

Exploring the physics of galaxy formation with supercomputers

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The Universe features a rather strange composition, with unknown components in the form of dark matter and dark energy dominating today's energy density. Numerical simulations have already played a pivotal role in demonstrating that this unexpected cosmological model forms a viable theory for cosmic structure formation. Nowadays, they have also become our most important theoretical tool to study the dynamics in the baryonic sector, allowing us to comprehend how hydrogen and helium gases condense out in galaxies, form stars, and populate the predicted dark matter structures. However, we still struggle to understand the regulation of galaxy formation, which appears rather inefficient on a global scale, defying simple theoretical expectations. In this talk, I will review some of the current results of hydrodynamical simulations of galaxy formation and discuss how they help us to identify and constrain the physics shaping galaxies and clusters of galaxies. I will also discuss the promises and perils of using simulations as astrophysical discovery tools.