Path-integral theory for photoemission spectra of electron-phonon coupled systems and anomalous isotope effect

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Using a new path-integral theory [1], we study the angle resolved photoemission spectra (ARPES) of one- and two-dimensional metallic many-electron systems coupled with Einstein phonons. The multiple scatterings of electrons due to phonons are shown to completely dominate the ARPES, even if the electron-phonon coupling strength is intermediate. These multiple scatterings result in spectral evolution from a broad Gaussian to a two-headed asymmetric Lorentzian as the momentum changes from the band bottom to the Fermi one ($\equiv p_F$), as shown in Fig. 1. We have also found that this two-headed structure near p_F becomes most distinct in the two dimensional non-half-filled cases with no charge density wave gap. These results qualitatively agree with recent experiments of ARPES on the Be(0001) surface and $Bi_2Sr_2CaCu_2O_8$.

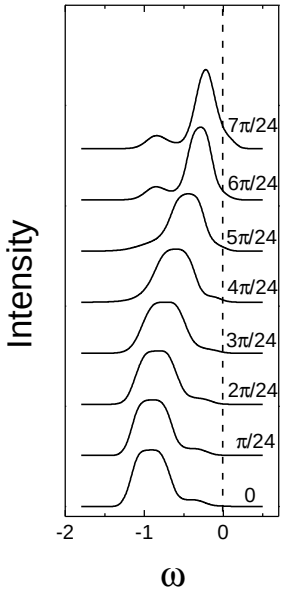

Fig.1 ARPES of 1D e-ph system at about 30% -filling.

In terms of nonlinear couplings between the electrons and the phonons, we also show the microscopic origin of anomalous isotopic band shift appeared in the ARPES of $Bi_2Sr_2CaCu_2O_8$, in good agreement with the recently discovery by Gweon *et al*. [2].

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[1] K. Ji, H. Zheng, and K. Nasu, Phys. Rev. B **70**, 085110 (2004).

[2] G. –H. Gweon *et al.*, Nature (London) **430**, 187 (2004).