Open position for a 3-year PhD thesis in theoretical physics:

"Non-equilibrium thermoelectric transport in quantum conductors"

PhD supervisor :
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Location : Service de Physique de l'Etat Condensé (SPEC), Groupe Modélisation et Théorie (GMT), CEA-Saclay

Funding : CEA PhD contract (« thèse phare »).

Starting date: October 2018 (possibility to start with a Master 2 internship from March 2018)

Applications should be sent to Geneviève Fleury, with a CV and a short letter of motivation.
We are looking for motivated candidates with interest and good background in condensed matter physics, nanoelectronics, thermodynamics, quantum physics, and/or numerical simulations.

Summary: Seebeck and Peltier thermoelectric effects provide an eco-friendly way of converting heat into electricity and vice-versa. Research in thermoelectricity has been rekindled in recent years by nanostructuration and the promising perspectives it offers. Important progress has been made but it remains insufficient from a practical standpoint. It turns out that till date, research studies in thermoelectricity have overwhelmingly focused on the near equilibrium regime. Yet it is acknowledged that promising thermoelectric performances are to be expected far from equilibrium. In particular, recent theoretical works suggest that the thermoelectric efficiency of nanodevices should be greatly enhanced by using an external time-dependent parameter driving the system out of equilibrium [1].

On the other hand, technical progress has led to the emergence of new experiments in nanoelectronics, operating at high frequency, in the GHz range or above (see for instance the realization of the first single "Leviton" source in SPEC, CEA-Saclay [2]). These experiments show that brand new studies probing dynamic thermoelectric transport in nanodevices are within grasp, from a technical standpoint. They also raise important fundamental questions about energy transfers at short length and time scales.

The goal of the thesis is to investigate time-dependent thermoelectric conversion in mesoscopic conductors. Using the numerical tools and analytical framework recently developed by our collaborators at INAC, CEA-Grenoble, for the study of time-resolved quantum transport in nanodevices [3], we will build up a numerical platform suitable for the study of dynamic thermal and thermoelectric transport. We will test it on a simple model analytically solved in [1] and then, apply it to various systems (made of semiconductor, graphene, superconductor, ...). Our approach will be also relevant for other current issues in quantum thermodynamics.

References

[1] Boosting thermoelectric efficiency using time-dependent control, *H. Zhou, J. Thingna, P. Hänggi, J.-S. Wang & B. Li*, Scientific Reports **5**, 14870 (2015)
[2] Minimal-excitation states for electron quantum optics using levitons, *J. Dubois, T. Jullien, F. Portier, P. Roche, A. Cavanna, Y. Jin, W. Wegscheider, P. Roulleau & D. C. Glattli*, Nature **502**, 659 (2013)
[3] Numerical simulations of time resolved quantum electronics, B. Gaury, J. Weston, M. Santin, M. Houzet, C. Groth & X. Waintal, Physics Reports **534**, 1 (2014). See also https://kwant-project.org/