Contribution ID: **160** Type: **Oral talk (15 min + 5 min questions)**

THE PRESSURE EFFECT ON CRYSTAL AND MAGNETIC STRUCTURES OF VAN DER WAALS MATERIALS

Wednesday, 13 July 2022 16:20 (20 minutes)

The recent discovery of magnetic ordering in van der Waals (vdW) materials down to the monolayer limit has opened a new direction in the field of two-dimensional materials, allowing researchers to explore magnetism in lower dimensions in simple crystal systems. The advent of long-range 2D ferromagnetism brings about new transport phenomena in two dimensions, like tunneling magnetoresistance and electrical switching of magnetic states promoting 2D ferromagnets as versatile platforms for engineering new quantum states and device functionalities. CrBr3 and Fe3GeTe2 are also one of the brightest representatives of this class of materials, which also attract the attention of researchers because of the various observed physical phenomena. The knowledge of relationship between magnetic and crystal structure of such compounds, which can be obtained from high-pressure investigations, is very essential for understanding the nature and mechanism of physical phenomena observed in it.
The present work focuses on the investigations of crystal and magnetic structures of CrBr3 and Fe3GeTe2 in wide temperature and pressure ranges. Detailed studies of the crystal structure of the materials were carried out using neutron diffraction on a DN-6 diffractometer of a pulsed high-flux IBR-2 reactor (FLNP, JINR, Dubna, Russia) in temperature range of 6-300 K and at pressure up to 5 GPa. Neutron diffraction investigations of CrBr3 revealed to observe the formation of the long-range ferromagnetic order which leads to the negative thermal volume expansion and anomalous thermal variation of interatomic distances and angles, caused by the spin-lattice coupling. Related effects were found in vibrational spectra of this compound. Noticeable anomalies near the Curie point are observed on the temperature dependences of Raman peak frequencies as well as on their full-width at half-maximum which indicates the strong spin-phonon coupling in CrBr3. The high pressure effect made it possible to identify unusual changes in the diffraction spectra and changes of Raman modes, which may be associated with a phase transition in CrBr3. It was also obtained the evolution of the unit cell parameters, bond lengths under high pressure. The X-ray diffraction of Fe3GeTe2 at high pressure revealed anomalies on the baric behavior of structural parameters without clearable structural transition with changing the symmetry. The vanishing of the vibrational modes of Fe3GeTe2 at high pressures and low temperature can be caused by the suppression of the long-range magnetic order.

The speaker is a student or young scientist

Yes

Section

1. Synchrotron and neutron radiation sources and their use in scientific and applied fields

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Session Classification: Synchrotron and neutron radiation sources and their use in scientific and applied fields