北京大学量子材料科学中心

International Center for Quantum Materials, PKU

Seminar

Sensing magnetization oscillation in quantum regime

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Time: 3:30pm, Oct. 26, 2017 (Thursday)

时间：2017年10月26日 （周四）下午3:30

Venue: Room W563, Physics building, Peking University

地点：北京大学物理楼，西563会议室

Abstract

Quanta of magnetization oscillation, i.e., magnons, are essential ingredients in spintronics technology. Although their characteristics have been investigated for a long time, the behavior in the quantum regime, where the number of thermal excited magnons is nearly zero, is still unknown. Here we demonstrate ultra-sensitive sensing of magnons using a superconducting qubit. Superconducting "transmon" qubits, which are formed by two electrodes shunted by Josephson junctions, have dipole antennas in their structures and thus they couple to surrounding electromagnetic fields. Owing to their huge dipole moments which are typically 4th-order-magnitude larger than those of atoms, the transmon qubits can detect a change in microwave signal to a single photon level. We exploit such feature for sensing the magnetization oscillation in a magnet, and demonstrate that the coherently excited magnetization oscillation obeys the Poissonian magnon number distribution [1-3]. Our ultra-sensitive sensing method provides a powerful tool for magnetization oscillation sensing as well as quantum information processing.

[1] Y. Tabuchi, S. Ishino, T. Ishikawa, R. Yamazaki, K. Usami, Y. Nakamura, Hybridizing ferromagnetic magnons and microwave photons in the quantum limit,
Phys. Rev. Lett. **113**, 083603 (2014).

[2] Y. Tabuchi, S. Ishino, A. Noguchi, T. Ishikawa, R. Yamazaki, K. Usami, Y. Nakamura, Coherent coupling between a ferromagnetic magnon and a superconducting qubit, Science **349**, 405-408 (2015).

[3] D. Lachance-Quirion, Y. Tabuchi, S. Ishino, A. Noguchi, T. Ishikawa, R. Yamazaki, Y Nakamura, Resolving quanta of collective spin excitations in a millimeter-sized ferromagnet, Science Advances **3**, e1603150 (2017).

About the speaker

2008-2012 Paramagnetic electron spin quantum computing project. (PhD student at Graduate school of Engineering Science, Osaka University.)

2012-2015 Quantum repeater project. (Postdoctoral researcher at Research Center for Advanced Science and Technology, the University of Tokyo).

2016- Superconducting quantum computing project (Assistant professor at Research Center for Advanced Science and Technology, the University of Tokyo).