CEA - Saclay 91191 Gif-sur-yvette Cedex

Service de Physique de l'Etat Condensé

SÉMINAIRE

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Mercredi 15 septembre 11h15

Orme des Merisiers SPEC Salle Itzykson, Bât.774

Terahertz sensing and noise mapping in mesoscopic semiconductor and carbon devices

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In this seminar, I will present two different topics concerning mesoscopic physics and its device applications; terahertz (THz) sensing and noise mapping.

1) ***Terahertz sensing and imaging***: The advantageous properties of THz waves - permeability through objects opaque for visible light, the important energy spectrum in the meV range, etc. - potentially enable various applications of imaging and spectroscopy in this band. However, since the THz region is located between the electronic and photonic bands, even basic components like detector and source have not been fully established, compared to the technically mature, other frequency regions. The THz wave also has the problem of a low imaging resolution, which results from a much longer wavelength than that of the visible light. In this work, by employing nano-structured devices based on a carbon nanotube (CNT), graphene, and a two-dimensional electron gas (2DEG) in a GaAs/AlGaAs heterostructure, we have created a new type of THz sensing and imaging devices as follows: i. Frequency-selective THz-photon detection with a CNT/2DEG hybrid device [1] ii. On-chip near-field THz imaging based on a 2DEG [2] iii. Wide-band, frequency-selective THz detection with a graphene device.

2) ***Noise mapping:*** Observations of electric potential distributions in solid-state devices provide clear and rich information for a microscopic understanding of charge transport properties. For meso- and nano-scopic devices, this issue is of particular interest because transport properties in such systems often exhibit remarkable space dependence. In this work, we have developed a new type of scanning electrometer based on a 2DEG [3]. The basic mechanism is that local potential is detected through gate effects for the 2DEG sensor via capacitive coupling with a sample. Using this technique, we have demonstrated mapping of the potential distribution for other 2DEG samples in a GaAs/AlGaAs interface and in a graphene surface. Spatial distribution of temporal potential fluctuation (noise voltage) has been successfully imaged for the GaAs-based 2DEG in quantum Hall states [4]. The experimental data reveal linear distribution resulting from unstable relaxation of edge-state electrons. We have further found that for the graphene sample, the potential amplitude fluctuates with the period of 50-100nm. This feature has not been obtained for the GaAs-based 2DEG. We have recently observed THz photoconductivity in graphene devices, and are now studying the effect of the potential fluctuation on local THz photoconductivity with the above near-field THz imaging technique.

[1] Y. Kawano et al., Appl. Phys. Lett. 95, 083123 (2009).

[2] Y. Kawano et al., Nature Photonics 2, 618 (2008).

[3] Y. Kawano et al., Appl. Phys. Lett. 84, 1111 (2004).

[4] Y. Kawano et al., Appl. Phys. Lett. 96, 142109 (2010).

The seminar will be given in English. A coffee break will be served at 11h00.
