# THERMALIZATION IN SMALL DRIVEN QUANTUM SYSTEMS

Thingna Juzar [1], Barra Felipe [2], Esposito Massimiliano [1,*]

[1] Université du Luxembourg,
[2] Universidad de Chile
[*] massimiliano.esposito@uni.lu

## ABSTRACT

We consider a small driven quantum system (described by a time dependent Hamiltonian) interacting with a set of quantum levels which are initially thermally distributed and play the role of a finite reservoir. We identifying two distinct regimes which lead to a closed effective description for the system dynamics with a corresponding consistent nonequilibrium thermodynamics description.

The first regime occurs when the reservoir levels are dense enough to be efficiently mixed by the system-reservoir interaction. In this case, the system dynamics is described by a conventional Redfield master equation [1] with time dependent system energies.

The second regime occurs when the reservoir level spacing is large compared to the system-reservoir interaction. In this case the system-reservoir level-crossing dynamics is accurately described by a Landau-Zener mechanism which leads to a discrete time master equation description for the system dynamics [2].

A consistent stochastic thermodynamic description for the system can be established in these two regimes and the resulting thermodynamic quantities (e.g. energy, work, heat, entropy, dissipation) can be evaluated solely in terms of the effective master equation.

For a driven Fermionic level crossing initially Fermi-distributed reservoir levels, the effective master equation formulation and its corresponding stochastic thermoydnamics is shown, in the two regimes, to be in good agreement [4] with the numerically exact quantum dynamics and its corresponding thermodynamic identities derived in Ref. [3].

## REFERENCES

[1] M. Esposito and P. Gaspard, "Quantum master equation for a system influencing its environment", Phys. Rev. E **68**, 066112 (2003)

[2] F. Barra and M. Esposito, "Dissipation in small systems: A Landau-Zener approach", Phys. Rev. E **93**, 062118 (2016)

[3] M. Esposito, K. Lindenberg and C. Van den Broeck, "Entropy production as correlation between system and reservoir", New J. Phys. **12**, 013013 (2010).

[4] J. Thingna, F. Barra, and M. Esposito (in preparation).