Current fluctuations, or noise, measurement can provide very useful information on a conductor. A simple characterization of these fluctuations is given by their spectral density measured at frequency $\omega$: $S_2(\omega) = \langle i(\omega) i(-\omega) \rangle$, with $i(\omega)$ the Fourier component of the current and $\langle \rangle$ denoting time averaging. Usual quantum shot noise measurements deal with the dependence of $S_2(\omega)$ on the dc bias voltage $V$. The dynamical response of the noise spectral density $S_2(\omega)$ to an AC+DC bias $V(t) = V + \delta V \cos \omega_0 t$ is considered. It measures how the noise is modulated by the AC voltage, in the same way as the AC conductance measures the modulation of the average current. This quantity unveils information on the dynamics of charge neutral excitations that AC conductance and noise do not provide.

The dynamical response of noise is shown to be described by the correlator $\langle i(\omega) i(\omega_0 - \omega) \rangle$. We have designed an original experimental setup able to address this quantity for $\omega \sim \omega_0$ (Figure 1) and measured the dynamical response of the noise emitted by a tunnel junction in the quantum regime, at very low temperature $T$ and high frequency such that $\hbar \omega = \hbar \omega_0 >> k_B T$. For a small AC excitation the noise susceptibility is defined as the linear response of the noise modulation to the AC voltage.

For a slow AC voltage, the noise follows the excitation and the noise susceptibility is simply $dS_2(\omega)/dV$. At high exciting frequency, the noise responds instantaneously to the excitation (since the tunnel junction has no intrinsic time) but not adiabatically, as demonstrated in Figure 2. This is in quantitative agreement with the calculation we have performed. These measurements will be crucial to understand environmental effects on higher moments of noise in the quantum regime.

References:

* Environmental Effects in the Third Moment of Voltage Fluctuations in a Tunnel Junction
  B. Reulet, J. Senzier and D.E. Prober

* Dynamics of Quantum Noise in a Tunnel Junction under ac Excitation
  J. Gabelli and B. Reulet

Contact: Bertrand Reulet
Lab. de Physique des Solides, Univ Paris-Sud, CNRS-UMR8502, F-91405 Orsay, France
(e-mail) reulet@lps.u-psud.fr (tel) 33 1 69 15 53 22