Dynamics of the critical phonon modes in quantum paraelectric $SrTiO_3$

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We report our recently performed triple-axis inelastic neutron scattering experiments on single-crystal $SrTiO_3$ at 37 mK. These are the first measurements deep into the enigmatic quantum polar acoustic state in the vicinity of the ferroelectric QCP. Measurements are taken at and around $\boldsymbol{q} = 0$ in multiple directions in reciprocal space. In addition, we explore how the pressure affects the phonon mode in $SrTiO_3$ up to 5.0 kbar around 2 K. Our observations shed light on the coupling of the soft optical mode with the acoustic phonons, and its response to external pressure [1]. We believe this could help us understand the importance of anharmonic lattice dynamics and unusual thermal transport in $SrTiO_3$.

The proximity of $SrTiO_3$ to a quantum critical point [2] and the evolution of the underlying modes when being tuned with even modest applied pressure has become a promising new branch of the study of quantum critical phenomena. The critical point here is associated with a soft optical phonon mode responsible for the ferroelectric instability through a continuous displacive transition. Our recent dielectric measurements under pressure [1,3] expose the formation of a 'quantum polar-acoustic state' below 2 K.

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