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The Three Hundred Project: contrasting clusters galaxy density in hydrodynamical and dark matter simulations

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Galaxy cluster detection algorithms for IR and optical surveys are usually tested and optimize using semi-analytical large-scale-structure simulations. However, the impact of baryonic physics in the abundance and structure of dark matter sub-haloes might be important and so lead to significant bias on the performance of those algorithms. Thus, it is important to carefully understand the differences between hydro-dynamical and dark-matter-only (DM-only) simulations. For this purpose, we use the Three Hundred Project sample of 324 galaxy clusters, which correspond to zoom regions re-simulated with full physics and for DM-only. We investigate the substructures of galaxy clusters for three type of simulations: low resolution and high resolution DM-only simulations, and low resolution hydro-dynamical simulations. We find that for equivalent resolution, the hydro-dynamical simulation present more substructures, specially at low mass, in compare with the dark-matter-only simulations, which underestimates the galaxy abundance. When increasing the DM-only resolution, this lack of galaxies is compensated. Nevertheless, when accounting for resolution effects we osbserve that hydro-dynamical simulations predict larger galaxy density towards the cluster core. A potential cause for this effect is the cooling effect of gas, which would make the stellar and gas cores more resistant to be stripped out and to tidal disruptions.

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