Magnetic field-induced phase transitions in Cu(en)$_2$SO$_4$ – dimerized S = 1/2 quantum antiferromagnet

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The studies of the magnetic properties of single crystals of Cu(en)$_2$SO$_4$ (en = ethylenediamine - $C_2H_8N_2$) in magnetic fields applied along the b - axis showed that this structure consists of an array of coupled magnetic dimers on the square lattice connected by interdimer interactions. This was confirmed by the study of magneto-structural correlations. The analysis of susceptibility, magnetization, and specific heat within a simple model of the Heisenberg antiferromagnetic dimer with spin 1/2 showed that the intradimer interaction is J/k_B = -5.52, corresponding energy gap is $\Delta/k_B \approx 11$ K and a critical field $B_c^b \approx 7.8$ T [1]. The strength of effective interdimer interactions was estimated from the mean field approximation, J'/k_B = -0.3 K. Previous studies of Cu(en)$_2$SO$_4$were carried out in the singlet phase of the dimerized quantum system, which is characterized by the nonmagnetic ground state S = 0.
This work is devoted to the response of the heat capacity of powder and single-crystal samples on the application of magnetic field applied along the a, b, and c axes. The heat capacity was measured in magnetic fields from 0 to 9 T at temperatures down to 0.4 K. At low temperatures, in magnetic fields above 7 T, sharp λ-like anomalies are observed. Based on the obtained results, magnetic phase diagrams were constructed in all field orientations and compared with the results of powder sample. From the obtained phase diagrams, the average value of critical field was estimated B_c = 6.5 ± 0.5 T and saturation field B_{sat} = 11.0 ± 0.5 T. Below B_c, the singlet nonmagnetic phase is stable while in higher fields up to B_{sat} a magnetically ordered phase is induced. Further studies at lower temperatures and higher fields are required to refine the boundaries of the ordered phase as well as to determine the character of the corresponding quantum phase transitions.

References:

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