Magnetic excitation in electron-doped $Pr_{1.40-x}La_{0.60}Ce_xCuO_{4-y}$

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For the emergence of superconductivity in the electron-doped cuprate oxide, both substitution of cation such a Ce^{4+} at a rear-earth site and annealing procedure under oxygen reducing condition are required. Although the magnetism is recognized to play a key role in the mechanism of superconductivity the effects of Ce-doping and oxygen-reduction on the spin correlation is not fully understood. In order to extract these two effects on the magnetism, we carried out high-energy inelastic neutron scattering measurement on the as-grown and the Ar-annealed $Pr_{1.40}La_{0.60}CuO_{4-y}$, and as-grown $Pr_{1.40-x}La_{0.60}Ce_xCuO_{4-y}$ with x=0.08 and 0.18. All samples exhibit long-range antiferromagnetic (AF) order at low temperature.

By using chopper spectrometer installed in J-PARC, we have successfully observed the dynamical spin response below ~300 meV throughout the first Brillouin zone for all samples. The dispersion relation in as-grown and annealed $Pr_{1.40}La_{0.60}CuO_{4-y}$ are well reproduced by the two-dimensional spin-wave relation with the nearest neighbor exchange coupling J of ~140 meV, while the absolute value of dynamical susceptibility is much reduced in the annealed sample, over the energy range determined in the present study. Therefore, the magnetic moment is drastically suppressed by the reduction annealing. On the other hand, in a series of as-grown samples, the zone boundary energy increases upon Ce-substitution, suggesting that the magnetic excitation becomes steeper with the electron-doping, and the total intensity does not change so much by Ce-substitution. These experimental facts suggest the distinct effect of oxygen reduction and Ce-substition. The origin of anomalous reduction of intensity after annealing is discussed in terms of change in the spin density cloud in the real space.

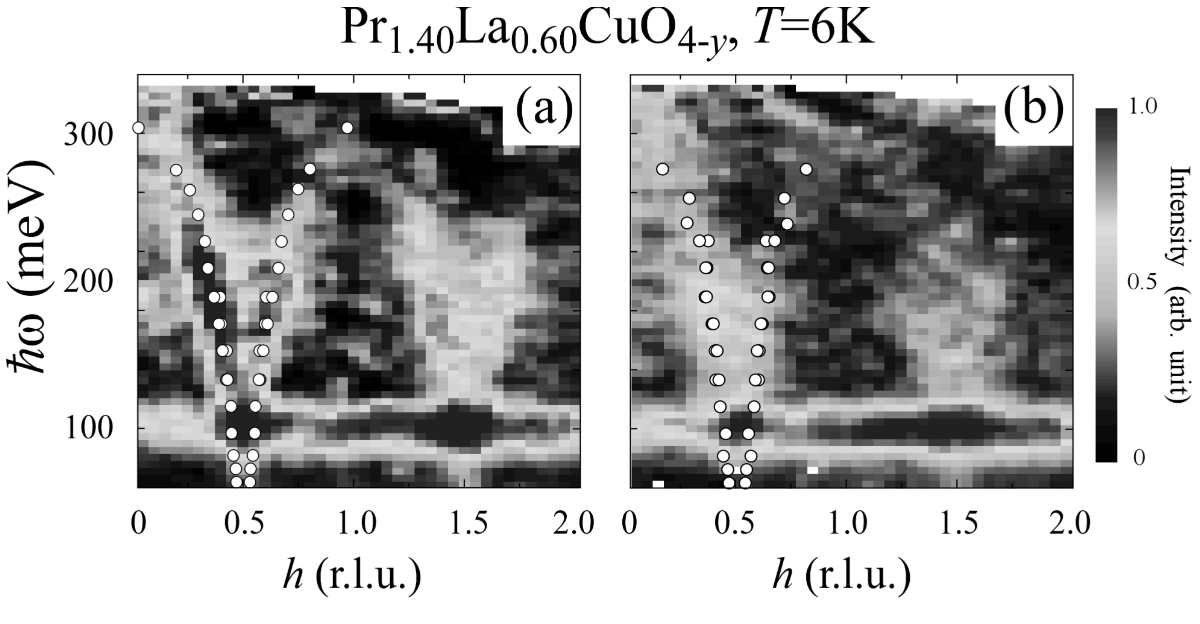

Figure 1: Magnetic excitation spectrum for (a) as-grown and (b) annealed $Pr_{1.40-x}La_{0.60}Ce_xCuO_{4-y}$.