

# Lise Meitner, 1878-1968

Roger Boyle

June 28, 2024

# Fission – who had that idea?

Roger Boyle

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# She was robbed!

Lise Meitner's failure to win the Nobel Prize

Roger Boyle

June 28, 2024

# Caveat

I have not a physicist or a chemist.



# Lise Meitner, 1878 – 1968



# As a little girl



<https://www.sutori.com/story/lise-meitner--5qbAN2A1q1pgenc8cPWXY62>

LM was born in Vienna (then the Austro-Hungarian Empire) in 1878, into a highly cultured, liberal and educated family. Both her parents were of Jewish ancestry, but non-practising.

She was both exceptionally intelligent and studious, with a passion for science.

# Schooling

LM attended the Mädchen Bürgerschule in Czerninplatz, Vienna.



She did well, but formal education for girls ended at 14.

# University

LM was lucky in that the 1890s saw a surge of interest in science in Austria, at the same time as a slight opening of university opportunities for women.

She entered the university of Vienna – the atmosphere was hostile to women and this coloured her opinions for life.



She excelled.

In Vienna, LM met and was taught by exceptionally influential men: Boltzmann, Planck among them. She became interested in the new work on radioactivity.



Wikipedia

After Vienna, she wanted to pursue research into radioactivity. Marie Curie (in Paris) turned her down, but she travelled to Berlin to study under Planck who was at the heart of atomic physics.

Berlin was very unwelcoming to women students.

She was introduced to Otto Hahn, a rising radio-chemist. They were contemporary and got on well together.

# Otto Hahn

Hahn had a distinguished record in radio-chemistry, working, inter alia, with Rutherford.



Local prejudices required that Hahn and LM could work together *if* they did not use the established laboratories, which were off limits to women.

# Progress

## Cutting a long story short

Together, LM and Hahn made exceptional progress, and attracted the attention and support of the physics and chemistry communities.

Over decades (interrupted 1914-18) their professional partnership flowered during a thrilling period of scientific discovery and development: Relativity, Quantum Mechanics and their own area of Nuclear Physics were all being developed fast.

They were frequent associates of the scientific pantheon: Bohr, Curie M, Curie I, Einstein, Fermi, Dirac, Heisenberg, Rutherford, Schrödinger, . . . . LM and the Curies were alone as women in this company.

There was no suggestion on any part that Hahn was the senior partner – LM and he were equals.



# Solvay Conference 1933



<http://www.hilliontchernobyl.com>

The three women in the pantheon are Irene Curie, Marie Curie, LM.

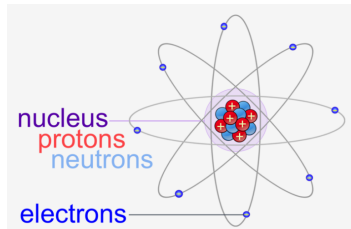
# BEWARE: Science

‘The structure of matter preoccupied man long before the beginning of systematic natural science.’

*The Nature of the Atom*, Lise Meitner, Fortune Magazine, 137-188, Feb 1946.

Matter is composed of *atoms*. An atom is one of a number of known *elements*, such as Hydrogen, Carbon, Silicon, Chlorine, Uranium, . . . . On our planet, there are 94 naturally occurring elements.

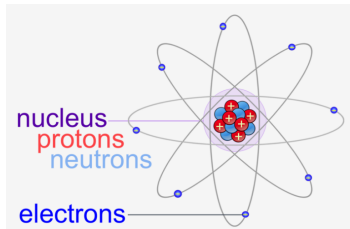
# BEWARE: Science



<http://thebiologyprimer.com/atoms-and-molecules/>

Think of an atom as a *nucleus* of protons and neutrons, surrounded by orbiting electrons.

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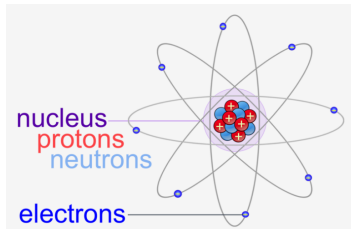


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Think of an atom as a *nucleus* of protons and neutrons, surrounded by orbiting electrons.

An atom is tiny. Really tiny. Really really tiny. The radius of a Hydrogen atom is  $0.529 \times 10^{-10}$  metres (about 10000 times *smaller* than the wavelength of visible light).

# BEWARE: Science

A particular atom is determined by the number of (positively charged) protons it has: e.g., Hydrogen has 1, Helium has 2, Carbon 6, Oxygen 8, Gold 79, Uranium 92, ...

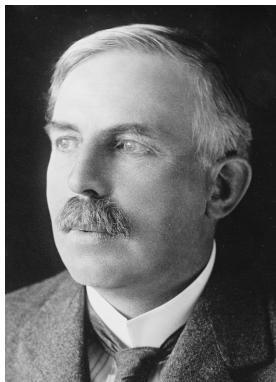
The unusual element Protactinium has 91 protons. Hahn and LM were first to isolate a stable form of it in 1917.



<https://www.writersreserve.com/reference/science/periodic-table/091-protactinium-pa/>

# Sir Ernest Rutherford

1871–1937



Wikipedia

*A theory that you can't explain to a bartender is probably no damn good.*

# BEWARE: Science

Rutherford's team discovered the *neutron* 1931.

Radio-physics/radio-chemistry research groups immediately set up experiments that bombarded atoms of known elements with neutrons 'to see what happened'.

Particularly Uranium, the heaviest [biggest] known element, was studied, There were hopes of synthesising heavier, unknown elements – *transuranics*.

Results were disparate and confusing.



## Germany 1933+

After Hitler's elevation to Reichskanzler, life for the intelligentsia, especially those who were deemed 'non-Aryan', became progressively less comfortable. Prominent physicists, such as Einstein and Schrödinger, had cause to worry seriously.

The Nazi regime began to develop the idea of 'German science' which excluded the fundamental ideas of relativity and quantum mechanics.

LM was unable to demonstrate Aryan credentials and became marginalised within her profession.

# Germany 1938

After the annexation of Austria (the Anschluss), LM's Austrian nationality could no longer protect her from the Third Reich's laws and processes.

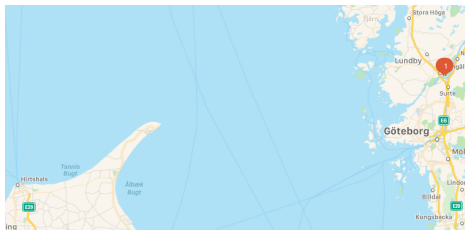
A clandestine operation by many of Europe's senior physicists spirited her from Berlin to the Netherlands, and thence to Sweden.

The Swedish research community absorbed her on a low salary and without serious practical facilities: she continued correspondence with Hahn and made fundamental theoretical contributions and suggestions for experiments for transuranics.

# BEWARE: Science

Hahn was unable to understand how his experiments bombarding Uranium delivered traces of lighter elements such as Barium.

LM, visited by her physicist nephew Otto Frisch, considered the matter theoretically during a 1938 Christmas stay at Kungälv.



<https://duckduckgo.com/?q=Kungälv&t=brave&ia=web&iaxm=places>

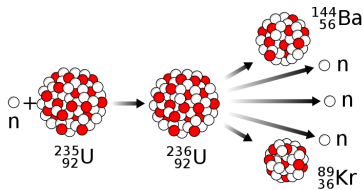
## BEWARE: Science

On a walk in the snowy woods, LM had the brilliant insight that perhaps the neutron caused a Uranium atom to split. She sat in the snow with paper and pencil and outlined the energy exchanges implied, and saw that they corresponded precisely with Hahn's observation.

$$E = mc^2$$

This was the very first identification of nuclear fission and its implication for structure and energy surplus.

# BEWARE: Science



[https://commons.wikimedia.org/wiki/File:Nuclear\\_fission\\_reaction.svg](https://commons.wikimedia.org/wiki/File:Nuclear_fission_reaction.svg)

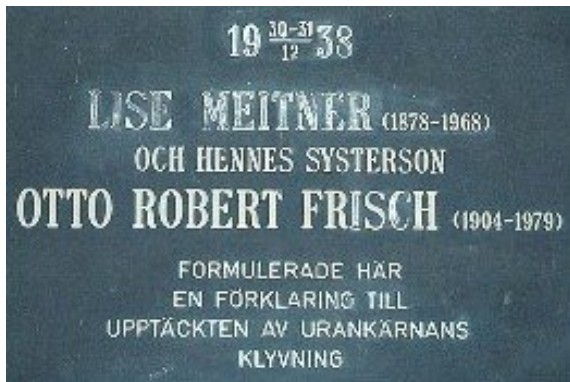
The atom splits into Barium and Krypton; there are *three* spare neutrons, **and a lot of energy**.

The three spare neutrons are available to repeat the split of other Uranium atoms ... and generate more energy. This would be a *chain reaction*, and is the key to nuclear power and weaponry.

# Kungälv, Sweden

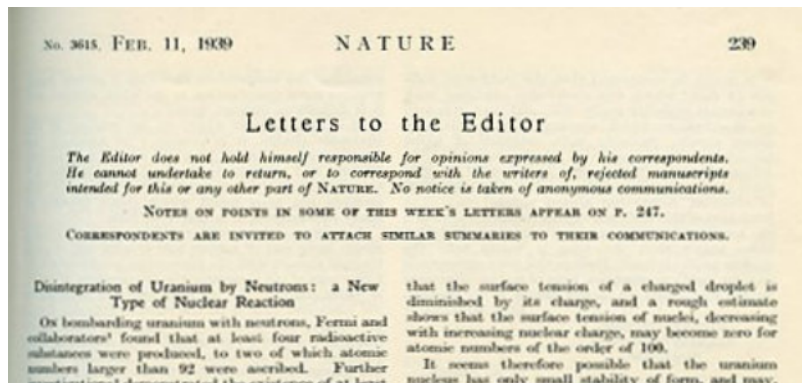


<http://www.epsnews.eu/2016/12/eps-historic-site-the-home-of-lise-meitner-in-sweden/>



<https://artikel19.blogspot.com/2006/03/atomldern-startade-i-kunglv.html>

LM and Frisch rush to publication.





LM's theory spread with astounding speed through the Physics and Chemistry communities. It was persuasive and soon verified.

Many were quick to realise the military potential of the energy explosion: famously, when this was explained in July 1939 to Einstein he said *Daran habe ich gar nicht gedacht* [I did not even think about that]. Fearful of German exploitation, he swiftly put in place correspondence that encouraged Roosevelt to initiate the Manhattan Project.

Einstein later found himself conflicted and regretted his role in the development of atomic weapons.

# Fission

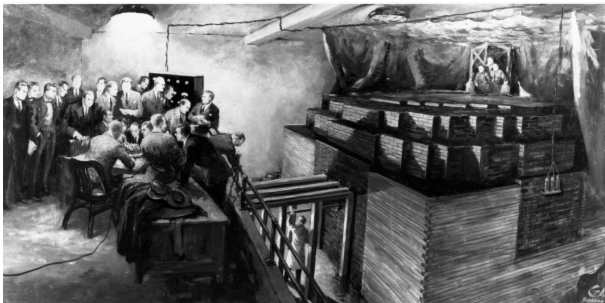
As war in Europe came closer, a rift grew between Hahn and LM.

The potential uses of the enormous energy release of fission chain reaction became clear internationally. Roosevelt, Stalin and Hitler were quickly aware of the possible military use.

On December 2nd 1942, Enrico Fermi initiated the first man-made exhibition of a controlled nuclear chain reaction at the university of Chicago.

The apparatus was called *Chicago Pile 1*.

# Chicago, December 1942



<https://news.uchicago.edu/story/uchicago-commemorate-75th-anniversary-first-chain-reaction>

Apparatus was primitive, and the possible outcomes quite unknown!

# Atomic weapons

At Los Alamos, the Manhattan Project was conducted under enormous secrecy by a large and very intellectually powerful team of American, British and emigré scientists.

In Germany, with vastly inferior resources, Werner Heisenberg led a German team with similar aims. They made significant inroads but failed to produce controlled fission. Interesting questions remain over Heisenberg's true position in this work (cf. Michael Frayn's play *Copenhagen*)..

# Atomic weapons

Despite being invited, LM played no role in the Manhattan Project.

# Atomic weapons

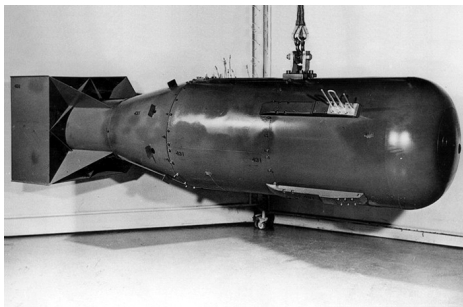
Despite being invited, LM played no role in the Manhattan Project.

*I will have nothing to do with a bomb!*

On refusing an invitation to join a group of British scientists, including Otto Frisch, to go to Los Alamos in 1943.

# Little Boy

On August 6th, 1945, 'Little Boy' was dropped on Hiroshima. This was the first offensive use on our planet of an offensive nuclear weapon.



<https://www.storypick.com/atom-bomb-on-hiroshima/>

Along with other significant German scientists, Hahn was spirited away to Farm Hall near Cambridge, and was soon able to resume serious scientific activity.

LM conducted a celebrated tour in the US, but was eclipsed: her retiring personality and disconnection from the physics mainstream left her isolated.

The Nobel Committees set about awarding prizes retrospectively for the wartime years.



# Nobel prize for Chemistry, 1944

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In his acceptance speech, Hahn said *The expression 'nuclear fission' [Kernspaltung, fission nucléaire] is due to Meitner and Frisch.*

# Nobel prize for Chemistry, 1944

'Meitner's exclusion from the chemistry award may well be summarized as a mixture of disciplinary bias, political obtuseness, ignorance, and haste.'

Crawford, Sime and Walker, *A Nobel tale of postwar injustice*,  
Physics today, 50(9), 25-32 1997

## Post-war ...

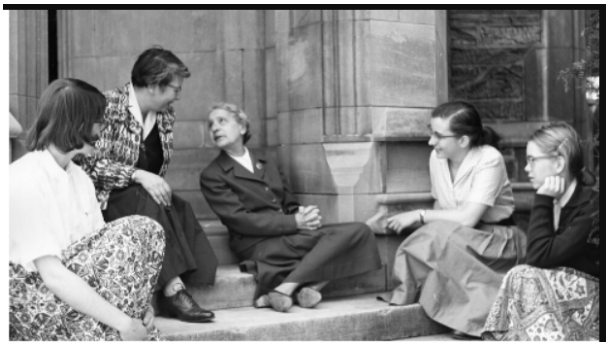
LM is now nearing 70. She remains an influential and well-liked member of the international physics community but is much less professionally productive. She has 'mild celebrity' status.

She maintains cordial relations with Hahn who continues to conduct science and organisation of science in the reconstructing (West) Germany.

LM lives and naturalises in Sweden. She never forgets her struggle as a woman, and is a vociferous champion of women in science.

# Aged 81 ...

Bryn Mawr University, April 1959



<https://www.aip.org/history-programs/niels-bohr-library/ex-libris-universum/love-information>

Photo by Heka Davis, courtesy of AIP Emilio Segrè Visual Archives, Physics Today Collection.

# Physics Today, 13, 16-21, 1960

## The status of women in the professions

- In principle, nearly all male professions have become accessible to women; in practice, things often look different.

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- ... prejudice persists. It is directed against women in middle class occupations and high-ranking posts. Nobody seems to have protested against women as factory workers.
- (Quoting Vassar) 'A woman, having received from her Creator the same intellectual constitution as man, has the same right as man to intellectual culture and development.'

## Later years

As her health declined, LM moved to Cambridge where Otto Frisch was pursuing a highly successful career as a physicist. She died in 1968.

It was her wish to be buried alongside her brother in Bramley, Hampshire.

# Bramley, Hampshire



‘Lise Meitner, 1878-1968, A physicist who never lost her humanity’

# Bramley, Hampshire

RG26 5NQ



# Greifswald, Germany

Mecklenburg-Vorpommern



# Greifswald, Germany

Mecklenburg-Vorpommern



*Meitnerium* is an unstable transuranic element of atomic number 109 and a half-life of 4.5 seconds.

It was first synthesised in Germany in 1982 at the *GSI Helmholtzzentrum für Schwerionenforschung*, Darmstadt.

# Diolch yn fawr

Anna Schwarzbach's statue of LM at Humboldt University, Berlin,  
<http://www.jacqueslanciault.com/2015/10/26/...>



*'Science makes people reach selflessly for truth and objectivity; it teaches people to accept reality, with wonder and admiration, not to mention the deep awe and joy that the natural order of things brings to the true scientist.'*