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Higher Derivative Theories: Ghosts and renormalizability

In quantum field theories, the addition of higher-derivative terms to the free Lagrangian density greatly improves its renormalizability. In fact, an extension of the Einstein-Hilbert action with such terms could be renormalized, potentially yielding a quantum field theory of gravity applicable at all energy scales. The drawback is the appearance of ghosts, pathological degrees of freedom that need to be “cured”.

In this talk we employ the Pais-Uhlenbeck oscillator as a toy model to study these issues. The system is a higher-derivative scalar field that provides a simple framework for capturing the relevant features of higher-derivative theories. Such subtleties may be obscured in more complex theories such as quadratic gravity. We explain the different ways in which the ghost Fock space can be quantized. We show how each quantization prescription affects renormalizability, as well as derive the renormalization group flow of a generic non-derivative interaction potential.

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