On the 75th anniversary of the discovery of SF. History. Known and unknown facts

Sergey Khlebnikov
V.G. Khlopin Radium Institute

Nucleus-2015
St-Petersburg

G.N.Flerov and K.A.Petrzhak

HISTORY. 1920th - 1940

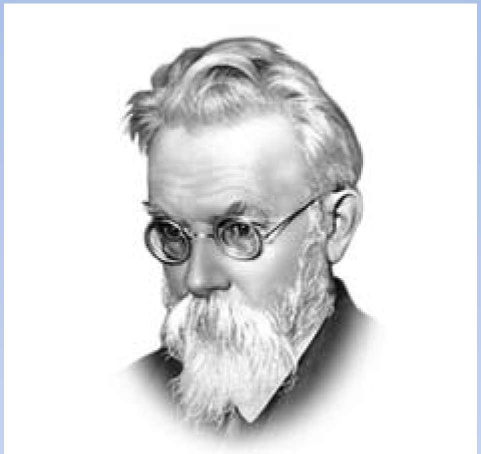
Theoretical investigations: high level
Gamov (1928)
Ivanenko (1932)
Tamm (1934)

Experiments: 1920-s - very hard situation
(there was nothing (accelerators.
natural sources of radioactivity…))

Radium Institute. Creation

Radium Institute was founded in 1922 by initiative of academician V.I. Vernadsky and under his leadership by the means of integration of all radiological enterprises available by that time in Petrograd:
Radium Laboratory under the Academy of Sciences,
Radium Division of the State Roentgenological and Radiological Institute,
and Radiochemical Laboratory.
The **State Radium Institute** became a center where the russian nuclear science and engineering were born and being developed

Radium Institute. Creation



Vernadsky Vladimir I. 1863-1945

The founder and First Director of the Radium Institute (1922-1939)
Founder of many radiological facilities in the country.
The great scientist and lexicographer, a geologist, chemist,
one of the founders of radiogeology and biogeochemistry.
Appreciated the practical significance of radioactivity,
and put a lot of effort to the theoretical and practical use of this phenomenon.

Khlopin Vitaly G. 1890-1950

Director of the Radium Institute (1939 – 1950).
The first Head of Department of Radiochemistry.
Largest Russian chemist, creator of the national radiochemistry and radiochemical techniques.
Together with Vernadsky founded the Radium Institute.
Creator of the national Ra and He industry. Received the first Soviet radium.
Established the law of distribution of microcomponents between the solid and liquid phases.
Provided the scientific management in the development of chemical and technological part of the Soviet atomic project.
Founded a school of domestic radiochemistry.

KHLOPIN RADIUM INSTITUTE HISTORY

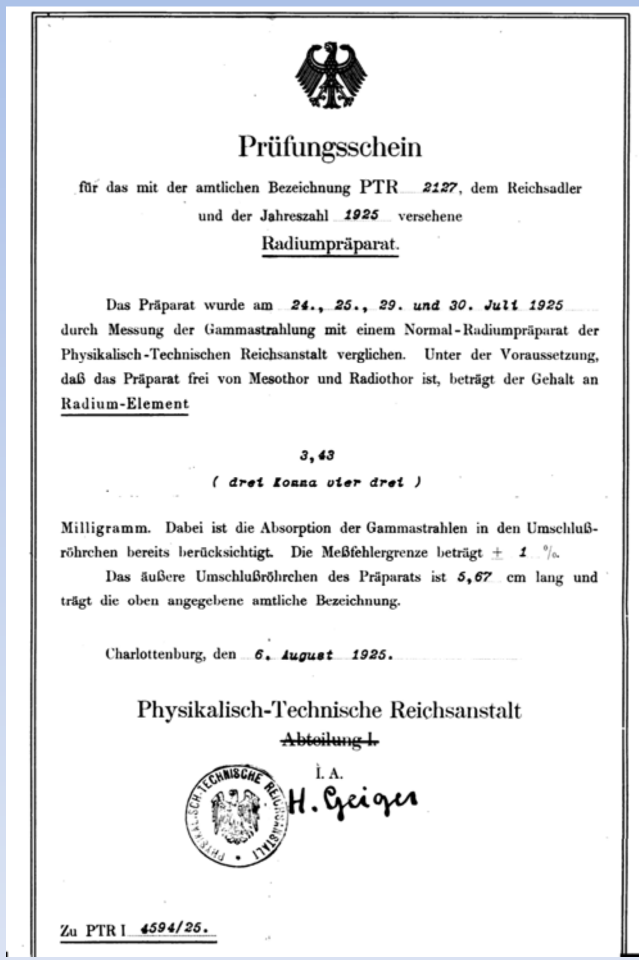
Comprehensive approach to the problem of radioactivity was characteristic for the founders of the Institute and predetermined also comprehensive structure of the Institute, based on combination of physical, chemical, and radiogeochemical investigations.

Native radiochemistry as a science arose within the walls of the Institute.
In 20-30-s V.G. Khlopin and his progeny ascertained general behavior of co-precipitation, sorption, and liquid radioelement extraction processes, which were later taken as a base for commercial radiochemical technologies.
Creation of native radium industry and the State radium Fund (middle 20-s) were the main practical results of Institute's working already in early years of its activity

Fundamental researches were carried out by I.E. Starik and his teammates in radiocolloids and adsorption of radionuclide microquantities.
These works formed a basis for further studies on contaminations and decontamination.

Radium Institute was a place, where the native physics of atomic nuclei was started.
Just here in the end of 20-s the theory of alpha decay was created by G.A. Gamov.
In 1937 L.V. Mysovskiy and I.V. Kurchatov put into operation the first in Europe cyclotron.
In 1940 K.A. Petrzhak and G.N. Flerov discovered a phenomenon of spontaneous fission.
The base of native neutron physics, fission physics, and non-destructive gamma test were also formed at the Institute.

Certificates for products from Ra manufactured in the Radium Institute signed by H. Geiger (left) and Marie Curie (right)



Prüfungsschein

für das mit der amtlichen Bezeichnung PTR 2127, dem Reichsadler und der Jahreszahl 1925 versehene

Radiumpräparat.

Das Präparat wurde am 24., 25., 29. und 30. Juli 1925 durch Messung der Gammastrahlung mit einem Normal-Radiumpräparat der Physikalisch-Technischen Reichsanstalt verglichen. Unter der Voraussetzung, daß das Präparat frei von Mesothor und Radiothor ist, beträgt der Gehalt an Radium-Element

3,43

(drei Komma vier drei)

Milligramm. Dabei ist die Absorption der Gammastrahlen in den Umschluß-röhrchen bereits berücksichtigt. Die Meßfehlergrenze beträgt ± 1 %.

Das äußere Umschlußröhrchen des Präparats ist 5,67 cm lang und trägt die oben angegebene amtliche Bezeichnung.

Charlottenburg, den 6. August 1925.

Physikalisch-Technische Reichsanstalt

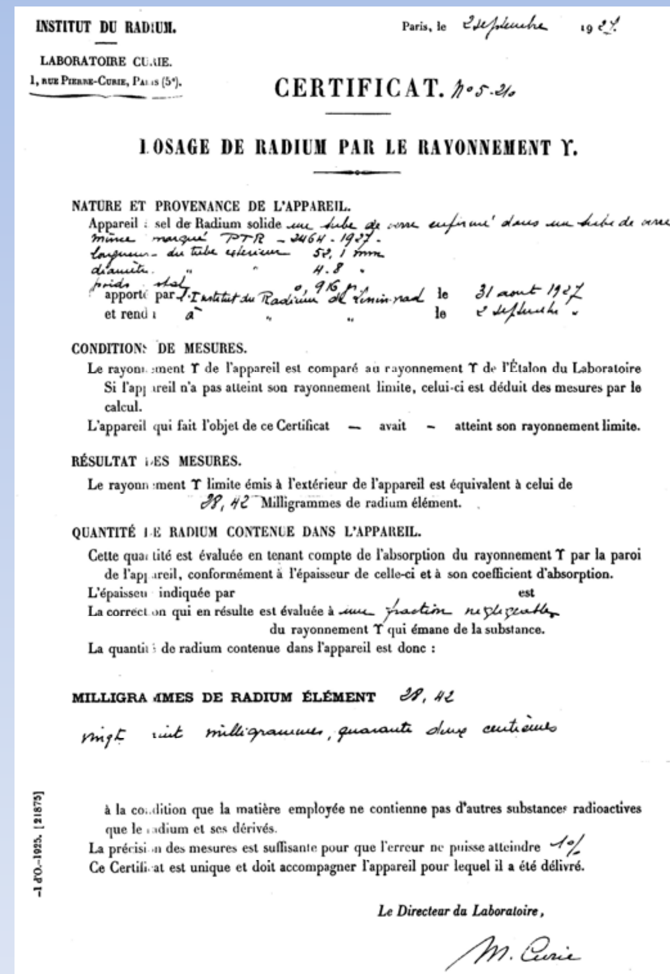
~~Abteilung I.~~

I. A.

H. Geiger

Physikalisch-Technische Reichsanstalt

Zu PTR I 4594/25.



INSTITUT DU RADIUM.

LABORATOIRE CURIE.

1, rue Pierre-Curie, Paris (5e).

Paris, le 2 septembre 1927

CERTIFICAT. N° 5-210

DOSAGE DE RADIUM PAR LE RAYONNEMENT γ.

NATURE ET PROVENANCE DE L'APPAREIL.

Appareil : sel de Radium solide un tube de verre enfermé dans un tube de verre mince marqué PTR - 2464 - 1927.
longueur du tube extérieur 53,1 mm
diamètre " " 4.8 "
poids total 0,916 gr
apporté par l'Institut du Radium de Leningrad le 31 aout 1927
et rendu à " " le 2 septembre "

CONDITIONS DE MESURES.

Le rayonnement γ de l'appareil est comparé au rayonnement γ de l'Étalon du Laboratoire

Si l'appareil n'a pas atteint son rayonnement limite, celui-ci est déduit des mesures par le calcul.

L'appareil qui fait l'objet de ce Certificat — avait — atteint son rayonnement limite.

RÉSULTAT DES MESURES.

Le rayonnement γ limite émis à l'extérieur de l'appareil est équivalent à celui de 28,42 Milligrammes de radium élément.

QUANTITÉ DE RADIUM CONTENUE DANS L'APPAREIL.

Cette quantité est évaluée en tenant compte de l'absorption du rayonnement γ par la paroi de l'appareil, conformément à l'épaisseur de celle-ci et à son coefficient d'absorption.

L'épaisseur indiquée par est

La correction qui en résulte est évaluée à une fraction négligeable du rayonnement γ qui émane de la substance.

La quantité de radium contenue dans l'appareil est donc :

MILLIGRAMMES DE RADIUM ÉLÉMENT 28,42

vingt huit milligrammes, quarante deux centièmes

à la condition que la matière employée ne contienne pas d'autres substances radioactives que le radium et ses dérivés.

La précision des mesures est suffisante pour que l'erreur ne puisse atteindre 1%

Ce Certificat est unique et doit accompagner l'appareil pour lequel il a été délivré.

-I d'O.-1925. [21873]

Le Directeur du Laboratoire,

M. Curie

Physical experiments
in the Radium Institute
1920-30-s

Myssowsky Lev V. 1888-1939

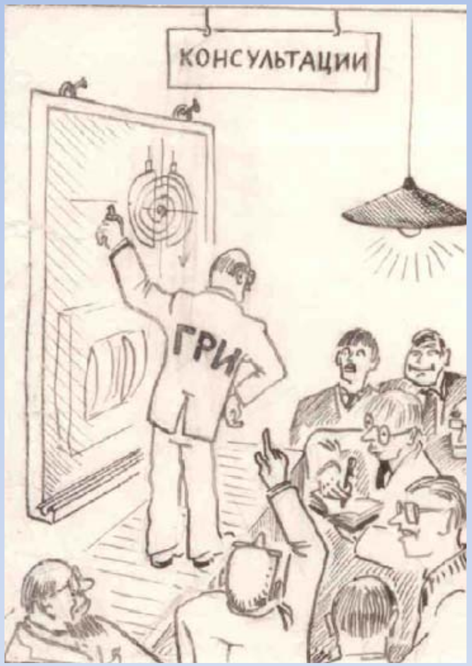
The first Head of Department of physics of the Radium Institute.

Research in nuclear physics and on cosmic rays.
Initiated work on construction of the first in Europe cyclotron.
Proposed the method of thick photographic emulsions,
the method of γ - ray defectoscopy.
Discovered the nuclear isomers.
Created the setup for the separation of Rn from Ra.

Lev Myssowsky (Mysovskiy) Lev Vladimirovich

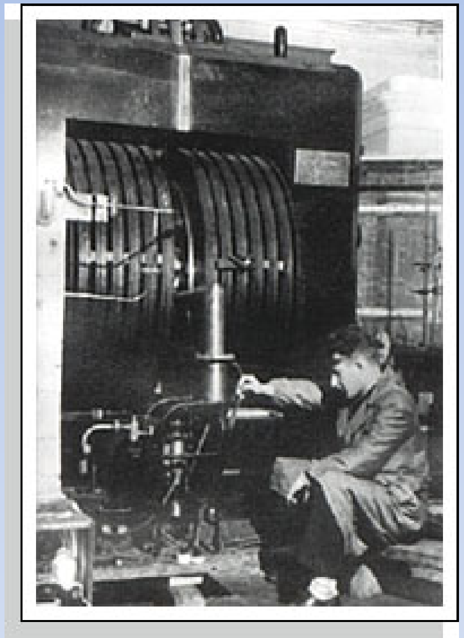
Head of the Department of Physics. Born in February 18, 1888 in Saratov. In 1914 he graduated from St. Petersburg University and was left at the University. From 1918 to 1922 he worked in the X-ray and Radiological Institute; from 1922 to 1939 - Head of the Department of Physics of the Radium Institute. Under his leadership in RIAN created the first in the USSR the setup for Rn production; in 1932-1937 under his leadership i the Institute created the first in the USSR and Europe cyclotronin March-June 1937, the first beam of accelerated protons E = 3.2 MeV has been received. In December 1932 scientific consultant of the group on nuclear physics (deputy. Head of Group – Kurchatov). In 1934 he demonstrated the presence of neutrons in cosmic rays. He developed the techniques for measuring of various types of radiation (widely used in the organization of individual production of the nuclear industry); In 1922, one of the first he put forward the idea of creating a particle accelerator; in 1925, he proposed a method for the detection of charged particles by means of thick photographic emulsions; in 1926 the created method of gamma-radiography; In 1935, together with IV Kurchatov e.a. the nuclear isomers have been discovered, together with IV Kurchatov came to the conclusion that the probability of fast neutrons capture is very small.

Humorous pictures, dedicated to the first All-Union conference on radioactivity in the Radium Institute in 1932

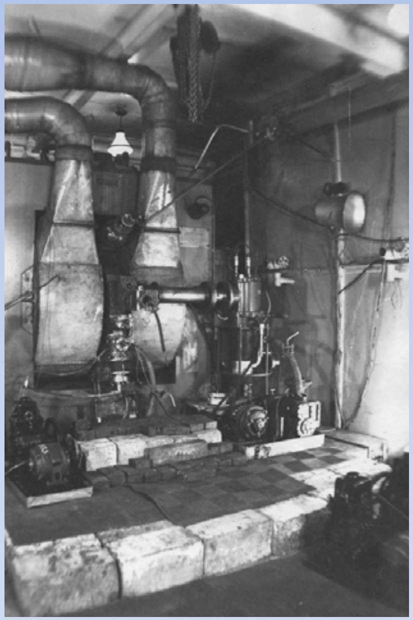


The first in Europe cyclotron of Radium Institute Operated in 1937 - 1976

I. Kurchatov and M.Mesheryakov near the cyclotron (~ 1936)



The cyclotron coils



Vacuum pumps and cooling system

Discovery of the spontaneous fission

K.A. Petrzhak and G.N. Flerov in 1940

Biography of K.A. Petrzhak

K.A.Petrzhak was born on 4 September 1907 in Lukow (Poland, Russian Empire).
In 1914, his family, running away from German troops, went to Russia by train. The train crash killed the entire family, except for KA and his older brother. And for the next 6 years junior Petrzhak was a homeless boy. He was good at drawing, so he earned by painting portraits in trains. And one day his drawing was liked a head person, and he recommended him (by a note) to a porcelain factory. So, he started working as a painter at a porcelain factory in Malaya Vishera (Russia).

In 1928 he went to Saint-Petersburg to study at ”rabfac” of Leningrad State University.

In 1931 he started studying in radiology group there.
In November 1936 K. Petrzhak completed his diploma work under supervision of I. Kurchatov and graduated from University.

In 1934 he started working at Radium Institute. Here he worked till the last days of his life. I. Kurchatov was the head of laboratory where he started working. There Konstantin Petrzhak wrote Ph.D. thesis "study of thorium and samarium radioactivity". Profs V.G. Khlopin and I. Kurchatov were his scientific supervisors.

K.A.Petrzhak: from 1940th

In 1940 - discovery of the spontaneous fission.

In 1941-1942 served in Red Army.

In March 1942 was ordered to leave the army and started to work in Soviet atomic project.

In 1947 founded a laboratory of neutron physics and nuclear fission in Radium Institute.

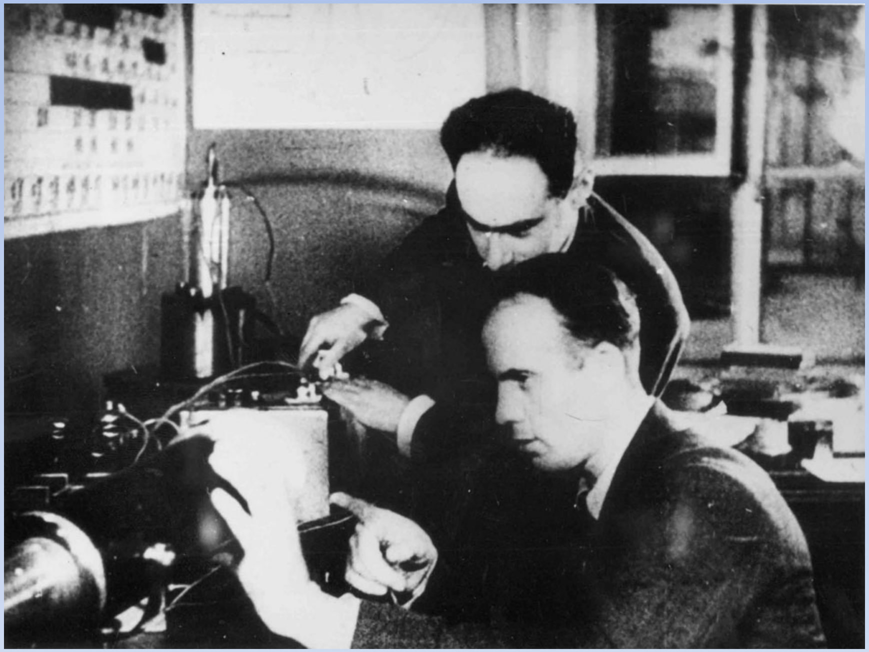
Awards:
1946 -   Stalin prize (2nd degree; jointly with G. Flyorov for discovery of spontaneous fission)

1950 - Council of Ministers Prize (for work on fulfillment of governmental tasks)

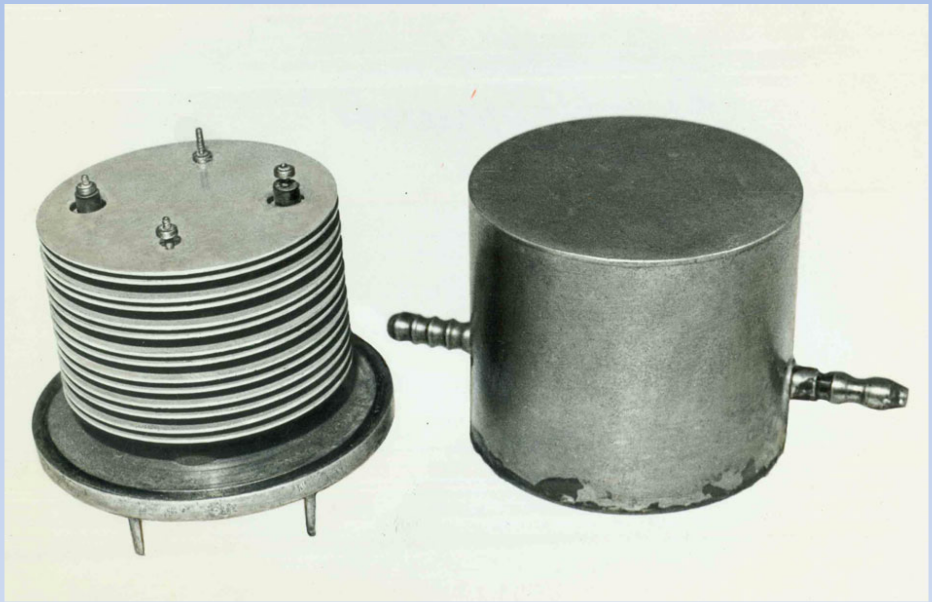
1953 - USSR State Prize (for work on soviet atomic project)

1953 - Order of the Red Banner of Labour (for work on soviet atomic project

Experiments in Leningrad

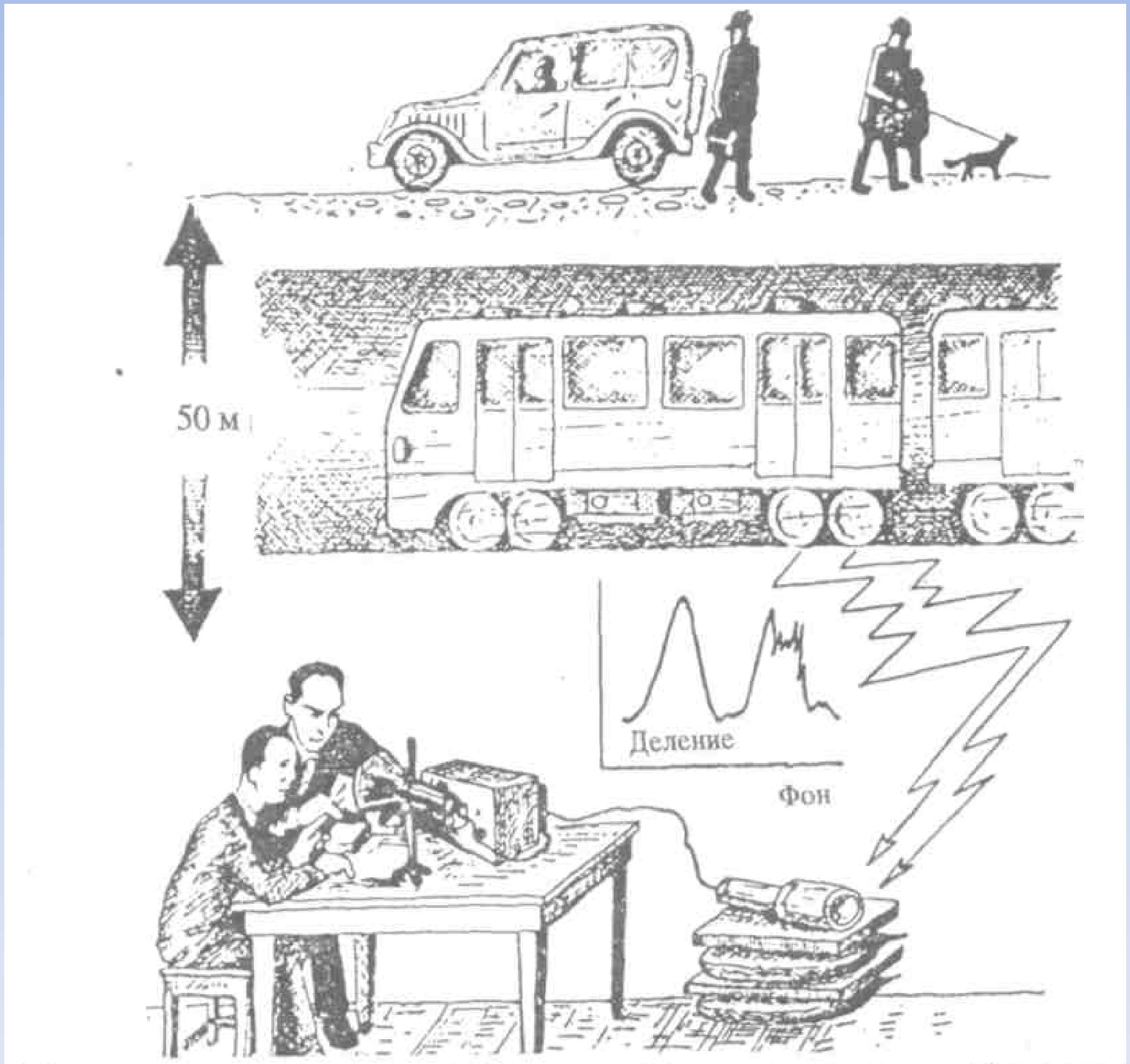


K. Petrzhak and G. Flerov in the laboratory of Radium Institute

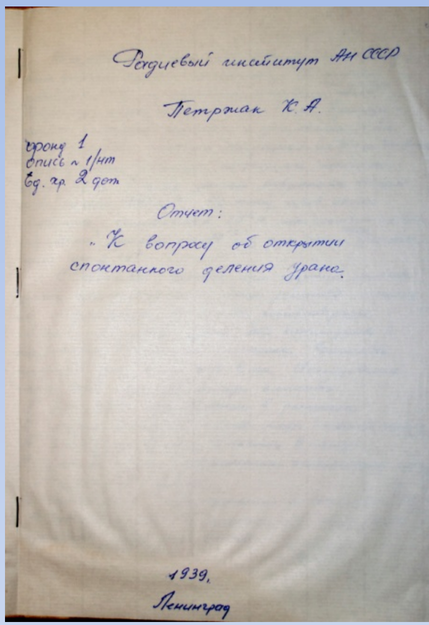


The multilayer fission chamber that was used for the experiments on spontaneous fission
Was donated by K. Petrzhak to the memorial museum of I.V. Kurchatov (Moscow)

Experiments in Moscow



First known Report of K. Petrzhak on SF (1939)

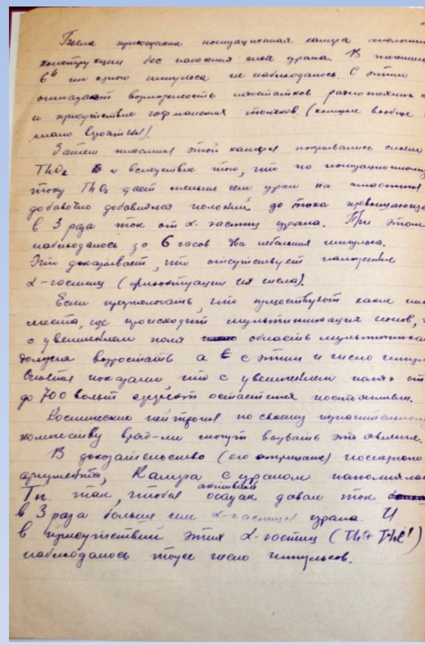

Радиевый институт АН СССР

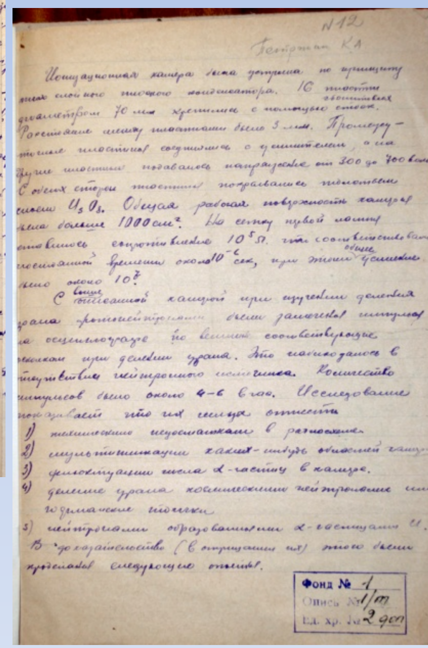
Петржак К.А.

фонд 1
опись № 1/нт
ед. хр. 2 доп

Отчет:
«К вопросу об открытии спонтанного деления урана»

1939.
Ленинград

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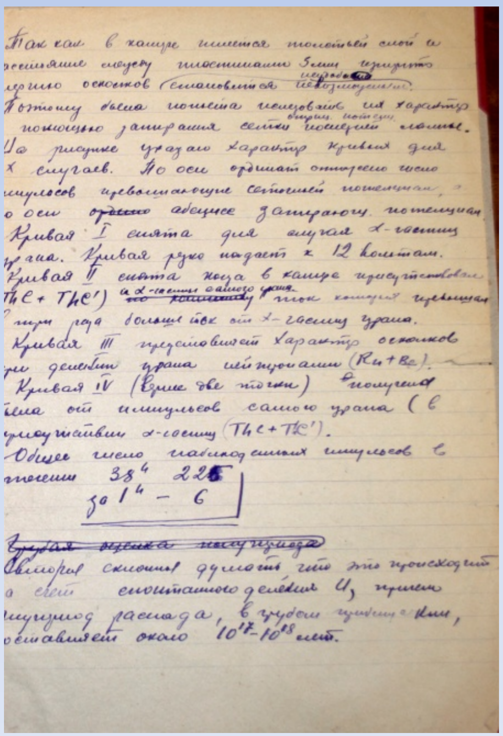
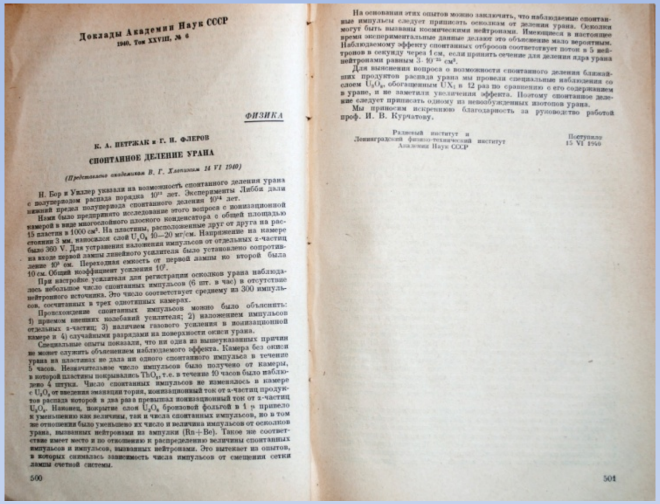
Фонд № 1
Опись № 1/нт
Ед. хр. № 2 доп



The first papers on SF (1940)



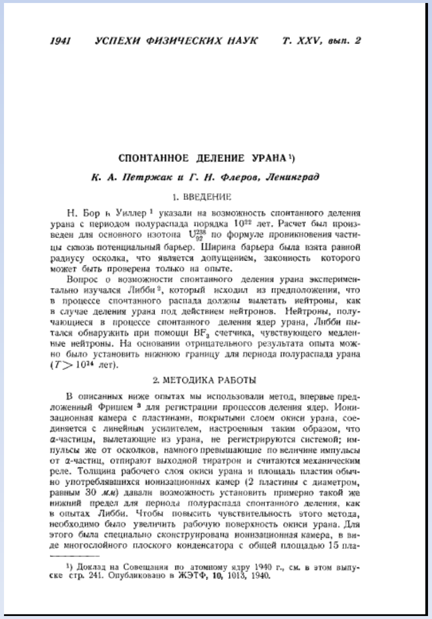
Доклады Академии Наук СССР

1940, Том XXVIII, № 6

ФИЗИКА

К. А. ПЕТРЖАК и Г. Н. ФЛЕРОВ

СПОНТАННОЕ ДЕЛЕНИЕ УРАНА



1941 УСПЕХИ ФИЗИЧЕСКИХ НАУК Т. XXV, вып. 2

СПОНТАННОЕ ДЕЛЕНИЕ УРАНА [1])

К. А. Петржак и Г. Н. Флеров, Ленинград

1. ВВЕДЕНИЕ

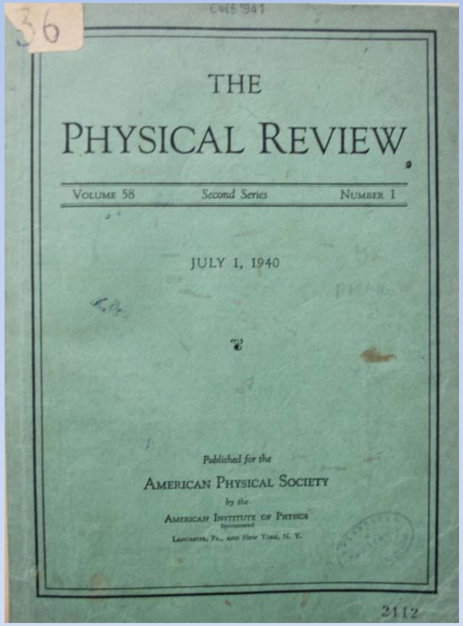
Н. Бор и Уиллер [1] указали на возможность спонтанного деления урана с периодом полураспада порядка 10^{22} лет. Расчет был произведен для основного изотопа U^{238}_{92} по формуле проникновения частицы сквозь потенциальный барьер. Ширина барьера была взята равной радиусу осколка, что является допущением, законность которого может быть проверена только на опыте.

Вопрос о возможности спонтанного деления урана экспериментально изучался Либби [2], который исходил из предположения, что в процессе спонтанного распада должны вылетать нейтроны, как в случае деления урана под действием нейтронов. Нейтроны, получающиеся в процессе спонтанного деления ядер урана, Либби пытался обнаружить при помощи BF_3 счетчика, чувствующего медленные нейтроны. На основании отрицательного результата опыта можно было установить нижнюю границу для периода полураспада урана ($T > 10^{14}$ лет).

2. МЕТОДИКА РАБОТЫ

В описанных ниже опытах мы использовали метод, впервые предложенный Фришем [3] для регистрации процессов деления ядер. Ионизационная камера с пластинами, покрытыми слоем окиси урана, соединяется с линейным усилителем, настроенным таким образом, что α-частицы, вылетающие из урана, не регистрируются системой; импульсы же от осколков, намного превышающие по величине импульсы от α-частиц, отпирают выходной тиратрон и считаются механическим реле. Толщина рабочего слоя окиси урана и площадь пластин обычно употреблявшихся ионизационных камер (2 пластины с диаметром, равным 30 *мм*) давали возможность установить примерно такой же нижний предел для периода полураспада спонтанного деления, как в опытах Либби. Чтобы повысить чувствительность этого метода, необходимо было увеличить рабочую поверхность окиси урана. Для этого была специально сконструирована ионизационная камера, в виде многослойного плоского конденсатора с общей площадью 15 пла-

1) Доклад на Совещании по атомному ядру 1940 г., см. в этом выпуске стр. 241. Опубликовано в ЖЭТФ, **10**, 1013, 1940.



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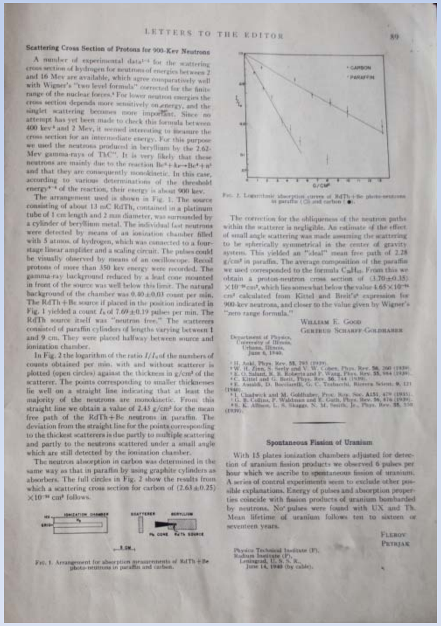

LETTERS TO THE EDITOR

Spontaneous Fission of Uranium

With 15 plates ionization chambers adjusted for detection of uranium fission products we observed 6 pulses per hour which we ascribe to spontaneous fission of uranium. A series of control experiments seem to exclude other possible explanations. Energy of pulses and absorption properties coincide with fission products of uranium bombarded by neutrons. No pulses were found with UX and Th. Mean lifetime of uranium follows ten to sixteen or seventeen years.

FLEROV
PETRJAK

Physics Technical Institute (F),
Radium Institute (P),
Leningrad, U. S. S. R.,
June 14, 1940 (by cable).

Thank you!