Ultra-small zero-field skyrmions in ferromagnetic and synthetic antiferromagnetic multilayers

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Recently room-temperature skyrmions stabilized in ferromagnetic films and multilayers by interfacial Dzyaloshinskii-Moriya interaction (DMI) has been demonstrated showing promise for encoding information bits in new computing technologies [1]. In ferromagnetic multilayered systems, the observation of skyrmions requires indeed the application of perpendicular field of a few tens of mT. Here we first show that inserting a bias layer in the multilayer stack, and utilizing interlayer electronic coupling between this bias layer and the ferromagnetic skyrmion multilayer, we successfully demonstrate the stabilization of sub 100 nm skyrmions at room temperature. However, a remaining challenge in ferromagnetic systems is that a transverse deflection of moving skyrmions is present that hinder their efficient manipulation. Antiferromagnetic skyrmions could lift these limitations [4-5]. In this study, we will show that room-temperature antiferromagnetic skyrmions can be stabilized in synthetic antiferromagnet (SAF) systems. Utilizing the same type of electronic bias layer, we demonstrate by Magnetic Force Microscopy [6] and by spin NV relaxometry [7] that the spin-spiral state obtained in a SAF system with vanishing perpendicular anisotropy can be turned into isolated antiferromagnetic skyrmions stable at zero field. These experimental results are completed with model-based estimations of their size and stability, showing that room-temperature stable antiferromagnetic skyrmions below 10nm in radius can be anticipated in further optimized SAF systems [6]. Finally, we will show how non collinear spin textures stabilized in SAF systems can be electrically detected through the analysis of their magnetoresistive response [8].

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