北京大学量子材料科学中心

International Center for Quantum Materials, PKU

Weekly Seminar

Exploration of various magnon states using magnetization state tomography

Tomosato Hioki

Tohoku University

Time: 3:00pm, Dec. 7, 2022 (Wednesday)

时间: 2022年12月7日 （周三）下午3:00

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Abstract

State tomography is one of the essential tools in quantum science to analyze the quantum and classical nature of elementary excitations in solids. Elementary excitations in magnetic materials include magnons (spin waves) and their scattering processes determine various magnetic properties. Recently, magnon states characterized by unconventional fluctuations, such as squeezed states, mixed states, and entanglement between magnons, have been theoretically predicted. Thus, its experimental approach has been awaited with a view to its application to quantum and nonclassical computation using magnetic materials.

Here we have demonstrated a state tomography for magnetization dynamics that enables us to experimentally obtain the Wigner function, a probability distribution function that represents the fluctuation distribution of magnetization dynamics. By utilizing recently developed spin-current generation and detection techniques, we realized the observation of magnon fluctuations and the reconstruction of the Wigner function. With this method, we demonstrated that the coherence of precessional motion, which is conventionally thought to be lost in about 100 nanoseconds, is retained for microseconds. In the parametric excitation, two degrees of freedom, 0 and π, remain in the oscillation phase, and it is expected to be possible to generate various magnon states.

About the speaker

Tomosato Hioki is a condensed matter physicist, with an interest in magnetism and spintronics. He received a Master degree and Doctoral degree from Tohoku University in Japan, for his experimental work on ultrafast spectroscopy of magnetic and phonon excitations under the supervision of Prof. Dr. Eiji Saitoh. This research has established a high-throughput spin wave observation and generation method, which has dramatically accelerated the development of new power-saving computing devices using magnetic materials. In recognition of his achievements, he completed his doctoral studies within two and a half years with the best thesis award, and proceeded with the current assistant professor career in Tohoku University. His current research focuses on quantum magnonics where magnons and their correlation lead to various counterintuitive magnetization dynamics in ferromagnetic materials. His experimental technique includes microwave spectroscopy, ultrafast laser technique, and micro-structuring of thin films.