Neutron Study Reveals New Magnetic Structure in NaMnGe₂O₆ Pyroxene

Scientific Achievement
This work completes the study of the evolution of magnetic properties of the alkali-metal pyroxenes as a function of the d-orbital occupancy from d¹ to d⁵ and reveals a new magnetic structure in NaMnGe₂O₆.

Significance and Impact
Neutron powder and single crystal x-ray diffraction reveals that the Jahn Teller (JT) distortion on Mn³⁺ is incompatible with the local structure distortion in pyroxene and addresses the long-lasting puzzle why high pressure is needed to synthesize Mn-pyroxene.

Research Details
- NaMnGe₂O₆, a new pyroxene compound has been synthesized under high pressure and fully characterized.
- Elastic neutron scattering experiments were performed (using a 50 mg sample for NOMAD and a 400 mg sample for HB-2A) to confirm the magnetic phase transition and determine the magnetic structure.

(a) The schematic drawing of octahedra at the M site in the JT inactive NaScGe₂O₆, weak JT active NaTiSi₂O₆, and JT active NaMnGe₂O₆; (b) Magnetic structure of NaMnGe₂O₆ indicates the spin up-up-down-down intrachain ordering along the c-axis.


Neutron diffraction work was performed at the ORNL Spallation Neutron Source’s NOMAD and High Flux Isotope Reactor’s HB-2A instruments.