LMU LUDWIG-MAXIMILIANS-UNIVERSITÄT MÜNCHEN

ARNOLD SOMMERFELD CENTER FOR THEORETICAL PHYSICS

Sommerfeld Theory Colloquium

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A two-particle Aharonov-Bohm effect: Bell Inequality and Quantum Tomography

In small conductors, at sufficiently low temperatures, the wave nature of electrons becomes important. To demonstrate quantum interference, the Aharonov-Bohm effect has played a key role. I briefly review this develop-ment and then discuss a novel Aharonov-Bohm effect in which two particles are necessary to enclose a flux. In particular the quantization of charge and quantum diffraction lead to current fluctuations known as shot noise. Shot noise tests two-particle processes. Of interest are geometries in which there exists a two-particle Aharonov-Bohm effect even under conditions when there exists no single-particle Aharonov-Bohm effect. Such a geo-metry was proposed and analyzed [1] and successfully demonstrated in an experiment by Heiblum et al. [2]. In the zero-temperature limit the two-particle Aharonov-Bohm effect is a witness of orbital entanglement: its amplitude directly determines the degree to which a Bell inequality can be violated [2]. Quantum state tomography using shot noise correlations pro-vides an approach to directly determine the degree of entanglement. In the future high-frequency single electron sources will permit to generate deter-ministically few electron excitations: we discuss a two-particle collider [3].

[1] P. Samuelsson, E. V. Sukhorukov, M. Buttiker, Phys. Rev. Lett. 92, 026805 (2004).
[2] I.Neder, N. Ofek, Y. Chung, M. Heiblum, D. Mahalu and V. Umansky, Nature, 448, 333 (2007).
[3] S. Ol'khovskaya, J. Splettstoesser, M. Moskalets and M. Buttiker, arXiv:0805.0188.

Wednesday, 4th June 08, 11:15 h, Room 348 / 349, Theresienstr. 37 / III

Prof. J. v. Delft