Stripe order and spin dynamics in triangular-lattice antiferromagnet $KErSe_2$: A single-crystal study with a theoretical description

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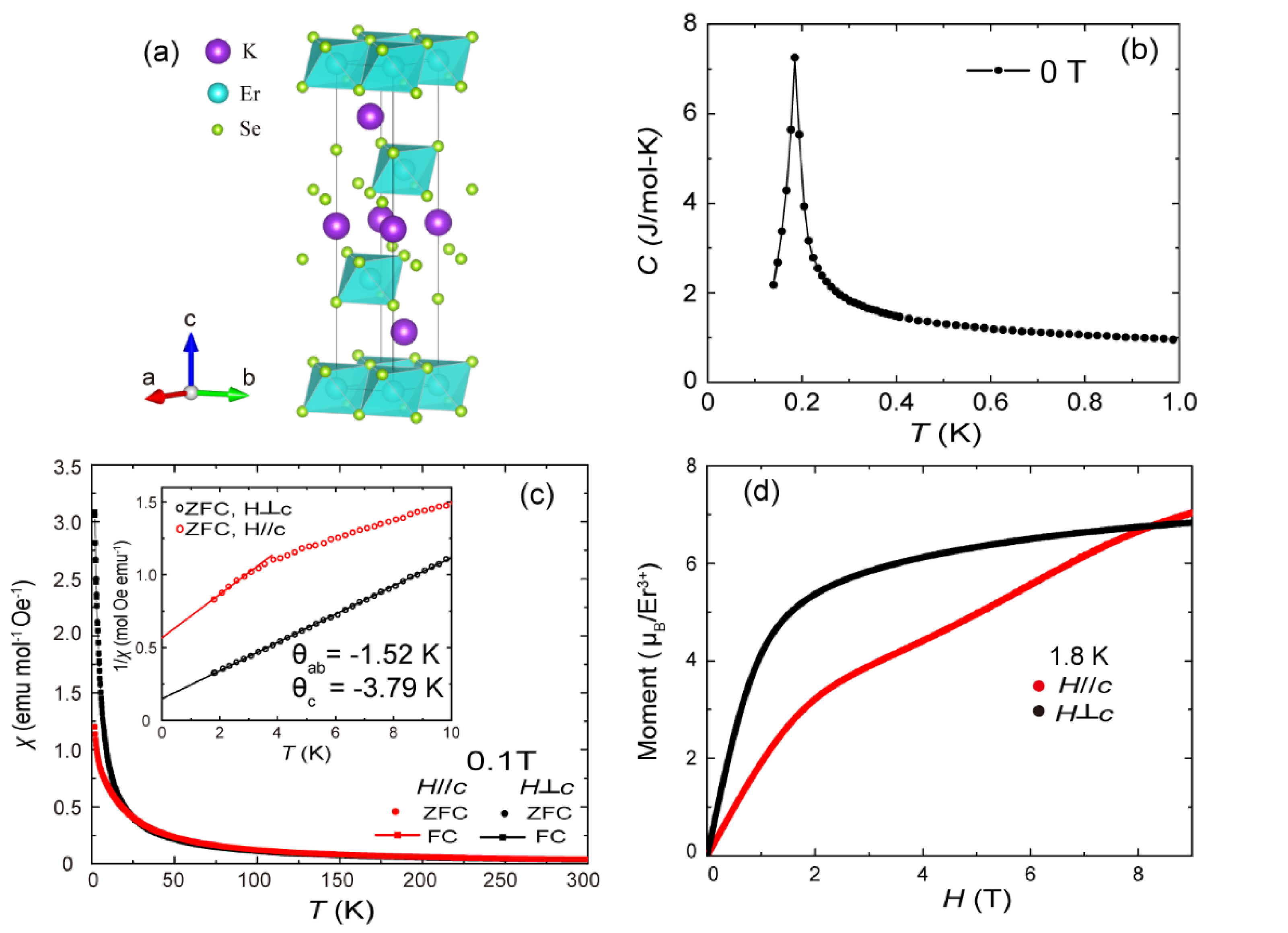
Abstract

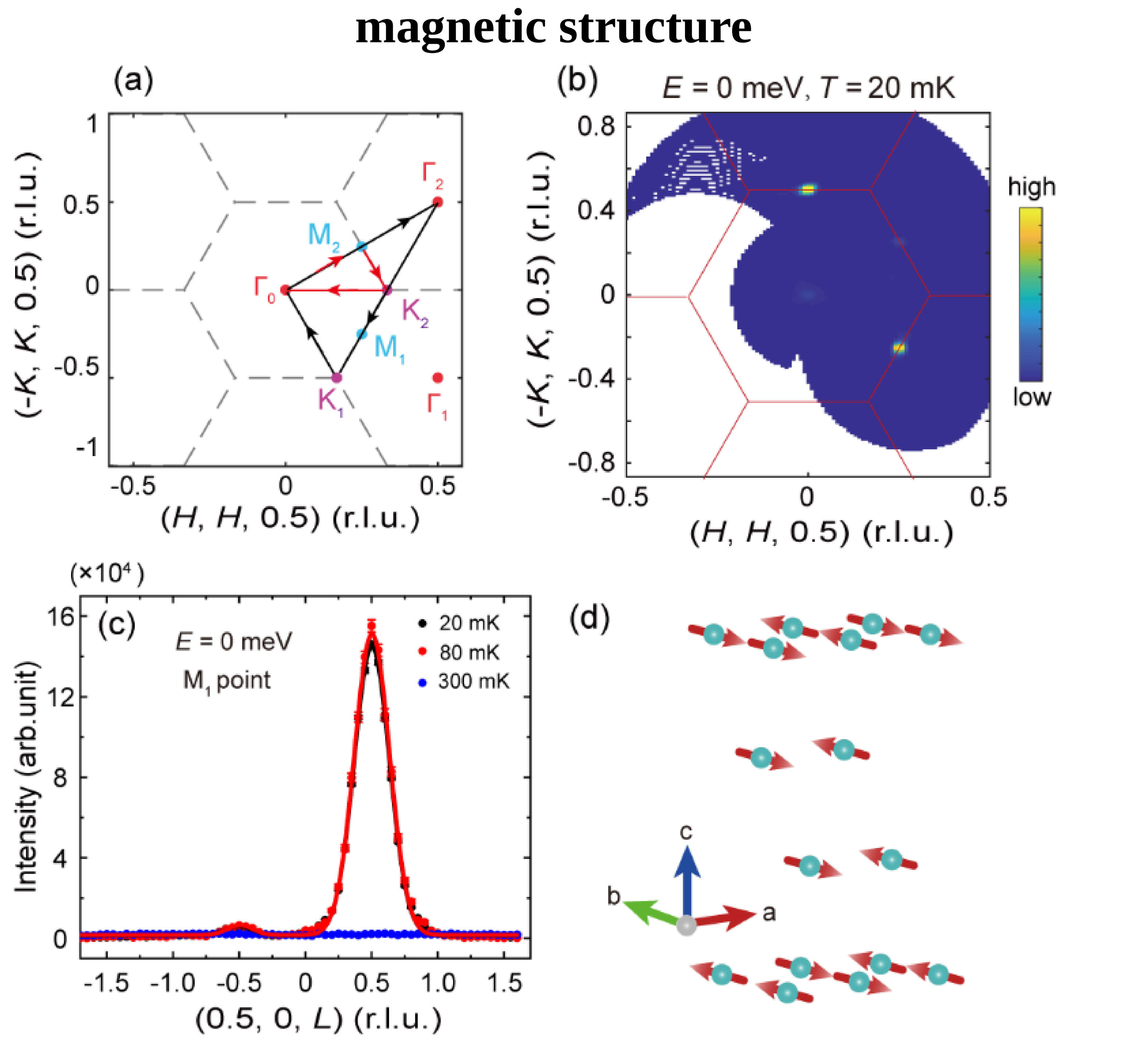
The rare-earth triangular-lattice chalcogenide is a great platform for exploring both spin liquids and novel magnetic orders with anisotropic spin interactions and magnetic frustrations. Here, we report the thermodynamic and neutron scattering measurements of rare-earth triangular-lattice chalcogenide $KErSe_2$, using single-crystal samples. Our experiments revealed a long-range stripe order below 0.2 K. Although the magnetic order was three-dimensional, magnetic excitations exhibited negligible modulation along the *z* direction, indicating very weak interlayer coupling. Furthermore, magnetic excitation developed a well-defined spin-wave dispersion with a gap of ~0.03 meV at M points. Both the stripe order and spin-wave excitations could be quantitatively understood from the anisotropic spin interactions of the Er^{3+} Kramers doublets. Our results therefore established the important role of the anisotropic spin interaction for the novel magnetic order and excitations in this system.

Structure, heat capacity and susceptibility



a, Schematic diagram of $KErSe_2$ crystal structure. **b**, Temperature dependence of heat capacity measured under a zero field. **c**, DC magnetic susceptibility under zero-field-cooling (ZFC) and field-cooling (FC) on $KErSe_2$ single crystal. The inset shows the Curie–Weiss fit of inversed magnetic susceptibility below 10 K. **d**, Isothermal magnetization for $H \,//\, c$ and $H \perp c$ at $T = 1.8$ K.

Three-dimensional magnetic order and magnetic structure

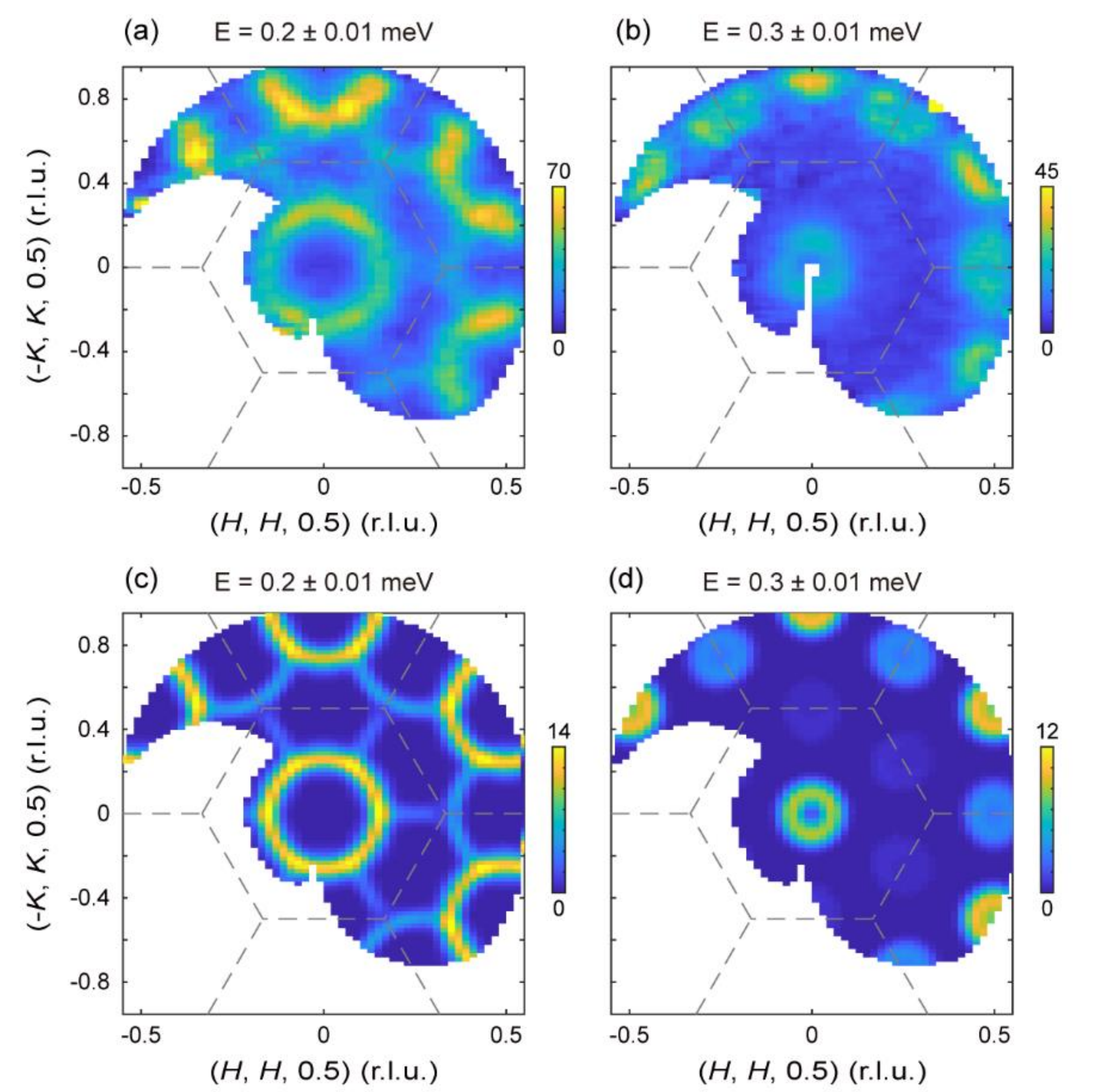


a, Sketch of the reciprocal lattice of $KErSe_2$. **b**, The elastic neutron scattering signals in the (*H*, *K*, 0.5) plane at 20 mK. **c**, L-cuts for the magnetic Bragg peaks at the indicated temperatures. The solid lines are the fitting results of the Gaussian profile. The weak peak at $L = -0.5$ originates from the misalignment of minor single crystals. **d**, Magnetic structure of $KErSe_2$ with $k = (1/2, 0, 1/2)$. Only half of the doubled magnetic unit cell along the c-axis is shown for clarity.

References

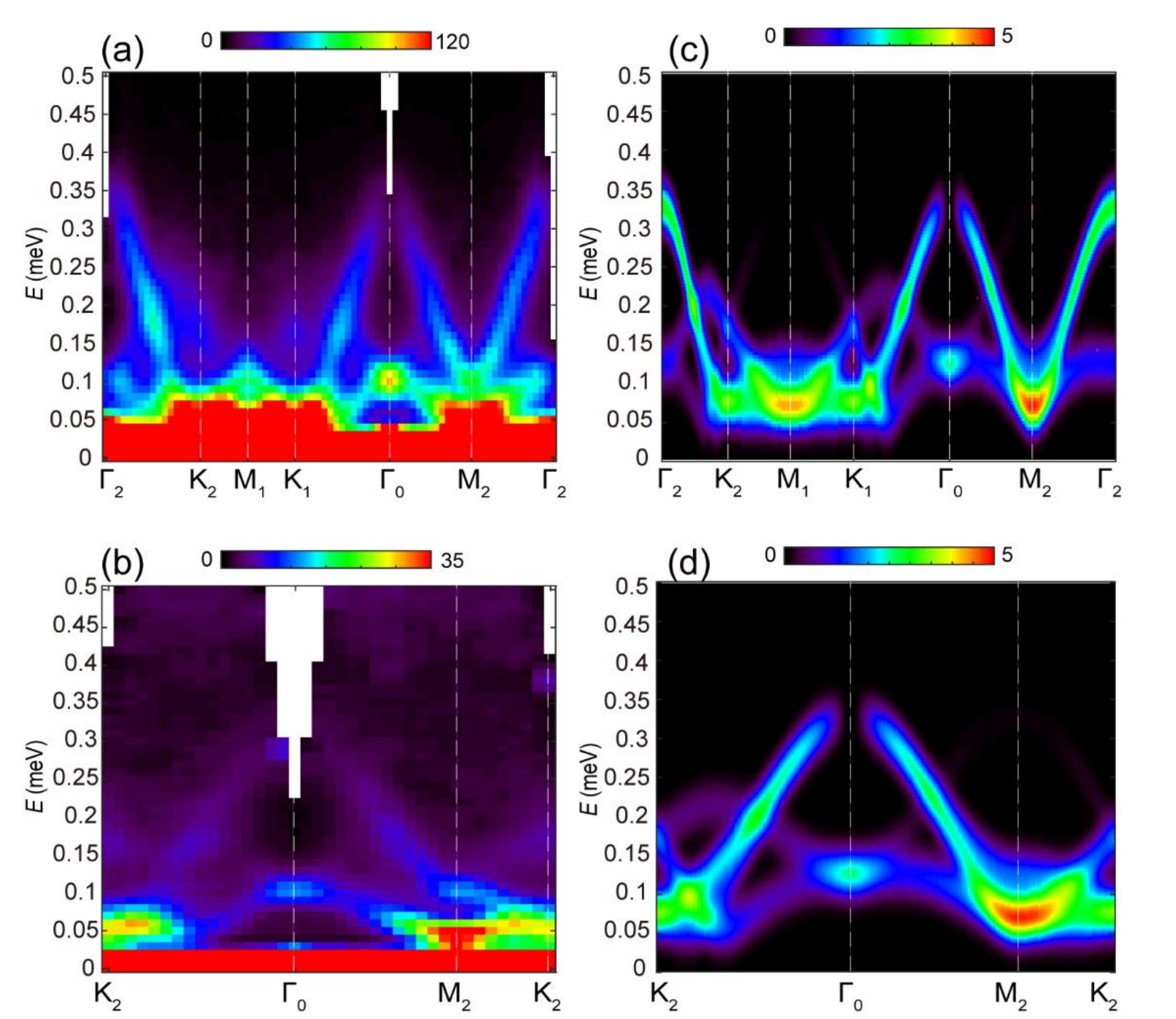
For detailed information, please refer to Gaofeng Ding *et al.*, arXiv: 2210.15867 (2022).

The measured and calculated momentum dependence of spin excitations in (*H*, *K*, 0.5) plane at 20 mK



a,b, (H, K, 0.5) contour plots with energy transfer $E = 0.2$ and 0.3 meV measured at 20 mK. **c,d**, Corresponding calculated spin excitations using anisotropic Heisenberg model with nearest-neighbor exchange interactions. A representative set of exchange parameters with $J_{zz} = 0.06$ meV, $J_{\pm} = 0.01$ meV, $J_{\pm\pm} = -0.04$ meV and $J_{z\pm} = 0.06$ meV.

The measured and calculated spin-wave dispersions at 20 mK



a,b, spin-wave dispersions along the two different high-symmetry directions of reciprocal lattice with incident energy $E_i = 1.8$ (0.8) meV. **c,d,** The corresponding calculated spin excitation dispersions. The color bars indicate the scattering intensity of arbitrary units on a linear scale.