Report on MERIT-WINGS Long-term Overseas Dispatch

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Location: Oxford Instruments NanoScience (UK)
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Research project: Cryogenic high-frequency measurements of magnetic thin films

■Location

Bus on my way back arriving at the main gate

Oxford Instruments is a company that traces one of its origins to a startup from the University of Oxford and develops and manufactures research and industrial experimental equipment. Its headquarters, where I visited, is located in Abingdon near Oxford, and the company maintains multiple sites across Asia—including Japan—as well as in Europe and North America. Among its divisions, I was affiliated as a research student with the Apps Lab, a team verifying manufactured instruments or applying them to real experiments, within the NanoScience business unit, which specializes in cryogenic experimental systems and superconducting magnets. In the Apps Lab, I conducted research on high-frequency measurements of magnetic thin films under cryogenic conditions.

■Research introduction and progress

When a static external magnetic field is applied to a ferromagnet and a microwave alternating magnetic field is irradiated, the magnetization undergoes precessional motion around the external field. Once the microwave field is switched off, the precession amplitude—i.e., the magnetization component perpendicular to the external field—decays and eventually converges to the field direction. The relaxation rate (the rate of amplitude decay) is a key material parameter because it sets the energy barrier for spintronic devices whose operation depends on both the expectation value and fluctuations of magnetization dynamics. This relaxation rate is known to exhibit a complex temperature dependence arising from multiple concurrent relaxation mechanisms within the ferromagnet. Measuring and characterizing this dependence at low temperatures is essential for the development of high-precision, high-efficiency spintronic devices in which the influence of thermal fluctuations is minimized.

To evaluate the relaxation rate of a magnetic thin film only a few tens of nanometres thick,

I assembled a GHz-frequency measurement setup inside a low-temperature environment provided by a TeslatronPT Plus variable-temperature physical-property measurement system developed and manufactured by Oxford Instruments. The high-frequency circuit was carefully designed both to ensure sufficient signal strength from the injected microwave field and to suppress heat losses that could disturb the cryogenic environment. The relaxation rate was determined by measuring the microwave power spectrum absorbed by the magnetic film. After stabilizing the measurement protocol, I used QCoDeS—a Python-based data-acquisition library developed by the universities of Copenhagen, Delft, Sydney and the Microsoft quantum computing consortium—to automate a series of measurements under systematically varied temperatures, external magnetic fields, and other conditions.

The resulting data revealed a relaxation-rate peak within a temperature range of several tens of kelvin. One possible origin of this behaviour is the presence of rare-earth impurities in the sample, which we plan to investigate further through detailed analysis and additional measurements.

■Daily life during my stay

Perhaps because my stay was in a European country and at a private company, I found that office hours were generally shorter than what I was used to in Tokyo. Many colleagues seemed to spend their evenings relaxing with family or friends, or taking part in local community activities, which I found very nice. While I was also able to have sufficient personal time after work, I was always mindful of making steady progress within the relatively short office hours and my fixed two-and-a-half-month stay, which made me feel accomplishment and toughness simultaneously every day. This lifestyle reminded me of the importance of setting clear priorities and working with focus.

Changing my research environment also gave me first-hand insight into how circumstances shape one's approach. Because there was not an ongoing work on magnetization dynamics or high-frequency measurements in the host laboratory, I often needed to design and propose measurement circuits and protocols entirely on my own. Some of them were so familiar in my home laboratory that their significance is easy to overlook, but during my stay I had to take accountability for each of them. I feel that this experience will help me cultivate an important habit of independent, ground-up thinking in my future research. I also realized that knowledge and skills I take for granted in my own laboratory can become strengths when viewed from outside. I owe this realisation to the members of the people in

The pub where I had a drinking party on the last day of my visit.

Apps Lab, who took an interest in my research and asked valuable questions at every stage.

I also enjoyed spending time with many people both inside and outside the laboratory. I often went for coffee breaks or lunches with the laboratory members, chatting not only about research but about many everyday topics. Thankfully some colleagues had visited Japan and were interested in the country, so we often talked about Japanese geography, history, food, and daily life. Lunchtime also offered chances to meet people from other departments, which led to visits to local pubs or invitations to larger gatherings. At group meetings, discussions were always serious and candid, yet everyone showed respect to others and attentive to keeping the atmosphere constructive, which let me feel genuinely comfortable.

Daily life itself was very pleasant. I stayed in central Oxford and commuted about twenty minutes by bus to the laboratory. Beyond the brick-built townscape stretched wide open countryside, and on sunny days I loved listening to music on the upper deck while watching the scenery change. There were no stop announcements on the bus, however, so it was easy to miss my stop if I became too absorbed in the view. Oxford itself is already famous for its historic streets, but it is also interlaced with rivers, including the Thames, which serve as peaceful retreats for residents. Along the Thames, I was lucky enough to see many horses running across the meadows—an extraordinary sight from a Tokyo perspective. I mostly cooked for myself, which became a daily pleasure. Supermarkets offered an abundance of bread, dairy products, meat, and fruit, along with ingredients from Asia, the Middle East, Europe, Africa, and Latin America, making even shopping an enjoyable experience. Although the UK is known for high prices, I found that buying in bulk or choosing sale items allowed me to eat delicious meals at a reasonable cost. Favourites included a burger of lamb and blue cheese on a black-sesame bun, where the cheese melted beautifully from the heat of the meat, and English breakfasts I made in the morning. I even used a tin of caramel given to me by a lab member to make banoffee pie (banana + toffee), a classic British dessert. With the long, mild summer days, I sometimes enjoyed my home-cooked dinners outdoors.

Double lamb blue-cheese hamburger.

English breakfast cooked by me. It is unfortunately not a full breakfast since it does not include bacons or mushrooms.

■**Acknowledgements**

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City viewed from Magdalen Tower in Magdalen College, University of Oxford.