

## **Nanothermodynamics : for equilibrium and non-equilibrium**

1-5 December 2014 @Oort

Ten years ago, in the first volume of the journal Nano Letters (in the editorial of Vol. 3 (2001)), the editor, Paul Alavisatos, invited T. L. Hill to present his perspective on the nanothermodynamics. In the introduction was written "It is perhaps only now that we are in a position to control and pattern matter on the nanometer scale sufficiently well that detailed experimental studies of the thermodynamics of small systems can be realized. Such studies are essential for the promise of nanoscale science to mature further."

*The aim of the workshop was to investigate the possibility to use Hill's nanothermodynamics and to show what has been done on that topic until now (T.L. Hill, Thermodynamics of Small Systems, Part 1, Benjamin, New-York, 1963).*

Theoreticians, experimentalists, simulation people from different scientific fields were present (around 40). There were chemists, physicists and a few people from biophysics and computer science.

Except a few presentations, the talks were not directly on Hill's nanothermodynamics, because it is very rarely used. They were however related to smallness or systems with long-range correlations. Looking at small scales, it was shown that the interpretation of the collected data faces the limits of the existing models. The question of interpreting data using better theories was then central with the possibility to use Hill's nanothermodynamics.

In addition to the talks, large parts of the time were dedicated to discussions in plenary sessions, in small groups on selected topics and in informal groups. One of the practical results is the identification of three main topics that will be investigated in the future by three different groups in collaboration, mixing people from different communities:

How to apply Hill's nanothermodynamics to investigate systematically

- 1- Time dependent processes at the nanoscale,
- 2- Accurate analysis of nano-sensors responses,
- 3- Systems under confinement.

The discussions were very vivid, the presence of different scientific communities that didn't know each other was very fruitful. It clearly helped to better identify theoretical and experimental challenges necessary to apply Hill's nanothermodynamics to small systems. It took the whole week to define the future collaborations and the topic that will help to mature nanoscale science further.

The facilities provided by the Lorentz Center were very well appreciated by all participants, they contributed a lot to the positive and constructive atmosphere of the workshop and to its full success. As organizers we thank the Lorentz Centre and the people who made with us the workshop possible.

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