Highlights

Other Materials - 2015

Nonequilibrium fluctuations as a distinctive feature of weak localization

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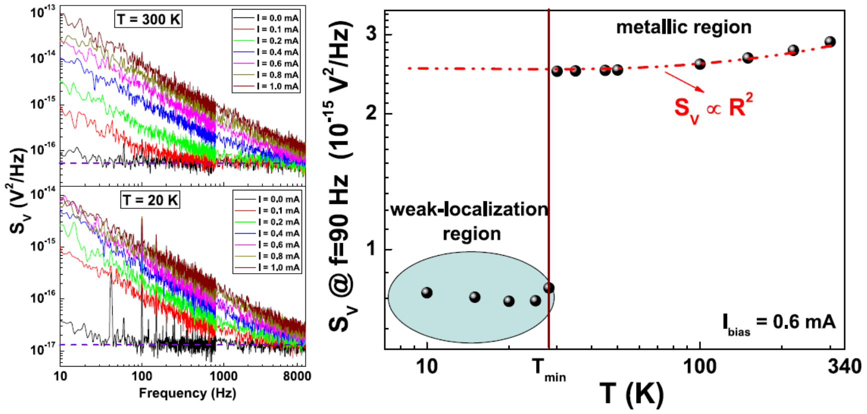
In two-dimensional materials, such as graphene, topological insulators, and two-dimensional electron gases, quantum interference effects, and in particular weak localization (WL), are likely to occur. These coherence effects are usually characterized by well-defined features in dc electrical transport, such as a resistivity increase and negative magnetoresistance below a crossover temperature. Recently, it has been shown that in magnetic and superconducting compounds, undergoing a WL transition, a specific low-frequency 1/f noise appears (see left panels in the figure below). An interpretation in terms of nonequilibrium universal conductance fluctuations (UCFs) has been given [1]. The universality of this unusual electric noise mechanism has been here verified by detailed voltage-spectral density investigations on ultrathin copper films. Also in the case of a simple metallic thin film, it has been observed that the amplitude of the noise is different when the crossover between WL and metallic region occurs (see right panel in the figure below). In particular, the voltage-noise is characterized by an anomalous linear dependence versus *I*, which is due to the dephasing effect on the local conductance fluctuations of the current bias exploring the percolative network of the sample. This anomalous fluctuation behaviour, detected in the WL regime, is a material-independent feature only associated with partial restoration of the sample coherence.



(Left) The spectral traces in the metallic (300 K) and WL (20 K) regions are shown for a 12 nm ultrathin copper film. (Right) Its noise amplitude, at 90 Hz and at a fixed bias current of 0.6 mA, is reported as a function of temperature.

[1] Barone, C. et al., Phys. Rev. B 87, 245113 (2013).