# The Mochima simulations: testing the effects of baryonic physics on one zoom-in spiral galaxy.

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**Abstract**

The interplay of star formation and supernova (SN) feedback in galaxy formation is a key element for understanding galaxy evolution. Since these processes occur at small scales, it is necessary to have sub-grid models that recover their evolution and environmental effects at the scales reached by cosmological simulations. We simulate the same spiral galaxy inhabiting a Milky Way (MW) size halo in a cosmological environment changing the sub-grid models for SN feedback and star formation. We test combinations of the Schmidt law and a multi-freefall based star formation with delayed cooling feedback or mechanical feedback. We reach a resolution of 35 pc in a zoom-in box of 36 Mpc. On the baryonic side, we compare the galaxies at redshift 0 with global and interstellar medium observations in the MW and local spiral galaxies. The simulations show successful comparisons with observations. Nevertheless, diverse galactic morphologies are obtained from different numerical implementations. We also look at the dark matter distributions focusing on the halo morphology, geometry and profiles, as well as the phase space distribution. We found that the modifications of the gravitational potential due to the presence of baryons induce different dark matter distributions modifying the mass density profile and the velocity distribution. The uncertainties on those features impact directly the dark matter direct and indirect detection rates. As a consequence, predictions using cosmological simulations have to be taken with caution as the dark matter distribution changes with baryonic physics. We highlight the importance of detailed modelling of the star formation and feedback processes, especially when increasing the resolution of simulations. Future improvements could alleviate the degeneracies exhibited in our simulated galaxies under different sub-grid models.

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