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Anisotropic model in scale-dependent gravity

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The cosmological dynamics of a scalar-dependent gravitational model, whereby both the Newtonian coupling constant (G) and the cosmological constant (Λ) vary as functions of cosmic time, were examined within the framework of a spatially homogeneous anisotropic Bianchi type-I cosmological model. The dimensionless variables, including the normalized Hubble parameter $h = H/H_0$, energy mass, and dark energy density Ω_m and Ω_Λ , facilitated the transformation of the modified gravitational field equations into a closed system of five first-order, coupled differential equations in redshift space, with $g = G/G_0$ and $Z = dg/dz$ were numerically integrated using a fourth-order Runge-Kutta method, employing initial conditions that were consistent with Planck data. The model's predicted values for the deceleration parameter $q(z)$, the effective equation of state $w_{\text{eff}}(z)$, the statefinder parameters $r(z)$ and $s(z)$, and the $Om(z)$ diagnostic were juxtaposed with those derived from the concordance Λ CDM model. The study indicates that, within this scenario, the universe has transitioned from a decelerating phase in the past to an accelerating phase currently, with w_{eff} approaching -1 at low redshifts. The statefinder and Om diagnostics confirm that the scalar-dependent gravity model closely approximates Λ CDM in late epochs, permitting slight deviations that indicate fluctuations in G and Λ . The findings suggest that scale-dependent gravitational couplings in anisotropic backgrounds may provide a coherent and convincing alternative explanation for the late-time acceleration of the universe.

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