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Above-room-temperature formation of magnetic skyrmion in β-Mn typechiral magnets

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Magnetic skyrmions are nanometric particle-like objects in magnets whose stability is topologically protected due to their vortex-like spin structures, and therefore have recently attracted increasing attention from the viewpoints of possible technological applications for spintronics, as well as their interesting emergent electro-magnetic responses. Indeed, those in metallic systems had been shown to be controllable by low electrical current excitation, both experimentally and theoretically, and thus proved to be very promising for the application to ultra-low power consumption high-density memory that can use one skyrmion as one information unit. For that purpose, skyrmions in the magnets with crystal chirality as meditated by Dzyaloshinskii-Moriya interaction are preferable due to their smallness in size (typically <~150 nm) and unique helicity (spin-swirling direction in the vortex). However, skyrmions in chiral magnets have so far been observed only below room temperature and limited to a single class of materials, namely, B20-type (MnSi-type) alloys. Toward technological applications, it has been crucial to overcome these limitations.

In this presentation, we demonstrate the formation of skyrmions with unique spin helicity at and above room temperature in a new class of cubic chiral magnets, namely β-Mn-type Co-Zn-Mn alloys with a different chiral space group from that of B20 compounds. Combined investigations in terms of Lorentz transmission electron microscopy, magnetization, and small angle neutron scattering measurements unambiguously reveal the formation of the skyrmion crystal under the application of magnetic field in both thin-plate (thickness<~150 nm) and bulk forms. Our findings demonstrate the possibility that new skyrmion-hosting systems can be found in a variety of non-centrosymmetric crystal symmetries, which will stimulate further experimental exploration of other realization. Likewise, our discovery of stable skyrmion beyond room temperature overcomes a key difficulty in integrating the skyrmions into technological spintronics devices and applications.

Biography:

Yusuke Tokunaga was born in Tokyo, Japan in 1977. He earned his bachelor's degree in 2000, Master's degree in 2002, and PhD in 2005 from Department of Applied Physics, University of Tokyo. After spending two years as a researcher at Spin Superstructure Project, ERATO, Japan Science and Technology Agency (JST) and four years at Multiferroics Project, ERATO-JST, he moved to Advance Science Institute (ASI), RIKEN as an ASI Research Scientist in 2011, and then toRIKEN Center for Emergent Matter Science as a Senior Research scientist in 2013.He is currentlyassociate professor of Department of Advanced Materials Science, University of Tokyo.His current area of interest is in cross-correlated phenomena in stronglycorrelated electron systems,multiferroic materials, and magnetic skyrmions.