Samarkand State University named after Sharof Rashidov

Samarkand International Symposium on Magnetism

2 – 6 July, 2023

BOOK OF ABSTRACTS

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Book of Abstracts

Main Topics

Spintronics, Magnonics, Magnetotransport
Magnetophotonics (linear and nonlinear magnetooptics, magnetophotonic crystals)
High Frequency Properties and Metamaterials
Diluted Magnetic Semiconductors and Oxides
Magnetic Nanostructures and Low Dimensional Magnetism
Magnetic Soft Matter (magnetic polymers, complex magnetic fluids and suspensions)
Soft and Hard Magnetic Materials
Magnetic Shape-Memory Alloys and Magnetocaloric Effect
Multiferroics
Topological Insulators
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Theory
Magnetism in Biology and Medicine
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5OT-A-2

MAGNETIC ORDERING IN A DIPOLAR MAGNET $LiGdF_4$

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Rare-earth tetrafluorides $LiREF_4$ are considered as magnetic systems with dominant dipolar interaction. However, the magnetic ordering in different members of this family is strongly influenced by anisotropy of magnetic ions, varying from a dipolar Ising ferromagnet (T_C=1.53 K) for holmium system to a planar antiferromagnet (T_N=0.38 K) for erbium compound. Lack of magnetic ordering in the most isotropic $LiGdF_4$ down to at least 400 mK [1] results from a recently established fine balance of various competing magnetic interactions which can be treated as a new type of "hidden" magnetic frustration [2]. This opens a wide space for experimental studies both of fundamental and practical importance. The former implies the search for novel exotic low-temperature types of magnetic ordering while the latter promises achievements in the sphere of magnetic refrigeration applications.

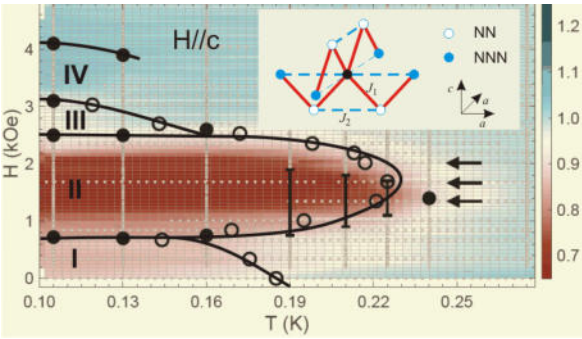

Figure 1. Phase diagram of $LiGdF_4$ measured in magnetic field along the tetragonal axis. Color map corresponds to the intensity of the microwave absorption at a frequency ν=35.35 GHz, points mark clear non-resonant features on the absorption *curves*, lines are guide-to-eye to separate different ordered phases, arrows indicate positions of magnetic resonance modes in the ordered state. Inset shows the magnetic surrounding of each magnetic ion.

A detailed study of the phase diagram and magnetic resonance spectra was performed at temperatures below 400 mK using a home-made microwave spectrometer built into the dilution fridge cryostat. Phase boundaries were determined by non-resonant features on absorption curves recorded at sweeping temperature or field at a given microwave frequency. At H=0 the system undergoes the transition into a magnetically ordered phase below T_N=0.19(1) K. In magnetic field applied along the tetragonal easy-axis we observed a cascade of transitions with the following critical fields at minimum T=100 mK: H_{c1}=0.70(5), H_{c2}=2.5(1), H_{c3}=3.1(1) and H_{c4}=4.10(5) kOe (see Figure 1), the last critical point being the saturation field. The transition at H_{c1} is probably first order and accompanied by abrupt appearance of intense resonance modes in the absorption spectrum. The trivial phase diagram in the transverse magnetic field consists of the only ordered phase saturated above H_{sat}=7.0(5) kOe. The magnetic resonance of a ferromagnetic type is developed above H_{sat} in both field directions.

The origin of the peculiar phase diagram (Figure 1) remains unclear, however the first step to interpret it can be made by taking into account that magnetic ions in $LiGdF_4$ are arranged into a network of orthogonal chains of edge-sharing triangles with two nearest- and one next-nearest-neighbour bonds (see Inset to Figure 1). The effective J_1, J_2 couplings of exchange and/or dipolar origin introduce initial frustration which can be overwhelmed by magnetic field and anisotropy.

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[1] T. Numazawa et al., *AIP Conf. Proc.,* **850** 1579 (2006).
[2] S.S. Sosin et al., *JETP Lett.*, **116** 771 (2022).