POLYTECHNIQUE MONTRÉAL

LE GÉNIE EN PREMIÈRE CLASSE

SÉMINAIRE DU DÉPARTEMENT DE GÉNIE PHYSIQUE

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Amphithéâtre du Pavillon J.-A. Bombardier, salle 1035

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How is the electromagnetic field radiated by a quantum current?

A classical current in a conductor radiates a classical electromagnetic field. We explore some properties of the field radiated by a conductor when electron transport must be described by quantum mechanics, i.e. when the electron current becomes quantum itself. Using a tunnel junction between normal metal contacts placed at ultra-low temperature as a quantum conductor, we demonstrate the existence of squeezing as well as entanglement in the microwave radiation, thus proving that the electron shot noise generates a quantum electromagnetic field [1,2]. This is corroborated by the direct demonstration of photon pairs emitted by the sample [3,4].

Beyond these experiments, performed in frequency domain by measuring quadratures of the electromagnetic field at two frequencies, it is tempting to address quantum properties of the electromagnetic field not at a given frequency but at a given time. Indeed, electron transport in quantum conductors often bears no intrinsic timescale, thus no preferred frequency. Hence, quantum correlations in the radiated field are extremely broadband. This comes from the statistics of current fluctuations, whose correlations can be clearly understood in time domain.

We will discuss very recent theoretical results aiming at understanding quantum electromagnetic fields in time domain, such as quadratures or photon statistics [5].

[1] Gabriel Gasse, Christian Lupien and Bertrand Reulet, Phys. Rev. Lett. **111**, 136601 (2013).

[2] J ean-Charles Forgues, Christian Lupien, and Bertrand Reulet, Phys. Rev. Lett. **114**, 130403 (2015).

[3] Stéphane Virally, Jean-Olivier Simoneau, Christian Lupien, Bertrand Reulet, Phys. Rev. A **93**, 043813 (2016).

[4] Jean-Olivier Simoneau, Stéphane Virally, Christian Lupien and Bertrand Reulet, Phys. Rev. B 95, 060301(R) (2017)

[5] Stéphane Virally and Bertrand Reulet Phys. Rev. A 100, 023833 (2019).

Vous êtes tous les bienvenus.

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