



## Magnetic X-ray Imaging using Single Polarization and Multimodal Ptychography

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The ongoing upgrade of synchrotrons to 4th generation, offering higher brilliance and coherence, creates a valuable opportunity to enhance the penetration depth and sensitivity of coherence-based X-ray techniques. This improvement particularly benefits the detection of weak dichroic signals from magnetic materials, relevant across fields from condensed matter to biology. Visualizing the microscopic magnetic structure provides essential insight into the material properties and macroscopic behavior of magnets, highlighting the importance of advanced microscopy techniques. To probe the microscopic structure of magnetic and other dichroic materials, polarized X-rays are used because these materials respond differently based on the incident light's polarization. Separating magnetic contrast from electronic signals therefore typically requires multiple polarization states or a polarization analyzer. Here, we leverage the redundancy in ptychographic datasets—obtained via overlapping illumination—to recover more information than a single image of the sample. Indeed, ptychography can also uniquely distinguish multiple incoherent light components in a single scan. Therefore, we demonstrate that multimodal ptychography can disentangle magnetic and electronic contributions from a single polarization measurement without the need for varying incident polarization or a polarization analyzer. This approach simplifies measurements and reduces artifacts while offering an efficient way to study complex magnetic materials. Our results open the door to imaging with high sensitivity and spatial resolution magnetic materials such as antiferromagnets and altermagnets, as well as other non-magnetic dichroic systems.