Coexistence of Ferromagnetic and Stripe Spin Fluctuations in YFe_2Ge_2

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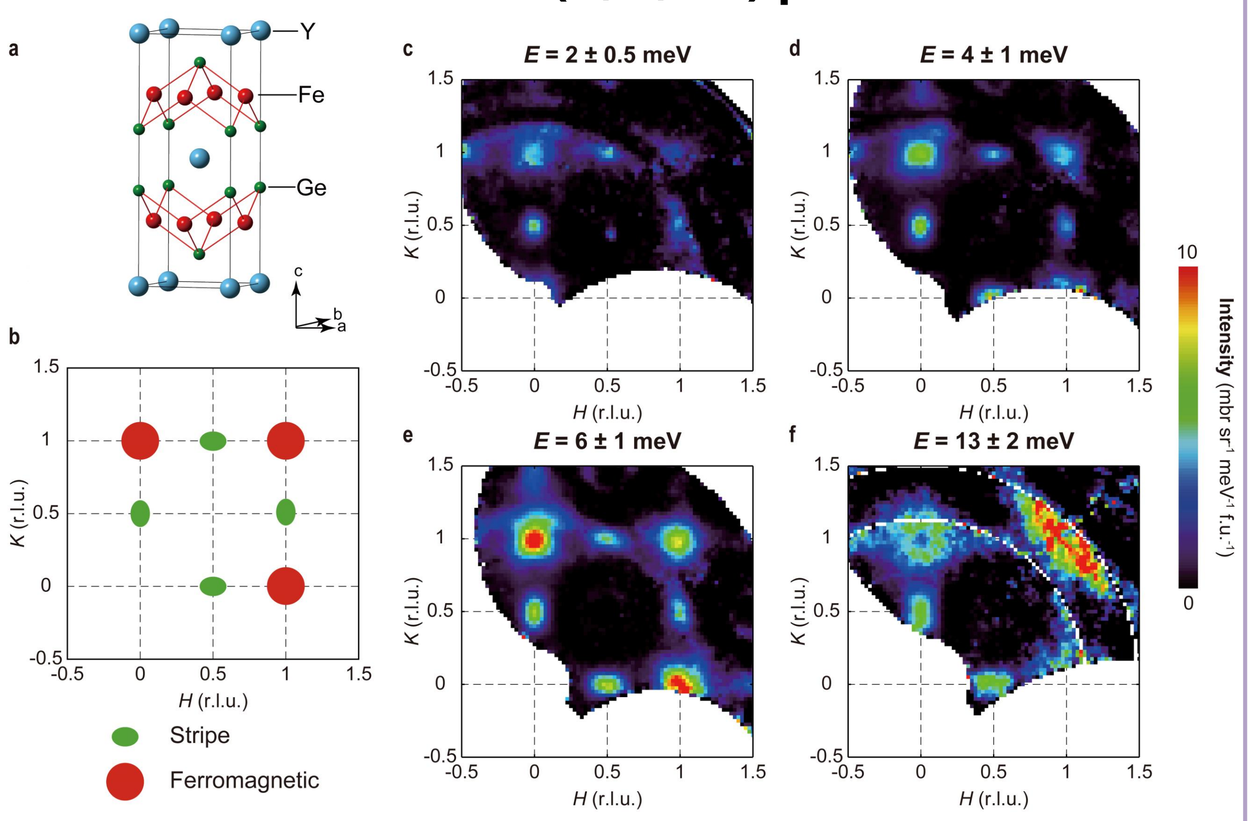
Abstract

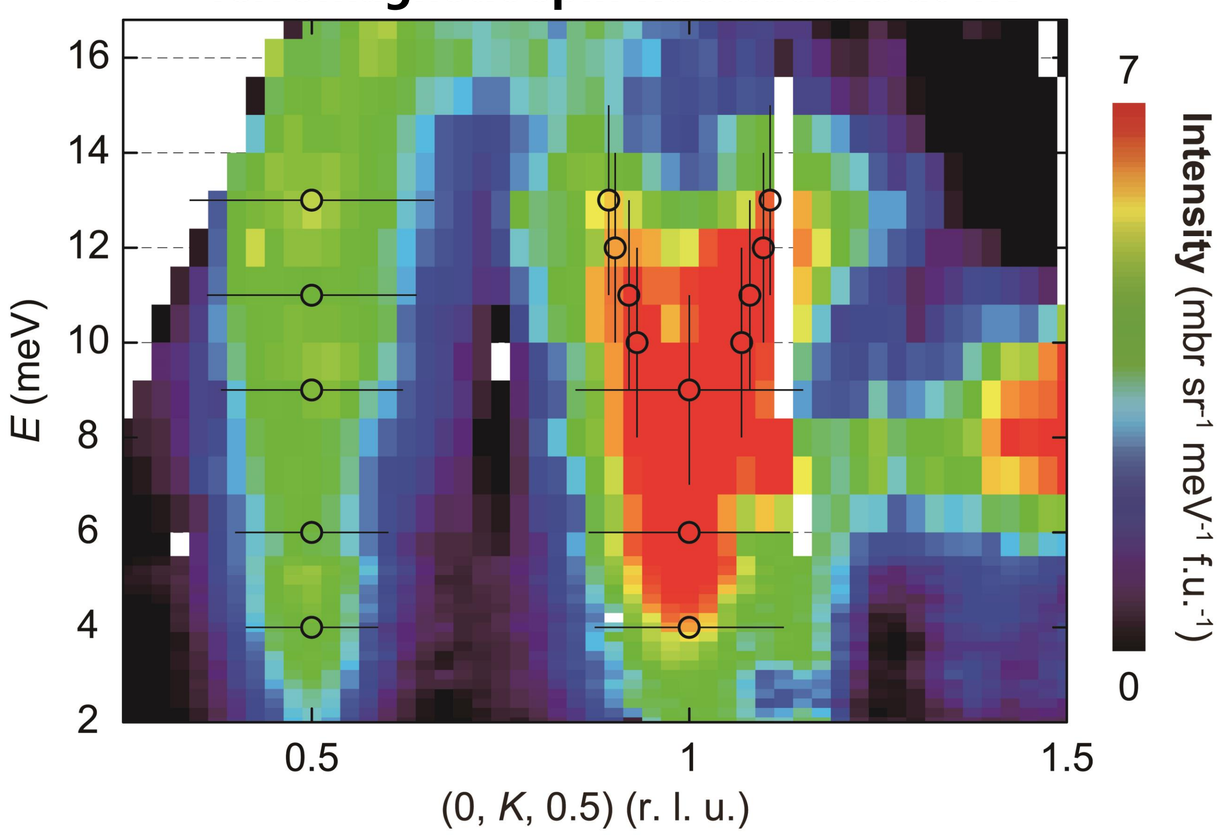
The recently discovered iron-germanide superconductor YFe_2Ge_2 is of great interest because it is a possible new unconventional iron-based superconductor other than iron pnictides/chalcogenides. Here we report neutron scattering measurement of single-crystalline YFe_2Ge_2 in the normal state, which has the same crystal structure to the 122 family of iron pnictide superconductors. Like the iron pnictides, YFe_2Ge_2 displays anisotropic stripe-type antiferromagnetic spin fluctuations at (π, 0, π). More interesting, however, is the observation of strong spin fluctuations at the in-plane ferromagnetic wave vector (0, 0, π). These ferromagnetic spin fluctuations are isotropic in the (*H*, *K*) plane, whose intensity exceeds that of stripe spin fluctuations. Both the ferromagnetic and stripe spin fluctuations remain gapless down to the lowest energies measured. Our results naturally explain the absence of magnetic order in YFe_2Ge_2 and also imply that the ferromagnetic correlations may be a key ingredient for iron-based materials.

Momentum dependence of the spin fluctuations in (*H*, *K*, 0.5) plane at 4K



a, Schematic diagram of YFe_2Ge_2 crystal structure. **b**, Schematic representation of the stripe and ferromagnetic spin fluctuations in the (*H*, *K*, 0.5) plane (1-Fe unit cell). **c-f**, Background subtracted constant-energy images at indicated energies. Notably there is the coexistence of the anisotropic stripe and the isotropic in-plane ferromagnetic spin fluctuations in YFe_2Ge_2.

Dispersions of the stripe and in-plane ferromagnetic spin fluctuations at 4K

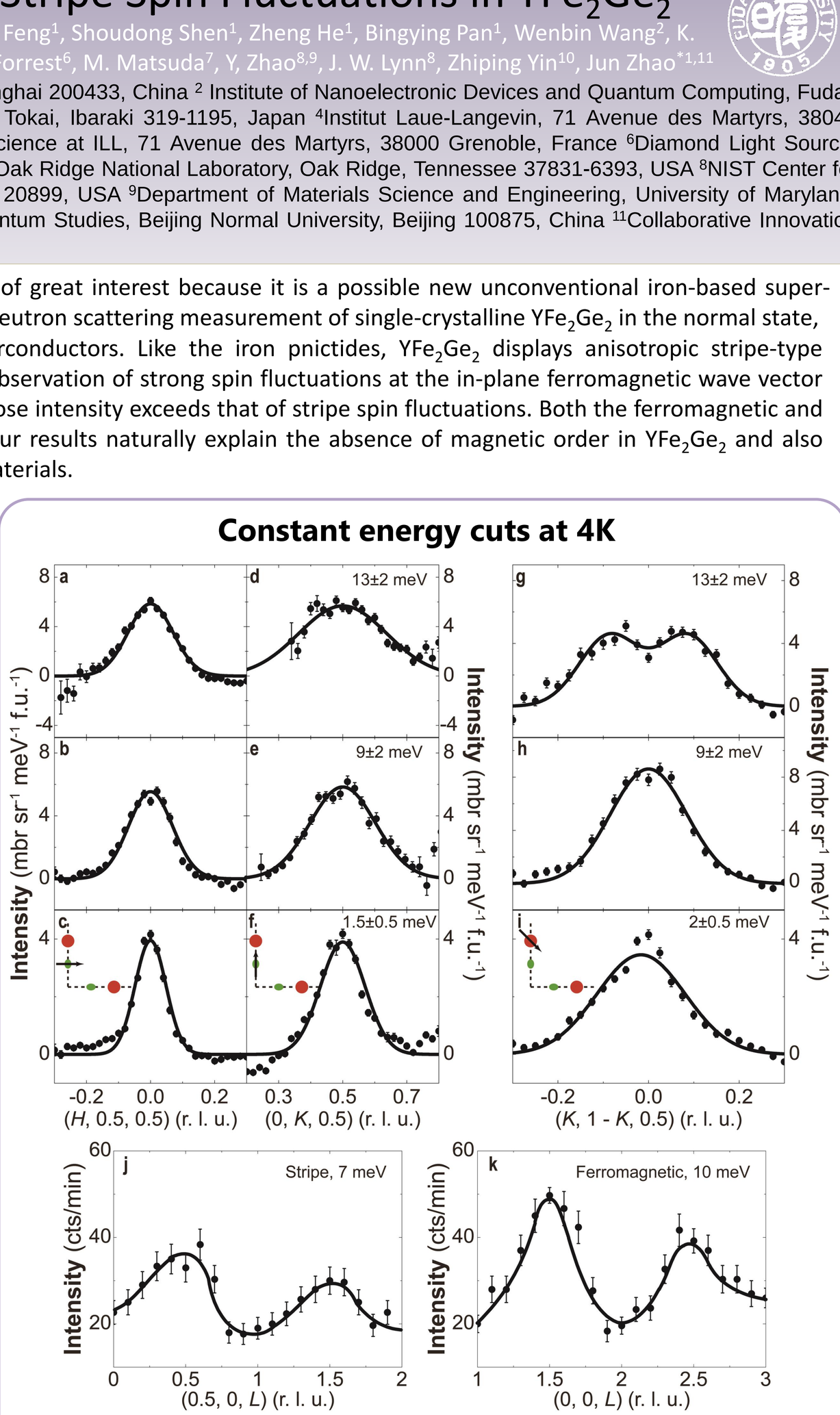


Background subtracted dispersion of the spin fluctuations projected on the *K* direction. The stripe spin fluctuations exhibit a steeper cone-like dispersion, while the splitting into two branches of the ferromagnetic ones can be clearly observed at higher energies. The open circles and the horizontal bars represents for the peak positions and the full-width at half maximum (FWHM) determined from the Gaussian fitting of the constant-energy scans. The vertical bars indicate the range of integrated energies.

References

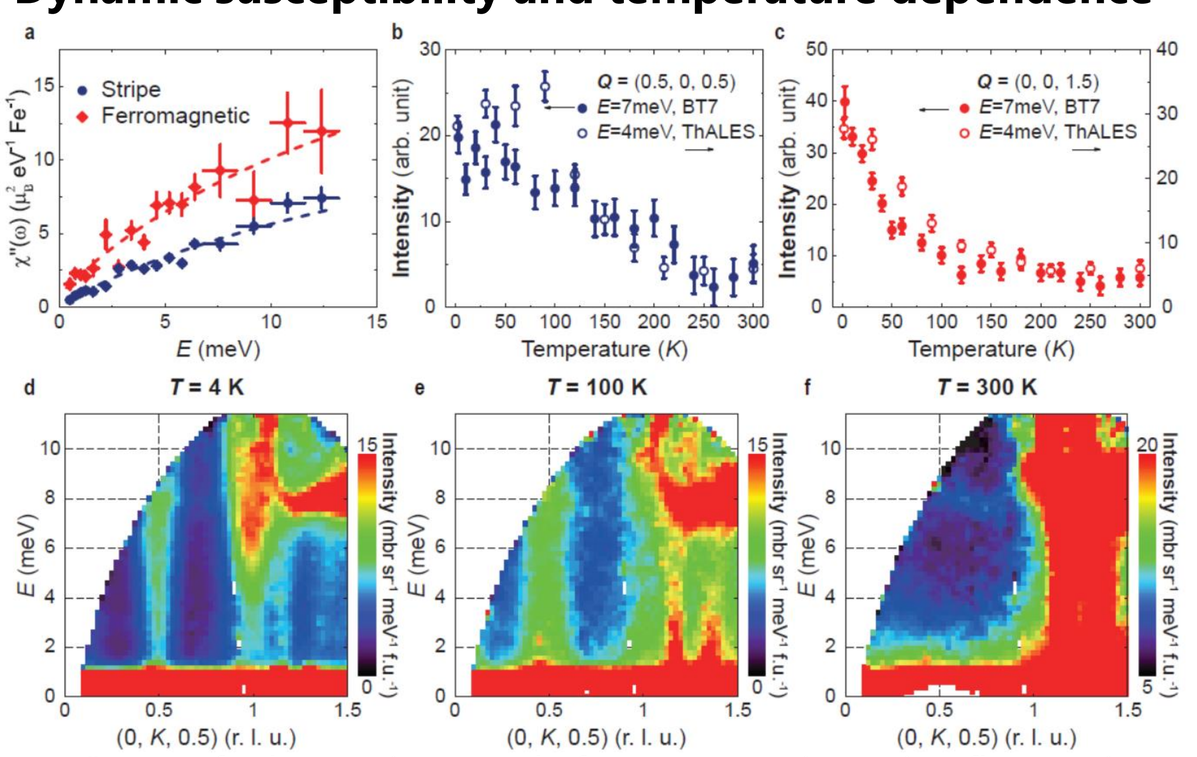
For detailed information, please refer to Hongliang Wo *et al.*, Phys. Rev. Lett. **122**, 217003 (2019).

Constant energy cuts at 4K



Background subtracted constant-energy scans for **(a-c)** the stripe spin fluctuations along the *H* (transverse) direction, **(d-f)** the stripe spin fluctuations along the *K* (longitudinal) direction and **(g-i)** the in-plane ferromagnetic spin fluctuations along the (*K*, *1-K*) direction. **j-k**, Constant-energy scans along the *L* direction for the stripe and the in-plane ferromagnetic spin fluctuations.

Dynamic susceptibility and temperature dependence



a, $\chi''(\omega)$ of the stripe and ferromagnetic spin fluctuations. Temperature dependence of **(b)** the stripe and **(c)** the ferromagnetic spin fluctuations at 4meV and 7meV. **d-f**, Raw data for the *E*-**Q** relationship at different temperature. A proximity to ferromagnetic order and the competition between stripe and ferromagnetic instabilities is evidenced.