



Minicurso: Quantum Thermodynamics Applied to Thermal Machines, Pseudo- Hermiticity and Superradiance

23/09/2025 - 01/10/2025

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The main topics to be covered in this course are:

Class #	Date	Topic
1 (8h-10h)	Tuesday 23/09	Laws of classical thermodynamics. Applications: Carnot's cycle. Carnot's theorem: the maximum efficiency of a heat machine.
2 (10h-12h)	Tuesday 23/09	Thermodynamic potentials: the Helmholtz and Gibbs potentials. Enthalpy.
3 (8h-10h)	Wednesday 24/09	Crookes's fluctuation theorem: Jarzynski equality for thermodynamic potentials.
4 (10h-12h)	Wednesday 24/09	Overview on quantum thermodynamics: heat and work. Quantum open systems: the master equation under weak coupling and Markovian conditions.
5 (8h-10h)	Thursday 25/09	Gibbs states as equilibrium states. Gibbs states for harmonic oscillators and two-level systems. Quantum fluctuation theorems.
6 (10h-12h)	Thursday 25/09	Applications of quantum thermodynamics: quantum thermal machines. The Otto cycle with bosonic and fermionic working substances.
7 (8h-10h)	Friday 26/09	Quantum friction and entropy production. Comparison between friction at negative temperatures and friction at positive temperatures.
8 (10h-12h)	Friday 26/09	Parametric oscillator (squeezing) as working substance. Thermal reservoirs <i>versus</i> non-thermal reservoirs. Master equation for squeezed reservoirs: steady states.



9 (8h-10h)	Monday 29/09	Two-level systems as working substances. Master equation for two-level fermionic systems. Negative temperatures. Otto cycle. Efficiency. Quantum friction and entropy production.
10 (10h-12h)	Monday 29/09	Some directions to follow: perspectives: work in progress.
11 (8h-10h)	Tuesday 30/09	Superradiance and superabsorption of moderated atomic samples.
12 (10h-12h)	Tuesday 30/09	Superradiance and superabsorption of dense atomic samples.
13 (8h-10h)	Wednesday 01/10	Quantum mechanics of pseudo-Hermitian Hamiltonians.
14 (10h-12h)	Wednesday 01/10	Applications of Pseudo-Hermiticity.

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