Hydrodynamic Analogs of Quantum Tunneling

Das, Ahitagni (School: Delhi Public School Siliguri)

Analogs constitute a powerful tool in physics: not only do they simplify complex phenomena but also allow the possibility of transferring experimental data from one field to another. First conceived by Couder & Ford, walker systems can behave as a quantum particles. Here we explore analogs of quantum tunneling. Unlike quantum-systems, classical Hamiltonian-systems cannot overcome barriers as they are stuck at a particular energy-level. We use a simple self-designed apparatus to form walker systems. We confine the walkers in submarine barriers & notice that after multiple collisions their walker is able to cross the barrier. We experimentally study how the probability of crossing varies with various factors like barrier thickness, speed of particle, & angle of impact. Experimentally we found that escape probability increases with decrease in barrier thickness (resemblance with Eddi et al.), increase in barrier velocity, & decrease in impact angle. To delineate the phenomenon mathematically we consider the motion of the walker to be governed by a Rayleigh friction term, which originates from the walker's interaction with waves that it has already emitted in the past due to impact on the vibrating surface. Our mathematical model attempts to understand if the walker's transmission or crossing properties are intrinsic to their non-Hamiltonian nature considering both linear & Hamiltonian landscapes. Our mathematical model also incorporates a relationship between the incident-angle and penetration-depth of the walker & a probability distribution model to investigate the probability of crossing the barrier for randomised initial angles. We are currently investigating how the the liquid layer between surface & barrier effects the probability