MAGNON AND SOLITON EXCITATIONS IN A CARRIER-POOR, ONE-DIMENSIONAL S = 1/2 ANTIFERROMAGNET

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9.7 cm

Upon cooling to below $T_C = 293K$, the compound Yb_4As_3 undergoes a structural transition from a cubic high-temperature phase into a trigonal low-T structure. This transition is accompanied by a change in the electronic structure from a homogeneous intermediate-valence metallic state, with an Yb valence close to 2.25, to a low-T semimetallic phase, with a carrier concentration n $\approx 10^{-3}$ / formula unit. The low-T phase can be characterized by a charge ordering of Yb^{3+} ions along the $< 111 >$ direction. As a result of a superexchange interaction among the Yb^{3+} spins mediated by the surrounding As atoms, S = 1/2 antiferromagnetic (afm) Heisenberg chains are formed that are coupled only very weakly to each other.

Here we report measurements of the specific heat, thermal expansion and thermal conductivity on Yb_4As_3 aiming at an investigation of its low-temperature magnetic properties. A large in-T linear specific heat, $C = \gamma T, \gamma = 200 mJ/K^2 mole$, is observed for $B = 0$ and $T < 2K$. This term is completely independent of the carrier concentration, which can be strongly modified by partial substitution of either P or Sb for As. We attribute γ to the magnon excitations of the afm chains. In finite magnetic fields, distinct anomalies were found in the above thermodynamic and transport quantities. These anomalies are well described by the classical sine-Gordon soliton solutions for an easy–plane Heisenberg antiferromagnet. Our findings strongly suggest that Yb_4As_3 represents the first example of an afm S = 1/2 spin–chain system where this type of non–linear excitations could be identified.

13.4 cm

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