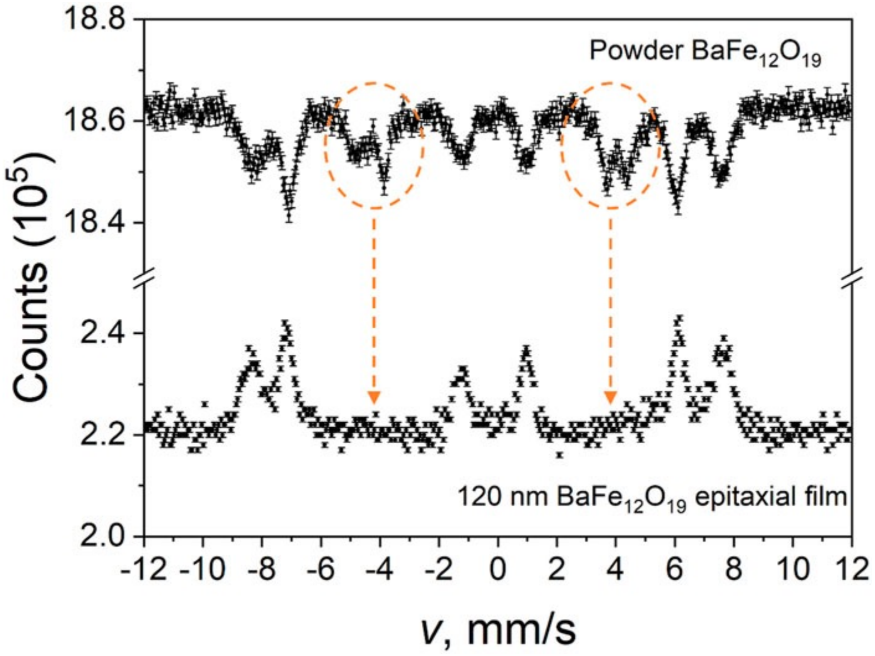
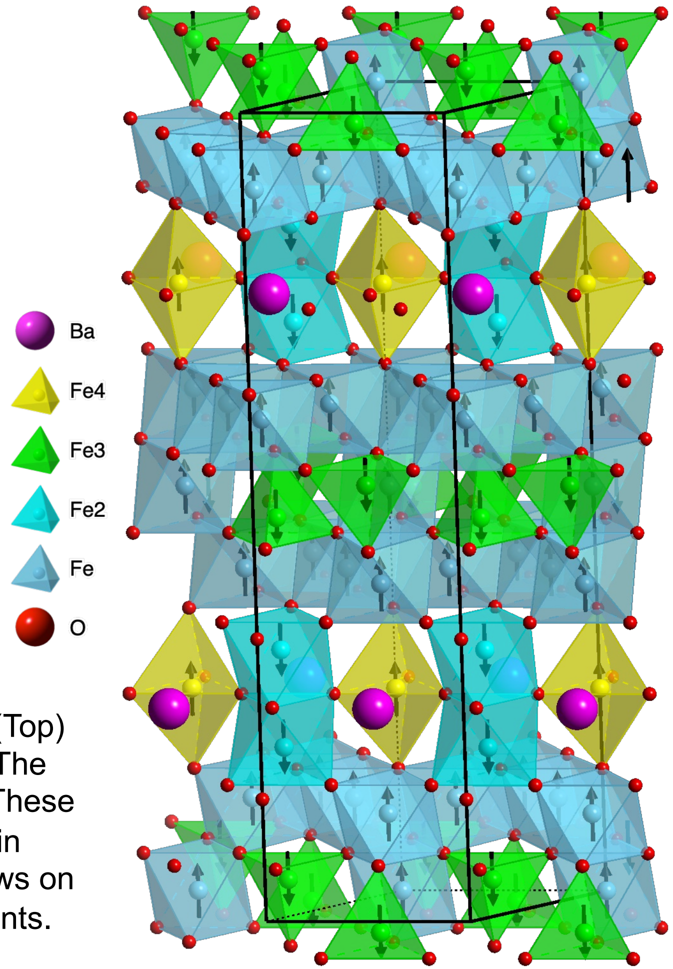
MIP: PARADIM at Cornell University, DMR-2039380
External User Project - 2025

Sensing the Local Magnetic Environment in Thin Films

Natarajan Ravi (Spelman College) and Darrell Schlom (Cornell U.)

Mössbauer spectroscopy is a powerful way to sense the local magnetic environment around specific atoms in a crystal structure. As many PARADIM discoveries involve thin films, PARADIM users are excited to be able to now apply this technique to films by using Mössbauer spectroscopy in a backscattering geometry dubbed conversion electron Mössbauer spectroscopy (CEMS). Here, users of PARADIM together with members of the In-House Research Team grow thin films containing isotopically purified iron (^{57}Fe) to determine the orientation of the magnetic moments of these iron atoms in single-crystal iron thin films. Next the team extends the concept to a more complex system, $BaFe_{12}O_{19}$, the common refrigerator magnet. Though common, its crystal structure is complex as shown on the right. The missing peaks in the CEMS spectrum indicate that the magnetic moments lie in the up/down direction (see Figure). The project is **part of the NSF-funded PREM: Advanced Interface Materials** and made **use of PARADIM's signature molecular-beam epitaxy system** and the capabilities for Mössbauer spectroscopy at Spelman College.





Figures: (**Top**) Mössbauer spectra of $BaFe_{12}O_{19}$ in two forms: (Top) a randomly oriented powder and (Bottom) a single-crystal film. The dashed arrows point to missing peaks not seen in the powder. These missing peaks signify that the magnetic moments in the film lie in either up or down directions. (**Right**) Crystal structure with arrows on the ^{57}Fe atoms indicating the directions of their magnetic moments.

Y.E. Li, *et al.* *AIP Advances* **15**, 015323 (2025). Data availability: 10.34863/0rh9-yn63.