Superconductivity in a $\text{La}_2\text{CuO}_4/\text{La}_{1.56}\text{Sr}_{0.44}\text{CuO}_4$ Superlattice

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Recently complex oxide heterostructures have attracted a lot of interest since in $\text{LaAlO}_3/\text{SrTiO}_3$ heterostructures superconductivity was discovered with a $T_c \approx 200\text{mK}$ [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 $\text{La}_{1.85}\text{Sr}_{0.15}\text{CuO}_4/\text{La}_2\text{CuO}_4$ 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 $\mu$SR (LE-$\mu$SR) study on a $\text{La}_2\text{CuO}_4/\text{La}_{1.56}\text{Sr}_{0.44}\text{CuO}_4$ superlattice, where none of the constituents is superconducting. We find in this system superconductivity with a $T_c \approx 40\text{K}$. 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 $\text{La}_2\text{CuO}_4/\text{La}_{1.56}\text{Sr}_{0.44}\text{CuO}_4$. Furthermore, from ZF measurements and temperature trends of the asymmetry, we find a peculiar remaining magnetic state.