Spin correlations in electron-doped antiferromagnetic ordered phase of Pr1-xLaCexCeO4

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High-transition temperature (T_c) superconductivity mediated by spin fluctuations is one of central issues in the strongly correlated electron systems. Extensive neutron scattering measurements on hole-doped $La_{2-x}Sr_xCuO_4$ have revealed an evolution of spin correlation by doping and its intimate relationship with the superconductivity [1, 2]. To understand a novel magnetism in carrier-doped Mott insulators and the role in the high-T_c SC mechanism, comparative studies betweeen hole-doped and electron-doped systems are indispensable. However, due to the difficulty in preparing superconducting single crystalline samples, experimental studies for electron-doped system have been far behind compared to those for hole-doped system.

Recent neutron-scattering study revealed the existence of the commensurate low-energy spin fluctuations in optimally electron-doped $Nd_{1.85}Ce_{0.15}CuO_4$ (NCCO)[3] and $Pr_{0.89}LaCe_{0.11}CuO_4$[4]. These observations indicate that the collective spin fluctuations commonly exist in the SC phase irrespective of carrier type. However, to investigate the universal nature in the electron-doped system further systematical study is important. We therefore performed systematic neutron scattering measurements on the $Pr_{1-x}LaCe_xCeO_4$ system.

Figure 1 shows the peak profiles with ω=3, 5, and 8 meV for the non-superdonducting sample of $Pr_{0.93}LaCe_{0.07}CuO_4$ ($T_N \sim$100K). Clear commensurate low-energy spin fluctuations are observed at the antiferromagnetic zone center as is the case of non-doped mother compound. However, the peak-width is slightly broader than the resolution limited value. This result suggests that the doped electron can affect the spin fluctuations and reduces the spatial coherence length. Further upon doping, the paek-width drastically broadens when the system becomes superconductor and the broadening of the width continuously progresses in the superconducting phase, indicating a close relation between the spin correlations and the superconductivity in the electron-doped system.

References

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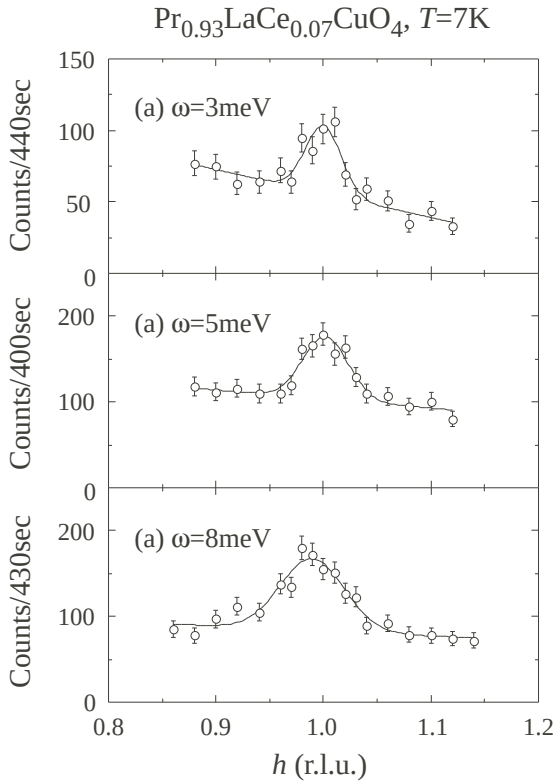

Fig. 1. Constant energy spectra with ω= (a) 3 meV, (b) 5 meV, and (c) 8 meV for $Pr_{0.93}LaCe_{0.07}CuO_4$ measured at 7K.