Phase–Space Dynamics of an Inhomogeneous Cosmology with Non–Minimal Coupling

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Abstract

We investigate the dynamical stability of an inhomogeneous cosmological model in which a scalar field is non–minimally coupled to the Ricci curvature. The framework is based on a Lemaître–Tolman–Bondi (LTB) geometry and extends the standard scalar field cosmological picture by allowing the coupling between the scalar field and Ricci curvature to evolve dynamically. The resulting modified Einstein field equations lead to changes in the effective matter–scalar interaction, acceleration, and energy density.

We formulate the resulting cosmological equations as an autonomous dynamical system and use phase–space methods to identify and classify its critical points. In particular, we investigate the stability of the cosmological regimes associated with different values of the curvature–scalar coupling and determine whether the system admits a stable asymptotic state. The analysis provides a dynamical perspective on the evolution of the model and establishes whether the cosmological behaviour obtained from the background equations corresponds to unstable configurations, attractors, or saddle points. These results form a first step toward determining the viability and late–time behaviour of the proposed inhomogeneous cosmological framework.