LIFE SCIENCE:


"Tsutsuji"- Azalea

Medical Biology

New experimental approaches are always being undertaken at SPring-8. This is particularly the case with medical and biological specimens that require various approaches to elucidate their functions. One good example is reported by Dr. Dilanian in this volume. Membrane proteins play many important roles in cells but they are generally difficult to crystalize for protein crystallography. Even when they form 2D crystals, powder diffraction from them has a large number of overlapping reflections that must be separated for structural analysis. The Australian group from the University of Melbourne and CSIRO proposed a novel technique to separate these reflections. Their method was applied to the best-quality data from bacteriorhodopsin (bR) that was obtained at SPring-8 and the high-resolution structure of the protein was obtained.

Another method of obtaining the protein structure from a 2D crystal is proposed by Dr. Iwamoto of JASRI. It is based on Fourier transform holography that utilizes the coherent X-ray beam from SPring-8. Iwamoto's idea is to make use of a large number of object-reference pairs oriented in the same direction. This dramatically improves the signal-to-noise ratio, and an averaged high-resolution image was successfully obtained. One possible application of this method is to a 2D crystal of membrane protein that is labeled with a marker such as nano-gold.

The intense X-ray beam from SPring-8 has been widely used for imaging experiments. It is well known that X-ray phase-contrast CT has not only higher density resolution than conventional absorption-based CT but also highly quantitative. Hoshino *et al*. applied the technique to an eye lens. Detailed analysis of the density gradient in lens revealed discontinuities that may be related to the formation process of the lens.

High-resolution CT using an X-ray microscope is also an advantage of SPring-8. The work of Professor Matsuo's group in Keio University revealed the internal structure of the semi-spherical protrusion of the malleus (a bone in the middle ear) called the processus brevis from both wild-type mouse and transgenic osteopetrotic mouse that has stone-like bones. Since this structure is only 300 μm in diameter, an effective voxel size of 0.22 μm was necessary. Unlike the wild type, the bone of osteopetrotic mouse lacked blood vessels, suggesting a role of osteoclasts in bone formation.

Dr. Akiyama's group in Nagoya University is working on the circadian clock in a cyanobacterium that is analogous to the circadian clocks of eukaryotes including humans. The clock is realized by the phosphorylation and dephosphorylation of protein KaiC. KaiA stimulates phosphorylation whereas KaiB promotes dephosphorylation, and these proteins are assembled into a complex. Thus, interaction between the proteins in solution can be studied by small-angle X-ray scattering. The results indicated that KaiC ticks through expanding and contracting motions of the part of its structure called the C2 ring. For this measurement, which requires a prolonged experiment, the stability of the X-ray beam from SPring-8 is indispensable.

In all of these studies, X-ray imaging and scattering techniques are used for the same purpose, that is, to resolve the structure of a nonperiodic sample. It is interesting to note that these two techniques are becoming increasingly inseparable, implying a feature of synchrotron radiation science.

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