Random Telegraph Noise in $La_{1-x}Ca_xMnO_3$ single crystals

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Electric noise measurement in many different materials are usually aimed at the evaluation of the intrinsic noise level important for the performance of electronic devices made of these materials. However, noise measurements are also effective tool to provide insight into fundamental charge transport mechanisms in these materials (see eg. [1]). $La_{0.86}Ca_{0.14}MnO_3$ is mixed-valence oxide material which due to its rich variety of crystallographic, electronic and magnetic phases and abundance of interesting physical phenomena remains a training area for fundamental research [2]. The ferromagnetic insulating state appears at temperatures below Curie temperature (T_C) which in these materials coincides with the temperature of the metal-insulator transition.

We report on the robust Random Telegraph Noise (RTN) of the conductivity of $La_{0.86}Ca_{0.14}MnO_3$ manganite at low temperatures. At room temperatures, the spectra of the conductivity fluctuations are featureless and follow the $1/f$ shape in the entire investigated frequency and current bias range. However, at low temperature, slightly above T_C, a clear Lorentzian excess noise appears and eventually dominates the spectral behavior. The cutoff frequency of the excess noise is bias and magnetic field independent but is clearly thermally activated with an activation energy of 300 meV. In time domain the responsible fluctuator appears as a pronounced two level random telegraph noise which persisted and could have been monitored in exceptionally wide temperature range of more than 50 K. At all temperatures where it could have been observed, the amplitude of RTN decreases exponentially with increasing bias current in exactly the same manner as the sample resistance increases with the current, pointing out to a nontrivial physical origin of these fluctuations. It has to be emphasized that, surprisingly, the responsible two-level fluctuator has a macroscopic character and affects the resistance of the entire sample. We propose the model for such behavior based on our previous investigations of the metastable resistivity states in the ferromagnetic insulating manganite [3]. We tentatively associate the robust macroscopic RTN with the transitions of a critical cluster along the percolation path between the stable high resistivity states and metastable low resistivity one.

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