

Shyh-Yuan Lee Biography

A look into one of accelerator physics' most important contributors

Lea Feuillet

I approve the sharing of this document

HONR298J
University of Maryland
May 18th

Professor Shyh-Yuan Lee is a Taiwanese particle accelerator physicist who has devoted his career to the study and growth of the field of beam physics after obtaining his PhD on the “Theory of effective interaction and operator in nuclear structure” in 1972. After working at various labs such as the Max Plank Institute and Brookhaven National Laboratory, Dr. Lee held a tenure position for 28 years at Indiana University, teaching various classes and being an advisor to over 40 graduate students. He has published 2 textbooks on particle accelerators and has a third book to be published in August 2020 on “The Fundamental Physics of Sound”.

1 Early Life

Shyh-Yuan Lee was born in Southern Taiwan in 1943, while World War II was still at its peak and Taiwan was part of the Empire of Japan. His father was a barber and his mother stayed at home to raise him and his siblings. His parents had a total of nine children, six girls and three boys. Shyh-Yuan was the second to youngest child, with one younger sister. Not long before his birth, his parents left their hometown, walking along the railroad tracks for one full night before settling in a farming town to find more opportunities as barbers. Most of Shyh-Yuan’s siblings followed in their father’s footsteps and became barbers themselves. However, his second oldest brother worked as an elementary school teacher, which provided enough money to get Shyh-Yuan through high school and university.

World War II had a harsh effect on the Taiwanese population, making everyone in the country poor. Shyh-Yuan Lee actually only received his first pair of shoes in fourth grade when he was 11 years old. Attending elementary school was compulsory at that time, but in farming villages very few people attended middle and high schools due to the difficulty of entry exams and the elevated tuition cost. However, Shyh-Yuan was very lucky and was able to continue his education after elementary school. The middle school was in a town about 30 km from his own, which meant a 2 hour round trip by bus every single day just to get to school. His high school was even further away, in the capital city Taipei, where most students had a tough living situation. Shyh-Yuan had to share a rental room with about 40 square feet available per person. Luckily, cheap food vendors at nearby street corners were available for affordable meals. Shyh-Yuan took an interest in mathematics and science during middle and high school and was part of the 95th percentile in his high school class of about 500 students. His high school chemistry teacher encouraged him to pursue a physics degree as an undergraduate student. On the other hand, Shyh-Yuan’s parents’ wanted him to study medicine in order to improve his family’s financial situation. While medicine is the preferred major in Taiwan, as medical doctor is a highly respected profession, Shyh-Yuan chose physics as his first choice on the self-chosen preferred-major list, filed about a month before the college entrance exam. His father had actually sent him a letter telling him to choose the medicine major, but it arrived a day too late. His entrance exam score granted him his first preference: physics, and he entered Taiwan University in 1962.

At Taiwan University at that time, there were few opportunities for undergraduate physics research as few funding opportunities were available. In contrast to his high school living situation, the university had dorms and a cafeteria which made it considerably easier

for him. Furthermore, because the college entrance exams were so highly competitive, there were many opportunities for college students to tutor middle and high school students in Taipei city. In order to get himself through university, Shyh-Yuan took a total of seven night tutoring jobs each week on top of classes, earning about 20 US dollars per month. This was enough for room and board and tuition fees in the 1960's. Shyh-Yuan's favorite past time during college was playing the "go" game, sometimes at the expense of studying and doing class work. However, he still ranked at about top 20 percent of his class of 40 students which opened him doors to studying in the US for graduate school.

2 Graduate School and Career

After one year of compulsory military service, nearly 80 percent of Taiwan University's 1967 class came to America for graduate study, and Shyh-Yuan Lee was no exception. He entered the physics department at the Illinois Institute Technology in 1967 and passed the qualifying exam in May 1968. However, during a trip to visit a university friend at Stony Brook in the summer 1968, they discussed the graduate study program there and went to see the admission officer. The admission officer asked Shyh-Yuan some questions and asked him to apply. He was subsequently accepted to the second year graduate school at Stony Brook. After the qualifying exam, Shyh-Yuan wanted to conduct high-energy experiments for his Ph.D. thesis, and joined a scintillation detector group for a half-year, working on polishing scintillators for particle tracking triggers. He also attended a course taught by Pr. Thomas T.S. Kuo on the "advanced many-body problem in nuclear structure." Shyh-Yuan found this course so fascinating that he decided to study the effective interaction of nuclear structure for his thesis, under Kuo's supervision. Dr.Lee obtained his PhD in 1972 by submitting his thesis entitled "Theory of effective interaction and operator in nuclear structure".

After completing his PhD work, Shyh-Yuan moved to Germany for postdoctoral work at the Max Planck Institute in Heidelberg and Heidelberg University. He worked under two renown theoretical physicists, Pr. Hans Weidenmüller and Jörg Hüfner for a total of two years, learning much about how to solve physics problems. In the following years, Shyh-Yuan travelled the world, working as a postdoc at the University of Paris - XI for a year, teaching physics at the National Central University in Taiwan for 2 years, and taking another postdoctoral position at the University Washington at Seattle for a year. These traveling years were extremely beneficial to Shyh-Yuan's career and learning experience, working on nuclear effective interaction, kaonic atoms, and nuclear heavy-ion scattering. In 1977, Dr.Lee went back to Stony Brook University as a visiting assistant professor to work on heavy-ion experiments.

Accelerator science had drawn a lot of interest from the 30s to the 60s, but Shyh-Yuan Lee was not familiar with this subject during his graduate school years. He joined accelerator physics just like many colleagues: from different areas of study such as nuclear, high energy, solid state, atomic physics, engineering and chemistry. There were few books on beam physics in 1984 and Dr.Lee had little knowledge on the topic of accelerator physics. In order to educate himself on this subject, he read any technical notes that he could possibly get his hands on.

Shyh-Yuan met his wife at Taiwan University in 1967 and got married in 1972 at Stony Brook University. His wife attended UPenn and majored in biochemistry. She then pursued an M.S. in biochemistry but was unable to finish it as the couple had to move to Germany for Dr.Lee's postdoc. Shyh-Yuan and his wife had two children and thanks to his wife, he was able to work 16-hour days during his work with the RHIC design group. Unfortunately, his wife succumbed to cancer in 1989.

Shyh-Yuan considers his career as a beam physicist to have started when he took an opportunity to work at the Brookhaven National Laboratory (BNL) on the feasibility design-study of Relativistic Heavy Ion Colliders (RHIC) on January 1, 1984. During that year, the major effort in high-energy physics was the design and construction of the Superconducting Super Collider (SSC), and the RHIC design team was no exception. At BNL, their work was mainly focused on working on the RHIC accelerator complex, including the design of the AGS Booster. They all worked on performance issues and tried to solve the technical problems of the RHIC.

At Brookhaven, Dr.Lee's first assigned task was to study beam dynamic problems during the transition-energy crossing. The instability of transition energy is associated with the beam charge induced resonances due to impedances in the circuits, which is a physics problem familiar to most scientists. After that, his second task was to help improve the conceptual design report of the RHIC lattice that was going to be submitted to the DOE in May 1984. Shyh-Yuan spent about five months revising the RHIC lattice which was then accepted by the International Review Committee in January 1985. The main challenge when doing so was fitting the beam line lattice into the existing tunnel, built for the ISABELLE proton-proton collider. At that time, computers still used punch cards as inputs and Dr.Lee's superior complained that he used too much of RHIC's computing budget even though the mainframe computer was much less powerful than any present-day laptop. However, this mainframe was still much improved in comparison with Courant's time in the design of Alternating Gradient Synchrotron (AGS). During this design task, Shyh-Yuan benefitted from many fruitful discussions with Ernest Courant and Al Garren, who had designed an accelerator lattice design program SYNCH. The new RHIC lattice was submitted in the CD0 to the DOE in 1985. RHIC was approved for construction in 1990. This lattice with modifications remains the backbone of the current RHIC lattice.

According to Dr.Lee, the advantage of being an accelerator physicist lies in the opportunity for collaboration with the control group scientists to participate and analyze beam data. Benefitting from collaboration with many BNL colleagues and friends, such as E. Bleser and K. Gardener, they could work on any problems related to the accelerator complex like the AGS booster design or the transport line. In 1984 and 1985, Shyh-Yuan shared an office with Steve Tepikian, a graduate student from Stony Brook University doing his own thesis with Pr.Courant. Since they shared office, they ended up working together to solve a few problems on the spin polarization preservation in high-energy accelerators, and the topic of spin dynamics in synchrotrons has become a hobby of his for some years. Dr.Lee also benefitted from Prof. Alan Krisch of Michigan University and his world leading spin-polarization experimental group. Shyh-Yuan considers Alan a great teacher of his on physics, experimen-

tal methods, and even society and philosophy. Pr.Krisch's perfection with spin experiments and data analysis were crucial to PrLee's efforts in conducting beam dynamics experiments.

In the 1990's, the Superconducting Super Collider project had been approved for construction and Dr. Lee received an offer from Indiana University for a beam physics faculty position in 1990. Upon his arrival, a beam physics experimental group to study beam dynamics was launched at the IU Cyclotron Facility (IUCF). IUCF had just commissioned a storage ring with electron cooling called the IUCF Cooler which stemmed from the idea by Prof. Robert Pollock, and was able to store proton beams with kinetic energies from 45 MeV up to 500 MeV. With electron cooling, this particle beam had similar characteristics as that of the planned SSC collider, which allowed them to use the IUCF to help with the SSC project. With the SSC Director John Cameron's approval, the IU accelerator and the SSC physics groups successfully launched beam experiments at the IUCF Cooler to study various beam physics problems. With financial help from the SSC group, they established the world first 6-D turn-by-turn phase tracking system at the Cooler Ring in 1991 and used experimental data to derive the nonlinear Hamiltonian of the beam inside the accelerator. They carried out many successful experiments on nonlinear beam dynamics, experiments on ground motion and synchro-betatron coupling, chaos resulting from overlapping resonances, beam dynamics with double rf systems, attractors in dissipative system, negative resistance instability, strange attractors, space charge effects, and many other. Sadly, the experiments wound down after the unfortunate termination of the SSC project. Nevertheless, these beam physics experiments provided resources to train many of Shyh-Yuan and other professors' graduate students in accelerator physics. Besides their beam dynamics experiments at IUCF Cooler, Shyh-Yuan and his colleagues worked with fellow accelerator scientists at National Accelerator Laboratories (BNL, Fermilab, LANL, and SLAC) to train graduate students.

His decision of joining Indiana University's faculty was primarily based on his devotion to beam physics education and teaching the physicists of tomorrow. Shyh-Yuan Lee considers the best parts of being a professor at a university are the teaching opportunities and the possibility of having graduate students. He considers that graduate students are much like trusted friends with whom you can work alongside solving physics and technical problems. During his 28-year tenure at IU, Dr.Lee has benefited from working and supervising over 40 Ph.D. students. During his years at IU, Shyh-Yuan also published two particle accelerator physics textbooks. The first one was *Spin Dynamics and Snakes in Synchrotrons* published in 1997, which covers mostly acceleration and storage of polarized beams in high energy synchrotrons. The second was entitled *Accelerator physics* (1999) and focused on historical accelerator development and particle accelerator phenomena. The textbooks were based on lecture notes and research works with his colleagues and students.

The United States Particle Accelerator School, USPAS, was founded by Dr. Melvin Month, a visionary in the field of beam physics education. His unyielding push for the USPAS provided the foundation of present day beam-physics education. The termination of the SSC in 1993 was a devastating event for many within the beam physics community, including Dr. Lee who had invested a lot of time and energy in the project. However, this ending started a conversation between Dr. Month and Dr.Lee on the future of beam physics

and allowed him to establish the Masters of Science degree in Beam Physics and Technology within IU's Physics Department in collaboration with the USPAS . This program is a great service to students around the country and it motivates lab technicians to excel on their research work. The degree also provides students opportunities to take many specialized advanced classes that can promote their future career in the field of particle accelerators. After Dr. Month's retirement from the USPAS in 1998, Shyh-Yuan Lee served as the USPAS director for 4 years.

3 Awards and Legacy

In 2006, Pr.Lee received the Humboldt Senior Research Lifetime Achievement Award. With the award, he was able to spend a fruitful sabbatical year at the Society for Heavy Ion Research (German: Gesellschaft für Schwerionenforschung), abbreviated GSI, in Germany to work with Prof. Ingo Hofmann. A few years later in 2013, Professor Shyh-Yuan Lee received the USPAS Prize for Lifetime Achievement in Accelerator Physics and Technology for "his extraordinary contributions to accelerator education including mentoring a large cadre of highly-regarded students, for overseeing the Indiana University - USPAS Master's Degree Program in Accelerator Physics and for serving as USPAS Director from 1998 to 2002". [1] His own interpretation for receiving this award "is that the award is to honor [his] collaborations during these 30-some years working on beam physics, solving various physics and engineering problems". Beam physics and technologies are evolving and there will be more challenges for young accelerator scientists and engineers to solve, today, and tomorrow.

Dr.Shyh-Yuan Lee has retired from teaching since January 1, 2018. Nowadays, he is not working on any specific projects but is always ready to provide any needed volunteer work. There is no specific project but he is happy to do any needed volunteer works. In past years, Dr.Lee has had many fruitful collaboration with colleagues at the Taiwan Photon Source in Taiwan and the Tsinghua University in China. During his teaching years at IU, Pr.Lee taught the basic physics of sound and the acoustic technology labs for about 5 years and has devoted great interest in this subject. He has recently submitted a textbook on "fundamental physics of sound," to be published in August 2020.

[1] Stony Brook Physics Astronomy: News, 15 Aug. 2013, www.physics.sunysb.edu/Physics/news/whatsnew_single.php?date=2013/20130815.