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Quantum interference by spin manipulation using electric field

- Demonstration of the basic principle of spin transistors -

Motivation

We are trying to realize new devices whose function is based on the manipulation of “spin-orbit interaction (SOI)”. The SOI is the relativistic effect of moving electrons in a semiconductor, which can be controlled by gate voltage.

Originality

We investigated the interference effect of the electron wave due to the precessional motion of the electron’s spin and demonstrated that the spin precession can be controlled by external gate voltage, which is the basic principle of spin transistors.

Impact

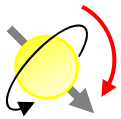
The electrical control of the electron’s spin in a semiconductor allows us to implement new functions in conventional electronic devices. For example, a spin transistor can be realized by controlling spin precession by gate voltage.

Contact person: Toshiyuki Kobayashi
Physical Science Laboratory, NTT Basic Research Laboratories
TEL: 046-240-3325 FAX: 046-270-2363
e-mail: t-koba@will.brl.ntt.co.jp

What is the Spin-orbit Interaction ?

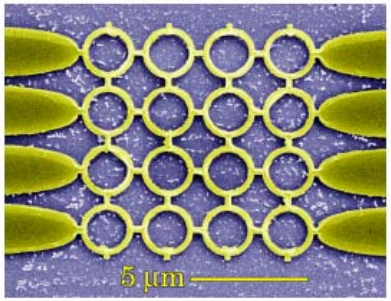
Rotating electron

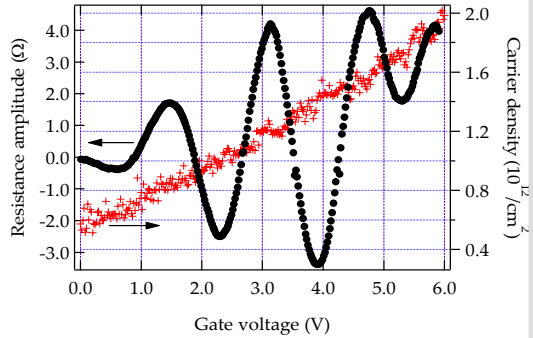
The spin-orbit interaction (SOI) causes spin precession.
The larger the SOI, larger the precession angle.



Spin precession

Quantum Interference Experiment





Electron waves interfere by changing spin precession angle by gate voltage.
Resistance of the semiconductor ring oscillates with the spin precession.

T. Bergsten et al. Phys. Rev. Lett. 97, 196803 (2006)

Spin Transistor

Novel transistors controlling spin