Physics of Strongly Correlated Systems

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- Long range electronic correlation: Superconductors
- Long range spin correlation: magnetic materials (CMR manganites)
- Nanoscale strongly correlated systems
- Hybrid organic-inorganic systems

Experimental methods

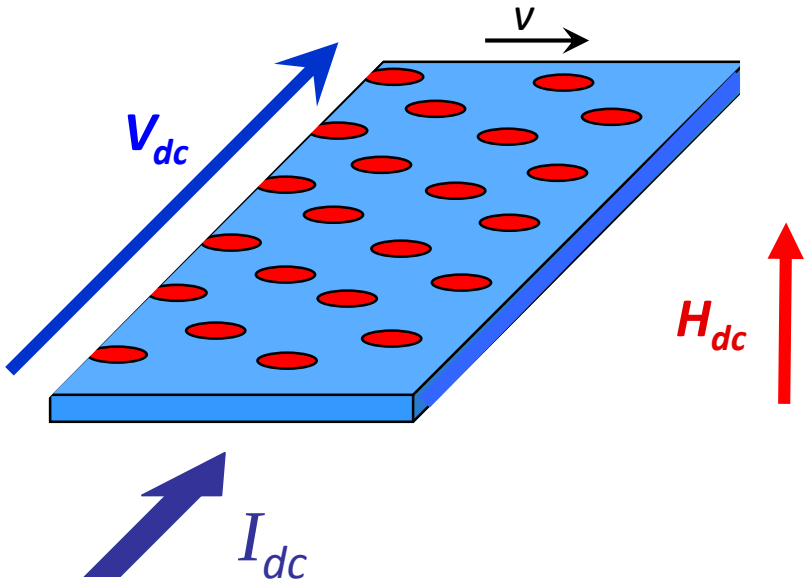
- Noise and metastable states
- Transport
- Magnetization and Susceptibility

  - Temperature 1.5 K - 450 K
  - Magnetic Field up to 9 T
  - Signal analysis dc – 25 GHz
  - Hydrostatic pressure up to 15 kbar

    - Thin Films — *in house and collaborations*
    - Single Crystals — *collaborations*
    - Nanoparticles — *in house*
    - Hybrid Systems — *collaborations*

Strongly Correlated Electronic System: Superconductivity

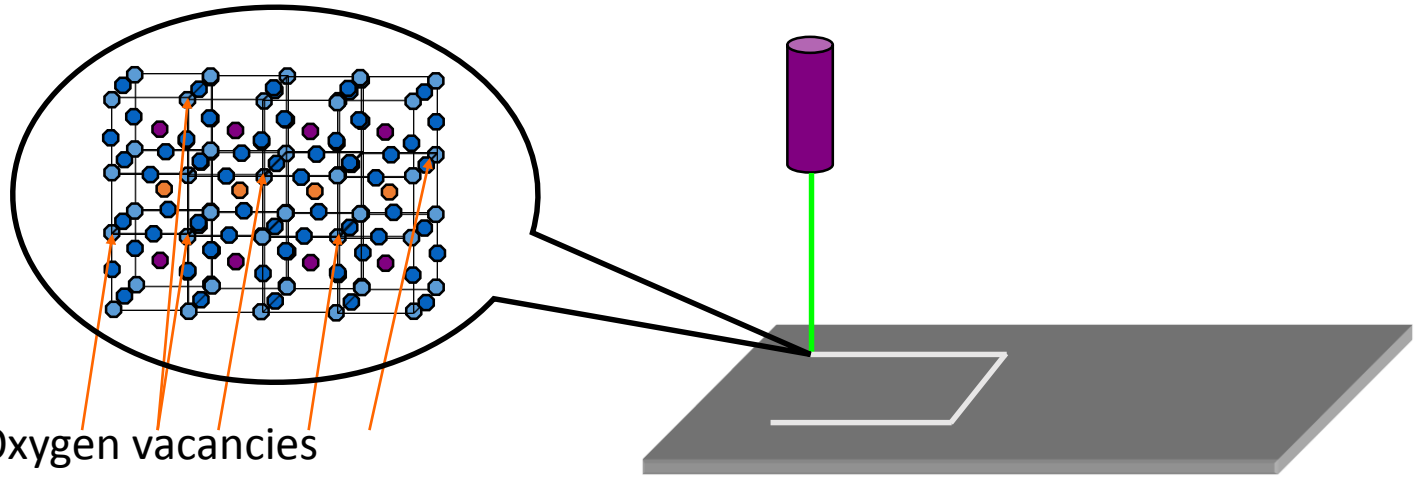
- Vortex dynamics
  - Channeled vortex motion
  - Quasi-Josephson Effects



Artificial channels for easy vortex motion

- Strong interactions between channeled vortices make their motion coherent.
- Coherent vortex flow results in quasi-Josephson effects; attractive alternative to weak links in HTS.
- Channels for vortex motion can be fabricated either by increasing pinning in the channel banks, or by decreasing pinning in the channel area with respect to the pinning in the banks.

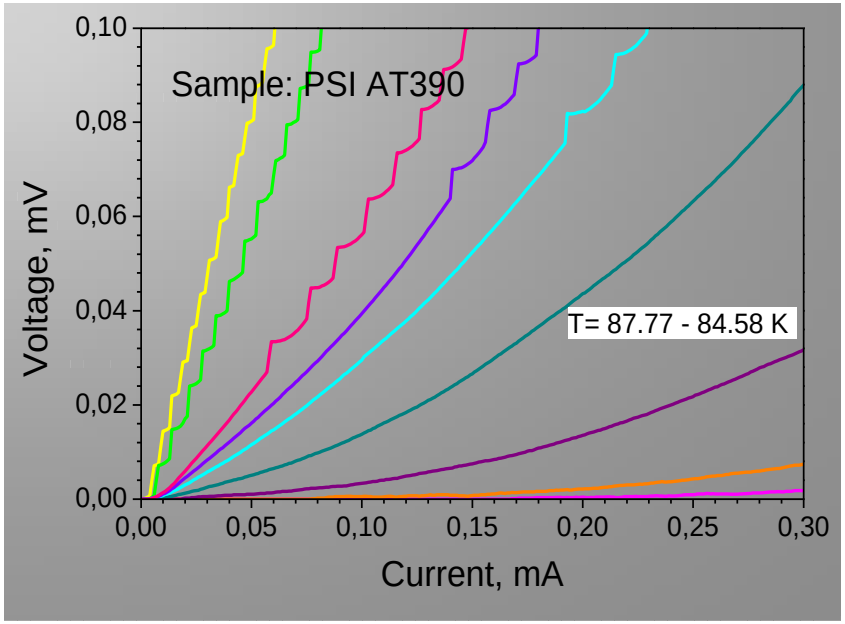
Laser Writing

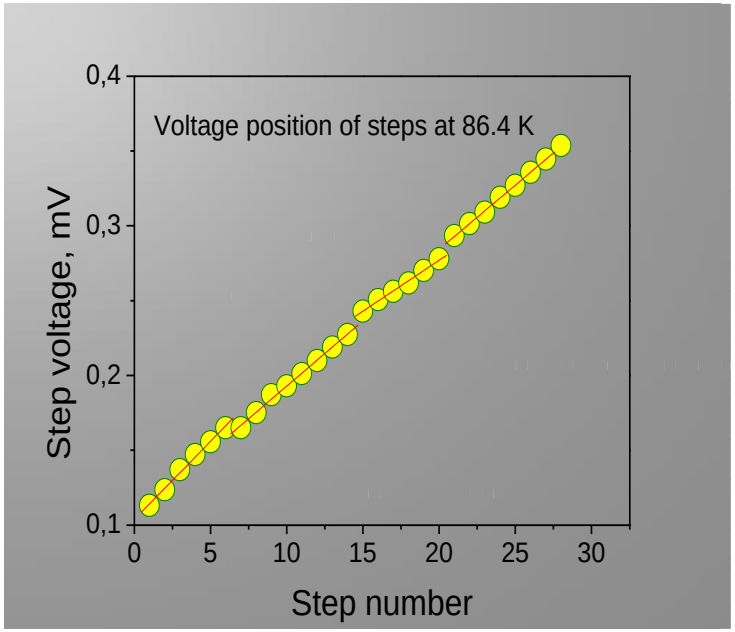


Alternative techniques investigated:

<u>Electron Writing,</u> YBCO-LSCM Bilayers, Molecular Pinning

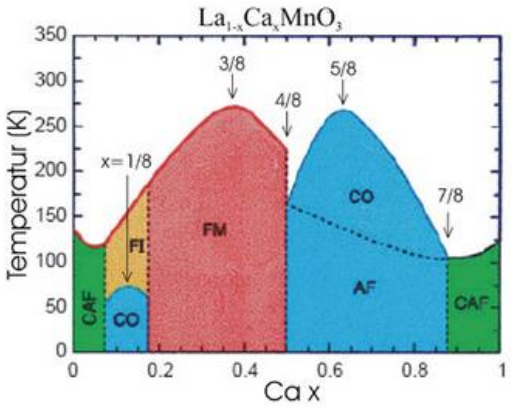
Coherent vortex motion

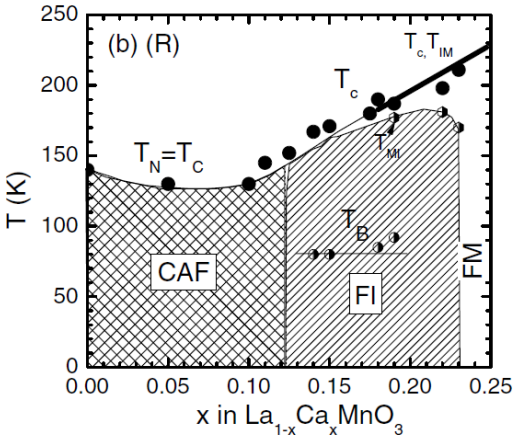


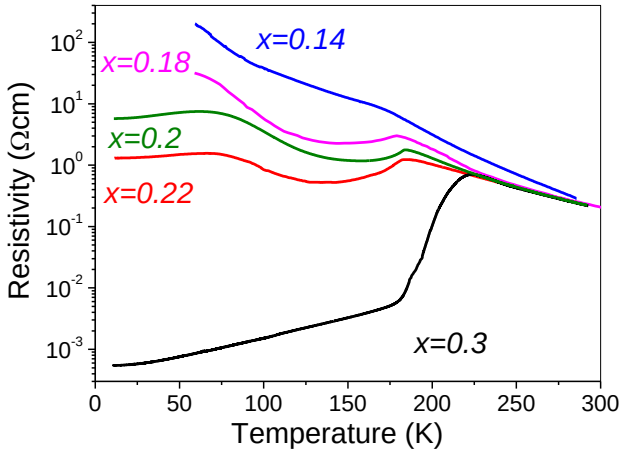


Strongly Correlated Spin System: CMR Manganites

- Metastable resistivity states and noise
- Nongaussian noise in ferromagnetic insulating manganite
- Manganites on nanoscale



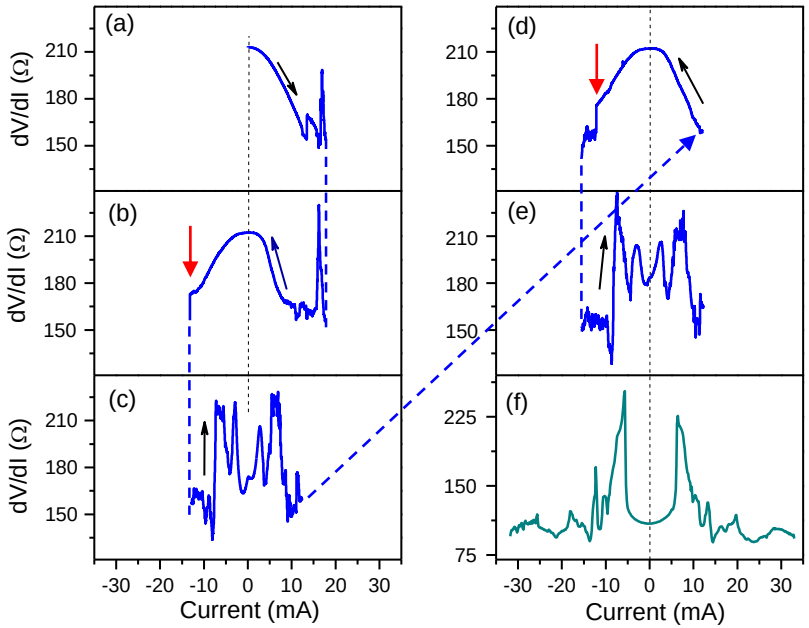




Low-doped $La_{1-x}Ca_xMnO_3$

Metastable resistivity states

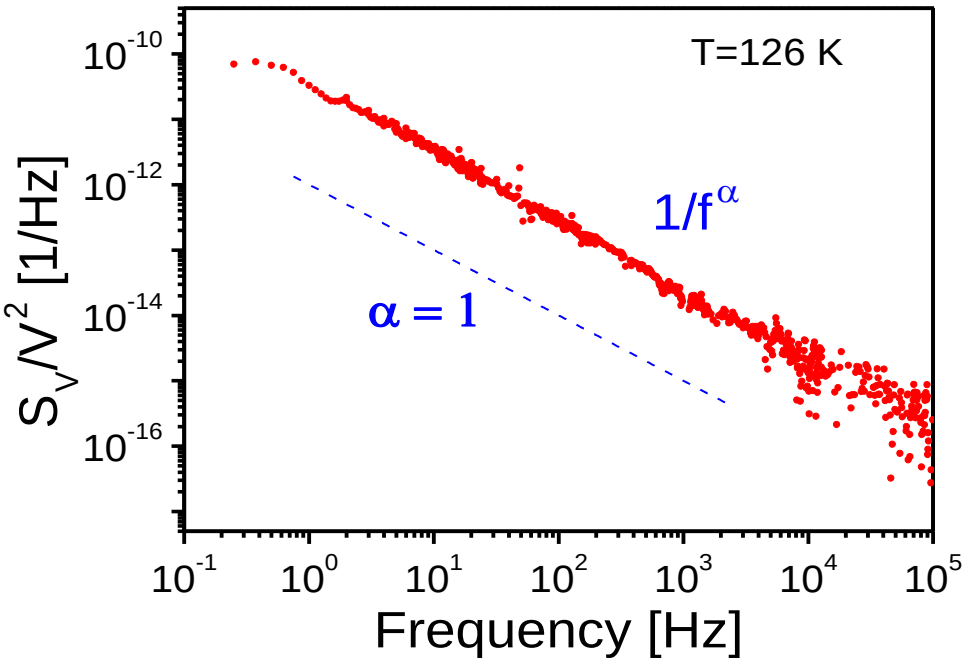
Pristine state



Low Resistivity state

$La_{0.82}Ca_{0.18}MnO_3$

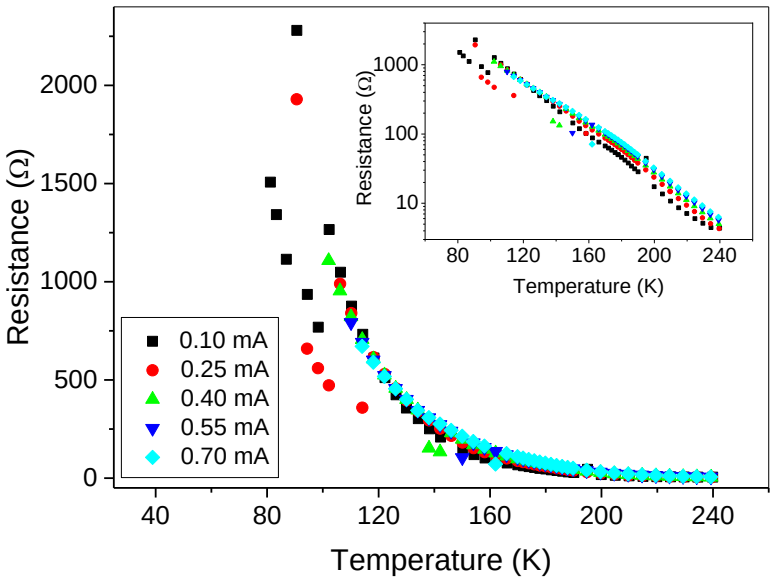
Metastable resistivity states and noise

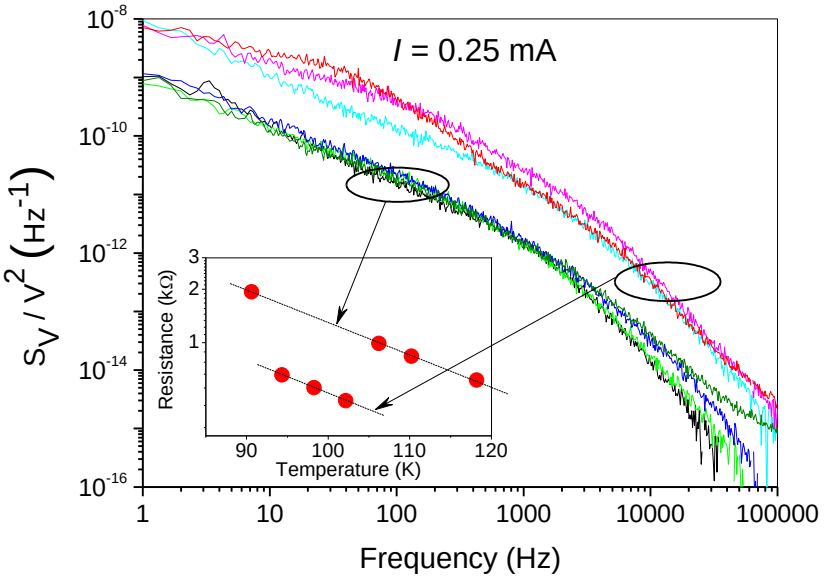


D-H-D model of 1/f noise:

$$S(\omega,T) \propto \frac{kT}{\omega} D(\tilde{E})$$

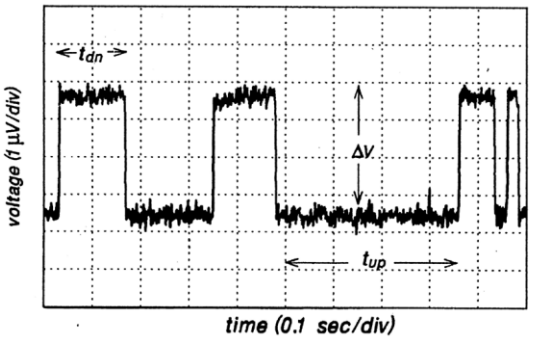
Noise signatures of metastable resistivity states

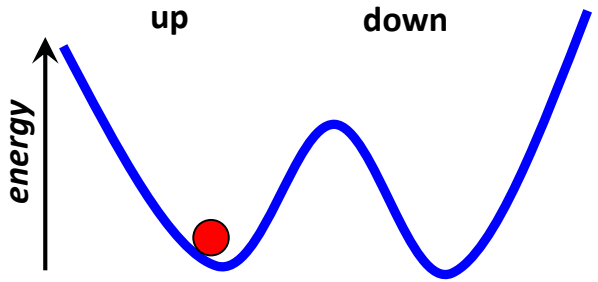


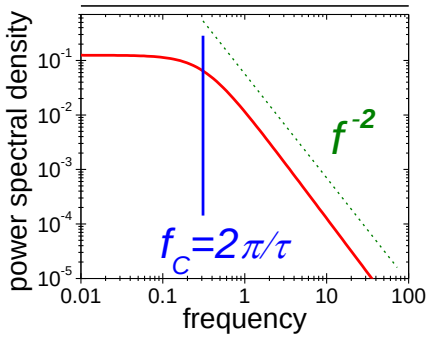


$La_{0.86}Ca_{0.14}MnO_3$

Non Gaussian noise - RTN







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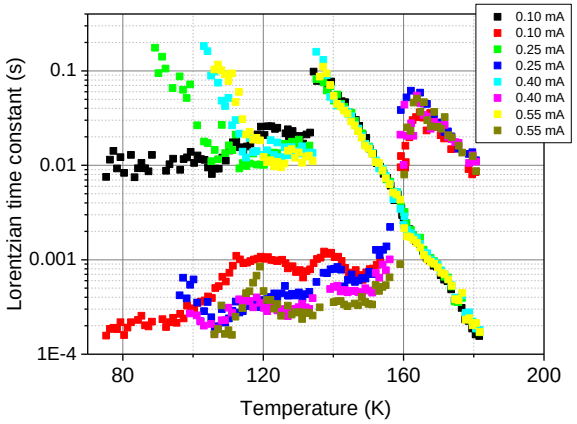
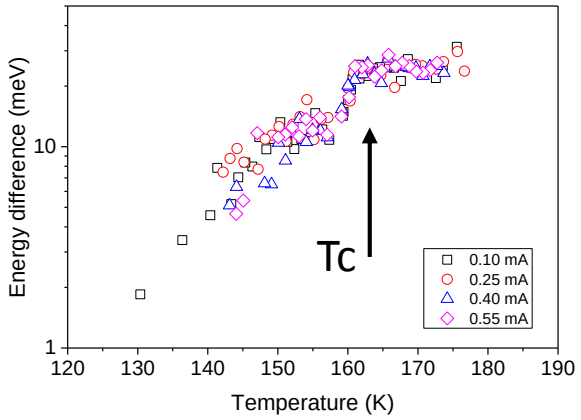
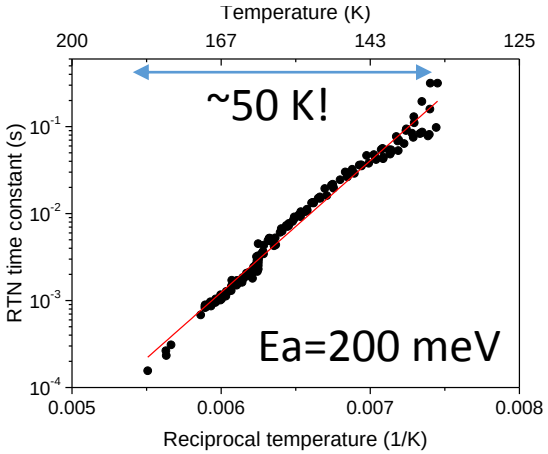
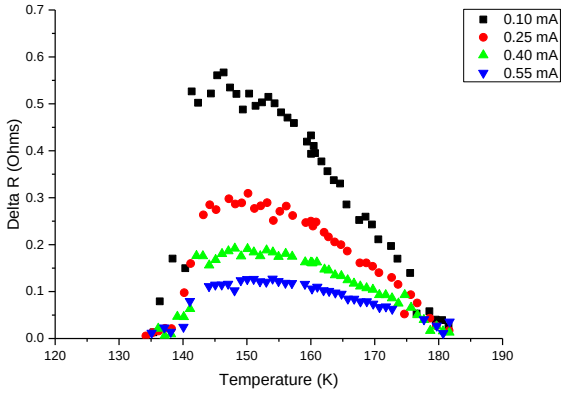




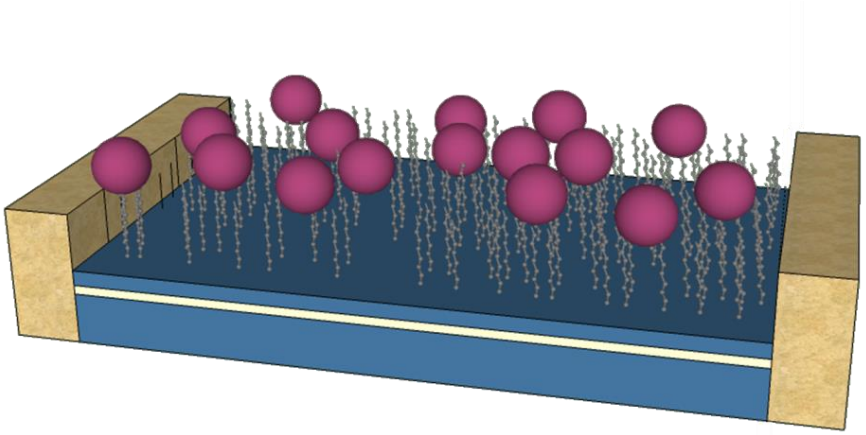


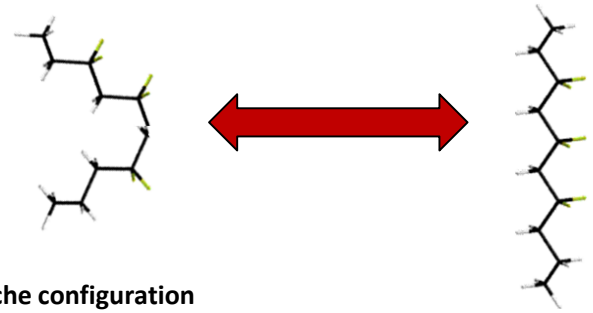


Hybrid Organic – Inorganic Systems

- Crackling noise in self-assembled molecular layers
- Crackling noise in equilibrium
- Inverse proximity effect

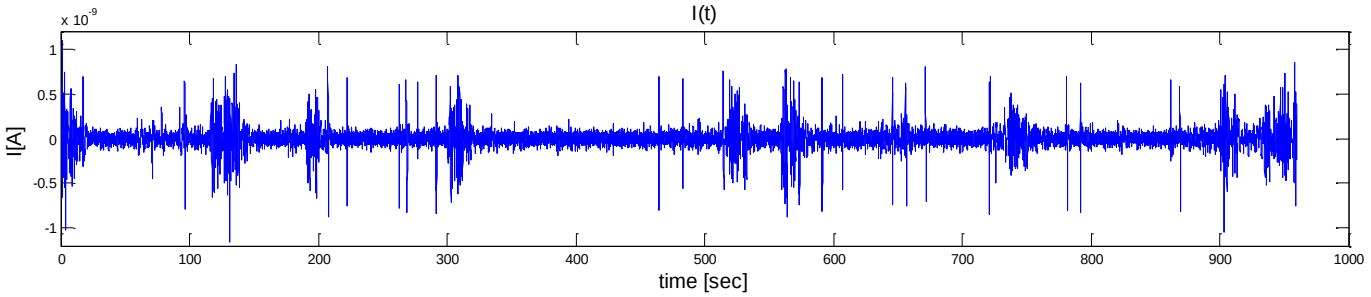
Charge avalanches in 2D SAM



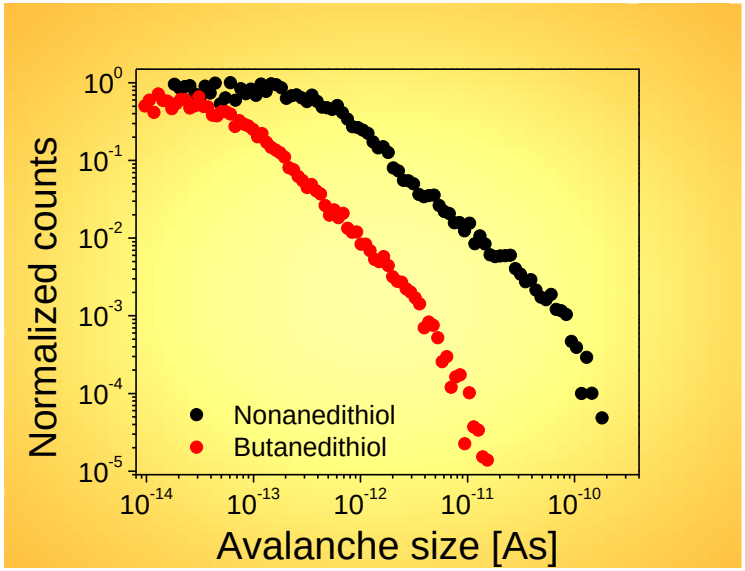


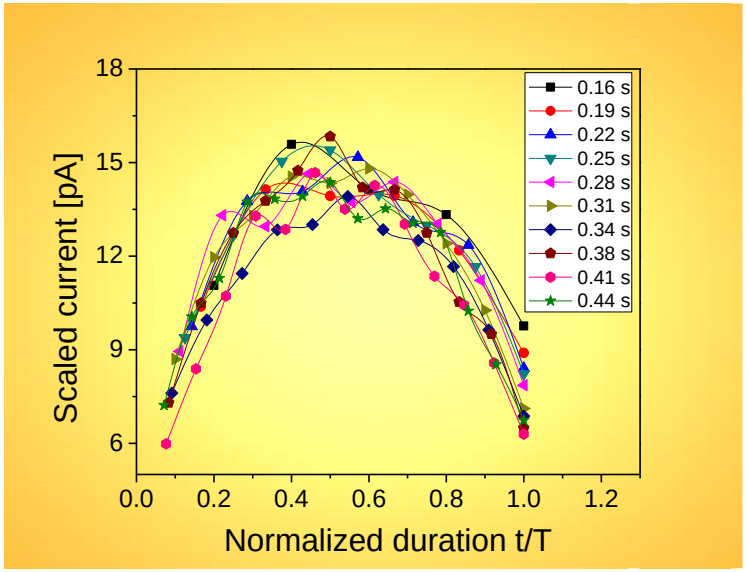
Gauche configuration
(high barrier – no conductivity)

All-trans configuration
(low barrier – high conductivity)



Universal crackling noise





Inverse proximity effect in hybrid S-N systems