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Anomalous Electron-Phonon Coupling in Cuprates and its Doping Dependence

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It is well known that conventional superconductivity is mediated by phonons. Phonon renormalization at specific wavevectors (Kohn anomalies) appears in phonon dispersions in many of these compounds with high T_cs in agreement with LDA calculations. In the case of the cuprates, LDA calculations predict neither any significant Kohn anomalies nor electron-phonon coupling strong enough to account for high T_c superconductivity. However, inelastic neutron and x-ray scattering experiments found huge softening and broadening of the bond-stretching phonons indicating that electron-phonon coupling in the cuprates is much stronger than expected from LDA. In the LaSrCuO family phonon renormalization has been observed in the vicinity of the reduced in-plane wavevector q_{in}=(0.25, 0) (in units of (2π/a,2π/a where a is the near-neighbor Cu-Cu distance). The effect is strongest at low temperatures and in compositions that exhibit the so-called stripe order where it occurs at the wavevector that corresponds to the charge order. Detailed **q**-dependent studies revealed that the underlying electronic instability is 2D in nature in the 214 compounds, i.e. for q_{in}=(0.25, K), it is peaked at K=0 with the full width at half maximum of about 0.15 r.l.u. The strength of this phonon renormalization tracks T_c disappearing at the nonsuperconducting extremes of doping. In YBCO the similar phonon anomaly is quasi-1D with bond-stretching phonon renormalization occurring around q_{in}=(H, 0.25) for all investigated H (in units of (2π/a,2π/b where a/b is the near-neighbor Cu-Cu distance in the direction paralle/perpendicular to the Cu-O chains). Relationship between these effects and band structure will be explored. Experimental results will also be compared with expectations of LDA-based calculations as well as with predictions of models based on dynamic stripes.