Local magnetic and electric state in pure and doped graphene

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Graphene is very interesting and potentially important material for solid state physics and electronics. The problem of ferromagnetic state in monoatomic layer of carbon atoms is still not quite clear. We consider a possibility of creation of the local magnetic moment $M(\mathbf{r})$ and electric polarization $P(\mathbf{r})$ as a problem of induced magnetic and electric polarization of the electron gas in graphene. We use a model of perturbation with an impurity in state A or B with strongly localized potential $V(\mathbf{r})$. We find the energy level of electron localized at the impurity and the wave function using different methods (solving the Schrödinger equation and using the Green's function formalism). Then we use Green's function formalism to calculate the induced magnetization and induced electric polarisation of the electron system using the linear approach of Dirac's Hamiltonian. We consider two cases with chemical potential $\mu = 0$ (no free carriers) and $\mu \neq 0$. If the chemical potential is equal to zero, we have only pure polarization and distribution of local induced magnetization and electrical moment as $\sim 1/r^3$. If the chemical potential is not zero, the RKKY oscillations appear on top of pure polarization. At small carrier density it enhances the induced local moments but a larger impurity density destroys the local magnetization and electric polarization.