

## My Long Road of Research with Kakenhi

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In the process of preparing this manuscript, using KAKEN database, I looked back over the various research topics I have tried to address with funding from the Grants-in-Aid for Scientific Research (Kakenhi) over the course of my career. As I reviewed the numerous long-ago research projects, I felt I had slipped back in time to my days as a young and mid-career researcher. Every one of the projects was full of happy memories as well as less pleasant recollections of more difficult times. Often in my career I have thought that my research was going well, only to come up suddenly against an even more difficult challenge that dragged me deeper and deeper into the problem. In what follows, I'd like to write about a few of these personal memories.

I can't remember what kind of Kakenhi grants my supervisor advisor applied for while I was a student. I have the impression that in those days, people decided to apply for a grant because some interesting idea had occurred to them. The situation was not like today, when it is essential to obtain grants to carry out even the most modest research projects. Perhaps the biggest difference between then and now is that back then university professors had time, and as students we were able to have long discussions and debates with our professors on a daily basis. We had so much time that our debates would sometimes reach a dead end and both student and professor would nod off midstream. Education, I believe, really is something that requires time. I wonder whether university students today are receiving a true education, when everyone is constantly so busy. Which was better, I wonder, now or then?

Once I became an assistant professor at a university, I was in a position to apply for Kakenhi funding myself. I applied for a Grant-in-Aid for General Scientific Research (C) and launched myself upon a new research project. At first, in order to

carry out research on low-dimensional spin systems, I was using pseudo two-dimensional crystals as specimens, but I decided I wanted to try working on true two-dimensional materials, and started a series of experiments on oxygen monolayer films. The experiment involved absorbing a single layer of oxygen molecules onto graphite and studying the magnetic phase transition. I was a complete amateur when it came to experiments of this kind, and soon found myself in all kinds of difficulties.

For several years, I was unable to produce any decent data, and naturally couldn't write my research paper. This situation dragged on for some years. Luckily, the professor who was my boss at the time didn't put any pressure on me to get on with writing my paper. (Well, perhaps there was just a little bit.) Things really are different at the top of the tree, I thought to myself at the time. But today I don't think even the biggest figures in the field would be able to get away with such a relaxed attitude. But for some strange reason the Kakenhi funding kept coming in, and even my slow-moving research eventually began to show signs of tortoise-like progress. Eventually, like light beginning to dawn after a long dark night, I started to obtain decent results. I don't know much about how the screening system worked in those days, but I am impressed and grateful for the way it continued to support a young researcher who had ideas but was not able to produce results for a long time. I wonder whether the current screening system works that way.

As an associate professor, I made a decision to make a break with my previous research and start on a new type of project, partly because I moved from the university to an inter-university research institute during this time. I was now in an environment where I could use as much synchrotron radiation, that dream light, as I liked. I was practically able to immerse myself in it. I was given beamline modification clearance and was able to spend several months monopolizing the beamline for my initial research project. Using a method known as synchrotron magnetic X-ray scattering, I started my work on magnetism. But once again a long night lay ahead of me before any results started to come in. When I calculated the strength of magnetic diffraction from organic materials, the beam intensity turned out to be insufficient and out by two digits. But given that I had started off with little more than a hunch and a willingness to try and see what happened, perhaps this was a result that should have been foreseen. At least once I directed so much synchrotron radiation at my materials that I burned a hole in

them before I noticed what I was doing. I remember one of the postdocs who worked with me at the time telling me, “You’re always looking into the stands, aiming to hit a homerun, and you don’t keep your eyes on the ball.” (And that’s why you keep getting struck out!) But even then the Kakenhi funding stayed by my side, and one day I was able to obtain some remarkable results from a Grant-in-Aid for Scientific Research (B) project that went beyond anything I had imagined. I was running an experiment using resonant X-ray scattering to observe the charge ordering of transition metal oxides, and had ended up being able to observe the orbital ordering as well. I was astonished by this result, which I had not been aiming to achieve at all. I still remember well the morning when the signals appeared on my computer screen. I made sure to bring the lesson home to that postdoc right away: “The important thing is to keep swinging, and then when you hit you really hit big!” As a result, I was able to do joint research with many colleagues on this discovery with the help of a Grant-in-Aid for Scientific Research (A).

Once I became a full professor, I returned once more to a university and decided to embark on structural properties research using neutrons as well as synchrotron radiation. I applied for a Grant-in-Aid for Scientific Research (S) and set about trying to build the necessary equipment for fundamental experiments and neutron scattering. This grant helped me to do research with numerous students at the university. A lot of the time our research did not go well. But that’s essentially the way it always is with research. This was one of the lessons I wanted to teach my students—and that if you keep working without being discouraged by these setbacks, eventually something will work out. I’m not so confident that I succeeded in getting the message across. My fervent hope is that the Kakenhi grants-in-aid system will continue to support researchers in their endeavors even in the midst of a long succession of failures.

After that I returned to the inter-university research institute and with the help of a Grant-in-Aid for Scientific Research (S) set about building equipment for resonant X-ray scattering in the soft X-ray region. Getting this equipment successfully launched cost me a lot of setbacks and hard work. I was ultimately unable to produce meaningful results during the period of my research, but thanks to the diligence and indefatigability of my co-researchers, we have recently started to produce good results at last. When I look back on my career, my research seems

to full of failures and disappointments, but in the end the failure of experiments to produce the desired results is one of the things I find interesting, and I feel I've actually enjoyed the experience. If you told me to do it all again, though, I'm afraid I'd have to respectfully refuse.

When I was asked to contribute something to this series, and started to think about the subjects I might address, all kinds of topics came to mind—perhaps because I was working as a Senior Program Officer at the Japan Society for the Promotion of Science (JSPS) Research Center for Science Systems. “The Importance of Dual Support,” “Securing Diversity: Promoting Bottom-Up Research,” “Assessing the Effectiveness of Kakenhi: Long-Term Ripple Effects,” “The Mistake of Moving to Obtain a Grant,” “The Importance of the Establishment of a Fund System,” “Contradictions between Ambitious Challenges and Results-First Research,” and “The Truth about the Research Center for Science Systems.” Eventually, though, I decided that other people could surely address these topics with far more skill than I could hope to command, and I decided to write this extremely personal (and perhaps self-indulgent) account instead. If any readers feel that the time they have spent reading my contribution has been wasted as a result, I beg their forgiveness.