APCTP SEMINAR

Electron Avalanche via Inelastic Scattering and Collapse of Correlated Insulator

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Online via ZOOM

We investigate the half-century-old puzzle in the resistive transition of charge-density-wave and Mott systems where the DC electric fields that cause instability of the insulating state have been orders of magnitude smaller than theoretical predictions based on the Landau-Zener tunneling. Despite the phenomenological understanding via resistor network models, the lack of microscopic understanding has limited the advances in the field. By introducing coupling to inelastic medium, we demonstrate that electron avalanche transitions occur at arbitrarily small electric fields and that the avalanche is controlled by the electron decay rate Γ that sets the energy cutoff for multiple inelastic scattering. This mechanism creates the ingap-states that are responsible for the avalanche transition. We study the steady-state nonequilibrium using the Keldysh Green's function theory. The low-field avalanche strongly modifies the charge gap in CDW and Mott insulators leading to the premature collapse of the insulating state at electric fields much smaller than the Landau-Zener prediction and in the typical experimental range of a few 10 kV/cm. We also show that different spectra of inelastic medium result in diverse switching behaviors such as the two-stage transitions in the CDW and one-stage insulator-to-metal transitions in Mott systems. We compare the temperature dependence of the theory with some experimental measurements.

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