Excitonic Mass Gap in Uniaxially Strained Graphene

Anand Sharma [1,2]
Valeri Kotov [2]
Antonio H. Castro Neto [3]

[1] *Institut fuer Theoretische Physik, Universitaet Frankfurt, Max-von-Laue Str. 1, 60438 Frankfurt, Germany*
[2] *Department of Physics, University of Vermont, 82 University Place, Burlington, Vermont 05405, USA*
[3] *Centre for Advanced 2D Materials and Graphene Research Centre, National University of Singapore, 6 Science Drive 2, 117546, Singapore*

sharma@itp.un-frankfurt.de

Abstract

We study the condition of spontaneously generating an excitonic mass gap due to Coulomb interaction between anisotropic Dirac fermions in an uniaxially strained graphene. The mass gap equation is realized as a self-consistent solution for the self-energy within Hartree-Fock mean-field and static random phase approximation. It depends not only on the momentum because of long-range nature of the interaction but also on the velocity anisotropy due to uniaxial strain. We solve the nonlinear integral equation self-consistently by performing large scale numerical calculations on variable grid sizes. We evaluate the mass gap at the charge neutrality (Dirac) point as a function of dimensionless coupling constant and anisotropy parameter. We also obtain the phase diagram of the critical coupling, at which the gap becomes finite, against velocity anisotropy. Our numerical study indicates that with an increase in uniaxial strain in graphene the strength of critical coupling decreases which suggests anisotropy supports formation of excitonic mass gap in graphene.

Figures

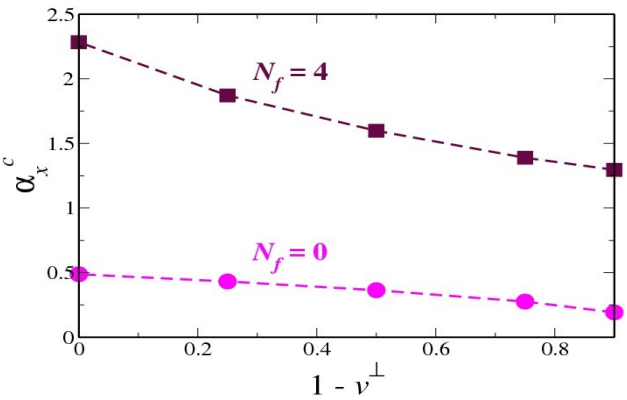

Figure 1: Phase diagram showing the dependence of the critical coupling constant, on the applied uniaxial strain in graphene for mean field (N_f =0) and static random phase approximation (N_f =4).