

# Lise Meitner

“A physicist who never lost  
her humanity”

# Lise Meitner



- Described radioactive decay
- Experimented with nuclear fission
- Discovered Protactinium #91
- Nominated for the Nobel Prize 12 times
- Meitnerium #109 named after her

# Background and Education:

- Born November 7, 1878, the 3rd of 8 children to Phillip and Hedwig Meitner, in Vienna--the capital of the Austro-Hungarian Empire
- Her father was a lawyer--one of the first Jewish free men-- and her mother was a musician
- The family was of Jewish middle class descent, but she was surrounded more by liberal, intellectual, professional friends of the family than by religion and the synagogue
- She was baptized and converted to Protestantism in 1908, at the age of 30

# Education

- Girls in Vienna were educated until the age of 14, but due to Lise's family environment, all Meitner



children received an advanced education

- Austrian universities were not open to women until 1897, at which point Lise and her sisters studied for the "Matura," an entrance examination

- Lise crammed 8 years of courses into two years, and passed the Matura in July 1901, at the age of 23, one of four girls out of fourteen

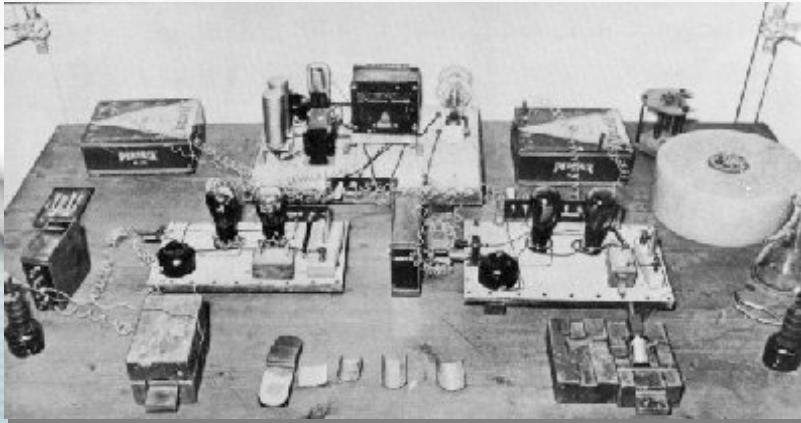
- She entered the University of Vienna in October 1901

## Early Mentors:

- She was the first woman admitted to the Physics Department
- Her first professor was Franz Exner, who worked in a lab directed by a follower of Mach, the 1902 Chair of Natural Philosophy
- In her second year of study in Vienna, she took many physics courses, all taught by one person, the famous theoretical physicist, Ludwig Boltzmann
- He believed the atom was divisible, which went against the scientists who said that God had not intended it to be so
- "Boltzmann gave her the vision of physics as a battle for ultimate truth, a vision she never lost." -said nephew, Otto Frisch

- 2nd woman in physics to receive her Ph.D., on the "Conduction of Heat in Inhomogeneous Solids"
- By 1906, she had completed studies on Rayleigh's experiments on Fresnel Lenses and proved them, but was at a loss as to what would be her next step, because there were no professional opportunities for women in physics
- She wanted to study radioactivity and wrote Madame Curie for a position in her lab, but none were available
- That same summer, Boltzmann committed suicide, which strengthened her resolve to stay in physics and so she continued radioactivity experiments at night, studying alpha particles, while teaching girls by day
- At the end of those studies, determined to continue her studies in Berlin with the great minds in science, including Max Planck

# Obstacles to studying in Berlin:



- Planck didn't understand why she wanted to study there since she already had her degree
- She was not allowed to matriculate at the University of Berlin
- Depended on her family for a monthly allowance
- Not allowed to go up to the labs
- Given a carpentry room in which to study with three microscopes to count alpha, beta, and gamma rays

# Partnership with Otto Hahn:



- Hahn was a chemist, studying radioactive elements
- September 28, 1907, exactly one hundred years ago, was the start of a 30 year partnership
- Systematically measured beta radiation of every radioactive element and studied their spectra
- Explained radioactive recoil
- Discovered Protactinium #91
- Discovered nuclear fission
- Explained the Auger effect, radiationless transitions of electrons



# Early Significant Events:

- 1909 - Allowed to work in the laboratories of the University of Berlin
- 1910 - The Meitner-Hahn labs were expanded into three rooms
- 1912 - Appointed assistant to Max Planck in the Institute of Theoretical Physics, first paid position at the University of Berlin for a woman
- 1912-1913 - Published 10 papers with Otto Hahn
- 1912 - The Kaiser Wilhelm Institute for Chemistry was opened with Otto Hahn in charge of the radioactivity department. Lise Meitner appointed an unpaid "guest" position as a physicist in his lab.
- 1915 - Served as an x-ray technician/nurse in WWI, while Hahn also served in the German army

# Kaiser Wilhelm Institute for Chemistry



- 1917 - Lise concerned that Fritz Haber turned the research at the Institute towards chemical warfare and returned to the lab
- March 1918 - identified Protactinium without Otto Hahn, but gave him full credit as first author
- 1921 - The Hahn-Meitner division of the Institute surpassed the budgets of all other labs and Lise became Director of Physical Radioactivity Division, another first for a woman
- 1921 - Confirmed the existence of the positron

# Significant Events continued

- 1922 - Underwent "Habilitation" at the University of Berlin and became a "Privatdozentin," one of the first women in Germany to accomplish this
- Her lecture, on The Problems of Cosmic Physics was incorrectly published in the newspaper as "cosmetic" physics, a gross error alluding to the prejudice
- 1924 - First woman to receive the American Association to Aid Women in Science award, based on the Nobel Foundation rules; she shared it with a chemist from the University of Paris
- 1924 - First woman to receive the Second Place Silver Medal of the Leibniz Prize
- This began an era when the Hahn-Meitner team was nominated for the Nobel Prize each year for at least 10 years by Max Planck

# The "Players" of the Nuclear Era:



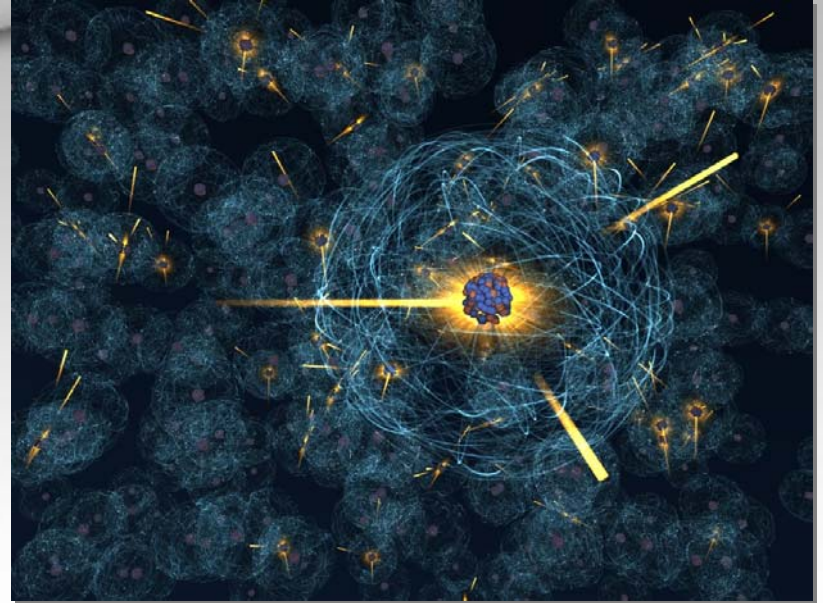
Scanned at the American  
Institute of Physics

- Max Planck
- Albert Einstein
- Niels Bohr
- Ernest Rutherford
- Enrico Fermi
- Hans Geiger
- Max von Laue
- Fritz Haber
- Werner Heisenberg
- Walther Nernst
- Wolfgang Pauli
- Fritz Strassmann

# Nuclear Fission:

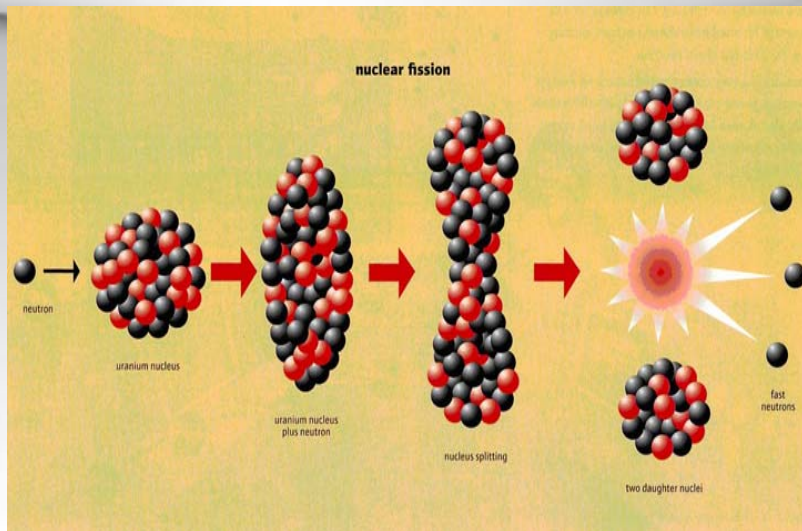
“To want to split the atom by bombarding it is rather like shooting birds in the dark in a place where there are only a very few birds.” --Einstein

- March 5, 1933 - Hitler's rise to power
- Max Planck feared for the safety of Einstein and Meitner
- Einstein was dismissed and Haber resigned
- Meitner was forced to resign her position at the University of Berlin
- She persuaded Hahn to conduct experiments on bombarding Uranium with neutrons at KWI
- 1938 - She was denounced by the president of KWI, “The Jewess endangers the Institute.”



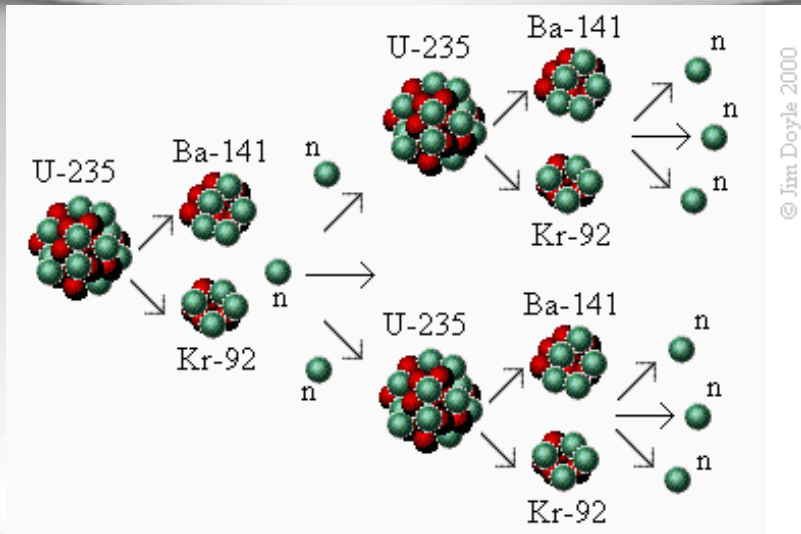
- July 13, 1938 - Escaped to the Dutch border; Hahn gave her a diamond ring to sell in case of emergency
- Arrived in Sweden, her home for the next 20 years

# Nuclear Fission explained:



- 1937 - Niels Bohr described the nucleus as a liquid drop with surface tension keeping it together and giving it shape
- 1938 - Meitner, Hahn, and Strassman bombarded Uranium with slow neutrons; they thought they would get Radium but got Barium instead
- Hahn wrote Meitner in Sweden for an explanation of this event

# Nuclear Fission continued...

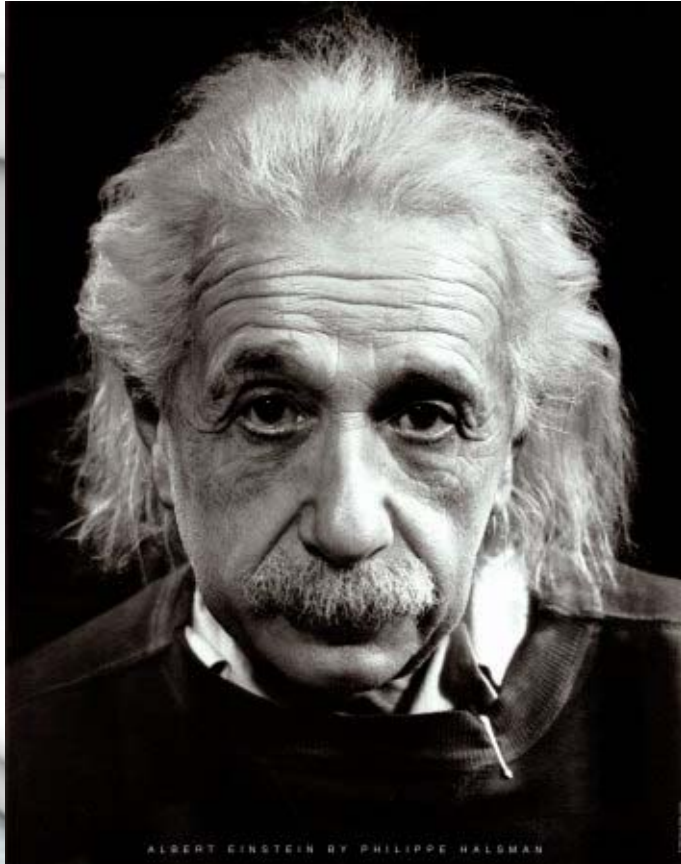


- Meitner and nephew, Otto Frisch, skiing on Christmas vacation, pondering Hahn's letter
- Meitner described the process in which the nucleus deforms, making it more energetically stable than the original nucleus, continues to distend, then energetics takes over, and the atom splits into smaller droplets
- Used  $E=mc^2$  to explain change in mass and release of 200 MeV of energy
- Frisch coined the term, "fission," referring to cell division

“Perhaps you can suggest some fantastic explanation... If you can think of anything that might be publishable, then the three of us would be together in this work after all. We don't believe this is foolishness or that contaminations are playing tricks on us.”-- Otto Hahn in a letter to Lise Meitner, December 1938

- Meitner and Frisch published their explanation in *Nature* in February 11, 1939, using the word, “fission” for the first time
- Otto Hahn received the Nobel Prize in 1944 for his “discovery” of fission; Lise Meitner attended but reproached him for sending her out of Nazi Germany
- Meitner's work crowned with Nobel Prize for Hahn
- Hahn gave an undisclosed amount of his Nobel Prize money to Meitner; she gave it to the Aid Committee for Atomic Physicists at Princeton where Einstein was





- Einstein's comment in his book, Out of My Later Years,  
"I do not consider myself the father of the release of atomic energy. My part in it was quite indirect. I did not, in fact, foresee that it would be released in my time. I believed only that it was theoretically possible...It was discovered by Hahn in Berlin, and he himself misinterpreted what he discovered. It was Lise Meitner who provided the correct interpretation."

# Post-Nuclear Fission Era:

- Remained in Sweden for the next 20 years at the Technical University of Stockholm as a research professor
- Always remained an Austrian citizen
- First to recognize the potential of nuclear fission as a weapon, stating, "I will have nothing to do with a bomb."
- Refused to participate in the Manhattan Project and never wanted to be associated with it even though she was dubbed, "the Mother of the Atomic Bomb."
- Spent one year at the Catholic University in Washington, DC as a visiting professor in 1946
- Refused to move back to Berlin to direct the Max Planck Institute for Chemistry due to her views on Nazi Germany

# Awards and Recognition:



- 1924, 1925 - Leibniz Prize and Lieben Medal
- 1946 - Woman of the Year, Women's National Press Club
- 1949 - Max Planck Medal, German Physics Society
- 1954 - Otto Hahn Prize
- 1959 - Order of Merit, German government
- 1966 - Enrico Fermi Prize by the AEC
- 1992 - Meitnerium, element #109

# Lise Meitner-Minerva School for Computational Quantum Chemistry Jerusalem, Israel



- Inaugurated July 6, 1997
- Its stated goals are to create a critical quantum chemical activity in Israel, and to foster an intense scientific collaboration between Israeli and German groups. Its guiding principle would be the interplay of theory and experiment.

# A few tributes to Lise Meitner:





- Lise Meitner Gymnasium in Leverkusen, Germany
- There is also one in Geldern, Germany
- Lise Meitner Park in Hamburg, Germany

# Notable Quotes:



- "I myself have not in any way worked on the smashing of the atom with the idea of producing death-dealing weapons. You must not blame us scientists for the use to which war technicians have put our discoveries."
- "I would rather walk the length of Broadway in the nude than see myself in a movie."

Lise Meitner passed away in Cambridge, England, just three days shy of her 90th birthday



- On her grave, her epitaph reads, "A physicist who never lost her humanity."



# Harvard University doesn't give tenure to a woman physicist until 1992



- Robert Millikan in response to his opinion on hiring a female physicist in 1936:
- "In Europe Fraulein Meitner of Berlin and Madame Curie of Paris are in the front rank of the world's recognized physicists. I should, therefore expect to go farther in influence and get more for my expenditure if in introducing young blood into a department of physics I picked one or two of the most outstanding younger men, rather than if I filled one of my openings with a woman. I might change this opinion if I knew of other women who had the accomplishments and attained to the eminence of Fraulein Meitner. I know of no other living woman who has had anything like her accomplishment or has prospects in the future of having such

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