

1 spin field effect transistor

A type of quantum field effect transistor that operates purely on the flow of spin current in the absence of charge current. The rotating field induces a time-independent dc spin current, and at the same time generates no charge current. The physical principle of our SFET is due to a spin flip mechanism provided by the field.

2 Hamiltonian

$$H = \sum_{k,\sigma,\alpha=L,R} \epsilon_k C_{k\alpha\sigma}^+ C_{k\alpha\sigma} + \sum_{\sigma} [\epsilon + \sigma B_0 \cos \theta] d_{\sigma}^+ d_{\sigma} + H'(t) + \sum_{k,\sigma,\alpha=L,R} [T_{k\alpha} C_{k\alpha\sigma}^+ d_{\sigma} + \text{c.c.}] \quad (1)$$

We assume that there is only one orbit in the scattering region.

$$\epsilon_{Lk} = \epsilon_{Rk} = \epsilon_k.$$

A rotating magnetic field is

$$\mathbf{B} = B_0 \sin \theta [\cos(\omega t) \hat{x} + \sin(\omega t) \hat{y}] + B_0 \cos \theta \hat{z}. \quad (2)$$

A counterclockwise rotating field allows a spin-down electron to absorb a photon and flip to spin-up, and it does not allow a spin-up electron to absorb a photon and flip to spin-down.

The scattering region is characterized by an energy level $\epsilon = \epsilon_0 - qV_g$, controlled by the gate voltage V_g .

We solve the transport properties (charge and spin currents) of the model in both adiabatic and nonadiabatic regimes using the standard Keldysh nonequilibrium Green's function technique.

References

- [1] Y, K, Kato. Observation of the Spin Hall Effect in Semiconductors[J]. Science, 2004.