YNU YOKOHAMA National University 物理工学ユニット談話会、テラヘルツ・ナノ光科学研究拠点講演会

Ultrafast Spin Fluctuations in the Antiferromagnet $Sm_{0.7}Er_{0.3}FeO_3$ Revealed by Femtosecond Noise Correlation Spectroscopy

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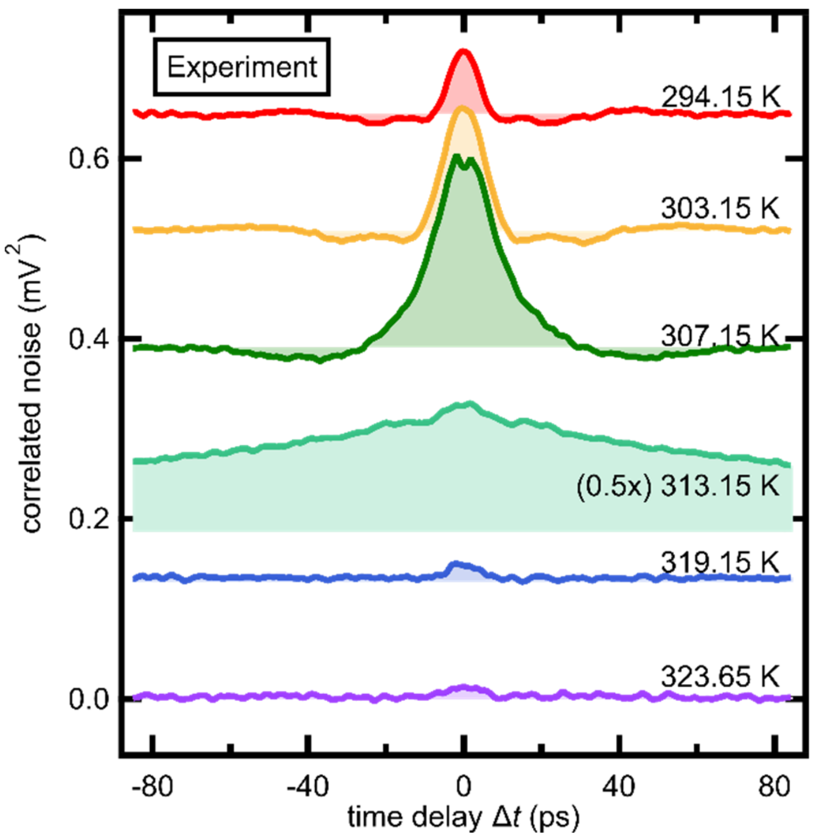
Date＆Time：September 11th, 2025 (Thu) 10:30 ~ 11:30　Place：General Research Building, W202

Although often regarded as detrimental, fluctuations can carry valuable information about the fundamental properties and dynamics of the materials in which they arise. In magnetic systems, random thermal fluctuations of collective spin waves – known as magnons – naturally occur and can influence a multitude of different physical phenomena.

Directly accessing these fluctuations is essential for understanding such fundamental processes, and in the case of antiferromagnets, for advancing the design of next-generation spintronic devices. However, detecting intrinsic spin fluctuations in antiferromagnets remains challenging due to their extremely small amplitude and ultrafast dynamics.

In this talk, I will introduce two-color femtosecond noise correlation spectroscopy (FemNoC), a technique designed to overcome this limitation[1,2]. FemNoC uses pairs of ultrashort laser pulses at two wavelengths, separated by a variable time delay *Δt*, to detect subtle fluctuations in light polarization caused by transient spin noise. By cross-correlating the polarimetric signals of individual laser pulses, the method can directly resolve ultrafast, stochastic spin fluctuations with femtosecond precision.

Applying FemNoC to the antiferromagnet $Sm_{0.7}Er_{0.3}FeO_3$ near its spin-reorientation transition – where the spin lattice rotates by 90° – revealed two key findings[3] (see Figure 1): 1. a pronounced enhancement of quasi-ferromagnetic spin-wave fluctuations near the transition, and 2. the first observation of ultrafast stochastic spin switching (random telegraph noise, RTN) on picosecond timescales, representing the fastest RTN process recorded to date.



[1]M. A. Weiss et al., Rev. Sci. Intr. 95, 083005 (2024). [2]M. A. Weiss et al., arXiv: 2501.17531 (2025). [3]M. A. Weiss et al., Nat. Commun. 14, 7651 (2023).

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