Physical Review B 2021 vol.104 N13

Crystal-field potential and short-range order effects in inelastic neutron scattering, magnetization, and heat capacity of the cage-glass compound HoB12

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Abstract

The strongly correlated system HoB1211 with boron sublattice Jahn-Teller instability and nanoscale electronic phase separation (dynamic charge stripes) was studied in detail by inelastic neutron scattering (INS), magnetometry, and heat capacity measurements at temperatures in the range of 3-300 K. From the analysis of registered INS spectra, we determined parameters of the cubic crystal field (CF) at holmium sites B4=-0.333 meV and B6=-2.003 meV (in Stevens notations), with an unconventional large ratio B6/B4 pointing to the dominant role of conduction electrons in the formation of a CF potential. The molecular field in the antiferromagnetic (AFM) state Bloc=(1.75±0.1) T has been directly determined from the INS spectra together with short-range order effects detected in the paramagnetic state. A comparison of measured magnetization in diluted Lu0.99Ho0.01B12 and concentrated HoB12 single crystals showed a strong suppression of Ho magnetic moments by AFM exchange interactions in holmium dodecaboride. To account explicitly for the short-range AFM correlations, a self-consistent holmium dimer model was developed that allowed us to reproduce successfully field and temperature variations of the magnetization and heat capacity in the cage-glass phase of HoB12 in external magnetic fields.

http://dx.doi.org/10.1103/PhysRevB.104.134436

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