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Investigating the Redshift Evolution of Dynamical States and Mass–Dispersion Relations in Galaxy Clusters from the TNG300 and TNG-Cluster Simulations

Galaxy clusters are the most massive gravitationally bound systems and represent the most recently formed structures in the Universe under the hierarchical formation model. In this work, we reconstruct the dynamical mass profiles of galaxy clusters from the TNG300 and TNG-Cluster simulations by numerically solving the Jeans equation based on the kinematics of member galaxies. By comparing our results with the simulations' true mass profiles, we assess the dynamical states of the simulated galaxy clusters and track their evolution with redshift. We explore the mass–velocity dispersion relation at various redshifts, which also serves as a practical tool for estimating galaxy cluster masses from observed galaxy velocity dispersions. Our results yield simulation-based calculations for the redshift evolution of the dynamical states and scaling relations of galaxy clusters, which can then be cross-checked against observational cluster masses to validate the hierarchical structure formation model.

Section

Galaxy/Extragalactic

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