

REMINISCENCE OF DR. TIHIRO OHKAWA

Tihiro's Life at University of Tokyo

I became a student of the Department of Physics, Faculty of Science, University of Tokyo in 1959 and a year later I chose the Prof. Goro Miyamoto Laboratory for my senior year study. At that time main activities in the Miyamoto Laboratory were both accelerator physics and nuclear fusion. Dr. Tihiro Ohkawa (Tihiro, hereafter) belonged to the Miyamoto Laboratory as a lecturer, but he was on leave of absence from Univ. of Tokyo. He went to CERN, Switzerland in 1959 and then, he joined General Atomics (GA) directly from CERN without coming back to Tokyo in 1960. So, I am not sure when I met Tihiro for the first time.

However, I am almost sure about the location where I met him for the first time. The Miyamoto laboratory had a fairly large room in the basement facing the courtyard of the Department of Physics building. At that time four desks were placed in one corner of the room used by administrative assistances. The other corner had bookshelves and a table used as a lab library. The other half of the room had two big tables and benches. Weekly seminars were held there and that was the room every one of the lab members comes at least once a day for tea and/or lunch breaks. It functioned as a salon for lab members although there were no fancy furniture but two blackboards and a bulletin board. Of course, we had daily conversations or played games for enjoyment too. But quite often all kinds of physics discussions took place there also. If one was interested in the subject, he just participated in them. If not, he just left. There were no ranks during the discussions. Professors and students were equally treated. This was the room I met Tihiro first. This was the room we heard new information around the world and got most of suggestions/advice from Tihiro. When Prof. Miyamoto received cards/aerograms from Tihiro, he posted them afterwards on the bulletin board. So, my relationship with Tihiro had started there even before I met Tihiro. This was the beginning of my acquaintance with Tihiro and it lasted for over half a century. Direct communications with Tihiro were mostly done in this room also until I left for US in 1969.

The total number of the Miyamoto laboratory including staff, students and visiting researchers was nearly 30. Tihiro was already semi-legendary among the Miyamoto laboratory members because of his earlier accomplishments and activities in the world. And he was literally almost legendary too. He was a research associate under Prof. Goro Miyamoto when he first went to MURA and worked with Dr. Kerst during 1955-1957. He came back once in 1957, but two years later he went to CERN and then to GA. Afterwards, he never came back and stayed in Tokyo for a period longer than a few months. In the meantime, he was promoted to a lecturer, to an associate professor, and then he was offered a professor position of the Department of Physics, Faculty of Science, University of Tokyo, which is considered as a top academic university in Japan. He never gave a course lecture nor had his own student. Tihiro himself recalled that when he turned down the offer for a professor of Dept. Physics, the professors were very unhappy by saying, "Nobody has ever turned down a professor here." What a legendary story this is.

Although our direct interactions with Tihiro at the Miyamoto laboratory were very limited because of his long absence from Univ. of Tokyo, I already heard some of the stories in the Miyamoto laboratory, which Tihiro told us later at GA and elsewhere.

Around the time I finished my PhD (in 1966), Tihiro was back in Tokyo for a short time of period and gave us an advice, "Go to PPPL (Princeton Plasma physics Laboratory) if you like to study fusion. Come to GA if you are interested in a venture project in fusion." Three years later I went to PPPL, but the history did not allow me exactly to follow the Tihiro's advice as I describe it later. However, Tihiro's life itself went on just like his advice.

Tihiro often told us he got his Doctor of Science under the old Japanese system that was different from the present PhD system after the WWII and he was proud of it. In the old system, one has to submit a thesis to the university describing a distinguished accomplishment achieved by him alone in a science field. In the present PhD system, one must finish a PhD course and summarize accomplishments of the science field related to his thesis and then claim some new work done by him alone. Accordingly, the summary part is the longest part of a PhD thesis. Whereas, in the old system a thesis can be very short as long as a new unique part is clear. Tihiro's thesis describes the invention of the FFAG (Fixed Field Alternating Gradient) accelerator idea that clearly satisfies the requirement. Although I got my PhD under the new system in 1966, Prof. Miyamoto still encouraged us the old spirit by saying, "The shorter a PhD thesis, the better."

Tihiro told us that he had trained himself to come up with 10 new ideas every day whatever subjects were. He also told us he learned how to use a short time effectively. Tihiro said that an innovative life of a physicist could last only for 10 more years. Therefore, we must have carefully chosen a subject we work on. Otherwise, we would waste the most effective period of our lives. It sounded very convincing to us. A strange thing was that even half a century later the same word, "only 10 more years", applied to his scientific life. It remained a mystery when he had time to train himself. I missed a chance to ask this question directly to Tihiro. But Shigeru Mori, a colleague scientist in the Miyamoto laboratory, said that it must have been during the days in the Miyamoto laboratory. If so, that is very amazing since it was right after the WWII and everybody in Japan was striving for food to survive. On the other hand, it was quite possible in the atmosphere of the Miyamoto Laboratory.

Tihiro often mentioned that he appreciated the environment he studied at the Miyamoto Laboratory. Prof. Miyamoto had a very unique style. He always encouraged everyone to come up with new ideas and enjoyed himself to get involved in discussions. There was also another person associated with the Miyamoto Laboratory from whom every lab member learned a lot. He was Giichi Iwata. He was older than or about the same age as Prof. Miyamoto, but he was officially just a research associate at that time and later became a professor of Ochanomizu University. (So, he will be called Prof. Iwata in this article.) Prof. Iwata was a theoretical physicist and did not formally belong to the Miyamoto Laboratory. However, he always stayed in the Miyamoto Laboratory because he did not get along well with his professor. He was excellent at analytical mathematics and

foreign languages. He was always very kind to everybody and offered us helps. Tihiro also recalled those days by saying he was very lucky to have both Prof. Miyamoto and Prof. Iwata so that he had opportunities to learn both experimental and theoretical physics in the Miyamoto Laboratory

This is an episode we heard directly from Tihiro. One day a Japanese professor, who had just visited US, told Tihiro that the Dr. Don Kerst's group in MURA (Mid-western Universities Research Association) was also working on the FFAG concept. Tihiro was chagrined at the news, but he did not know what to do. Then, Prof. Iwata encouraged him to write a letter to Don Kerst and to tell him that Tihiro invented a FFAG concept independently. Tihiro hesitated to do so because of his English capability at that time, but Prof. Iwata wrote a draft letter for him. This became a trigger for Tihiro to be invited to MURA.

Tihiro had another luck in the Miyamoto Laboratory. There was also Shigeru Mori as a research associate under Prof. Miyamoto. (Later he became the director of Fusion Group at JAERI, and also the vice-chairman of JAERI board.) He was very strong at engineering. Tihiro respected his engineering ability, saying, "I am pretty good at machining skill, but Shigeru Mori is better although I can beat him in calculations." So, Tihiro had a chance to learn and polish his capabilities in all three aspects, experiment, theory and engineering, in the Miyamoto Laboratory.

Actually, there was the fourth element he had a chance to learn there: Science policy. However, I believe he also learned a lot about this aspect at MURA and GA. So, I will pick this subject up later.

Tihiro's Research Life at GA

I joined GA in July 1970. After I spent about a year as a postdoctoral at PPPL. I was planning to stay another year there, but the Vietnam War got worse and the budget for US fusion was squeezed. The PPPL's response to the smaller budget was to cut all PhDs. Therefore, I contacted Tihiro and he accepted me to stay at GA. I was still a lucky one. A number of PhDs with US citizenship left US and went to Europe or somewhere else since they could immediately be drafted if they stayed in US without a job. A couple of years later, I saw Tihiro telling Dr. Harold Furth, director at PPPL, that PPPL made a big mistake by cutting PhDs at PPPL to zero.

I went to PPPL to learn fusion research based on the Tihiro's advice, but the mischief of history gave me a chance to work on a venture fusion project at GA also. I soon learned many different approaches between PPPL and GA fusion managements: For example, the next year after I joined GA, I wanted to present a paper at the APS DPP (Division of Plasma Physics) annual meeting about the result of my work done at PPPL. A year before, I presented a paper at an APS meeting about my work done at Univ. of Tokyo. PPPL paid me travel expenses to LA and PPPL even gave me a chance to do a practice run at PPPL. It turned out my slides prepared in Tokyo were in a wrong format. Then, PPPL made new slides for me for free. But at GA, Tihiro did not agree to send me to the APS meeting because the work was done at PPPL. He told me I should ask PPPL to pay travel expenses. Even then, he also said that he had a reservation to send me to the APS meeting since my salary during APS had to be paid by GA. I withdrew my paper submitted to APS. However,

this gave me a good opportunity to learn mechanisms of project costs, administrative costs, overhead costs, and so on, particularly for a small project at GA which I had never thought about before.

Another episode about APS: Next year I attended APS annual meeting and presented a paper about work done at GA. APS DPP annual meeting was usually held at a hotel for about a week. One evening Tihiro told me, "Tonight there will be a gathering of APS big fellows for (trump) card games. Come with me, but do not play. Just watch." I followed Tihiro to a large suite room. There were many APS big names (so-called APS mafias) playing cards with drinks. It was a wonderful opportunity for me to learn their characters since I could see their hands from behind and how they played. I left the room around 2 o'clock in the morning, but the play was still going on. Next morning when I attended a review talk scheduled as the first talk of the day, I saw most of the big players showed up in the review talk room. I learned that those biggies were very energetic in every aspect.

An episode at an IAEA conference: The IAEA conference held at Wisconsin in 1971 was the first one I attended. It was in the middle of cold war and severe competitions were going on between East and West. We had very limited knowledge about their progress in fusion research at that time. Tihiro told me to catch any Russians during the conference and to get as much information as possible about their research. So, first I had to make Russian friends and then I was busy to collect information from them while members from US big research groups got together by themselves enjoying reunion dinners. This almost became our custom between Tihiro and me during any international meetings later on since we were a small group so that we had to minimize sitting together around the same table for dinner in order to gather more outside information efficiently.

Tihiro might have been known in the fusion community as a tough manager to persuade once he opposed something. Maybe he was. But this is a story showing that he was not a simple stubborn person. Around early 1970s I used to drop in Tihiro's office after daily experimental runs and discussed the results with him and got his suggestions for the next day experiment. At that time a desktop calculator with transcendental functions were very new and fairly expensive. (It was HP-35. It cost about \$100.) We had one in our experimental laboratory, but none of us had one in our office area. So, experimentalists, who spent most of their time in the laboratory, knew how nice they were and wanted to have one around our office area too for common usage. However, we could not persuade Tihiro for approval.

By that time Tihiro had already lost his habit to come down in the experimental laboratory daily since he had to spend most of his time in his office to manage various projects. One evening I visited his office as usual and started our discussions. But that day I was prepared for a trick. I hid a lab calculator in my pocket and went into his office for discussions. After a while we needed some calculation. I took the calculator out of my pocket and got an answer quickly. Usually Tihiro was the first one to get an answer, but I beat him at that time. Tihiro immediately showed an interest in the calculator. Next week we had a big surprise. We found a calculator on everybody's desk. This is a good example how flexible Tihiro was once he was convinced. He did not dwell on his prides.

I saw him using the calculator quite often since then. The instruction book for the HP-35 and the leather cover were found in his desk drawer after his death. We do not know real reason why he kept them for nearly half a century, but they must have given him a poignant memory since he was not a type to keep everything for remembrance.

Tihiro was very quick to evaluate a physics problem. This was because not only he had a good training on evaluating a physics problem analytically, but also he was always a step ahead of us at the start. He remembered fundamental formulae for physics while a most of us had to create the formulae from a scratch or consult a physics formulae book after we went back to our offices. Moreover, he had fundamental values of material properties in his head. Thus, he could evaluate a physics problem anywhere and anytime. Also, there were not so many reference fusion books since it was still very early days after the declassification of magnetic fusion research. Both Tihiro and I had a book "Physics of Fully Ionized Gases" by Lyman Spitzer and a "Chronological Scientific Tables" (published in Japan). I always carried them as bibles for plasma physics, but Tihiro had them in his head.

While I was still at Univ. of Tokyo, Tihiro and Shoichi Yoshikawa (PPPL) were often invited together to Japan as top fusion researchers working actively in the world. Both gave us seminar talks. We enjoyed Tihiro's introductory parts since he explained background of the subjects clearly. However, we were easily lost once he started talking details because it was not easy for us to follow his equations written on a blackboard. They were fundamental equations for Tihiro, but not necessarily for us. Whereas in the case of Shoichi's talks, he started from basic equations so that all we needed was to follow his calculations line by line. So, Shoichi was popular in that sense. Tihiro's physics talks had the same trend during his GA days so that we had to review his talk afterwards before we understood his talks. He did not have an atmosphere we could ask detailed questions on the spot.

It was Tihiro who gave me an advice to go to a language school in order to improve my English when I decided to stay at GA in 1970 instead of going back to the University of Tokyo. He told me, "You had better improve your English in order to be a good group leader. A physicist may listen to you as long as your physics idea is good, but that is not enough as a manager. You have to communicate with other people including engineers, technicians and administrative persons." I believe this advice was based on Tihiro's own experiences. I took private English lessons at the Berlitz language school near the downtown San Diego twice a week at night for nearly a year. It cost me \$ 2000 that was almost the same amount I spent for my two-year old used car or my salary for two months. However, it was worth doing it.

Around that time the Fusion group headed by Tihiro was still a very small group and was just a section of the Science Department at GA. In a few years the Fusion group grew very quickly from a Section, a Department and to a Division, but the main business at GA was High Temperature Gas -cooled Nuclear Reactor for a long time. Therefore, the Fusion Group did not get in-house priorities at GA over a number of matters. We were not quite happy about the situation. For example, the GA machine shop had a priority over outside machine shops. We had to use them if the GA shop could do a job within a reasonable time frame. The quality of the GA

shop was good, but it was expensive and slow because of the nuclear reactor high quality assurance standard. Our experimental equipment did not need that high quality all the time. Tihiro himself was not happy too, but he usually had to take the side to calm us down patiently. The other example was office move. When the reactor group wanted to expand, but to stay together, they requested us to move our fusion offices elsewhere. A lot of fusion people thought that was Tihiro's policy to move our offices around, but he was the one getting pressures from outside. He did not tell us the outside pressure because he knew it did not do any good for us and told us some other excuses. This showed how patient Tihiro was and waited to keep his brawny points for something more important.

Outside people often asked about the histories how he came up with the octopole* and doublet ideas. (* "Octupole" is always spelled as "Octopole" at GA. Once I had a chance to ask Tihiro about it and found that he thought "Octopole" is the correct spelling until then. I told him, "It is all right because GA octopole is a proper machine name. Since then, we intentionally spell it "Octopole".) One day in 1970, he took me into a room in the central round building. There were a number of fusion device models. Vacuum chambers were made out of glass and magnetic field lines were made of colorful wires. Pinches, stellarators, heliacs, multipoles and so on. Each was about a meter long in size. He explained me that they were made when they discussed what to make in early 1960s, so that they could get good ideas about advantages and disadvantages. He said they compared all of them before they chose the octopole. A few years later, another GA group wanted to use the room, so we had to evacuate the room. I tried to save some of the models. I thought we could move them to a balcony of a fusion laboratory. Tihiro did not agree with me since he knew that GA would charge us for the balcony space in addition to the room footage once we used it openly. Tihiro asked us, "Which would you prefer old models or new diagnostics?" We had no choice but to say "the latter". However, I still regret we threw such historical valuables away. Now I have a sneaky feeling that the value of the models for Tihiro was not an individual single piece, but the whole set, that is, the fact that he surveyed all ideas before what to choose. Therefore, it did not mean much unless we save all of them.

Fusion experimental devices at GA had all fairly short lifetimes. DIII-D may be the only exception. Why? It was because of the Tihiro's philosophy.

Before the GA fusion group expanded very quickly in early 1970s, GA was not considered as the first choice for applicants. Therefore, we had a very difficult time for recruiting. We received many applications. We invited about one third of applicants for interview. After several staff members individually talked to them, Tihiro collected interview comments and discussed them with key staff members (managers). Offers were made to about one third of the interviewees. Then, about one third of them accepted our offer. Salaries offered were not necessarily lower than the national average. However, GA was considered as a small fusion group located in the far end of the nation or the farthest place from Europe. So, we only found one person accepting our offer out of 30 applicants. We needed more than 100 physicists and engineers for the Doublet projects. That is, we looked at literally thousands of applications and we had thousands of interview talks.

Tihiro Ohkawa had a clear philosophy on his project management: “The right man in the right place”. When a fusion project was small, the project was managed by the same person from its beginning to its end. However, as a project grew bigger, he appointed a different manager in each phase if he thought that was the best: Conceptual design; engineering design; constructions; operations; next upgrade step. Quite often consecutive two phases were staggered so that inputs from the previous phases were well utilized. Also, he made sure physics (theory and experiment), engineering and diagnostics are well coordinated in each phase. In other laboratories, there is a tendency that a project becomes a particular person’s project from the beginning to the end, Tihiro tried to avoid that as much as possible.

He also actively introduced project management techniques. He hired a project scheduler to assist project managers. He even tried to apply this method to physics research programs too.

He used secretaries very effectively. They helped managers so that a manager can concentrate on his research jobs rather than on business management. He listened to their suggestions too. We often felt as though the secretaries were our bosses.

Tihiro’s Role in Japanese Fusion Research

When Tihiro Ohkawa joined GA in 1960, he was already recognized as an excellent and innovative young physicist in Japan. His invention of FFAG was a quite remarkable accomplishment although demonstration of a FFAG operation did not materialized successfully until this 21 century due to lack of technologies at that time. Prof. Miyamoto were jokingly telling us, “Tihiro’s devices have never worked.”, but he had fully appreciated his talent. He commented on a science journal interview, “ What Tihiro Ohkawa needs now is a research funds and a wife.”.

He played an important role in the big discussions deciding the Japanese research directions of nuclear fusion development right after the fusion work was declassified. The plans were called the A-plan and the B-plan, and Japan finally chose the A-plan, which emphasized plasma physics research instead of going into projects with more emphasis to developing a fusion reactor (B-plan). The A-plan created Institute of Plasma Physics, Nagoya University supported under Ministry of Education. Later it was converted into National Institute for Fusion Science. The B-plan was later realized in JAERI under Science Technology Agency. The Miyamoto Laboratory was considered to be the B-plan side. However, Miyamoto Laboratory provided key researchers for both sides in the Japanese fusion research history. Tihiro Ohkawa was recruited from both side for their key positions, but he turned all of them down.

He served as a member of the Research Council of NIFS. He was one of the two foreigners appointed for a member of Research Council for the first time. This position was very important for Japan since NIFS was not only a national fusion research laboratory, but also it had a mission to coordinated entire fusion research

efforts of Japanese universities under the Ministry of Education, Science and Culture (Monbusho).

He was also served as a consultant for JAERI and provided key suggestions.

I have so many reminiscences about his daily life over 70 years too. However, I would like to leave them to contributions by his friends and family members. I really feel lucky that he gave me so much great pleasant memories. Please sleep in piece, Tihiro.