Differential evolution of AGN in clusters

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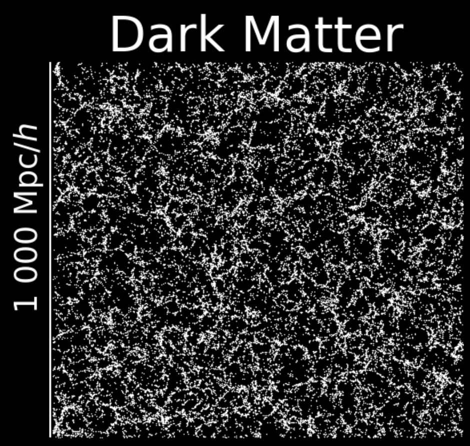
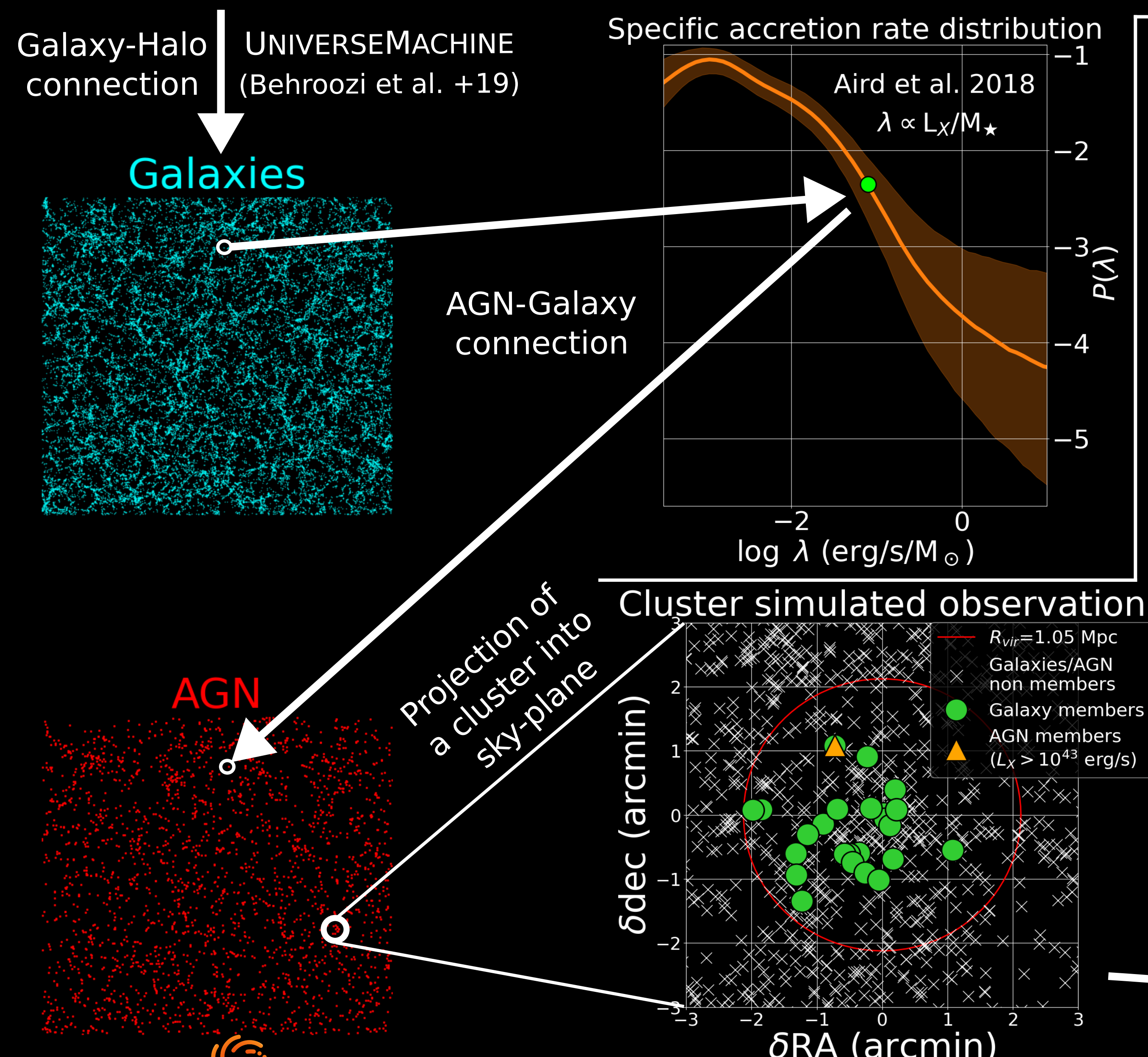
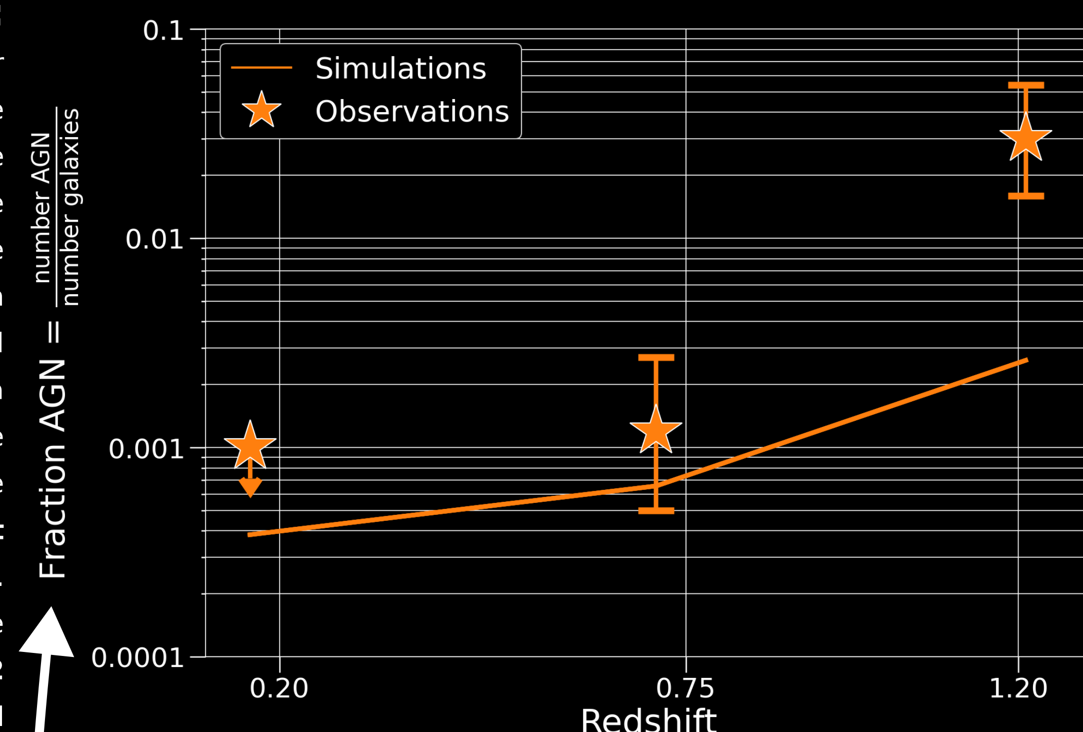


Motivation and semi-empirical model construction: The **role of different AGN triggering mechanisms remains as one of the open questions in Astrophysics**. We studied the **influence of small-scale environment (<1 Mpc)** into the AGN triggering mechanism. We developed a novel semi-empirical model (SEM) to construct AGN mock catalogues based on state-of-the-art observations. A graphical workflow of this model is shown in the figure on the left. The starting point are dark matter N-body simulations (MDP2, Klypin et al. 2016), that are populated with galaxies using abundance matching techniques (UNIVERSEMACHINE, Behroozi et al. 2019). Then **AGN are painted on this galaxies constrained by the latest observations of AGN populations. The latter step is done under the explicit assumption that accretion events are independent of the environment** (i.e halo mass). The figure shows a 10 Mpc/h slice of a box from MDP2 cosmological simulation with 1000 Mpc/h side size at the snapshot z=0.75. The dots represent the positions of dark matter haloes (top panel), galaxies within these dark matter haloes (middle panel) and AGN within the same dark matter haloes (bottom panel). The key feature of this approach is the reproduction by construction of the predictions and observables (e.g. HMF, SMF and XLF). The **key parameter to populate galaxies with AGNs is the specific accretion rate** defined as $\lambda=L_X/M_\star$. It is related with two observables that have been well characterized in the last years thanks to multi-wavelength observations in extragalactic survey fields. This has allowed to infer its probability distribution $P(\lambda)$. It describes the probability of a galaxy with mass $M_\star$ of hosting an AGN with luminosity L_X. For each galaxy in the catalog we randomly pick a λ from the distribution. This effectively associate an AGN X-ray luminosity to all galaxies.



Comparisson with observations:

We calculate the fraction of X-ray AGN in a cluster parent sample defined as in observations. We compare the results of the models with the observations of Matini et al. (2009, 2013). We select galaxies and AGN in the cluster sample following selection effects as defined in observations. Only galaxies/AGN within the virial radius, brighter than a magnitud limit and within a velocity dispersion are consider a members. The impact of selection effects is illustrated in the figure on the left. The **number of AGN represent the field expectation by model construction**. Results are shown in the figure on the right. The **model u**nderpredicts the number of AGN at **z~1.2 respect the observations**. At z~0.75 model prediction is consistent with observations. Finally, **at low redshift, z~0.2, the model seems to overproduce AGN respect cluster observations**, although firm conclusions cannot be made since observations only place a lower limit.



AGN incidence and physical interpretation: Field expectation cannot reproduce the observations. **We find a differential evolution of the incidence of AGN in clusters respect to field**. AGN activity is enhanced at high redshift and suppressed at low redshift in massive clusters respect to field. This point to a **different efficiency of AGN triggering mechanisms depending on their small-scale environment (<1 Mpc) that evolves with cosmic time.** This could be explained by the different physical processes happening in clusters respect low dense environments such as ram-pressure or galaxy interactions. This effects are expected to be stronger in the outskirts of the cluster.

References: Aird et al. (2018); Behroozi et al. (2019); Georgakakis et al. (2017, 2019); Klypin et al. (2016); Martini et al. (2009, 2013); Peluso et al. (2022)

BiD4BEST — Big Data applications for Black hole Evolution Studies

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