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Electron-electron interaction and excitonic effects in graphene systems[1]

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Owing to the unique electronic structure of graphene and enhanced electron-electron and electron-hole interactions in lower dimensions, graphene structures exhibit interesting and novel electronic and optical properties. We discuss in this talk results from recent theoretical studies on several graphene systems. First-principles calculations, based on the GW-Bethe-Salpeter Equation approach, have predicted very strong features in the optical absorption spectra of single-layer graphene and multi-layer graphene, arising from resonant excitons. Many of these features have since been observed experimentally. We also explore the effects of charge carrier doping and of having an external electric field on the absorbance of graphene and bilayer graphene. Graphene nanoribbons are semiconductors that, owing to electron-electron interactions, also exhibit extraordinarily magnetic and excitonic effects. Another intriguing phenomenon is one in the magneto-optical response of graphene, which involves resonant transitions of absorption of a photon together with the simultaneous creation of an intervalley, intra-Landau level exciton and a K-phonon. Finally, first-principles results on the plasmon satellite structures in the spectral function of graphene computed with the GW method and beyond are presented. We discuss the origin of these phenomena and make comparison with experiments.

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