# SINGLE-PARTICLE EMISSION FROM TIME-DEPENDENTLY DRIVEN QUANTUM DOTS

J. Splettstoesser

Department of Microtechnology and Nanoscience (MC2), Chalmers University of Technology, SE-41296 Göteborg, Sweden
email: janines@chalmers.se

Nanoscale systems such as quantum dots are ideal devices for the manipulation of single and few particles. In particular, when driven by some external agent, e.g., a time-dependent gate-voltage, quantum dots can serve as single-electron sources for electronic devices. This is of interest for metrology and for the preparation of single-particle states for quantum information. In this talk, I will present various aspects of our research on single-particle emission from time-dependently driven quantum dots.

For the operation of nanoscale devices, it is important to understand their response to switches and time-dependent driving at possibly high frequencies. The charging and discharging of the driven dot can typically be described by a time-scale given by the inverse of the dot's charge relaxation rate, similar to a classical RC time. However, the full quantum dot dynamics is in general governed by a larger set of time scales governing also the spin and heat decay (via a newly discovered "fermion-parity rate") or taking account for particle hopping processes in more complex quantum dot setups. I will show how such time-scales explicitly impact the emission process [1, 2].

A second part of my talk will aim at the detection of these time scales. In particular, I will show how they can be extracted from pump-probe measurements of charge and heat currents [1], and from a fitting free nonadiabatic pumping spectroscopy [3]. The latter directly relies on errors that occur, when the driving is too fast, and which can therefore clearly be attributed to limitations individually set by different relevant (charge) relaxation rates.

If time permits, I will, finally, present protocols for "quantum optics with electrons", where tunable single-electron sources constitute an essential building block, see e.g. [4]. Importantly, they here allow for coherent manipulation and characterization of electronic quantum states.

[1] J. Schulenborg, R. B. Saptsov, F. Haupt, J. Splettstoesser, and M. R. Wegewijs, Phys. Rev. B 93, 081411(R) (2016).
[2] J. Vanherck, J. Schulenborg, R. B. Saptsov, J. Splettstoesser, and M. R. Wegewijs, 10.1002/pssb.201600614.
[3] R.-P. Riwar, B. Roche, X. Jehl, and J. Splettstoesser, Phys. Rev. B 93, 235401 (2016).
[4] G. Haack, M. Moskalets, J. Splettstoesser, and M. Büttiker, Phys. Rev. B 84, 081303(R) (2011).