05. PHYSICAL PROPERTIES AND STRUCTURE

05.1-46 PHASE TRANSITION FROM A PARAMAGNETIC TO A MAGNETICALLY ORDERED CRYSTAL. By T. Maczynski and J. Kosiński, Institute of Physics, Warsaw Technical University, 00-662 Warszawa, Koszykowa 75, Poland.

On the basis of Landau's theory we have calculated the continuous and discontinuous phase transition of a paramagnetic crystal of symmetry P6/mmm to magnetically ordered phases. The symmetry changes are induced by active representations connected with the wave vector \( \mathbf{q} \rightarrow \mathbf{q}_0 \), \(-0.5 < \mathbf{q} < 0.5\). These representations fulfill the reality condition, the Kovalev condition and the weak Lifshitz condition. We have considered two active representations which correspond to spins perpendicular to the \( C_6 \) axis. It has been proved that there can appear two types of spin structures: \( /1 \) with constant spin length, i.e. helical structures, and \( /2 \) with varying spin length, i.e. sinusoidal structures. For the first case, formulae for the spiral structures which are valid for any value of \( \mathbf{q} \) from the interval \(-0.5,0.5\) have been given. We can thus obtain commensurate or incommensurate helical spin structures. With an appropriate value of \( \mathbf{q} \) we can obtain the helical structure of dysprosium crystal. In Landau's theory, the corresponding phase transition can be continuous. For the second case we give an example of a sinusoidal spin structure which is characteristic for neodymium crystal. The type of magnetic group to be assigned to a particular spin structure depends on the value of \( \mathbf{q} \).


A first order ferro-paraelectric phase transition in \( \text{CH}_{3}\text{NH}_{3}\text{HgCl}_3 \) at 61°C was observed by differential scanning calorimetry, by birefringence and DXR-measurements. The DSC-peak exhibits considerable structure and extends over about 1°C. The ferroelectric room temperature structure has space group \( P2_1\) but shows three pseudo two-fold axes. (Ben Salah et al., Solid State Chem. 1982) 493, 178). Further refinement was achieved by the introduction of two domains linked by a two-fold axis (R(2) decreased from 0.056 to 0.046). In the paraelectric phase, the structure is described in the monoclinic space group \( C2 \), the corresponding phase transition can be continuous. The structures of the chemically related compounds \( \text{CH}_{3}\text{NH}_{3}\text{HgBr}_3 \) space group \( P2_1/m\) and \( \text{CH}_{3}\text{NH}_{3}\text{HgJ}_3 \) space group \( P2_1/n \) were also determined, but these compounds are not ferroelectric at room temperature.


Quartz and its isotype ALPO_4 (Berlinite) have many physical properties in common, especially the symmetry change at the \( \alpha - \beta \) transition and the microdomain structure near the transition temperature. We report on our elastic neutron scattering results of the intermediate incom­mensurate phase of ALPO_4 existing in a temperature range of about 1.5 K between the \( \alpha \) and the \( \beta \) phase. The experiments were performed on the triple axis spectrometer UNIJAS at the FRJ-2 reactor in Jülich using 0.25° collimation. Crystals with typical dimensions of 2.5 x 2.5 x 20 mm^3 were grown under hydrothermal conditions. After having passed the \( \omega - \varphi \) transition several times, satellite reflections were observed in the directions \( a^* \), \( b^* \) and \( a^* - b^* \) in various Brilliouin zones. In particular, satellites corresponding to directions of the modulation vector \( \mathbf{q} \) perpendicular to the reciprocal lattice vector \( \mathbf{Q} \) exhibit large structure factors. The temperature dependence of \( \mathbf{q} \) which indicates the incom­mensurate character of this intermediate phase has been determined unambiguously, within the temperature interval of 1.5 K the satellites display a linear shift from \( q = 0.02 \) up to \( q = 0.038 \) reciprocal units with increasing temperature.

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Lead phosphate and the isostructural mixed phases \( \text{Pb}_3(\text{P}_{0.2}\text{As}_{0.8}) \text{O}_4 \). By U. Bismayer, E. Salje, A. M. Blazer and J. Cosier, Clarendon Laboratory, Parks Rd., Oxford OX1 3PU, UK.

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Lead phosphate and the isostructural mixed crystals of lead phosphate-ar­senate exhibit ferroelastic transitions between the phases \( R m \), \( C2/c \) and \( P2_1/c \). Precise measurements of optical birefringence and dielectric measure­ments revealed at temperatures below 100 K all compounds a further phase transition. In lead arsenate this probably corresponds to the transformation of \( \text{Pb}_3(\text{VO}_4) \) to the acentric phase \( P2_1/c \). In \( \text{Pb}_3(\text{PO}_4) \) the critical order parameter ex­ponent \( \beta \) fits in with a multicompound order parameter model with \( q = 3, d = 2 \) (Salje and Devarajan, J. Phys. C (1981) 14, L1029). Along with the results of infrared reflection spec­troscopy, diffuse X-ray, neutron and Raman scattering, the precursor ordering behaviour indicates dynamical fluctuations in \( \text{Pb}_3(\text{PO}_4) \) and a static inter­mediate phase in the mixed crystals.

The transition \( C2/c \rightarrow P2_1/c \) is interpreted in terms of a two-order-parameter theory, which clearly demonstrates how the first-order transition in pure \( \text{Pb}_3(\text{AsO}_4) \) becomes smoother in \( \text{Pb}_3(\text{P}_{0.2}\text{As}_{0.8}) \).