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BOOK OF ABSTRACTS

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Creation of the Magnetic Skyrmions by the Stray Fields Produced by Superconductor Ring

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Magnetic skyrmions are topologically non-trivial magnetization configurations. In recent decades, skyrmions have attracted much attention due to their potential applications such as racetrack memory, microwave oscillators and logic nanodevices. Conventionally, magnetic skyrmions are stabilized by the Dzyaloshinskii-Moriya interaction (DMI), which imposes rather strong constraints on the choice of magnetic materials. Here, we propose an alternative approach to generate the skyrmion by the inhomogeneous field produced by superconducting (SC) nanostructure placed in the vicinity of the magnetic system, made of the material which does not exhibit DMI.

In the Meissner state, the eddy currents in a SC nanostructure shield its interior from the external magnetic field by forming a stray magnetic field outside the SC system. The stray field can be controlled by both the external magnetic field and the time-dependent electric field. When the magnetic system is located in the vicinity of the SC nanostructure, the stray field of the superconductor can influence the magnetization dynamics. In our work, we theoretically investigate the creation of magnetic skyrmions in a uniform magnetic layer by the stray field of an SC ring.

The hybrid system under study consists of a Ga:YIG ferrimagnetic (FM) thin film and a flat SC ring made of Nb. In Ga:YIG, the shape anisotropy is overcome by the out-of-plane anisotropy, leading to the out-of-plane orientation of the magnetization. We have considered two cases: a) the system is placed in an external magnetic field perpendicular to the FM layer and eddy currents are induced in the SC ring b) the electric field pulse is applied to the SC ring to create a unidirectional superconducting current. In both scenarios, the eddy currents in the SC create a non-uniform distribution of the magnetic field with radial symmetry in the FM film, which is favorable for the appearance of Neel-type skyrmions.

We did not consider the impact of the FM layer on the SC strip. Our studies were carried out in two steps. First, we calculated the static stray field generated by the SC strip. It was determined from the distribution of SC currents, which was found by semi-analytical solution of the London equation [1]. The stability and sizes of the skyrmion in the magnetic film are calculated taking into account the SC stray fields (Zeeman interaction), the exchange interaction, the magnetostatic interaction and the out-of-plane magnetic anisotropy. The generalized DeBonte ansatz [2] is used to describe the inhomogeneous skyrmion magnetization.

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