Anomalous structural phase transitions in $LiCsSO_4$; The compressible hcp Ising model

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The main objective of the paper is to derive a compressible three-dimensional hcp Ising model in which planar rotations of SO_4 tetrahedrons in ferroelastic $LiCsSO_4$ are expressed as S=1/2 spin states. The spins are coupled to the acoustic phonons. Due to the anisotropy of the perpendicular axes in the basal plane, we can describe the anomalous low-temperature phase transitions in terms of two order parameters representing spin-density waves. The first order parameter corresponds to the modulated phase below the order-disorder phase transition temperature, T_C. The ground-state configuration of the modulated 'magnetically-ordered' phase is a multi-soliton lattice of domain walls which get narrower with a decreasing temperature till the lock-in point, TThe second order parameter is induced at the temperature lower than T_C and describes a collinear orientation of the planar turns of the tetrahedrons SO_4. Introduction of the spin-phonon coupling enables us to estimate the role of the phonons in maintaining the anomalous low-temperature structural phase transitions in $LiCsSO_4$. Considering then the phonons to be slow variables in the process, we can also estimate scattering of the phonons on the pseudomagnetic structure. And further, to interpret and reproduce numerically the empirically observed anomalous temperature variation of the phonon frequency as observed in Brillouin light scattering experiment.

9.7 cm

13.4 cm

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