Conductance through Quantum Wires with Levy-type Disorder: Universal Statistics in Anomalous Quantum Transport

Victor Gopar (University of Zaragoza, Spain)

Random processes characterized by density probabilities with a long tail – Levy-type processes – have been found in very different phenomena and fields, such as biology, economy, and physics. Recent transport experiments have shown the possibility of manipulate the sample disorder to produce Levy processes in a controllable manner. With this motivation we study the conductance G through one-dimensional quantum wires with disorder configurations characterized by long-tailed distributions (Levy-type disorder). We calculate analytically the conductance distribution which reveals a universal conductance statistics: the distribution of conductances is fully determined by the exponent α of the power-law decay of the disorder distribution and the average $\langle \ln G \rangle$, i.e., all other details of the disorder configurations are irrelevant. For $0 < \alpha < 1$ we found that the fluctuations of $\ln G$ are not self-averaging and $\langle \ln G \rangle$ scales with the length of the system as L^{α}, in contrast to the predictions of the standard scaling-theory of localization where $\ln G$ is a self-averaging quantity and $\langle \ln G \rangle$ scales linearly with L. Our theoretical results are verified by comparing with numerical simulations of one-dimensional disordered wires.