738th ASRC Seminar

Date: Nov. 28 (Wed), 13:30~

Location: Room 302, ASRC Bldg.

Speaker: Dr. Yuma Okazaki

(National Institute of Advanced Industrial Science and Technology)

Title: **Phonon, electron, and nuclear spin hybrid system in an electromechanical resonator**

Abstract:

The first short topic is about a hybrid system composed of a gate-defined electronic nanostructures such as the quantum dot and quantum point contact integrated into a piezoelectricity-based electromechanical resonator. This system enables us to detect milli-Kelvin phonon states (the corresponding mechanical amplitude is the order of 10^{-14} m) via current flowing through the nanostructures [1,2]. Such highly sensitive detection of the mechanical motion is the central ingredient to develop MEMS-based quantum sensors and macroscopic quantum machines.

The second main topic is about investigations in an electromechanical resonator whose electrically tunable phonon state imparts a dynamically oscillating strain to the nuclear spin ensemble located within it. As a consequence of the dynamical strain, we observe both nuclear magnetic resonance (NMR) frequency shifts and NMR sidebands generated by the electromechanical phonons [3]. This prototype system potentially opens up quantum state engineering for nuclear spins such as coherent coupling between sound and nuclei, and acoustic detection of solid-state nuclei.

[1] Y. Okazaki et al. "Quantum point contact displacement transducer for a mechanical resonator" Appl. Phys. Lett. **103**, 192105 (2013).

[2] Y. Okazaki et al. "Gate-controlled electromechanical backaction induced by a quantum dot" Nature Commun. **7**, 11132 (2016).

[3] Y. Okazaki et al. “Dynamical coupling between a nuclear spin ensemble and electromechanical phonons” Nature Commun. **9**, 2993 (2018).

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