Ferromagnetic Fluctuations in Heavily Overdoped Bi-2201 cuprates

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It has been theoretically proposed that a ferromagnetic (FM) phase exists and is related to the suppression of superconductivity in the heavily overdoped (HOD) regime of the hole-doped high-T_c cuprates [1]. In non-superconducting HOD La-214 cuprate, three-dimensional FM fluctuations have been suggested from muon-spin-relaxation (μSR) and transport measurements [2]. The FM fluctuations/order have also been suggested in HOD Bi-2201 from RIXS [3] and in heavily electron-doped $La_{2-x}Ce_xCuO_4$ from transport and magnetic measurements [4]. In this talk, we review our results of the two-dimentional FM fluctuations in HOD Bi-2201 cuprates [5,6].

We found in HOD Bi-2201 that the magnetization curve tended to be saturated in high magnetic fields at low temperatures, suggesting the precursor phenomenon toward a possible FM transition at a lower temperature. μSR measurements revealed that spin fluctuations are developed at low temperatures in HOD Bi-2201. The ab-plane electrical resistivity, specific heat and magnetic susceptibility χ of HOD Bi-2201 exhibited temperature dependences characteristic of a metal with two-dimensional FM fluctuations. All these results suggest that two-dimensional FM fluctuations exist in the HOD regime of Bi-2201, suggesting the universality of FM fluctuations in the HOD regime of the high-T_c cuprates.

We also investigated the Fe-substitution effects on FM fluctuations in HOD Bi-2201 [6]. The χ exhibited hysteresis between the zero-field and field cooling at low temperatures, suggesting the formation of spin-glass state. The muon-spin relaxation rate and χ were enhanced by the Fe substitution. The effective Bohr magneton estimated from χ was larger than that of a bare Fe^{3+} spin, suggesting the Fe-induced enhancement of FM fluctuations. We propose the formation of FM spin clusters around each Fe, which is in contrast to antiferromagnetic spin clusters suggested in Fe-substituted Bi-2201 in the overdoped regime [7].

The origin of FM fluctuations in the HOD regime of the hole-doped cuprates would be the itinerant ferromagnetism due to the Fermi-surface nesting and the large density of states or would be the localized ferromagnetism due to the double exchange interaction relating to the $Cu3d_{x^2-y^2}$ and $Cu3d_{3z^2-r^2}$ orbitals.

References

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