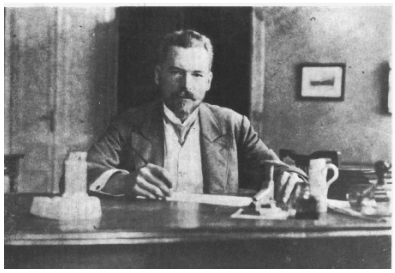

Contribution ID: **42** Type: **Invited talk**

Emergence of Irreversibility and Hydrodynamic behavior from the Quantum Many-Body Dynamics: Experimental Evidence from Loschmidt Echoes and Related Experiment

Tuesday, 20 September 2022 11:15 (45 minutes)

The search for a justification and an appropriate description of irreversible macroscopic dynamics of fluids from time reversible mechanics was initiated Boltzmann, Loschmidt, Einstein and Smoluchowski. However, in spite of the impressive advances on both the experimental and progress addressing statistical nature, it has remained a polemic issue. Nowadays, the focus shifted towards the quantum dynamics mainly because of expectancies generated by the increasing number of qubits/spins handled on quantum information processing and the need for a match between the theory of gravitation with quantum mechanics. More than two decades ago we identified[1,2], at Córdoba, that Nuclear Magnetic Resonance could to address quantum signatures from spin diffusion and implement the time reversal procedures for an unlimited number of interacting spins. We realized that we could observe decoherence, irreversibility and the emergence of hydrodynamic behavior. With this purpose we developed a number of experimental strategies that generalized the one-body time reversal of the Spin Echo of Hahn. We dubbed this set of procedures as Loschmidt Echoes [3]. In this presentation I will review our experimental and theoretical quest to test our Central Hypothesis of Irreversibility [4]. According to this, and much as friction and dissipation results from reversible Newton equations, quantum dynamics of many-body systems far from equilibrium becomes decoherent, and hence irreversible in the thermodynamic limit of decreased interaction with the environment while the number of spins/qubits remains essentially infinite. Thus, in consistency with our most recent experimental findings [5,6], hydrodynamical irreversible behavior should result as an emergent property of reversible quantum dynamics.

[1] Quantum Dynamical Echoes in Spin Diffusion on Mesoscopic Systems.

HM Pastawski, PR Levstein and G Usaj, Phys. Rev. Lett. 75, 4310-4313 (1995)

[2] A Nuclear Magnetic Resonance answer to the Boltzmann-Loschmidt controversy?

HM Pastawski , G Usaj , PR Levstein, J Raya and J Hirschinger, Physica A 283 166 (2000)

[3] Loschmidt Echo, A Goussev, R Jalabert, HM Pastawski and D Wisniacki (2012) Loschmidt echo. Scholarpedia, 7(8):11687.

[4] Loschmidt echo in many-spin systems: a quest for intrinsic decoherence and emergent irreversibility. PR Zangara and H M Pastawski, Phys. Scr. 92 033001(2017)

[5] Perturbation independent decay of the Loschmidt echo in a many-spin system studied through scaled dipolar dynamics CM Sánchez, AK Chattah, KX Wei, L Buljubasich, P Cappellaro, and HM Pastawski, Phys. Rev. Lett. 124, 030601 (2020)

[6] Emergent decoherence induced by quantum chaos in a many-body system: A Loschmidt echo observation through NMR, CM Sánchez, AK Chattah, and HM Pastawski. Phys.Rev.A, 105, 052232 (2022), J. Magn. Res. (submitted)

Primary author: PASTAWSKI, Horacio (Academia Nacional de Ciencias)

Presenter: PASTAWSKI, Horacio (Academia Nacional de Ciencias)

Session Classification: Tuesday session