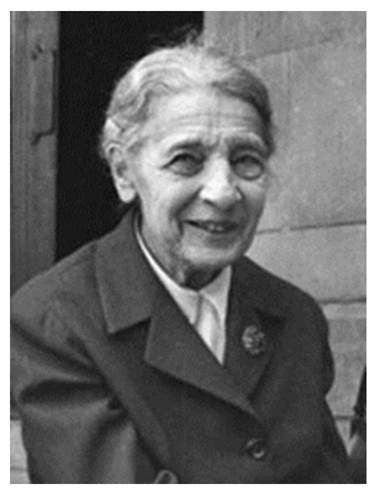
Case study: Lise Meitner
1944 Nobel Prize in Chemistry awarded to collaborator Otto Hahn

After finishing her Ph.D. degree, Lise Mietner moved to Berlin, Germany. She came to study physics with Max Plank. This was where she met Otto Hahn. Hahn was working with famous chemist Emil Fischer when he met Lise Meitner. At that time, Fischer did not allow women in his laboratory. Instead, Hahn and Meitner created a workshop in the basement of the Chemical Institute just for Lise to work in. For 15 years Lise Mietner and Otto Hahn worked together. Then, in 1920, they decided to separate their research projects.

During the years they worked together, they had an extremely close professional relationship but a far more formal personal one. Hahn respected her and her research but was unlikely to defend her when others questioned her ability, despite the fact that she was nominated for the Nobel Prize 13 times throughout her life. By colleagues and peers (including Albert Einstein) she was seen as far more capable and the principal figure in their collaborations. In 1934 Meitner recruited Hahn, along with Fritz Strassmann, to help her with her work on synthesizing “transuranic elements” (elements beyond uranium in the periodic table), as Meitner was more of a theorist than an experimental physicist.

The rise of Nazi power in Germany brought great difficulties for Meitner due to her Jewish background. She could not present any of her own work, and Hahn could not mention her in presentations of work they completed together. She was forced to move to Sweden in 1938 to ensure that she could carry on working in some capacity. Shortly before she left Germany, Meitner, Hahn, and Strassmann had confirmed that they had split uranium nuclei in to smaller nuclei. While Meitner was in Stockholm, she continued scientific correspondence with Hahn regarding their investigation of uranium. She made further theoretical progress with her nephew, Otto Frisch, and quickly proposed an explanation to Hahn stating that neutrons had split the nucleus of uranium; this was the first theoretical interpretation of fission. At Meitner’s “urgent” request, they carried out the instructed experiments to confirm her theories.

She and Frisch later published their interpretation describing this process of “fission,” shortly after Hahn and Strassmann published their work as well with no credit to Meitner. Hahn wanted to protect both himself and his workplace given the dangerous political climate in Germany at the time. He won the 1944 Nobel Prize in chemistry for the discovery of nuclear fission. Meitner’s contributions were recognized in other ways; she shared the 1966 Fermi Prize of the Atomic Energy Commission with Hahn and Strassmann. She was also invited to join the team that created the atomic bomb but refused and consistently hoped that the project would not work. Despite this, she became a sought-after source of interviews for news organizations. Hahn resented her newfound recognition and released a statement to the press denying her involvement.



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Case Study: Chien-Shiung Wu
1957 Nobel Prize in Physics awarded to collaborators Tsung Dao Lee and Chen Ning Yang

After immigrating to the United States from China in 1936, Chien-Shiung Wu's Ph.D. work at the University of California Berkeley caused her to become an authority in nuclear fission. She was often consulted by top scientists such as Enrico Fermi. After graduation, she ended up at Columbia University and focused her research on beta decay, a type of radiation that occurs when a neutron becomes a proton by emitting an electron. She was always known for her careful and reliable experiments and expected the same care from her graduate students. Despite her reputation as a researcher, she was often held back by discrimination of both her gender and nationality and was often overlooked for promotion opportunities. She was one of the few scientists asked to stay on at Columbia after the war working on the Manhattan Project, and in 1952, she was finally promoted from a researcher to a faculty member at Columbia.

At this time, particle physics was a quickly growing field, and many new particles were being discovered, including two particles known as the tau (τ) meson and theta (θ) meson. These particles have the same mass, spin, and lifetime, but one decayed into two particles called pions (pi mesons), and the other into three pions. This violated Fermi's Law of Parity, the idea that real physical events are always symmetric with their mirror images. The scientists Tsung Dau Lee and Chen Ning Yang realized in their research that no experiment had been done to actually confirm conservation of parity in weak interactions of elementary particles. They published a paper proposing experiments that might settle the issue. Knowing about Wu's expertise in beta decay, Lee approached her regarding his ideas, and she put together a team to perform the difficult experiment that Lee proposed to disprove Fermi's Law. She announced her team's result in 1957, disproving Fermi's Law, which was astonishing at the time. The group published their work with Wu as the first listed name in the paper.

Yang and Lee were awarded the 1957 Nobel Prize in physics for their theoretical work that prompted Wu's experiment. Many people, including Wu herself, believe that she should have been credited by the Nobel Committee, though the Committee did not qualify her work as a "discovery or invention" and therefore it did not satisfy their requirements. She was recognized elsewhere for her work; she was soon promoted to a full professorship at Columbia and received many honorary degrees later in her lifetime. She was also the first woman to serve as the president of the American Physical Society.

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Case Study: Marietta Blau
1950 Nobel Prize in Physics awarded to Cecil Powell

Marietta Blau was a particle physicist who played an important role in developing photographic techniques to detect particles. After completing her doctorate in 1919 at the University of Vienna, she could not find any suitable research positions with income or status in Vienna. She pursued her own research as an unpaid volunteer at the Institute for Radium Research in Vienna, where she performed groundbreaking research. While at the Institute, Blau developed photographic nuclear emulsions, a way to take pictures of high energy interactions of nuclear particles. She recruited doctoral student Hertha Wambacher to aid her and together they discovered cosmic ray “stars” – micro configurations of particle paths resulting from the split of a nucleus hit by a cosmic ray. She also worked on identifying alpha particles and protons and attempting to determine their energy, among other new research.

Blau faced great prejudice due to her gender and Jewish religion. When Hitler annexed Austria in 1938, Blau was working in Norway but was forced to flee. With the help of a recommendation from Albert Einstein, she acquired a secure position as a professor in Mexico City. Before she left Austria, her scientific papers were confiscated by officials, some of which included plans for future research. Later on, some of the ideas were published by her former collaborator Wambacher and Georg Stetter, both who were supporters of the Nazi party. Blau spent a few years in Mexico before moving to the United States in 1944 to further her research.

In 1950, Cecil Powell won the Nobel Prize for Physics for applications of the photographic method that Blau developed early in her career. Powell decided to make this his field of research once he had been alerted to Blau and Wambacher’s previous research of the topic. Blau was also nominated for the 1950 Nobel Prize due to her development of photographic nuclear emulsions but did not win.

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Case Study: S. Jocelyn Bell Burnell
1974 Nobel Prize in Physics awarded to Martin Ryle and Antony Hewish

As a 24-year-old graduate student, Susan Jocelyn Bell Burnell observed the first known pulsar, a type of star that gives out rapid and regularly spaced radio signals. She began her graduate studies in 1965 at Cambridge under Antony Hewish, an astronomer working on designing a radio telescope to detect "twinkling," quick-changing radio sources known as quasars outside of our galaxy. Bell and other students helped build the telescope over a span of two years, though Bell alone ran the device and analyzed the data. In October of 1967, Bell noticed regularly recurring signals that looked different than quasar signals or interference from other places. At first, her mentor thought that the signals were man made, and the pair even entertained the idea of an alien source. Bell solidly determined that the unusual signals were not terrestrial and found a few different sources of the same type of signals in different locations in the sky. The discovery was published in 1968 with Hewish as the first author and Bell as the second author of five.[1]

The 1974 Nobel Prize in physics went jointly to Hewish and his own mentor, Sir Martin Ryle, a long serving head of the Cambridge radio astronomy group. The pair was recognized for their work in the advancement of radio astrophysics, with Hewish recognized specifically for *"his decisive role in the discovery of pulsars."*[2] Bell and Hewish jointly received the 1973 Michelson medal from the Franklin Institute in Pennsylvania for the discovery of pulsars. The media became obsessed with Bell's story, and she received great press coverage for her involvement in pulsar discovery. One outlet even said the Nobel must stand for No-Bell. Her role has been argued to be the most important in the discovery as she initially noticed the tiny and easily missed signals and proved that they were from stars further away from our own Sun. On the other hand, Hewish's ideas sparked the construction of the telescope used to make the discovery. Bell Burnell never revealed bitterness that she did not receive the Prize, personally believing that advisors that set up their own lab assume risks that deserve reward. In 2014, she became the first female president of the Royal Society of Edinburgh.

The Open University, courtesy AIP Emilio
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[1] A. Hewish, S.J. Bell, J.D.H. Pilkington, P.F. Scott, and R.A. Collins, "Observation of a rapidly pulsating radio source," *Nature* 217, no. 5130 (1968): 709-713.
[2] "The Nobel Prize in Physics 1974," http://www.nobelprize.org/nobel_prizes/physics/laureates/1974/