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Letter

Engineering the spin polarization of one-dimensional electrons

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Abstract

We present results of magneto-focusing on the controlled monitoring of spin polarization within a one-dimensional (1D) channel, and its subsequent effect on modulating the spin–orbit interaction (SOI) in a 2D GaAs electron gas. We demonstrate that electrons within a 1D channel can be partially spin polarized as the effective length of the 1D channel is varied in agreement with the theoretical prediction. Such polarized 1D electrons when injected into a 2D region result in a split in the odd-focusing peaks, whereas the even peaks remain unaffected (single peak). On the other hand, the unpolarized electrons do not affect the focusing spectrum and the odd and even peaks remain as single peaks, respectively. The split in odd-focusing peaks is evidence of direct measurement of spin polarization within a 1D channel, where each sub-peak represents the population of a particular spin state. Confirmation of the spin splitting is determined by a selective modulation of the focusing peaks due to the Zeeman energy in the presence of an in-plane magnetic field. We suggest that the SOI in the 2D regime is enhanced by a stream of polarized 1D electrons. The spatial control of spin states of injected 1D electrons and the possibility of tuning the SOI may open up a new regime of spin-engineering with application in future quantum information schemes.

Keywords: spintronics, spin polarization, spin–orbit interaction

(Some figures may appear in colour only in the online journal)

Introduction

There is considerable interest in utilizing the spin of electrons in future quantum information schemes. The use of semiconductors in this regard, with their flexibility, is particularly important both for spintronics and future information processing. The spin degree of freedom can most easily be monitored when electrons are restricted to lower dimensions and in terms of this the confinement of electrons to two-dimensions (2D) with their concentration controlled by a gate is extremely useful for such investigations. Although, the GaAs electron gas is one of the cleanest semiconductor systems with relatively small spin–orbit