Condensed Matter Seminar

Strain engineering of electronic correlations in graphene

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In graphene, strain has a significant effect on the electronic properties. Due to graphene's peculiar lattice symmetry and band structure, the effect of strain is unique. Any deformation of the lattice structure affects the low energy quasiparticles near the Dirac point in the same way a gauge field does. The crucial difference is the fact that the effective field has opposite sign in the two Dirac cones and thus the total field vanishes and time reversal symmetry is restored. Of particular interest are inhomogeneous strain configurations that give spatially varying gauge fields corresponding to almost constant pseudo-magnetic fields. In such cases the unit cell has a large number of atoms and the direct diagonalization of the single-particle Hamiltonian is not possible. We have instead developed approximate methods to find the Green's function and subsequently physical properties [1]. With great improvement in speed by performing computations on video cards (GPUs) we studied the effect of various strain configurations on the electronic properties. We have shown how the superconducting proximity effect is modified [2], how a valley filter can be achieved by using a combination of pseudo and real magnetic fields [3] and we have presented possible strain configurations by using pillars deposited on substrates [4]. I will present an overview of our recent results and give insight into the possibility of inducing magnetism in graphene by applying strain.

References:

[1] L. Covaci, F.M. Peeters and M. Berciu, Phys. Rev. Lett. 105, 167006 (2010).
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[3] A. Chaves, L. Covaci, K. Rakhimov, G.A. Farias and F.M. Peeters, Phys. Rev. B 82, 205430 (2010).
[4] M. Neek-Amal, L. Covaci, and F. M. Peeters, Phys. Rev. B 86, 041405(R) (2012).