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Cooper-pair splitter: towards an efficient source of spin-entangled EPR pairs

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In quantum mechanics the properties of two and more particles can be *entangled*. In basic science pairs of entangled particles, so called Einstein-Podolsky-Rosen (EPR) pairs, play a special role as toy objects for fundamental studies. They provide such things as "spooky interaction at distance," but they also enable secure encoding and teleportation and are thus important for applications in quantum information technology. Whereas EPR pairs of photons can be generated by parametric down conversion (PDC) in a crystal, a similar source for EPR pairs of electrons does not exists yet. In several theory papers, it has been suggested to use a superconductor for this purpose. The superconducting ground state is formed by a condensate of Cooper-pairs which are electron pairs in a spin-singlet state. Since there are many Cooper pairs in a metallic superconductor like Al, the main tasks are to extract Cooper pairs one by one and to split them into different arms. A controlled and efficient splitting is possible if one makes use of Coulomb interaction [1]. This has recently be demonstrated by two groups [2-4] using hybrid quantum-dot devices with both superconducting and normal metal contacts. In the present talk, I will discuss the Cooper-pair splitter results from the Basel-Budapest-Copenhagen team [3] and compare with the other experiments. As an outlook we discuss approaches that aim at entanglement detection. The Cooper pair splitter holds great promises because very large splitting efficiencies approaching 100% and large pair current rates appear feasible. This work has been done by L. Hofstetter, S. Csonka, A. Geresdi, M. Aagesen, J. Nygard and C. Schönenberger

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