Skyrmions in a Doped Antiferromagnet

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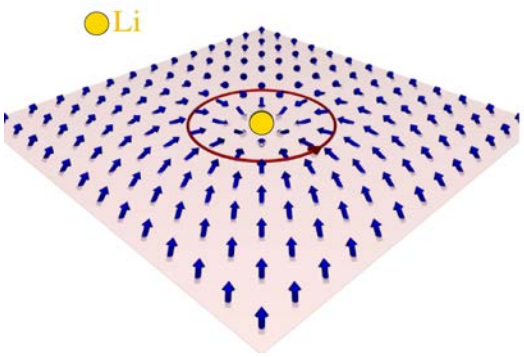
Skyrmions are "knots" in an otherwise ordered spin texture, which behave as excitations with particlelike properties. They have been observed in various ferromagnetic (FM) metals. Skyrmions have been predicted to emerge also in the ground state of doped antiferromagnetic (AFM) insulators, but the identification of such isolated skyrmions has been a challenge.

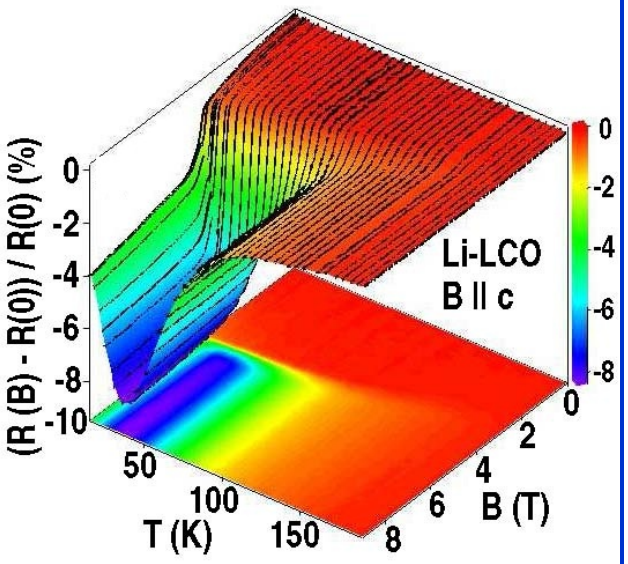
Our study of the effects of temperature T and magnetic field B on the in-plane electrical resistance R of the insulating AFM $La_2Cu_{0.97}Li_{0.03}O_4$ reveals a striking nonmonotonic T dependence of the magnetoresistance (MR) step associated with a weak FM transition. We show that the data are described very well by including the effect of skyrmions within the existing theoretical framework for the MR. The combination of the magnetization and the MR data performed over a wide range of T, B, and field orientations rule out all other known mechanisms as a possible explanation.

This is the first experimental support for the predictions of skyrmions in AFM insulators. Our work may offer new insights into the mechanisms that can stabilize or suppress topological excitations in complex magnetic systems.



The skyrmion configuration of the weak FM moments associated with the AFM ordering of spins on Cu atoms in CuO_2 planes. Weak FM moments have a staggered order along the c axis. The red circle represents the skyrmion core size.

The surprising nonmonotonic T-dependence of the MR step size. A steplike decrease of the MR is a result of the first-order, weak FM transition caused by a discontinuous spin-flop reorientation of the weak FM moments in a sufficiently large B||c.



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