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Spin Ensembles in Diamond for Sensing and Many-Body Physics

Dr. Demitry Farfurnik

[The Bar-Gill Lab](#), *Quantum Information, Simulation and Sensing*
Racah Institute of Physics,
Hebrew University of Jerusalem, Israel

Abstract

The study of quantum many-body spin physics in realistic solid-state platforms has been a long-standing goal in quantum and condensed-matter physics. We demonstrate separate steps required to reach this goal using NV centers in diamond. First, standard (TEM) electron irradiation is used for the enhancement of N to NV conversion efficiencies by over an order-of-magnitude [1]. Second, robust pulsed [2] and continuous [3] dynamical decoupling (DD) techniques enable the preservation of arbitrary states of the ensemble. These combined efforts, which already resulted in the demonstration of enhanced magnetic sensing [4], could lead to the desired interaction-dominated regime. Finally, we simulate the effects of continuous and pulsed microwave (MW) control on the resulting NV-NV many body dynamics in a realistic spin-bath environment [5]. We emphasize that dominant interaction sources could be identified and decoupled by the application of proper pulse sequences, and the modification of such sequences could lead to the creation engineered interaction Hamiltonians. We introduce a new family of pulse sequences derived from the symmetry group of an icosahedron, which provide the most general two-body Hamiltonian engineering capabilities [6]. The resulting engineered Hamiltonians could pave the way towards the creation of non-classical states, e.g. spin-squeezed states, which were not yet demonstrated in the solid-state, and could eventually lead to magnetic sensing beyond the standard quantum limit (SQL).

[1] D. Farfurnik et al., Appl. Phys. Lett. 111, 123101

[2] D. Farfurnik et al., Phys. Rev. B 92, 060301(R)

[3] D. Farfurnik et al., Phys. Rev. A 96, 013850

[4] D. Farfurnik, A. Jarmola, D. Budker and N. Bar-Gill, J. Opt. 20, 024008

[5] D. Farfurnik, Y. Horowicz and N. Bar-Gill, Phys. Rev. A 98, 033409

[6] K. BenAttar, D. Farfurnik and N. Bar-Gill, in preparation

ההרצאה תתקיים ביום רביעי, ה-1.5.19 בשעה 12:30

באודיטוריום המכון למצב מוצק, קומת כניסה

The lecture will take place on Wednesday, 1.5.19 at 12:30
at the Solid State Institute auditorium, entrance floor

Host: Assistant Professor Yoav Sagi