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The Three Hundred Project: Clusters Galaxy Density from high resolution dark matter only simulations with realistic SAMs and its application to the Euclid Survey

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Cluster number counts at visible and IR wavelengths will be a key cosmological probe in the next decade thanks to the Euclid satellite mission. For this purpose, the performance of cluster detection algorithms, which at these wavelengths are sensitive to the spatial distributions of the cluster galaxy members and their luminosity functions, need to be accurately characterized. Using The Three Hundred hydrodynamical and dark-matter-only simulations, we studied a complete sample of massive clusters beyond 7 (5) $\times$ 10^{14} $M_{\odot}$ at redshift 0 (1) on a $(1.48\ \mathrm{Gpc})^3$ volume. We find that the mass resolution of the current hydrodynamical simulations (1.5×10^9 $M_{\odot}$) is not enough to characterize the luminosity function of the sample in the perspective of Euclid data. Nevertheless, these simulations are still useful to characterize the spatial distribution of the cluster substructures assuming a common relative mass threshold for the different flavours and resolutions. By comparing with the dark-matter-only version of these simulations, we demonstrate that baryonic physics preserves significantly low-mass subhalos (galaxies), as has also been observed in previous studies with less statistics. Furthermore, by comparing the hydro simulations with higher resolution dark-matter-only simulations of the same objects and taking the same limit in subhalo mass, we find galaxy density profiles that are significantly more cuspy towards the centre of the clusters, where the low-mass substructures tend to concentrate. We conclude that using a dark-matter-only simulation may lead to some biases on the spatial distribution and density of galaxy cluster members.
Based on the preliminary analysis of few high-resolution hydro simulations we conclude that a mass resolution of 1.8×10^8 h^{-1} $M_{\odot}$ will be needed for The Three Hundred simulations to approach the expected magnitude limits for the Euclid survey. These simulations are currently under way.

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