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## Phonon renormalization in $\text{LaCoO}_3$

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$\text{LaCoO}_3$  features two broad crossovers observed around  $T_1 = 100$  K and  $T_2 = 200$  K. These crossovers are typically associated with the temperature dependent population of excited spin states of the  $\text{Co}^{3+}$  ion, which evolves upon heating from the low-spin (LS),  $S = 0$ , to high-spin (HS),  $S = 2$ , configuration. Since the  $\text{CoO}_6$  octahedra expands around the larger HS sites, a static LS-HS order was proposed by Goodenough in the 1960's [1] but was never confirmed experimentally. More recent studies [2,3] propose a dynamic short-range order of alternating LS and HS Co sites. A corresponding dynamic distortion of the crystal lattice mimics closely the Co-O breathing mode. Here, we use inelastic neutron scattering to study the lattice dynamics of  $\text{LaCoO}_3$  over a wide temperature range,  $5 \text{ K} \leq T \leq 700 \text{ K}$ . We find strong phonon renormalization of low- as well as high-energy phonon modes with periodicities corresponding to the proposed superlattice.

- [1] P. M. Raccah and J. B. Goodenough, Physical Review 155, 932 (1967).
- [2] J. Kuneš and V. Křápek, Physical Review Letters 106, 256401 (2011).
- [3] V. Křápek et al., Physical Review B 86, 195104 (2012).

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