Possible mechanism of long-time relaxation in the electron glass

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Long-time relaxation of electronic transport in high-resistivity materials such as amorphous InO [1] has been puzzling for nearly two decades. Various models based on complex changes of the occupation of the localized states have been proposed, see e.g. [2, 3].

The exponentially low rate of long-range single-particle hops, however, seems to provide a simpler explanation: At zero temperature, in the formation of the Coulomb gap, such long-range hops are responsible for the low-energy part of the single-particle density of states. Roughly speaking, only after relaxation concerning all hops up to a certain length, the single-particle density can be expected to be correct for energy values down to the Coulomb interaction energy corresponding to this length. Thus, the related energy-bound is inversely proportional only to the logarithm of the relaxation time.

In a quench, a second bound is likewise important: The influence of the finite final temperature can be emulated by performing only such single-particle hops for which the decrease of the total energy exceeds a certain bound. There are several possibilities, however, to relate this bound to the final temperature.

To investigate, how the interplay of these bounds influences the conductivity, we have performed a series of numerical experiments: Using software developed for the study of the Coulomb gap in very large samples [4], low-energy system states are constructed by means of relaxation with respect to all single-particle hops satisfying the two bounds introduced above. Percolation analyses concerning the fastest single-particle hops, which are possible for the obtained system states, yield estimates of the characteristic hopping time and thus of the conductivity. First results confirm that relaxation over macroscopic time scales can be understood this way. In this contribution, we will analyse the influence of temperature, localization radius, and disorder strength.

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