Designing materials at the nanoscale: Semiconductor and Graphene Quantum Dots

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We review here recent theoretical and experimental results on designing materials at the nanoscale - semiconductor and graphene quantum dots. We briefly describe lateral quantum dot molecules as building blocks of quantum circuits based on electron spin: artificial Haldane gap device, GHZ maximally entangled state, Berry's phase and e-e driven topological phases generators[1,2]. We next turn to the locking of spin and orbital motion and emergence of tunable topologically protected chiral surface states in HgTe qdots[3]. Finally, we describe one atom thick semiconductor quantum dots made of graphene and compare them with semiconductor quantum dots. We show how their electronic, optical and magnetic properties can be engineered by the size, shape, type of edge, topology and number of layers [4-9]. Preliminary comparison of theory with experiment on optical properties of colloidal graphene qdots will be made[9].

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