Recent results on new magnetocaloric materials: Yb3Ga5O12 and LiGdF4

Edward Riordan*[1], Elsa Lhotel[2], Stéphane Raymond[3], Mike Zhitomirsky[4], Christophe Marin[5], and Nimbo Camara[6]

[1]Institut Néel – Centre National de la Recherche Scientifique - CNRS : UPR2940 – France
[2]Institut Néel – Centre National de la Recherche Scientifique - CNRS : UPR2940 – France
[3]Institut Recherche Interdisciplinaire de Grenoble – CEA – France
[4]Institut Recherche Interdisciplinaire de Grenoble – CEA – France
[5]Institut Recherche Interdisciplinaire de Grenoble – CEA – France
[6]Institut Recherche Interdisciplinaire de Grenoble – CEA – France

Abstract

Apart from fundamental interest, the delayed magnetic ordering in conjunction with a large unfrozen entropy makes frustrated materials interesting for low temperature magnetic cooling (1). The developing space applications and increasing costs of helium motivate a continuing search for new refrigerant materials for adiabatic demagnetization refrigeration in the 0.1 - 4 K temperature range (2). In this context, Yb3Ga5O12, a frustrated spin system consisting of magnetic ytterbium ions on the hyperkagome lattice, and LiGdF4, a frustrated Heisenberg antiferromagnet (3), are promising candidate materials for magnetic cooling with neither ordering to well below this range.

Magnetisation measurements are used to further characterise the magnetocaloric effect in both materials, finding a strong magnetocaloric effect in both materials. Evidence of a magnetic transition in LiGdF4 is found below 300 mK for applied fields below 0.7 T. In Yb3Ga5O12 neutron scattering measurements have been performed which find Q-dependent magnetic correlations (4,5). In applied field, the excitations are consistent with Zeeman splitting and specific heat measurements. They can be accounted for by spin wave calculations with dominant dipole-dipole interactions. These results highlight

*Speaker

the presence of a microscopic contribution to the magnetocaloric effect in Yb3Ga5O12 determined by collective excitation modes. In addition, recent high energy resolution time-of-flight measurements could better resolve the different modes, opening the way to the determination of the system Hamiltonian.

We have also measured two materials with non-magnetic Y substituted on the Yb site. In which we have found a higher than expected magnetic moment, as well as a greater than expected magnetocaloric power. The persistence of a strong magnetocaloric effect in diluted samples provides further evidence that the spin correlations in Yb3Ga5O12 are predominantly dipolar in nature and opens a new possibility for improving the capabilities

of these materials in the context of adiabatic demagnetisation refrigeration.

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