Pioneers of Science

Nobel Prize Winners in Physics

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Preface

Now that you have in hand this volume, I hope that you will find it as enjoyable as many readers, perhaps yourself included, found the first general-interest book published by The Institute of Physics, *A Random Walk in Science*. Some aspects of this later book might also be considered random. In it the biographical notes of the Nobel laureates are arranged in the order of the date of the award, although few or many years may have elapsed between the time the award-winning work was performed and the date of the Nobel Prize. Further, in any one year there seems to be an element of chance as to which of several eminent physicists will be struck by the lightning of Nobel recognition. However, taken together, the achievements of the Nobel Prize winners briefly described in this book highlight the progress of twentieth-century physics.

It was felt desirable that the biographies be held to their present short length and that they be written to interest the general reader. To that I mentally added 'students and prospective students of physics.' I recall that Aage Bohr addressed his Nobel lecture to 'Dear Students.'

Each biographical note seeks to identify the work for which the award was given and its place in modern physics. Here some 'physics jargon' may appear, but I trust that any technical discussion will be as acceptable as that, say, in the *Scientific American*. In the biographies you may note the sort of family background, education, apprenticeship, and work habits which may distinguish a successful scientist. You may also note that some scientists are loners, while others enjoy interaction with colleagues and feel a social responsibility.

As the drafts of the biographies were completed, I sent each living Nobelist a copy of his, requesting suggestions for its improvement. In the case of shared awards, each recipient saw the other biographies and had opportunity to comment on how the physics was divided. The biographies in their present form have greatly benefited from the generous help I have received from the laureates. In their replies they made corrections, suggested viewpoints, and provided up-dating information on their current interests. Some were historic documents in themselves. Also, I welcomed the warm approval they expressed for the preparation of this book.

In a lecture to students at the Claremont Group of Colleges in 1960, Dr I I Rabi described the life of a physicist before World War II and nuclear weapons clouded his public image: 'The history of a physicist's life was very simple. He was born; he became interested in physics in some way, either through reading or through the personal influence of a teacher or a lecturer; he wrote his thesis and received his PhD degree; he died. The rest and essential part of this biography could be read only in the scientific journals, in which were described his own work and the work of his students and colleagues. It was an eminently satisfactory life, to my mind the only serious occupation for a gentleman. The drama in which he played his role was epic in quality: the drama of man's unfolding discovery of the world in which he finds himself . . . The stage on which he played his role was the globe . . . He had no counterpart to the art critic, the music critic, the literary critic, or the dramatic critic to plague him. No one stood between him and his public because his public were his colleagues. With all the fringe benefits which I have tried to describe so alluringly, you will not be surprised to learn that his actual take-home pay was not large. Plain living and high thinking were the order of the day . . .'

The Artists

The portrait drawings of the 49 physicists who received Nobel awards from 1901 to 1945 were made by the Princeton artist and pianist Carola Spaeth Hauschka (1883–1948), widow of Hugo Hauschka, of Vienna. She had two brothers: Duncan Spaeth, a Princeton professor who in his spare time coached crews on Lake Carnegie, and Sigmund Spaeth, a music critic known as the 'tune detective' of radio.

In 1905 Mrs Hauschka went to Europe for piano studies and was a pupil of the famous Polish teacher, Theodore Leschetizky, in Vienna. After 1921 she was a resident of Princeton where she was a frequent accompanist on the piano of Albert Einstein. During World War II Mrs Hauschka was active as a grey lady for the Red Cross, and visited many hospitals where she made sketches of wounded soldiers. She was a well known member of the art colony at Boothbay Harbor, Maine, where she had a summer home. In her artwork Mrs Hauschka used oil and water-colours and also made pastel and charcoal sketches. She was an excellent teacher.

Mrs Hauschka encountered afflictions which she bore with fortitude. However, about two years before her death, illness, loss of her home, and the discovery that she had cataracts, led to a nervous breakdown.

In her correspondence with me about the Nobel portraits, Mrs Hauschka referred to the subjects as 'my noble physicists' (some of whom she knew personally). Her respect and affection for them is apparent in her drawings, and I consider this book as a memorial to Mrs Hauschka.

Mr Peter Geoffrey Cook, also a Princeton artist, kindly consented to continue the series of portraits of the Nobel laureates (1946–1972) in a style consistent with Mrs Hauschka's drawings. Mr Cook was a 1937 graduate of Princeton University with an AB in architecture, and was a student of the National Academy School and the Art Student League. Mr Cook has taught painting at the National Academy School in New York, at New Hope, Pennsylvania, at Clearwater, Florida, and at Princeton, New Jersey. He is a member of the National Academy of Design and has won some 15 prizes for figure, landscape and portrait painting.

The portraits of the 1972–1979 Nobelists were drawn by Mr John B Fleming, who was formerly Registrar of Glasgow School of Art, where he had been a member of the full-time teaching staff for almost 30 years. He was well known as a freelance illustrator and collaborated with several authors on numerous books and newspaper articles. Sadly, John Fleming died on 31 January 1986.

The final 16 portraits (1980–1987) were drawn by Mr Hugh Masterson, a former student at Trinity College, Dublin who is now based in Denver, Colorado.

Acknowledgments

I would like to express my warm gratitude to the Nobel laureates who so kindly corrected and up-dated their biographical notes and offered encouragement for the completion of this book. For its unique feature, the portrait drawings, I acknowledge the beautiful work of the artists mentioned above. Some of these portraits were originally commissioned for *College Physics* by Weber, White and Manning. The Institute of Physics and I thank the McGraw-Hill Book Company for permission to reproduce those drawings in this book.

I would like to express my gratitude to Mr Neville Hankins, Miss Valerie Jones, Mrs Terry Poole, Mr Sean Pidgeon and Mr Richard Fidzcuk for their painstaking work in the preparation of the text and in the design of the two editions of this book.

Robert L Weber

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Introduction

Alfred Nobel and His Prizes

Alfred Bernhard Nobel (1833–1896) was the son of a Swedish inventor. Never in good health, he was taught chiefly by tutors. He studied engineering at St Petersburg and for about a year in the United States, under John Ericsson. While experimenting in his father's factory, Nobel found that when nitroglycerine is dispersed in an inert material such as fuller's earth or wood pulp the explosive (dynamite) can be handled more safely. He also invented and patented other explosives and detonators.

Nobel acquired an immense fortune from the manufacture of explosives and the exploitation of the Baku oilfields. He never married; he is reputed to have held feelings of guilt and loneliness. He had a sardonic view of his fellow men, tempered with benevolence and hope for the future of mankind.

In his will, Nobel set up a fund of $9 million, 'the interest on which shall be annually distributed in the form of prizes to those who, during the preceding year, shall have conferred the greatest benefit on mankind. The said interest shall be divided into five equal parts, which shall be apportioned as follows: one part to the person who shall have made the most important discovery or invention within the field of physics; one part to the person who shall have made the most important chemical discovery or improvement; one part to the person who shall have made the most important discovery within the domain of physiology or medicine; one part to the person who shall have produced in the field of literature the most outstanding work of an idealistic tendency; and one part to the person who shall have done the most or the best work to promote fraternity between nations, for the abolition or reduction of standing armies and for the holding and promotion of peace congresses.

'The prizes for physics and chemistry shall be awarded by the Swedish Academy of Sciences, that for physiological or medical works by the Karolinska Institute in Stockholm, that for literature by the Academy in Stockholm, and that for champions of peace by a committee of five persons to be elected by the Norwegian Storting [Parliament].'

Nobel's estate was bequeathed to a foundation that did not yet exist, and when his will was read in January 1897 it was contested by some of his relatives. Some of the designated prize-awarding bodies (none of whom had been consulted in advance) were hesitant initially to assume the formidable task, but after three years the problems were settled, the Nobel Foundation was created as legatee in June 1900, and by December 1901 the first set of prizes was awarded.

Nobel's stipulation that awards be made for work done 'during the preceding year' was set aside from the start; the selection committee felt that it often takes years to establish the value of a contribution to physics. A Nobel Prize is not awarded for a lifetime's work, but rather for a particular achievement. Arne Tiselius, when head of the Nobel chemistry committee, wrote: 'You cannot give a Nobel Prize for what I call "good behaviour in science." There are . . . great names who have played roles as teachers, organisers, and as sources of inspiration, but when you try to find a particular contribution, a particular discovery, you may fail to do so.'

Nobel awards are made only to living persons, and by tradition no single Nobel Prize has ever been awarded to a group larger than three persons. Each autumn nominations for the Nobel Prizes in science are solicited in some 650 letters sent to members of the Royal Swedish Academy of Sciences, members of the Nobel committees for physics and chemistry, past physics and chemistry prize winners, professors of physics and chemistry at eight Swedish universities and at some 40–50 universities or institutions selected by the Academy, and to other scientists in foreign academies and large research institutions. Some 60–100 physicists may thus be nominated. The Nobel selection officials, an extraordinarily conscientious group, then undertake the staggering spare-time workload of investigating the nominees. A committee chairman has said: 'You cannot define who is best. Therefore you are left with the only alternative: to try to find a particularly worthy candidate.'

Ernest Rutherford 1871–1937

Many physicists assume that Ernest Rutherford received a Nobel Prize. He did, but for chemistry, so the title of this book logically excludes him. Mention of Rutherford in this Introduction is an attempt to compromise an arbitrary limitation and is a recognition of Nobelist Rutherford as the father of nuclear physics.

Ernest Rutherford (Lord Rutherford of Nelson) received the 1908 Nobel Prize for chemistry 'for his investigations into the disintegration of the elements, and the chemistry of radioactive substances.' Rutherford himself found amusement in his transformation to a chemist.

Rutherford was born near Nelson, New Zealand, the fourth of eleven children. His ability in mathematics and physics enabled him to obtain scholarships to Nelson College, Canterbury College, and then Cambridge University. There at the Cavendish Laboratory in 1896 Rutherford and J J Thomson showed that the electrical conductivity produced in air by the newly discovered x-rays could be explained as being due to their producing equal numbers of positively and negatively charged molecules (ions). Electrical conduction and saturation current were explained in terms of the mobility and recombination of these charged particles. Rutherford then investigated the conductivity produced by radioactive materials, and showed that they emitted at least two kinds of radiation which he called alpha (identified as helium nuclei) and beta (electrons). The permanence of atoms was challenged by the view that radioactive atoms were unstable, spontaneously emitting particles, losing mass, and changing their properties as they decayed toward a stable structure.

Rutherford moved to the University of Manchester in 1907. To probe the structure of atoms he suggested to graduate students Hans Geiger and E Marsden an investigation of the scattering of energetic alpha particles by thin metal foils. When they reported that one particle in 8000 striking a platinum foil was deflected by more than a right angle, Rutherford expressed his amazement in saying later it was 'as if you fired a 15-inch naval shell at a piece of tissue paper and the shell came right back and hit you.' These large deflections were explained by Rutherford as arising from a single encounter of an alpha particle and a small, positively charged *nucleus* in the atom. Earlier speculations, by J J Thomson and others, that an atom contained a diffuse positively charged cloud were thus replaced by the nuclear atom model: the positive charge is associated with a massive nucleus of diameter 10^{-5} that of the atom, and is balanced by the negative charge of a surrounding cloud of electrons. This theory was carried further by Niels Bohr, who spent three months with Rutherford and showed how a planetary model for the atom could account for the observed spectrum of hydrogen.

Rutherford's experiments characteristically used simple apparatus and reflected his remarkable intuition in conceiving simple ideas which proved to be correct. To explain why atomic mass increases more rapidly than atomic number, he suggested the existence of a neutral particle, the *neutron*. Chadwick later verified its existence, and the bombardment of nuclei with neutrons opened the way to transmutation of elements and the release of nuclear energy.

Rutherford was a remarkable team leader; nuclear physics research in many universities throughout the world was initiated by men trained at the Cavendish Laboratory by Rutherford. On the occasion of one of his discoveries, a friend said to him, 'You are a lucky man, Rutherford, always on the crest of the wave.' Rutherford smilingly