Dispersion of Spin Stripe Fluctuations in FeGd Measured by Megahertz X-ray Photon Correlation Spectroscopy

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Spontaneous fluctuations play a critical role in understanding phase transitions, yet their dispersion remains largely unexplored – unlike well-characterized quasiparticle excitations such as magnons and phonons, which are routinely studied using inelastic neutron or x-ray scattering. In this work, we investigate the spontaneous fluctuations of spin stripes in a FeGd magnetic superlattice (Fig. 1) using X-ray Photon Correlation Spectroscopy (XPCS) at a megahertz (MHz) repetition-rate x-ray free-electron laser. Enabled by the significant enhancement in counting statistics at MHz rates, we demonstrate the ability to resolve the dispersion of spin stripe dynamics across at least one Brillouin zone. Our results establish MHz-XPCS as a powerful and unique tool for probing spontaneous fluctuations and the emergent phenomena they drive in complex materials.



Figure 1. Resonant X-ray diffraction profile of the spin stripes in FeGd.