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Understanding Semiclassical Backreaction in Quantum Mechanics

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The backreaction of quantum degrees of freedom on classical backgrounds is a poorly understood topic in theoretical physics. Understanding how to properly deal with the phenomenon of backreaction is an important problem that can have severe implications. For example, in gravitational physics we often only have a classical description of the background, and it has been argued that backreaction of quantum fields can lead to the halting of Hawking radiation. There are several popular methods to deal with backreaction in quantum field theories. Most often it is treated within the semiclassical approximation with the help of various ad hoc prescriptions accounting for the effect of quantum excitations on the dynamics of the background. It is important to assess when each method offers a good approximation to the full QFT picture, which I will do explicitly in this talk for a QFT in 0 dimensions (a.k.a. quantum mechanics). I will focus on two popular methods: (i) the mean-field approximation whereby quantum degrees of freedom couple to the classical background via their quantum expectation values; (ii) the (stochastic) Truncated Wigner method whereby the fully coupled system is evolved using classical equations of motion for various randomly sampled initial conditions of the quantum degree of freedom, and a statistical average is performed a posteriori. I evaluate the performance of each method in a simple toy model against a fully quantum mechanical treatment, and identify its regime of validity. I will interpret the results in terms of quantum entanglement and loss of classicality of the background.

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