Hahn and Strassmann's discovery

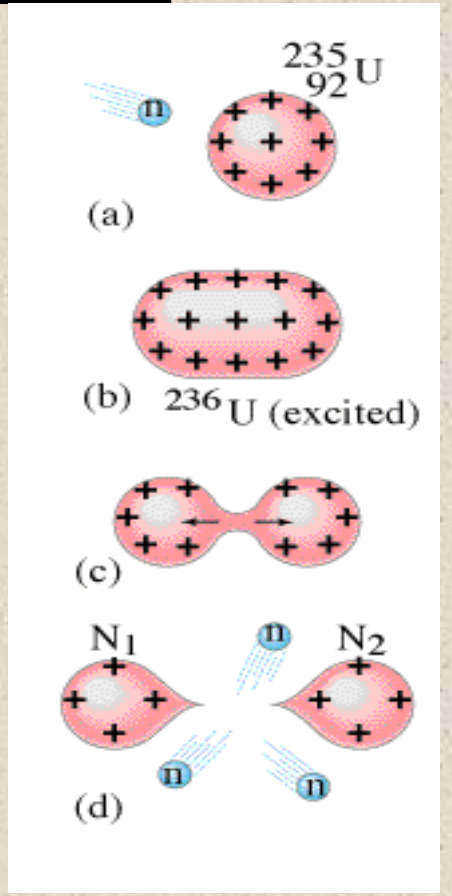
•Fermi discovers that neutrons are the way to go, and discovers many nuclear reactions

•In 1938, Otto Hahn and Fritz Strassmann discover that Uranium will split in half:

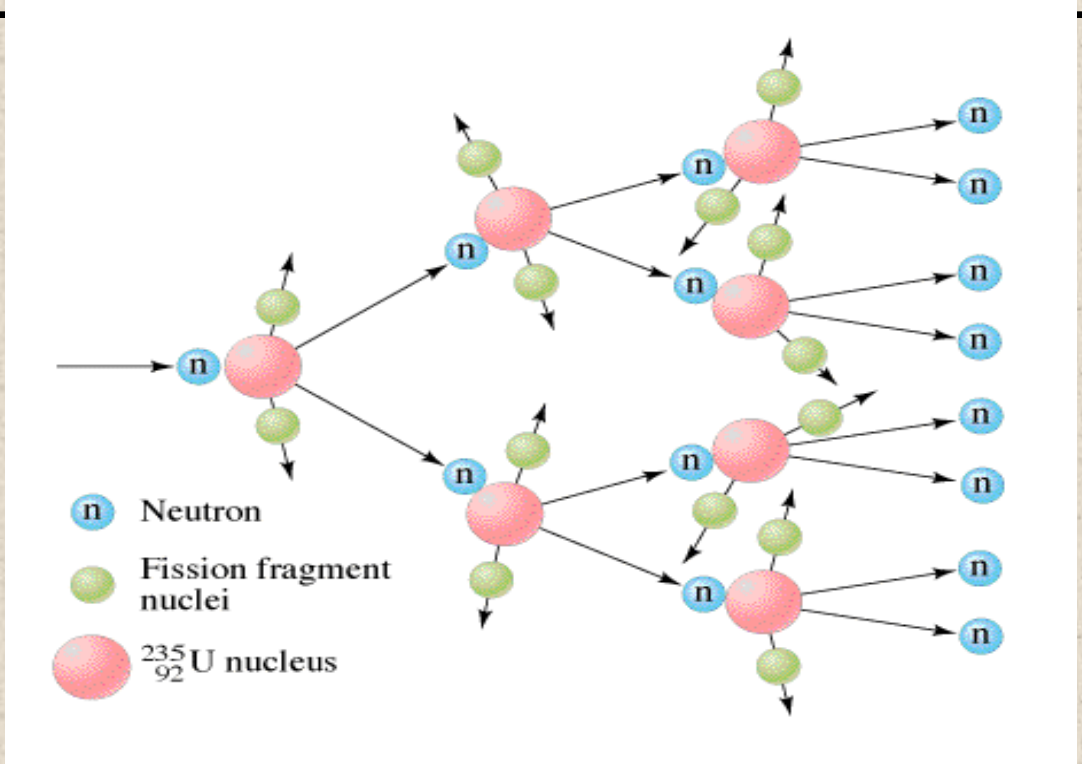
$n + {}^{235}_{92}U \dashrightarrow {}^{141}_{56}Ba + {}^{92}_{36}Kr + 3n$ (typical)

•The reaction releases 200 MeV

•The neutrons released could trigger further fission



Hahn and Strassmann's discovery



- Scientists begin to realize that a chain reaction could lead to a very powerful explosion
- Demo - critical mass…

Einstein's Letter to Roosevelt

In Summer 1939, US has no atomic energy program
Hitler has halted sales of Czech Uranium
Hitler classifies all nuclear research
Hungarian Physicist Leo Szilard (and many others) worried
Cannot convince Fermi
Turns to Einstein
Einstein returns from vacation, and writes a letter to 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.

Einstein is a pacifist
Einstein fears Hitler

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,

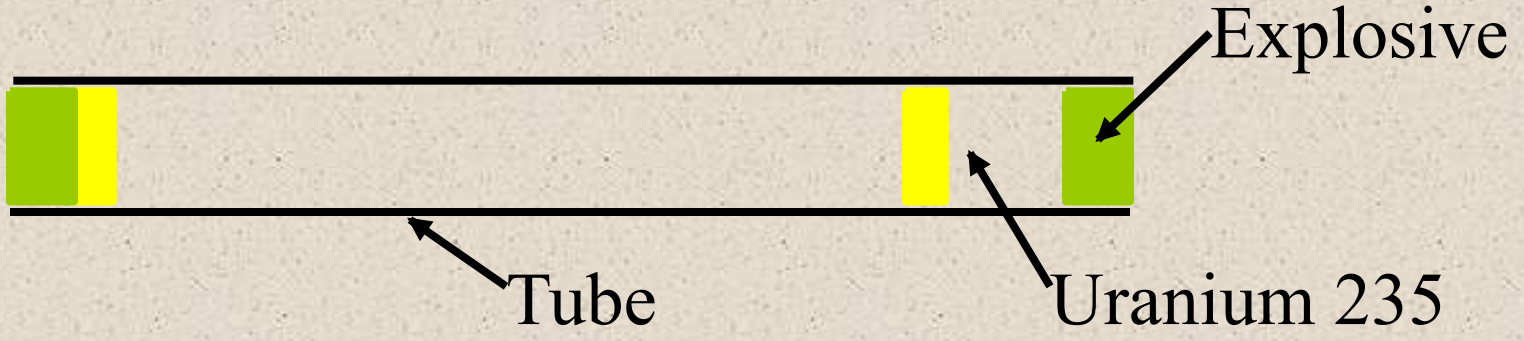
A. Einstein

(Albert Einstein)

- US starts 1 day before Pearl Harbor bombing.
- ($2\ ^1/_2$ years later)

The Manhattan Project

Started in 1942 in Los Alamos NM
Unprecedented rush to make a bomb
Basic concept - Combining two sub critical masses:



Separating U 235 from 238 by gaseous diffusion at Oak Ridge
Feynman and the chemical engineer

Hiroshima and Nagasaki

Near the end of WWII, the US had been bombing nearly every major city in Japan. For some reason, Hiroshima and Nagasaki had been spared. They had become refugee centers for those displaced by bombing elsewhere.

At 8:15, August 6, 1945 The U.S. detonated a Uranium Fission bomb 1,900 feet above the city of Hiroshima.

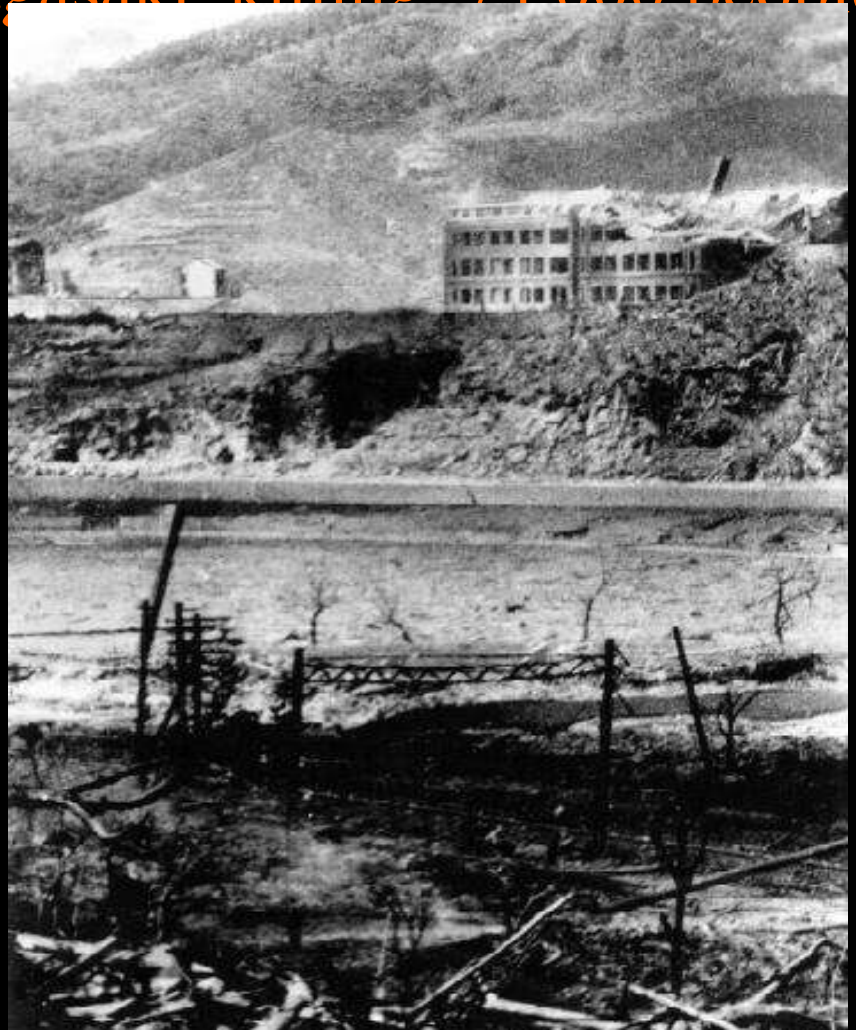
The devastation was nearly complete

About 100,000 people died immediately..

45,000 more died later from the radiation

People were killed, and all the people who knew them as well

3 days later, we dropped another bomb on the city of Nagasaki, killing 74,000 people,



This bomb was a plutonium bomb

Nagasaki's rugged topography protected larger parts of the city from the direct blast.

Emperor Hirohito surrendered on September 2

Hindsight vs. foresight…