Data release
Cosmic evolution of the incidence of Active Galactic Nuclei in massive clusters: Simulations versus observations

Iván Muñoz Rodríguez

October 26, 2022

Contents

1 Overview **2**

2 Dataset **2**

2.1 UM catalogue 2

2.1.1 id 3

2.1.2 upid 3

2.1.3 vmp 3

2.1.4 v 3

2.1.5 r 3

2.1.6 sfr 3

2.1.7 obs_sfr 3

2.1.8 lgmp 3

2.1.9 lgm 3

2.1.10 lgsm 3

2.1.11 lgobs_sm 3

2.2 Added to UM 3

2.2.1 lgLxGMedian, lgLxAMedian 3

2.2.2 dist_obs 4

2.2.3 x_rot, y_rot, z_obs_rot 4

2.2.4 vx_rot, vy_rot, vz_rot 4

2.2.5 final_redshift 4

2.2.6 angle_los 4

2.2.7 FOV 4

2.2.8 r_parent 4

2.2.9 id_obs 4

2.2.10 delta_redshift_lim 4

2.2.11 delta_redshift 4

2.2.12 lgssfr 4

2.2.13 lgssfr_q_remap 5

2.2.14 Schreiber 5

2.2.15 SF_Schreiber 5

2.2.16 [band]_qUM 5

2.2.17 [band]_SFRq_remap 5

2.2.18 reseed 5

2.2.19 id_clust_reseed 5

Table 1: Overview of the mock catalogue content.

	Name	units	Description
UniverseMachine	id	-	2.1.1
	upid	-	2.1.2
	vmp	km/s (physical)	2.1.3
	v	km/s (physical)	2.1.4
	r	kpc/h (comoving)	2.1.5
	sfr	$M_\odot$/yr	2.1.6
	obs_sfr	$M_\odot$/yr	2.1.7
	lgmp	$\log_{10}(M[M_\odot/h])$	2.1.8
	lgm	$\log_{10}(M[M_\odot/h])$	2.1.9
	lgsm	$\log_{10}(M[M_\odot])$	2.1.10
	lgob_sm	$\log_{10}(M[M_\odot])$	2.1.11
This paper	lgLxGMedian,lgLxAMedian	erg/s	2.2.1
	dist_obs	Mpc/h (comoving)	2.2.2
	x_rot, y_rot, z_obs	Mpc/h (comoving)	2.2.3
	vx_rot, vy_rot, vz_rot	km/s (physical peculiar)	2.2.4
	final_redshift	-	2.2.5
	angle_los	rad	2.2.6
	FOV	rad	2.2.7
	r_parent	kpc/h (physical)	2.2.8
	id_obs	-	2.1.1
	delta_redshift_lim	-	2.2.10
	delta_redshift	-	2.2.11
	lgssfr	$\log_{10}(\mathrm{ssfr}[\mathrm{yr}^{-1}])$	2.2.12
	lgssfr_q_remap	$\log_{10}(\mathrm{ssfr}[\mathrm{yr}^{-1}])$	2.2.13
	Schreiber	$\log_{10}(\mathrm{ssfr}[\mathrm{yr}^{-1}])$	2.2.14
	SF_Schreiber	-	2.2.15
	[band]_qUM	mag	2.2.16
	[band]_SFRq_remap	mag	2.2.17
	reseed	-	2.2.18
	id_clust_reseed	-	2.2.19

1 Overview

In Muñoz Rodriguez et al. 2022 we explore the role of the environment on AGN activation. We constructed AGN mock catalgues by populating dark matter haloes from simulation with galaxies using UniverseMachine (Behroozi et al., 2019). These galaxies where populated after with AGN using specific accretion rate distributions derived from observations (Georgakakis et al., 2017; Aird et al., 2018). The explicit assumption of this latter step is the independence of the environment on AGN triggering. This is because observations used to construct the specific accretion rate distributions are based of deep-beam observations that cover mainly low-dense (field) halo populations. We compare the predictions of the model with the latest observations of X-ray AGN fractions in clusters. In what follows we detail the content of the dataset of the paper, necessary data to reproduce the results.

2 Dataset

2.1 UM catalogue

The next features in the catalogue come from the model of UniverseMachine (Behroozi et al., 2019). Publicly available catalogues can be found in `https://www.peterbehroozi.com/data.html)`. In next subsections we provide a sum up of the features that we use from this model and a brief description

2.1.1 id

Unique halo identification number. This number different for each halo in the different simulated boxes in UM.

2.1.2 upid

-1 for central halos, otherwise, ID of largest parent halo. This has to main uses: first isolate central (parents) from satellites and construct the parent sample filtering by halo masses; second allows to study the "true" members of the clusters since satellites haloes have upid == to the unique identification number of the parent.

2.1.3 vmp

Maximum halo velocity at the time when peak mass was reached (physical km/s).

2.1.4 v

Maximum halo velocity (physical km/s).

2.1.5 r

Halo virial radius as defined in Bryan & Norman (1998) (comoving kpc/h)

2.1.6 sfr

True star formation rate ($M_\odot$/yr). This value does not account for systematic of the observations (see Behroozi et al., 2019).

2.1.7 obs_sfr

observed SFR, including random and systematic errors ($M_\odot$/yr). We used this value to calculate magnitudes associated to the galaxies following Georgakakis et al. (2020).

2.1.8 lgmp

$\log_{10}$ halo peak historical virial mass ($M_\odot/h$). Virial as defined in Bryan & Norman (1998)

2.1.9 lgm

$\log_{10}$ halo virial mass ($M_\odot/h$). Virial as defined in Bryan & Norman (1998)

2.1.10 lgsm

$\log_{10}$ true stellar mass ($M_\odot$)

2.1.11 lgobs_sm

$\log_{10}$ observed stellar mass, including random and systematic errors ($M_\odot$)

2.2 Added to UM

Muñoz Rodríguez et al. (2022)

2.2.1 lgLxGMedian, lgLxAMedian

X-ray luminosity (erg/s) using Georgakakis et al. (2017) and Aird et al. (2018) specific accretion rate distribution respectively. These values are estimated as $L_X = K \cdot \lambda \cdot M_\star$ where K is a constant, λ is drawn randomly from the specific accretion rate distribution and $M_\star$ correspond to lgobs_sm (see Sec. 2.1.11). See further ddetails in Muñoz Rodríguez et al. 2022.

2.2.2 dist_obs

Comoving distance to the observer in Mpc/h

2.2.3 x_rot, y_rot, z_obs_rot

Coordinates of the haloes after projecting into the sky-plane.

2.2.4 vx_rot, vy_rot, vz_rot

Velocities of the haloes after projecting into the sky-plane.

2.2.5 final_redshift

Redshift of the object. Account for peculiar velocities

2.2.6 angle_los

Angular separation relative to the centre of the cluster in radians. In combination with FOV (see Sec. 2.2.7) used to estimate cluster membership as described in Muñoz Rodriguez et al. 2022.

2.2.7 FOV

Angle subtended by the virial radius of the parent halo in radians. this is the angular distance that correspond to radius of the parent cluster (r_parent, see Sec 2.2.8) at the redshift of the cluster, i.e $z = 0.2, 0.75$ or 1.25. In combination with angle_los (see Sec. 2.2.6) used to estimate cluster membership as described in Muñoz Rodriguez et al. 2022.

2.2.8 r_parent

Size of the parent halo in **physical** units in kpc. Physical units are defined as comoving divided by 1+redshift, i.e (r/(1+redshift)), where r is described above (see Sec. 2.1.5) and redshift (z) correspond to the redshift of the cluster, i.e $z = 0.2, 0.75$ or 1.25. r_parent is used to calculate FOV (see Sec. 2.2.7)

2.2.9 id_obs

Unique identification number of the halo (see Sec. 2.1.1) that corresponds to the cluster being simulated.

2.2.10 delta_redshift_lim

For a particular cluster maximum delta_redshift (see Sec. 2.2.11) allowed for members. These limits are calculated as 3 times the velocity dispersion of the parent halo times 1+redshift . For low and intermediate redshifts velocity dispersion for the mass of the cluster is calculated using Munari et al. (2013), for the highest redshift this velocity dispersion is fixed to 2 000 km/s. Used to estimate cluster membership as described in Muñoz Rodriguez et al. 2022.

2.2.11 delta_redshift

difference between the redshift of the object (final_redshift, see Sec.2.2.5) and the systemic redshift of the cluster (fixed to be $z_{\mathrm{cluster}} = 0.2, 0.75$ or 1.25 depending of the redshift of the box), i.e. final_redshift$-z_{\mathrm{cluster}}$. Used to estimate cluster membership as described in Muñoz Rodriguez et al. 2022.

2.2.12 lgssfr

$\log_{10}$ of the specific star formation rate of the object, estimated as $\log_{10}$(obs_sfr/obs_sm), where obs_sfr and obs_sm are listed above (see Sec.2.1.7 and Sec. 2.1.11). This is used to determine magnitudes of **star-forming** galaxies

2.2.13 lgssfr_q_remap

re-mapped values for the specific star formation rate using Schreiber et al. (2015) main sequence. This is used to determine magnitudes of **passive** galaxies

2.2.14 Schreiber

Specific star formation rate from the main sequence described in Schreiber et al. (2015). For star-forming galaxies, values are drawn from the main sequence plus a random scatter of 0.2. For quiescent galaxies this value is shifted a quantity that has been fixed empiricaly to reproduce observations. See more details in Georgakakis et al. (2020).

2.2.15 SF_Schreiber

Boolean that indicates if a galaxy is consider star-forming (True) or quench (False) relative to the main sequence of Schreiber et al. (2015).

2.2.16 [band]_qUM

Magnitude associated to the band, using lgssfr values from UM for both star-forming and quench (see Sec. 2.2.12). [band] corresponds to IRAC1 at redshift of 1.25 and R_PRIME for redshift 0.2 and 0.75

2.2.17 [band]_SFRq_remap

Magnitude associated to the band, using SFR re-mapped both SF and quench calculated as described in Georgakakis et al. (2020) (see also Sec. 2.2.14). [band] corresponds to IRAC1 at redshift of 1.25 and R_PRIME for redshift 0.2 and 0.75.

2.2.18 reseed

Number of the re-seeding, used for internal calculation. This indicates the different realizations AGN seeding for the same cluster.

2.2.19 id_clust_reseed

Unique identifier of the parent cluster and reseeding (see descriptions above). Flag for internal calculation

References

Aird J., Coil A. L., Georgakakis A., 2018, , 474, 1225

Behroozi P., Wechsler R. H., Hearin A. P., Conroy C., 2019, , 488, 3143

Bryan G. L., Norman M. L., 1998, , 495, 80

Georgakakis A., Aird J., Schulze A., Dwelly T., Salvato M., Nandra K., Merloni A., Schneider D. P., 2017, , 471, 1976

Georgakakis A., Ruiz A., LaMassa S. M., 2020, , 499, 710

Munari E., Biviano A., Borgani S., Murante G., Fabjan D., 2013, , 430, 2638

Schreiber C., et al., 2015, , 575, A74