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Electron correlations in carbon nanotubes and semiconductor nanowires

J.A. van Dam[1], Y.-J. Doh[1], A.L. Roest[2], E.P.A.M. Bakkers[2], P. Jarillo-Herrero[1], J. Kong[1], H.S.J. van der Zant [1], C. Dekker[1], L.P. Kouwenhoven[1], S. De Franceschi[1]

[1] *Kavli Institute of Nanoscience, Delft University of Technology, PO Box 5046, 2600 GA Delft, The Netherlands*

[2] *Philips Research Laboratories, Professor Holstlaan 4, 5656 AA Eindhoven, The Netherlands*

Nanostructured materials offer unique opportunities to create simple and tunable electronic systems in which complex quantum phenomena can be investigated. In this talk I will discuss various aspects of quantum transport in three-terminal field-effect devices based on individual semiconductor nanowires and nanotubes.
I will consider first the case of quantum-dot nanostructures in which Coulomb blockade effects play a dominant role. A quantum dot confining a finite electronic spin can be regarded as an artificial magnetic impurity and it can give rise to Kondo effect. This phenomenon has been widely explored in semiconductor quantum dot devices. Here, I will report on the observation of a spin-less Kondo effect in carbon nanotubes. In this case, the role of spin is taken over by an orbital degeneracy arising from the two equivalent ways electrons can circle around the circumference of a nanotube.
I will then focus on semiconductor nanowires strongly connected to superconducting electrodes. Here Coulomb interactions are suppressed and superconducting correlations can be induced in the nanowire due to the proximity effect. Under these circumstances, the nanowires form superconducting weak links operating as mesoscopic Josephson junctions with electrically tunable coupling.

Keywords : nanotube, nanowire, Kondo, Josephson