

Unveiling the phonon dynamics in quasi-2D organic-inorganic hybrid perovskites $\text{BA}_2\text{MA}_{n-1}\text{Pb}_n\text{I}_{3n+1}$ (with $n = 1 - 4$)

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The original objective of this experiment was to investigate the low-energy phonon dispersion relations of $\text{BA}_2\text{MA}_{n-1}\text{Pb}_n\text{I}_{3n+1}$ ($n = 1 - 3$) in the energy-transfer range of 0–2 meV using the HODACA cold neutron triple-axis spectrometer. However, based on the results of the previous beamtime, the INS intensity obtained from $\text{Cs}_3\text{Cu}_2\text{I}_5$ was found to be insufficient to provide data with the statistical quality required for publication. Therefore, the experimental plan was revised to improve the counting statistics of the $\text{Cs}_3\text{Cu}_2\text{I}_5$ measurements. To enhance the signal-to-noise ratio, the energy-transfer range was narrowed from 0 – 3 meV to 0 – 1.2 meV, while maintaining an energy step size of 0.2 meV. In addition, the counting time at each scan point was significantly increased. Measurements were performed at the (020) and (111) Bragg positions at 200, 300, and 400 K.

The measurement conditions were set to $\text{mcu} = 16$ for the (020) scan at 200 K, $\text{mcu} = 10$ for the (020) scans at 300 and 400 K, and $\text{mcu} = 10$ for all (111) scans at 200, 300, and 400 K. These modifications were intended to improve the counting statistics and obtain higher-quality INS spectra for subsequent analysis of the low-energy acoustic phonons. The measured INS spectra obtained under the revised experimental conditions are presented in Figs. 1 and 2.

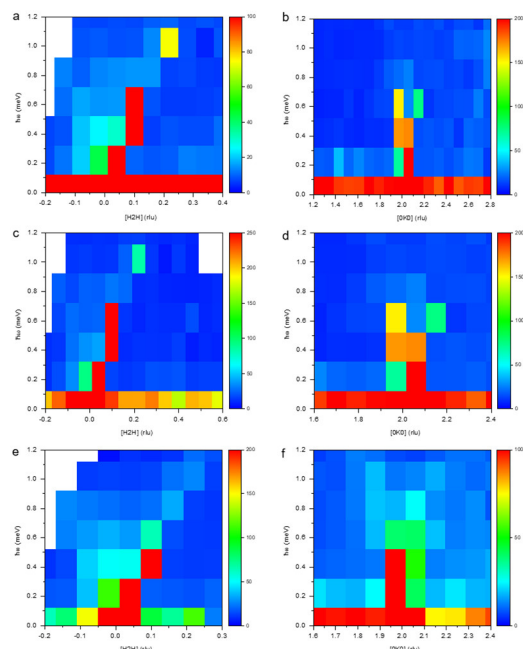


Fig. 1 Phonon spectra measured along the [H2H] and [0K0] directions at (a-b) 200 K, (c-d) 300 K, and (e-f) 400 K.

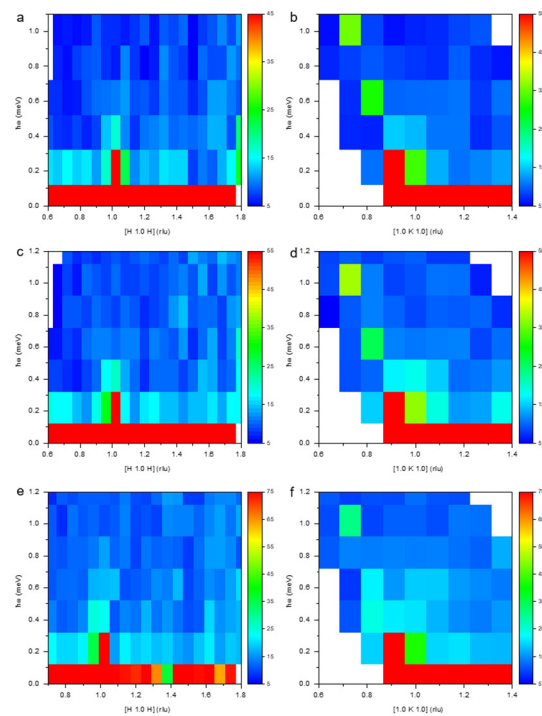


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