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Hidden correlations in the zero-point motion of electrons revealed by non-Gaussian quantum noise

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We have performed the measurement of the correlation between the low frequency voltage fluctuations and the power fluctuations of the high frequency electromagnetic field generated by a tunnel junction at very low temperature. Our experiment provides the first observation of the correlation between the electron transport at low frequency and the photon field at high frequency, both when real photons are emitted ($eV>hf$, with V the dc voltage and f the frequency) and when the electromagnetic field is solely due to vacuum fluctuations. In terms of electrons only, our observations indicate that the intrinsic current fluctuations in a tunnel junction are given by $S_3(0,f) = e^2I$, regardless of the frequency f. Despite its classical look, this result expresses that the high frequency current fluctuations, caused by the zero-point motion of electrons, are correlated with their low frequency counterpart, associated with "real" motion of electrons. In terms of photons only, we observe that the electromagnetic field exhibits a discontinuity at $eV=hf$, not in the amplitude of the fluctuations but in their relative phases.