Abstract for an Invited Paper
for the MAR07 Meeting of
The American Physical Society

Analog Experiments on Quantum Chaotic Scattering and Transport[1]

STEVEN ANLAGE, University of Maryland

The transport properties of mesoscopic and nanoscopic materials are dominated by quantum interference effects. Nevertheless it is challenging to delineate these effects through conventional transport experiments on real materials. Complications arise from finite temperatures (thermal smearing, inelastic scattering), and the excitation of two-level systems that can cause the electrons to "decohere" and drop out of the quantum-coherent transport process. We approach this problem from the perspective of nonlinear dynamics and utilize a unique experimental technique that directly simulates the quantum scattering properties of complicated (ray-chaotic) systems. A microwave cavity is used to simulate solutions to the time-independent Schrödinger equation for a two-dimensional ray-chaotic infinite square-well potential. The classically chaotic ray trajectories within a suitably shaped microwave cavity play a role analogous to that of the chaotic dynamics of noninteracting electron transport through a ballistic quantum dot in the absence of thermal fluctuations. In wave chaotic scattering, statistical fluctuations of the scattering matrix S and the impedance ('reaction') matrix Z depend both on universal properties and on nonuniversal details of how the scatterer is coupled to external channels. We remove the non-universal effects of the coupling from the experimental Sdata using the radiation impedance obtained directly from the experiments, thus eliminating one of the most significant complications in conventional transport measurements. The Landauer-Büttiker formalism is applied to obtain the conductance of a corresponding mesoscopic quantum-dot device. We find good agreement for the probability density functions of the experimentally derived surrogate conductance, as well as its mean and variance, with the theoretical predictions based on random matrix theory [1]. We also observe a linear relation between the quantum dephasing parameter and the cavity ohmic loss parameter. The results apply to scattering measurements on any wave chaotic system. We also discuss future directions for this work.

[1] S. Hemmady, *et al.*,(http://dx.doi.org/10.1103/PhysRevB.74.195326) Phys. Rev. B 74, 195326 (2006).

[1]This work is done in collaboration with Thomas Antonsen, James Hart, Sameer Hemmady, Edward Ott, and Xing Zheng, and is supported by the AFOSR MURI and DURIP programs.