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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 fractional excitations in the QSL phase. Although previous inelastic neutron scattering measurements have focused on magnetic excitations, the phonon dispersions have not been well-studied. However, 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. Our measurements have focused on the phonon dispersion in α-RuCl3 to observe this phonon renormalization effect. 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 particular under magnetic fields. We will discuss our results with a focus on examining the low-energy acoustic phonon relevant to the phonon renormalization effect. Notably, our inelastic neutron scattering measurements under magnetic field will be compared with inelastic x-ray scattering measurements without a magnetic field and with DFT calculations of the phonon branches to clarify the behavior of these phonon branches in this phase of interest.

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