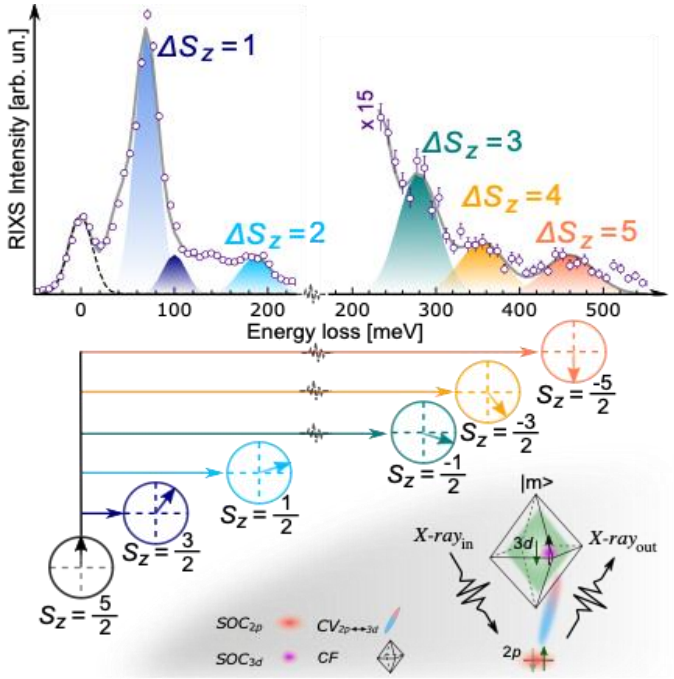
Discovery of New Magnon Modes in an Antiferromagnetic Thin Film



Top: RIXS spectrum of a-Fe_2O_3 showing magnon modes, DS_z=1, 2, 3, 4 and 5, corresponding to different, final spin state S_z (middle panel). Bottom: RIXS process and interactions needed to access multi-magnons with DS_z>2.

J. Li, Y. Gu, Y. Takahashi, K. Higashi, T. Kim, Y. Cheng, F. Yang, J. Kunes, J. Pelliciari, A. Hariki, V. Bisogni. PRX 13, 011012 (2023).

This work was performed at NSLS-II.

Scientific Achievement

Scientists discovered a new set of magnon modes in a thin film of hematite (Fe_2O_3), while demonstrating that resonant inelastic x-ray scattering (RIXS) enables their direct measurement.

Significance and Impact

Antiferromagnetic (AFM) materials such as hematite offer potential for applications in information transfer via magnons. However, the fundamental magnetic properties of materials in thin film form are unknown. This study discovers a new method for studying magnetic excitations in hematite thin films, revealing new modes carrying spin momentum up to $DS_z = 5$.

Research Details

- Studied a well-known AFM material, hematite, as a thin film and discovered unexpected magnons up to ~500 meV corresponding to multiple, noninteracting magnons.
- Demonstrated at the SIX beamline that RIXS is capable of directly measuring magnon excitations beyond $DS_z = 2$, and up to $DS_z = 5$.
- Compared the discovered magnon spectrum with theoretical calculations that agreed with the findings.