Raman signatures of the antiferromagnetic ordering in 2-dimensional magnetic material MnPS$_3$

Magnetic ordering in the two-dimensional (2D) limit has been one of the most important issues in condensed matter physics for the past several decades. The recent discovery of new magnetic van der Waals materials heralds a much-needed easy route for the studies of two-dimensional magnetism: the thickness dependence of the magnetic ordering has been examined by using Ising- and XXZ-type antiferromagnetic van der Waals materials [1, 2]. Here, we investigated the magnetic ordering of MnPS$_3$, a two-dimensional antiferromagnetic material of Heisenberg-type, by Raman spectroscopy from bulk all the way down to bilayer. The phonon modes that involve the vibrations of Mn ions exhibit characteristic changes as temperature gets lowered through the Néel temperature. In bulk MnPS$_3$, the Raman peak at ~155 cm$^{-1}$ becomes considerably broadened near the Néel temperature and upon further cooling is subsequently red-shifted. In few-layer MnPS$_3$, the peak at ~155 cm$^{-1}$ exhibits the characteristic red-shift at low temperatures down to the bilayer, indicating that the magnetic ordering is surprisingly stable at such a thin limit.

References


Figures

Figure 1: Temperature dependence of Raman spectra for bulk MnPS$_3$ and Raman spectra of bilayer MnPS$_3$ at $T$=290 and 10 K.