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Cosmological simulations to investigate the concentration of halos in universes with and without baryons

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Dark matter halos are equilibrium structures that are gravitationally bound, where the average density of dark matter is 200 times the critical density of the Universe. These structures enabled the formation of galaxies and clusters, which are the brightest objects found in the Cosmos. In this work, we investigate how the presence of baryons affects the concentration parameter of halos, where this parameter is defined in terms of the characteristic radius of the Navarro-Frank-White radial density profile and the virial radius of the dark matter halo. Therefore, we used the code GADGET-2 to perform two cosmological simulations, the first without the presence of baryons and the second with baryons. The main features of the represented Universe were the same, so we kept a volume $(10\ \mathrm{Mpc})^3$ and 256^3 dark matter particles for both cases and 256^3 gas particles for hydrodynamic simulation. From this simulation, the halos were found, at the instant $z = 0$, using the ROCKSTAR code. As a result, we found that the concentration parameter in the simulation without baryons was 18% lower on average, compared to the hydrodynamic simulation. Finally, in the model without baryons, the concentration of dark matter halos was relatively lower, moreover, there was a strong correlation between the concentration curve of our model and the theoretical results for high-mass halos.

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