Magnetoelectric feedback effects in magnetic resonant tunneling structures

C. Ertler,[1] W. Pötz,[2] and J. Fabian[1]

[1] *Institute for Theoretical Physics, University of Regensburg, 93040 Regensburg, Germany*
[2] *Institut für Physik, Karl-Franzens-Universität Graz, Universitätplatz 58010 Graz, Austria*

The development of ferromagnetic dilute magnetic semiconductors (DMSs) with reasonably high Curie temperatures such as GaMnAs has strongly stimulated the survey of designing all-semiconductor spintronic devices. Especially, heterostructures made of stacked layers of both magnetic and nonmagnetic semiconductors provide a lot of opportunities for controlling and tuning their spin-dependent transport properties. For instance, highly efficient spin valves, spin switching and spin filtering devices have been demonstrated by exploiting magnetic resonant tunneling structures [1].

Here, we show that in resonant tunneling structures, which comprise a ferromagnetic quantum wells made of a DMS-material, interesting dynamical effects can occur [2]. In such systems the transport and magnetic properties become strongly coupled, since the ferromagnetic order in the quantum well is mediated by the itinerant carriers, which can tunnel in and out of the well. Both the Coulomb interaction of the particles and the magnetic exchange field, which causes a spin splitting of the well subbands, give rise to strong feedback effects on the tunneling current. Interestingly, for a broad voltage range self-sustained high-frequency oscillating currents associated with an oscillating well magnetization appear. The requirements for the occurrence of these dc-driven magnetoelectric oscillations are investigated and possible device setups, which should allow for an experimental observation, are discussed.

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