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Spin dynamics with Solid State NMR and GPU calculations: Loschmidt Echoes, Intrinsic Decoherence and Quantum Dynamical Phase Transitions[1]

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After overviewing argentine Condensed Matter Physics outside the Metropolitan area I will focus on the Loschmidt Echo [LE], a concept developed and pursed at Córdoba. It is the recovered fraction of a localized excitation after a spreading period followed by an imperfect time reversal procedure [1]. In Solid State NMR, the LE has allowed us to quantify the decoherence and irreversibility induced by an uncontrolled environment. Notably complex many-body dynamics makes the system particularly sensitive to environmental disturbances presenting a decoherence rate that becomes perturbation independent beyond some small threshold. These experiments and the theoretical analysis based on the Feynman's path integral, summarized at a tutorial level, fueled the field of dynamical quantum chaos [4]. The quest for a perturbation independent decoherence as an emergent phenomenon in thermodynamic limit, lead us to discuss other dynamical observables that depend non-analytically on the environment strength, i.e. that undergo a quantum dynamical phase transition QDPT [2]. GPU based high performance computing boosts the evaluation of the LE [3], allowing us to asses thermalization and how the Metal-Insulator transition (also a QDPT) emerges in interacting many-body systems.

[1] ***Loschmidt Echo,*** A. Gousev, R.A. Jalabert, H.M. Pastawski and D.A. Wisniacki. *Scholarpedia* **7**, 11687 (2012)

[2] ***Environmentally induced quantum dynamical phase transition in the spin swap operation,*** G.A.Álvarez, E.P.Danieli, P.R. Levstein, and H.M. Pastawski, *J. Chem.Phys.* **124**, 1 (2006)

[3] ***Interaction-disorder competition in a spin system evaluated through the Loschmidt echo*** P.R. Zangara, A.D. Dente, A. Iucci, P.R. Levstein, and H.M. Pastawski, *Phys. Rev. B* **88**, 195106

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