International Journal of Education and Social Science Research

ISSN 2581-5148

Vol. 8, Issue.3, May-June 2025, page no. 139-155

To cite this article: Juan Núñez Valdés (2025). TEN HIGHLY RELEVANT FEMALE PHYSICISTS NOT AWARDED THE NOBEL PRIZE, International Journal of Education and Social Science Research (IJESSR) 8 (3): 139-155 Article No. 1072, Sub Id 1673

TEN HIGHLY RELEVANT FEMALE PHYSICISTS NOT AWARDED THE NOBEL PRIZE

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DOI : https://doi.org/10.37500/IJESSR.2025.8311

ABSTRACT

This article presents the biographies, some of them longer than others, of ten female physicists from different countries. Their contributions to this discipline, and above all, their achievements equal to or greater than those of the male scientists with whom most of them worked, made them worthy of being awarded the Nobel Prize. However, that award was given to their male colleagues, but not to them just because they were women. The main objective of the article is to bring them to light and to consider them as role models in physics for society.

KEYWORDS: Women scientists, women not awarded the Nobel Prize in physics, injustices in the awarding of Nobel Prizes, gender difficulties

1. INTRODUCTION

Since 1901, the year in which the German scientist Wilhelm Conrad Röntgen was awarded the first Nobel Prize in Physics in history, there have been a total of 224 researchers who have been awarded this prize, of which only 5 of them were women, which represents a meager 2.2% of women laureates (note that this very low number of women makes this Nobel Prize category the one in which the fewest women have been awarded). These 5 women were, in chronological order of the year in which the prize was awarded, Marie Curie (1903), Maria Goeppert-Mayer (1963), Donna Strickland (2018), Andrea M. Ghez (2020) and Anne L'Huillier (2023). A fairly complete biography of each of them can be checked in [7].

However, for various reasons, throughout history there has been a significant number of female physicists who, despite deserving of being awarded, have not been recognized. Most of these women are a result of the "Matilda effect," whereby only the merits of male researchers in a group are recognized, ignoring the contributions of women in the group, which in many cases are equal to or greater than those of their male colleagues. Others are due to direct obstruction by their male colleagues, who in many cases did not even mention them in their respective acceptance speeches. Recall, for example, that Marie Curie herself, the first woman to receive a Nobel Prize and the only woman to have received two such prizes so far, was included in the 1903 Nobel Prize in Physics only at the insistence of two people, a member of the Nobel Prize Committee who advocated for the

presence of women scientists, the Swedish mathematician Magnus Goesta Mittag-Leffler, and her husband and research partner Pierre Curie, who refused to accept the prize that had also been awarded to him if it was not given to her as well [7]. In this regard, remember that, to date, there are only 5 researchers who have managed to obtain two Nobel Prizes, herself (physics, 1903 and chemistry, 1911) and the following 4 men: John Bardeen (both in physics, 1956 and 1972), Linus Carl Pauling (chemistry, 1954, peace, 1962), Frederick Sanger (both in chemistry, 1958 and 1980) and Barry Sharpless (both in chemistry, 2001 and 2022).

In this context, the main objective of this article is to recognize and highlight the merits of those women physicists who developed brilliant professional careers and achieved great milestones in that discipline, despite which they were not awarded the Nobel Prize, most often solely because they were women.

The methodology followed consisted of searching for information from different sources on the personal and professional aspects of the women cited in the work. The results of the research include the biographies of ten women physicists who were never awarded the Nobel Prize despite richly deserving it. Six of them, those included in Section 2, are relatively well-known in society, while the other four, to whom Section 3 is dedicated, are not at all, except perhaps in the scientific community related to the fields of physics in which they conducted their research.

2. Well-known female physicists who have not won the Nobel Prize

Among the relatively well-known female physicists who were not awarded the Nobel Prize, the following six ones can be cited, listed chronologically by year of birth. Only the most notable biographical details of their lives are included, because complete biographies of them can be found in the literature. Besides, an attempt is made to explain the reasons why they were not awarded the prize.

2.1. Lisa Meitner

Lisa Meitner, born in Vienna on November 7, 1878, who in 1912 moved with Otto Hahn to the Kaiser-Wilhelm-Institut fur Chemie (although without pay for her work), had to flee Germany in 1938 as a result of the war and found asylum in Sweden, where she began working at the Siegbahn Institute in Stockholm, forming a research group with Hahn and Fritz Strasmann, who remained in Germany. Together, they discovered barium in their experiments, although she already suffered her first setback, as German racial policy did not allow Hahn and Strassmann to include her in this discovery or to recognize that they were working with a non-Aryan woman in exile.

However, this was not her greatest frustration. When the Nobel Prize in Chemistry was awarded solely to Otto Hahn for the discovery of nuclear fission, he took all the credit for the discovery, failing to mention that most of the experiments and ideas had been proposed by Lise.

Meitner's exclusion from the award was attributed by some of her friends, and even outside her circles,

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to the intervention of Manne Sieghban and other Swedish academics: a display of jealousy and competition prevented them from conceiving that a female colleague could be worthy of a Nobel Prize while they were not.

However, Strasmann did acknowledge Meitner's work at the time, stating that

What makes a difference that Lise wasn't directly involved in the discovery. Her initiative led to the collaboration with Hahn; she was part of our team and intellectually linked to it through correspondence. She was, in a way, the intellectual leader of our team and therefore belonged to it, even though she wasn't physically present at the discovery of fission.

Lisa Meitner (Figure 1) died in Cambridge on October 27, 1968 [10].

Figure 1: Lise Meitner

2.2. Marietta Blau

Marietta Blau was born on April 29, 1894, to a Jewish family living in the Leopoldstadt district of Vienna. She studied physics and mathematics at the University of Vienna, combining these studies with an internship at the Institute II of Physics and the Radium Research Institute of the Austrian Academy of Sciences. In 1919, she earned her doctorate and spent several months at the Central X-ray Institute of the Vienna General Hospital.

In 1921, she moved to Berlin to conduct research on electrical energy and spectral analysis at the Fürstenau, Eppens & Co. X-ray tube factory. However, she remained there for a short time, obtaining

an assistant position at the Institute for the Physical Foundations of Medicine at the University of Frankfurt, where she was able to publish several articles on absorption and the theory of X-ray effects.

In 1923, after returning to Vienna to care for her mother, she obtained a position at the Institute for Radium Research and the Institute II of Physics, where she worked under the direction of Steven Meyer, who was very sensitive to the role of women in research. She was also assisted by scientists Hans Pettersson and her collaborator G. Kirsh.

In the 1932/33 academic year, Blau obtained a scholarship to study crystallography in Göttingen with Professor Pohl from the Association of Austrian Academies. She also worked at the Radium Institute in Paris with Marie Curie and Frédéric Joliot.

Back in Vienna, Blau continued her research on a method based on the detection and determination of alpha particle energy, adapting photographic emulsions to the needs of nuclear physics, alongside Hertha Wambacher, who had first been her student and later her close collaborator. For their work, they both received Austria's most prestigious scientific award, the Ignaz L. Lieben Prize, in 1937.

However, the annexation of Austria by Germany on February 14, 1938, dissolved this collaboration, as she was Jewish and Wambacher sympathized with the Nazi Party.

For this reason, Albert Einstein himself intervened to find her a more stable position outside of Europe. After several previous attempts in different countries, he managed to get Blau to move to Mexico with her mother. However, due to a lack of resources, she was unable to continue her research. This meant that she never knew that her photographic method had been used to make new discoveries in nuclear physics.

After her mother's death in 1944, Blau (Figure 2) emigrated to the United States, where she began working in the research department of an industrial company until Columbia University recruited her as a member of its scientific staff to develop a research program based on her photographic detection method to analyze particles produced by fission reactors. Two years later, she obtained a position at Brookhaven National Laboratory, where she was able to implement the program she had developed.

But the pauses in her research took their toll. In 1950, Cecil Powell was awarded the Nobel Prize in Physics for perfecting the photographic emulsion technique pioneered by Blau. Powell had discovered the pion (pi-meson) using the photographic method, and himself acknowledged in his autobiography that he began using this method for the research that earned him the Nobel Prize after reading about the publications of Blau and Wambacher through Walter Heitler.

Finally, in 1960, she returned to Vienna, where she was both rewarded with a series of official awards, such as the Schrödinger Prize from the Academy of Sciences, and ignored by her former colleagues.

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She died in that city on January 27, 1970 [5].

Figure 2: Marietta Blau

In recognition of her work, the Austrian Federal Ministry for Women, Science and Research annually awards a scholarship called the Marietta Blau-Stipendium, the Marietta-Blau-Saal is a room in University Vienna (sometimes used for coffee breaks) and the Marietta-Blau-Gasse in area 22 of Vienna is a street name.

2.3. Hertha Wambacher

The aforementioned collaborator of Marietta Blau for a time, Hertha Wambacher, was also born in Vienna, on March 9, 1903, and like her, enrolled at the University of Vienna, where she studied chemistry and physics. Her thesis advisor was Marietta Blau, with whom she continued to collaborate after obtaining her doctorate in 1932.

For their work at the Radium Research Institute of the Austrian Academy of Sciences on the use of photographic emulsions to detect ionizing particles, Blau and Wambacher were awarded the Haitinger Prize in 1936 and the Lieben Prize in 1937.

In 1937, a year before her scientific break with Marietta Blau, both discovered "fragmentation stars," or star-shaped trails imprinted by cosmic particles through spallation with the atomic nuclei in the photographic emulsion, on photographic plates exposed to cosmic radiation at an altitude of 2,300 m.

After her break from Marietta Blau in 1938, Wambacher continued working on the identification of particles resulting from nuclear reactions between cosmic radiation and the components of photographic emulsion. In 1940, she obtained a university professorship and taught at the University

of Vienna.

In 1945, she was expelled from the university for political reasons and deported to Russia, from where she returned the following year. She fell ill with cancer and died in Vienna on April 25, 1950.

That same year, the renowned physicist Erwin Schrödinger nominated both her and Marietta Blau for the Nobel Prize in Physics, but both were rejected [6].

2.4. Chien-Shiung Wu

Chien-Shiung Wu was born on May 31, 1912, in Liu He (Ho), Taicang, Jiangsu, the same year the Republic of China was inaugurated.

After completing her primary studies, Wu enrolled at the National Central University in Nanjing as a mathematics student, although recent high-impact discoveries in physics led her to switch to that discipline the following year. Her devotion to Madame Marie Curie also played a significant role in her decision.

She graduated in 1934 with the highest grades, and her thesis was supervised by Professor Shi Shi-Yuan, who, interestingly, had worked with Marie Curie.

After graduating, Wu worked for a year as an assistant professor at Zhejiang University, from where she transferred to the Academia Sinica. After a short time there, she decided to continue her studies abroad, being accepted to the University of Michigan in the United States in 1936. She moved there by boat and that was the last time she would see her parents.

Although her supervisor at Academia Sinica had suggested her study at the University of Michigan, Wu opted for the University of Berkeley with another female classmate. There, she met Luke Chia-Liu Yuan, who greatly assisted her during her stay and also facilitated many of the professional opportunities that both she and her husband would later pursue.

Thanks to Luke, Wu was able to work at the University of Berkeley under the supervision of Professors Ernest Lawrence and Emilio Segrè, who supervised her doctoral thesis consisting of two parts: the first, dealing with breech radiation and electromagnetic radiation, and the second, on the production of radioactive isotopes of xenon using uranium nuclear fission. She earned her doctorate in 1940.

However, despite this doctorate, Wu (Figure 3) was unable to secure a permanent position at the university, both for ethnic and gender reasons. So, after a brief stay at Smith College, she was hired, thanks to the intercession of Professor Lawrence, as a professor at Princeton University, becoming the university's first female professor. Her husband, Yuan Jialiu, a Berkeley graduate whom she had recently married, was already waiting for her at that university.

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Despite being a woman and of her race, Wu (Figura 3) was also allowed to collaborate at Columbia University on the Manhattan Project in 1944, which aimed to develop nuclear weapons.

In 1956, two Chinese-American physicists, Tsung-Dao Lee and Chen Ning Yang, predicted the violation of the parity law in weak interactions and suggested a possible experiment to verify it. The following year, 1957, Wu performed this experiment in the case of beta decay. However, the 1957 Nobel Prize in Physics was awarded only to the two male physicists.

However, not despairing, she continued her scientific activity, which allows her to obtain professorship at Columbia University in 1958 and the Wolf Prize in Mathematics a few years later, in 1970. [3]

Figure 3: Chien-Shiung Wu

Wu died in New York on February 16, 1997.

2.5. Rosalind Franklin

One of the most important female physicists in history who also failed to win the Nobel Prize was Rosalinda Elsie Franklin, born on July 25, 1920, in Chepstow Villas (Notting Hill, London).

In 1942, she was offered a position at the British Coal Utilisation Research Association, where she studied coal, compared the density of helium, and completed her doctoral thesis in 1945 entitled “The Physical Chemistry of Solid Organic Colloids with Special Reference to Coal”.

In 1947, she traveled to Paris, where she worked as a researcher at the State Central Chemical Services Laboratory and became an X-ray crystallographer. In 1951, she entered King's College London, where

she remained for two years.

She was the one who, in May 1952, together with her doctoral student Raymond Gosling, obtained the now famous and well-known photo 51, which showed an image of DNA obtained by X-ray diffraction, although she didn't give it much importance and put it in a drawer.

In February 1953, New Zealander Maurice Hugh Frederick Wilkins, who was working with them in the laboratory, showed Watson and Crick the photos Franklin had taken, albeit without her permission. By then, James Dewey Watson and Francis Crick were already aware of a report that Franklin (Figure 4) had submitted to a journal for review, which was confidential, but which the reviewer leaked without any respect for her. In that report, Franklin concluded that the bases in the structure of DNA are located inward, and in her photo 51, it was clear that the structure was a double helix.

In 1954, Watson and Crick published an article in the Proceedings of the Royal Society entitled “The Complementary Structure of Deoxyribonucleic Acid”, taking advantage not only of Franklin's work but also of the work of another author, Erwin Chargaff.

Four years after Franklin's death in London on April 16, 1958, Watson, Crick and Wilkins were awarded the 1962 Nobel Prize in Physiology or Medicine for their discovery of the helical model of DNA. None of the three acknowledged either the authorship of the photo or Rosalind Franklin's participation in the discovery, and did not mention her in their acceptance speeches [2]. In fact, Watson's opinion of her was this:

> She was determined not to emphasize her feminine attributes. Although she had strong features, she was not unattractive and could have been very pretty if she had shown the slightest interest in dressing well. But she didn't. She never wore lipstick, to enhance the contrast with her straight, black hair, and at 31, all her dresses displayed the imagination of a nerdy English teenager.

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Figure 4: Rosalind Franklin

She was always very clear about what she wanted to do and how to achieve it. Already, in 1940, in a letter she wrote to her father, when she was just 20 years old, she said:

Science and life cannot and should not be separated. For me, science provides a partial explanation of life.

The question many researchers are currently asking is: Would Rosalind have been awarded the Nobel Prize, along with Watson, Crick, and Wilkins, in 1962, if she had not died earlier? Unfortunately, there is no answer for her.

2.6 Jocelyn Bell

Another woman who was unfairly treated in the Nobel Prize awards was Northern Irishwoman Susan Jocelyn Bell, born in Belfast on July 15, 1943, who earned her doctorate in Physics at Cambridge under the supervision of Antony Hewish.

Hewish proposed her to find more quasars (sources of celestial radiation), as only 10 or 20 were known to date. For three years, she helped build a telescope, along with three other students (who later abandoned the project), to monitor quasars, eventually finding between 100 and 150 more quasars and some curious signals that would later become known as pulsars.

As a result of this research, Bell (Figure 5) and Hewish attended a high-profile conference in 1967, where they presented their results and information about pulsars.

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Figure 5: Jocelyn Bell

Seven years later, in 1974, the Royal Swedish Academy of Sciences awarded the Nobel Prize in Physics for the first time to the field of astronomy for the discovery and study of pulsars. The winners were Antony Hewish and Sir Martin Ryle (who had devised a new interferometric procedure), completely ignoring Bell's work on that discovery.

Many researchers involved in this field disagreed with the non-awarding of the prize to Jocelyn Bell and directly accused both Hewish of appropriating her work and the Swedish Academy of failing to take Bell's work into account in that discovery. But he never defended her and in fact counterattacked, stating the following

After all, Jocelyn Bell was a graduate student at the time. Failure to detect that pulsating source would have been negligent.

Jocelyn Bell is now completely retired from her research work [4].

3. Little-known female physicists who were not awarded the Nobel Prize

The four female physicists whose biographies are presented below not only failed to win the Nobel Prize, despite the brilliance of their discoveries in the field of physics, but also, in the author's opinion, are little known to the general public outside of strictly scientific circles. Their biographies, somewhat more extensive than those described in the previous section, are also arranged chronologically by year of birth and it is tried to to explain in them the reasons why they were not awarded the prize.

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3.1 Harriet Brooks

In 1906, Harriet Brooks, aged 30, announced her engagement to Bergen Davis, a physics professor at Columbia University, but this announcement became to be a hindrance to her scientific career. The female dean of Barnard College, a women's college affiliated with the university, firmly believed that a woman could not fulfill her marital duties and her academic responsibilities simultaneously, and asked for her resignation. Brooks sent a private, personal letter to the dean, strongly opposing this request

> I think that it is an obligation I owe to my profession and my sex to demonstrate that a woman has the right to practice her profession and not be forced to abandon it simply because she gets married. I cannot conceive how women's colleges, which invite and encourage women to pursue professional careers, can be founded or maintained by denying this principle.

Finally, this matter fell through because Brooks had already decided to drop out of Barnard College, but it reflects the passion with which she defended her views.

Born in Ontario, Canada, in 1876, and after living for a time in Quebec, the Brooks family finally settled in Montreal. She enrolled at McGill University, where she was able to study thanks to prizes and scholarships she won, ultimately graduating at the top of her class in natural philosophy, physics, and mathematics.

Immediately after graduating, she began research under Ernest Rutherford in the area of electricity and electromagnetism, although she ultimately opted for nuclear physics.

Brooks focused on the case of thorium, a solid radioactive metal, about which there were various theories that postulated that this material was a gas, a vapor, or a very fine powder. Brooks demonstrated that it was a gas with a significantly lower molecular weight than thorium, and this discovery led Rutherford and other scientists to conclude that, through radioactivity, one element had been converted into another. She was the first researcher to characterize the gas now called radon.

In 1901, she went to work in Pennsylvania, from where she went to Cambridge University in England. She returned sometime later to Canada, to McGill University to work with Rutherford. She wrote several papers joint to him between in 1901 and 1902 which were published in Royal Society Transactions and in the Philosophical Magazine.

In 1904, she left McGill again to become a professor at Bernard College and then spent several periods in Europe, some under the supervision of Marie Curie.

When Brooks (Figure 6) married Frank Pitcher, who had been her laboratory instructor before

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graduating, she devoted herself to raising a family and severely limited her research, already again at McGill University.

Brooks died on April 17, 1933, at the age of 56, presumably from overexposure to radiation over so much of her life, as had happened to her one-time supervisor, Marie Curie [8].

Figure 6: Harriet Brooks

3.2. Ruby Payne-Scott

Ruby Violet Payne-Scott, born on May 28, 1912, in Grafton, New South Wales (Australia), completed her secondary education at a girls' school with excellent grades in mathematics and botany. She won two scholarships to enroll at the University of Sydney, where being the only woman in her class, she studied physics, chemistry, mathematics, and botany. She earned a Bachelor of Science degree in physics in 1933 (the third Australian woman to do so), a Master of Science degree in physics in 1936, and an Education Diploma.

After holding several minor positions, both in research and teaching, she was hired at the beginning of World War II by the Australian Government's Commonwealth Scientific and Industrial Research Organization to work in the Radiophysics Division. She and her colleague, Joan Freeman, were the first two women to work in this department.

After the war, her group focused on radio astronomy (a branch of astronomy that studies celestial bodies through their emissions in the radio wave spectrum), achieving great success, which allowed her to become a true pioneer in solar radio astronomy. In 1946, she also participated in an experiment in which, for the first time, the position and angular size of a solar flare were calculated using a novel technique, interferometry.

In addition to her scientific achievements (she was a notable radio physicist and radio astronomer),

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Payne-Scott was also characterized by her great activism. She was a communist, an atheist, and, especially, a feminist, and this led to her being monitored by the Australian Security Intelligence Organization (the Australian Security Agency). Although she had married in 1944, she had to keep that marriage secret so as not to lose her position as a permanent researcher at the CSIR. However, six years later it was discovered that she was married and this caused her brilliant scientific career to be definitively cut short in 1951, when she was only 39 years old, depriving her, without it being too risky to venture it, of a possible Nobel Prize for her knowledge in radio astronomy and radiophysics, in which she is currently considered a reputed specialist [9].

In her honor, the AustralianAcademy of Sciences instituted in 2021 the la Ruby Payne-Scott Medal and Lecture for women in science, which annually recognises and is restricted to female researchers normally living in Australia and for research conducted mainly in that country.

Payne-Scott Scott (Figure 7) died on 25 May 1981, after a few final years in which she suffered from Alzheimer's. In 2012, Google celebrated heris 100th birthday with a Doodle [9].

Figure 7: Ruby Payne-Scott

3.3 Yvonne Choquet-Bruhat

Daughter and sister of mathematicians, Yvonne Choquet-Bruhat was born in Lille, France, on December 29, 1923. In 1941, she participated in the Concours Général, a competition to determine the best students in France, winning the silver medal in physics. From 1943 to 1946, she studied at the École Normale Supérieure in Paris, becoming a professor there in 1946. Later, from 1949 to 1951, she was a research assistant at the French National Center for Scientific Research, where she earned her doctorate.

Between 1951 and 1952, she worked at the Institute for Advanced Study in Princeton, where she

demonstrated the local existence and uniqueness of solutions to Einstein's equations in vacuum. The following year, she moved to the University of Marseille and in 1958 received the CNRS gold medal (CNRS, the Centre National de la Recherche Scientifique in French, is a France's leading scientific research institutions). She also worked at the universities of Reims and Pierre and Marie Curie in Paris, where she retired in 1992.

In 1978, she was elected a corresponding member of the American Academy of Sciences (the first woman to do so), and in 1979, she became the first woman to be elected a full member. From 1980 to 1983, she served as chair of the Comité international de relativité générale et gravitation, and in 1985, she was elected to the American Academy of Arts and Sciences. In 1986, she was chosen to deliver the prestigious Noether Lecture of the Association for Women in Mathematics.

As it has been already commented, during her time at the Institute for Advanced Study in Princeton, Choquet-Bruhat (Figure 8) demonstrated the local existence and uniqueness of solutions to Einstein's equations in vacuum, and at the Pierre and Marie Curie University in Paris. There, she made important contributions to mathematical physics, particularly in general relativity, supergravity, and non-abelian gauge theories of the Standard Model. Her work in 1981 with the Greek mathematician and physicist Demetrios Christodoulou showed the existence of global solutions to the Yang-Mills, Higgs and spinor field equations in 3+1 dimensions (Demetrios Christodoulou became well known for his proof, together with Sergiu Klainerman, of the nonlinear stability of the Minkowski spacetime of special relativity in the framework of general relativity). In 1984 she did what is considered perhaps the first study by a mathematician of supergravity with results that can be extended to the now important eleven-dimensional model, although she was not a mathematician [1].

Figure 8: Ivonne Choquet-Bruhat

Among her numerous awards are the CNRS Gold Medal and the Grand Cross of the French Legion of Honor, but she was never nominated for the Nobel Prize.

She died on February 11, 2025, precisely the International Day of Women and Girls in Science, at the

age of 101.

3.4. Vera Rubin

Vera Florence Cooper Rubin (née Vera Florence Coper), better known as Vera Rubin, was born on July 23, 1928, in Philadelphia, Pennsylvania, to a family of Jewish immigrants.

After graduating with a degree in astronomy from Vassar College in 1948, she wanted to enroll at Princeton University, but was denied admission because she was a woman. She then enrolled at Cornell University, where she studied physics under Philip Morrison and quantum physics under Richard Feynman and Hans Bethe. In 1951, she earned her master's degree and a doctorate in 1954 under the supervision of George Gamow. Her thesis proposed that galaxies were clustered together, rather than randomly distributed throughout the universe.

After completing her doctorate, she worked on the faculty for another eleven years and then joined the Carnegie Institution, where she met her future friend, Kent Ford. Her discoveries, including the Rubin-Ford effect, as they named it, earned her several awards, including the Gold Medal of London's Royal Astronomical Society, making her the second woman to receive it after Caroline Herschel in 1828.

In 1970, Rubin obtained the strongest evidence to that point of the existence of dark matter, whose nature is still unknown, but whose presence is crucial to understanding the universe.

Rubin always encouraged girls interested in exploring the universe to pursue their dreams, and she fought for the recognition of women in science, and for science and religion. In an interview, she stated [11]

In my own life, my science and my religion are separate. I'm Jewish, so for me, religion is a kind of moral code and a story. I try to conduct my science in a moral way, and I think that, ideally, science should be viewed as something that helps us understand our role in the Universe.

Rubin (Figure 9) earned “Honoris Causa” doctorates from numerous universities, including Princeton, Harvard, and Yale. She was a research astronomer at the Carnegie Institution of Washington and a member of the U.S. National Academy of Sciences and the Pontifical Academy of Sciences, having received numerous awards and honors throughout her life as a result of her enormous work. The Rubin-Ford Effect and asteroid (5726) Rubin were named in her honor, as was the Vera C. Rubin Observatory. However, she was not awarded the Nobel Prize in Physics. She died in Princeton, New Jersey, on December 25, 2016 [11].

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Figure 9: Vera Rubin

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