Dynamic rotor mode in antiferromagnetic nanoparticles

We present experimental, numerical, and theoretical evidence for an unusual mode of antiferromagnetic dynamics in nanoparticles. Elastic neutron scattering experiments on 8-nm particles of hematite display a loss of diffraction intensity with temperature, the intensity vanishing around 150 K. However, the signal from inelastic neutron scattering remains above that temperature, indicating a magnetic system in constant motion. In addition, the precession frequency of the inelastic magnetic signal shows an increase above 100 K. Numerical Langevin simulations of spin dynamics reproduce all measured neutron data and reveal that thermally activated spin canting gives rise to an unusual type of coherent magnetic precession mode. This "rotor" mode can be seen as a high-temperature version of superparamagnetism and is driven by exchange interactions between the two magnetic sublattices. The frequency of the rotor mode behaves in fair agreement with a simple analytical model, based on a high-temperature approximation of the generally accepted Hamiltonian of the system. The extracted model parameters, such as the magnetic interaction and the axial anisotropy, are in excellent agreement with results from Mossbauer spectroscopy.

General information
Publication status: Published
Organisations: Department of Energy Conversion and Storage, Mixed Conductors, Electrofunctional materials, Imaging and Structural Analysis, University of Copenhagen, Jülich Research Centre, Technical University of Denmark
Number of pages: 10
Publication date: 2015
Peer-reviewed: Yes

Publication information
Journal: Physical Review B Condensed Matter
Volume: 91
Issue number: 9
Article number: 094421
ISSN (Print): 0163-1829
Ratings:
Scopus rating (2015): CiteScore 2.8 SJR 2.377 SNIP 1.216
Web of Science (2015): Impact factor 3.718
Web of Science (2015): Indexed yes
Original language: English
Electronic versions:
Dynamic_rotor_mode.pdf
DOIs:
10.1103/PhysRevB.91.094421
Source: FindIt
Source ID: 274573567
Research output: Contribution to journal › Journal article – Annual report year: 2015 › Research › peer-review