

Supercomputer Simulations of the Emergence of Cosmic Structure

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Numerical simulations have played a pivotal role in helping to establish the cold dark matter model as the leading cosmological theory, despite its content of unknown dark matter and dark energy. I review what we have learned from high performance computing about the internal structure and formation history of the non-linear dark matter halos that form the backbone of cosmic large-scale structure. I will discuss modern simulations that try to light up dark matter halos with luminous stars and accreting quasars, focusing in particular on the influence of supermassive black holes on galaxies and large clusters of galaxies. Finally, I discuss new results from ultra-large cosmological calculations that aim to help in the quest to observationally constrain the mysterious dark energy.