The volume of data generated and shared by society, businesses, public administration and researchers increases immeasurably. To store this data we need to continuously increase the number of storage devices and density. Today's technology is constantly evolving, the capacity, the speed of writing and reading is increasing, however it seems that it is inevitably approaching the physical limits of further miniaturization and increasing the density of packing. To overcome these limits we need to look forward for new generation of data storage technology. One of the new concepts is to store the data in atomic structures[1] or to introduce small disturbances in the magnetic configuration on the surface of magnetic materials. One of such ideas is the manipulation of specific configurations of magnetic moments in ferromagnetic materials, called **skyrmions** (see Fig. 1). Skyrmion is possibly the smallest, but energetically stable perturbation of a uniform magnetization. Its structure can be described as a small swirling defect in the magnetization texture. Professor Albert Fert, the Nobel Prize Laureate in Physics in 2007 and a leading researcher of skyrmion behavior, during one of the conference[2] underlined the fascinating properties of skyrmions showing great potential for highly energy-efficient applications for storing and processing information.

Figure 1. 3D visualization of Néel-type skyrmion. Figure reproduced from[4].

The main scientific objective of the project is to carry out theoretical studies based on the micromagnetic simulations about bi-stable skyrmion states in multilayer ferromagnetic nanostructures in the form of nanodots. The achievement of the Project objectives shall move the research beyond the state of the art and open the new ways for new applications of skyrmions in data storage and processing technology. In order to propose new skyrmion based applications, first, basic research on physical factors, like material parameters, external magnetic field and geometry, and their influence on the of bi-stable skyrmion states properties have to be done. The project was divided into five main research objectives. The first three involve the study of the influence of various factors on the properties and stabilization process of bi-stable skyrmion states due to the influence of: (i) material parameters for different size of the nanodot, (ii) nonuniformity of the dot edge, or (iii) the presence of additional, nonuniform layer of the ferromagnetic material. Next, the knowledge gained will be used to study (iv) switching techniques between bi-stable states, and (v) static and dynamic properties of the previously designed nanodots arrays.

All the tasks listed in the Project are characterized by a great innovativeness and are motivated by the lack of the relevant results in literature. Nevertheless, bi-stability of the skyrmion was presented for the first time in our paper[3] which was selected for the cover of Physica Status Solidi: Rapid Research Letters journal. The further development of knowledge about bi-stable skyrmions in the form of systematic studies proposed in the Project gives a real chance to fully understand the physical phenomena determining the properties of these systems, and thus speed up the possibilities of their experimental verification.

An additional effect of the project will be the new knowledge about the skyrmion numerical relaxation processes, and new and optimized relaxation algorithms for this type of systems will be developed. Also an open-source software for the analysis of the results of micromagnetic simulations will be designed and published. Overall, the proposed research should help to better understand the properties of the skyrmions stabilization process, bi-stable skyrmion states, and will have outstanding influence on future studies and applications of skyrmions.

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