量子物理学・ナノサイエンス第 431 回セミナー

Magnonic superradiant phase transition and quantum squeezing in thermal equilibrium

講師　：　馬場　基彰 准教授
横浜国立大学 大学院工学研究院

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概　要

The superradiant phase transition (SRPT) is a second-order phase transition where a static electric or magnetic field is ordered spontaneously due to an ultrastrong interaction with matters in thermal equilibrium. Although the SRPT has not been observed since its first prediction in 1973, its magnonic (spin-wave) version was confirmed in a magnetic material ErFeO3 recent years [1-3]. In this seminar, we will present experimental results [1,3] and theoretical background [2] of this magnonic SRPT. In addition, thermal-equilibrium quantum squeezing obtained at the SRPT critical point [4] will also be presented. The quantum technologies like quantum computing have been developed basically based on non-equilibrium phenomena. Because quantum states in those phenomena are usually excited states in systems of interest, such states are easily destroyed due to a variety of decoherence phenomena. In contrast, the SRPT provides quantum squeezing in the most stable state of systems in thermal equilibrium, thus its squeezing is robust against decoherence, which might give us a foundation of decoherence-robust quantum technologies.

[1] X. Li, M. Bamba, N. Yuan, Q. Zhang, Y. Zhao, M. Xiang, K. Xu, Z. Jin, W. Ren, G. Ma, S. Cao, D. Turchinovich, and J. Kono, Observation of Dicke cooperativity in magnetic interactions. Science **361**, 794–797 (2018).
[2] M. Bamba, X. Li, N. Marquez Peraca, and J. Kono, Magnonic superradiant phase transition. Communications Physics **5,** 3 (2022).
[3] D. Kim, S. Dasgupta, X. Ma, J.-M. Park, H.-T. Wei, X. Li, L. Luo, J. Doumani, W. Yang, D. Cheng, R. H. J. Kim, H. O. Everitt, S. Kimura, H. Nojiri, J. Wang, S. Cao, M. Bamba, K. R. A. Hazzard, and J. Kono, Observation of the magnonic Dicke superradiant phase transition. Sci. Adv. **11**, eadt1691 (2025).
[4] K. Hayashida, T. Makihara, N. Marquez Peraca, D. Fallas Padilla, H. Pu, J. Kono, and M. Bamba, Perfect intrinsic squeezing at the superradiant phase transition critical point. Sci. Rep. **13,** 2526 (2023).

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