

# Complex tunneling dynamics

Ciann-Dong Yang

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## Abstract

Tunneling dynamics and tunneling trajectories are modeled exactly by complex-extended Hamilton–Jacobi formulation in this paper. It is found that the wave-like properties of tunneling particles, such as reflection, refraction, and transmission resonance, can be identified and explained in terms of particle’s motion in complex space with the tunneling time defined as the usual sense of classical time. Following the complex trajectories determined by the complex Hamilton equations of motion, we can connect classical trajectories smoothly with tunneling trajectories using position and velocity continuity at the interface of the media, locate the particle’s position at any instant, and find the time spent by a particle within the potential. A microscopic tunneling model is also developed to explain the probabilistic nature why a particle with the same incident conditions sometimes transmits the potential and sometimes is reflected from the potential.