Non-Unitary Quantum Many-Body Dynamics

Unitarity is a fundamental property of quantum mechanics which underlies the dynamics of closed quantum many-body systems, the concept of thermalisation and the emergence of statistical mechanics. A different paradigm for quantum dynamics arises in presence of an external environment, which can represent for example dissipation due to a bath or an external monitoring apparatus[1]. Other sources of non-unitarity can arise for example in presence of non-Hermiticity due to post-selection of measurement outcomes [2,3] or to non- reciprocal, “one-way” interactions, the latter providing a novel paradigm for phase transitions in active matter and finding several applications in quantum information processing.

The goal of this project is to explore the consequences of non-unitarity on the dynamics of quantum many-body systems, in particular for what concerns the dynamics of quantum information. Examples include: the study of entanglement dynamics in presence of non- reciprocal couplings, the role of interactions in simple models of monitored quantum systems or the robustness of measurement induced transitions to different types of measurement protocols and observables.

During this theoretical internship, the Master's student will acquire, develop, and apply state- of-the-art techniques for open quantum many-body physics to solve paradigmatic models for non-unitary quantum systems. This internship can naturally evolve into a PhD Thesis at the interface between nonequilibrium quantum dynamics, open quantum systems, statistical physics and quantum information.

[1] X Turkeshi, A Biella, R Fazio, M Dalmonte, M Schiró, Physical Review B 103 (22), 224210 (2021)

[2] X Turkeshi, M Schiró, Physical Review B 107 (2), L020403 (2023)

[3] Y. Le Gal, X Turkeshi, M Schiró, SciPost Physics 14 (5), 138 (2023)

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