Electron wave packet dynamics for spin dependent tunneling current induced in one-dimensional nanostructure.

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Recent advances in nanotechnology have allowed us to fabricate nanoscale building blocks such as supremolecules or semiconductor quanum dots [1,2]. In due course these nano-objects would be assembled "archtectually" [3] to form nanosale circuits operating, possibly, under the principle of quantum mechanics. Since electric current in such nano-circuits is not macroscopic but consists of a few number of electrons, it must be quantum mechanical in nature, that would be characterized by interference as well as discreteness.

To study the nature of such quantum mechanical current we have recently developed a computation code for solving the time-dependent Schroedinger equation directly for a system of a few electrons bound to a quasi-one-dimensional nanoscale potential well. This system is also coupled to electrodes at borh terminals which is modelled by absorbing boundaries. In the present study we have focused on a system fabricated with three-terminals mimicking nanoscale transistors, namely, source, gate and drain. The source-drain transient current has been calculated by a flux of the probability density of the electron wave packet absorbed on the downstream side of the drain region where an absorbing potential has been placed. A remarkable dependence of the transient current on the spin configuration of the transmitted electrons has been observed. The origin of this spin dependence will be discussed on the basis of the nodal pattern of the electron wave packet.

[1] T. Sako et al., Phys. Rev. A 81, 022501 (2010).

[2] T. Sako et al., J. Phys. B 45, 235001 (2012).

[3] Molecular Architectonics: http://molarch.jp/?lang=en