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Emergent ω/T Scaling of Magnetic Response from Freezing of Spin Dynamics in Doped Antiferromagnets [1]

Igor Sega
Dept. of Theoretical Physics, J. Stefan Institute, Ljubljana, SL-1000, Slovenia
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Since the early neutron scattering experiments on low doped La-based high temperature superconductors [1] the simple scaling form of dynamic magnetic respons $\chi''(\mathbf{q},\omega,T)$ in the wariable ω/T has been observed in other high-T_c cuprate superconductors at low (hole) doping. In [2] it was shown that such behavior naturally follows from basically two assumptions, well established experimentally for doping levels for which there is no static magnetic order, i.e., a) the low-ω response is overdamped, and b) the thermodynamic spin-spin correlation length "freezes" at low temperature, i.e. remains finite and temperature independent. These two assumptions together with the sum rule obeyed by $\chi''(\mathbf{q},\omega,T)$ result in a linear-in-T dependence of the effective damping over most of the temperature range above some T_{QC} with a crossover to a finite value bellow T_{QC}. Moreover, this quantum critical behavior of damping manifests itself in the scaling of the peak position of the $\mathbf{q}$-integrated response $\chi''(\omega,T)$ with temperature. Such behavior has been observed quite recently in underdoped $YBa_2Cu_3O_{6.45}$ compound as well [3], providing yet another test for the above assumptions. Surprisingly, however, the scaling behavior has been recently reported to apply to $\chi''(\mathbf{q},\omega,T)$ as well [3]. It is shown, that the above approach still remains valid, and enables one to extract the bare damping of magnetic fluctuations at low ω from experimental data. The limitations of the above approach and possible application to electron doped compounds, e.g, PLCCO [4] are also discussed.

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