

Massachusetts Institute of Technology  
Department of Physics

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**Condensed Matter Theory Seminar**

**“Loschmidt Echoes, an experimental and theoretical tool to study Quantum Chaos, Quantum Dynamical Phase Transitions and Many Body Localization”**

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**Abstract:** I will focus on the Loschmidt Echo [LE], 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 make 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, which in this talk are summarized at a tutorial level, fueled the field of dynamical quantum chaos. 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 equilibration and thermalization. We will also see how the Metal-Insulator transition (also a QDPT) emerges in interacting many-body systems.

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

[http://www.scholarpedia.org/article/Loschmidt\\_echo](http://www.scholarpedia.org/article/Loschmidt_echo)

[2] Environmentally induced quantum dynamical phase transition in the spin swap operation, G.A.Álvarez, E.P.Danieli, P.R. Levstein, and HMP, *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 HMP, *Phys. Rev. B* 88, 195106 (2013)

**12:00pm**  
**Tuesday, February 24, 2015**  
**Duboc Seminar Room (4-331)**