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Graphene magnetism due to point defects

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Much interest has been generated on intrinsic magnetism in materials without d or f electrons. This is especially true for carbon-based materials and, in particular, graphene. Many theoretical studies have predicted that point defects in graphene should carry a magnetic moment and these can in principle couple either ferromagnetically or antiferromagnetically. However, the experimental evidence for such magnetism remains both scarce and controversial. In this talk we will review our recent experimental results on graphite and graphene where we show that pure graphite exhibits no ferromagnetism or anti-ferromagnetism down to liquid helium temperatures. We will also show that point defects in graphene produced by; (i) fluorine adatoms in concentrations, x, gradually increasing to full stoichiometric fluorographene CFx (x=1.0) and (ii) irradiation defects (vacancies) – carry magnetic moments with spin 1/2. Both types of defects lead to notable paramagnetism but no magnetic ordering could be detected down to liquid helium temperatures. The induced paramagnetism dominates graphene's low-temperature magnetic properties, despite the fact that the maximum response we could achieve was limited to one moment per approximately 1000 carbon atoms. Our work clarifies the controversial issue of graphene's magnetism and opens the way to novel devices making use of its intrinsic magnetism. We also discuss how the magnetic properties of graphene can be changed by electric fields.