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Unraveling skyrmion spin texture using resonant soft x-ray scattering[1]

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The recent discovery of skyrmions, that were originally predicted in context of high energy physics, in magnetic materials has sparked tremendous interest in the research community due to its rich physics and potential in spintronics applications. Skyrmions have an unusual spin texture that manifests as magnetic knot and can be easily moved around. Understanding the fundamental physics and mechanisms for controlling their dynamical properties presents important scientific challenges. So far experimental verifications of the skyrmions in magnetic systems have come from neutron scattering and Lorentz transmission electron microscopy (TEM) measurements. In this talk we report the first observation of the skyrmions using resonant soft x-ray scattering. We have used soft x-rays tuned to the Cu L_3 edge to diffract off the skyrmion lattice in a multiferroic Cu_2OSeO_3 compound. We show that in Cu_2OSeO_3 there exist two skyrmion lattices arising due to the two inequivalent Cu-O sublattices that have two different magnetically active *d*-orbitals. The two skyrmion sublattices are mutually rotated with respect to each other. The angle of rotation could be changed by an external magnetic field, thereby indicating possible existence of a new phase. We have also studied skyrmion spin texture in an ultra-thin Fe/Gd multilayer that shows perpendicular anisotropy. The Fe/Gd sample exhibits a near perfect aligned stripe phase. Within a small range of temperature and magnetic field we observe a hexagonal scattering pattern due to skyrmion bubbles. Analysis of the scattering pattern suggests that the skyrmion lattice unit cell contains two skyrmions. The biskyrmion state is also revealed by Lorentz TEM images. The near room temperature discovery of skyrmion in a technology relevant material is a significant step towards using skyrmions in magnetic devices.

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