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EINLADUNG

zum Vortrag
von

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Harvesting “blue” energy from mixing river- and seawater with nanoporous supercapacitors

am **Dienstag, 9. Dezember 2014, um 17:30 Uhr**

Ort: Lise-Meitner-Hörsaal, Fakultät für Physik, Universität Wien,
1090 Wien, Strudlhofgasse 4 / Boltzmanngasse 5, 1. Stock

Barrierefreier Zugang: Boltzmanngasse 5, Lift, 1. Stock rechts über den Gang zum Hintereingang des Hörsaals

Abstract:
In this talk we will discuss the harvesting of renewable energy from the spontaneous irreversible mixing of river- and sea-water. A thermodynamic analysis shows that a free-energy dissipation of about 2kJ takes place with every liter of river water that flows into the sea, i.e. the equivalent of a waterfall of 200m. Using modern nanomaterials it is becoming possible to harvest this so-called “blue” energy at economically interesting rates, especially in regions with river deltas and sharp salinity gradients. This is currently being done in test factories by pressure-retarded osmosis and by reverse electro-dialysis, which both involve (expensive) membranes. Recently, however, Brogioli constructed a micro-fluidic solid-state device to harvest this blue energy by cyclically charging and discharging a supercapacitor made of (cheap) nanoporous carbon electrodes immersed in sea and river water, respectively [1]. The energy is then stored in compressed and released in expanded electric double layers formed by the ions in the vicinity of the electrode. In this talk we will show that Brogioli's device can be seen as an analogue of a Stirling heat engine, and we propose a modification to construct the most efficient "blue engine" based on a Carnot-like cycle [2]. Engines (or factory plants) based on this cycle would be perfectly reversible and would not at all contribute to global warming as they are perfect heat-to-power converters. We will also discuss ongoing work that shows that the efficiency of the energy-harvesting process can be boosted significantly by using cold salty water and warm fresh water [3].
Finally, we will discuss our first attempts to study optimal energy-per-time conditions of these blue-energy devices rather than the optimal energy-per-cycle. This optimal-power question involves ionic transport in porous electrodes, electrokinetics as described by (modified) Poisson-Nernst-Planck equations, the balance between dissipation and harvest, and RC-times of equivalent circuits.

[1] D. Brogioli, Phys. Rev. Lett. 103, 058501 (2009).
[2] N. Boon and R. van Roij, Mol. Phys. 109, 1229 (2011).
[3] M. Janssen, A. Härtel, and R. van Roij, cond-mat 1405.5830.