Spin Chirality and Berry Phase Phenomena in Pyrochlore-type Mo-Oxides

Y. Tokura
Department of Applied Physics, University of Tokyo
Spin Superstructure Project, ERATO, JST
Correlated Electron Research Center (CERC), AIST

In $Nd_2Mo_2O_7$ and related $R_2Mo_2O_7$ (*R* being a rare-earth ion) compounds, the Ising anisotropy of Nd (or *R*) moments on the pyrochlore lattice interact ferromagnetically with each other and anitiferomagentically with Mo spins, giving rise to the non-coplanar configuration with spin chirality. This spin-chirality habit is transmitted to the ferromagnetic Mo system with the similar phyrochore lattice via the d-f exchange interaction. Thus the conduction electrons on the spin-chiral lattice gain the quantum Berry phase, which shows up as an increasing transverse conductivity σ_{xy} with the increase of the spin chirality (or the decrease of temperature)[1].
The anisotropic Hall effect and magnetization have been investigated for single crystals of $Nd_2Mo_2O_7$ under high magnetic fields up to 27T. The Hall resistivity changes sign with increasing magnetic field applied along [111] direction, while it monotonously approaches zero with the field applied along [100] or [110] direction. The specific heat measurements under magnetic fields (*H*) along the respective directions indicate that the reversal of the spin chirality occurs for *H*//[111], corresponding to the transformation from the two-in two-out to three-in one-out configuration of the Nd (and hence Mo) moments. The observed behavior of the Hall resistivity is in accord with the prediction by the Berry phase theory and is interpreted in terms of field-induced reversal of spin chirality on the pyrochlore lattice.
Further attempts to manipulate the spin chirality and Berry phase in these conducting ferromagnets are presented.

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[1] Y.Taguchi, Y.Oohara, H.Yoshizawa, N.Nagaosa, and Y.Tokura, Science, **291**, 2573 (2001).