High excess noise level in the $(BEDT\text{-}TTF)_2X$-salts

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Quasi-two-dimensional organic conductors are model systems for low-dimensional metals exhibiting both strong electron-electron and electron-phonon interactions. The interplay of charge, spin, and lattice degrees of freedom lead to a variety of different magnetic-insulating, metallic, and superconducting ground states [1].

Fluctuation spectroscopy has been used to study the charge-carrier dynamics in this class of materials for the first time [2]. Here, we report on the very high noise level in these systems based on Hooge's empirical law to quantify 1/f noise in solids. The value of the Hooge parameter γ_H, i.e. the noise level normalized by the sample's volume and the applied voltage, of $10^5 - 10^7$ is several orders of magnitude higher than values of $\gamma_H \sim 10^{-2} - 10^{-3}$ typically found in homogeneous metals and semiconductors [3]. Such extremely high noise levels have also been found for a number of high T_c-cuprate superconductors, where it has been pointed out that the high noise level is not inherent to the class of materials but can be explained, e.g., by the granularity of the samples [3]. Since the present molecular materials are in the clean limit, an explanation in terms of crystalline quality is not necessarily obvious.

Instead, we discuss differences in the conduction mechanism for the present molecular metals and the materials where the Hooge description works well. This explanation includes the possibility that the large noise level is an intrinsic property of the $(BEDT\text{-}TTF)_2X$ compounds originating, e.g., in an inhomogeneous current distribution [4]. We present systematic studies of the noise level in a number of different quasi-2D organic charge-transfer salts $(BEDT\text{-}TTF)_2X$ and discuss models for a more detailed understanding of this effect.

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