International Conference on Quantum Energy 2025

hosted by Dipartimento di Fisica e Astronomia Galileo Galilei

an event by ICQE

Contribution ID: **41**

Type: **Poster presentation**

# Relaxation timescale control of dissipative quantum spin systems

In the relaxation towards a steady state, a system usually explores out-of-equilibrium configurations that can enable intriguing and counterintuitive phenomenologies. One remarkable example is the Mpemba effect – i.e. water freezing faster when initially heated up –which can be naturally leveraged to accelerate relaxation towards the steady state.
Indeed, in a Markovian framework, one can obtain exponential gains preparing the system in an initial condition orthogonal to the slowest decaying mode of the evolution operator.
While such a scenario is by now established both in quantum and classical settings, in some systems it can often happen that the timescale separation between the second and third slowest mode is small (or even zero), so that killing the slowest decaying mode does not bring any concrete advantage.
In this talk, I will present a general recipe we developed that allows us to eliminate an arbitrarily high number of modes, ensuring the possibility of obtaining the desired relaxation timescale for any system.
Additionally, our method can also be used to tackle the complementary problem, which is that of extending as much as possible the out-of-equilibrium relaxation.
Indeed, killing fast decaying modes might be fundamental to extend the relaxation process when interested in specific phenomenologies that can be observed only in the transient relaxation phase.
We provide an example in a many-body interacting system (long-range qubit chain) and a specific use case that takes into account common experimental limitations that can be encountered for the state preparation in quantum simulators.

## Theme

Theme 3. Theoretical and experimental methods for quantum effects in energy processes

**Primary authors:** TEZA, Gianluca (Max Planck Institute for the Physics of Complex Systems); BEATO, Nicolò (Max Planck Institute for the Physics of Complex Systems)

**Presenter:** BEATO, Nicolò (Max Planck Institute for the Physics of Complex Systems)

**Track Classification:** Theme 3. Theoretical and experimental methods for quantum effects in energy processes