Supplementary Information: Symmetry of magnetic correlations in spin-triplet superconductor UTe_2

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I. SUPPLEMENTARY METHODS

A. MACS experiments and data analysis

Data were collected on MACS[1] in two separate experiments. The sample holder consisted of a copper threaded rod that held two copper disks, each supporting several coaligned single crystals of UTe_2 that were affixed with CYTOP fluoropolymer and Fomblin fluorinated grease (Supplementary Figure 1). The total mass of UTe_2 was approximately 1.2 g.

In the first experiment, a dilution refrigerator was used for cooling. In the second experiment, a top-loading cryostat was used for cooling. An empty cryostat was measured for background subtraction. Data were converted to $S(Q, E)$ with an empty can subtracted using Mslice in the DAVE software suite [2]. The subtracted data sets were exported for further processing. For the 5 K, 20 K, and 60 K sets, a slice of $S(Q, E)$ from $0 < H$ and $-0.2 < K < 0.2$, where there is no discernible magnetic intensity, was used as an estimate of an isotropic contribution to the scattered intensity due to the sample holder and grease. For the data taken at 150 mK, an additional slice from $0.75 < H$ and $0.8 < K < 1.2$ was included in the background.

A comparison of the effects of symmetrization are shown in Supplementary Figures 2, 3, 4, and 5. The major features of the excitations are clearly observed in the unsymmetrized images, and no new features are added by the symmetrization process.

Preliminary measurements were performed on DCS [3]. 1 meV = 1.6×10^{-22} J. Identification of commercial equipment does not imply recommendation or endorsement by NIST.

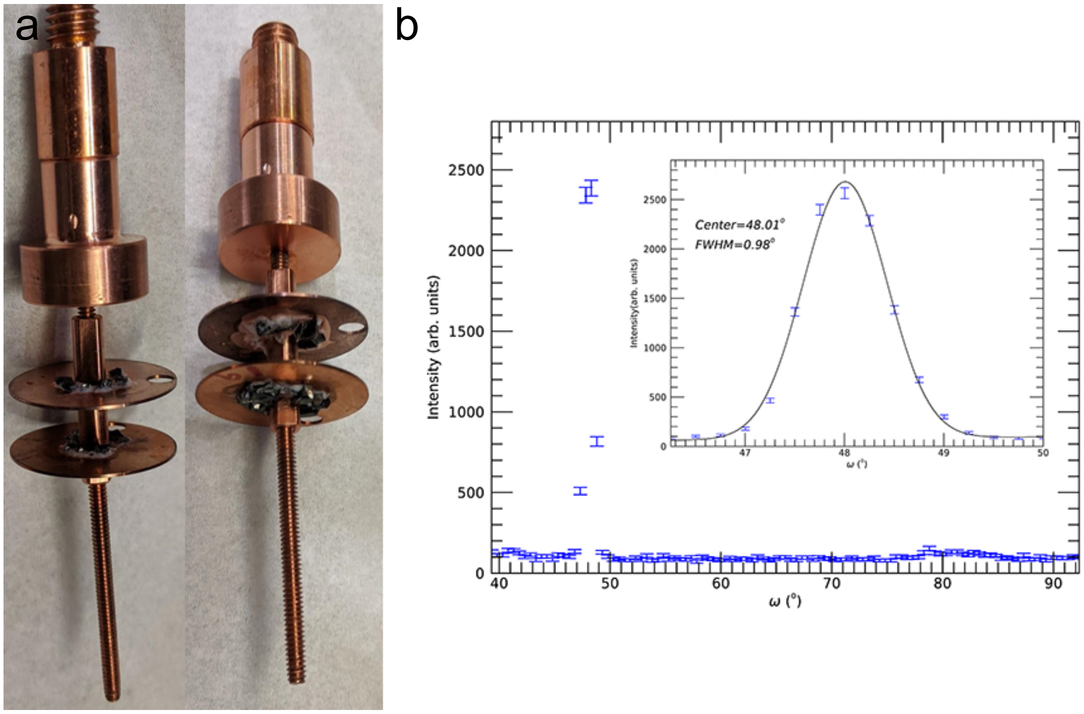
B. Fitting procedure

To determine the magnetic dispersion, data were binned into constant-Q sets, in which χ'' is a function of E. The data were then fit to Lorentzian lineshapes of the form $\chi'' = A/(1 + x^2) + b$, where $x = 2(E_0 - E)/(F)$. Here, E_0 is the peak position, F is the full width at half maximum, A is the amplitude, and b is a small constant offset to account for imperfect background subtraction. A floor of 2.5 was used for values F, which was important for controlling the fit at Q values where the excitation intensity is low. There were no indications of any sharper excitations in the data. Example sets are shown in Supplementary Figures 6 and 7.

II. SUPPLEMENTARY NOTE

A. Susceptibility versus scattered intensity

The total spectral weight plotted in Figure 3 of the main text is plotted in Supplementary Figure 8 as the scattered intensity S, which differs by a temperature prefactor. At higher temperatures, there is more spectral weight in S at lower E, which is most noticeable at 20 K and 60 K. However, these are small changes, and the energy-integrated S



Supplementary Figure 1: The assembled UTe_2 mosaic. a) Photographs of the coaligned UTe_2 single crystals on the two-disk sample holder. b) Rocking curve or sample-angle rotation scan of the 020 peak, showing the presence of a single Bragg peak in the 50 degree scan window, with a full width at half maximum of approximately 1 degree. This is indicative of a relatively low amount of in-plane rotational misalignment. Error bars correspond to an uncertainty of one standard deviation.

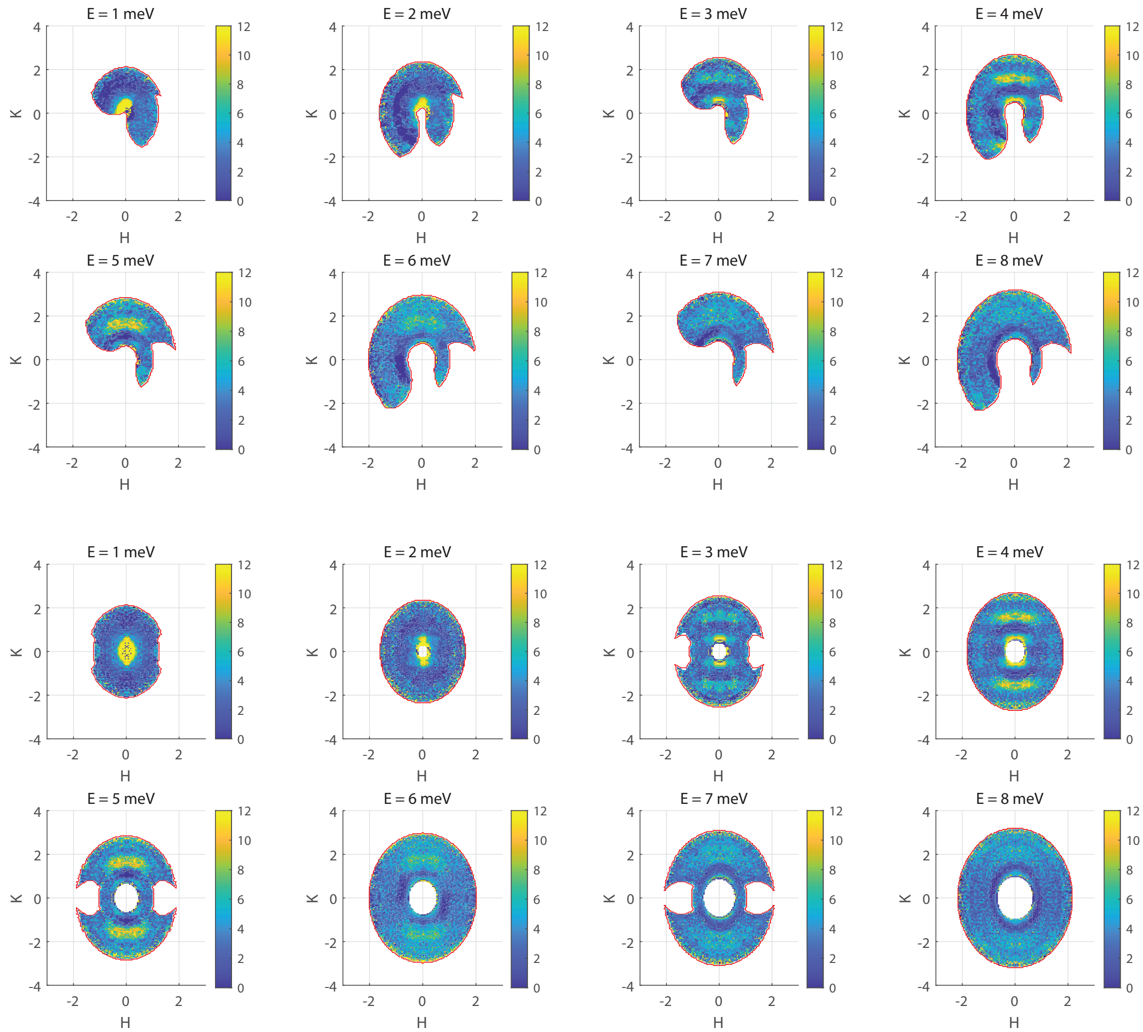
(total area) decreases on warming. For it to remain temperature-independent, the spectral weight would have to be dramatically redistributed across reciprocal space, or to much lower energy, such that it falls outside of the plotted Q and E range.

III. SUPPLEMENTARY REFERENCES

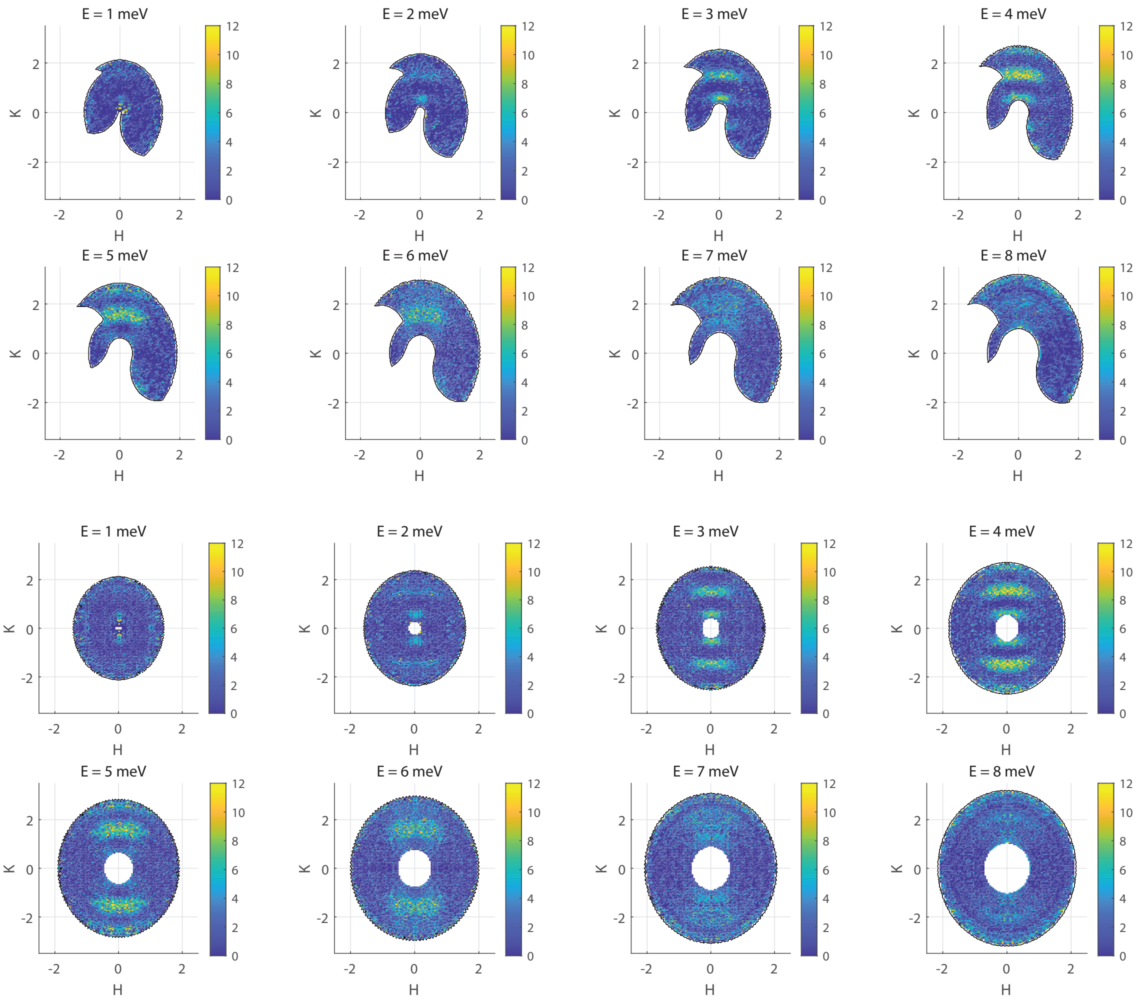
[1] Rodriguez, J. A. *et al.* MACS—a new high intensity cold neutron spectrometer at NIST. *Measurement Science and Technology* **19**, 034023 (2008).

[2] Azuah, R. T. *et al.* DAVE: A Comprehensive Software Suite for the Reduction, Visualization, and Analysis of Low Energy Neutron Spectroscopic Data. *Journal of Research of the National Institute of Standards and Technology* **114**, 341 (2009).

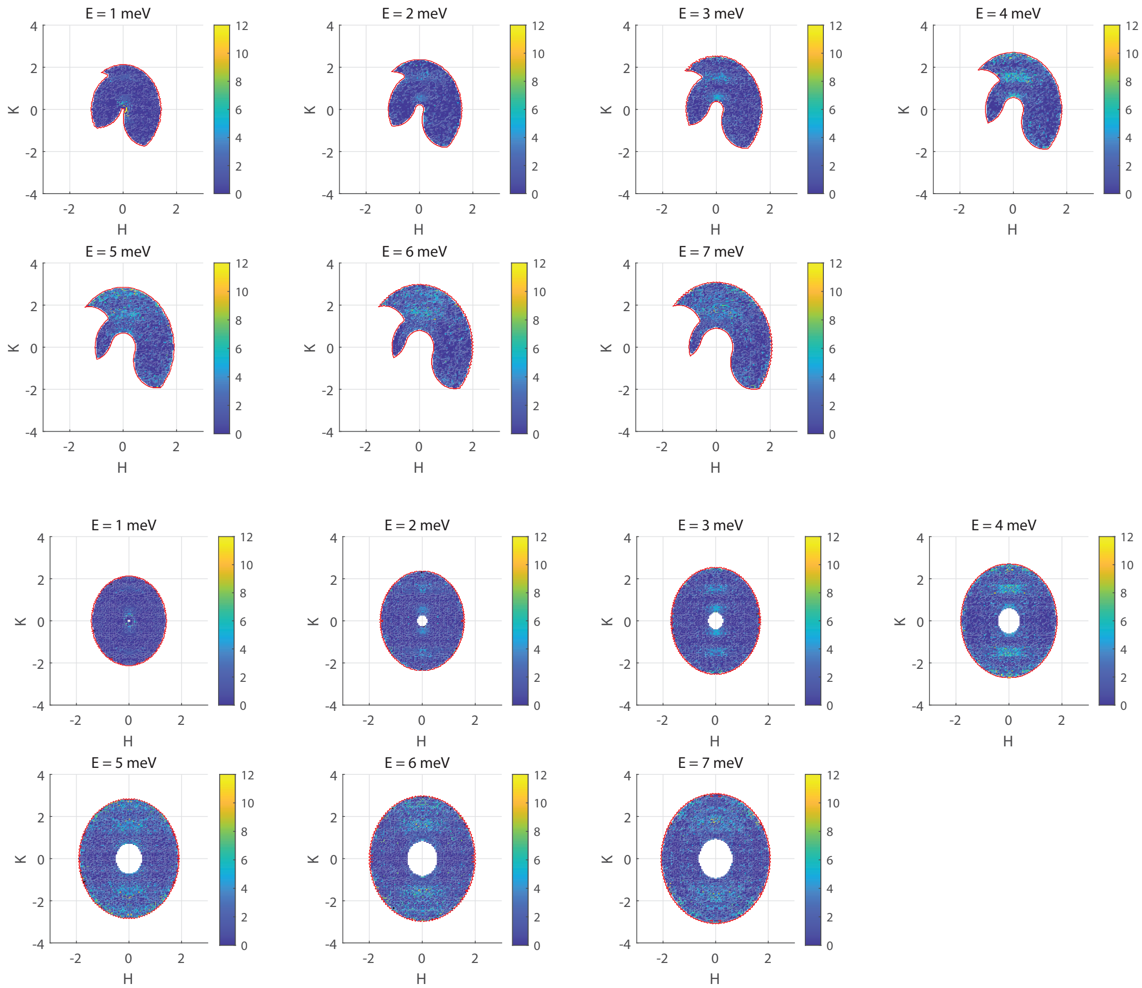
[3] Copley, J. R. D. & Cook, J. C. The Disk Chopper Spectrometer at NIST: a new instrument for quasielastic neutron scattering studies. *Chemical Physics* **292**, 477–485 (2003).



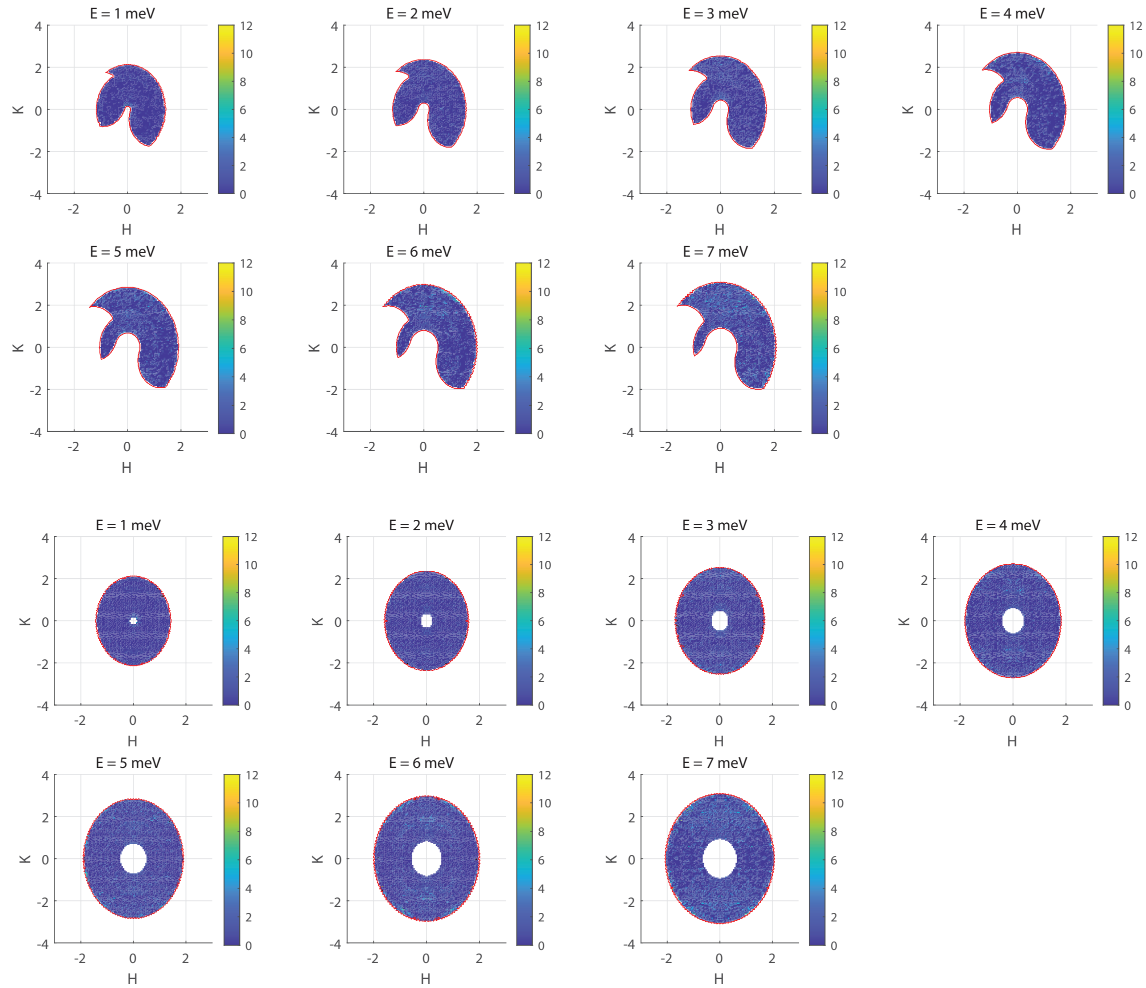
Supplementary Figure 2: $\chi''(Q, E)$ at 150 mK before and after symmetrization. Upper panels: Unsymmetrized data at indicated energies. Lower panels: The same data after symmetrization.



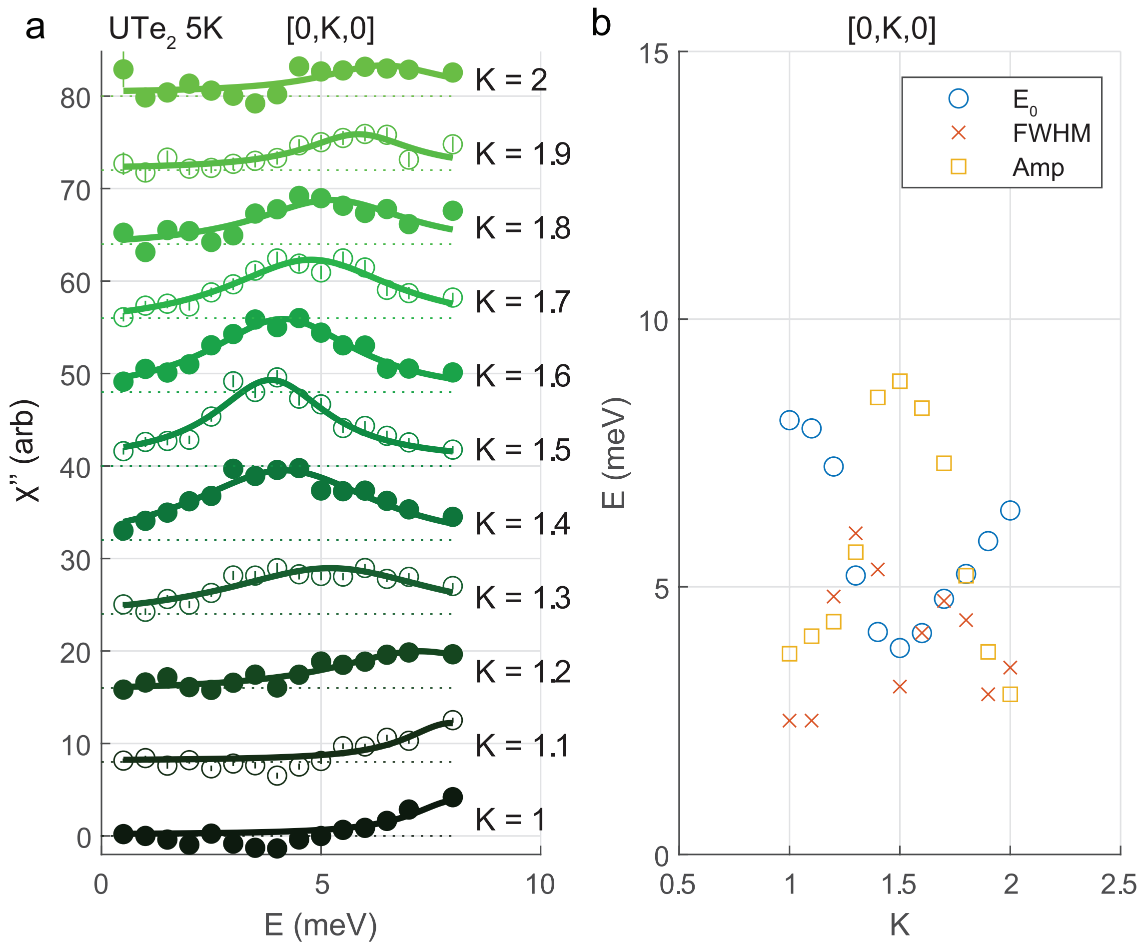
Supplementary Figure 3: $\chi''(Q, E)$ at 5 K before and after symmetrization. Upper panels: Unsymmetrized data at indicated energies. Lower panels: The same data after symmetrization.



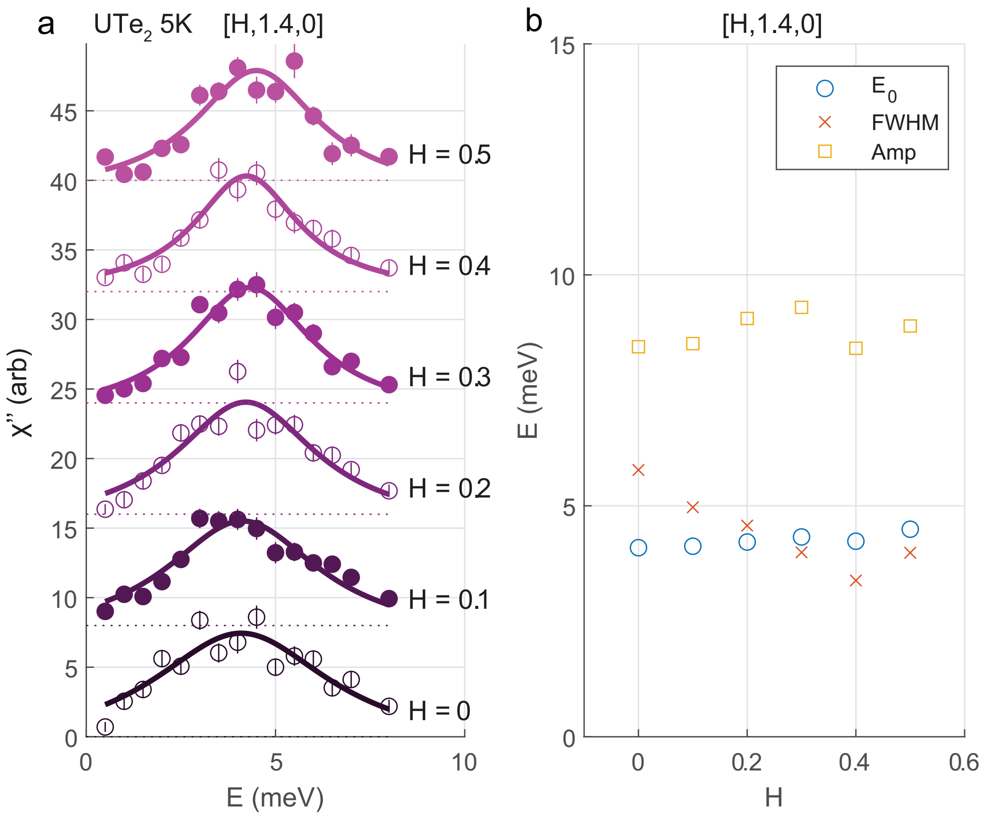
Supplementary Figure 4: $\chi''(Q,E)$ at 20 K before and after symmetrization. Upper panels: Unsymmetrized data at indicated energies. Lower panels: The same data after symmetrization.



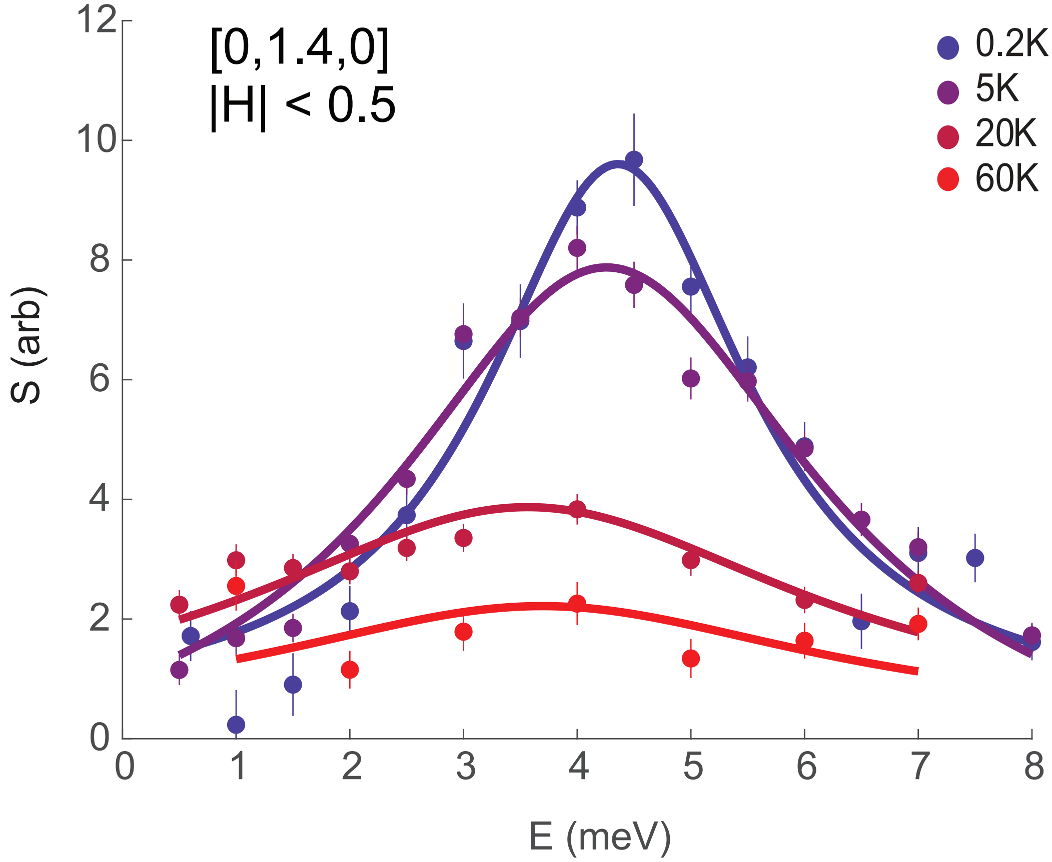
Supplementary Figure 5: $\chi''(Q, E)$ at 60 K before and after symmetrization. Upper panels: Unsymmetrized data at indicated energies. Lower panels: The same data after symmetrization.



Supplementary Figure 6: Example of fits and fit parameters for data at 5 K taken along $[0, K, 0]$ with $|H| < 0.1$. a) Data for $1 < K < 2$ were fitted to Lorentzian lineshapes. Error bars, indicated in the empty circular markers, are smaller than the marker size, and correspond to an uncertainty of one standard deviation.b) The peak energy E_0, full width at half max F (FWHM), and amplitude A (Amp) at different K values.



Supplementary Figure 7: Example of fits and fit parameters for data at 5 K taken along $[H, 1.4, 0]$ with $1.35 < K < 1.45$. a) Data for $0 < H < 0.5$ were fitted to Lorentzian lineshapes. Error bars correspond to an uncertainty of one standard deviation. b) The peak energy E_0, full width at half max F (FWHM), and amplitude A (Amp) at different H values.



Supplementary Figure 8: The temperature dependence of $S(Q, E)$ at the BZ edge. These data correspond to the same range as in Figure 3 of the main text. Error bars correspond to an uncertainty of one standard deviation.