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The Father of Nuclear Energy in China - Hoff Lu

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Abstract. Hoff Lu was a famous Chinese physicist, educator and internationally renowned scholar. In this paper, Hoff Lu's life course was recalled, his achievements in lithium ion physics and nuclear energy were studied, the famous "Hoff Lu irreversible equation" was introduced, and Hoff Lu's thoughts on scientific research and education were briefly explained.

1. Introduction

Hoff Lu (1914-1997) is well known throughout the world as a famous Chinese physicist, educator and internationally renowned scholar. In 1993, Hoff Lu was awarded the "20th Century Achievement Award" by Cambridge Biographies Center. At the same time, the American Biographical Institute selected him as "The World 5000 Elite" and awarded him the "International Recognition Award." In 1998, Houston Baptist University in the United States and Hoff Lu's alma mater in 2004, the famous University of Minnesota, all established bronze statues for Hoff Lu. This is the third in the United States following Confucius and Sun Yat-sen. The statue of a Chinese celebrity is also the only statue of a Chinese scientist in the United States [1]. On June 15, 2004, Haris, the mayor of Honolulu, Hawaii, announced that June 15th of each year will be "Hoff Lu's day" [2]. As he is the world's first expert who published authoritative papers on the use of nuclear energy and the theory of atomic bomb physics in American core journals, he is hailed as "the father of nuclear energy in China" and "The first person in the world to reveal the secret of an atomic bomb". Hoff Lu has created many world firsts in his life, and is especially renowned for his "Hoff Lu irreversible equation".

2. Hoff Lu's life

Hoff Lu, originally from Laizhou in Shandong Province, was born in Shenyang on June 7, 1914. His father, Lu Jinggui, studied at the University of Illinois and Purdue University. He was called back as a railway engineer and a member of the Road Committee of the Transport Committee of the three provinces of East China. The mother Cui Keyan once studied at the Tokyo Girls' Institute of Japan with Qiu Jin at a public expense. Under the influence of the family's patriotic, pragmatic and studious spirit, Hoff Lu has established a great aspiration for science to save the country and revitalizes China. In 1929, Hoff Lu graduated from the second junior high school in the province of Shenyang East Gate, and then entered the middle school study of Northeastern University. In 1931, he enrolled in the Hebei Provincial Institute of Mechanical and Electrical preparatory science. In 1932, he was admitted to the Physics Department of Yenching University of Science. In 1936, He got a bachelor's degree from Yenching University and was admitted to the Graduate School of the University of Minnesota in the same year. He was appointed as a teaching assistant in the Physics Department of the Arts and

Sciences College and became a member of the American Physical Society. He received a master's degree in science from the Graduate School of the University of Minnesota in 1939 and has been an honorary member of the American Sigma Cossacks Society since 1941. During the Anti-Japanese War, he declined his enthusiasm for the retention of his friends and the generous treatment of the United States, and went back to the motherland with painstaking efforts. He was appointed as a professor at National Sun Yat-Sen University, National Guangxi University, National Zhejiang University, Qilu University Hangzhou Branch, Fudan University, Peking University, and deputy director of the Shanghai Institute of Nuclear Research, Chinese Academy of Sciences; and a member of the National Science and Technology Commission Physical Group; In 1964, he was elected as a director of the Chinese Physical Society and was appointed as a member of the Theoretical Physics Committee of the Chinese Physical Society. He also served as Chairman of the Shanghai Physical Society; Deputy Director of the Physics Terminology Committee of the Chinese Physical Society; Director of the Chinese Institute of Nuclear Physics; and Member of the Department of Mathematical Sciences of the Chinese Academy of Sciences. [3]

3. Hoff Lu's physical contribution

Hoff Lu has made outstanding contributions in nuclear physics, theoretical physics, neutron physics, plasma physics, and fluid mechanics. He published the first paper from 1937 (23 years old) to accurately determine the abundance ratio of lithium 7 and lithium 6 is 12.29. He created many first [4], such as: the world's first scientist to discover the isotope effect of hot salt ion emission; the world's first scientist to accurately measure the abundance ratio of lithium; The first scientist to disclose the secrets of atomic bombs and nuclear energy; China’s first scientist to observe nuclear fission; China’s first scientist to fully introduce the knowledge and application of atomic energy physics; the world’s first to propose basic equations of relaxation and compression— "Hoff Lu irreversible equation" scientist. These are Hoff Lu's contributions to the development of world physics.

3.1. Lithium Ion Study

From 1937 to 1938, Hoff Lu was called "the beginning of the age of atomic energy". As early as 1937, Hoff Lu started to create a 180-degree focused mass spectrometer to study the emission performance of the hot salt ion source and the isotope effect of thermionic emission was found so that the abundance ratio of lithium isotopes and potassium isotopes can be accurately determined. In 1938 he also accurately measured the isotope abundance ratio of lithium 7, lithium 6 isotope abundance ratio is 12.29, and published in the " Physical Review" magazine entitled "A low temperature thermal source of Li ions" [5], Hoff Lu creatively proposed the time integration method in the article, which has aroused widespread concern in the international physics community. Hoff Lu's measured value was then selected as an accurate value on the international isotope table, and was adopted for nearly half a century until 1984 when the United States nuclear meter also quoted his measured value. At the time, a newspaper in the United States on the front page reported his achievements in measuring atomic weight [6]. 1953 Nobel Prize winner Emilio Segre explicitly acknowledged that Hoff Lu first discovered the isotope effect of hot salt ion emission [7]. In 1958, the book "Mass Spectrometry" by Walsh, University of Cambridge in the United Kingdom, introduced Hoff Lu’s time integration method and considered that this result was hard to come by. At the same time, Germany’s "Nuclear Tables" also quoted Hoff Lu’s value.

3.2. Outstanding contributions in the field of nuclear energy

After scientists discovered in 1939 that the chain reaction could release enormous energy, the scientific community reached the climax of studying nuclear energy. Based on the study of the lithium ion physics, Hoff Lu creatively proposed the principle that the magnetic field of the sector has a focusing effect on the incident charged particles. Based on this principle, Hoff Lu has invented a new 60-degree focused high-intensity mass spectrometer for the mass separation of microgram quantities of Boron 10 and Boron 11, and he first prepared the isotope target with others [8]. At the same time,

Hoff Lu systematically studied the condensed arc discharge of hydrogen and Boron trifluoride under low pressure and extracted ions in the axial direction, thus successfully inventing a strong source of Boron ions. This result was considered to be a frontier achievement of nuclear physics at the time. He laid an important foundation for him to carry out nuclear energy exploration. In 1941, Hoff Lu completed his doctoral thesis "a New Type High Intensity Mass Spectrometer and its Application to the Separation of Boron Isotopes". [9] He obtained a Ph.D. in philosophy from the University of Minnesota. His important achievement was paid attention to by the US Atomic Energy Department and was detained for being included in the "Top Secret Information concerning the manufacture of atomic bombs and atomic reactors". It wasn't until 1950 that the US Atomic Energy Commission's publication "Nuclear Science Abstracts" published its summaries. After Japan surrendered in 1945, Hoff Lu published four papers at the invitation of Science magazine: Atomic Energy and the Atomic Bomb, From Uranium to the Atomic Bomb, The Physics of the Atomic Bomb, and Half the Heavy Core. "Unbalanced", introduced the basic situation of the atomic bomb to the readers in an informal manner, and warned people that there is no secret about the atomic bomb. In 1947, Hoff Lu published a paper "on the physics of the atomic bomb" in the "American Journal of Physics ". [10] This was the first time in the world that the disclosure of the atomic bomb was made publicly. It also made Hoff Lu the "first person to disclose the secret of the atomic bomb". Hoff Lu discussed the whole principle of the atomic bomb in his article and proposed an easy way to estimate the critical size of atomic bombs and atomic reactors. These contents are widely used in international literature and monographs.

4. Hoff Lu's irreversible equation

Traditional fluid dynamics is based on the Stokes equation. This equation ($F = 6\pi\eta\alpha\upsilon$) is the resistance when the ball slowly moves at a constant speed in a viscous fluid, where η is the viscosity coefficient, α is the radius of the ball, and υ is the speed of the ball, which is called the Stokes formula. The Stokes theory is based on the assumption that the second viscosity is zero, so this formula is not yet perfect, and it cannot completely solve the problem. For a long time, many physicists have revised it, but with little success. Since 1950, Hoff Lu conducted a detailed study and investigation of this issue, and he believed that in addition to the restoration of elasticity, there is still an unrecoverable relaxation process. That is, after the fluid has been deformed, it is impossible to completely recover the original state. There must be some energy that will be converted into heat and lost, and thus will not be completely reversed. His dissertation "On Volume Viscosity and Acoustic Dispersion phenomena" is published in Chinese Journal of Physics. [11] In this article, Hoff Lu proposed the theory of creep change viscosity, first introduced the variable-capacity relaxation equation, and extended the classical fluid dynamic equations, resulting in the interpretation of anomalous sound absorption. In 1951, another important article by Hoff Lu, "Volume Viscosity and Compressibilities from Acoustic Phenomena", was published in the "The Journal of the Acoustical Society of America", which caused a sensation. [12] In this article, Hoff Lu extended the application of viscous viscosity theory of acoustics to all frequencies for the first time, and elaborated its principles and calculation methods in detail. In the same year, famous American theoretical physicists JJ Markham, RT Beyer, and RB Lindsay published an article titled "Absorption of sound in fluids" in the authority "Reviews of Modern Physics ". [13] This article strongly promoted Hoff Lu's relaxation and compression of basic equations, and was named for the first time in the world as "Hoff Lu irreversible equation", which is the most satisfactory scientific research achievement of Hoff Lu's life.

5. Hoff Lu's educational thought

Hoff Lu taught for more than 50 years and adhered to the motto of "Gentlemen use words and deeds" and "Integrity first," and paid great efforts for education and scientific research in China. Hoff Lu often warned his students: "Knowing and telling people and being honest with others." This is the motto of his life. Throughout his life, he is seeking truth from facts, both for people, for things, and science. [14]. He has taught at many universities and has trained generations of talents for the motherland, including several academicians and famous experts and scholars, such as the Chinese

Academy of Sciences Fang Shouxian, Ding Dazhao, Yang Fujia, Chen Jiaer, Xian Dingchang, Xu Zhizhan, Wang Naiyan, Gu Chaohao, etc. Researchers and educators have been loved and admired by countless later scholars and have become role models for physicists.

Hoff Lu has been working on the education front since he returned to China. When it comes to the division of disciplines, he believes that the subject setting in Chinese universities is very irrational. Especially in the undergraduate stage, there is no need to divide what nuclear physics, surface physics, general physics into physics. He thinks that the undergraduate stage is physics, big physics. With a solid foundation, in the postgraduate stage to divide the major and to learn physics, we should adhere to the basic physics, which must be used and play a role in the field of industry. His educational ideology: "Changes in power, flexible application; learns and learns, uses freely" [15]. When talking about personnel training, Hoff Lu pointed out that the talents cultivated in China's university science are still mainly flowing to education and scientific research systems, and there are very few in the industrial sector. The large number of technical problems that we face today has hindered economic development. This is one of the reasons that can be solved. The large enterprise systems in Europe and the United States already have directly affiliated scientific research institutions and strive to invent and create services for their own sustainable development and survival. Therefore, undergraduates majoring in physics should go to the industrial sector. The theory is linked to the actual situation, in order to make achievements. Hoff Lu's scientific and educational ideas have always emphasized innovation and emphasis on the future.

As a scientist, he has outstanding achievements; as an educator, he is a world leader. His life was devoted to science and education. His scientific contributions will always be recorded in history.

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