Pressure-Induced Phase Transitions in VdW Magnets

Lis O.N.[1,2], Kozlenko D.P.[1], Kichanov S.E.[1], Lukin E.V.[1], Zel I.Yu.[1]

[1] *Joint Institute for Nuclear Research, IIO, Dubna*
[2] *Kazan Federal University, Kazan, Russia*

Van der Waals compounds are currently one of the most interesting objects of research in the field of condensed matter physics due to the recently discovered magnetic properties in their two-dimensional forms. The structural features lead to a significant sensitivity of the physical properties in these compounds to external influences, which can cause many unusual phenomena: charge, orbital and spin ordering, superconductivity, various phase transitions, also important for the development of a wide range of spintronic devices.

High pressure is a direct method of controlled change in magnetic interactions due to variations in interatomic distances and angles. Performing studies at high pressures provides a unique opportunity to study the relationship of changes in the structural parameters of the crystal with changes in the magnetic structure, which is necessary to understand the nature and mechanisms of physical phenomena observed in the studied objects.

This work is devoted to the investigation of the crystal, magnetic structure and vibrational properties of vdW $CrBr_3$ in wide temperature and pressure ranges using neutron diffraction at DN-6 diffractometer of the IBR-2 reactor (FLNP, JINR, Dubna), also using X-ray powder diffraction and Raman spectroscopy. A negative thermal volume expansion in $CrBr_3$ below T_C = 37 K was observed, associated with spin-lattice coupling. The effect of high pressure leads to the suppression of magnetic ordering, and the transition from the initial FM state is expected at P~8.4 GPa to AFM or to PM state. Our results also demonstrate an isostructural phase transition in a $CrBr_3$ ferromagnet (2.5 –7 GPa). With a further increase in pressure to 38 GPa, significant changes are observed in the behavior of the frequencies of the vibrational modes, which is associated with the transition to a metallic state above 26 GPa.