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Graphene nano-photonics and carrier dynamics

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Graphene, a two-dimensional sheet of carbon atoms, has recently emerged as a novel material with unique electrical and optical properties, with great potential for novel opto-electronic applications, such as ultrafast photo-detection, optical switches, strong light-matter interactons etc. In the first part of this talk, I will review recent experimental work on exploiting graphene as a host for guiding, switching and manipulating light and electrons at the nanoscale [1]. This is achieved by exploiting surface plasmons: surface waves coupled to the charge carrier excitations of the conducting sheet. Due to the unique characteristics of graphene, light can be squeezed into extremely small volumes and thus facilitate strongly enhanced light-matter interactions. Additionally, I will discuss novel types of hybrid graphene photodetectors [2] and recent findings on carrier dynamics and hot carrier multiplication in graphene. By studying the ultrafast energy relaxation of photo-excited carriers after excitation with light of varying photon energy, we find that electron-electron scattering dominates the energy relaxation cascade rather than electron-phonon interaction [3]. This solves a long- standing debate on the relative contribution of electron-electron scattering versus optical phonon emission.

[1] J. Chen, M. Badioli, P. Alonso-González, S Thongrattanasiri, F Huth, J Osmond, M. Spasenovic, A. Centeno, A. Pesquera, P. Godignon, A. Zurutuza, N. Camara, J. Garcia de Abajo, R. Hillenbrand, F. Koppens, "Optical nano- imaging of gate-tuneable graphene plasmons", Nature (2012).
[2] G. Konstantatos, M. Badioli, L. Gaudreau, J. Osmond, M. Bernechea, P. Garcia de Arquer, F. Gatti, F. Koppens, "Hybrid graphene-quantum dot phototransistors with ultrahigh gain", Nature Nanotechnology (2012).
[3] Photo-excitation Cascade and Multiple Carrier Generation in Graphene. K.J. Tielrooij, J.C.W. Song, S.A. Jensen, A. Centeno, A. Pesquera, A. Zurutuza Elorza, M. Bonn, L.S. Levitov, and F.H.L. Koppens. ArXiv 1210.1205 (2012)