HQOC

HARVARD Quantum Optics Center

Special HQOC Seminar

Wednesday | April 29 | 4:00 pm | Lyman 425

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"Localization Effects and Hyperpolarization in Many-Spin Networks"

Non-equilibrium dynamics of many-body systems is important in many branches of science, such as condensed matter, quantum chemistry, and ultracold atoms. The seminar will be divided in two parts. First, I will report the experimental observation of a phase transition of the quantum coherent dynamics of a 3D many-spin system with dipolar interactions, and determine its critical exponents. Using nuclear magnetic resonance (NMR) on a solid-state system of spins at room-temperature, we quench the interaction Hamiltonian to drive the evolution of the system. The resulting dynamics of the system coherence can be localized or extended, depending on the quench strength [1]. We used spin-counting techniques [2] based on measuring the multiple-quantum coherence spectrum to determine the evolution of the cluster-size of correlated spins. Applying a finite-time scaling analysis [3] to the observed time-evolution of the number of correlated spins, we extract the critical exponents $v \approx s \approx 0.42$ around the phase transition separating a localized from a delocalized dynamical regime [4].

In the second part, I will talk about hyperpolarizing ensemble of 13C nuclear spins with Nitrogen Vacancy centers in diamonds. Polarizing nuclear spins is of fundamental importance in biology, chemistry and physics. Methods for hyperpolarizing 13C nuclei from free electrons in bulk, usually demand operation at cryogenic temperatures. We demonstrate that room-temperature approaches targeting diamonds with nitrogen-vacancy (NV) centers could alleviate this need developing a versatile approach for achieving efficient electron→13C spin alignment transfers, compatible with a broad range of magnetic field strengths and field orientations with respect to the diamond crystal [5]. This versatility results from combining coherent microwave- and incoherent laser-induced transitions between selected energy states of the coupled electron-nuclear spin manifold. 13C-detected Nuclear Magnetic Resonance (NMR) experiments demonstrate that these hyperpolarization techniques can be transferred via first-shell or via distant 13Cs, throughout the nuclear bulk ensemble.

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[2] J. Baum, M. Munowitz, A. N. Garroway, A. Pines, J. Chem. Phys. 83, 2015 (1985).
[3] J. Chabé, et. al., Phys. Rev. Lett. 101 (2008); G. Lemarié, et. al., Phys. Rev. A 80 (2009).
[4] G. A. Álvarez, D. Suter, and R. Kaiser, submitted (2014). arXiv:1409.4562.
[5] G.A. Álvarez, C.O. Bretschneider, R. Fischer, P. London, H. Kanda, S. Onoda, J. Isoya, D. Gershoni, and L. Frydman, arXiv:1412.8635 (2014).