Commensurability effects in Andreev antidot billiards

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A short period density modulation imposed upon a two-dimensional electron system (2DES) gives rise to an artificial electronic bandstructure which can be probed by magnetotransport experiments [1-3]. These are prominent examples of quantum mechanical effects in density modulated systems. Antidot lattices, on the other hand, with periods larger than the Fermi wavelength but smaller than the electron mean free path are model systems to explore the classically chaotic dynamics of electrons in the solid state. By 'adding' quantum mechanical effects like Andreev reflection novel phenomena emerge.

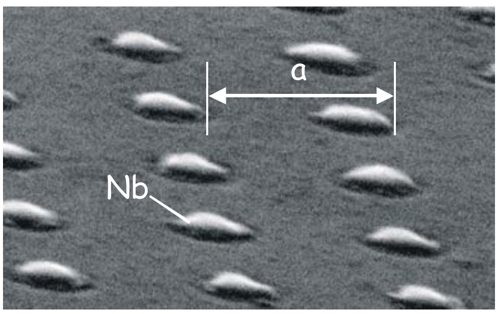
In the experiment we replaced the specularly reflecting antidots by retro-reflecting ones. This is done by placing a periodic array of Niobium dots onto an InAs quantum well containing a 2DES (see Figure 1). Below the critical temperature of the Nb dots we observe a strong reduction of the resistance around B = 0 and a suppression of the commensurability peaks [4] which are usually found in antidot lattices. Model calculations based on a classical Kubo approach show that a complete suppression of the commensurability features is expected for perfect Andreev reflection even though the electron and hole trajectories are still chaotic at finite B.

[1] C. Albrecht, J. H. Smet, D. Weiss, K. von Klitzing, R. Hennig, M. Langenbuch, M. Suhrke, U. Rössler, V. Umansky, and H. Schweizer, Phys. Rev. Lett. **83**, 2234 (1999)

[2] C. Albrecht, J. H. Smet, K. von Klitzing, D. Weiss, V. Umansky, and H. Schweizer, Phys. Rev. Lett. **86**, 147 (2001)

[3] R. A. Deutschmann, W. Wegscheider, M. Rother, M. Bichler, GAbstreiter, C. Albrecht, and J. H. Smet, Phys. Rev. Lett. **86**, 1857 (2001)

[4] J. Eroms, M. Tolkiehn, D. Weiss, U. Rössler, J. De Boeck, G. Borghs, Europhys. Lett. **58**, 569 (2002)



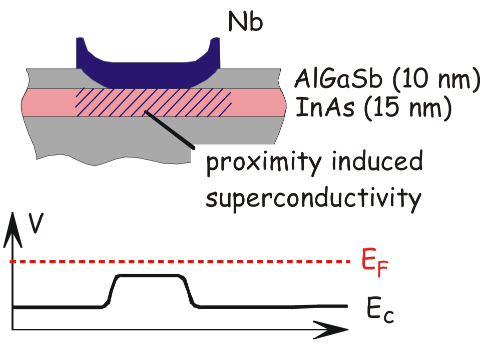


Fig. 1: SEM picture of an antidot lattice with period a = 400 nm. Right: A cross-sectional view of the sample design. The InAs underneath the Nb dot is superconducting due to the proximity effect. The electrostatic antidot potential is sketched below.