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SEMINAR סמינר

Silicon nitride intricate resonators for spin detection and polarization via resonant spin-mechanics coupling

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Abstract

Stoichiometric silicon nitride (Si_3N_4) films are a unique material in the field of nanomechanics due to their high internal stress that enables high mechanical quality factors along with high resonance frequencies. Moreover, the low optical absorption of Si_3N_4 films allow these resonators to be incorporated in a high finesse optical cavity displaying optomechanical phenomena, such as ground-state cooling, precision force displacement sensing, and microwave-optical transducers.

Here we propose a scheme to resonantly couple Si_3N_4 film resonators with 1 – 10 MHz resonant frequency to either nuclear or electronic spins. The resonators are placed inside a high finesse cavity, allowing efficient damping of the mechanical resonator to its grounds-state, while reducing its displacement noise. A resonant coupling between an optically cooled mechanical resonator to spins enables polarization of the latter species. The spin-mechanics resonant coupling also opens new paths for detection of nanoscale magnetic resonance force microscopy using transverse magnetization sensing.

To boost spin-mechanics coupling, we fabricate intricate ~MHz frequency Si_3N_4 resonators designed to reduce the effective oscillating mass, while mitigating internal and external mechanical losses. We explore both “trampoline” type design, and more complex phononic crystal structures. Finally, we demonstrate initial magnetic force sensing of an ensemble of electronic spins utilizing a trampoline resonator at a level of $\sim$ 10 fN.

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ההרצאה תתקיים ביום רביעי, ה - 6.12.2017 בשעה 12:30
באודיטוריום המכון למצב מוצק, קומת כניסה

The lecture will take place on Wednesday, 6.12.17 at 12:30
at the Solid State Institute auditorium, entrance floor

Host: Assistant Professor Yoav Sagi