Experimental observation of magnetic bobbers in chiral magnet

With the support by the National Natural Science Foundation of China and Chinese Academy of Sciences, the research team led by Dr. Du HaiFeng (杜海峰) at the High Magnetic Field Laboratory, Chinese Academy of Sciences collaborated with two teams led by Dr. Filipp N. Rybakov and Prof. Rafal E. Dunin-Borkowski at Forschungszentrum Jülich GmbH Germany reports the discovery of magnetic chiral bobbers in a chiral magnet. The result was published in *Nature Nanotechnology* (2018, 13: 451—455).

At the moment, we all are witnesses of a critical moment in the history of magnetic hard disk drives (HDD) and digital magnetic memory in general. The HDD turned to be an extremely successful approach for data storage technology. Nevertheless, new solid state disk drives which are purely based on semiconductor technologies in certain important indicators are already ahead of HDD. The main disadvantage of HDD is the presence of movable parts and mechanical engines which consume a lot of power and have natural limitation of their operating speed. Then, what is the future of magnetic memory devices? Will they be substituted by semiconductor devices completely?

In the light of recent progress in the field of design of a new materials and device manufacturing on a nanoscale, magnetic materials are right now approaching the stage of their reincarnation into a modern solid-state magnetic memory. One representative magnetic material is chiral magnets, which can support a very stable nanoscale magnetic vortex, termed as skyrmions. The magnetic skyrmion possesses small size, topological stability and low driven current so that it is a natural candidate for the data bit carriers.

However, the scheme of device requires lots of extra efforts to pin individual skyrmions to the desired position to achieve the data encoding because magnetic systems allowing coexistence and stability of more than one type of localized excitations are extremely rare in the nature. In this sense, the only way for binary data encoding is the presence or absence of skyrmion in a certain position.

A previous theory has predicted that cubic chiral magnets can also stabilise another type of localized excitation named chiral bobbers. In this work, they present the first direct observation of chiral bobbers and prove that in cubic chiral magnets they can coexist with magnetic skyrmions. The coexistence of this state in a wide range of parameters allowed them to introduce a novel approach for data encoding where the binary data stream, for instance 1-0-0-1-0-1-0-1, is represented by the sequence of S-B-B-S-B-S-B-S (S—skyrmion, B—chiral bobber). Because the information is encoded only in their sequence, any additional effort to maintain the distance between data bit carriers is not required at all. In this way, the cost consumed to pin the skyrmions in previous devices is totally saved.

This work is critical for the following development of magnetic storage technology and opens a new perspective for possible application of cubic chiral magnets.

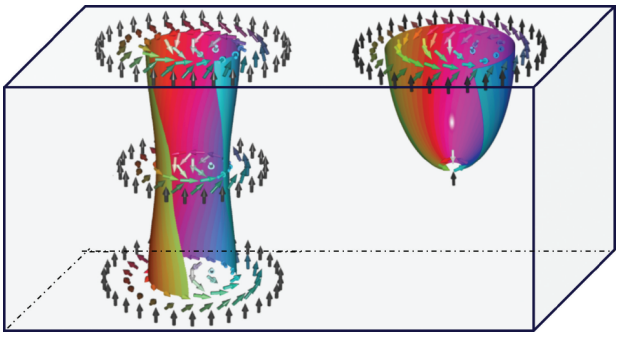

Figure Magnetic skyrmion and bobber in a nanostripe.