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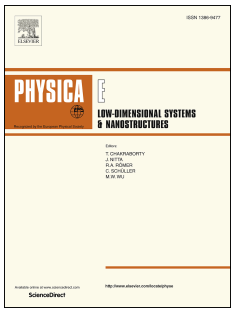

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Conductance of two-dimensional waveguide in presence of the Rashba spin-orbit interaction

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By using the transfer matrix method, we investigated spin transport in some straight structures in presence of the Rashba spin-orbit interaction. It is proved that the interference of two spin states is the same as that in one-dimensional Datta-Das spin field-effect transistor. The conductance of these structures has been calculated. Conductance quantization is common in these waveguides when we change the Fermi energy and the width of the waveguide. Using a periodic system of quadrate stubs and changing the Fermi energy, a nearly square-wave conductance can be obtained in some regions of the Fermi energy.

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Key words: Rashba spin-orbit interaction; Quantum waveguide; Conductance quantization; Datta-Das spin field-effect transistor; spin transport.

I. INTRODUCTION

Since Datta proposed the spin transistor [1], which demonstrates that the spin transport of the electrons in a two-dimensional electron gas (2DEG) can be controlled by the Rashba spin-orbit interaction(RSOI) [2], many similar idea devices have been brought forward [3-9]. Recently, Koo *et. al.* [10] reported the demonstration of the spin-injected field effect transistor in a high-mobility InAs heterostructure. They observed and fit to the Datta's theory [1] an oscillatory channel conductance as a function of monotonically increasing gate voltage. A great deal of one-dimensional (1D) devices [11, 12] were proposed and studied. We developed a systemetic theory of 1D quantum wave guide for turning structures and closed ring-shape structures [13, 14]. If the width of the waveguide is not narrow enough, the 1D approach can't work. Two-dimensional (2D) waveguides with lateral periodic magnetic modulations have been studied by Zhou *et. al.* [15]., and they reported that this structure can work as a spin filter just with a very weak magnetic modulation. In 2D case, the shape determines the wavefunctions of electrons localized there [16] and electron transmission. On the other hand, shape factor and RSOI can be used to control spin transport [17]. In presence of RSOI, waveguides with straight [18], nonuniform [19], and random configurations [20] have been studied by the scattering matrix method.

In this paper, we applied the 1D quantum wave guide theory of Rashba electron to the 2D