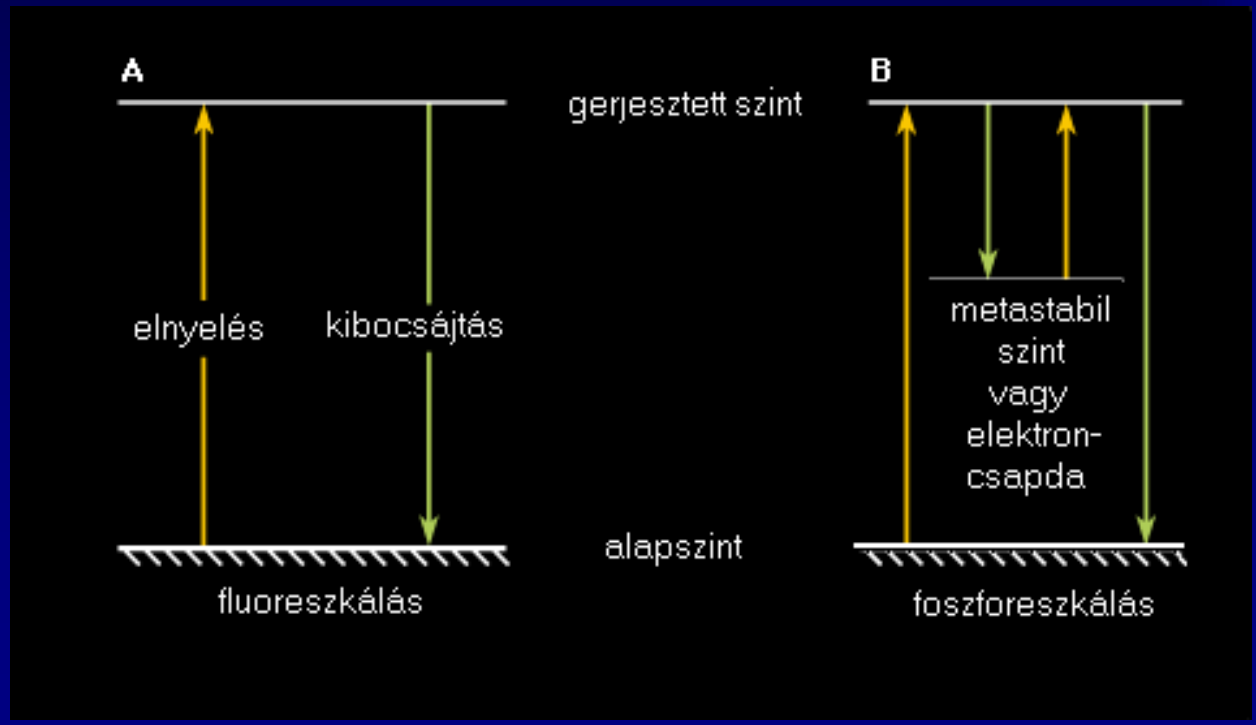
A magfizika rövid története

- lumineszcenciakutatások közben Antoine Henri Becquerel (1852-1908) felfedezi a rádiumsók természetes radioaktivitását (1896)



- Maria Sklodowska-Curie (1867-1934) felteszi, hogy a radioaktív sugárzás atomi tulajdonság (1896)
- fizikai-kémiai szeparáció: tórium, polónium, rádium (1897-1898)

- Ernst Rutherford (1871-1937) felfedezi az α és β sugarakat, valamint a radont (1899)

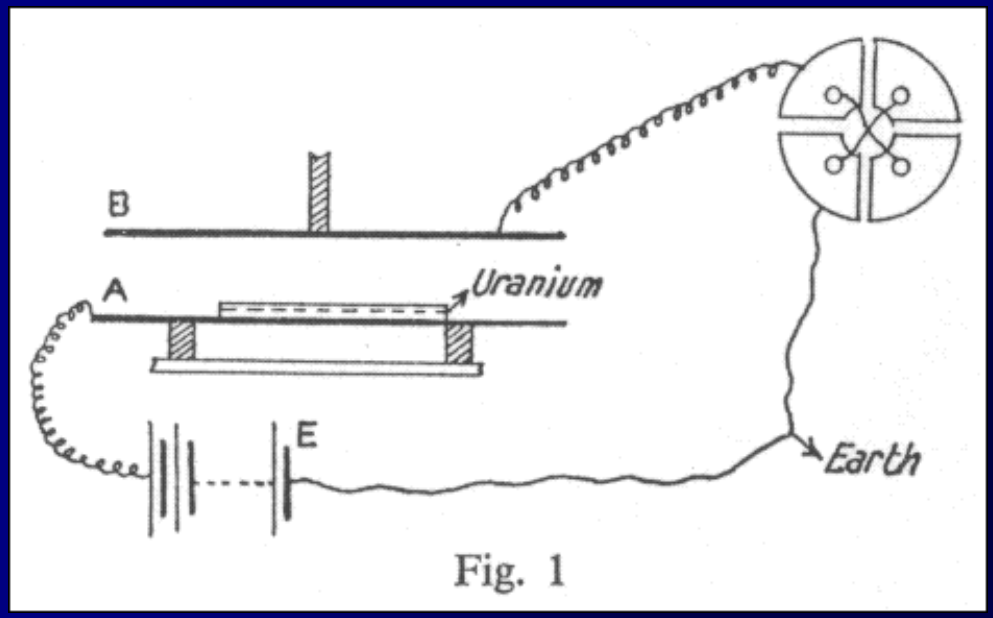


Fig. 1

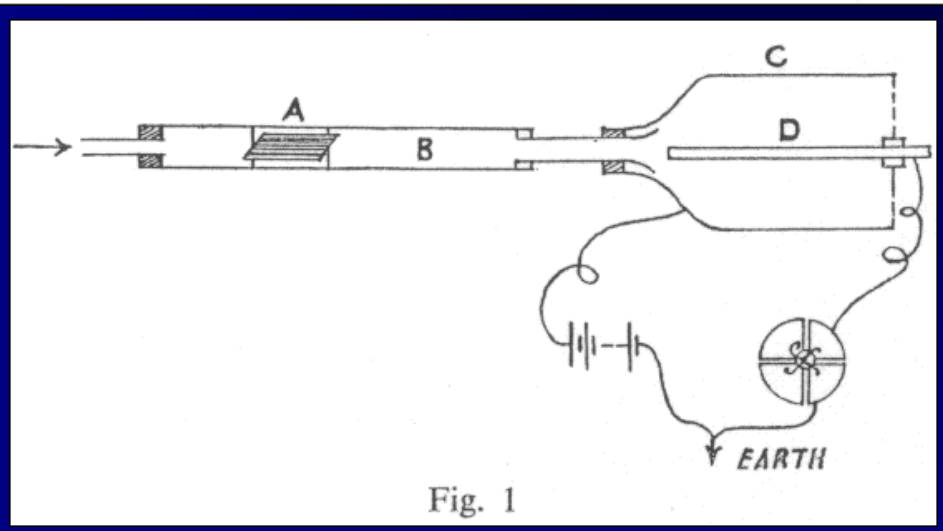
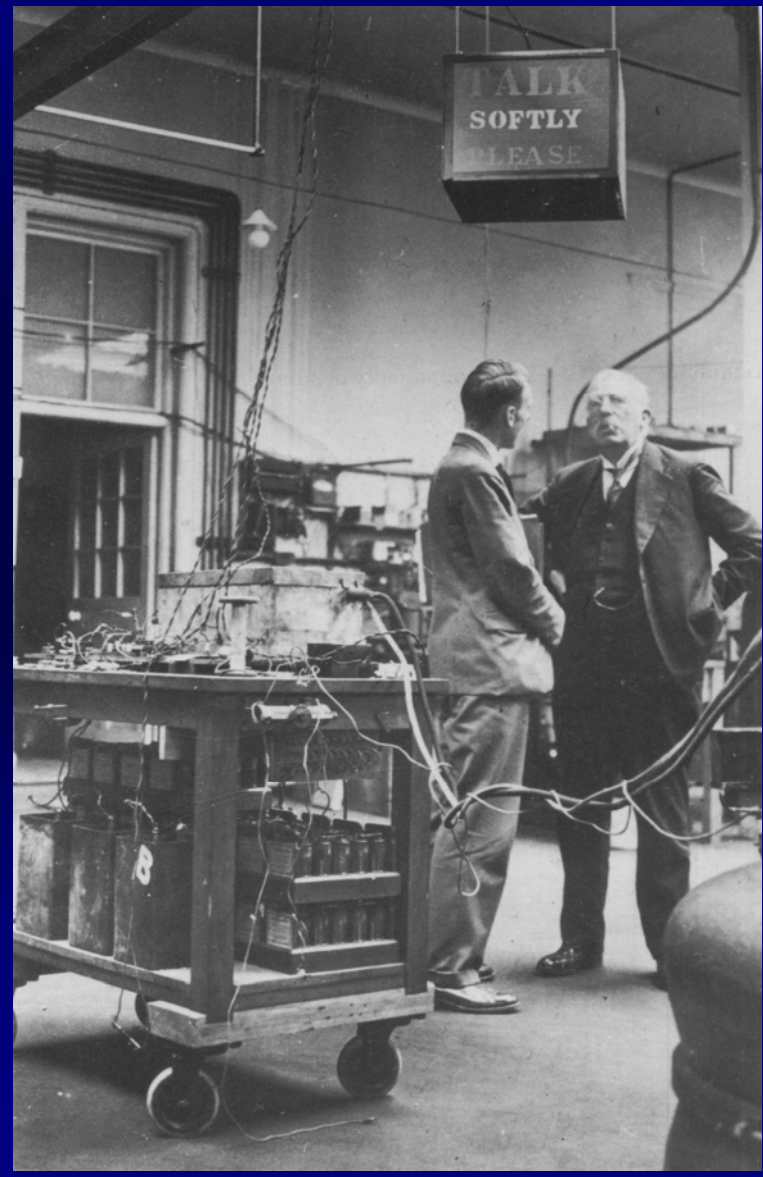
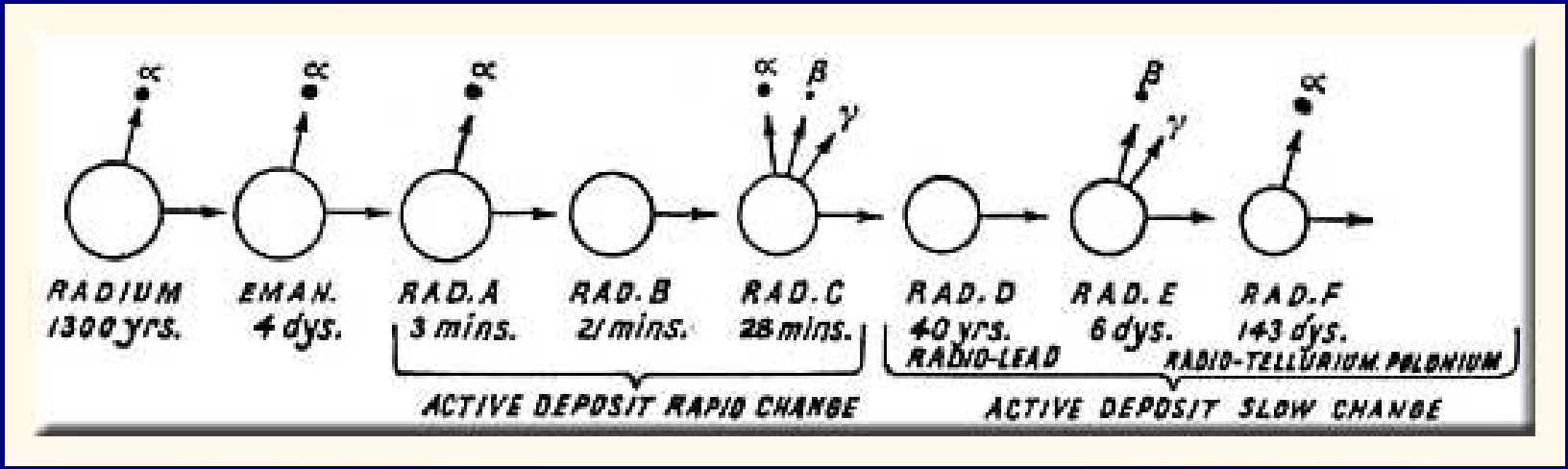


Fig. 1



- Paul Ulrich Villard (1860-1934) felfedezi a γ sugárzást (1900)
- M. Curie szerint a β negatív töltésű, az α is részecskékből áll (1900)
- Becquerel a β-ról megállapítja, hogy hasonlít a katódsugárzáshoz (*e*/*m* arány, 1900)
- felfedezi a radioaktivitás ionizációs, fiziológiai stb. hatásait (1901)

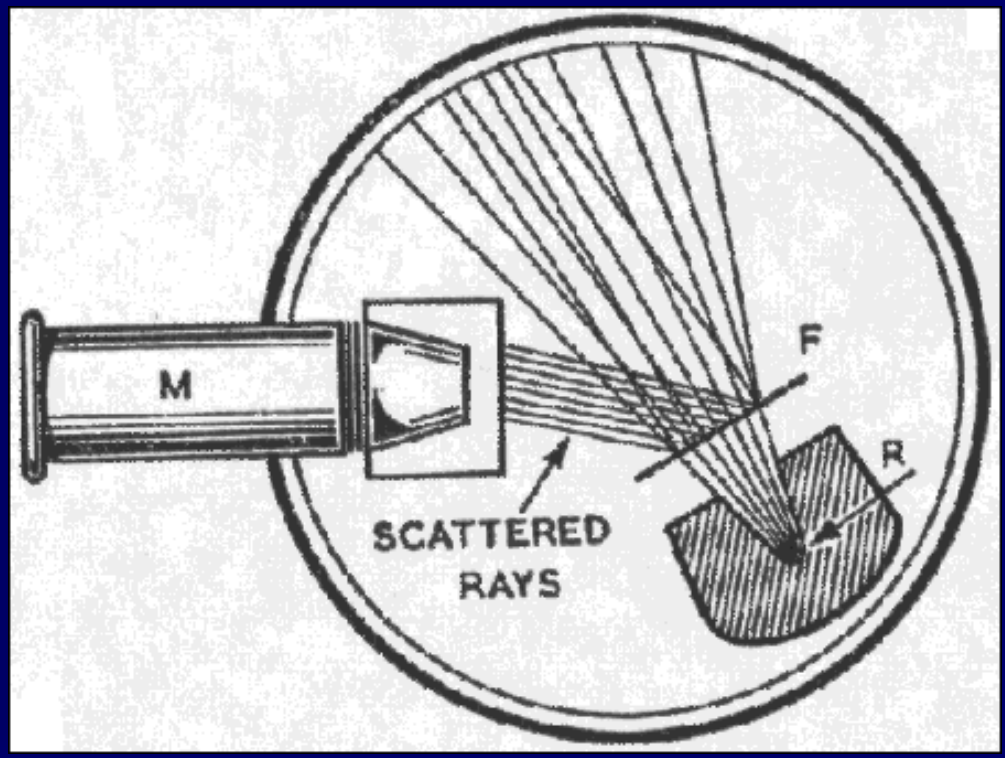
- M. Curie előállítja a tiszta rádiumsót (1902)
- Rutherford megalkotja a radioaktív bomlás elméletét - az atomok átalakulása (1902)



- megállapítja, hogy az α sugarak pozitív töltésű részecskék, megjósolja a transzuránokat (1903)

- Rutherfordék eszközt alkotnak a töltött részecskék észlelésére (Geiger-cső, 1909)
- bebizonyítja, hogy az α részecskék kétszeresen ionizált He atomok
- M. Curie fémrádiumot állít elő (1910)

- Rutherford α bombázással felfedezi a 10^{-12} cm átmérőjű atommagokat (1906-1911)



- Thomson az izotópokat vizsgálja (1911-1913)

- Henry Moseley (1887-1964) röntgen-vizsgálatokkal kimutatja, hogy az atommag töltése azonos
  a rendszámmal (1913)

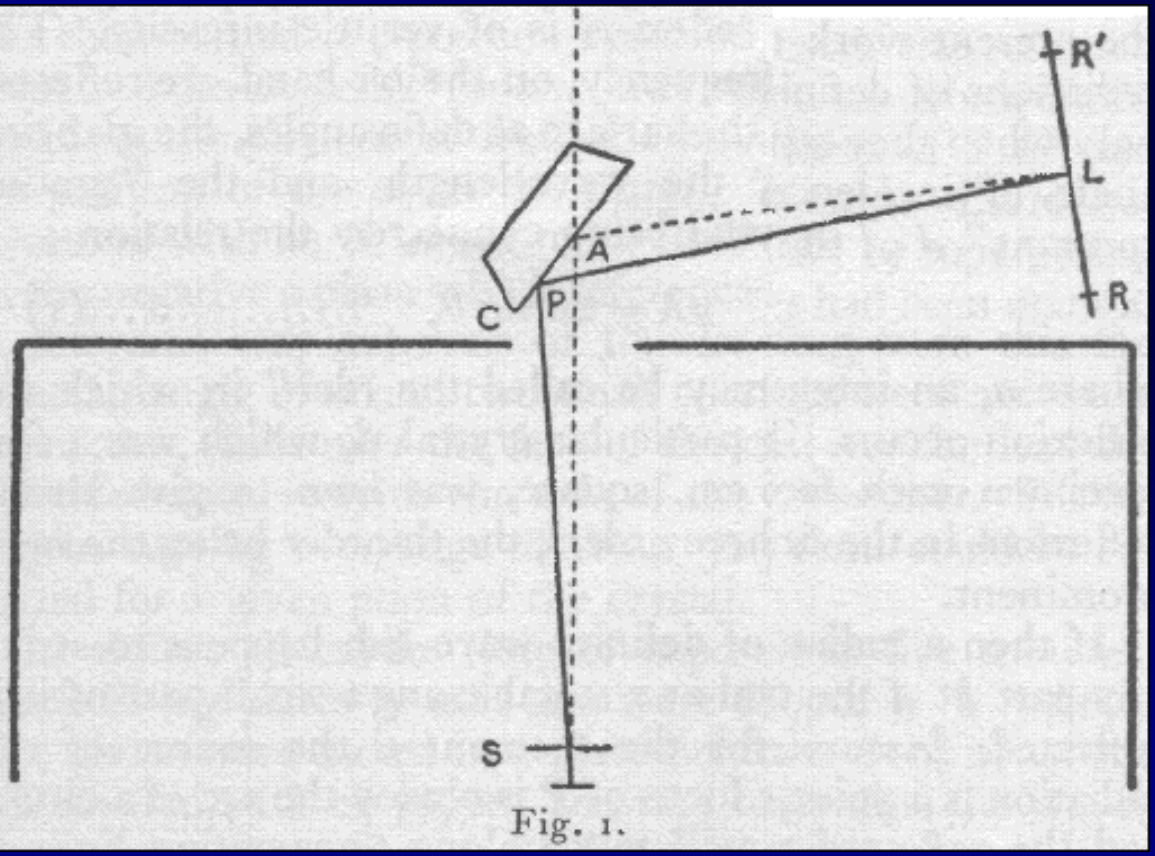


Fig. 1.

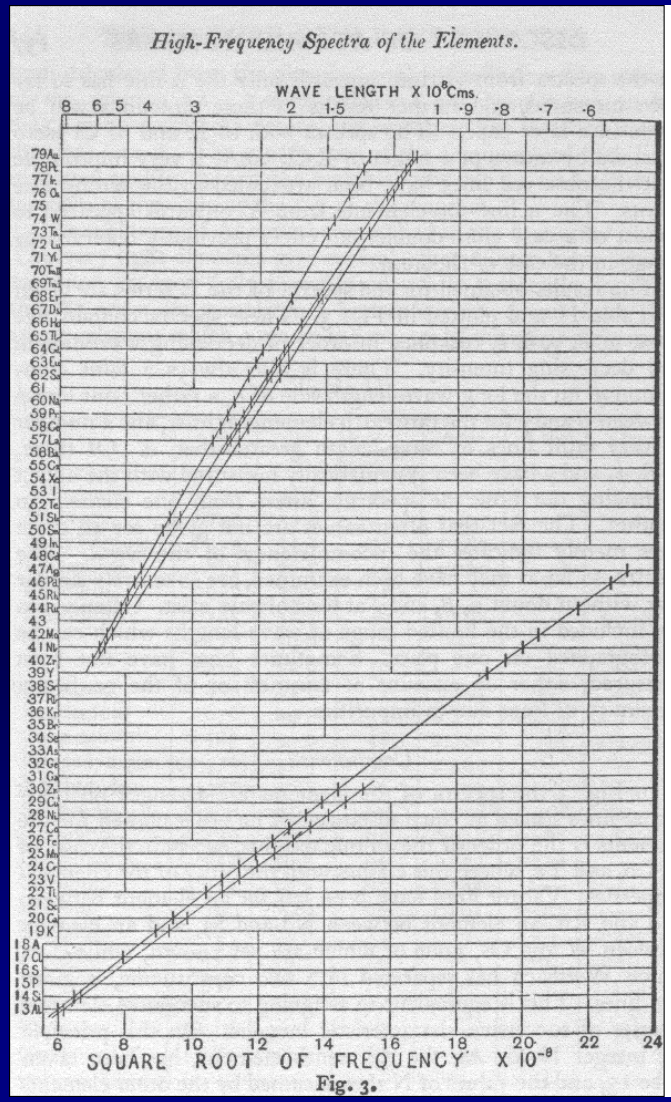
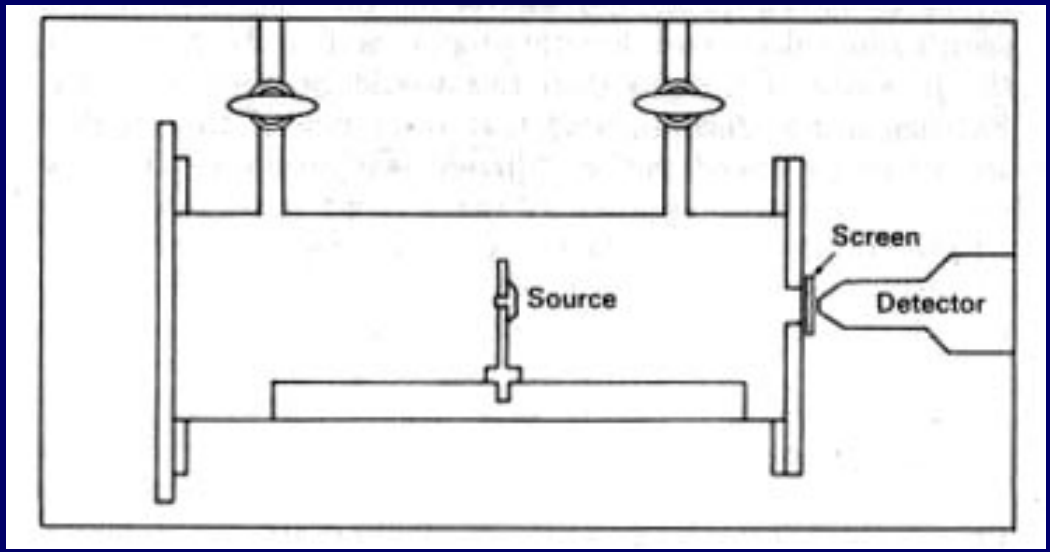


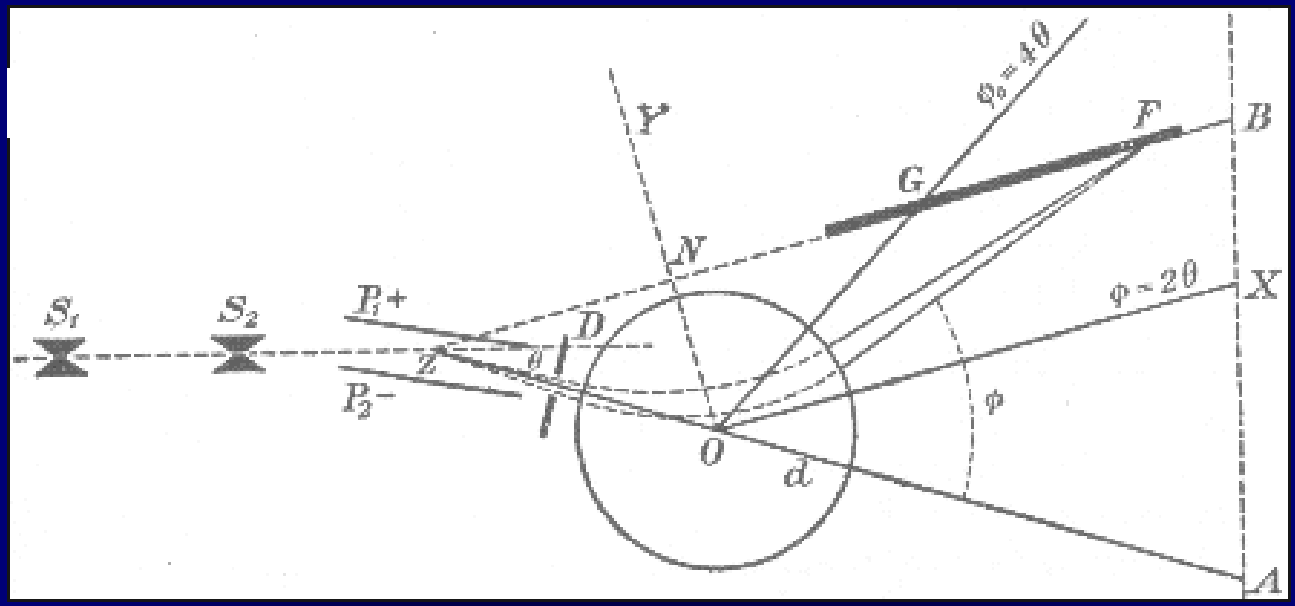
Fig. 3.

- Rutherford végrehajtja az első mesterséges magátalakítást (1919)
  nitrogén-14 + hélium-4 $\rightarrow$
  oxigén-17 + hidrogén-1



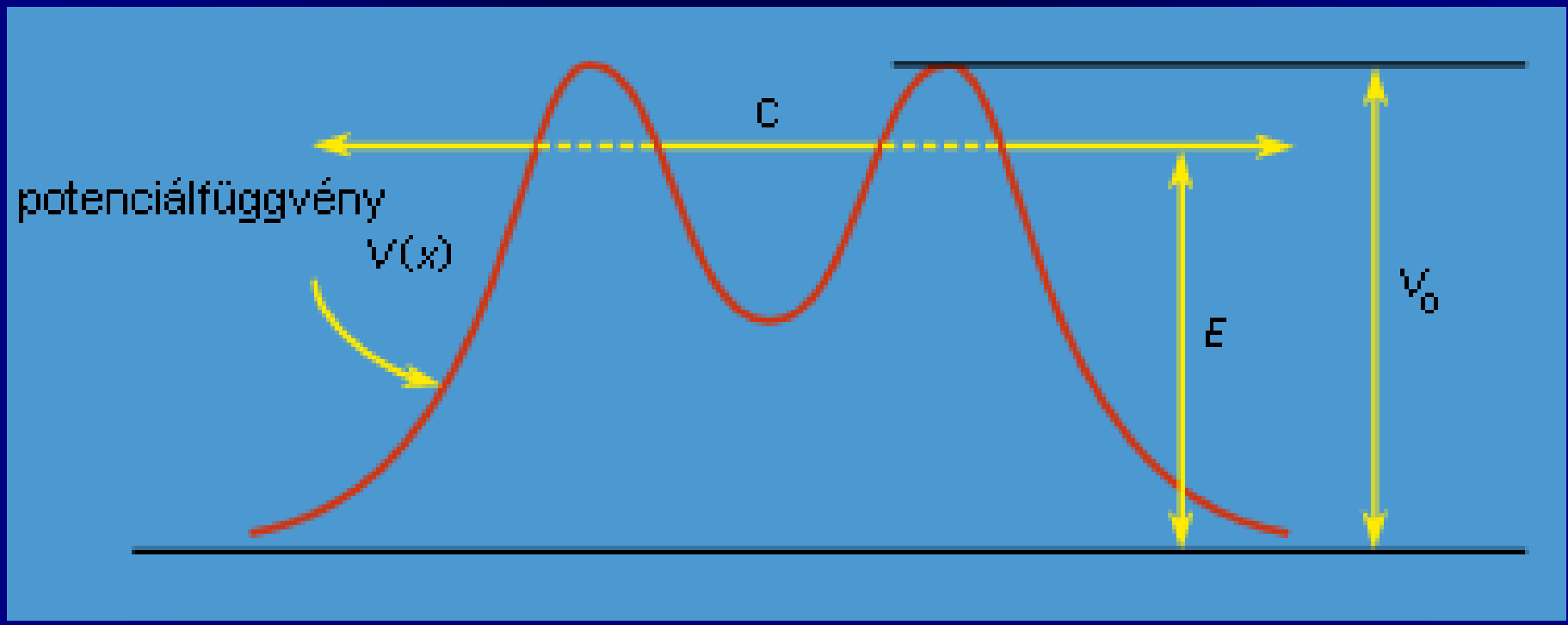
- felfedezi a protont (1914-1920)
- feltételezi a neutron létezését (1920)

- magtömegspektrometria - Francis W. Aston (1877-1945), 1920

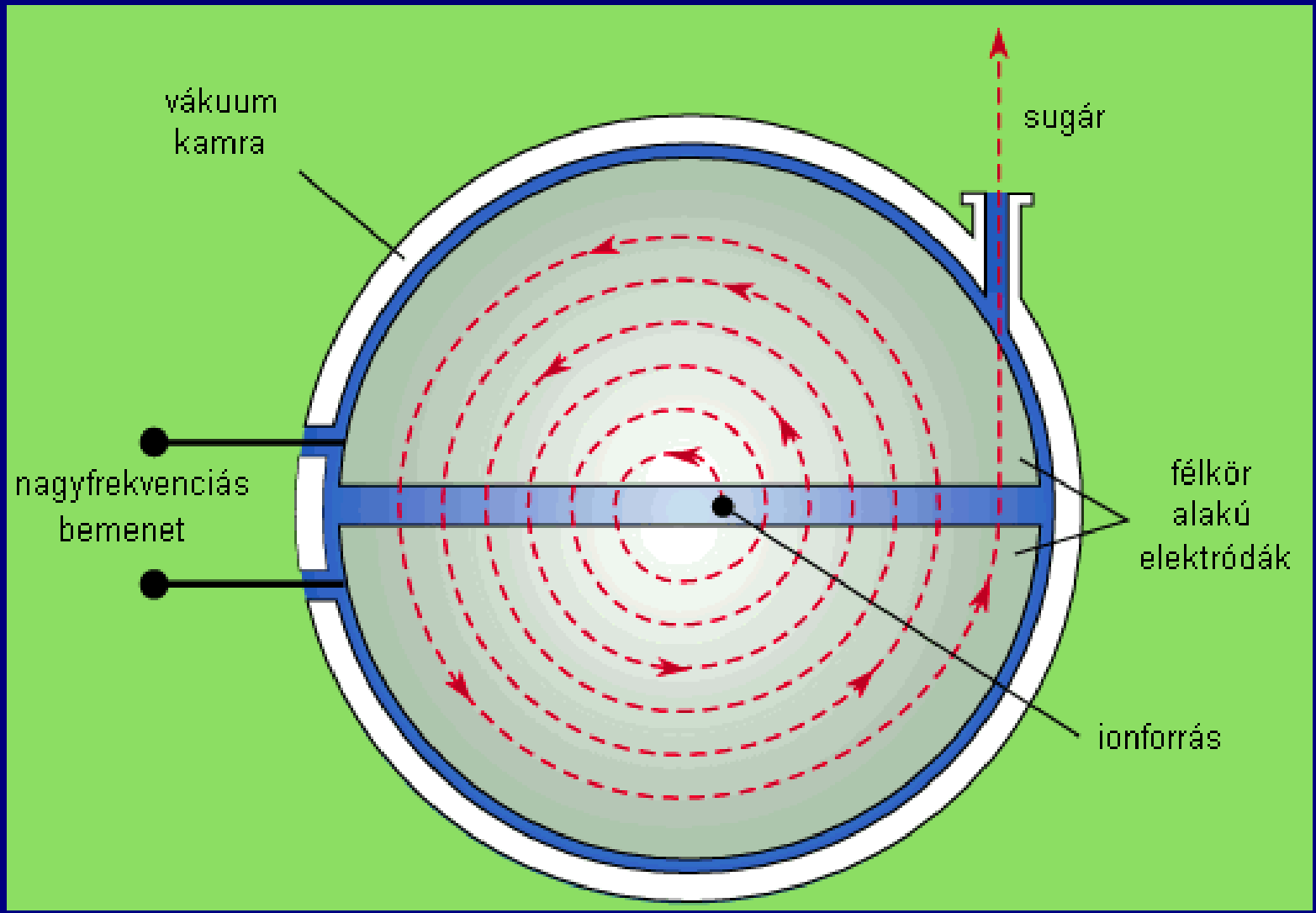


- Wolfgang Pauli (1900-1958) feltevése a magspinről (1924)
- létrejön a kvantummechanika (1925-26)

- az α sugárzás kvantummechanikája: G. Gamow (1907-1968) alagúteffektusként magyarázza (1928)



- gyorsítók: E. O. Lawrence (1901-1958) - Berkeley (1929)



- magspektrum: β sugárzás → neutrino - Wolfgang Pauli (1900-1958), 1926-1931

Abschrift/15.12.30 PW

Offener Brief an die Gruppe der Radioaktiven bei der Gauvereins-Tagung zu Tübingen.

Abschrift

Physikalisches Institut
der Eidg. Technischen Hochschule
Zürich

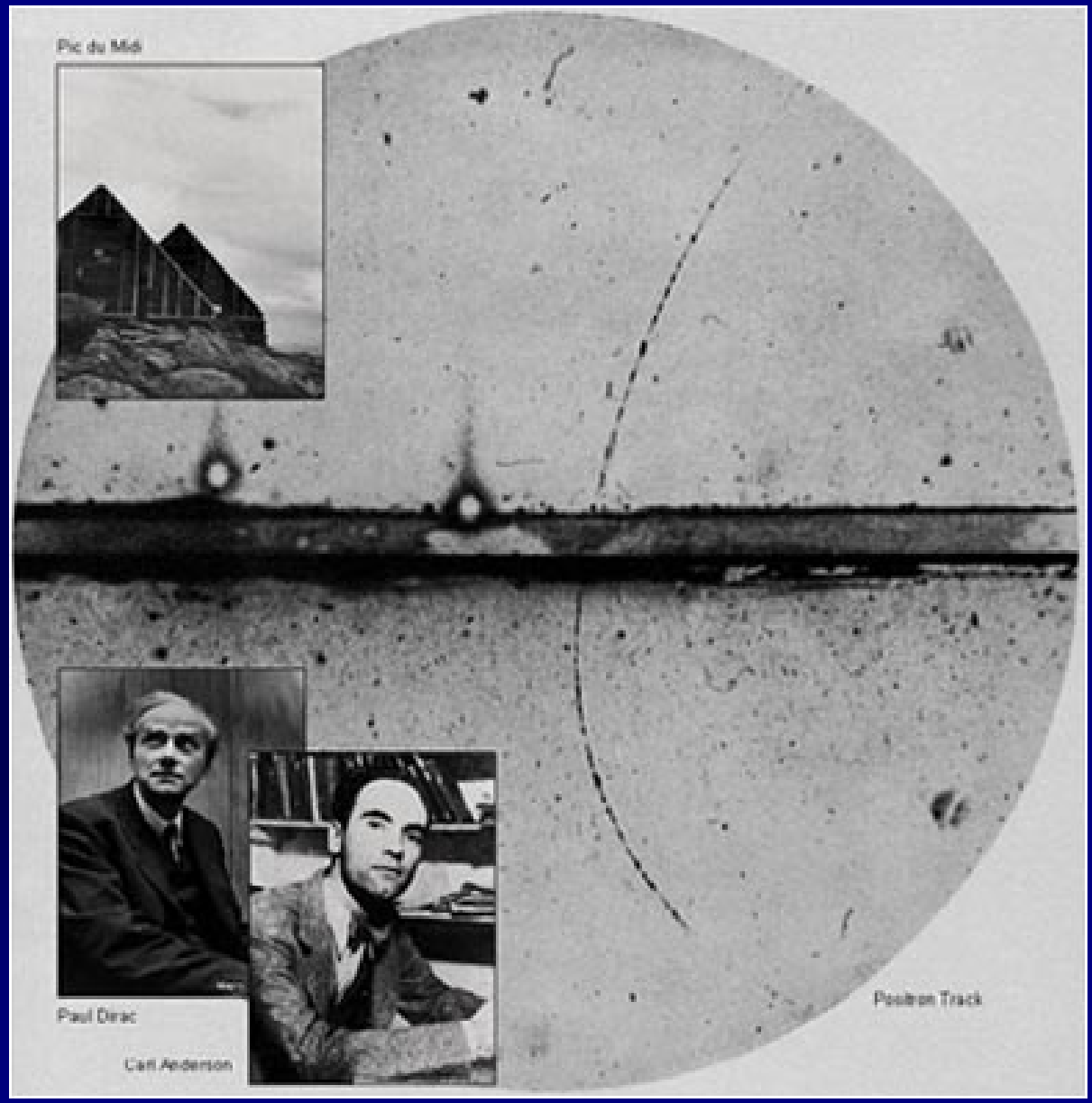
Zürich, 4. Dez. 1930
Gloriastrasse

Liebe Radioaktive Damen und Herren,

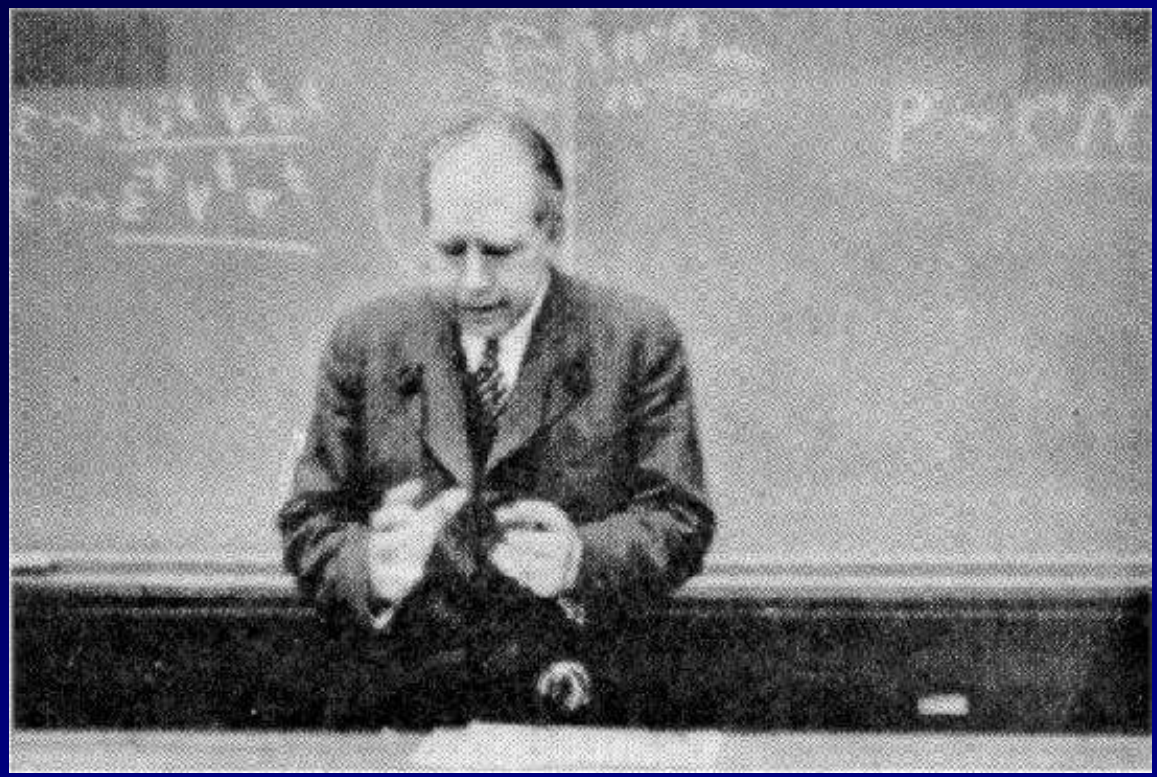
Wie der Ueberbringer dieser Zeilen, den ich huldvollst anzuhören bitte, Ihnen des näheren auseinandersetzen wird, bin ich angesichts der "falschen" Statistik der N- und Li-6 Kerne, sowie des kontinuierlichen beta-Spektrums auf einen verzweifelten Ausweg verfallen um den "Wechselsatz" (1) der Statistik und den Energiesatz zu retten. Nämlich die Möglichkeit, es könnten elektrisch neutrale Teilchen, die ich Neutronen nennen will, in den Kernen existieren, welche den Spin 1/2 haben und das Ausschliessungsprinzip befolgen und sich von Lichtquanten ausserdem noch dadurch unterscheiden, dass sie nicht mit Lichtgeschwindigkeit laufen. Die Masse der Neutronen müsste von derselben Grössenordnung wie die Elektronenmasse sein und jedenfalls nicht grösser als 0,01 Protonenmasse.- Das kontinuierliche beta- Spektrum wäre dann verständlich unter der Annahme, dass beim beta-Zerfall mit dem Elektron jeweils noch ein Neutron emittiert wird, derart, dass die Summe der Energien von Neutron und Elektron konstant ist.

- Bohr magfizikával foglalkozik (1930-)
- John Douglas Cockroft (1897-1967) és Ernest Walton (1903-1995) protonbombázással felhasítják a litium (majd a bór) magját (1932)
  $p + Li\text{-}7 \rightarrow \alpha + \alpha$
- neutron - James Chadwik (1891-1974), 1932

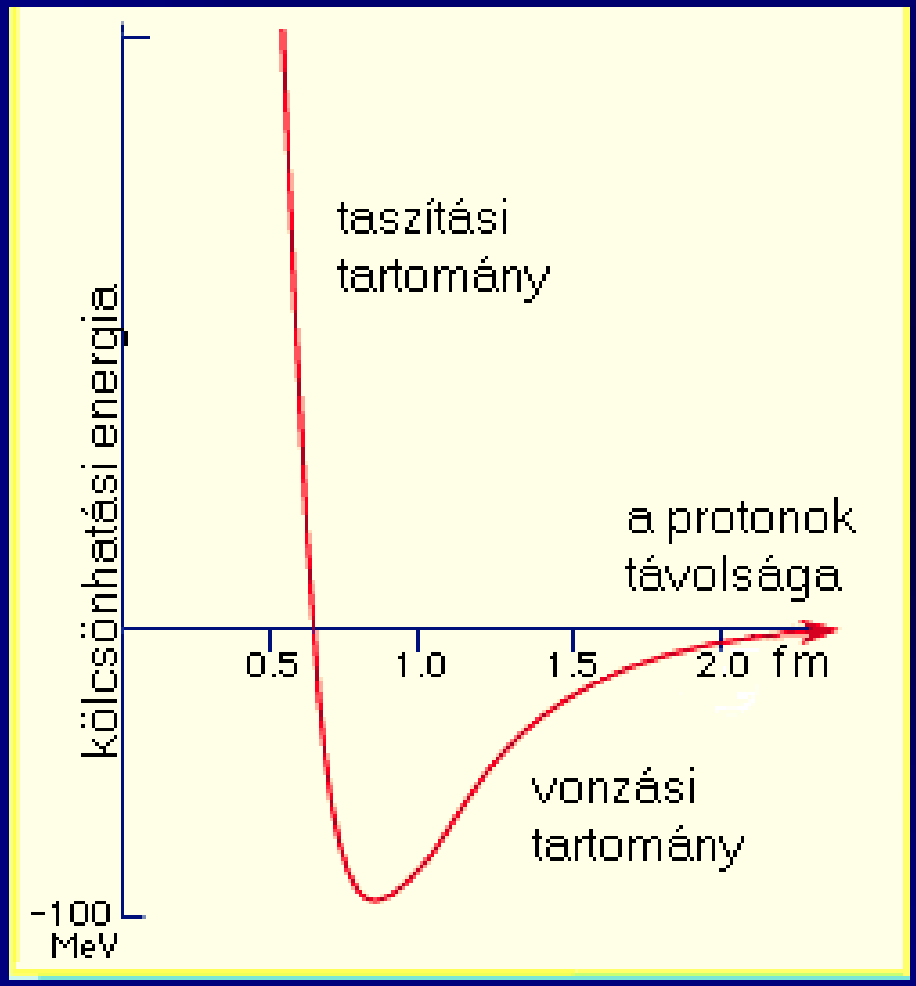
- kozmikus sugárzás, pozitron – P. A. M. Dirac (1902-1984), C. D. Anderson (1905-1991), 1932

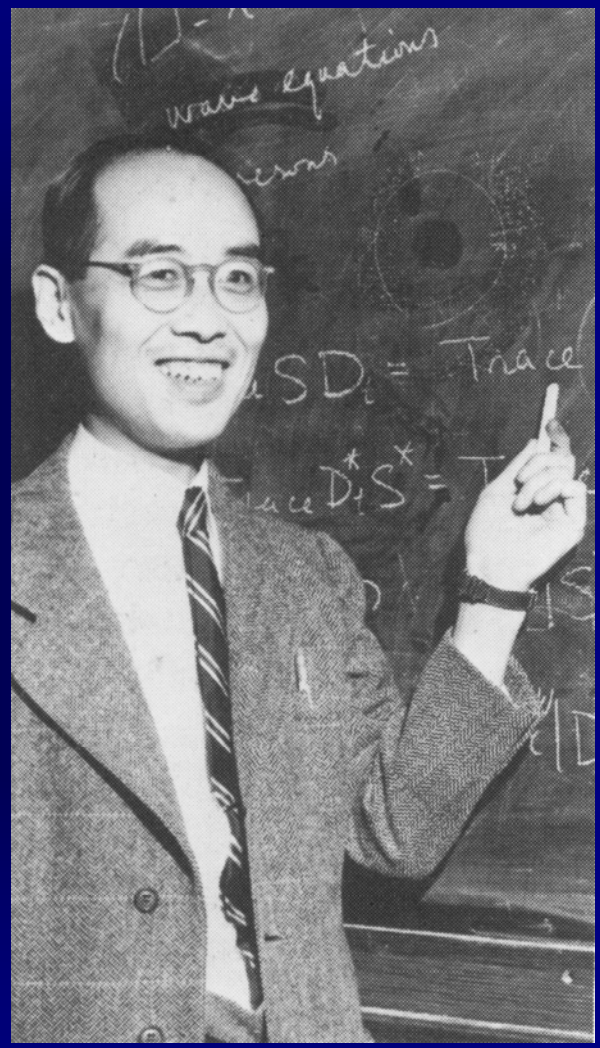


- Rutherford igazolja a tömeg-energia ekvivalenciát magátalakuláskor (1933)
- Bohr felvázolja az atommag folyadékcsepp modelljét (1936)

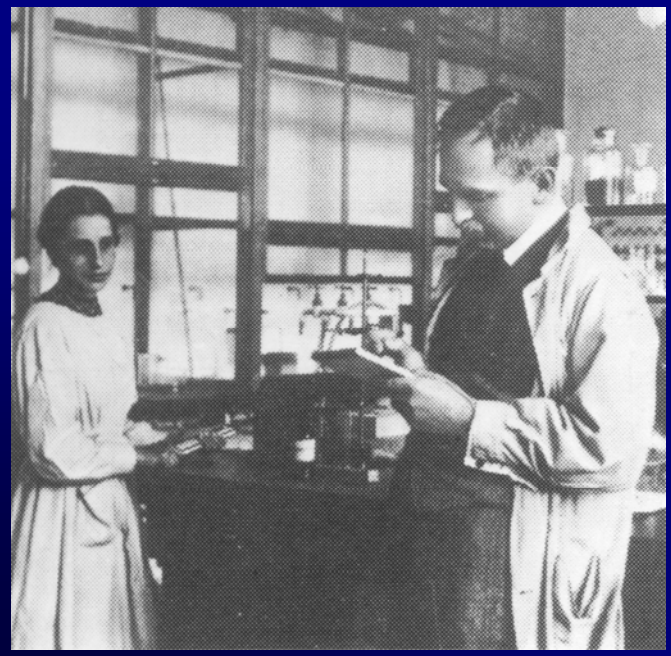


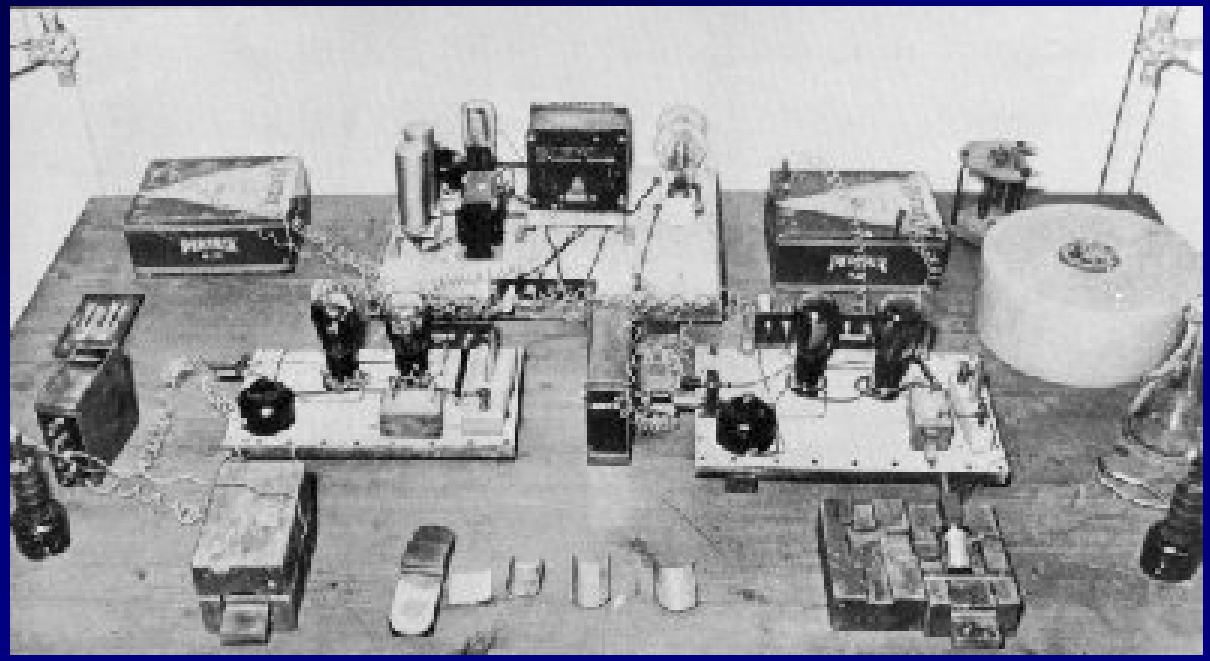
- Magerők, mezonok (1936-): H. Yukawa (1907-1981)



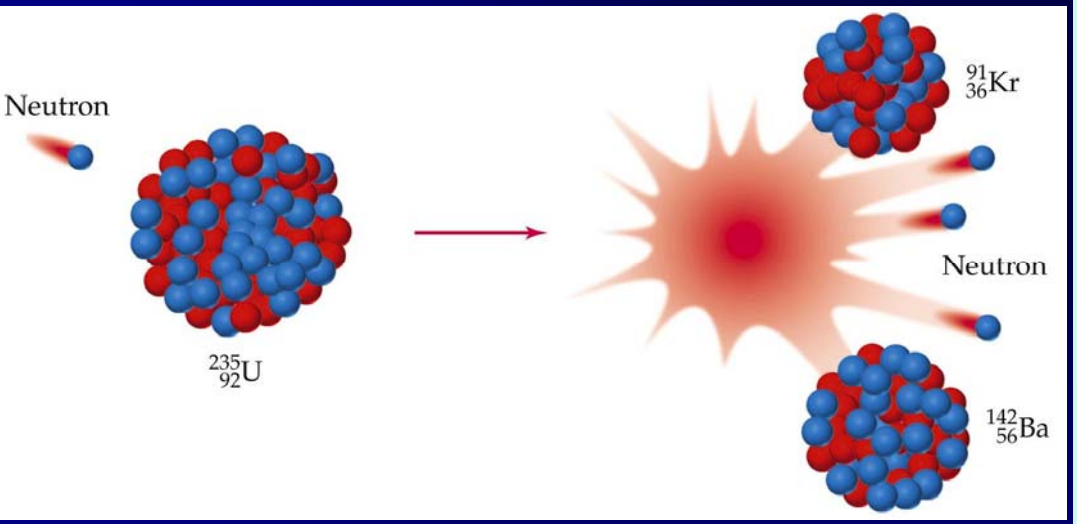


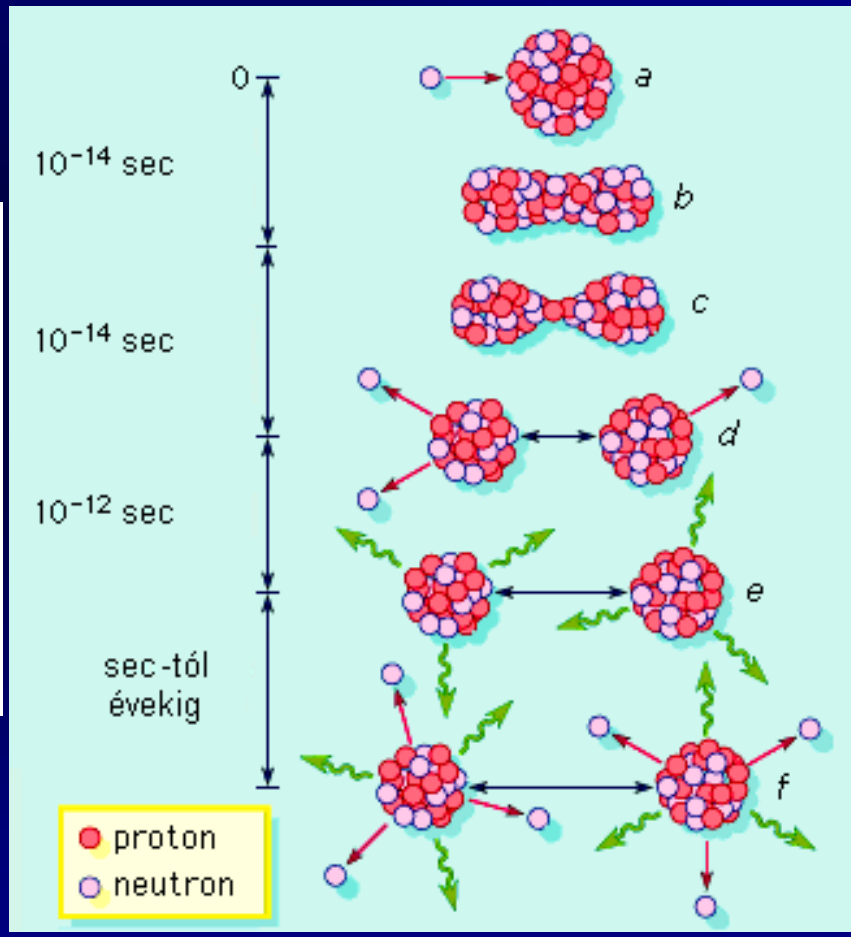
- Maghasadás (urán + neutron, 1938): O. Hahn (1879 -1968), L. Meitner (1878-1968)



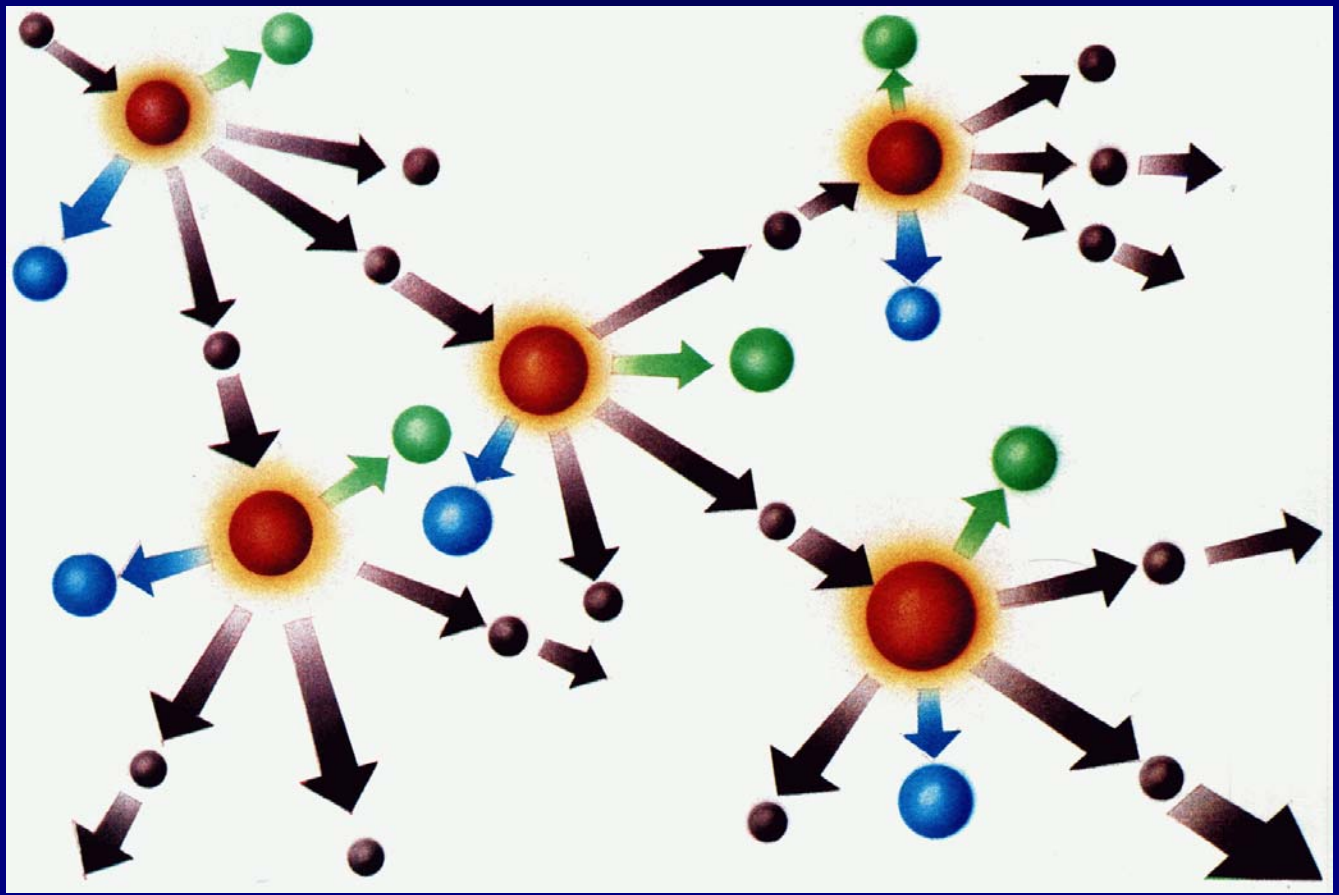


- Bohr és John A. Wheeler (1911-) a cseppmodelben értelmezik a maghasadást (1939)





- Enrico Fermi (1901-1954), Frédérick Joliot-Curie (1900-1958), Szilárd Leó (1898-1964) és mások – a láncreakció (1933-1939)



- Albert Einstein (1879-1955), Szilárd, Teller Ede (1908-2003) és Wigner Jenő (1902-1995) – levél F. D. Rooseveltthez (1939)

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 inofficial 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.

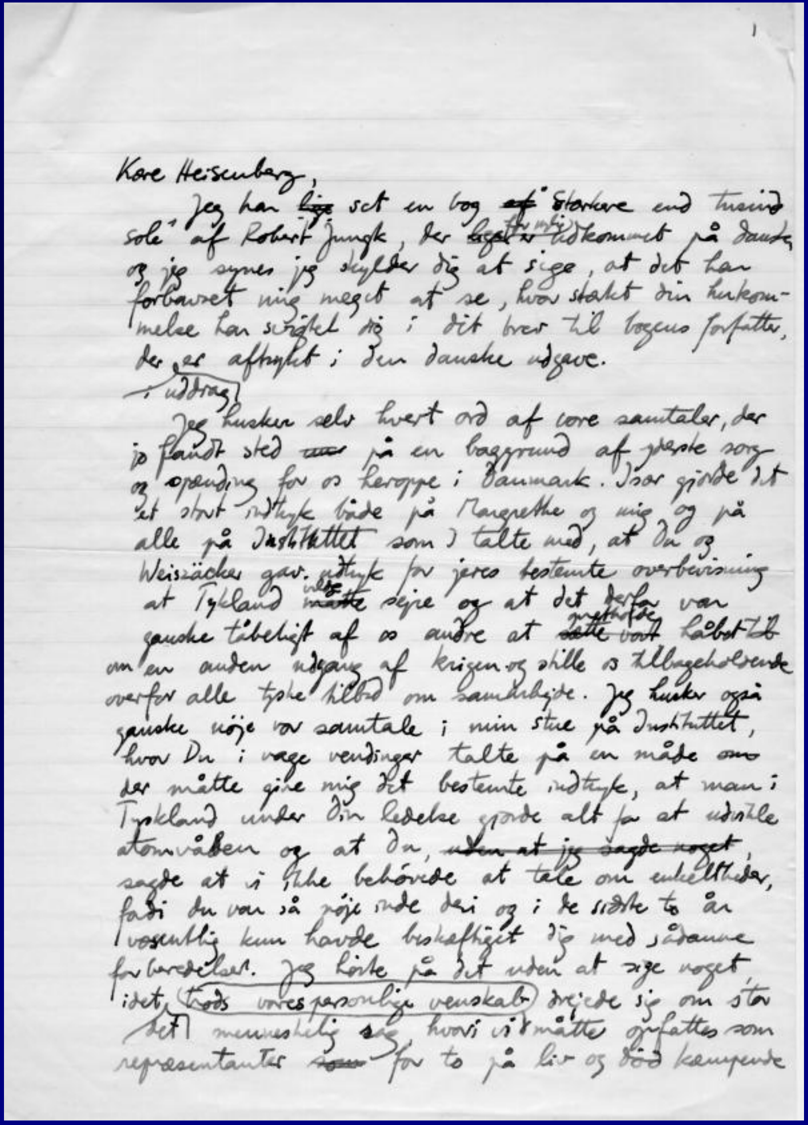
I understand that Germany has actually stopped the sale of uranium from the Czechoslovakian mines which she has taken over. That she should have taken such early action might perhaps be understood on the ground that the son of the German Under-Secretary of State, von Weizsäcker, is attached to the Kaiser-Wilhelm-Institut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

Yours very truly,

A. Einstein

(Albert Einstein)

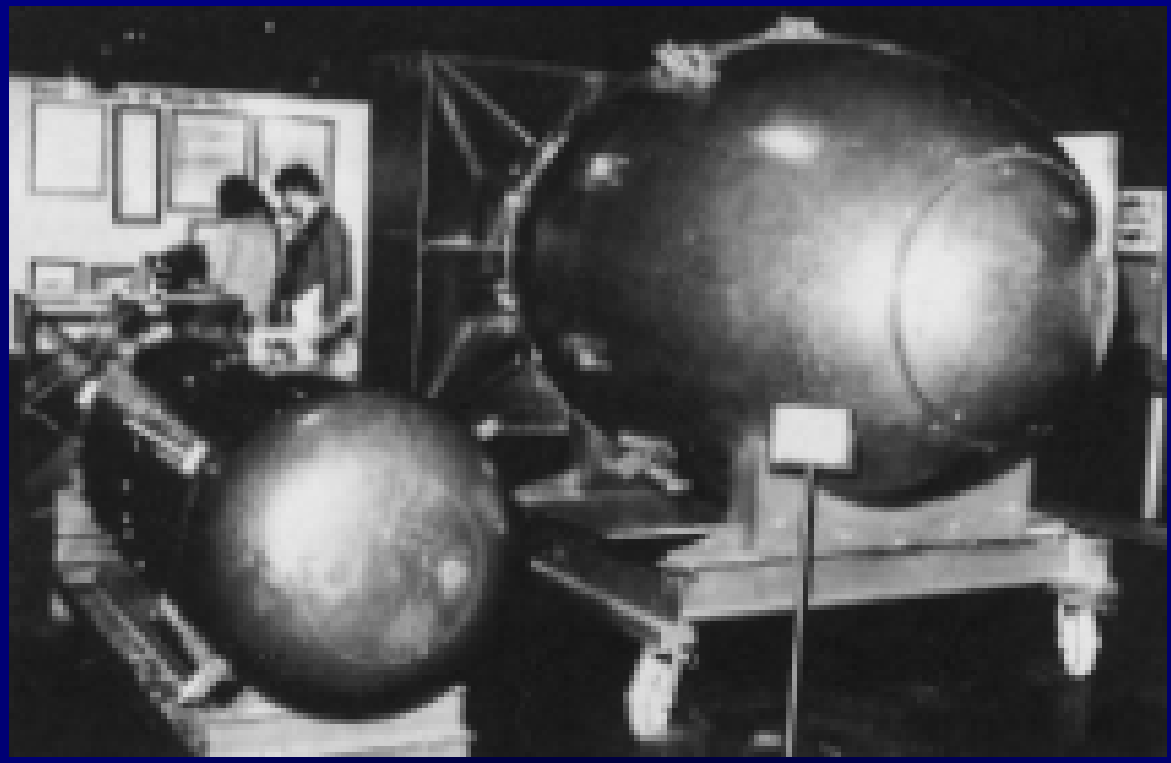
- Louis A. Turner (1898-?) és Glenn T. Seaborg (1912-1999) a plutóniumról (1940-41)
- Bohr és Heisenberg találkozója a megszállt Koppenhágában (1941) [Michael Frayn: Copenhagen]

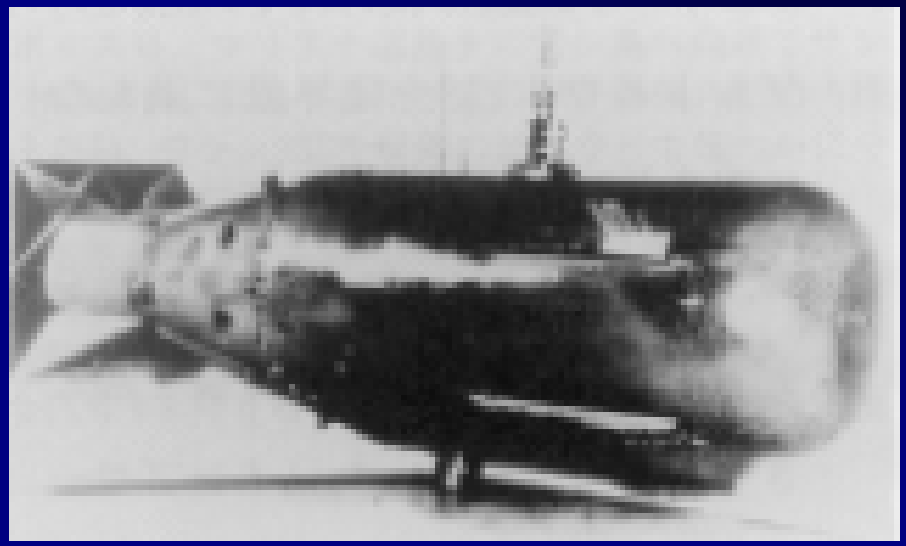


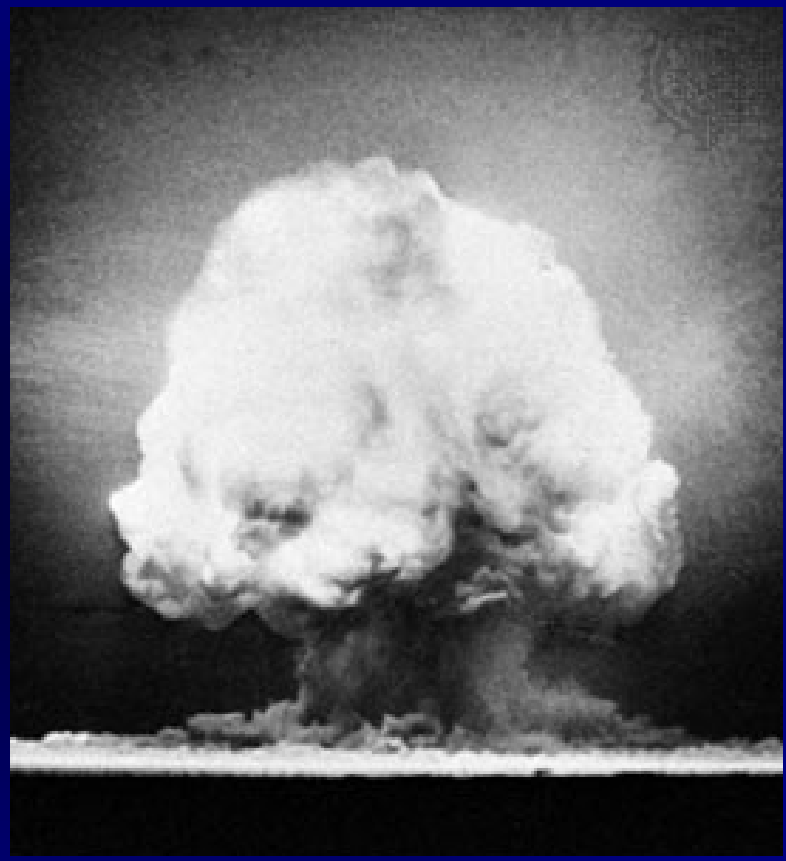
1

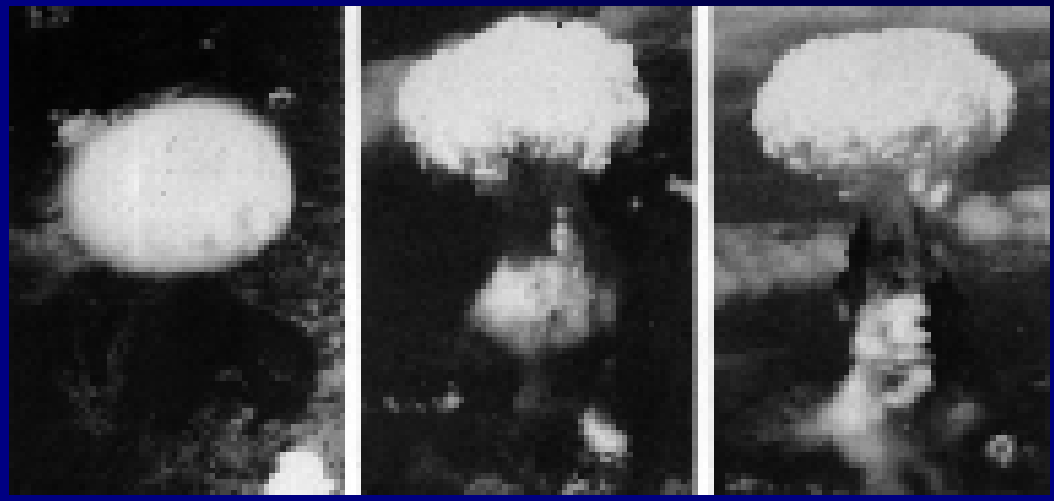
Kære Heisenberg,
Jeg har ~~lige~~ set en bog ~~af~~ "Stærkere end tusind sole" af Robert Jungk, der ~~lige~~ nylig udkommet på dansk, og jeg synes jeg skylder dig at sige, at det har forbavset mig meget at se, hvor stærkt din hukommelse har svigtet dig i dit brev til bogens forfatter, der er aftrykt i den danske udgave (i uddrag).
Jeg husker selv hvert ord af vore samtaler, der jo fandt sted på en baggrund af yderste sorg og spænding for os heroppe i Danmark. Især gjorde det et stort indtryk både på Margrethe og mig og på alle på Instituttet som I talte med, at Du og Weizsäcker gav udtryk for jeres bestemte overbevisning at Tyskland ~~måtte~~ ville sejre og at det derfor var ganske tåbeligt af os andre at [illegible] om en anden udgang af krigen og stille os tilbageholdende overfor alle tyske tilbud om samarbejde. Jeg husker også ganske nøje vor samtale i min stue på Instituttet, hvor Du i vage vendinger talte på en måde som der måtte give mig det bestemte indtryk, at man i Tyskland under din ledelse gjorde alt for at udvikle atomvåben og at du, ~~uden at jeg sagde noget,~~ sagde at i ikke behøvede at tale om enkeltheder, fordi du var så nøje inde deri og i de sidste to år væsentlig kun havde beskæftiget dig med sådanne forberedelser. Jeg hørte på det uden at sige noget idet (trods vores personlige venskab) drejede sig om stor det menneskelig sag, hvori vi måtte opfattes som repræsentanter ~~som~~ for to på liv og død kæmpende

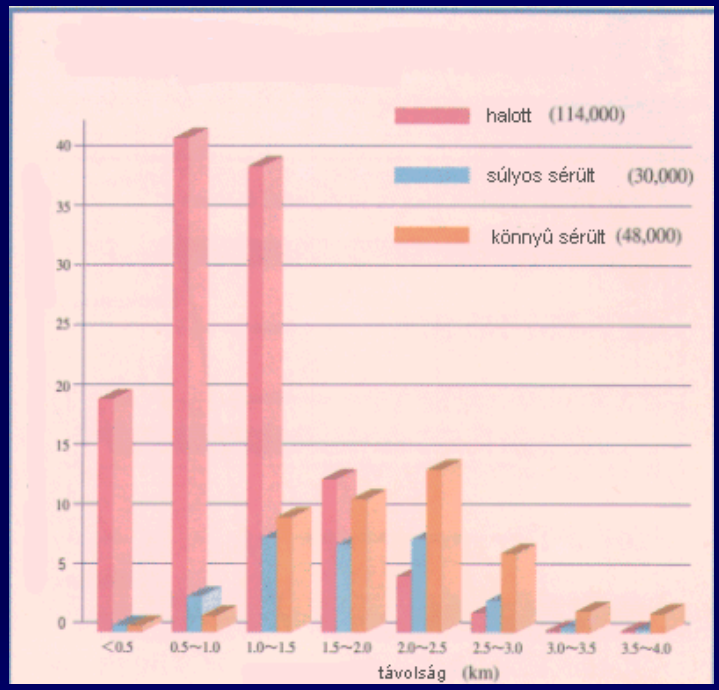
- A Manhattan-terv (1942-1945)
  - Leslie R. Groves (1896-1970)
  - uránszeparáció – Oak Ridge
  - a plutónium előállítása – Hanford – Compton
  - a bomba elkészítése – Los Alamos – Julius Robert Oppenheimer (1904-1967)
  - A Trinity kísérleti robbantás – Alamogordo (1945. július 16. 5:30)
  - A döntés
  - Hirosima (1945. augusztus 6.)










halott (114,000)
súlyos sérült (30,000)
könnyû sérült (48,000)
40
35
30
25
20
15
10
5
0
<0.5
0.5~1.0
1.0~1.5
1.5~2.0
2.0~2.5
2.5~3.0
3.0~3.5
3.5~4.0
távolság (km)


缶詰の缶

- az önálló brit bomba (1946-54)
- a szovjet bomba (1939-49)
- A hidrogén-bomba és a hidegháború
  - USA (1941-54)
  - SZU (1948-55)
- áramtermelő reaktorok
  - a reaktorépület világítására – Idaho, 1951
  - villamos hálózatba kötve – Obnyinszk, 1954
  - balesetek – Windscale, 1957; Three Miles Island, 1979; Csernobil, 1986

- fúziós erőmű
  - TOKAMAK (Szaharov, 1950-es évek eleje - ITER, 2016)
  - lézeres megoldás