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Phonon renormalization explained by electron-momentum dependent electron-phonon coupling

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Electron-phonon coupling, i.e., the scattering of lattice vibrations by electrons and vice versa, is a common phenomenon in solids and can lead to emergent ground states such as superconductivity and charge-density wave order. Signatures of strong electron-phonon coupling, e.g. softening and broadening of phonons on cooling, are typically assigned to the presence of nested parts of the Fermi surface or lattice anharmonicity. Here, we unravel a third scenario in the seminal strong-coupling material $\text{YNi}_2\text{B}_2\text{C}$. The three-dimensional Fermi surface features a large value of the electronic joint density-of-states but only for a particular value of the electron out-of-plane momentum k_z . Using a combination of inelastic neutron scattering and angle-resolved photoemission spectroscopy analyzed based on *ab-initio* lattice dynamical calculations we show that this peak of the electronic joint density-of-states as function of k_z is likely the origin for the spectacular phonon renormalization in $\text{YNi}_2\text{B}_2\text{C}$. Thus, our study rationalizes strong phonon anomalies in the absence of both classic, i.e. phonon-momentum dependent nesting and anharmonicity.

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