What? Location? Why?

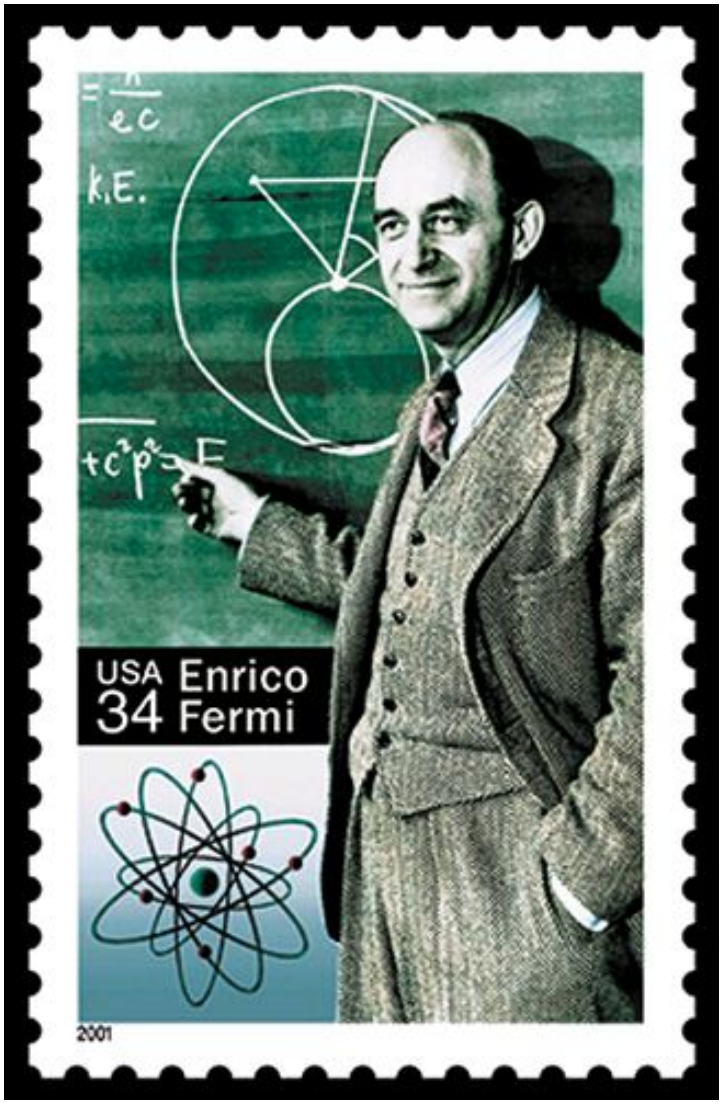
Enrico Fermi

A Modern Renaissance Man

Born 29 September 1901): Rome29 September 1901): Rome, Italy
Died November 28, 1954 (aged 53): ChicagoNovember 28, 1954 (aged 53): Chicago, IllinoisNovember 28, 1954 (aged 53): Chicago, Illinois, U.S.
Known for

(1) New radioactiveNew radioactive elements by neutron irradiation
Controlled
(2) nuclear chain reaction,
(3) Fermi-Dirac statistics
(4) Theory of beta decay

Notable award: Nobel Prize for Physics (1938)



Enrico Fermi, Physicist

Fermi was one of the greatest physicists of the 20th century.

He is best known for his leading contributions in the Manhattan Project but his work spanned every field of physics.

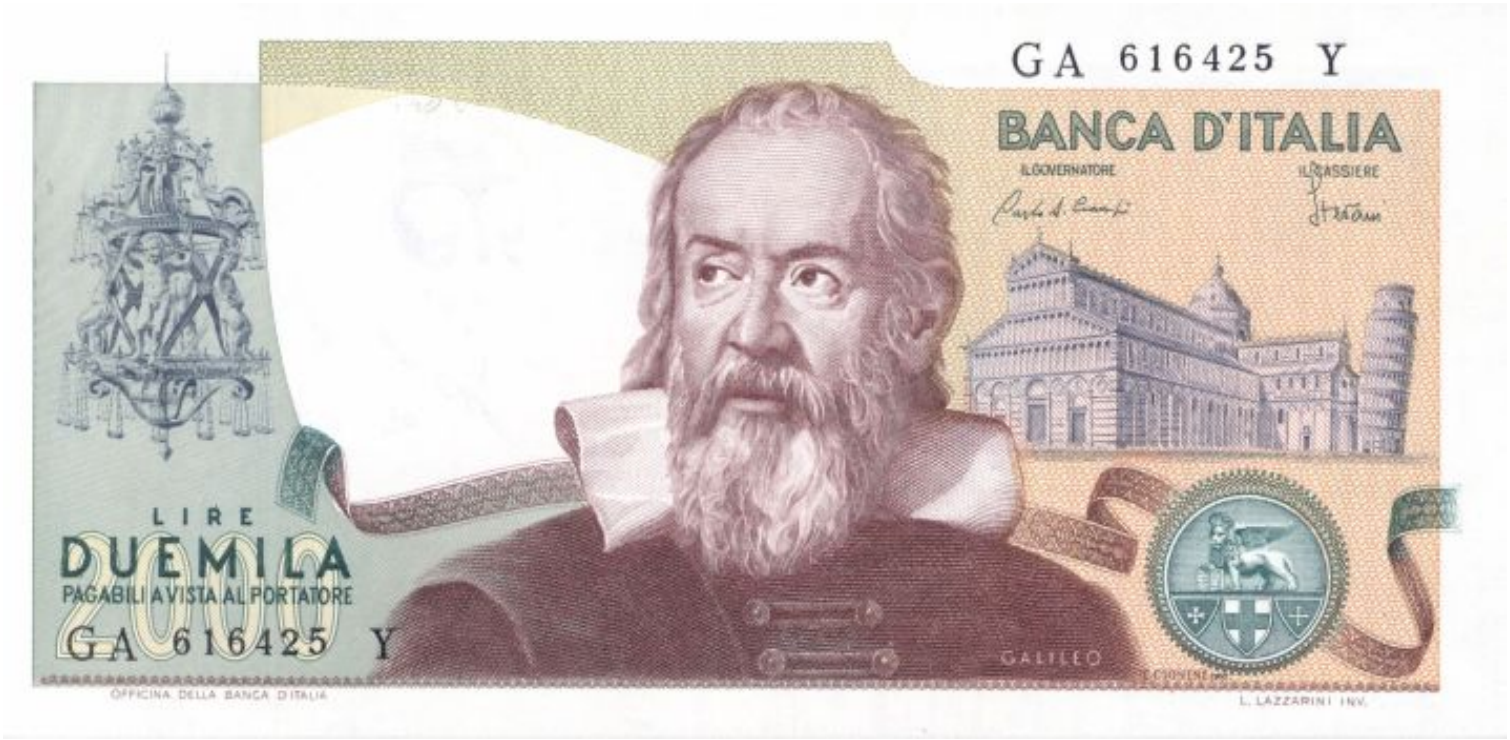
Early Years

In 1901, Enrico was born in Rome to Alberto Fermi, a Chief Inspector of the Ministry of Communications, and Ida de Gattis, an elementary school teacher.

As a young boy he enjoyed learning physics and mathematics and shared his interests with his older brother, Giulio. When Giulio died unexpectedly of a throat abscess in 1915 it brought great sorrow to the family and Enrico escaped into his studies.

Physics in Italy

Despite being the birthplace of physics, in the 20th century Italy had slipped behind the other European countries. That all changed with Enrico Fermi.



Scuola Normale Superiore di Pisa

Urged by a family friend, Fermi went to Pisa for his university studies.

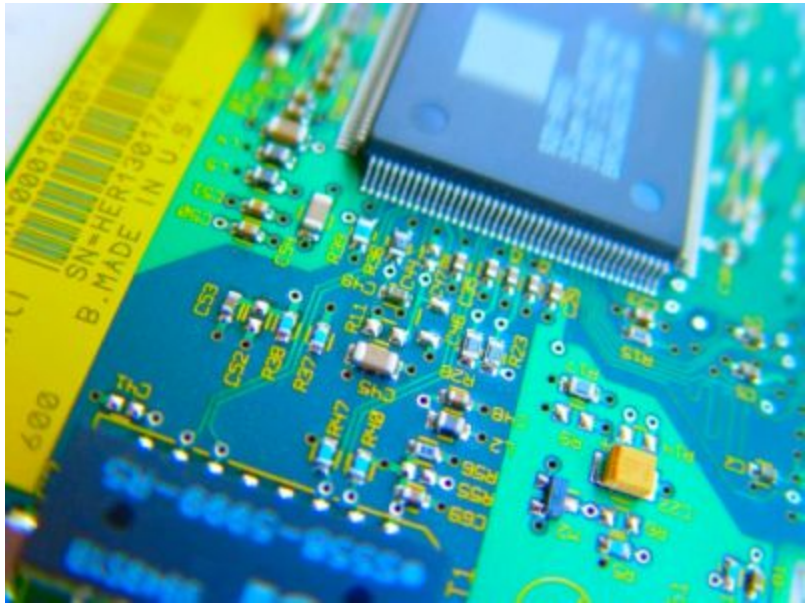
His exceptional abilities were recognized by his professors, some of whom received lessons on relativity theory from the young Fermi.

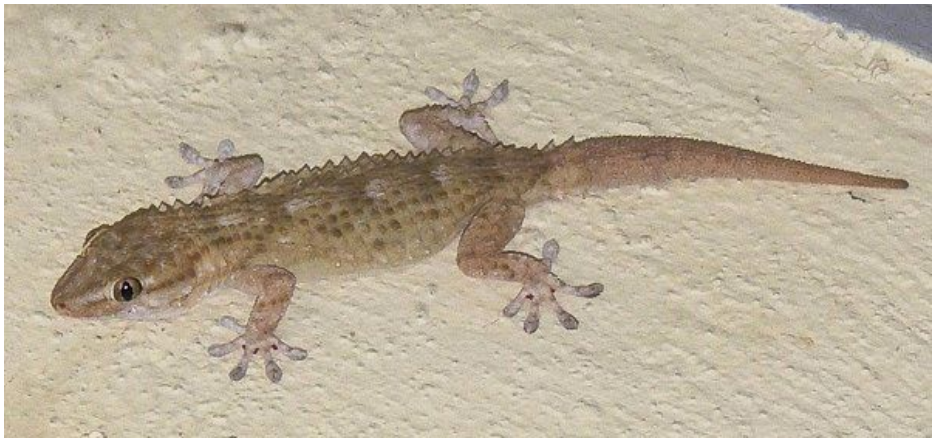
Fermi Electron Theory

While in Pisa, Fermi and his friends had a well-earned reputation as pranksters.

One afternoon, while patiently trapping geckos (used to scare girls at the university), Fermi came up with the fundamental theory for electrons in solids.

Fermi's theory later became the foundation of the entire semiconductor industry.





Professor Fermi

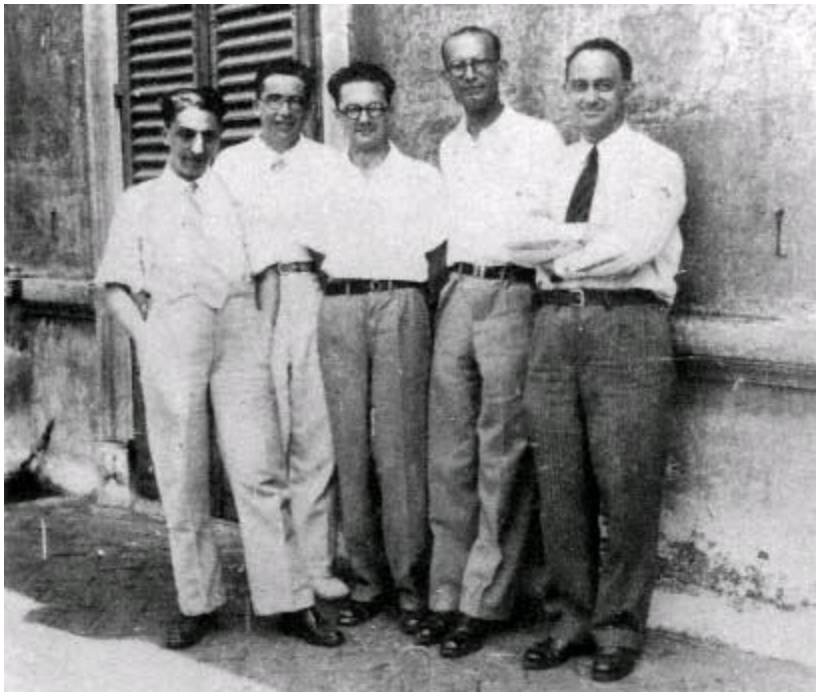
Thanks to the efforts of Professor (and Senator) Orso Mario Corbino, who recognized his talent, Fermi returned to Rome as professor of physics in 1924.

Fermi was only 24 years old but was already an internationally known scientist.

Via Panisperna Boys

In Rome, Fermi (with Corbino's help) gathered the brightest scientific minds in Italy in his theoretical physics group, known as the "Via Panisperna Boys."

Despite that fact that Enrico was only a few years older, his students (half-jokingly) called him "The Pope" because they considered him infallible.



Ettore Majorana

Fermi considered his Sicilian student, Ettore Majorana, to be far more brilliant than himself. Majorana's main fault was that problems were so simple for him to solve that he rarely bothered to write down and publish his calculations.

Majorana became full professor of theoretical physics in Naples University in 1937 without needing to take examination "for high and well-deserved repute, independently of the competition rules."

A few months afterwards, at the age of 31, Majorana mysteriously disappeared during a boat trip from Palermo to Naples.

Emilio Segrè

Born in Tivoli, Segrè enrolled in the University of Rome La Sapienza as an engineering student. He switched to physics in 1927 to work with Fermi.

While Segrè was visiting Berkeley in 1938, Mussolini's Fascist government passed anti-Semitic laws barring Jews from university positions, making Segrè an émigré.

Segrè and Owen Chamberlain (also Fermi's student) shared the Nobel Prize for their discovery of the anti-proton in 1959.

Emilio Segrè, Clyde Wiegand, and Owen Chamberlain examining film measuring the rate of antiproton travel, 1955

Fermi, Sportsman

An avid hiker and tennis player, Fermi showed the same intensity in his sports as in his science.

Often he would win his matches by simply outlasting his opponent.

Yet Fermi was also known for his modesty and would never make much of his achievement.

Fermi Problems

Fermi was famous for being able to avoid long, tedious calculations or difficult experimental measurements by devising ingenious ways of finding approximate answers.

He also enjoyed challenging his friends with “Fermi Problems” that could be solved by such “back of the envelope” estimates.

Laura and Enrico Fermi

Fermi Problem Example

"What is the length of the equator?"

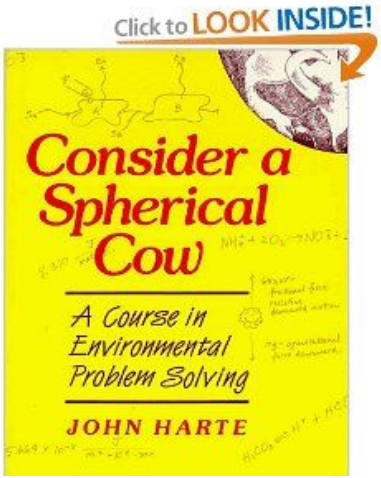
Fermi problems are solved by assembling simple facts that combine to give the answer:

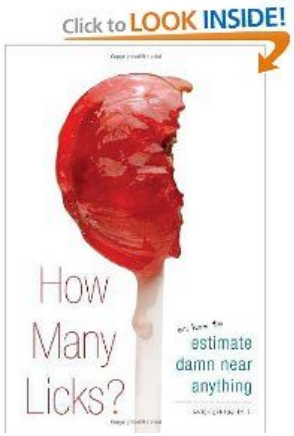
- The distance from Los Angeles to New York is about 3000 miles.
- These cities are three time zones apart.
- So each time zone is about 1000 miles wide.
- There are 24 time zones around the world.
- So the length of the equator must be about 24,000 miles

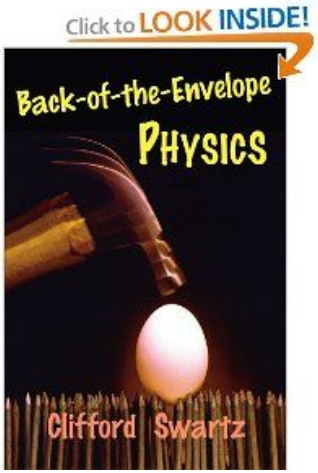
The exact answer is 24,901 miles.

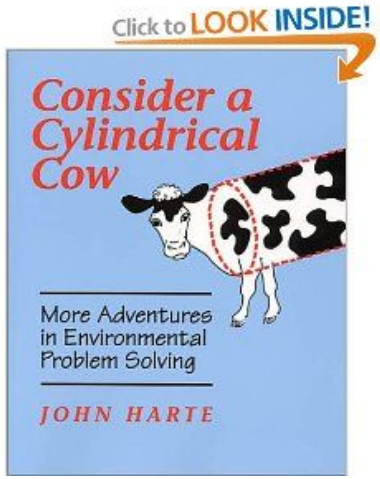
Many Guesstimation Books !

Guesstimation: Solving the World's Problems on the Back of a Cocktail Napkin
by Lawrence Weinstein , John A. Adam
Price: ~ $14.00



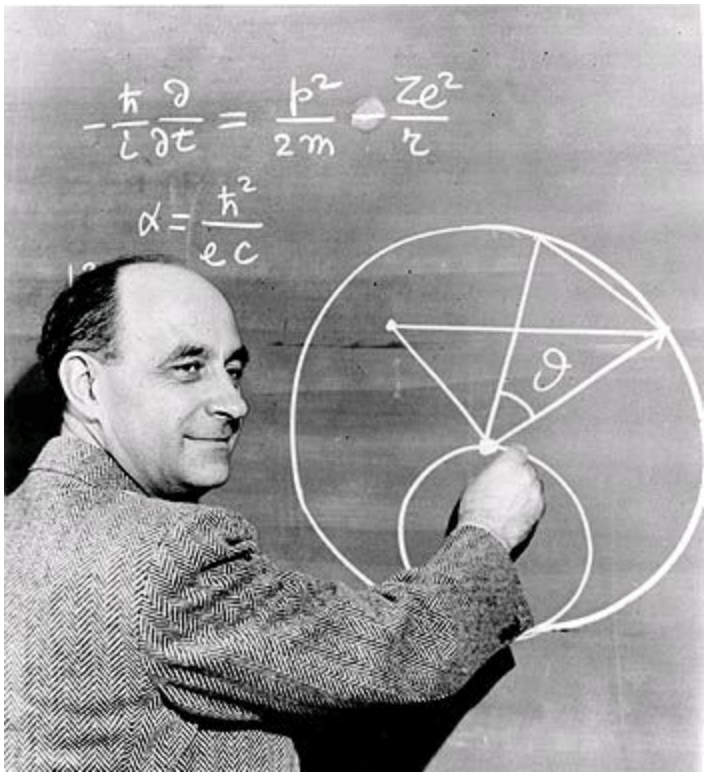






From Theory to Experiment

In 1934, Fermi learned of the nuclear experiments of Frédéric and Irène Joliot-Curie, he immediately shifted his group's work from theory to experiment.



Nobel Prize

In 1938, Fermi won the Nobel Prize in Physics for "demonstrations of the existence of new radioactive elements produced by neutron irradiation, and for his related discovery of nuclear reactions brought about by slow neutrons".

Emigration to America

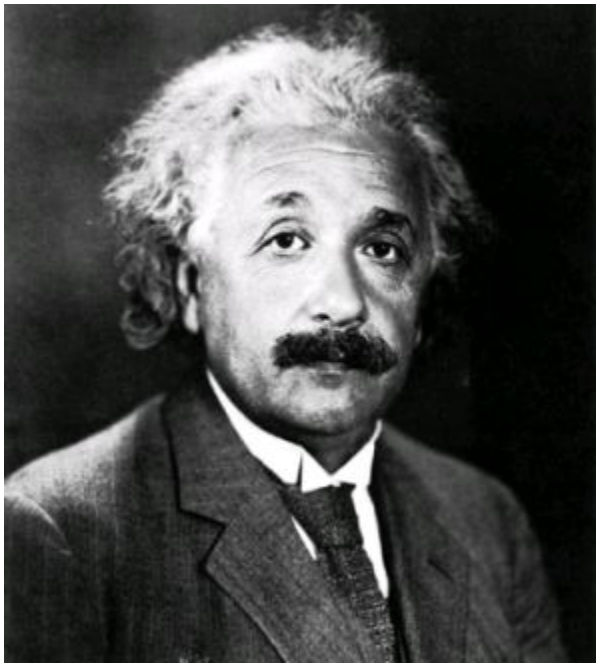
After receiving the Nobel prize in Stockholm, Fermi and his family emigrated to New York, mainly because of the fascist regime's anti-Semitic laws, threatened his wife Laura, who was of Jewish descent.

World War

In 1939, Nazi Germany invaded Poland, igniting World War II. The United States, initially neutral, was drawn in after Pearl Harbor is attacked in December 1941.

Einstein's Letter to Roosevelt

On August 2nd 1939, encouraged by a group of fellow physicists, the world's most famous scientist, Albert Einstein, writes a historic letter to President Roosevelt.



Albert Einstein
Old Grove Rd.
Nassau Point
Peconic, Long Island

August 2nd, 1939

F.D. Roosevelt,
President of the United States,
White House
Washington, D.C.

Sir:

Some recent work by E.Fermi and L. Szilard, which has been communicated to me in manuscript, leads me to expect that the element uranium may be turned into a new and important source of energy in the immediate future. Certain aspects of the situation which has arisen seem to call for watchfulness and, if necessary, quick action on the part of the Administration. I believe therefore that it is my duty to bring to your attention the following facts and recommendations:

In the course of the last four months it has been made probable - through the work of Joliot in France as well as Fermi and Szilard in America - that it may become possible to set up a nuclear chain reaction in a large mass of uranium,by which vast amounts of power and large quantities of new radium-like elements would be generated. Now it appears almost certain that this could be achieved in the immediate future.

This new phenomenon would also lead to the construction of bombs, and it is conceivable - though much less certain - that extremely powerful bombs of a new type may thus be constructed. A single bomb of this type, carried by boat and exploded in a port, might very well destroy the whole port together with some of the surrounding territory. However, such bombs might very well prove to be too heavy for transportation by air.

The United States has only very poor ores of uranium in moderate quantities. There is some good ore in Canada and the former Czechoslovakia, while the most important source of uranium is Belgian Congo.

In view of this situation you may think it desirable to have some permanent contact maintained between the Administration and the group of physicists working on chain reactions in America. One possible way of achieving this might be for you to entrust with this task a person who has your confidence and who could perhaps serve in an unofficial capacity. His task might comprise the following:

a) to approach Government Departments, keep them informed of the further development, and put forward recommendations for Government action, giving particular attention to the problem of securing a supply of uranium ore for the United States;

b) to speed up the experimental work, which is at present being carried on within the limits of the budgets of University laboratories, by providing funds, if such funds be required, through his contacts with private persons who are willing to make contributions for this cause, and perhaps also by obtaining the co-operation of industrial laboratories which have the necessary equipment.

I understand that Germany has actually stopped the sale of uranium from the Czechoslovakian mines which she has taken over. That she should have taken such early action might perhaps be understood on the ground that the son of the German Under-Secretary of State, von Weizsäcker, is attached to the Kaiser-Wilhelm-Institut in Berlin where some of the American work on uranium is now being repeated.

Yours very truly,

A. Einstein

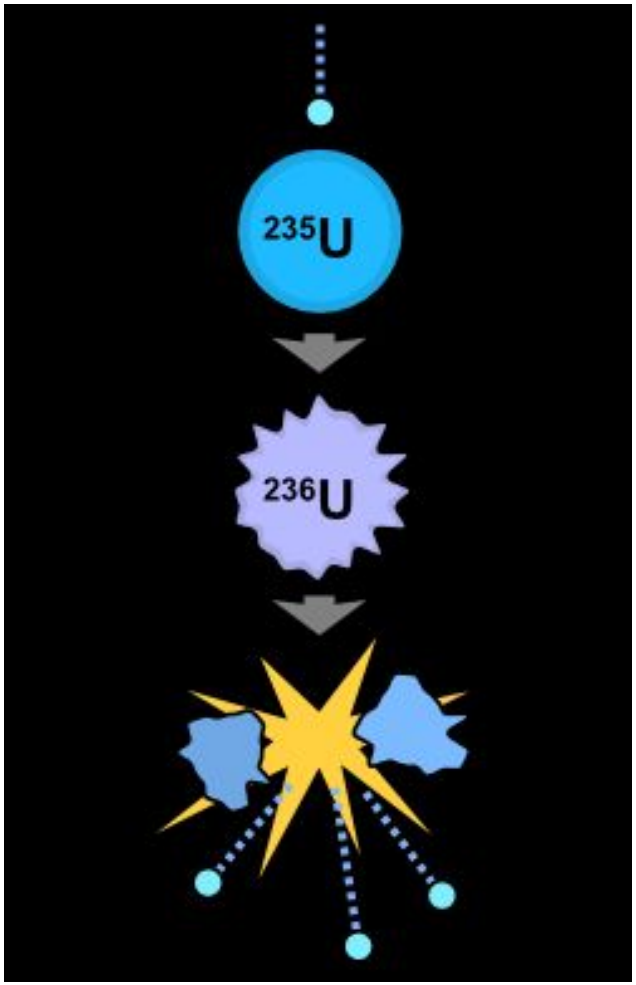
(Albert Einstein)

Nuclear Fission

The bombardment of uranium by neutrons was first studied by Enrico Fermi but the results were not fully understood at the time.

After Fermi's publication, Lise Meitner, Otto Hahn and Fritz Strassmann began performing similar experiments in Germany.

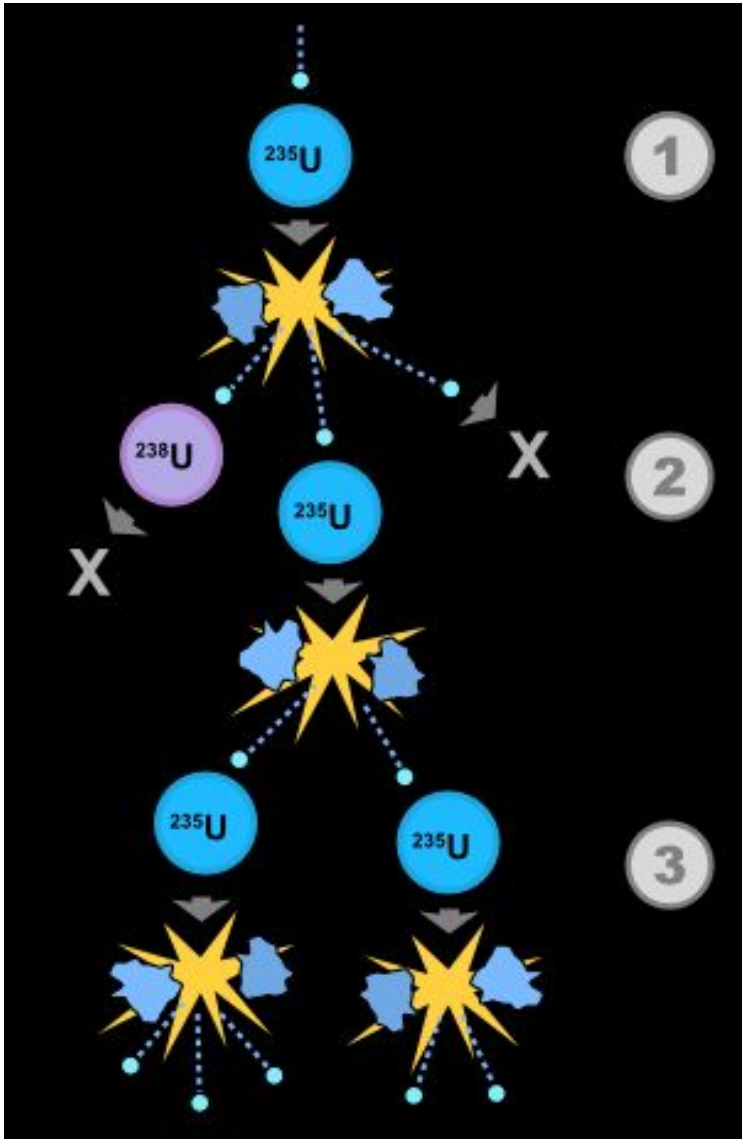
In 1939, they discovered that the uranium nucleus split (fission) under neutron bombardment, releasing nuclear energy.



Chain Reaction

Nuclear chain reactions had been foreseen as early as 1933 by Leo Szilard, although Szilard at that time had no idea with what materials the process might be initiated.

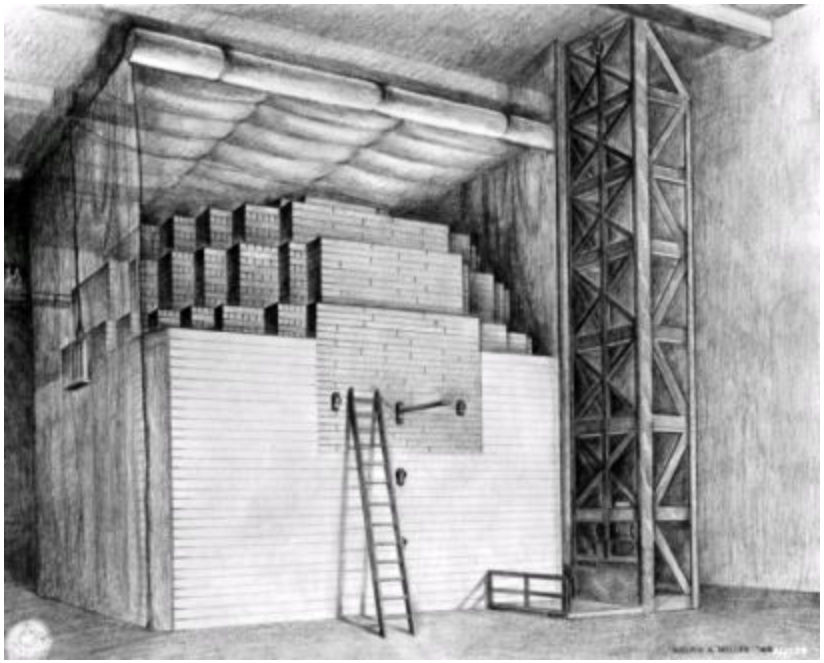
Fermi and Szilard proposed the idea of a nuclear reactor (pile) with natural uranium as fuel and graphite as moderator of neutron energy.



Chicago Pile-1

Fermi led the construction of Chicago Pile-1 (CP-1) , the world's first nuclear reactor.

Due to a construction labor strike, he built it inside a squash court at the University of Chicago.



The first artificial, self-sustaining, nuclear chain reaction was initiated within CP-1, on Dec. 2, 1942.

University of Chicago

Manhattan Project

CP-1 demonstrated that nuclear energy was not just a theoretical possibility but an experimental fact.

At that point, enormous resources were poured into the Manhattan Project in an effort to produce the atomic bomb, a decisive weapon to end the war.

Nuclear Physics in Nazi Germany

The Nazi reactor effort had been severely handicapped by the German physicists belief that heavy water was necessary as a neutron moderator.

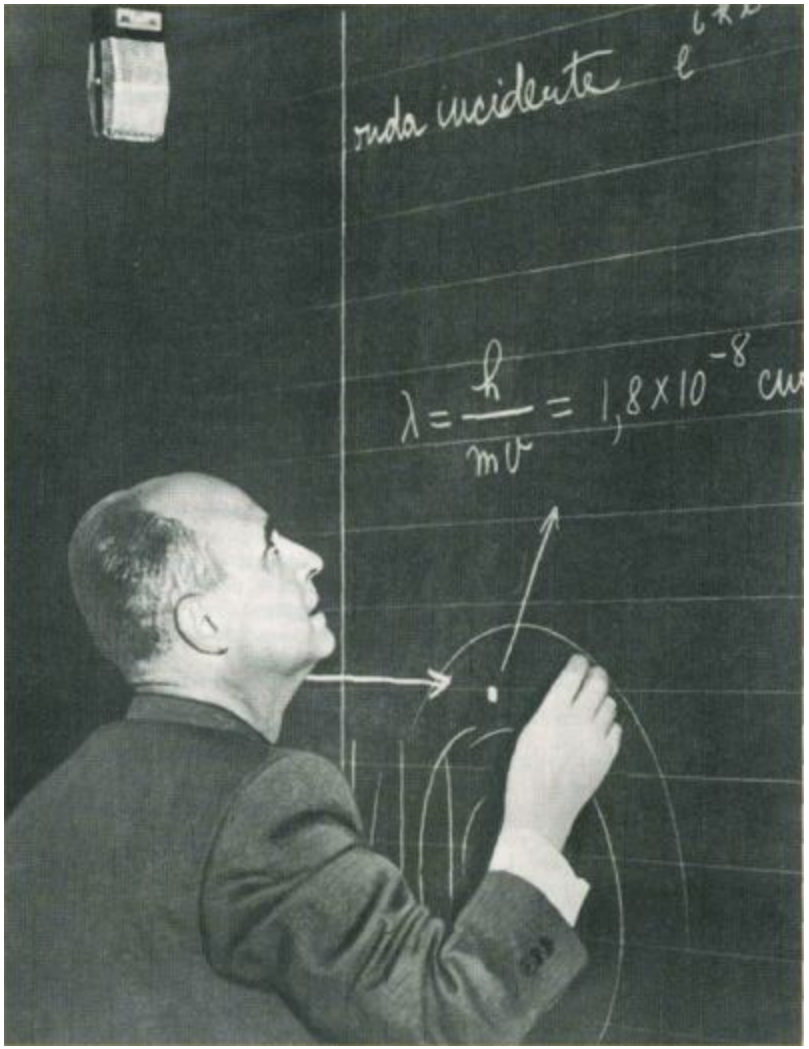
The Germans were short of heavy water because of Allied efforts to prevent Germany from obtaining it and they never stumbled on the secret of using purified graphite instead.

Nazi German experimental nuclear pile at Haigerloch

Post-War Work

In his later years, Fermi did important work in particle physics, especially related to pions and muons.

He was also known to be an inspiring teacher at the University of Chicago. His lecture notes were transcribed into books and are still used today.



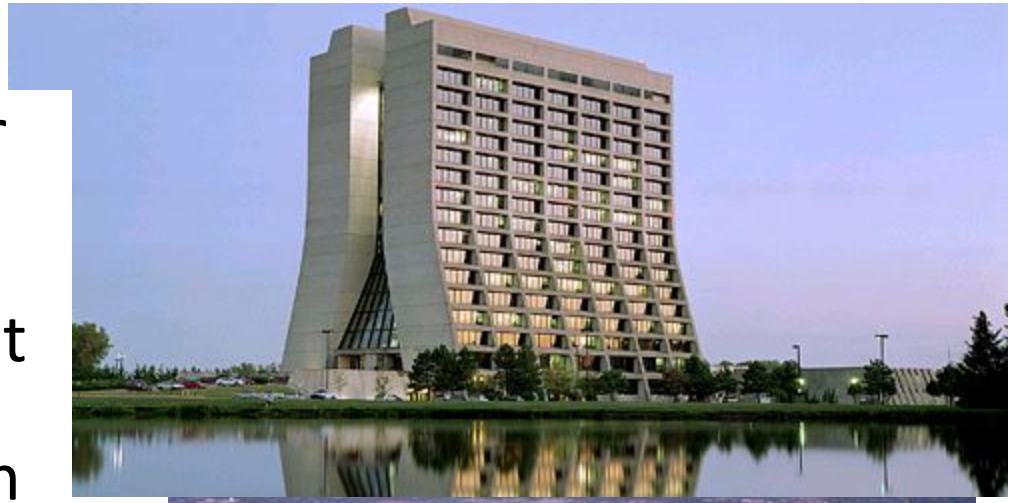
Fermi's Last Years

Fermi died at age 53 of stomach cancer; two of his assistants working on or near the nuclear pile also died of cancer.

Fermi and his team knew that their work carried considerable risk but they considered the outcome so vital that they forged ahead with little regard for their own personal safety.

Fermilab

- Fermi National Accelerator Laboratory (Fermilab), located in Batavia near Chicago, is a Department of Energy national laboratory specializing in high-energy particle physics.
- Fermilab's Tevatron particle accelerator, four miles in circumference, is the world's highest energy particle accelerator.



The Fermi Paradox

The extreme age of the universe and its vast number of stars suggest that if the Earth is typical, extraterrestrial life should be common.

Discussing this proposition with colleagues over lunch in 1950, Fermi asked: "Where is everybody?"

We still don't have a good answer to Enrico's question.