Interaction between topological insulators and single emitters in diamond

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Abstract

We study the interaction of a nitrogen-vacancy (NV) center in diamond with the edge of a topological insulator in two dimensions modeled from the Hamiltonian proposed by Kane and Mele [1,2]. We use this model for a theoretical topological insulator as a first approximation to the problem of characterizing edge states by means of a quantum sensor such as the NV center. In particular, the Kane and Mele model predicts conducting edge states associated with a given spin with reverse currents whose direction is topologically protected. Thanks to this property, when a small electric potential is applied, the edge states are polarized and generate a spin density that produce an inverse magnetization at each edge. The NV sensor detects these variations in the magnetization since the longitudinal relaxation of the spin in its ground state is modified. We simulate the relaxation rates considering variations in the magnetization once the conductive edge states are populated by applying an electric potential as a perturbation to the system. This research is motivated by the development of electro-optical devices that involve the properties of topological insulators.

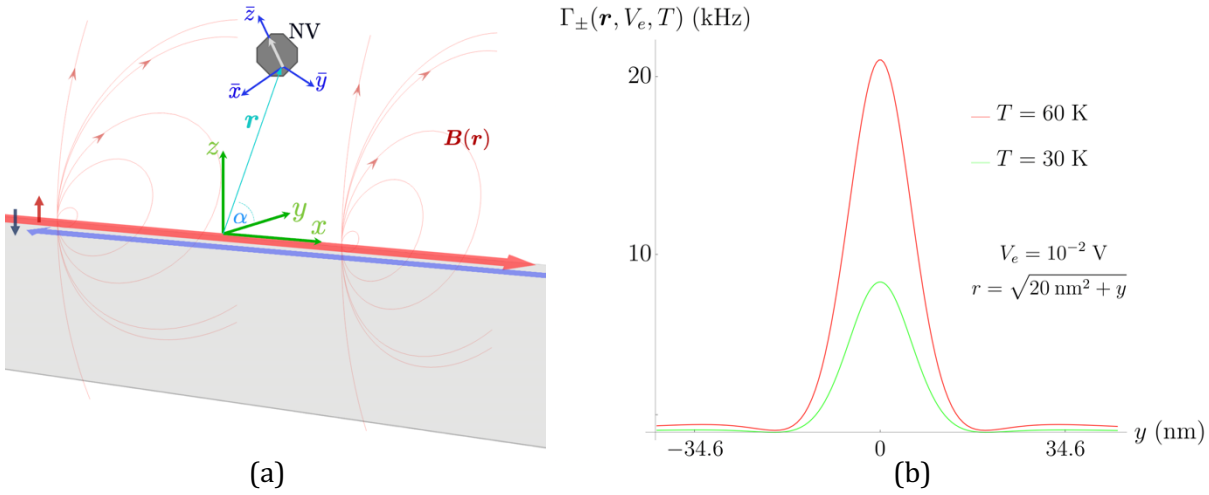

Figure 1: In (a), we show the spatial configuration between the topological insulator and the NV center sensor. In (b), the longitudinal spin relaxation rate in the ground state of the NV center when moving the sensor along the y-axis (transverse to the edge), keeping $z = 20$ nm constant for two temperatures and an applied voltage of 10^{-2} V

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Referencias

[1] Kane, C. L. and Mele, E. J. Quantum Spin Hall Effect in Graphene. Rev. Lett., volume 95, (2005), 226801.
[2] Kane, C. L. and Mele, E. J., Topological Order and the Quantum Spin Hall Effect. Phys. Rev. Lett., Volume 95, (2005), 14680.