Plasmonic effects of polarisable particles over graphene

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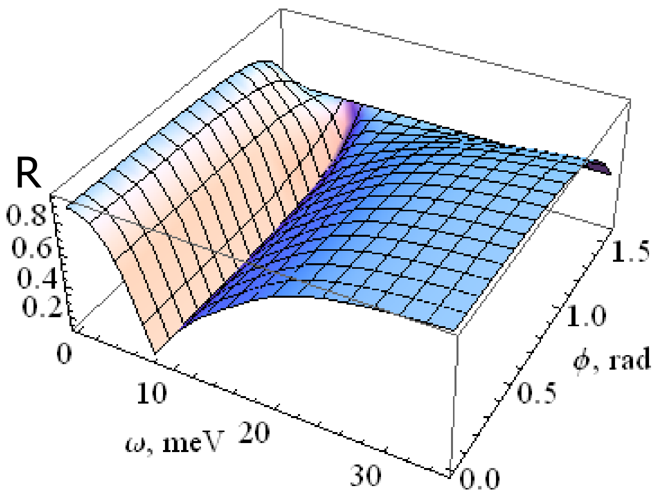
In this talk I will discuss some potentially interesting plasmonic effects that can arise from combining small polarisable particles (such as metallic or dielectric spheres) with graphene, related to surface plasmon-polaritons (SPPs) supported by the latter in the terahertz (THz) spectral range. Owing to the electromagnetic coupling between graphene SPPs and dipole moments of polarisable non-absorbing particles deposited on top it, the optical properties of such a composite system have some new features as compared to its constituents. The particle's polarisability is renormalised owing to the electromagnetic back action of SPPs which are excited in graphene when an external propagating electromagnetic wave impinges on the particle [1]. Moreover, beyond the usual dipole-dipole interaction, an indirect particle-particle coupling arises via polarisation charges induced on the graphene-covered interface by each particle. This indirect coupling has an oscillatory behaviour as a function of the interparticle distance. Coupled-dipole equations [2] taking into account these effects have been derived, which allow to calculate an effective optical conductivity of the particles' monolayer (PML).



The combined graphene-PML system possesses some interesting properties. There is a collective polariton mode that causes a considerable enhancement of the THz radiation absorption in graphene, while the reflection drops to nearly zero for a broad range of angles of incidence (see figure). The frequency of the resonant mode can be adjusted by changing the Fermi energy in graphene via electrostatic gating and therefore it can be used for electrically controlled reflection and transmission of THz radiation. Another interesting effect related to the collective graphene-PML mode arises in scattering of SPPs propagating across a linear interface between a plain graphene sheet and the composite layer lying in the same plane.

[1] Jaime E. Santos et al., Phys. Rev. B **90**, 235420 (2014).

[2] R. M. S. Pereira et al., J. Nanophotonics **9**, 09736 (2015).