Master 2 Internship

Title: Thermopower of ionic conductors

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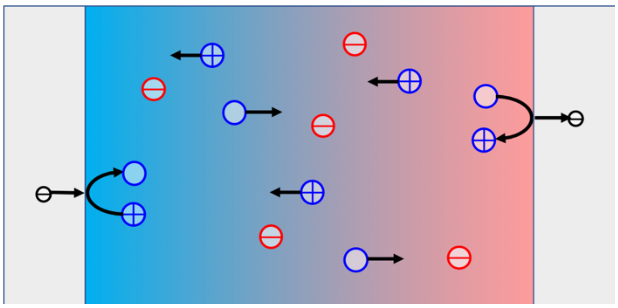
Project:

Thermoelectric materials are extensively studied in view of their application for harvesting waste heat, temperature sensing, and cooling devices. As their fundamental property, a heat flow across the material drags charged ions or molecules, thus inducing an electric current or a potential difference between the hot and cold side. As a relevant performance parameter, the thermopower S measures the voltage generated by a temperature difference. The thermopower of conventional electronic materials is of the order of k_B/e, and attains 20 k_B/e for organic polymers.

In recent years, much higher values up to 300 k_B/e were observed for ionic conductors, such as polymer-based electrolytes in gels or solid matrices [1]. Very recently we have proposed a model for these large values, and we have shown that the theoretical expression for the thermopower in ionic conconductors differs from that known for electronic systems. In particular, we found it to be independent of the mobilities of the charge carriers [2].

The present theory project aims at determining the thermopower of ionic conductors in the presence of redox reactions at catalytic surfaces. Then the number of charge carriers is not conserved, resulting in steady-state ion currents, as illustrated in the figure. From preliminary work we expect an intricate dependence on the carrier concentrations and mobilities.



The project work will mainly consist of analytical theory, based on Onsager's linear relations between thermodynamic forces and currents, which are completed by rate equations for the redox reactions.

[1] C.-G. Han, X. Qian, Q. Li, B. Deng, Y. Zhu, Z. Han, W. Zhang, W. Wang, S.-P. Feng, G. Chen, W. Liu, Science **368**, 1091 (2020)

[2] A. Würger, to be published (2020)