

# Spin-orbit interaction in the graphitic nanocone

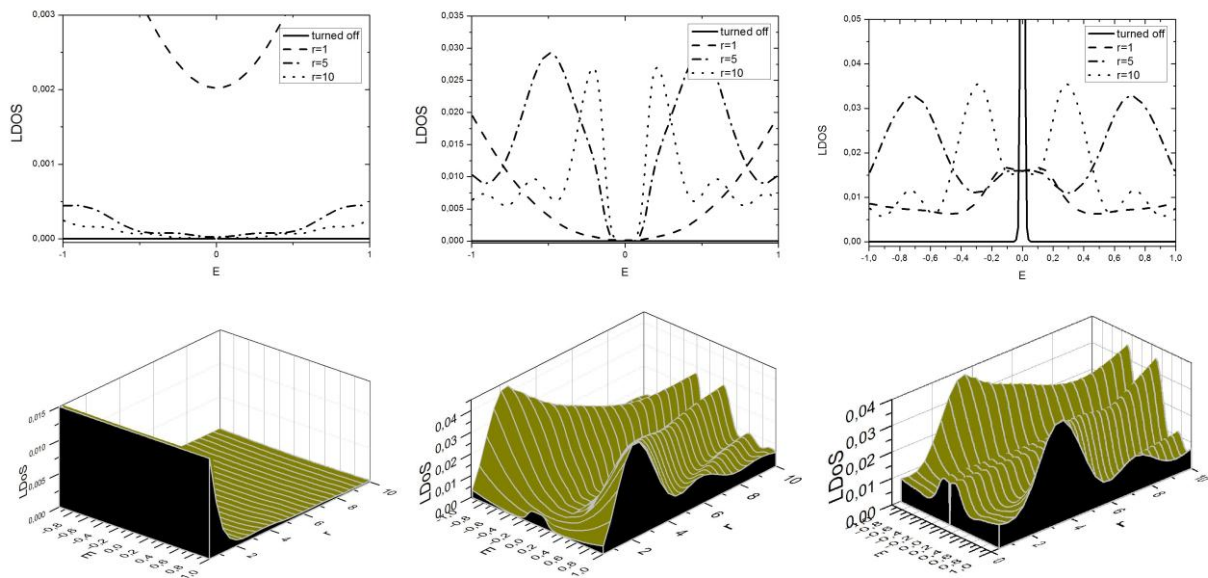
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**Abstract** The spin-orbit interaction in graphene is supposed to be weak, due to the low atomic number of carbon. In a curved graphene sheet where the symmetry of honeycomb lattice is broken there is a possibility of curvature-induced spin-orbit coupling. A consistent approach to introduce this kind of SOC has been developed by Ando [1]. The experimental evidence for this kind of spin-orbit coupling was reported by Kuemmeth et al. [2], where the authors measured the values of spin-orbit coupling in carbon nanotubes at various values of the magnetic field strength. It was revealed that the symmetry in electron-hole spectrum is broken. This can be caused by spin-orbit coupling. Energy spectra and transport properties of armchair nanotubes with curvature-induced spin-orbit interactions were investigated by Pichugin et al [3]. In [4] we derived the effective Hamiltonian for the graphitic nanocone with spin-orbit coupling induced by curvature and with the help of the Dirac-like equation, we introduced an explicit formula for the eigenspectrum of this Hamiltonian and found the solution numerically. Then we calculated the local density of states for different numbers of the pentagonal defects in the tip of the nanocone which influence the vortex angle.

## References

- [1] T. Ando, J. Phys. Soc. Jpn. **69** (2000) 1757.
- [2] F. Kuemmeth, S. Ilani, D. C. Ralph, P. L. McEuen, Nature **452** (2008) 448.
- [3] K. N. Pichugin, M. Pudlak and R.G. Nazmitdinov, Eur. Phys. J. B **87** (2014) 124.
- [4] R. Pincak, J. Smotlacha and M. Pudlak, EPJB (2014).



2D and 3D (bottom) graphs of the local density of states with and without (turned off) spin-orbital interaction for different distances  $r$  from the tip for different number of the defects:  $N_d = 1$  (left),  $N_d = 2$  (middle) and  $N_d = 3$  (right).