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Magnetism and magnetic interactions in graphene and graphite

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Magnetic materials and nanostructures based on carbon and other light elements provide a number of attractive opportunities for future information technologies such as spintronics and quantum information processing. In this talk, I review the first-principles studies of the magnetism induced by defects and edges in graphene and graphite. We show that in graphene the single-atom defects (e.g. vacancies and hydrogen chemisorption) induce the spin-polarized defect states [1,2]. The coupling between the magnetic moments is either ferromagnetic or antiferromagnetic, depending on whether the defects correspond to the same or to different sublattices of the graphene lattice, respectively. These results explain the recent experimental observations of high-temperature ferromagnetism in proton-irradiated graphite. Similarly, the zigzag edges of graphene are predicted to induce localized magnetic moments which can serve as a basis for novel spintronic devices. We address the question of the spin correlation length at finite temperatures in this one-dimensional magnetic system and establish the limitations of the proposed spintronic devices [3]. Finally, I consider the hyperfine interactions (i.e. the magnetic interactions between the spins of electrons and nuclei) in carbon nanostructures and materials [4]. Possible approaches for achieving long electron spin decoherence times in graphene-based nanostructures are discussed.

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