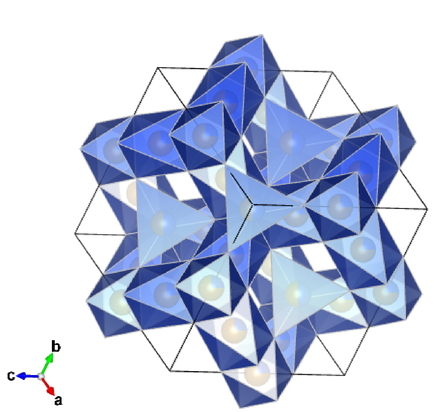
Acoustic Instabilities of $CuFe_2O_4$

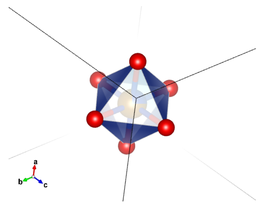
Enlin Shen

Department of Physics and Astronomy, University of Edinburgh

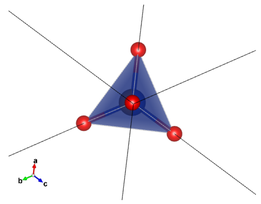
Crystal Structure of $CuFe_2O_4$



Stacking structure[2]

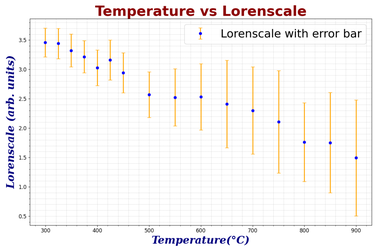


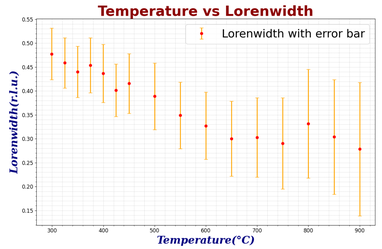
Octahedron structure[2]

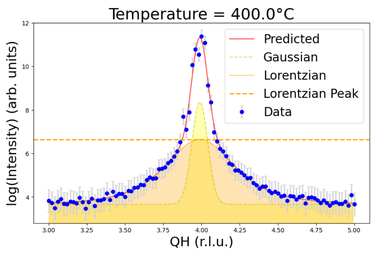


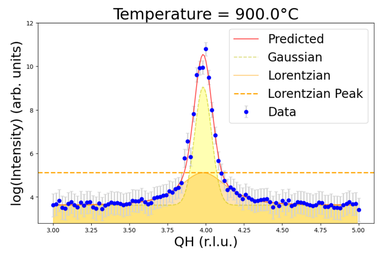
Tetrahedron structure[2]

Elastic Neutron Scattering along $[1, 1, 0]$

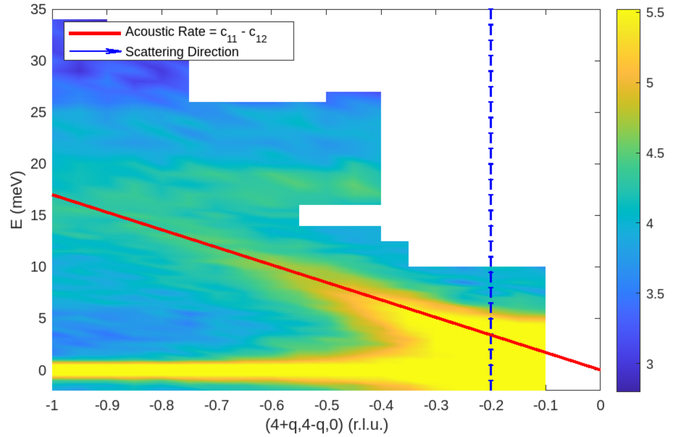






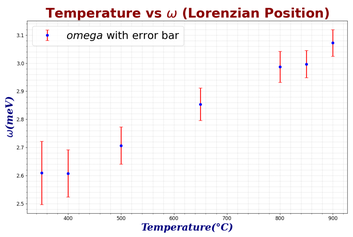


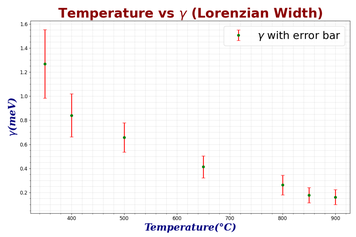
Inelastic Neutron Scattering along $[1, \bar{1}, 0]$

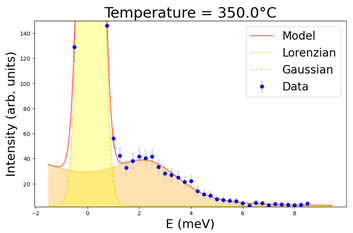


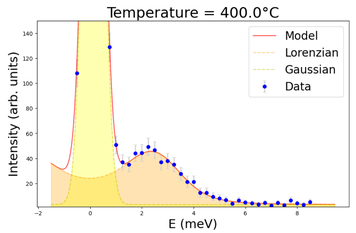
Room Temperature

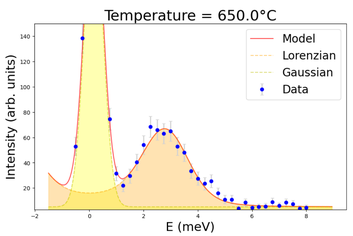
Scattering along $\vec{Q} = (3.8, 4.2, 0)$ with different Temperature

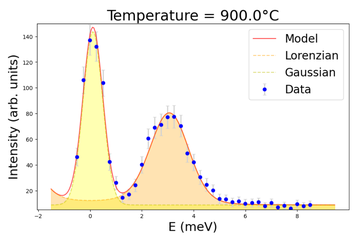




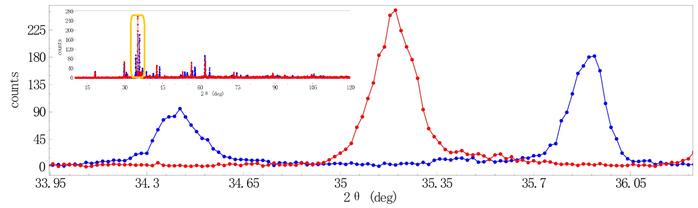




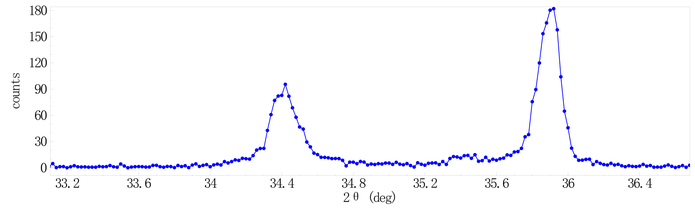




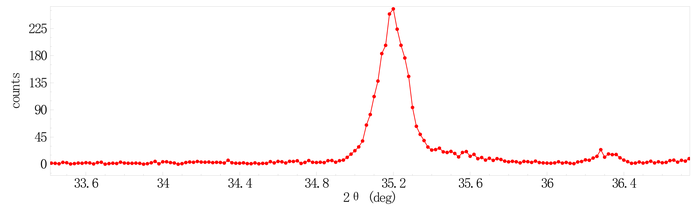
Transition show in X-ray Diffraction Pattern



Transition happens between Temperature = 50°C and 600°C.

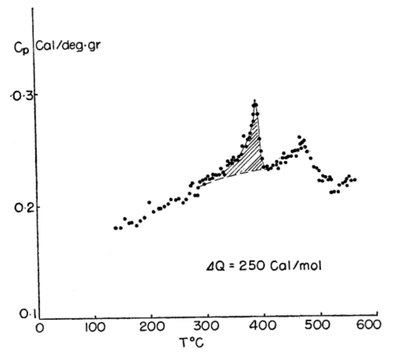


Intensity Pattern at Temperature = 50°C.



Intensity Pattern at Temperature = 600°C.

Motivation and Future Plan



Transitions related to Temperature [1]

- **Structural and Magnetic Transitions:**
  - Study the transition at 390°C, which corresponds to a structural transition from cubic to tetragonal in $CuFe_2O_4$.
  - Investigate the transition at 470°C, associated with the magnetic transition of the material.
- **Elastic Constants and Acoustic Rates:**
  - Along the direction $\vec{Q} = [1, \bar{1}, 0]$, the intensity plot should show an acoustic rate given by the formula of elastic constants $c_{11} - c_{12}$.
  - Along the direction $\vec{Q} = [1, 0, 0]$, the acoustic rate corresponds to c_{44}.
  - Plan further scattering experiments along these two directions to determine c_{11}, c_{12}, and c_{44}, while varying the temperature to observe how these constants soften with temperature changes.
- **Magnetoelastic Coupling:**
  - Relate the elastic response to the material's magnetism to uncover the origins of magnetostriction in $CuFe_2O_4$.

[1] Tohru Inoue and Shuhichi Iida. "Specific Heats of Copper Ferrite". In: *Journal of the Physical Society of Japan* (1958). DOI: 10.1143/JPSJ.13.656A.

[2] K. Momma and F. Izumi. "VESTA: A three-dimensional visualization system for electronic and structural analysis". In: *Journal of Applied Crystallography* (2011).