MAR12-2011-004482

Abstract for an Invited Paper
for the MAR12 Meeting of
the American Physical Society

Manipulating Plasmons Using Graphene for One-Atom-Thick Optical Signal Processing

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In this talk, we provide an overview of our recent theoretical work on merging the field of graphene with metamaterials and transformation optics. In particular, we show that the control and variation of graphene's conductivity, spatially and temporally, may offer a one-atom-thick platform for manipulation of optical signals propagating along the single sheet of graphene as the surface Plasmon polariton (SPP) surface waves. Since the phase velocity of the SPP surface wave directly depends on the graphene conductivity, tailoring the conductivity can be regarded as a "knob" to control and shape the propagation of such SPP across the graphene. We have shown that such inhomogeneous distribution of conductivity across the graphene gives rise to the notion of one-atom-thick transformation optics and metamaterials—essentially thinnest possible metamaterials [A. Vakil, N. Engheta, *Science*, 332, 1291 (2011)]. Additionally we have demonstrated, theoretically and using computer simulations, that one can achieve optical signal processing functions such as Fourier transforming across a single layer of graphene [A. Vakil, N. Engheta, "Fourier Optics on Graphene" *ArXiv* 1108.5218 (2011)]. The graphene-based Fourier optics suggests prospects for multilayer signal processing, allowing for design of ultra-compact nanoscale signal processing systems. We are also investigating other optical manipulation, such as waveguiding, field confinement in cavities, graphene antennas, optical spectrometry, and optical mirror reflection, all on one-atom-thick structures. In this talk, we will present some of our results on these topics.