Photonics, electronics and spintronics with graphene quantum dots

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We describe here our recent theoretical work aiming at design of graphene nanostructures capable of realizing the three functionalities of a quantum circuit: electronics, photonics and spintronics, in a single material and at the nanoscale[1]. Integration of these different functionalities using graphene quantum dots may enable Carbononics - a unified approach to Information and Communication Technologies. The design tools include size, shape, type of edge, sublattice symmetry, topology, number of layers and carrier density in graphene quantum dots[1-9]. In particular, sublattice engineering allows design of magnetic moments tunable with voltage and light, size engineering leads to optical gaps from THz to UV while shape engineering leads to a degenerate exciton spectrum allowing for the generation of entangled photon pairs via XX-X cascade[7,8]. Geometry and e-e interactions allow for the integration of topologically protected states of matter into carbononics[9,10]. Comparison with experiment on colloidal graphene quantum dots[6-8] as well as other competing material systems [10,11] will be given.

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