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Fractional Excitation-induced Phonon Renormalization in α-RuCl3

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The quantum spin liquid (QSL) phase is of immense interest to condensed matter physicists, and have been studied for decades. With a Kitaev model that is exactly solvable and gives a QSL ground state, α-RuCl3 is a promising Kitaev QSL candidate. Above the critical magnetic field Bc~7T and below T~6K there is evidence for the half-integer quantized plateau where anomalous measurements possibly arise from the fractional excitations in the QSL phase. Recent theoretical work has shown that the fractional excitations can induce phonon renormalization via the spin-lattice coupling, and would in particular affect the acoustic phonons, where longitudinal/transverse phonons harden/soften, respectively, as they approach the zone boundary. Our measurements have focused on the phonon dispersion in α-RuCl3 to observe this phonon renormalization effect in the putative QSL phase. We have used high-quality in-house grown α-RuCl3 single crystals for inelastic neutron and x-ray scattering measurements, combined with phonon dynamics calculations, to survey the acoustic phonons in the relevant scattering directions, in particular under magnetic fields. We will discuss our results with a focus on examining the low-energy acoustic phonon branches for the phonon renormalization effect.

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