A Dynamical Systems Approach to Higher-Dimensional Einstein-Gauss-Bonnet Cosmology

Abstract

Einstein-Gauss-Bonnet (EGB) gravity extends General Relativity through higher-curvature corrections in dimensions greater than four. We investigate its cosmological dynamics using a dynamical-systems formulation of the Friedmann and Raychaudhuri equations.

For a dust-filled FLRW spacetime with vanishing cosmological constant, the field equations are recast as an autonomous system of dimensionless variables. The Friedmann constraint restricts the physical phase space to the negative-curvature sector, $k < 0$. We analyse the finite equilibrium points and their stability for different spacetime dimensions.

A distinct behaviour emerges between $N = 5$ and $N > 5$. While the five-dimensional case admits only the General Relativity limit, an additional equilibrium exists within the physical phase space for $N > 5$. Although this equilibrium is non-hyperbolic, a nonlinear analysis using a conserved first integral establishes it as a genuine nonlinear centre. These results demonstrate a dimension-dependent structure in higher-dimensional EGB cosmological dynamics.