Team ahead of the 'curve' in magnetic study

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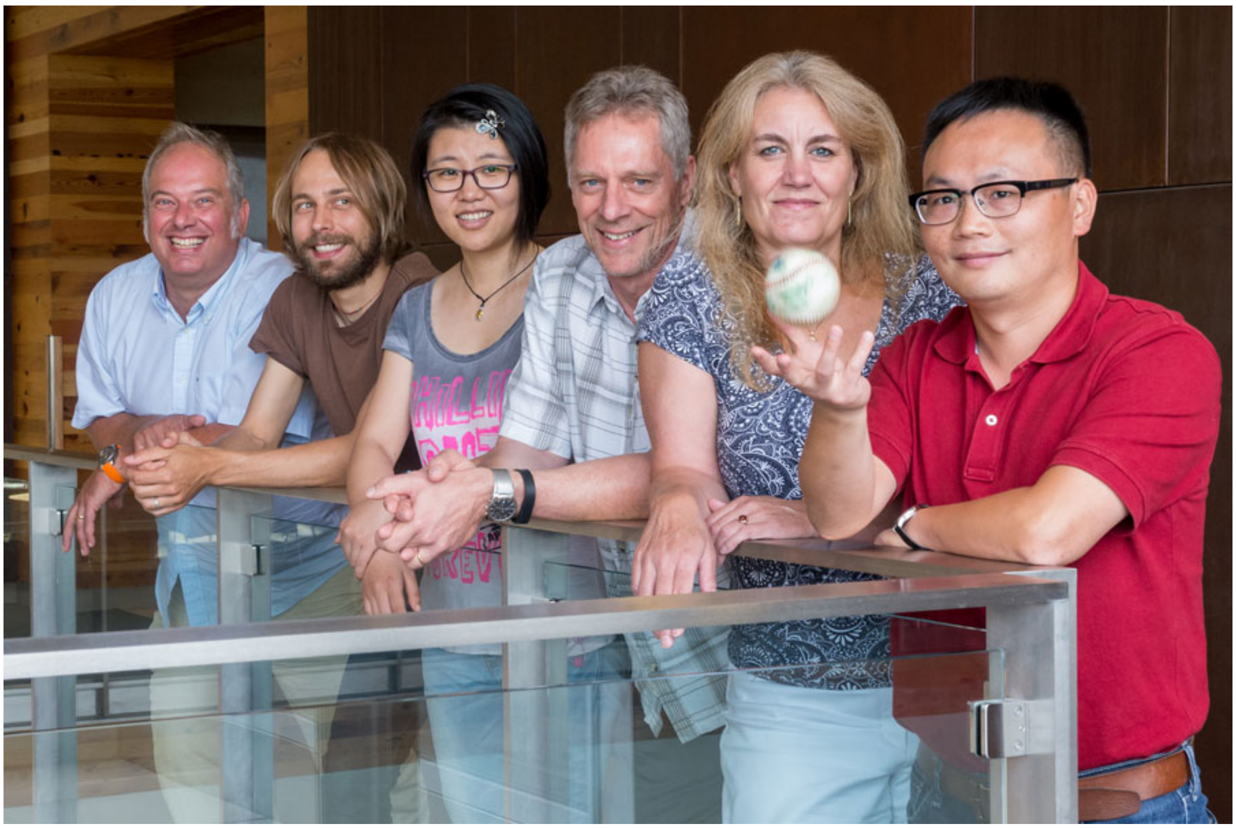

A new study by researchers at the U.S. Department of Energy's Argonne National Laboratory determined that magnetic skyrmions – small electrically uncharged circular structures with a spiraling magnetic pattern – do get deflected by an applied current, much like a curveball getting deflected by air. Credit: Mark Lopez

When a baseball pitcher uncorks a nasty curveball, the spinning motion of the ball forces air to flow around it at different speeds, causing the ball to "break" in one direction.

The physics behind this kind of deflection also work at smaller scales. For certain physical systems at the atomic level, a similar phenomenon occurs. Scientists have known for years that electrons get deflected when a magnetic field is applied.

However, until now scientists did not have a way of seeing if and how certain non-electrically charged, but magnetically organized, structures also take a curved path under an applied current—and the answer to that question could have big implications in the world of data storage.

In a new study by researchers at the U.S. Department of Energy's (DOE's) Argonne National Laboratory, scientists noticed that magnetic skyrmions – small electrically uncharged circular structures with a spiraling magnetic pattern—do get deflected by an applied current. Although skyrmions do not have electric charge, they do have what researchers call "topological charge," and it is this charge that causes their deflection.

"We noticed that the angle of deflection is dependent on the size of the skyrmion and the amount of current that we apply," said Argonne physicist Suzanne te Velthuis, who led the study.

Being able to manipulate the motion of skyrmions is of interest to materials scientists because the magnetic textures of the structures could serve as a method to encode data with low power. With the ability to control the motion of skyrmions with a small current, researchers could manipulate them in memory devices that form the basis of a new regime known as spintronics.

The researchers also noticed that the motion of the skyrmions caused by the applied current could be affected by defects or by how close the skyrmions come to the edge of the material.

"You can also think of the skyrmion motion as like trying to roll a bowling ball across a bowling alley," said Argonne materials scientist Axel Hoffmann, another author of the study. "If the alley is smooth, the ball or skyrmion will roll one way, but if it has many divots like an egg carton, it will roll very differently."

Sometimes if a skyrmion reaches the edge of the material, it will bounce back; in other cases, however, the skyrmion will disappear once it reaches the edge. "If we want to be able to use skyrmions for data encoding, we want to make sure that we do not lose the information that is embedded in the skyrmion," said former Argonne postdoctoral researcher Wanjun Jiang, the first author of the study.

"Understanding skyrmion physics could open up a wide range of new devices that are as yet still hypothetical," said Bryn Mawr College graduate student Xiao Wang, another author of the study.

A paper based on the study, "Direct Observation of the Skyrmion Hall Effect," appeared in the September 19 issue of *Nature Physics*.

More information: Wanjun Jiang et al. Direct observation of the skyrmion Hall effect, *Nature Physics* (2016). DOI: 10.1038/nphys3883 , arxiv.org/abs/1603.07393

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