

[Talk 13] $1/f$ noise on the nanoscale brings new insights on the low frequency cutoff paradox

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Starting with the work of Bernamont (1937) on resistance fluctuations, noisy signals of a vast number of natural processes exhibit $1/f$ power-spectrum. Such spectra are found in weather data, brain activity, currents of ion-channels and certain chaotic systems to name a few. The wide applicability of this spectrum resulted in conflicting theories distributed among many disciplines.

A unifying feature is that $1/f$ power spectrum is non-integrable at low frequencies implying that the total energy in the system is infinite. As pointed out by Mandelbrot (1950's) this infrared catastrophe suggests that one should abandon the stationary mind set and hence go beyond the widely applicable Wiener-Khinchin formula for the power spectrum. Recent theoretical and experimental advances renewed the discussion on this old paradox, for example in the context of blinking quantum dots [1,2]. Importantly the removal of ensemble averaging in nano-scale measurement revealed time dependent spectrum, at least for nano-crystals. In this talk ageing, intermittency, ergodicity breaking, and critical exponents of the sample power spectrum are discussed within a theoretical framework which hopefully provides new insights on the $1/f$ enigma. A generalisation of Wiener-Khinchin theorem, to ageing processes with an autocorrelation function which is scale invariant, provides a new spectral theory for $1/f$ noise [3].

[1] M. Niemann, H. Kantz, E. Barkai Phys. Rev. Lett. 110, 140603 (2013).

[2] S. Sadegh, E. Barkai, and D. Krapf New. J. of Physics 16 113054 (2014).

[3] N. Leibovich and E. Barkai, Phys. Rev. Lett. 115, 080602 (2015).