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# Rotational motion driven by single electron tunneling

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## Abstract

Much effort has been devoted to investigate the coupling of electrical and mechanical degrees of freedom on the nanometer scale in order to design novel electronic devices. An example is the nano-mechanical single-electron transistor (NEMSET), where electrons are transported from a source to a drain electrode via a movable nano-object which can be occupied by exactly one electron. The charged object experiences a force caused by the electric field between source and drain. The interplay of vibrational motion of the particle and the strong distance dependence of tunneling (which is responsible for charging/decharging) gives rise to mechanically assisted electron transport, called electron shuttling.

Recently we investigated a nano-rotor based on the same mechanism as the electron shuttle described above [1]. This rotor exhibits novel effects, which could be used for various applications, like sensors or charge pumps. The coupling of mechanical motion and tunneling leads to the self-excitation of oscillatory motion and for large bias voltage to rotational motion even in the presence of damping. The frequency of oscillation/rotation depends on the ratio of the driving force and the friction. For small ratios the rotors oscillates and the current through the device decreases with increasing bias voltage (negative differential conductance). For larger bias full rotations appear with increasing frequency. Thus one may realize a nanoscale motor driven by static voltage.

We will also present new results how the direction of rotation depends on the asymmetry of the rotor.

## Biography

A. Eisfeld has obtained his Ph.D. from the University of Freiburg and is now leading the research group *Quantum Aggregates* at the Max-Planck-Institute for the Physics of Complex Systems.