Superconductivity in a $La_2CuO_4/La_{1.56}Sr_{0.44}CuO_4$ Superlattice

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Recently complex oxide heterostructures have attracted a lot of interest since in $LaAlO_3/SrTiO_3$ heterostructures superconductivity was discovered with a $T_c \simeq$ 200mK [1]. This work demonstrated that the interface between complex oxides can lead to surprising new states. Already earlier the question of the electronic state at the interface of $La_{1.85}Sr_{0.15}CuO_4/La_2CuO_4$ heterostructures was raised [2]. Two possible scenarios for the reconstruction of the electronic states at the interface have been discussed: (i) the development of an extended depletion layer due to band bending (in analogy to the case of a pn interface in semiconductors), and (ii) charge transfer processes leading to a "midgap doping" with almost no depletion layer. The transport measurements performed were in favor of the "midgap doping" scenario.

To check these ideas we have performed a low energy μSR (LE-μSR) study on a $La_2CuO_4/La_{1.56}Sr_{0.44}CuO_4$ superlattice, where none of the constituents is superconducting. We find in this system superconductivity with a $T_c \simeq$ 40K. By applying a magnetic field parallel (Meissner state) and perpendicular (vortex state) to the film planes, we could show that the superconducting state is sheet like, most likely at the interfaces between $La_2CuO_4/La_{1.56}Sr_{0.44}CuO_4$. Furthermore, from ZF measurements and temperature trends of the asymmetry, we find a peculiar remaining magnetic state.

[1] N. Reyren et al., Science 317 (2007) 1196.
[2] I. Bozovic et al., Nature 422 (2003) 873.