Structural Biology and High-Energy Accelerator
The Birth of Pulsed Neutron Source and Photon Factory

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Biology is neither my specialty nor my favorite subject, Needless to say, I am not at all good at biology. The biology class was not pleasant when I was a student at the middle school. But now I am a fan of structural biology. The reason is simple why I became a fan. It is because accelerators are useful for structural analysis of proteins. Accelerators were originally invented and developed as tools of particle and nuclear physics and now are playing an important role in other fields of science. It is a great pleasure for me, for I myself have been engaged in the accelerator business for a long time. Studies on proteins as well as experiments on neutrinos and quarks are carried out simultaneously in one accelerator laboratory, which is so to speak a merging of different races in an academic community.

Let me describe briefly the history of high-energy physics in Japan. High-energy physics experiment in Japan started when the electron synchrotron was born at the Institute for Nuclear Study (INS), University of Tokyo. The construction of the synchrotron was initiated in 1956 and became operational at the end of 1961. During that time, a proposal of constructing a larger scale proton accelerator was presented by the voluntary group of high-energy physicists, headed by Prof. T. Kitagaki, to the National Committee of Nuclear Physics, the Science Council of Japan (JSC). It was strongly rejected by oppositions of representatives from other fields than high-energy physics (i.e.,theoretical nuclear & particle physics, nuclear physics and cosmic-ray physics). Reflecting the completion of the electron synchrotron, the Committee yielded to the increasing pressure of high-energy physicists and started discussions on the issue. After long argument, the Committee submitted a recommendation " On the future plan of nuclear physics " to the Government in 1962. The recommendation included the construction a large proton accelerator and reinforcement of facilities for nuclear- and cosmic ray physics as well. Up to that time, the Government approved all recommendations that had been made by the JSC. In fact, in 1964, a preparatory budget was allocated to INS and then it was believed that the proposed future plan would be materialized very soon in years ahead. A new working group was organized in INS to handle the proton synchrotron would be useless to perform valuable physics experiments. However high-energy physicists united to accept the new proposal as a milestone for further development of high-energy physics in Japan. Another important issue was how to establish and how to operate the new institute. At first the new institute was considered to be a traditional type of national institutes supervised directly by the Ministry. Most of traditional national institutes had been established and operated to carry out mission-oriented research designated by the respective Ministry. In applying this system to the new institute, anxiety and difficulties were anticipated about the autonomy in research, the status of researchers and the joint use of the facility by outside users. Fortunately this was solved by establishing a new category of national institute, Inter-University Research Institute, where the status of researchers is the same as in the national universities and the administrative structure is similar to the university structure. The new system was found to be quite beneficial in the operation, personnel affaires and joint use of the facilities in the new institute. In April 1971, the National Laboratory for High Energy Physics (KEK) was established as the first institute of the new category, the Inter-University Research Institute. The abbreviated name, NLHEP, was used at first, but finally, to make it shorter, KEK that was proposed by Prof. Takahashi was employed.

The energy of the KEK proton synchrotron was 8 GeV (later the energy was increased to 12 GeV) which was far behind the world level and creative efforts were needed to make maximum use of the accelerator. One of these was the use of a 500 MeV booster synchrotron, which supplied 500 MeV beams alternatively to the main synchrotron and to the spallation neutron source, muon facility and medical facility. Thanks to Professor Y Ishikawa, the leader of the neutron group, his efforts realized the world first pulsed neutron source KENS.

The use of synchrotron radiation in Japan was initiated at the INS electron synchrotron. During the period of its construction, Professors T. Sasaki, T. Ojio and K. Sagawa proposed to use the synchrotron radiation (SR) from the INS synchrotron. Their proposal was not immediately accepted by high-energy physics users of the synchrotron. However the earnest desire of Prof. Sasaki and the SR group, being supported by directors of Institute for Solid State Physics and Institute of Plasma Physics, moved Prof. S. Yamaguchi, who was in charge of the operation of the synchrotron. Prof. Yamaguchi proposed to make a small hole on the vacuum donut to extract SR through it and persuaded high-energy physics users to agree the extraction of SR. The SR users observed SR immediately after the electron beam circulated in the ring. Taking the opportunity, a community of SR users, which was named INS-SOR, was organized and the opening party was held in the conference at the 3F of INS main building. For the party, the Suntory Company offered free beer for advertising to put it on the market. The term " Synchrotron Orbital Radiation " was still used instead of " Synchrotron Radiation " in Japanese " Housyakou " which was introduced by Mr. G. Shigeto, the head of the Administration Department of KEK, when the construction of Photon Factory started.

SR users increased gradually with time and got unsatisfied for being parasite users of the synchrotron. In fall 1973, on the occasion of the physical society meeting, they held a big symposium on the use of SR and concluded to aim at the establishment of a new laboratory equipped with a SR facility. A 2 GeV class synchrotron was planned and the construction cost was estimated to be about 20 B\. However, in addition to the construction cost, it was considered to be even more difficult to find a site for the new SR laboratory. Recognizing this difficulty, they reached to a new idea to construct the new facility in the western part of KEK site. It did not interfere with the future plan of high-energy physics that was being designed by Prof Nishikawa, then the head of Accelerator Department. Making use of existing infrastructure of KEK seemed more realistic rather than constructing a new facility on a new undeveloped site. In addition it was anticipated that the electron accelerator for SR would have a possibility of being used as a part of future plan of high-energy physics. After all, a planning committee was organized at KEK and an SR facility, KEK Photon Factory (PF), was born in 1981, one year after the commissioning of pulsed neutron source (KENS). Since then both PF and KENS have played an important role in studies of material structure for more than -90 years. The third director of PF, Prof. Chikawa offered Dr. Sakabe of Nagoya University a post at PF to conduct experiments for structural analysis of proteins. To my knowledge, Dr. Sakabe majored in chemistry but his speciality, structural analysis of proteins, was not at all main streams of traditional physics and chemistry, and his appointment was controversial. After being appointed as a professor at PF, he developed a new camera for taking X-ray diffraction pattern of proteins in a very short time by the use of large imaging plates The camera, named as Sakabe camera, facilitated many users to take pictures and made a great contribution in the analysis of proteins. I guess now, Prof. Chikawa, who had accomplished outstanding works in the field of X-ray diffraction, anticipated Dr. Sakabe's capacity when he had asked Dr. Sakabe to work at PF.

I myself joined to the preparatory group of KEK in 1963 and worked in this field for 30 years until I retired from KEK in 1992. I do not mean that I made efforts for my scientific achievement. But I had only tried to contribute to the advancement of accelerator science in Japan. After my retirement from KEK, it was a great delight for me to have a post at the Japan Society for the Promotion of Science and have an opportunity of working for all academic fields, Now that the industry-academia cooperative committee on structural biology was organized and authorized by JSPS, the cooperation between academic community and industry will become more active and fruitful in the years ahead. The study of structural biology is currently many-sided and needs to use various experimental methods. Neutron diffraction enables us to know configurations of atomic nuclei in atoms and SR informs us the distribution of electrons circulating around the nucleus Various kinds of electron microscopes, nuclear magnetic resonance and other tools work complementary to explore molecular and atomic structures. But the knowledge that we will obtain in the next step is still unknown. The nuclear structure gives influences on macroscopic properties of condensed matters, as macroscopic properties of Helium3 and Helium4 are quite different. Will nucleons or quarks give any effect to macroscopic structures? One hundred years have passed since radioactivity opened the door to the microscopic world, and some of fundamental properties of matter have been made clear. Remaining important targets for future studies are matters with complicated and complex structures. Among them, the protein is one of the most important subjects. There are enormous numbers of matters that the structural biology should investigate. I would like to close my article wishing and expecting a greater progress of the structural biology in the coming 21st century.