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EINLADUNG zum IFP-SEMINAR

Magnetoelectric Crankshaft in $GdMn_2O_5$

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Host: Andrei Pimenov

Termin: Mittwoch, 10. Februar 2021, 16 Uhr CET

Ort: Via ZOOM,
https://tuwien.zoom.us/j/93044890183?pwd=S1NaeS9CazRGRFlhWnoxRHVwME5PZz09
(if link does not work please insert in browser by Copy/Paste)

Abstract:

Electric control of magnetism and magnetic control of ferroelectricity can improve energy efficiency of magnetic memory and data processing devices. The magnetoelectric switching [1] requires more than just a coupling between spin and charge degrees of freedom and is hard to achieve. We show that the application and subsequent removal of magnetic field along, a particular “magic” angle reverses the electric polarization of the multiferroic $GdMn_2O_5$ [2,3], induced by an antiferromagnetic spin ordering. The polarization follows a never before observed double hysteresis loop, requiring two up-and-down field sweeps to return the system to its original state. During the field sweeps, we find that the spins rotate in a unidirectional sense, in increments close to 90°.
$GdMn_2O_5$ thus resembles a microscopic magnetic analogue of a crankshaft, converting the back and forth variations of the magnetic field into a circular spin motion. The resulting magnetoelectric switching is independent of the sign of the magnetic field and does not require magnetoelectric cooling. It is found that the double hysteresis loop regime emerges as a topologically distinct region (around the magic angle) between two more regular single hysteresis loop regions at high or low field angles.
We discuss the energetics that lead to this remarkable deterministic behavior, and relate it to those in Thouless or charge pumps [4,5]. We furthermore demonstrate the robustness of the topological state by demonstrating a broad set of model parameters for which the double hysteresis region appears.

References

[1] Tokura, Y., Seki, S., & Nagaosa, N. (2014). Multiferroics of spin origin. Reports on Progress in Physics, 77(7). https://doi.org/10.1088/0034-4885/77/7/076501
[2] Tokura, Y., Seki, S., & Nagaosa, N. (2014). Multiferroics of spin origin. Reports on Progress in Physics, 77(7). https://doi.org/10.1088/0034-4885/77/7/076501
[3] Lee, N., Vecchini, C., Choi, Y. J., Chapon, L. C., Bombardi, A., Radaelli, P. G., & Cheong, S. W. (2013). Giant tunability of ferroelectric polarization in GdMn2O 5. Physical Review Letters, 110(13), 2–5. https://doi.org/10.1103/PhysRevLett.110.137203
[4] D. J. Thouless, Quantization of particle transport, Phys.Rev. B27, 6083 (1983
[5] Lohse, M., Schweizer, C., Zilberberg, O., Aidelsburger, M., & Bloch, I. (2016). A Thouless quantum pump with ultracold bosonic atoms in an optical superlattice. Nature Physics, 12(4), 350–354. https://doi.org/10.1038/nphys3584