

Exponential Quintessence Model: Analytical Quantification of the Fine-Tuning Problem in dark energy

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We explain the data of the DESI galaxy survey by using theoretical models of time-varying dark energy. Among such models, a quintessence field with the exponential potential is an attractive candidate for inducing time-varying dark energy. We analytically derive constraints on initial conditions that allow the kination epoch in the early Universe without conflicting with big bang nucleosynthesis. Compared to the severe 120-digit fine-tuning required for dark energy to be a cosmological constant, our result shows that the degree of fine-tuning is naturally relaxed by dozens of orders of magnitude. Furthermore, we discuss the method for testing this model through future observations of the gravitational wave background.

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