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Anisotropic Mesoscale Spin Structures In Non-Centrosymmetric Magnets Unveiled By Resonant Small-Angle X-ray Scattering

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Resonant elastic small-angle soft x-ray scattering (SAXS) is a unique and powerful tool that offers ultimate reciprocal-space resolution, enabling the study of long-periodic spin textures in noncentrosymmetric magnets. Its distinctive sample environment facilitates the exploration of previously uncharted spin texture transformations and allows for the extraction of small parameters that are inaccessible through other methods [1,2]. In this comprehensive study, we present recent SAXS studies on the noncentrosymmetric magnets Co8Zn8Mn4 and FeNiPdP.
Co8Zn8Mn4 is a cubic chiral magnet that hosts Bloch-type skyrmions at room temperature. Here, we employed SAXS in a vector magnetic field to control the propagation vector of magnetic spirals in order to extract the magnitude of anisotropic exchange interaction (AEI) as a function of temperature [2].

FeNiPdP (space group I4̄m2) has demonstrated the ability to host antiskyrmion spin textures [3] at room temperature [4]. Furthermore, due to the interplay between anisotropic Dzyaloshinskii-Moriya interaction and dipolar interaction, these textures can transform into elliptic Bloch-type skyrmions or non-topological magnetic bubbles when subjected to magnetic fields applied at an angle to the sample's c-axis. Previous studies using Lorentz transmission electron microscopy (LTEM) were limited to investigating tilting angles of up to approximately 45 degrees. In contrast, advancements in soft x-ray instrumentation now allow for the investigation of nanometric magnetic modulations under extreme sample conditions through resonant SAXS.

These comprehensive studies using SAXS not only reveal the rich and exotic magnetic phase diagrams of noncentrosymmetric magnets but also enhance their tunability, providing a significant platform for further fundamental research and potential applications in energy-saving technologies.

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