Quantum entanglement enabled symmetry breaking orders in a pyrochlore antiferromagnet

Bumjoon Kim
Pohang University of Science and Technology

Entanglement is a key element in future quantum technologies, differentiating quantum systems from classical ones. Measuring entanglement is particularly challenging for condensed matter systems comprising a vast number of particles. In this talk, we identify a spin system that exhibits symmetry-breaking orders solely permitted due to entanglement, which can thus be detected through a well-established framework of symmetry classification. In the pyrochlore antiferromagnet $Nd_2Ir_2O_7$, entanglement of spin states leads to the formation of spin quadrupolar and vector chiral orders that break the cubic symmetry of the pyrochlore lattice. These orders are detected using Raman spectroscopy. The entanglement manifests as intensity oscillations in the resonant inelastic x-ray scattering spectra, which allows for quantifying the degree of entanglement through a cluster model calculation.