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ABSTRACTS

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BC-7O/3 Mechanism of the vortex polarity switching in nanomagnets

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A growing interest in nanomagnetism is attracted nowadays to magnetic vortices. Vortex can form a ground state of submicron sized nanodots due to the competition between exchange and dipolar interaction [1]. Using vortex state nanodots, researchers designed a new kind of non-volatile memory that could offer high density storage and high speed vortex magnetic RAM for next-generation devices. One bit of information corresponds to the upward or downward magnetization of the vortex core (vortex polarity). Exciting the vortex motion by a high-frequency magnetic fields or by a spin polarized currents, one can switch the vortex polarity on a picoseconds time scale [2]. The switching process of a moving vortex includes two main stages. The vortex structure is excited at the first stage by a pumping (different magnetic fields or spin polarized currents), leading to the creation of an out-of-plane dip nearby the moving vortex. When the pumping is strong enough, the dip amplitude can reach the maximum possible value (second stage), leading to a vortex-antivortex pair generation from the dip structure; its finally causes the switching of the vortex polarity.

The aim of the current study is to describe the mechanism of the dip creation. Typically to observe the vortex switching, one has to excite the low-frequency gyroscopical vortex motion. Therefore it is difficult to distinguish the vortex motion and the dip creation process. That is why there exists a general opinion about dynamical origin of the vortex switching [3]. Recently we predicted the switching for the immobile vortex by a high-frequency homogeneous [4] and nonhemogeneous rotating magnetic fields [5].

The key point of this process is the creation of a dip. The physical reason for the dip creation is softening of a magnon mode and consequently a nonlinear resonance in the system of certain magnon modes with nonlinear coupling. The usually observed single-dip structure is a particular case of a multidip structure. The dynamics of the structure with n dips can be strictly described as the dynamics of nonlinearly coupled modes. We also predict the dip creation for the immobile vortex under the action of the in-plane spin current. We consider two geometries, nanodisk and nanoring. The latter case provides the pure planar vortex with a dip situated nearby the vortex center. Our study shows that the dip creation process is determined by the in-plane magnetization inhomogeneity, provided by the static vortex structure; the direction of the dip development is specified by the current direction, and not by the vortex polarity [6].

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