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Optics clues to pairing glues in the cuprates

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Ever since the discovery of high temperature superconductivity the issue whether or not the pairing is either mediated by a bosonic glue or by a radically different mechanism, and the nature of a glue if it exists, have been highly debated[1, 2]. If the 'glue picture' is applicable, infrared optical spectroscopy can be used to measure the spectrum describing the bosonic glue and its coupling to electrons, $\alpha^2F(\omega)$. From optical spectra of Bi-2201, Bi-2212, Bi2223, and Hg-1201 at various doping levels we observe that the two main components of $\alpha^2F(\omega)$ are (i) a peak at 50 meV and a broad temperature and doping dependent background. The 50 meV peak is most likely due to vibrational modes around, in view of the fact that this feature is practically independent of doping, temperature and stoichiometry. The background, which extends up to approximately 0.3 eV is found to increase drastically with decreasing temperature in the range 0 - 20 meV , corresponding to a strong increase of the coupling constant in the limit $T \to 0$. In the case that we take the entire spectrum found at room temperature to be pair forming we find an upper limit on T_c that is 2 times larger and has the same doping trend as the actually observed T_c's.

The two observations, (i) that $\alpha^2F(\omega)$ is temperature dependent and (ii) that the coupling constant is huge (~ 4), together indicate that the strong coupling formalism probably needs to be revised or extended. The use of a temperature independent $\alpha^2F(\omega)$ or λ in the analysis of resistivity measurements is for example certainly not justified.

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