BIRCK Nanotechnology Center

PURDUE UNIVERSITY Discovery Park

"BNC Seminar"

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BRK, ROOM 1001

Subhasis Ghosh

School of Physical Sciences, Jawaharlal Nehru University, New Delhi-110067

Email: subhasis.ghosh.jnu@gmail.com, subhasis@mail.jnu.ac.in

Title: Many Body Effects on Optical Properties of Graphene

Bio: Subhasis Ghosh is professor of physics in School of Physical Sciences, Jawaharlal Nehru University, New Delhi. He graduated from University of Calcutta and received Ph.D. from Indian Institute of Sciences, Bangalore. Then he spent a couple of years at Max Planck Institute, Stuttgart, as a research associate. He has published more than 100 papers in reputed research journals. His research interests are transport and optical properties of condensed- and nano-phase of organic and inorganic semiconductors, in particular, (i) magnetism in oxide semiconductors, (ii) physics and technology of organic field effect transistors, and (iii) physics and technology of Dirac-Weyl materials (graphene, MoS_2) and graphene based field effect transistor.

Abstract: Graphene, a two-dimensional (2D) material shows remarkable optical and electronic properties, such as a linear energy dispersion, chirality and half-integer quantum Hall effect. Multilayer graphene flakes, held together by weak van der Waals forces have also attracted attention due to their stacking dependent electronic and optical properties. Interestingly, a vast majority of these properties can be understood in terms of a non-interacting picture. In particular, the optical conductivity of monolayer graphene in the near infra-red and visible range has been found to be independent of frequency, and equal to $e^2/4\hbar$. From experimental investigations of the optical properties of chemically exfoliated mono and multilayered graphene flakes, we probe the effect of electron-electron interactions on the universal optical transmittance and excitons in graphene. The electron-electron or Coulomb interaction strength is varied both by modulating the dielectric constant of the exfoliating solvent, as well as changes in the carrier density. To vary the carrier density controllably, a method has been developed to dope (n-type and p-type) graphene monolayers through charge transfer interaction by trapping selected organic molecules between graphene and underneath substrates. Controllability has been demonstrated in terms of shift in Raman spectra and Dirac point in graphene monolayers. We find that the universality is robust throughout the visible range of the spectrum, and this is consistent with chiral symmetry as its origin. It has been shown that universality is broken if chiral symmetry can be broken. This is further supported by changes in the excitonic features which could disrupt the chiral symmetry. The shift and broadening of excitonic features are found to impact the onset of universality at low wavelengths. Our experiments also help to verify the theoretically predicted transmittance spectra in the presence of Coulomb interactions and resolve the discrepancy in the numerical factor governing the magnitude and frequency dependence of the transmittance in monolayer.

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