

# Proximity effect between superconductors and ferromagnets: from thin films to nanostructures

Hilbert v. Loehneysen

Physikalisches Institut and Center for Functional Nanostructures, Universität Karlsruhe  
Forschungszentrum Karlsruhe, Institut für Festkörperphysik, Karlsruhe

Recently, a new set of experiments has revived interest in the proximity effect. One of the major break-through was the prediction and experimental verification of  $s$ -junctions comprised of superconductor/ferromagnet (S/F) sandwiches [1]. Superconductors can be employed to probe the ferromagnetism of metals by virtue Andreev reflection. Using nanocontacts defined by e-beam lithography, the spin-polarization  $P$  of the current across the S/F interface can be determined reliably [2]. We recently observed a systematic decrease of  $P$  with increasing contact size, which is attributed to spin-orbit scattering [3]. Particularly intriguing is the non-local Andreev reflection, i.e. an incident electron from a ferromagnetic nanocontact is retroreflected as a hole in an adjacent contact forming a spatially separated but entangled Einstein-Podolski-Rosen pair [4]. Finally, the proximity-induced superconductivity can be probed by magnetization measurements. We report on the fate of normal metal (Ag) squeezed between a superconductor and a ferromagnet [5].

- [1] For a review, see A. I. Buzdin, *Rev. Mod. Phys.* **77**, 935 (2005).
- [2] F. Perez Willard et al., *Phys. Rev. B* **69**, 140502 (R) (2004).
- [3] M. Stokmair et al., *Phys. Rev. Lett.* **10**, 147005 (2008).
- [4] D. Beckmann et al., *Phys. Rev. Lett.* **93**, 197003 (2004).
- [5] H. Stalzer et al., *Phys. Rev. B* **75**, 224506 (2007).