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Particle Physics Challenges

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High Multiplicity Amplitudes and Anharmonic Oscillators

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Calculations of multiparticle scattering amplitudes in scalar field theories at high multiplicities exhibit an extremely rapid growth with increasing number of final state particles. This either indicates an end of perturbative behaviour, or possibly even a breakdown of the theory itself. With the discovery of a scalar Higgs boson this has also turned into a problem of the Standard Model.

To shed some light on this question we consider the quantum mechanical analogue of the scattering amplitude for multiparticle production in scalar quantum field theory, which corresponds to transitions in the anharmonic oscillator. For potentials both with and without degenerate vacua we show that the amplitude can be written as an exponential. This allows us to study its behaviour at large excitation number where tree-level perturbation theory violates unitarity constraints. We finally discuss possible generalisations to a broader class of quantum mechanical potentials governed by non-perturbative effects.

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