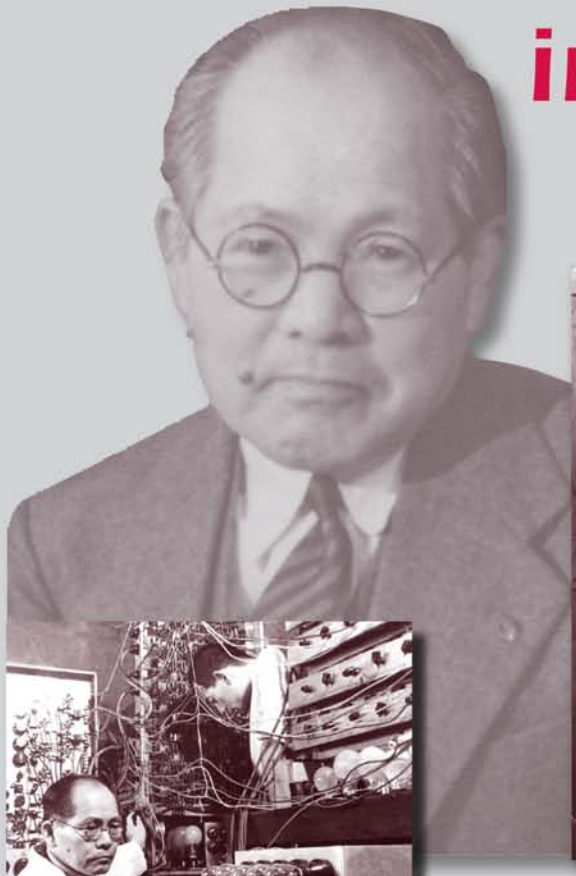
Yoshio Nishina

Father of Modern Physics in Japan



Dong-Won Kim

Taylor & Francis
Taylor & Francis Group

Yoshio Nishina

Father of Modern Physics in Japan

Yoshio Nishina
Father of Modern Physics in Japan

Dong-Won Kim

Taylor & Francis
Taylor & Francis Group
New York London

Taylor & Francis is an imprint of the
Taylor & Francis Group, an **informa** business

Taylor & Francis
Taylor & Francis Group
6000 Broken Sound Parkway NW, Suite 300
Boca Raton, FL 33487-2742

Version Date: 20140114

International Standard Book Number-13: 978-1-4200-1246-0 (eBook - PDF)

Preface

Yoshio Nishina has been one of my hero scientists ever since the mid-1990s when I wrote my first paper on the history of Japanese physics. I realized at once that he had made great contributions to the development of physics in Japan in the early twentieth century. I also discovered that there were few scholarly studies on him, and decided to write a short paper in order to analyze his role in the Japanese physics community in the 1930s and 1940s.

In March 1999, I interviewed Professor Emeritus Yoichiro Nambu of the University of Chicago with Professor Emeritus Laurie M. Brown of Northwestern University. Both Nambu and Brown were surprised when I naively asked questions like "How good a physicist was Nishina?" That interview not only reconfirmed the importance of Nishina in the history of physics in Japan but also led me to abandon my original plan for a paper in favor of writing a full biography of Nishina. After returning from Chicago, I received an e-mail from Brown. He stated that both Nambu and he agreed that I should write a biography of Nishina. Brown even offered to arrange for it to be published by the Institute of Physics (IOP) in Bristol, England. I hesitated for a while but finally decided to take on this great intellectual challenge. The Yoshio Nishina project began in the summer of 1999.

I would like to add special notes for Japanese titles and the arrangement of Japanese names in the book. Although family names precede given names in Japan, I have put given names first for two reasons. First, those Japanese scientists who are featured in this book published their most important works in English or in German, and adopted the Western way of presenting their names in their papers. So, the central figure of this biography was known to the scientific world as "Yoshio Nishina," not as "Nishina Yoshio." Second, this book is intended for the English speaking readers who are not familiar with the East Asian naming convention. I translated most of Japanese titles of books and papers into English and added "(Japanese)" at the end, but simply romanized the Japanese titles of journals or publishers.

Dong-Won Kim

Author

Dong-Won Kim was born in Seoul, South Korea, in 1960. He received his doctoral degree from Harvard University in 1991. His thesis was on the history of the Cavendish Laboratory at the University of Cambridge. He has taught history of science and technology at several universities in South Korea and the United States, including Korea Advanced Institute of Science and Technology (KAIST), Seoul National University and Johns Hopkins University. He is now visiting associate professor at Johns Hopkins University.

The list of his publication includes *Leadership and Creativity: An Early History of the Cavendish Laboratory, 1871–1919*, "J.J. Thomson and the Emergence of the Cavendish School, 1885–1900", "The Emergence of Theoretical Physics in Japan: Japanese Physics Community between the Two World Wars", "Winning Markets or Winning Nobel Prizes?: KAIST and the Challenge of Late Industrialization" (with Stuart W. Leslie), "Two Chemists in Two Koreas", and "Yoshio Nishina and Two Cyclotrons". His next book is on the history of science and technology in South Korea in the last half of the twentieth century.

Acknowledgments

During the project, I have been very lucky to receive a great deal of support from many people. First of all, I would like to express my deepest gratitude to Yoichiro Nambu and Laurie M. Brown who introduced me to this wonderful opportunity. I also would like to thank Silvan S. Schweber, Ewrin N. Hiebert, Shigeru Nakayama, and Takehiko Hashimoto for their encouragement and interest. Sam Schweber read the final draft and gave me a lot of worthwhile criticism and comments for revision. A condensed version of Chapter 6 of the book was published in the *Historical Studies in the Physical and Biological Sciences*, and I am grateful to Rod Home and John Heilbron who read the manuscript carefully and made the most useful comments and corrections. This book owes much to recent works on Nishina by Morris Low, Shizue Hinokawa, Kenji Ito and Dong Hoon Oh, with whom I had the pleasure to discuss our common interest. I thank Ito, Oh, Boumsoung Kim, and Hyungsub Choi who helped me to find some manuscripts and papers. The Department of the History of Science and Technology at Johns Hopkins University gave me two opportunities to read excerpts from the work in progress.

The staff of the Nishina Memorial Foundation, Institute of Physical and Chemical Research, Niels Bohr Archive, Special Collections of North Carolina State University, American Institute of Physics, Caltech Institute Archives, and the Bancroft Library, University of California, Berkeley, gave me access to many valuable manuscripts and photographs for the book, and I am grateful to them. I am especially grateful to Ms. Topsy Neher Smalley, the daughter of H. Victor Neher, who generously provided me with Neher's 1935 journal describing his trip to Japan and some photographs.

John Navas, first at IOP and then Taylor & Francis, has been my principal contact for the publication of the book, and I would like to extend my special thanks to him. I have been in poor health for some years and he has been most patient with my several delays of the final draft. The staff of Taylor & Francis has been also very helpful in preparing the book for publication.

Lastly but not least, I would like to thank my family for their warm encouragement.

Introduction

Japanese scientists and historians of science honor Yoshio Nishina as the "pioneer of modern physics in Japan," "founder of modern science in Japan," or as the "Christopher Columbus of Japanese physics." Hideki Yukawa, the first Japanese Nobel Laureate (physics, 1949), stated that without Nishina his generation could not have achieved such brilliant success in elementary particle physics during the 1930s and thereafter. Another Japanese Nobel Laureate (physics, 1965), Sin-itiro Tomonaga, made the same point in his eulogy of Nishina in 1951: "He made us aware of the modern methods of physical research." Eri Yagi concluded his article on Nishina for the *Dictionary of Scientific Biography* as follows: "Without Nishina's return from Europe with the principles of quantum mechanics, these two physicists [Yukawa and Tomonaga] might never have developed their potentials to the fullest."[1]

In 1991 there were several celebrations for the centenary of Nishina's birth: an international symposium was held in Tokyo to discuss Nishina's contributions to twentieth-century physics; a special documentary videotape with the title, "Nishina Yoshio: Father of Modern Physics," was coproduced by his hometown and the Nishina Memorial Foundation; and a special stamp was issued by the Japanese postal service on his birthday (December 6). Similarly, in 2005, Toshimitsu Yamazaki (Tokyo University and Riken) paid a tribute to the "Father of Nuclear and Particle Physics in Japan" with his paper, "Yoshio Nishina and the Dawn of Nuclear and Particle Physics," in a special session for the 50th anniversary of the establishment of the Nishina Memorial Foundation.[2]

I first encountered Yoshio Nishina in 1992 while examining the Cavendish Laboratory's annual photographs for my book on the history of the Cavendish. As I looked at the image of the young Nishina in the 1922 annual photograph, I vaguely remembered his name and asked myself, "What was this Japanese doing in this center of experimental physics?" I soon learned from fragmentary English sources that Nishina was trained under Niels Bohr for several years, that he coauthored the famous Klein–Nishina formula, and that during the 1930s and 1940s he contributed significantly to the development of several branches of physics in Japan. Later, after examining Japanese sources commenting on Nishina, I came to believe that I should investigate Nishina's life and works further. Thus I began what I considered at the time to be a "little" research project.

I quickly found that appraising Nishina's role in the international physics community and in the Japanese scientific community was more difficult than I had anticipated. The English sources hinted that the Klein–Nishina formula might be Nishina's only distinguished contribution to physics. For example, the *Dictionary of Scientific Biography* did not have an article for Nishina in its first edition in 1973.

It only added a short article for him in its supplementary volume in 1990 even though Nishina had died in 1951.[3] Therefore I struggled for some time to justify why I should study this seemingly "less important" physicist. On the other hand, as the first paragraph of the introduction indicates, the Japanese sources unanimously hailed him as a great scientist and as a perfect teacher. If so, why has the international scientific community and Western historians of science neglected him for so long? Getting to the bottom of this puzzle became one of the reasons for writing this biography of Yoshio Nishina.

I started the project to answer the following three questions: what kind of scientist (or physicist) was Nishina?; how good a physicist was he?; and how much and in what way did he contribute to the development of twentieth-century physics in Japan and the world? To answer these questions, I concentrated on analyzing the scientific works of Nishina and his junior researchers in the Institute of Physical and Chemical Research (Riken). I will argue that Nishina assumed three roles: a very competent researcher, a formidable teacher, and a shrewd administrator. By performing these three different, but closely related, roles magnificently, he not only made a significant contribution to the emergence and growth of a research network that eventually produced two Nobel Prize winners, but also raised the level of Japanese physics overall.[4]

While writing the biography, I have met several difficulties, most of which resulted from the simple fact that Nishina was a Japanese physicist. Clearly Nishina was Japanese. Thus, the social and cultural environments in which he had worked and had trained the subsequent generations of Japanese physicists were quite different from those in the West. Although Japan was a successful example of industrialization and Westernization in the late nineteenth and early twentieth centuries, it was still an East Asian country in which very different traditions dictated people's everyday life and thought. The teacher–student relationship and the funding system for research, for example, were not what they were in the West. In Japan, the prefix of "professor" meant not only a professional title but also the embodiment of respect and authority: therefore Yukawa and Tomonaga often called Nishina as "Professor Nishina" in their memoirs, although Nishina had never been appointed professor at any Japanese university. The question to be answered is therefore: how much did being Japanese influence Nishina's scientific work and contribute to his success?

On the other hand, Nishina was a physicist who had been deeply influenced by the Western research environment. After graduating from the Westernized Tokyo Imperial University and doing some research at Riken, he was thoroughly trained in Europe for more than 7 years at two leading research institutes: the Cavendish Laboratory in Cambridge and Niels Bohr's Institute of Theoretical Physics in Copenhagen. His most famous work, the Klein–Nishina formula, was produced while he was still working in Europe. Nishina befriended many distinguished physicists in Europe, including several Nobel Prize winners, who treated him as their equal. He spoke German and Danish fluently and English fairly well. Also Nishina was widely perceived as introducing the new quantum mechanics and a new research environment into Japan. Thus Nishina was one of the most Westernized Japanese physicists in the first half of the twentieth century. How, then, could he successfully manage his Western traits in the Japanese environment?

Perhaps a partial explanation is Nishina's unique quality that he described as "a fairly elastic adaptability to new conditions."[5] On the one hand, he was typically Japanese. He had been a model student from elementary school to university. He had behaved exactly as the typical Japanese did when he met and dealt with senior Japanese scientists or nonscientists outside his laboratory. That was why during the 1930s he excelled as the secretary of the 10th subcommittee of the Japan Society for the Promotion of Scientific Research that subsidized his cosmic ray research and later the construction of two cyclotrons; why he became the spokesman of science during World War II; and why he was regarded as the statesman of Japanese science during the American occupation that followed. On the other hand, Nishina behaved just like the leading Western scientists in his laboratory at Riken: he produced quality work in new fields of physics, became part of the international network, acted in an unauthoritarian manner, partook in open discussion and collaboration with junior researchers, and organized research groups of junior researchers with different educational backgrounds. Owing to this symbiosis of his Japanese and Western attitudes, Nishina enjoyed unanimous and unprecedented respect from both physicists and nonscientists.

Nishina's being a Japanese physicist also raises some problems of interpretation. In East Asia, such celebrated figures as Nishina traditionally are depicted as "perfect" men, flawless leaders whose mistakes or failures (if any) were not due to faults of their own. Criticism of heroes, particularly great *sensei* [teachers], is not permitted. Most Japanese sources on Nishina faithfully follow this tradition. Under such circumstances, one could doubt whether a historian of science who is culturally East Asian (as I am) can achieve an objective appraisal of Nishina's contributions. I agree with my Japanese colleagues that Nishina was a great man. Yet my appreciation of his greatness is based on ideas and opinions that are not necessarily those expressed in traditional Japanese scholarship, particularly in areas on how and why Nishina's role and contributions were critical to the development of the Japanese physics community. In studying Nishina's life and work, my goal has been to appraise his contributions accurately, and any such evaluation, honestly attempted, runs the risk of being somewhat critical.

Another problem of interpretation is that many Western physicists and historians of science regard the success of Japanese physicists since the 1930s as the exception rather than the rule. Perhaps as a result, Westerners have made little effort to incorporate the accomplishments of Japanese physicists into the larger framework of the history of physics. Worse, when studying the history of science in Japan, Westerners have tended to concentrate on a few topics such as Nishina's cooperation with Klein in the calculation of the Compton scattering cross section. They, however, often neglected Nishina's role in the spread of the fledging field of quantum mechanics in Japan and the construction of two cyclotrons. It should be emphasized that the latter was far more than a simple transfer of know-how from Ernest O. Lawrence's Radiation Laboratory in Berkeley to Riken.

Although Western scholarship has begun to recognize the merits of some twentieth-century Japanese physicists, in particular theoretical physicists like Yukawa and Tomonaga, the Japanese physics community in which those scientists worked has received scant attention.[6] Experimental works by Japanese physicists in

the first half of the twentieth century has never been explored seriously by any Western scholars. Nor have Westerners endeavored to understand the Japanese physics community of the twentieth century within its broader intellectual context. Most fail to appreciate the community's independence and importance, too. Language barriers undoubtedly were an obstacle but in fact they are a convenient excuse since many important scientific works by Japanese physicists were published in English or other Western languages in either prestigious Western or Japanese journals.

This short biography of Yoshio Nishina certainly does not solve all these problems mentioned above. However, if the book provides readers with new perspectives and more questions, I will have achieved my goal. I sincerely hope that more extensive biographies of Nishina with fresh perspectives will appear in the near future. Yoshio Nishina certainly has the greatness to deserve not just one but many biographies.

NOTES

1 Masao Suzuki and Ryogo Kubo (eds.), *Evolutionary Trends in the Physical Sciences: Proceedings of the Yoshio Nishina Centennial Symposium, Tokyo, Japan, December 5–7, 1990* (Berlin: Springer-Verlag, 1991); Sin-itiro Tomonaga, "Dr. Nishina," in Makinosuke Matsui and Hiroshi Ezawa (eds.), *Sin-itiro Tomonaga: Life of a Japanese Physicist*, translated by Cheryl Fujimoto and Takako Sano (Tokyo: MYU, 1995), pp. 11–114 on p. 114; Hideki Yukawa interview with John A. Wheeler (July 10, 1962), AIP MSS OH 575, Eri Yagi, "Nishina, Yoshio," *Dictionary of Scientific Biography, Supplementary II* (New York: Charles Scribner's Sons, 1990), Vol. 18, pp.684–687 on p. 686.

2 Satosho, Okayama Prefecture and Nishina Memorial Foundation, *Nishina Yoshio: Father of Modern Physics (VHS)* (Okayama: Sanyo-eiga, 1991); Toshimitsu Yamazaki, "Yoshio Nishina and the Dawn of Nuclear and Particle Physics," in 2005 2nd Joint Meeting of the Nuclear Physics Divisions of the American Physical Society and the Physical Society of Japan (Session 3S: Nishina Commemorative).

3 *Dictionary of Scientific Biography* has a rule that only deceased scientists with distinguish achievements be considered to be included in it.

4 Dong-Won Kim, "The Emergence of Theoretical Physics in Japan: Japanese Physics Community between the Two World Wars," *Annals of Science, 52* (1995), 383–402.

5 Y. Nishina to N. Bohr (April 1, 1929) in *Supplement to the Publications No. 17, No. 20 and No. 21* (Tokyo: Nishina Memorial Foundation, 1986), pp. 6–8 on p. 7.

6 Laurie M. Brown and Olivier Darrigol have published a series of papers and books on Japanese physicists' work on elementary particle physics. For more information see Chapter 4.

List of Abbreviations

AIP	American Institute of Physics
EOL	Ernest Orlando Lawrence Papers, The Bancroft Library, University of California, Berkeley
Nishina MSS	Yoshio Nishina Manuscript, Institute of Physical and Chemical Research
Riken (or RIKEN)	Institute of Physical and Chemical Research
Special Collections, NCSU Libraries	Harry Charles Kelly Papers, 1882–1995, MC 72, Special Collections Research Center, North Carolina State University Libraries
Bulletin IPCR	*Bulletin of the Institute of Physical and Chemical Research*
DSB	*Dictionary of Scientific Biography* (New York: Charles Scribner's Sons, 1973)
Proc. Phys. Math. Soc.	*Proceedings of the Physico-Mathematical Society of Japan*
SP	*Scientific Papers of the Institute of Physical and Chemical Research*

Contents

1 Youth

1.1 THE NISHINA FAMILY

Yoshio Nishina was born on December 6, 1890 in Hamanaka, a hamlet of the village of Shinjo, today known as Satosho Village, of Okayama Prefecture.[1] The Okayama Prefecture is located between Kobe and Hiroshima along the Setonaikai sea in the western region of Japan's main island. His family had gained local distinction in the 1830s, when Yoshio's grandfather, Arimoto, used his civil engineering skills to settle a dispute between Shinjo and a neighboring village over possession of some salt-making fields. In recognition of this service, the local daimyo (feudal lord) bestowed samurai status on Arimoto and one of his sons, Arihito. Yoshio's father, Arimasa, was the fourth son of Arimoto and inherited some of the family's farming and salt-making fields. He married Tsune, a daughter of the headman of a distant town, Takafuta, in Hiroshima Prefecture. The couple had five sons and four daughters (Yoshio being the eighth). Arimasa died when Yoshio was 16 years old. Yoshio's eldest brother, Teisaku, 20 years older than Yoshio, inherited the house, salt-making and farming business, and responsibilities as head of the family, including the role of father to his siblings. Yoshio's second eldest brother, Empei, was an inventor. Yasuo, the third son in line, was an electrical engineer. Masamichi, 3 years younger than Yoshio, died young in 1919. Three of Yoshio's four sisters married their cousins. The youngest, Toku, who was very close to Yoshio, married into a successful industrial family, the Uchida family of the nearby city of Kurashiki. The Uchida family later would financially support Nishina's stay in Europe.

Yoshio was born in the heart of one of the most glorious and turbulent times in Japanese history, the Meiji period (1868–1912). This was the period during which Japan transformed itself into a modern, industrialized nation.[2] A strong new central government in Tokyo abolished the old feudal system and enthusiastically adopted Western-style systems of politics, economics, education, science, and technology. Japan's new cabinet and parliament ran relatively smoothly. Its infant educational and public health systems quickly surpassed those of many Western countries, and its new railway and telegraph lines rapidly networked the country. Japanese industry began to dominate trade in the Far East and Southeast Asia by manufacturing and exporting products that, although less technologically sophisticated than Western products, were more familiar and thus more acceptable to Asian consumers. Japan's most surprising development in the eyes of the rest of the world was its emergence as a major military power in Asia. In 1894–1895 Japan's modernized armed forces defeated the Chinese army and navy on the Korean peninsula and then, in 1904–1905, vanquished Russian forces on land in Manchuria and at sea in the Tsushima Straight between Korea and Japan.

In this rapidly changing environment, a family's fortune rose or fell depending on its members' ability to adapt. The Nishina family's fortune was hamstrung by its ties to the dying feudal system. Thus, the local paper currency that the Nishina family had issued for local use became worthless when the central government issued the new national currency. The failure of the family-owned company accelerated the decline of Nishina family's fortune.[3] In December 1907, Empei received a patent for his fire-proof paint, which earned praise from the influential *Yomiuri Shimbun* (*Yomiuri Newspaper*) in the following year. Teisaku, head of the family, decided to set up a company, Nishina & Co., to manufacture and sell Empei's paint and other inventions, and invested a good part of the family fortune in the company. Empei's products, however, proved ineffective and the business rapidly declined. By late 1913, money had become so tight for the Nishina family that Teisaku was unable to send Yoshio his monthly allowance regularly.[4]

To restore their fortune, the Nishina family looked to the younger generation, and particularly to Yoshio, the family's most brilliant member. This expectation, as asserted by the Japanese historian of science, Kenji Ito, greatly influenced Nishina's decisions, especially his choice of career.

> Nishina Yoshio's great goal was to restore the house of Nishina. His search for success, his training to be an engineer, his entrepreneurial ambitions — all aimed at a restoration of the family fortune of the Nishina clan.[5]

However, Yoshio did not fulfil his family's hope that he would rebuild their fortune. Instead, his great contribution was made to the Japanese physics community.

1.2 YOSHIO NISHINA: THE STUDENT

When Yoshio entered school at the age of seven, he became a model student and remained so throughout his years of formal education.[6] As an elementary school student in his native village of Shinjo, he earned straight A's in subjects that included Japanese, arithmetic, and ethics. His performance at Shinjo's higher elementary school, which he entered in 1901, and then at the neighboring Kamogata's higher elementary school, to which he moved in 1904 after the Shinjo school was closed, earned Yoshio a graduation award for academic distinction from the prefectural governor in March 1905. His academic record for the next five years of schooling in Okayama, to which he moved to enter that city's middle school, was unmatched in the school's history: he earned A's in every subject every year, ironically, except in physics in his fifth year (Figure 1.1).

A letter that Yoshio wrote to his younger brother Masamichi in 1910 sheds light on Yoshio's attitude toward hard work.[7] In that letter, Yoshio advised his brother to prepare for every class on the previous day, to listen carefully in class, to review the material on the following day, and to review all subjects during the weekend, just as he himself had done in the middle school. Yoshio also found time for sports in middle school: tennis became his favorite and life-long hobby. Yoshio's stellar performance at Okayama Middle School, from which he graduated in March 1910, qualified him for acceptance by more prestigious high schools in Tokyo and Kyoto,

FIGURE 1.1 Yoshio Nishina in Youth. Above: Nishina's birth place in Shinjo Village (now Satosho Village) of Okayama Prefecture (Photo taken by the author). Below left: Yoshio (left in the back row), Yasuo (an elder brother, middle in the back row), Masamichi (younger brother, right in the back row) and children from the Nishina family. Below right: Yoshio as fifth year middle school student. (Courtesy of the Special Collections, NCSU Libraries.)

but Yoshio elected to enroll in the high school in Okayama because of its proximity to his hometown.

The Sixth High School in Okayama admitted Yoshio in April 1910 without requiring him to take the usual entrance examination. The high school was noted