SFB/TRR 21 - Kolloquium
18. Mai 2007, Tübingen

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Using quantum reflection from semiconductor surfaces to control electrons and ultra-cold atoms

I will show how the reflection of quantum-mechanical waves from semiconductor surfaces can provide sensitive control of electrons and ultra-cold atoms.

Firstly, I will focus on electrons in “superlattices”, comprising alternating layers of different semiconductor materials. Multiple reflections of electron waves from the layer interfaces can create a unique type of chaotic electron motion. The abrupt onset of chaos produces a sharp increase in the measured current flow by creating unbound electron orbits, which propagate through intricate web patterns in phase space and imprint themselves on the quantum-mechanical wavefunctions.

Next, I will consider how room-temperature semiconductor surfaces can be used to manipulate atoms cooled to nK temperatures. At such low temperatures, quantum-mechanical reflection can shield the atoms from the disruptive influence of the surface. By considering recent experiments performed at MIT on Bose-Einstein condensates, I will show that inter-atomic interactions and the aspect ratio of the condensate both play a crucial role in the reflection process. I will also consider how surfaces that are etched on nanometre and micrometre scales can be used to increase the reflection probability and control the shape of the reflected atom cloud.

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