



# Quantum Efficiency Seminar und Colloquium

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## Optical spectroscopy of graphene: Intrinsic properties, devices and hybrids

Since 2004, graphene has risen as an outstanding system to investigate the interplay between photons, electrons and phonons in reduced dimensions. Furthermore, graphene stands among the most promising candidates for realistic applications in electronic and optoelectronic nano-devices [1-3].

In this seminar, we will show how the intrinsic properties of graphene can be probed using relatively simple optical techniques. Inelastic light (or Raman) scattering provides quantitative information about the electronic structure, the position of the Fermi level (i.e. doping), as well as the influence of extrinsic factors such as disorder, strain, temperature... [4-5]. Combined with electrical measurements, optical spectroscopy reveals invaluable information on the operation of graphene-based devices. As a classic example, we will examine the energy dissipation mechanisms (electron-electron, electron-phonon, phonon-phonon couplings) in electrically-biased graphene channels [6,7].

In a second part we will introduce the potential of graphene for the design of new hybrid materials and devices. In particular we will address the interaction between graphene and colloidal quantum dots, another popular class of nano-materials that holds great promise for photonics and photovoltaics. Our study of resonant energy transfer (FRET) between individual CdSe/ZnS quantum dots physisorbed on graphene [8] and our ongoing research at IPCMS will be exposed.

Some references:

- [1] A. H Castro Neto et al. Rev. Mod Phys. 81, 109 (2009).
- [2] D.M Basko & A.C Ferrari, Nature Nanotechnology 8, 235 (2013).
- [3] F. Bonaccorso et al. Nature Photonics 4, 611 (2010).
- [4] S. Berciaud, S. Ryu, L.E. Brus & T.F. Heinz, Nano Letters 9, 346 (2009).
- [5] S. Berciaud, X. Li, H. Htoon, L. Brus, S.K. Doorn & T.F. Heinz, arxiv 1305.7025.
- [6] S. Berciaud, M.Y. Han, K.F. Mak, L.E. Brus, P. Kim & T.F. Heinz, PRL 104, 227401 (2010).
- [7] Y-J Yu, M.Y. Han, S. Berciaud et al. Applied Phys. Lett. 99, 183105 (2011).
- [8] Z. Chen, S. Berciaud, C. Nuckolls, T.F. Heinz & L.E. Brus, ACS Nano 4 2944 (2010).

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