76. Planar double quantum dot with two-electron occupation

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Double quantum dots (DQDs) in semiconductor structures are interesting physical systems to investigate the dynamics of the quantum states. In particular, when the DQD energy levels are controlled by external gate voltages, the interaction between the pair of dots can be modified to created energy level alignment resulting in resonant tunneling current through the DQD. The particle occupations of each dot affects the tunneling current through the Coulomb blockade effect, and the spin components of the particles in the dots also affect the current, as for instance via the Pauli blockade. These characteristics have been explored to use DQDs as platform for quantum computation, in which either charge or spin can play the role of the quantum bit (qubit). In this work we solve a model for the DQD in semiconductor structures. We consider the DQD formed in a two-dimensional electron gas by gate voltages in nearby electrodes. Our model is quasi-two dimensional, where the vertical direction is under strong confinement and the corresponding motion along it is considered quantized and frozen. The remaining planar problem is solved for the presence of two electrons in a potential profile of a DQD. Spin-orbit interactions, with the Rashba and Dresselhauss contributions, are included in our calculations, as is the effects of applied fields, electric and magnetic. The eigenstates are calculated by a modified split-operator method [1] to include two electrons and their spins. The energy levels are obtained in this method without the use of basis states, and in this way the method can give improved results for states close to a continuum of states. We present the dependence of the energy levels for applied magnetic and electric fields, aiming t use them in future simulations of the dynamics under time-dependent field for quantum computation applications. [1] M. H. Degani and M. Z. Maialle, J. of Computational and Theoretical Nanoscience 7, 454 (2010).

77. Wave-Packet Dynamics in Quantum Spin Hall Systems

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In the context of research on topological phases of matter, quantum spin Hall (QSH) systems are specially interesting for applications in spintronics. In this work, we numerically study the dynamics of wave packets in mercury telluride (HgTe) quantum wells. This system presents topologically-protected, spin polarized edge states (a signature of the QSH effect) if the width of the well is larger than a critical value ($d > d_c \sim 6.3$ nm). In our simulations, we consider the evolution of Gaussian wave-packet using the BHZ Hamiltonian using the method of (Fourier) split-operator method. We observe oscillatory behavior of the mean position of the packet that is closely related to effect of zitterbewegung. We also study the spin separation of the package into edge-state-like patterns at the edge of the system. The strong dependence of these behaviors with the initial conditions and the presence of electrical fields (in/out-of-plane) is also discussed.

78. Investigation of transport properties on PbTe/$Pb_{1-x}Sn_xTe$ heterostructures

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PbTe compounds have been used for the development of infrared photodetectors and diode lasers [1] over the decades. Introduction of Sn atoms makes this material even more interesting for practical applications as well as from the basics physics point of view. According to the band inversion model, the gap of Pb1-xSnxTe decreases as Sn composition increases, and vanishes for an intermediate alloy composition. Further increasing of Sn concentration leads to the band inversion and the energy gap starts to increase up to the SnTe value. Very recently, it was discovered that in the region of band inversion, transition from metallic to crystalline topological insulator (TCI) occurs [3]. Recent theoretical work demonstrated that the PbTe/Pb1-xSnxTe heterostructures can present topological states in the interface of the heterojunction. Such an interface of PbTe and Pb1−xSnxTe, at which four Dirac cones appear, is analogous to the surface of a weak TI [4]. In this work we perform electrical characterization in PbTe/Pb1-xSnxTe films for different values of x close to the band inversion in order to verify the existence a single gapless helical state in the [111] direction at the heterostructure interface. Morfological characterization will also be performed in order to provide a detailed view of these new structures. We hope that this work contribute to a better comprehension of the nature of topological insulators based on IV-VI compounds. Acknowledgments: The authors would like to acknowledge CAPES and FAPEMIG for support. References: [1] I. U. Arachchige and M. G. Kanatzidis, Nano Lett. 9 (4), 1583 (2009); [2] R. Jaramillo et al, Jour. Appl. Phys. 119, 035101 (2016); [3] P. Dziawa, Nature Materials 11, 1023 (2012).

79. Transition from negative to positive photoconductivity in p-type $Pb_{1-x}Eu_xTe$ films
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The phenomenon of photoconductivity has been used as an important tool to investigate the presence of additional states within the band structure of semiconductors [1] and has provided basic knowledge that allowed the development of photodetector and sensor devices along the last decades [2]. We investigated the photoconductivity effect in p-type $Pb_{1-x}Eu_xTe$ films for x=0.01, 0.02, 0.03, 0.05 and 0.06 at T=300K. The measurements revealed a clear transition from negative to positive photoconductivity as the Eu content x is increased at room temperature. This transition is related to the metal-insulator transition that occurs due to the disorder originated from the introduction of Eu atoms and it is an Anderson transition. Our investigation found that, from the potential application point of view, the sample x=0.06 is more suitable, i.e. it presents an almost noise free signal and the higher photoconductivity amplitude response observed. The photoconductive for the sample with x=0.06 was further investigated in the temperature range of 77 – 300K and, surprisingly, multiple additional transitions were observed with amplitudes that reached around 200 times the original value before illumination. We show that this anomalous behavior is a consequence of the generation and recombination rates between the bands and the 4f level and a defect level located inside the bandgap. The