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Unitary NEC Violation in P(X) cosmologies

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In the conventional Big Bang picture, our current (perturbative) theories of gravity are not powerful enough to reliably capture the earliest moments of our Universe –they break down due to the large curvatures and high energies. An alternative early Universe scenario is a 'non-singular bounce', in which an initially contracting phase bounces into an expanding Universe like the one we live in today. The bounce can take place at sub-Planckian energy scales, allowing us to apply all of our perturbative field theory techniques. However, attempts to realise such bouncing behaviour in General Relativity have encountered problems: in order for the matter sector to drive a bounce, it must violate the Null Energy Condition - which generically leads to unstable modes which quickly grow out of control. This talk reviews the recent progress in taming these instabilities in P(X) scalar field theories, and shows how higher derivative modifications to the theory in the UV can preserve stability and unitarity throughout the bounce. Significantly, the resulting theory is capable of describing an early Universe bounce entirely within a perturbative regime, is free from classical instabilities, and obeys tree-level unitarity constraints.

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