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Quantum Gravity Meets DESI: Dynamical Dark Energy in Light of Swampland Trans-Planckian Censorship Conjecture

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The question "How do we use quantum gravity to understand modern cosmology?" is on the same footing as "How do we use quantum gravity to understand the Standard Model?" The Swampland conjectures distill our lessons about quantum gravity from string theory, the holographic principle, and black-hole physics, imposing powerful constraints on and continually deepen our understanding of low-energy physics over the past twenty years. In this talk, I will explain how the latest DESI observations of dynamical dark energy align with the predictions of the Trans-Planckian Censorship Conjecture (TCC), and show how one can use Swampland TCC criteria to constrain dynamical dark energy parametrizations (CPL, BA, JBP, EXP, LOG) and theoretical realizations in modified gravity (f(T), f(Q) gravities), which prohibits eternal cosmological acceleration and aligns naturally with the quintom-B behavior from the latest DESI DR2 data. Our findings imply that viable dynamical dark energy scenarios would asymptotically transit to deceleration, shedding light on new physics consistent with both cosmological observations and fundamental Quantum Gravity principles. This talk is based on arXiv:2504.07791.

Primary author: Mr WANG, Junkai (Tsinghua University)

Presenter: Mr WANG, Junkai (Tsinghua University)

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