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Quantum Networks as Models of Mesoscopic Systems

TSAMPIKOS KOTTOS, Department of Physics, Wesleyan University, Connecticut-USA and MPI for Dynamics and Self-Organization, Gottingen-Germany

We review our work on quantum networks. These are one-dimensional systems consisting of vertices connected by bonds that have incommensurate lengths L. Particles with a fixed wave-number k can propagate freely on the bonds and scatter at the vertices. Combining the free propagation and the vertex scattering we have ended up with a quantum "evolution" operator on the graph. The corresponding classical dynamics was defined as follows: we have constructed a Liouville description by considering the evolution of a phase-space density over the space of directed bonds. The classical evolution operator consists of transition probabilities between connected bonds taken from the corresponding quantum evolution operator. Due to the multiple connectivity (stretching) and the compactness of the system (folding), the classical dynamics is chaotic. This analogy enables us to study the connection between statistical properties of eigenvalues and eigenfunctions and the classical dynamics. Finally, connecting them with leads to infinity we have also shown that quantum networks are excellent paradigms for the study of mesoscopic transport.