

From quantum to classical mechanics

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Revealing the connection between quantum and classical mechanics remains a challenge in physics. While significant progress has been made in understanding the quantum-to-classical transition in dynamics, a unified statistical mechanics perspective is still lacking. We introduce a protocol where the center of mass of a system of quantum particles follows classical dynamics when the number of particles is sufficiently large, which is supported by the central limit theorem. Leveraging Bohmian trajectories, we extend the notation of phase space to quantum mechanics and propose a novel statistical mechanics partition function in phase space for closed quantum systems. This function incorporates the ensemble of positions, momenta, and probability distribution (the square amplitude of the wavefunction), naturally bridging the quantum-to-classical transition in both dynamics and statistical mechanics.