PHYSICS AND ASTRONOMY COLLOQUIUM

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Many body effects in graphene revealed by infrared nano-imaging

Charge carriers in graphene behave as massless fermions obeying the Dirac equation with an effective speed of light given by the Fermi velocity. Early experiments seemed to suggest that many-body effects play only an insignificant role in the properties of graphene. In conflict with this common view infrared spectroscopy has uncovered rather exotic electrodynamics in graphene inconsistent with the picture of non-interacting Dirac quasiparticles [Nature-Physics 4, 532 (2008), PRL 102, 037403 (2009)]. Recent infrared nano-imaging studies have allowed us to take a much closer look at many-body effects at length scales commensurate with the omnipresent inhomogeneities of realistic samples. The experimental novelty of this work is that we have utilized propagating surface plasmons in graphene to probe losses in the electronic system [Nature 487, 82 (2012), Nano Letters 11, 4701 (2011)]. New nanoscopy data support the notion of strongly interacting electron liquid in graphene. This work – the first direct imaging of Dirac plasmons – also uncovers opportunities for nano-scale control of electromagnetic energy along the surface of graphene, far beyond what is attainable with metal-based plasmonics.

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