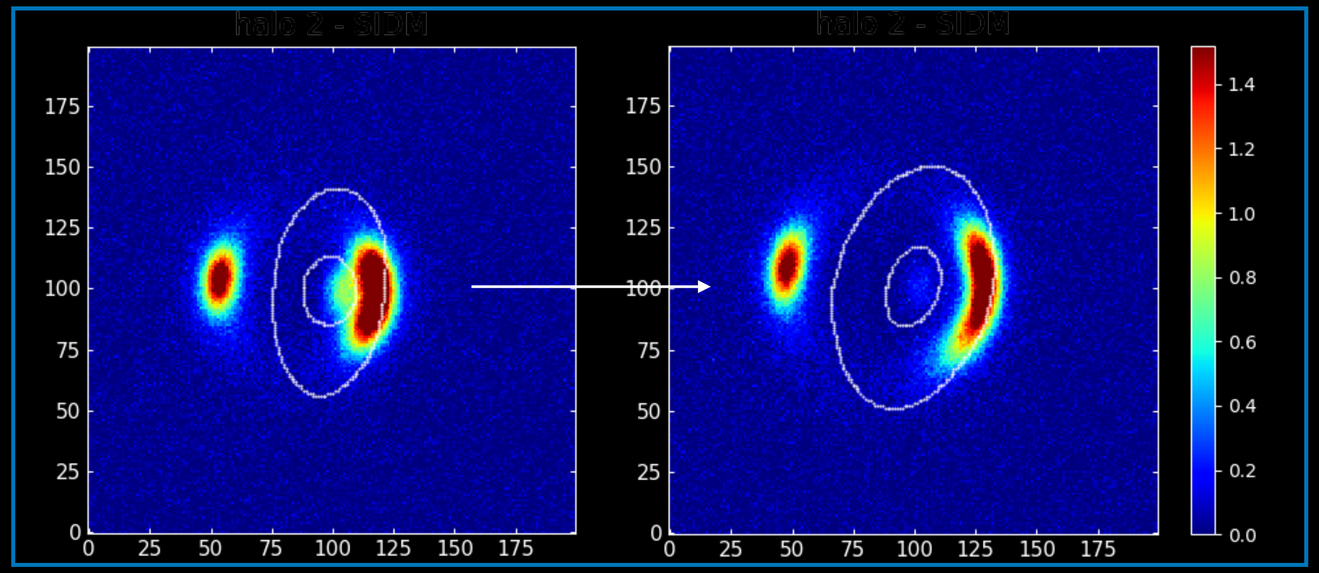


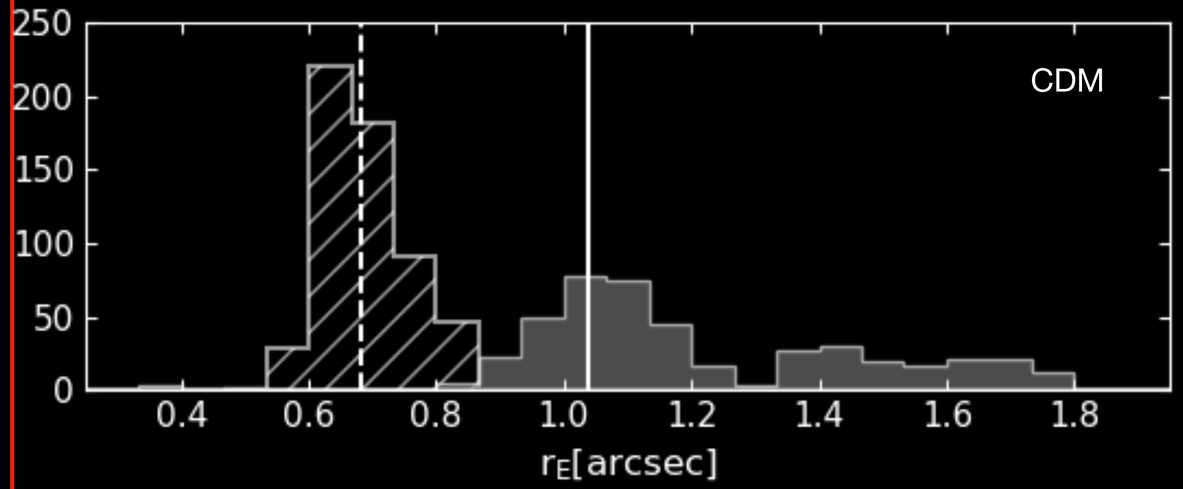
Zoom-in TNG+SIDM (Despali+19,22)

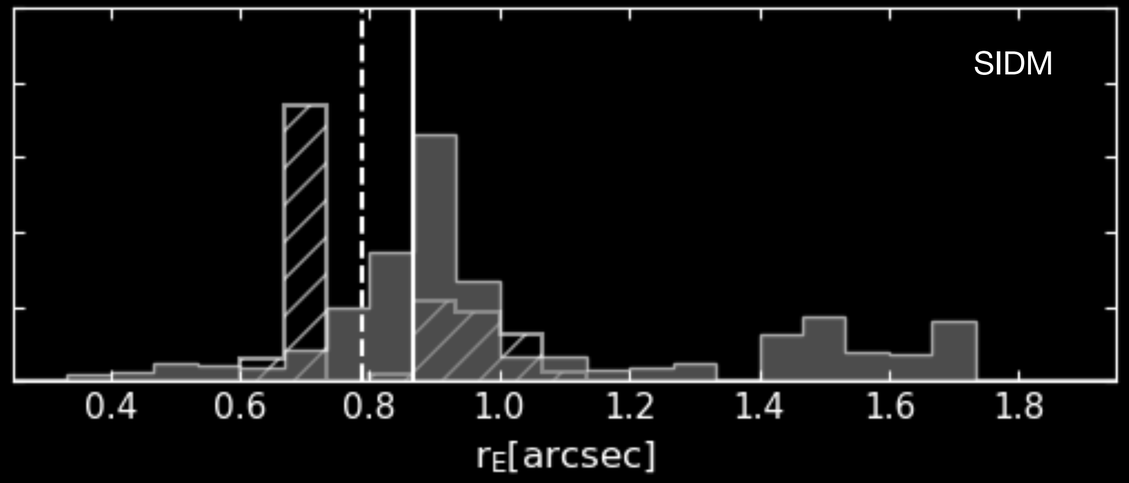


LENSING EFFECT

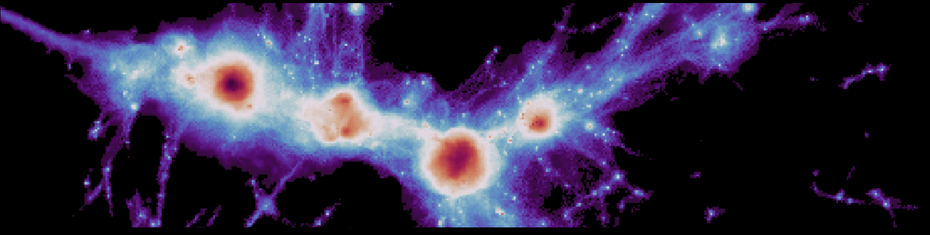




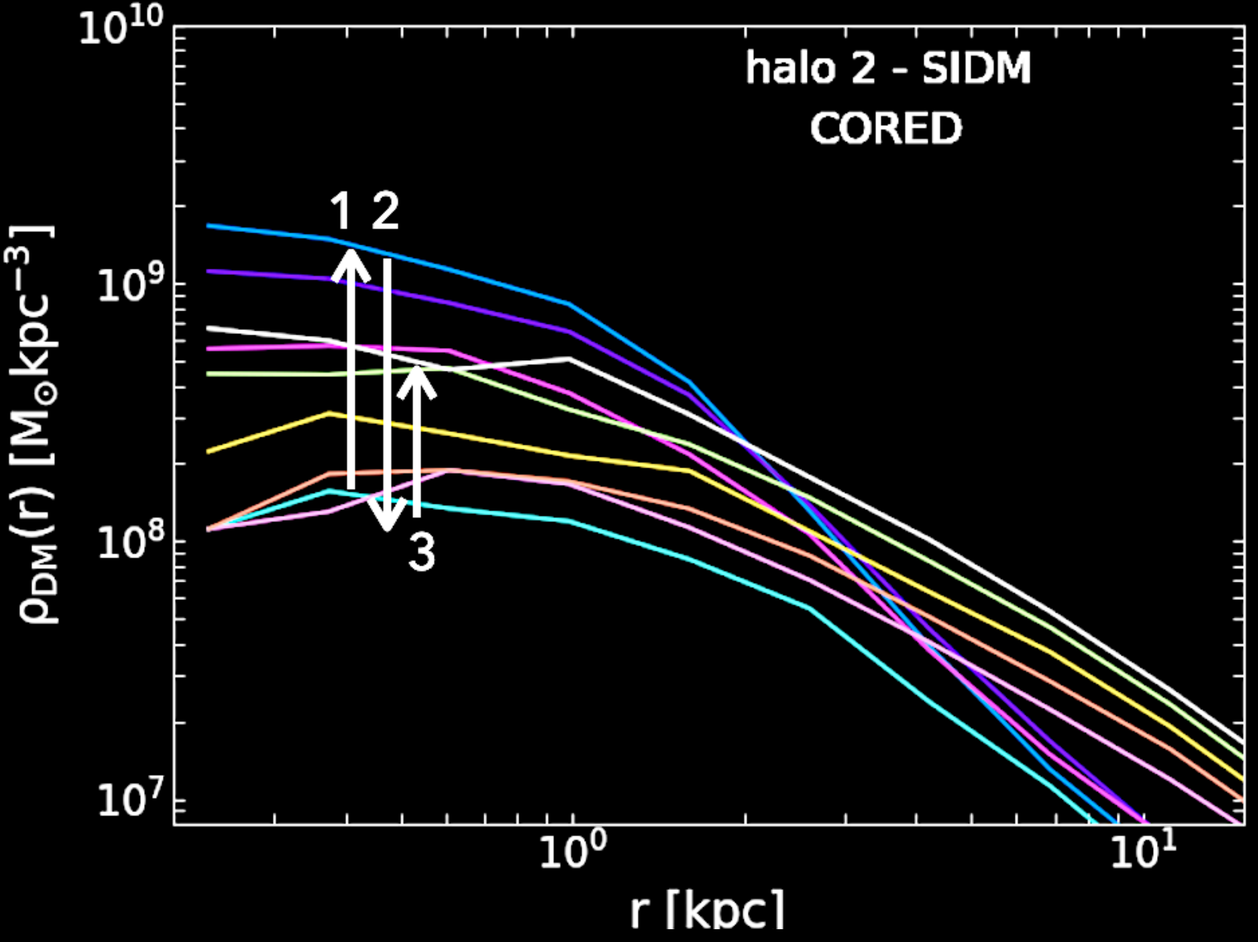


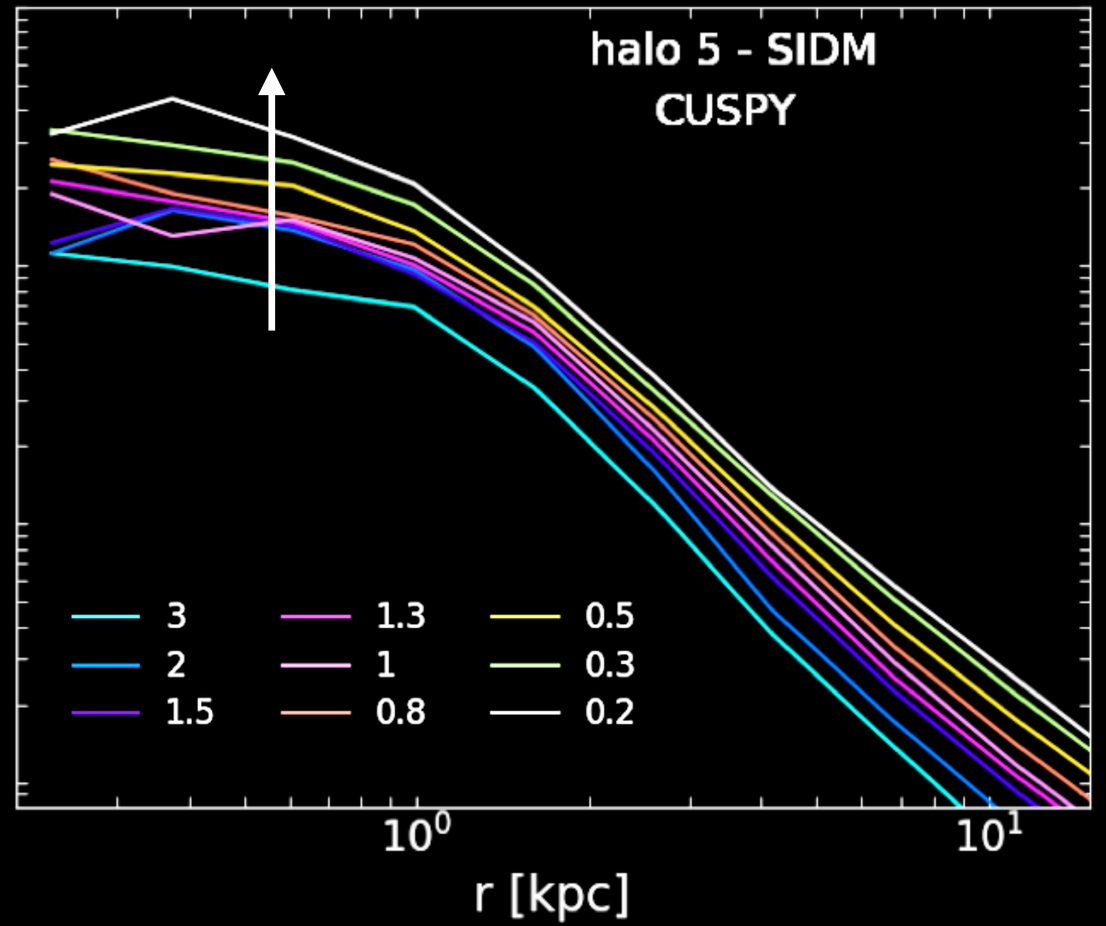


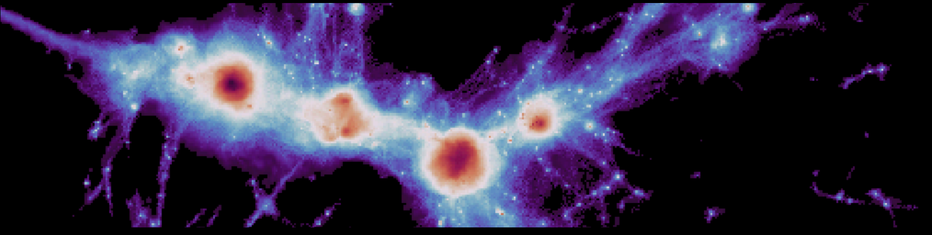
Zoom-in TNG+SIDM (Despali+19,22)



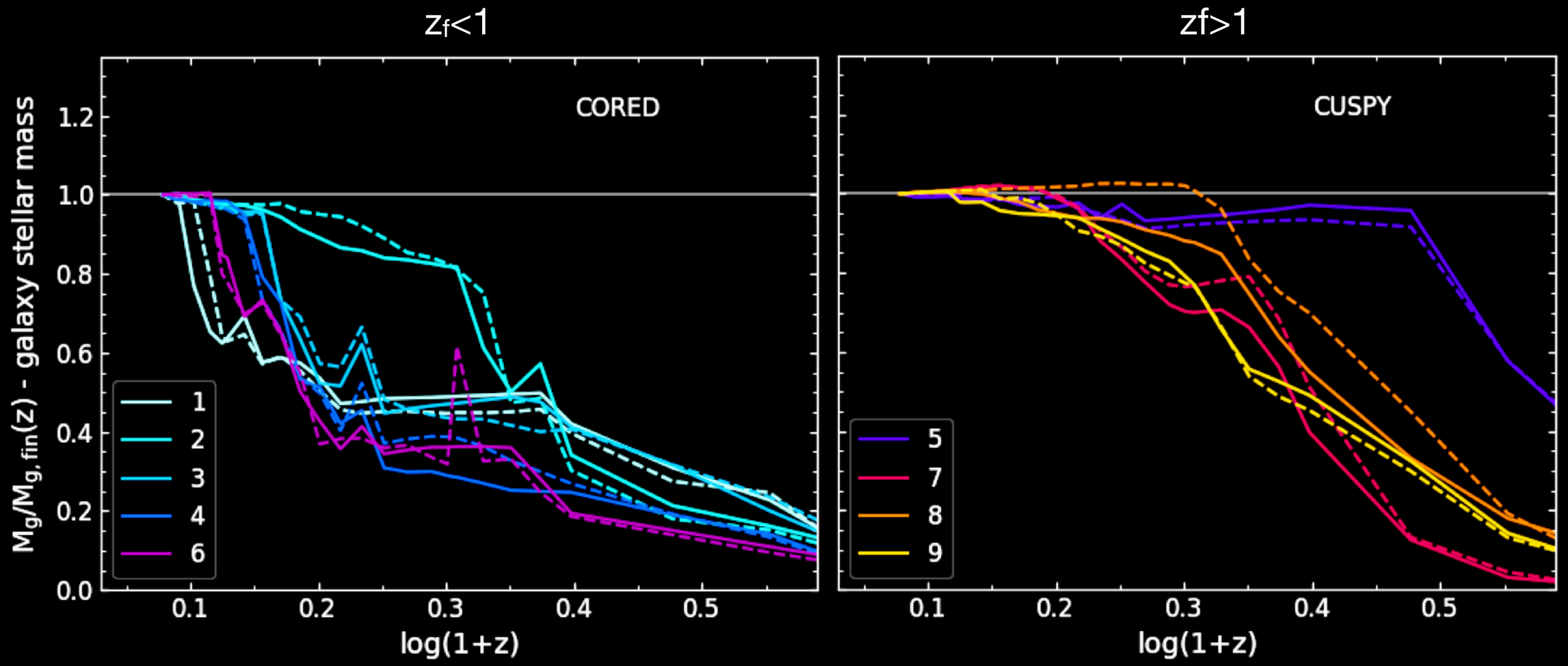
SIDM HYDRO SIMULATIONS

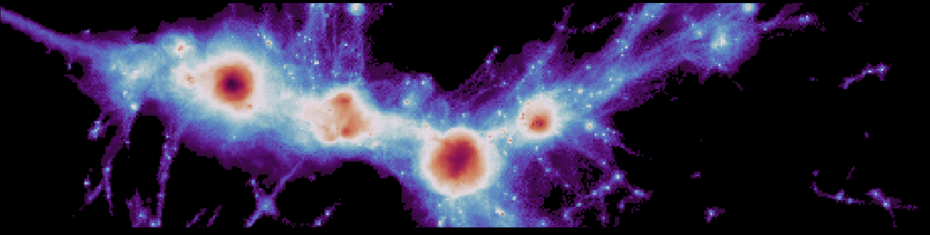




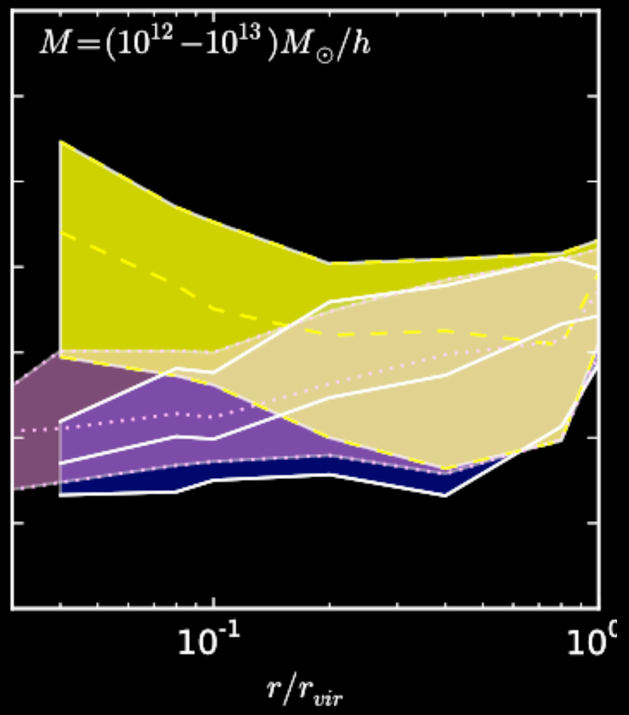


SIDM HYDRO SIMULATIONS



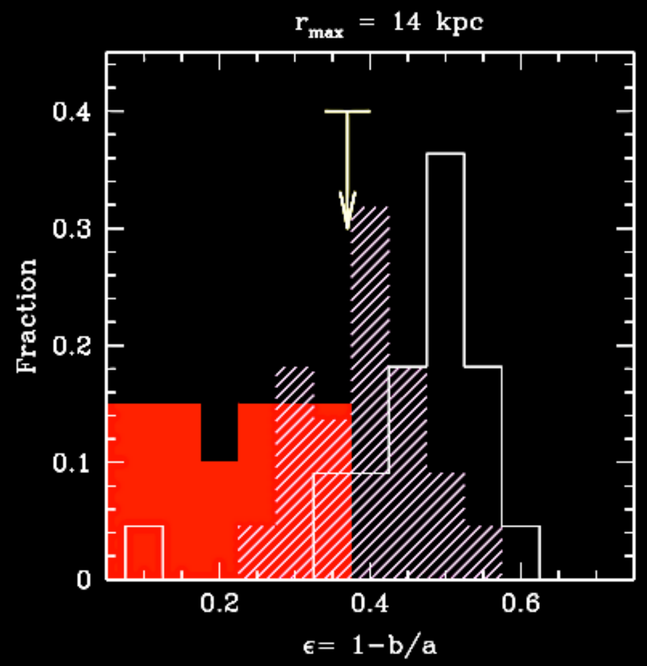


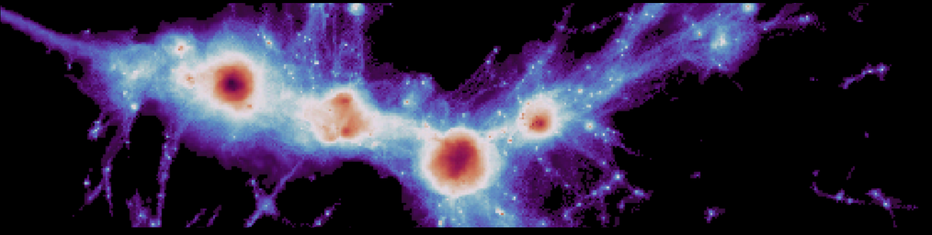
SHAPES



SIDM produces
<u>rounder</u> haloes

(Peter et al. 2013)

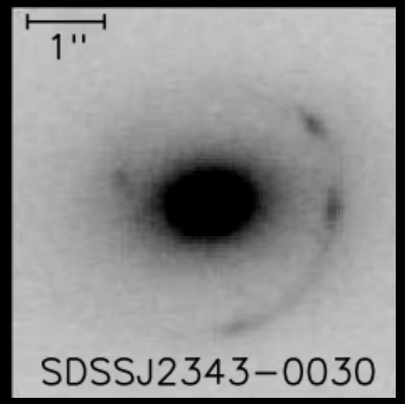


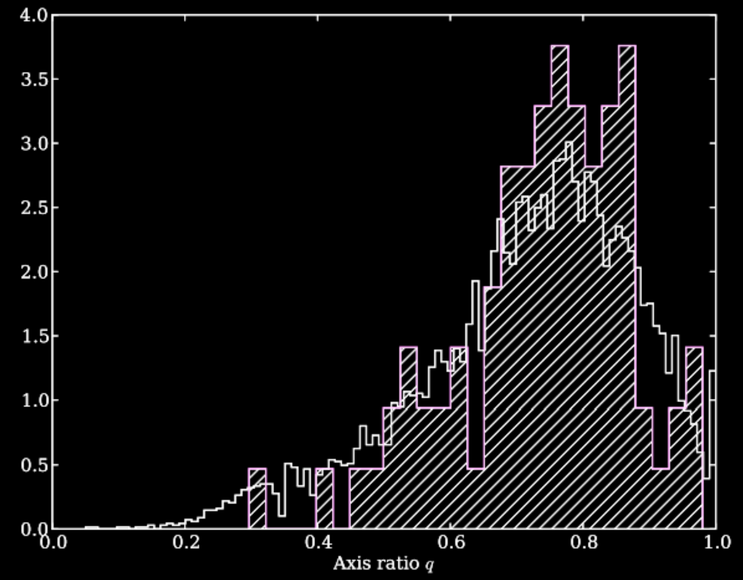


SHAPES

TOTAL MASS

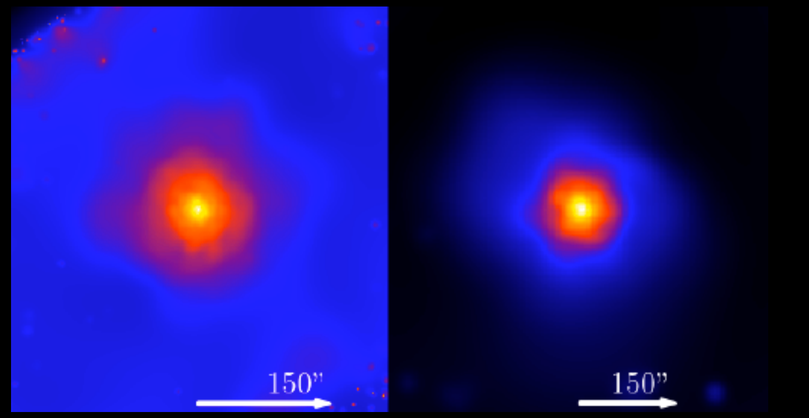
Grav. Lensing - galaxies modelled as SIE



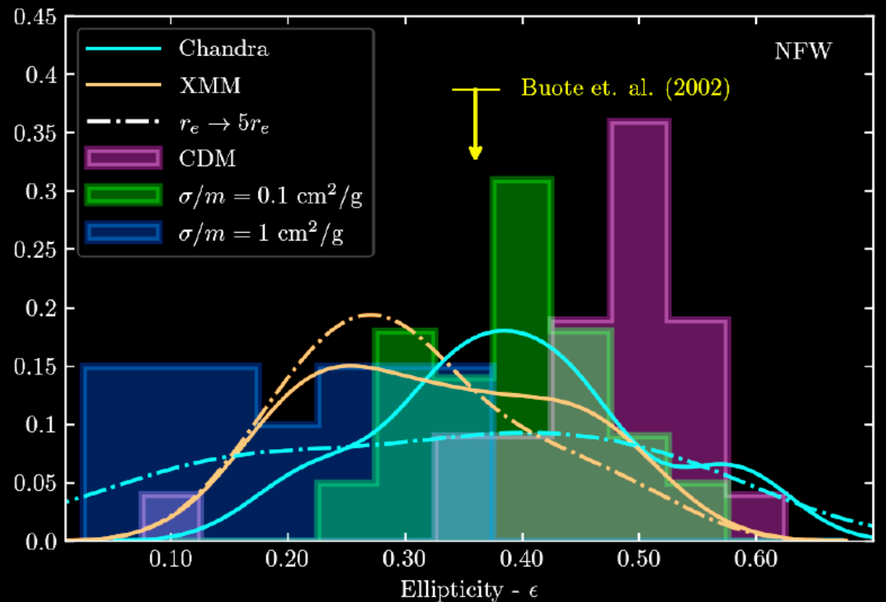


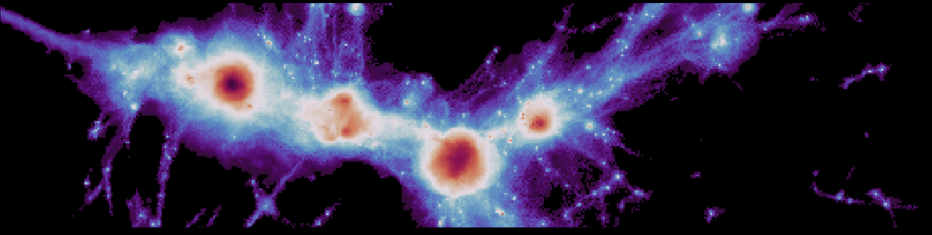
GAS: X-RAY

the X-ray emitting gas traces the gravitational potential



(McDaniel+21) - 11





SIDM + BARYONS: SHAPES

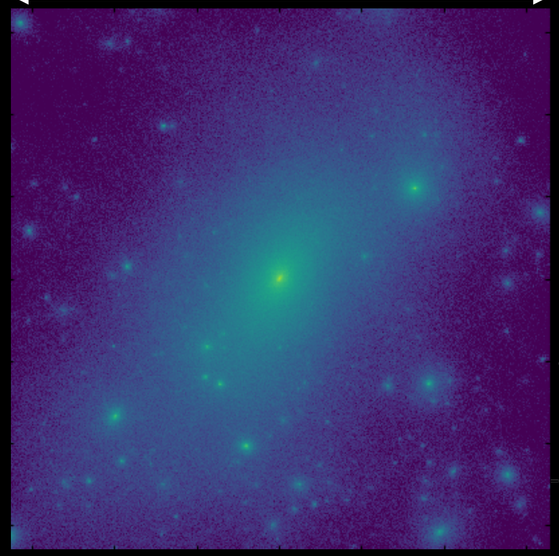
0.5 Rvir

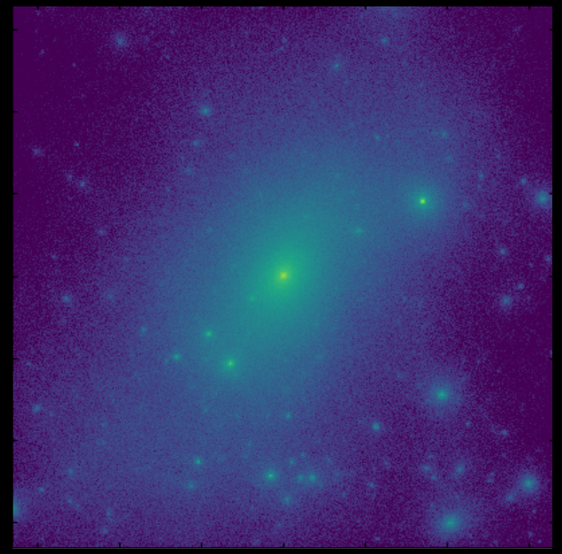
Chandra

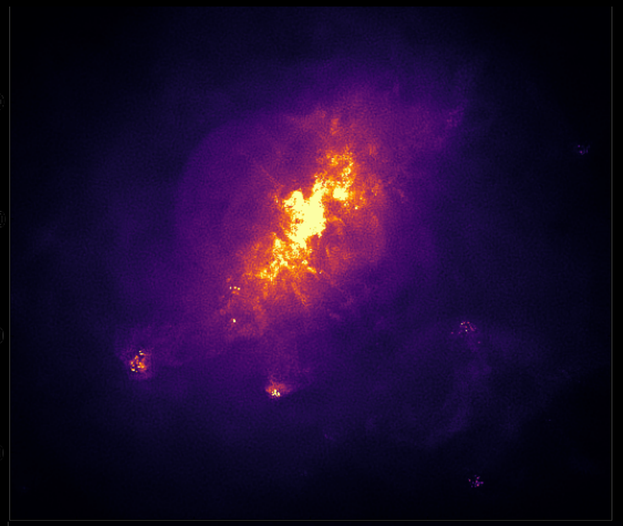
XMM

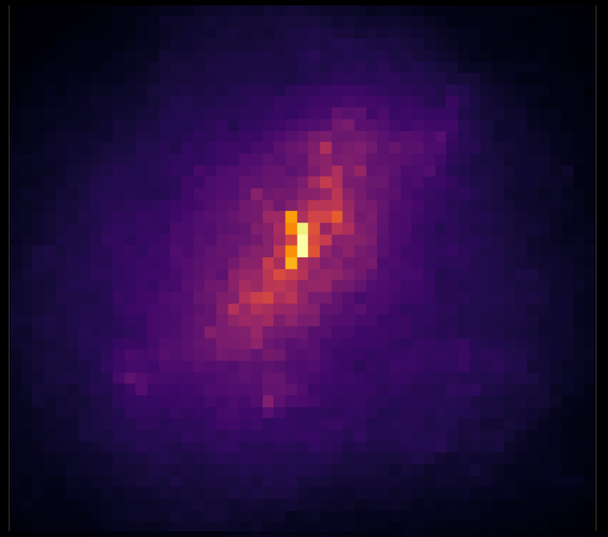
CDM

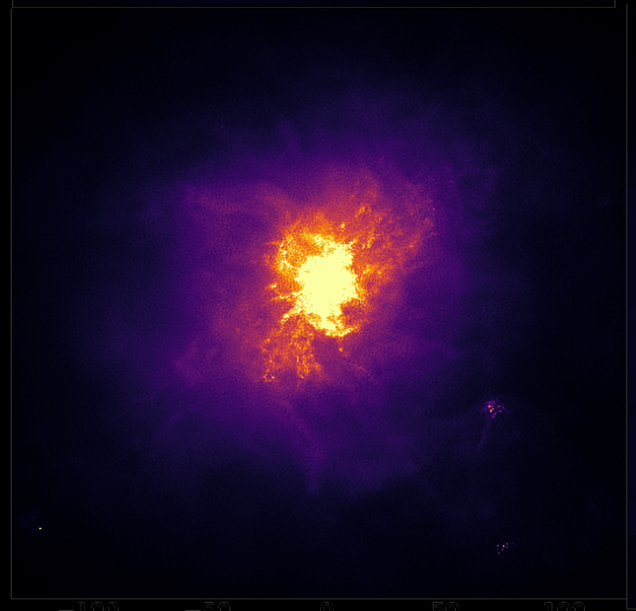
SIDM

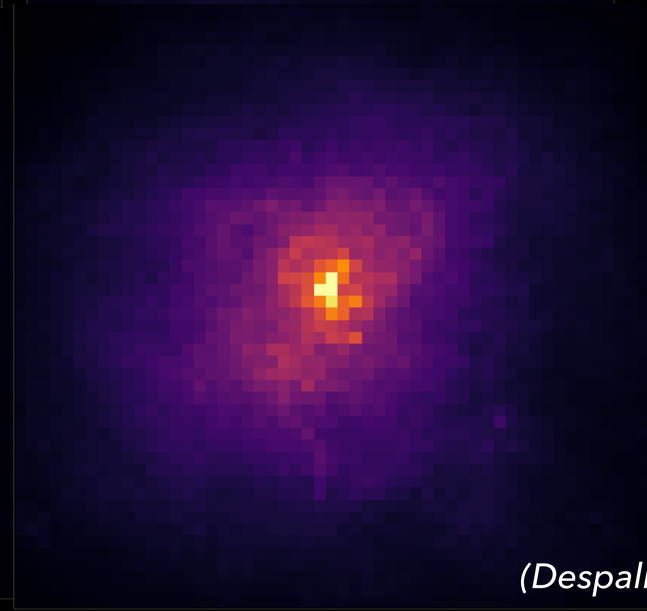




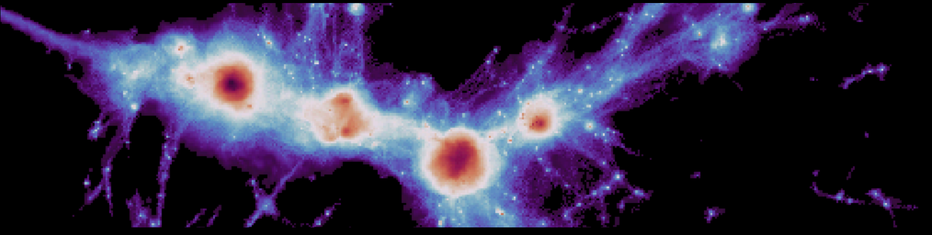








(Despali et al. 2022)



SIDM + BARYONS: SHAPES

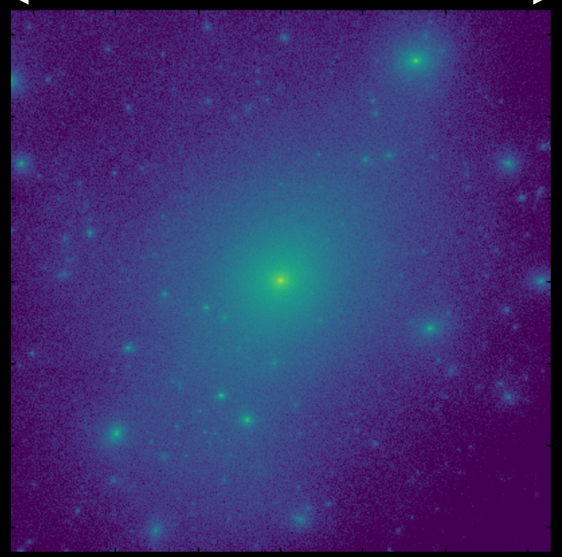
0.5 Rvir

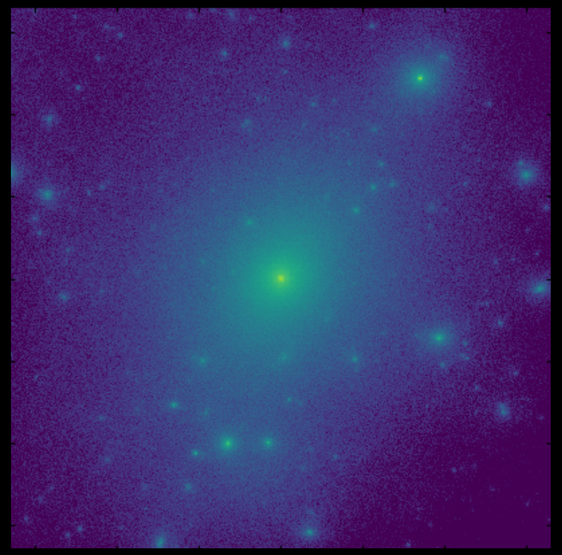
CDM

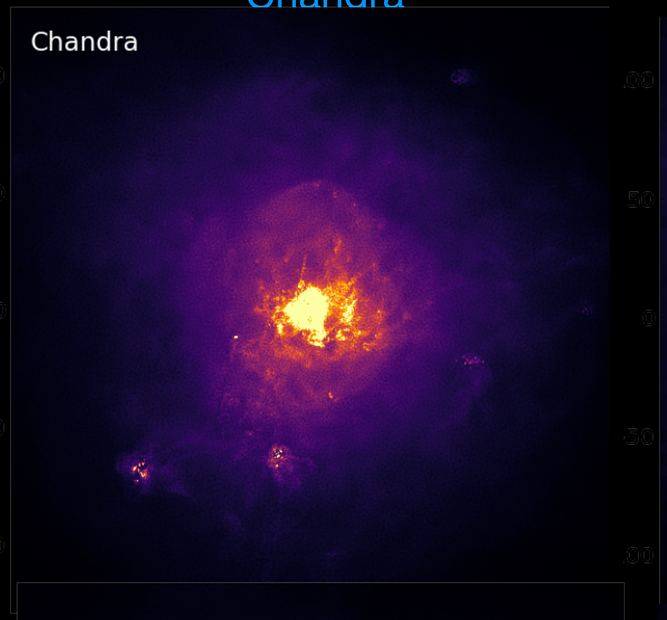
SIDM

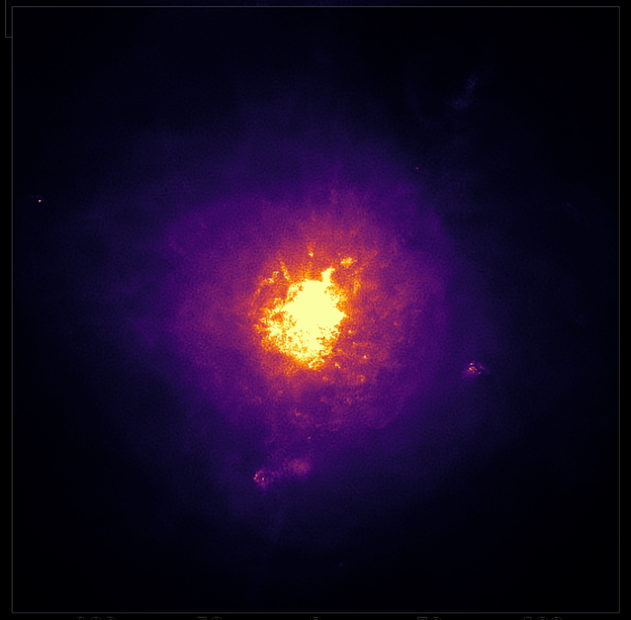
Chandra

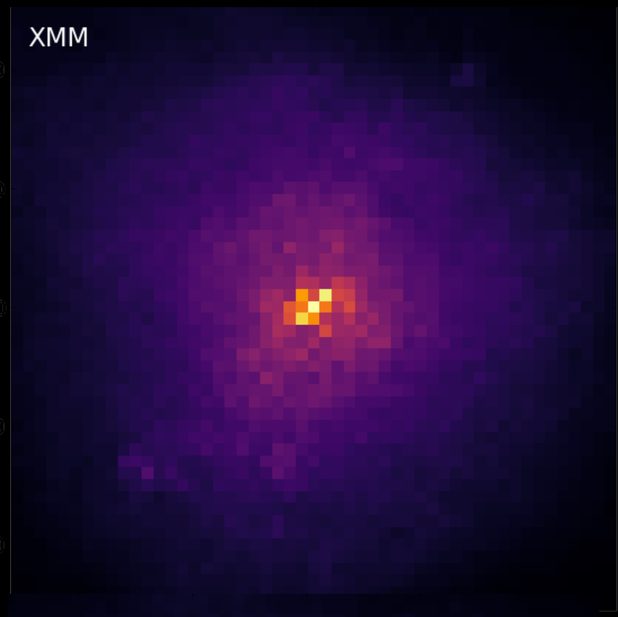
XMM

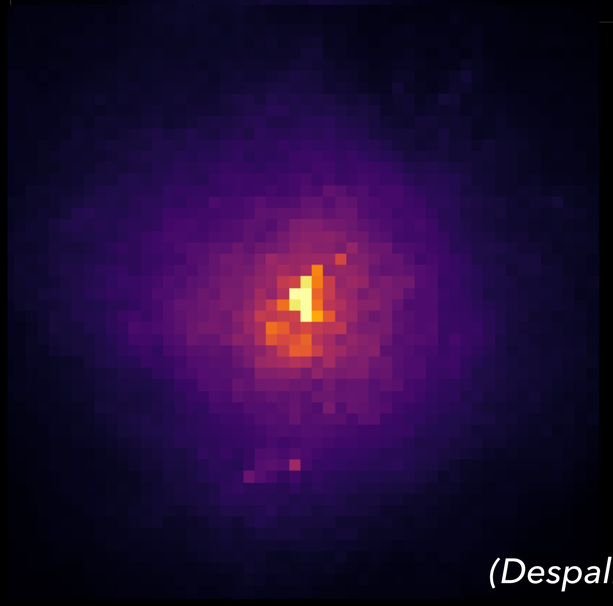




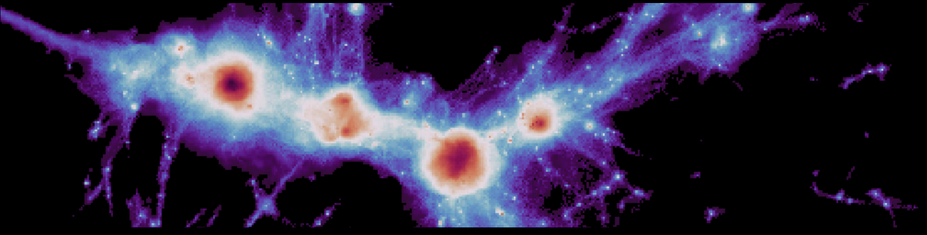








(Despali et al. 2022)



- CDM haloes are more elongated in the inner parts

- SIDM makes haloes rounder and reverses the trend

- baryons also make haloes rounder

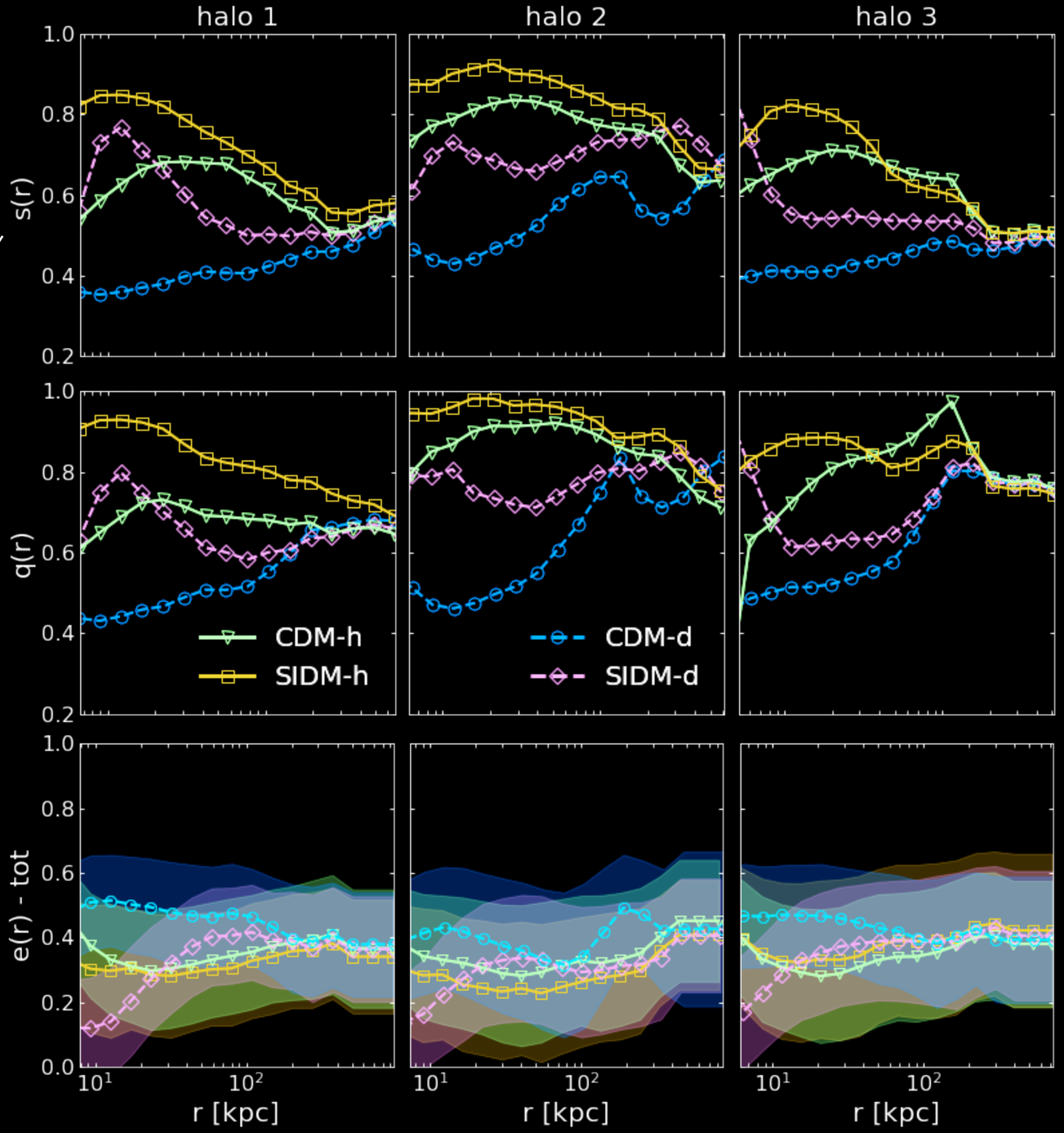
- both only influence the shapes in the inner regions

- hydro runs are more similar to each other than dm-only

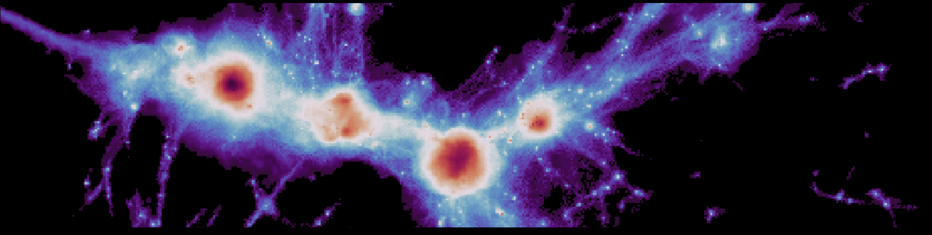
- in projection most of the difference is lost

3D

2D projected mass



(Despali et al. 2022)



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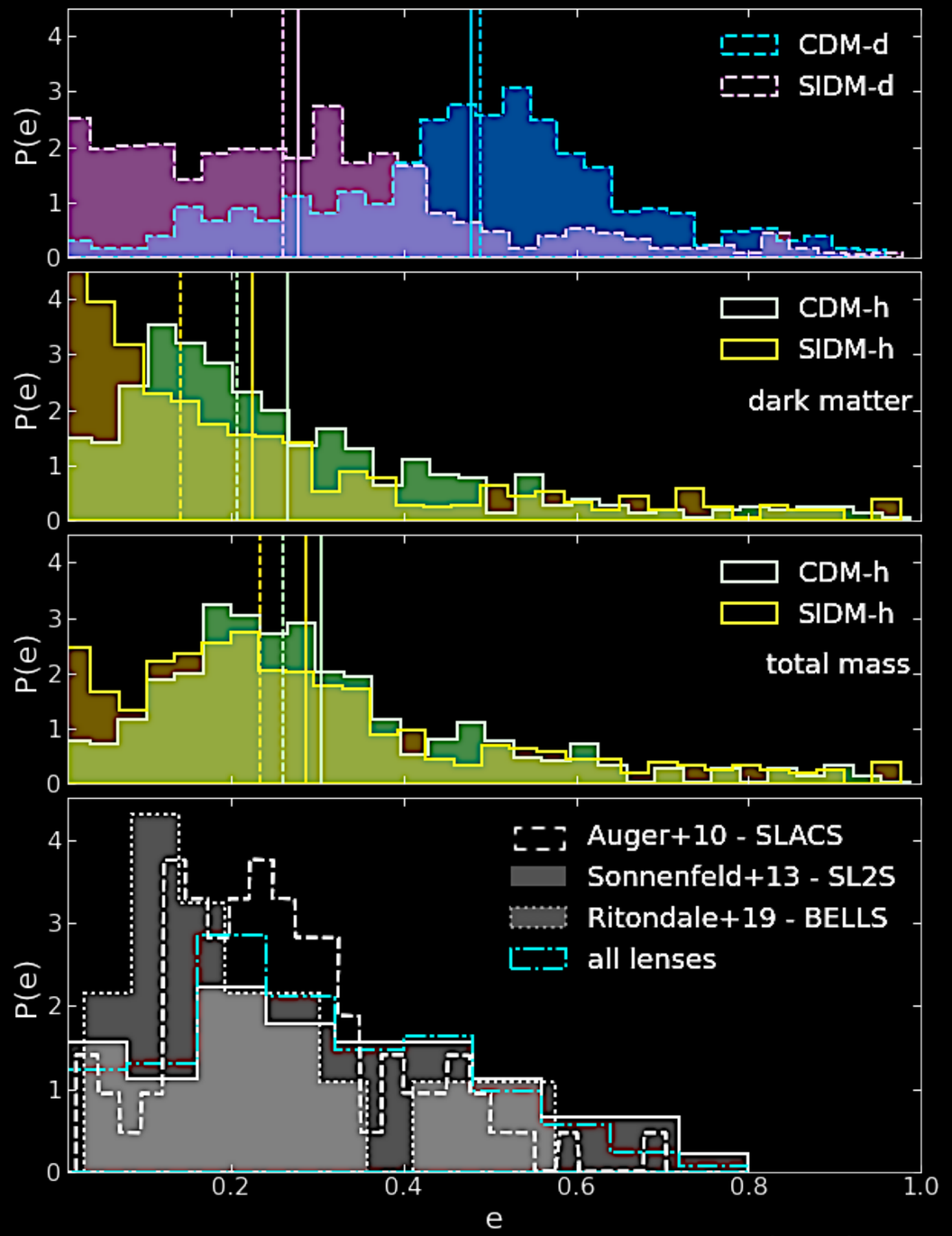
DM-only

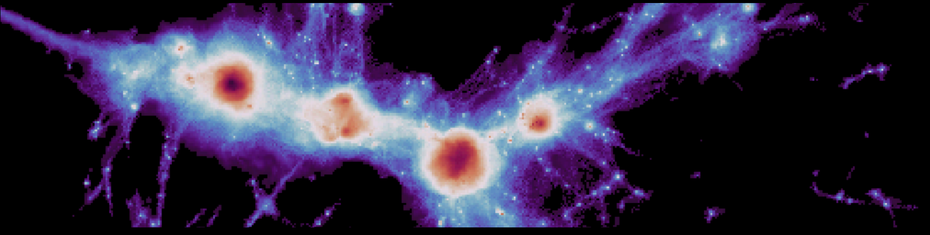
DM in hydro runs

total mass in hydro runs

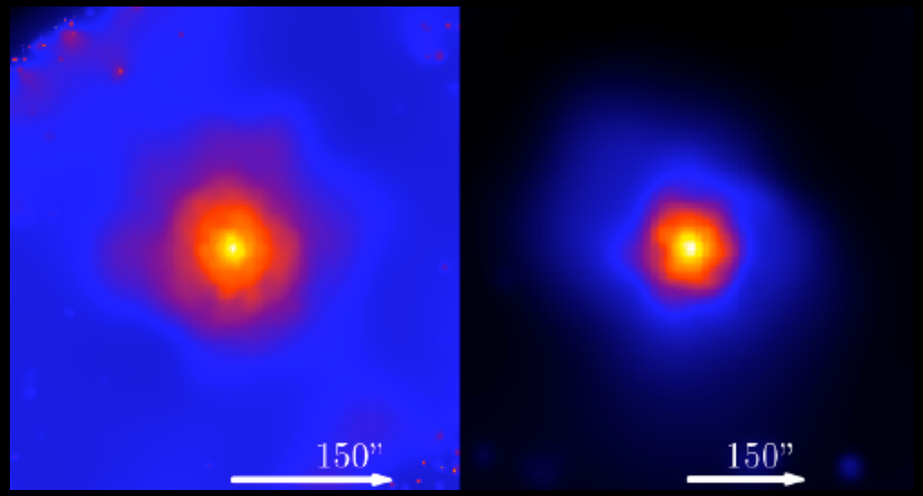
lensing observations

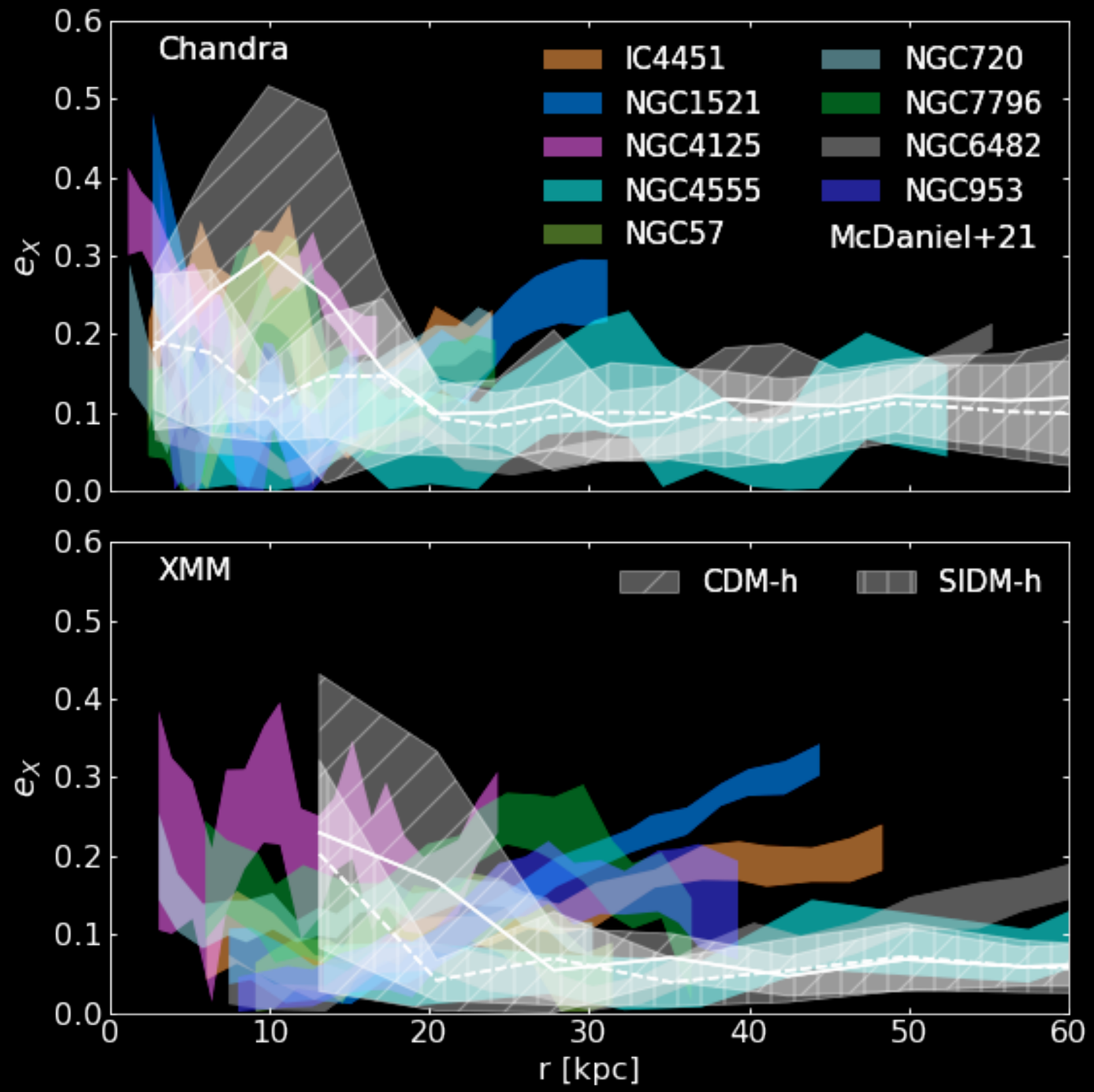


(Despali et al. 2022)



(McDaniel+21) -
11 elliptical galaxies in Xray



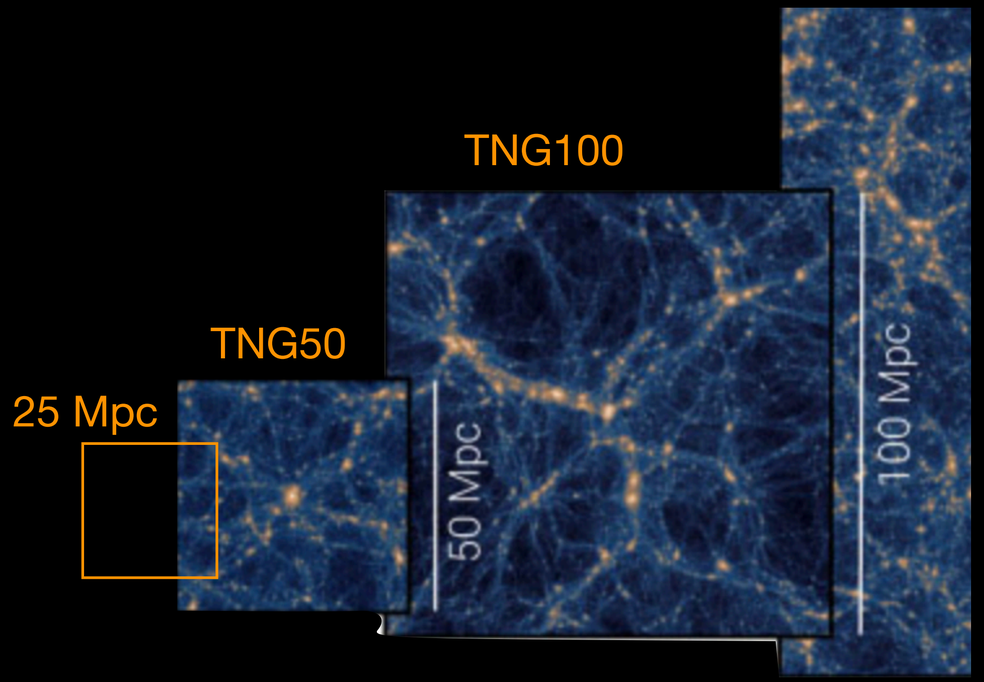


(Despali et al. 2022)

WDM
&
SIDM

TNG
model

NEW SIMULATIONS



max resolutuion: 4 x 10^5 M⊙, 280 pc

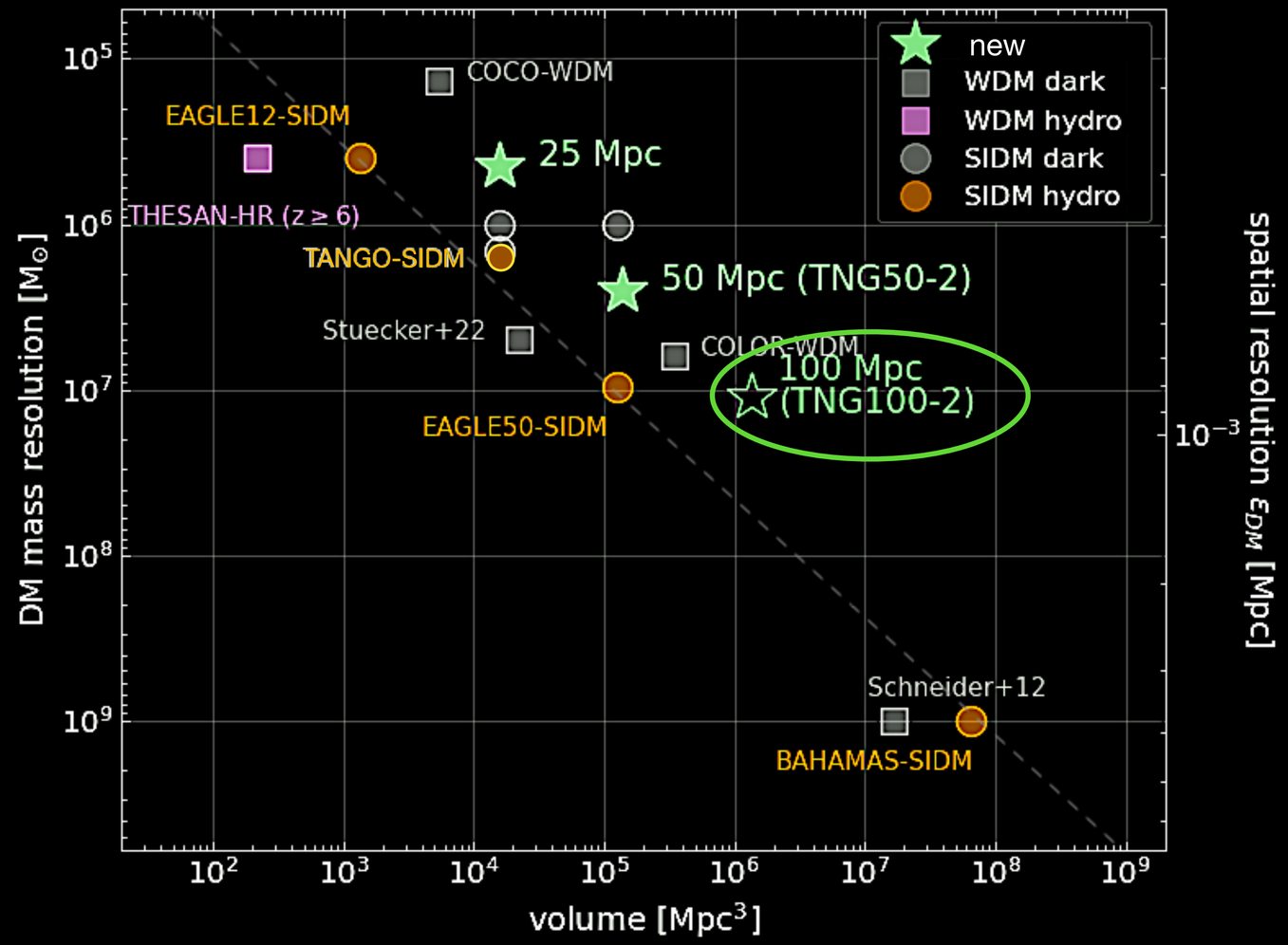
WDM, SIDM (constant, velocity-dependent & inelastic)

Despali et al. in prep: Annalisa Pillepich, Dylan Nelson, Volker Springel, Lauro Moscardini

NEW SIMULATIONS

WDM & SIDM

TNG model

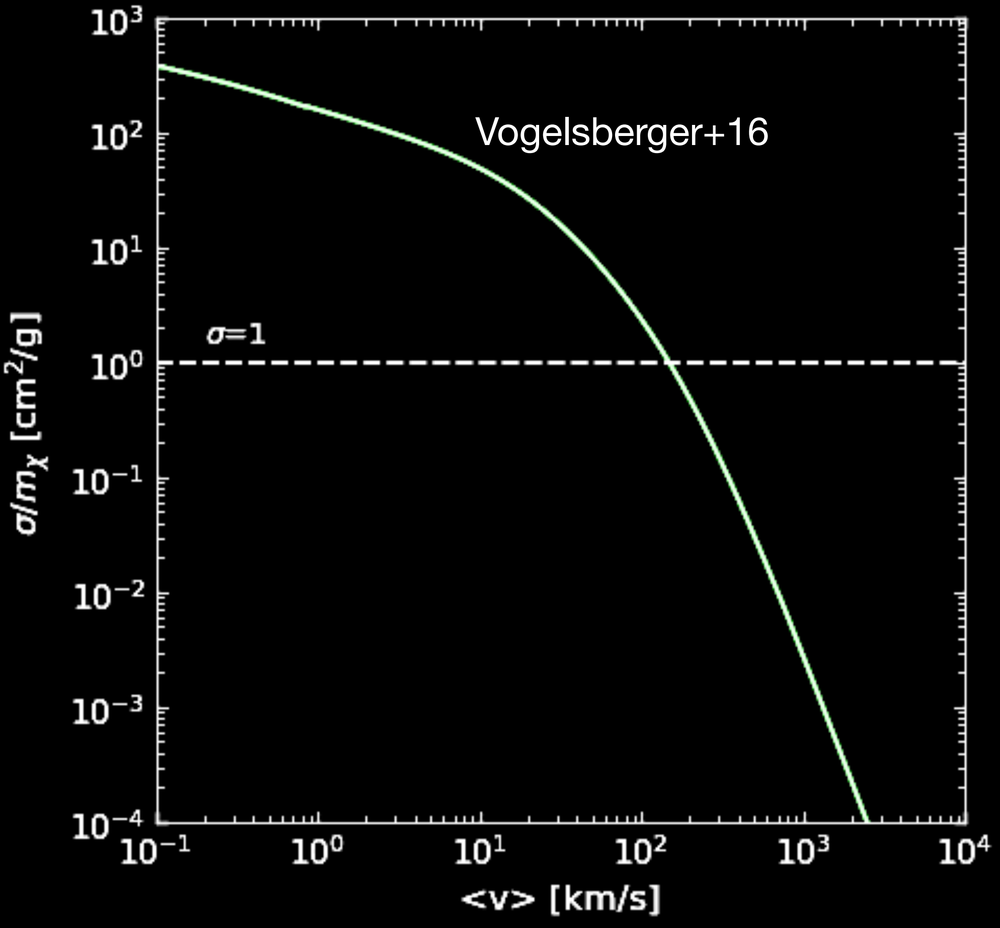


Despali et al. in prep: Annalisa Pillepich, Dylan Nelson, Volker Springel, Lauro Moscardini

NEW SIMULATIONS

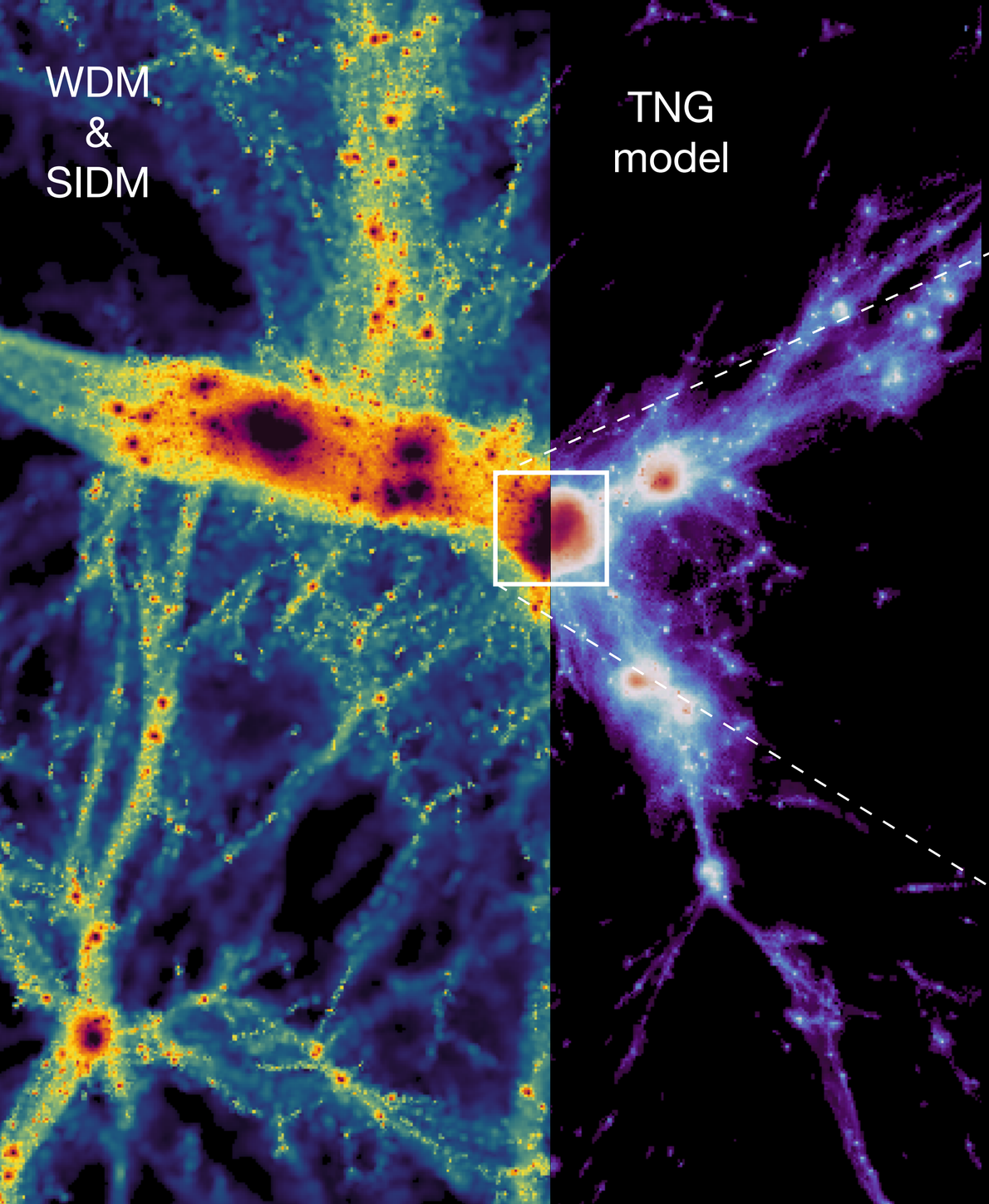
WDM
&
SIDM

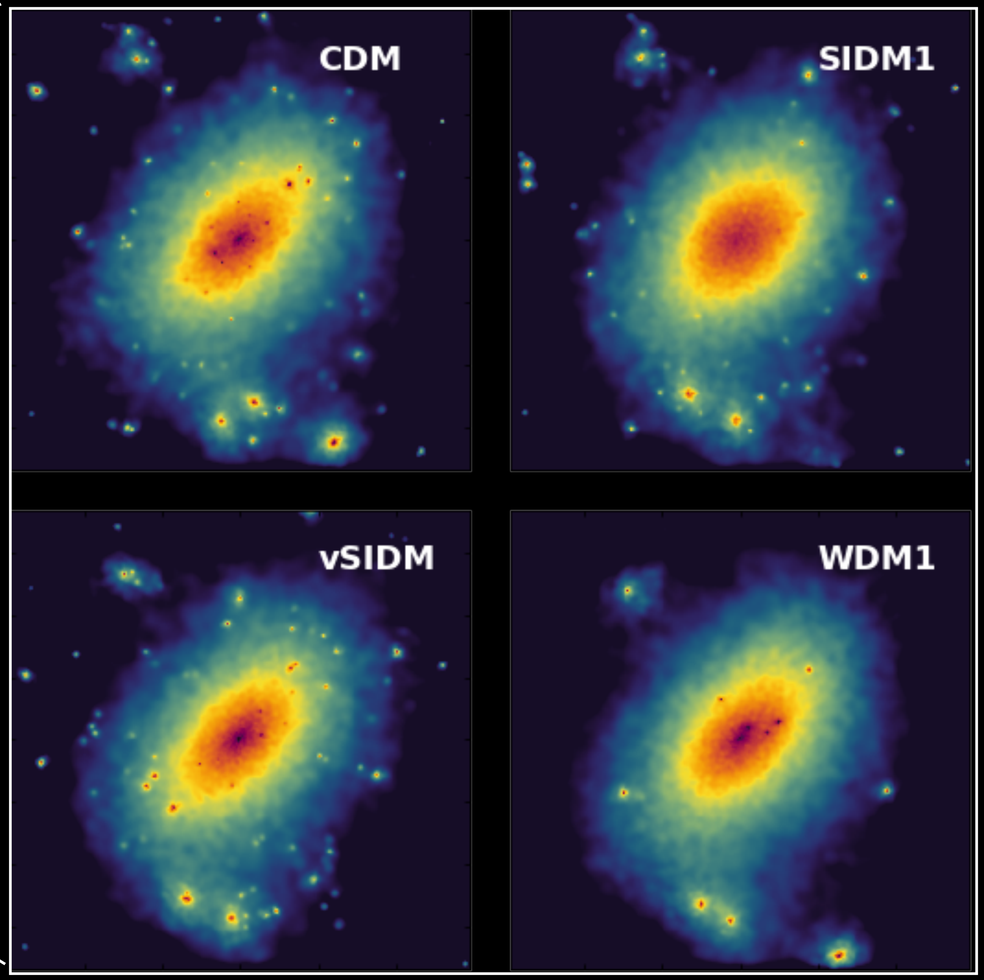
TNG
model



Despali et al. in prep: Annalisa Pillepich, Dylan Nelson, Volker Springel, Lauro Moscardini

NEW SIMULATIONS



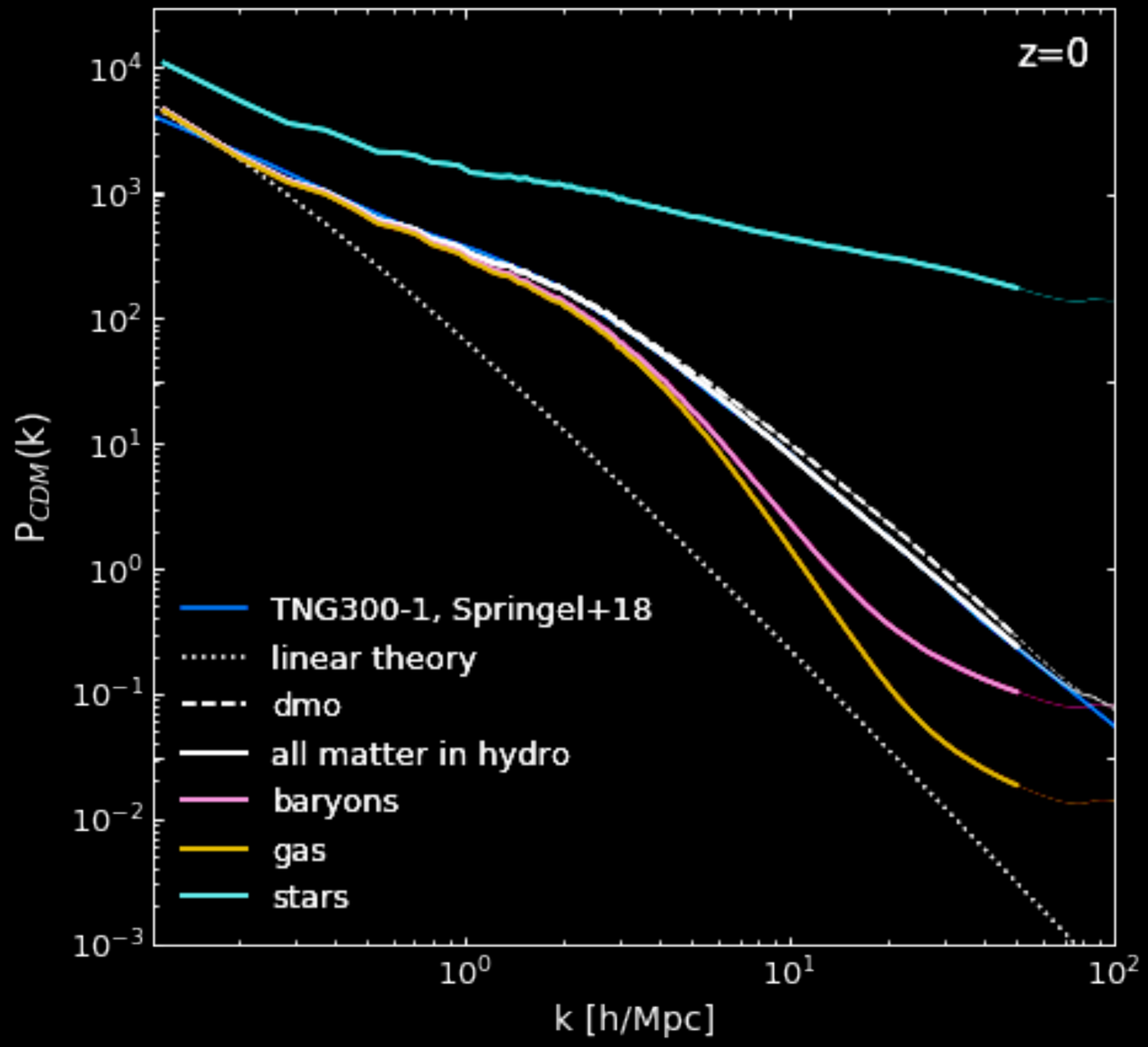


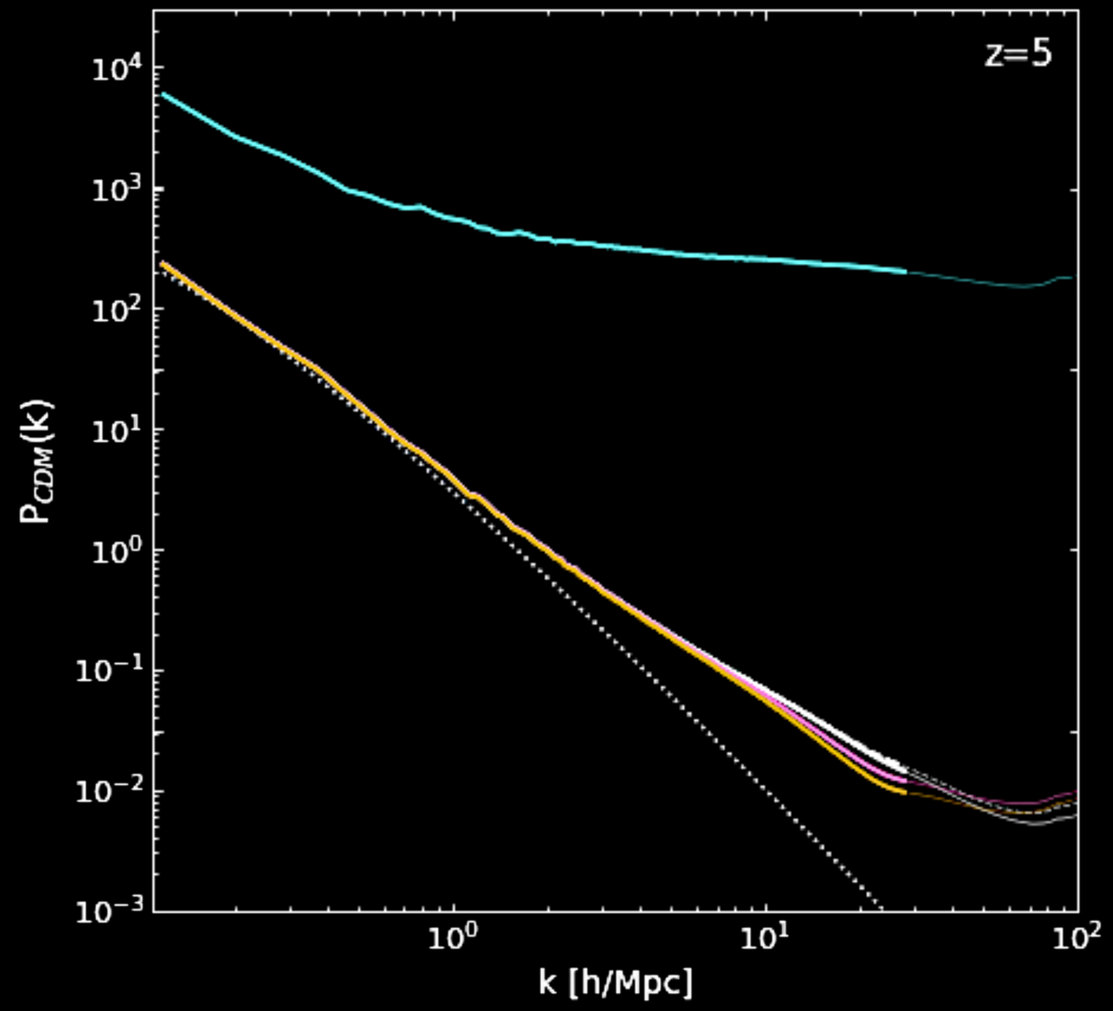
~10^8 M⊙, 2.8 kpc, 100 Mpc box

Despali et al. in prep

NEW SIMULATIONS

CDM





Despali et al. in prep

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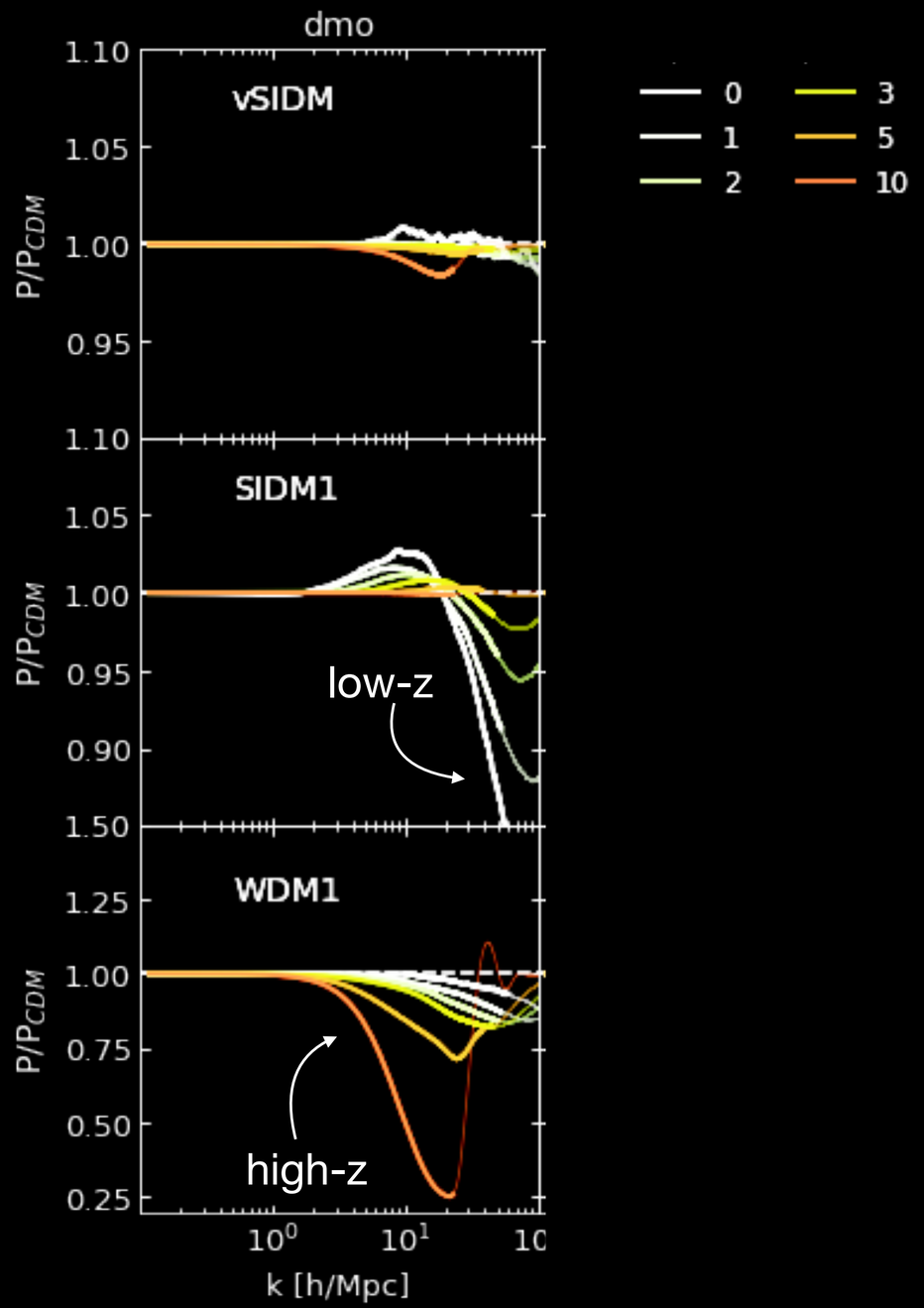
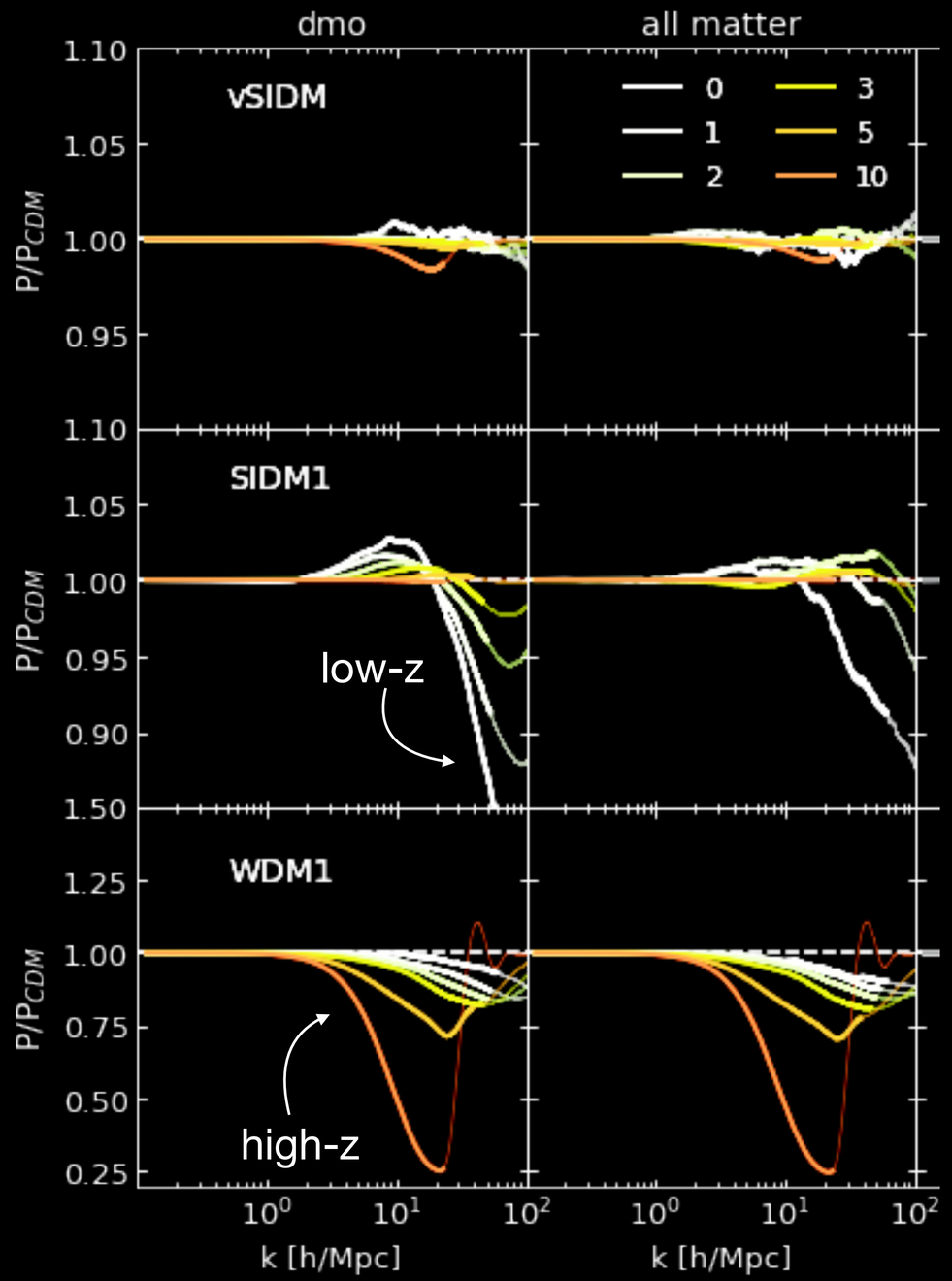
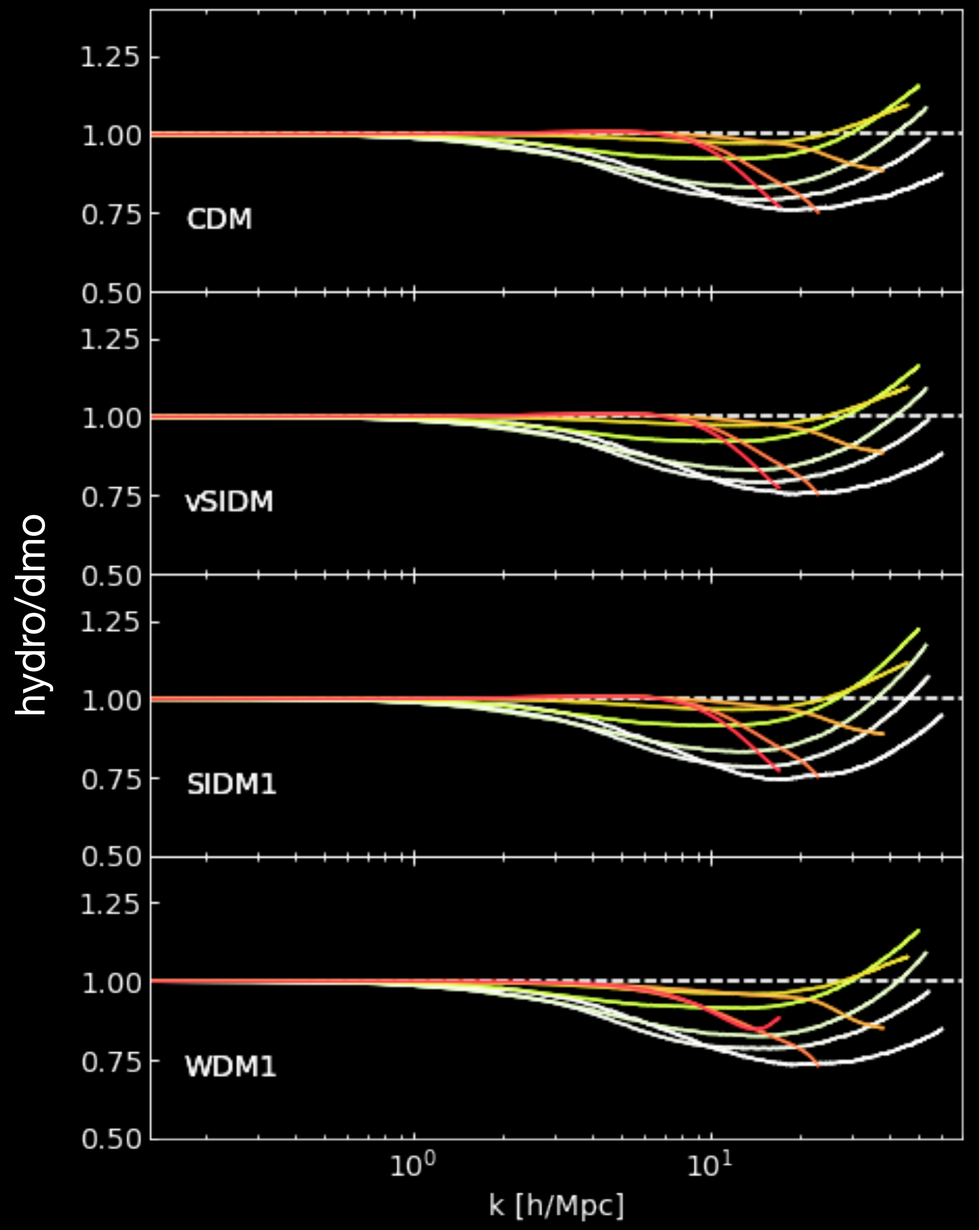


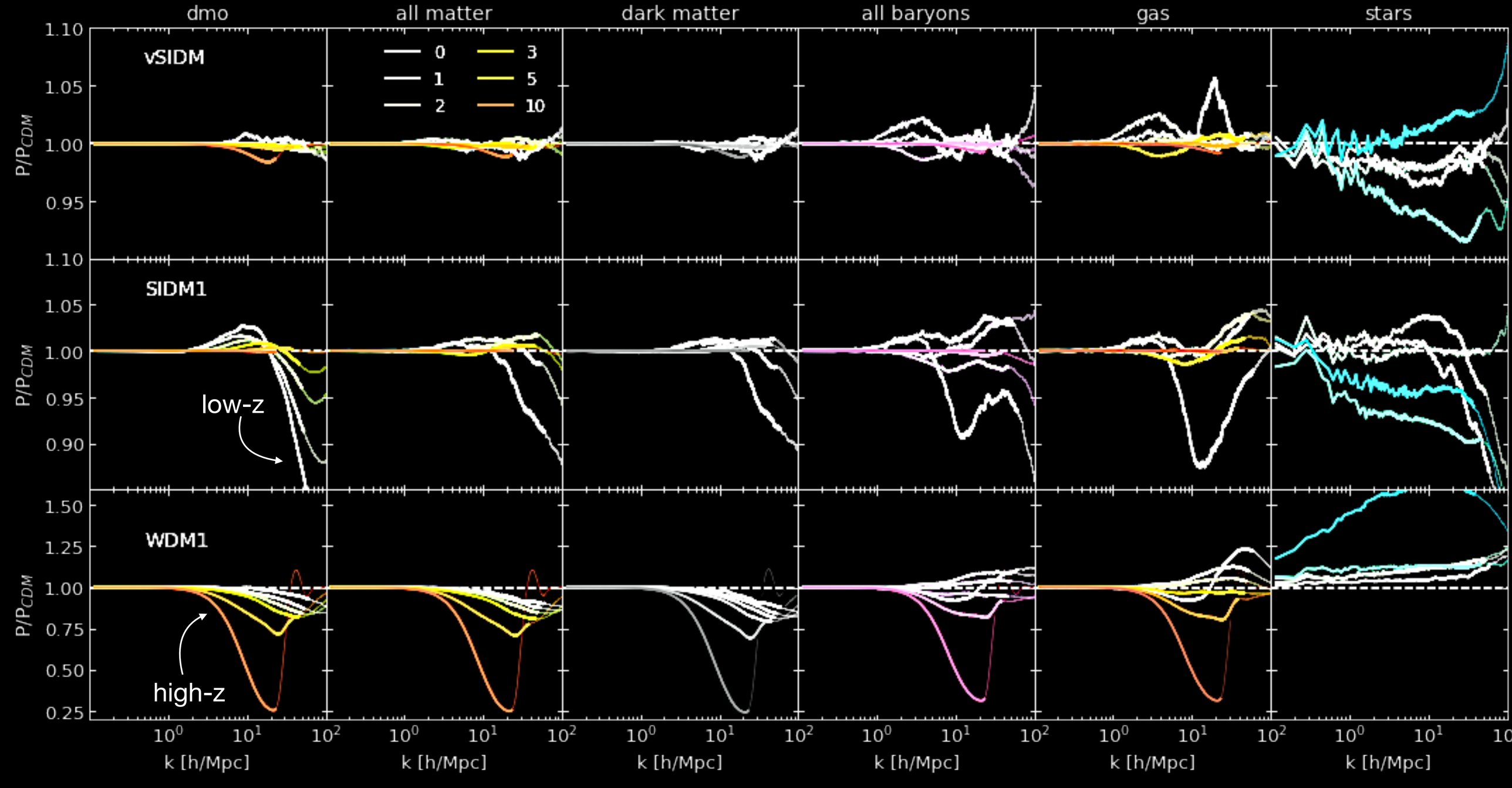
NEW SIMULATIONS





baryonic effect
very similar
in all models

NEW SIMULATIONS



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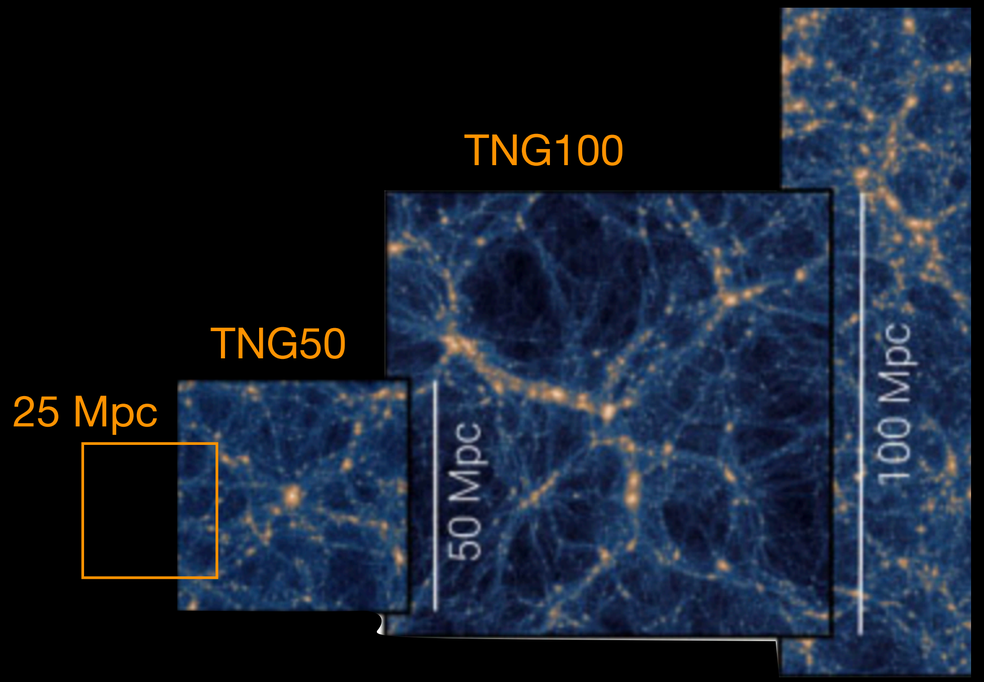

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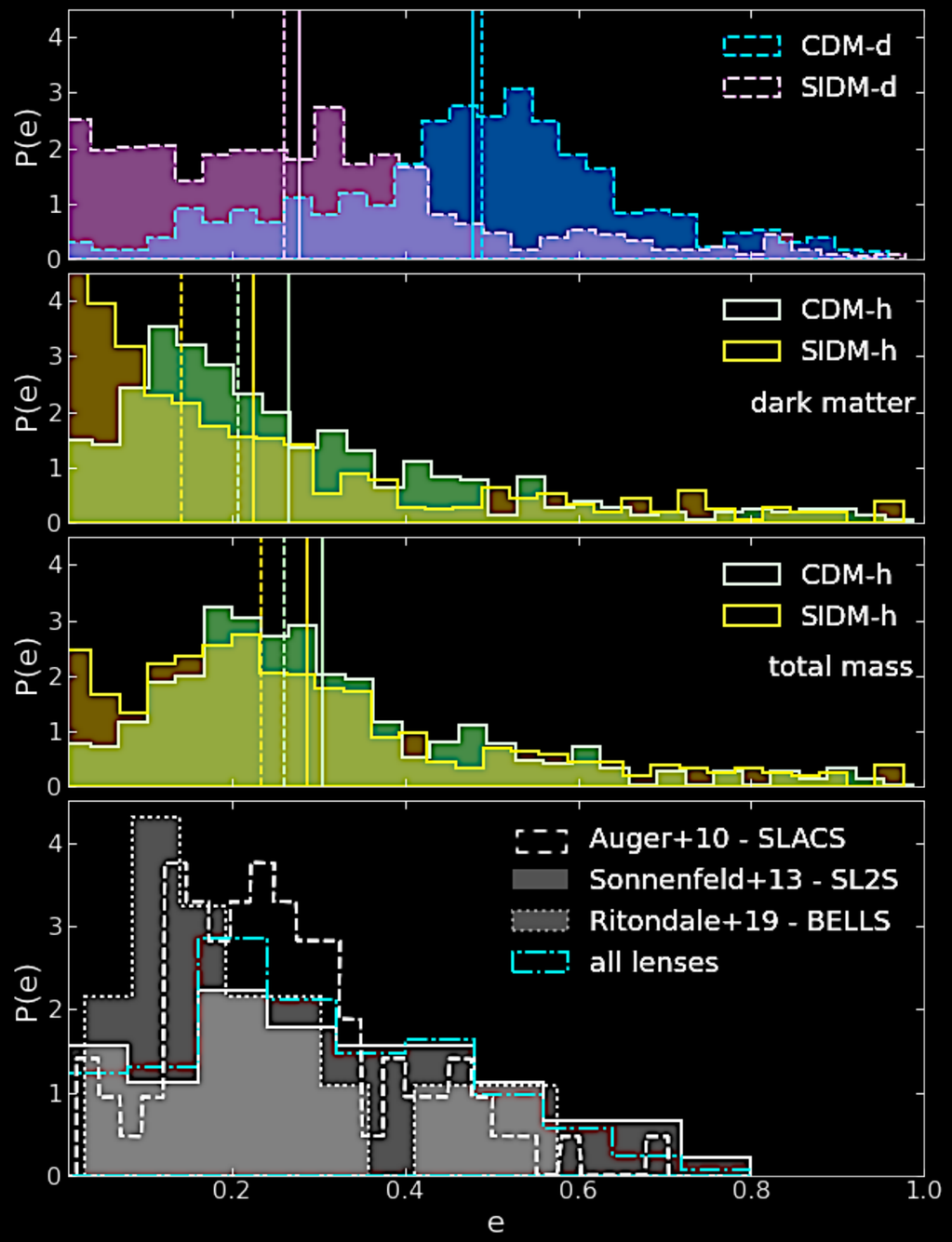
PROJECTED SHAPES VS LENSING



DM-only

DM in hydro runs

total mass in hydro runs

lensing observations

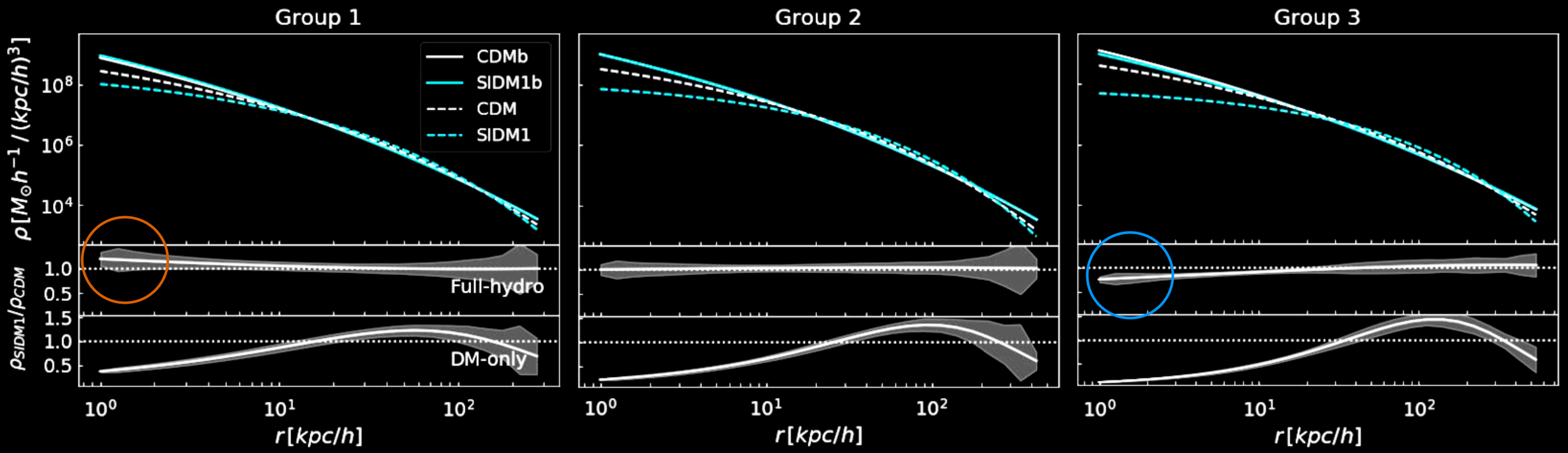
p-value

	CDM-d	SIDM-d	CDM-h	SIDM-h
SL2S	9.94e-09	0.23	0.17	0.11
BELLS	7.90e-07	0.25	0.12	0.51
SLACS	1.67e-15	2.81e-03	0.45	0.014
ALL	5.78e-25	9.00e-03	0.67	0.071

(Despali et al. 2022)

HALO PROFILES VS LENSING

log(M)~12-12.5 | log(M)~12.5-13 | log(M)~13-13.5



(Mastromarino, Despali et al. 2023)