SPIN-ORBIT EFFECTS IN SEMICONDUCTOR NANOSTRUCTURES IN A MAGNETIC FIELD

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We analyze the interplay between different spin-orbit (Dresselhaus, Bychkov-Rashba, and Zeeman) interactions in two-dimensional semiconductors under vertical and in-plane magnetic fields. The analysis is done in the effective-mass approximation approach. We obtained an analytical expression for the effective cyclotron frequency that depends on the spin-orbit interactions at the vertical magnetic field [1]. We show that spin precession in a semiconductor quantum wire, caused by the Rashba and the Dresselhaus interactions (both of arbitrary strengths), can be suppressed by means an in-plane magnetic field. Imposing a translational invariance in the longitudinal coordinate, we found a new type of symmetry, which arises at a particular set of intensity and orientation of the magnetic field and explains this suppression [2]. In virtue of this symmetry the spin precession is suppressed at arbitrary polarization of the injected electrons. By setting these conditions 'on' and 'off', the flow of a certain spin polarization through the device is either allowed or destroyed, thus, defining a transistor-like action for the spin. Introducing an additional random potential V_{sc} ($\langle V_{sc} \rangle = 0$) in the wire, we found that this symmetry is numerically robust even at large potential values : $Var(V_{sc}) \approx \pm 0.4 E_F$, where E_F is a Fermi energy of the injected electrons.

References

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