Superconductivity and magnetism in cuprate heterostructures

B. M. Wojek[1,2], E. Morenzoni[1], D.G. Eshchenko[1,2], A. Suter[1], T. Prokscha[1], E. Koller[3], E. Treboux[3], Ø. Fischer[3], H. Keller[2]

[1]*Laboratory for Muon Spin Spectroscopy, PSI, CH-5232 Villigen PSI, Switzerland*
[2]*Physik-Institut der Universität Zürich, CH-8057,Switzerland*
[3]*DPMC, Université de Genève, 1211 Genève 4, Switzerland*

Heterostructures consisting of magnetic/superconducting layers juxtaposed to each other are ideal systems to investigate the interplay (coexistence, competition) of the two order parameters, to study possible interlayer coupling and proximity effects. Recently, so called giant proximity effects have been reported in Josephson devices consisting of HTc electrodes and a barrier of a cuprate in the pseudogap or AF state [1, 2]. Low energy μSR offers the unique possibility to measure on a nm scale local fields, determine the spatial distribution of the magnetization throughout the layers and identify superconducting and magnetic fractions, quantities about which very little is known in multilayers. We used polarized low energy muons to investigate the local properties of single, bi- and trilayers composed of superconducting $YBa_2Cu_3O_{7-\delta}$ and semiconducting $PrBa_2Cu_3O_{7-\delta}$. ZF measurements show that the $PrBa_2Cu_3O_{7-\delta}$ layers (thickness 50 - 75 nm) display in all structures the known AF ordering of the Cu moments ($T_{Neel} \sim$ 285K) and of the Pr moments below ∼17K. However, measurements of the field profile B(z) in the Meissner state (field parallel to the interface) show that below the critical temperature of YBCO, supercurrents flow without dissipation over the 50 nm thick AF barrier. The measurements indicate that a finite superfluid density may be induced in the AF layer adjacent to the superconducting layer. If the magnetic field is applied perpendicular to the interface (parallel to the c-axis) the field distribution indicative of the formation of a relatively regular vortex lattice is observed at different positions of the trilayer structure.

[1] I. Bozovic et al., Phys. Rev. Lett. 93 (2004) 157002.
[2] P. Komissinskiy et al., Phys. Rev. Lett. 99 (2007) 017004.