Generics of the diamagnetism, Nernst signal, and finite size effects in superconductors above the transition temperature

S. WEYENETH, T. SCHNEIDER, Physics Institute, University of Zurich, CH-8057 Zurich, Switzerland — Various superconductors exhibit peculiar features above the transition temperature $T_c$. In particular the observation of a large Nernst signal $N$ and a remarkable diamagnetism above $T_c$ in cuprate and conventional superconductors attracted considerable attention. Noting that in these materials the spatial extent of the homogeneous domains is limited, we explore the relevance of a zero dimensional (0D)-model, neglecting thermal fluctuations, to describe the isothermal magnetization curves $m_d(H)$ in various superconductors above $T_c$. It is shown that for cuprates as well as for Pb nanoparticles, both, the full 0D-model as well as its Gaussian approximation, mimic the essential features of the magnetization curves above $T_c$ rather well. Furthermore, the isothermal Nernst signal of a superconducting Nb$_{0.15}$Si$_{0.85}$ film is fully consistent with this scenario. Accordingly, the observed diamagnetism above $T_c$ in Pb nanoparticles, in the cuprates La$_{1.91}$Sr$_{0.09}$CuO$_4$ and BiSr$_2$Ca$_2$CuO$_{8-\delta}$, as well as the Nernst signal in Nb$_{0.15}$Si$_{0.85}$ films, are all in excellent agreement with the scaling properties emerging from the here discussed 0D-model. Therefore, singlet Cooper pairs subjected to orbital pair breaking in a 0D-system are the main source of the observed diamagnetism and Nernst signal in an extended temperature window above $T_c$. 

S. Weyeneth
Physics Institute, University of Zurich, CH-8057 Zurich, Switzerland

Date submitted: 24 Nov 2010

Electronic form version 1.4