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THE PHYSICAL REVIEW
REVIEWS OF MODERN PHYSICS

Conducted by

THE AMERICAN PHYSICAL SOCIETY

JOHN T. TATE, *Managing Editor*

University of Minnesota, Minneapolis, Minn., U. S. A.

April 29, 1946

Dr. Leo Szilard
Metallurgical Laboratory
P.O. Box 5207
Chicago 80, Illinois

Dear Dr. Szilard:

It would seem to me that if you are in doubt with respect to the advisability from the standpoint of security of publishing the paper which you submitted in 1940 it would be best for you to send it to Lt. Col. John R. Ruhoff at Oak Ridge, Tennessee, P.O. Box E, to ask for his judgment. In other cases Dr. Tolman has felt that he should not accept the responsibility for making a recommendation but has advised that papers be sent to Lt. Col. Ruhoff.

Sincerely yours,

John T. Tate

John T. Tate,
Editor

JTT:B

ARMY SERVICE FORCES
UNITED STATES ENGINEER OFFICE
MANHATTAN DISTRICT
OAK RIDGE, TENNESSEE

IN REPLY REFER TO EIDMK-81

25 July 1946.

Mr. Leo Szilard,
Argonne Metallurgical Laboratory,
P. O. Box 5207,
Chicago 80, Illinois.

Dear Mr. Szilard:

The following of your reports are being withheld from declassification at the present time because of U. S. Patent Office objections:

"Divergent Chain Reaction in Systems of Uranium and Carbon (Report A-55)"

"Additional Notes for Report A-55"

The papers are also among several that have brought up a question of interpretation of the present Declassification Guide as it applies to nuclear characteristics and pile theory. In order to insure uniformity in the material being released all controversial papers are being withheld from declassification pending final decision on these questions. It will be necessary for us to withhold your papers for this reason as well as the objections raised by the Patent Office.

We regret our inability to make speedy declassification of your papers, but hope you will bear with us until the two questions above are resolved.

For the District Engineer:

Very truly yours,

Alton P. Donnell

ALTON P. DONNELL,
Major, Corps of Engineers,
Declassification Officer.

May 2, 1946

Professor Farrington Daniels
Director, Metallurgical Laboratory
P.O. Box 5207
Chicago 80, Illinois

Dear Professor Daniels:

I am enclosing a report which is substantially identical with the paper that I sent for publication to the Physical Review in February, 1940; that is, before the U.S. government began to give financial support for work on uranium. The publication of this paper was delayed at my request.

Having studied the criteria for declassification which you showed me yesterday, I have come to the conclusion that there is no reason why the publication of this paper should be delayed any longer and I am, accordingly, asking the editor of the Physical Review to have the paper printed.

I would appreciate it if you would have the paper examined so that if I should be in error and if there should be anything in the paper which, in accordance with the recommendations of the Tolman Committee should not be published at the present time, I can take the necessary steps to have those offending passages removed from the text if not any earlier, than at least in the proofs.

Very sincerely yours,

LS:jjp
encl. (Report A-55 copy 9 attached orig. let.)

Leo Szilard

May 11, 1946

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Several successive versions aborted

IN PLACE OF A SUMMARY

L. Szilard

Remarks added May, 1946.

That there is a serious possibility of maintaining a chain reaction in a system composed of uranium and graphite, first became apparent to the author in July, 1939. While at that time many of the constants involved were not well known, it was possible, in spite of this uncertainty, to make a comparison between a heterogenious uranium-carbon system and a homogenious uranium-water system, which led to the result that if a homogenious water-uranium system can be constructed which comes very close to be chain reacting, then it should be possible to make a heterogenious carbon-uranium system chain reacting, provided that the absorption of carbon is lower than.01 x 10^{-24}, which happened to be the experimental upper level for carbon absorption, at that time. The Government was advised of this situation in October, 1939. In January, 1940, experiments, made by Halban, Joliot, Kowarski, and Perrin, on uranium-water systems became known. One of the uranium-water systems investigated by them was almost capable of maintaining a chain reaction, and one could see that such systems can get very close to be chain reacting per the optimum concentration. In the opinion of the author, this made it exceedingly likely that a chain reaction can be set up in a uranium-carbon system under practically attainable conditions, if the capture cross-section of carbon had a value of, say, about one half of the experimental upper limit quoted above, i.e., .005.

In order to get somewhat oriented as to what the useable ratios of carbon to uranium and what the geometrical dimensions might be, some rough formulae to which such a simple theory leads, the author had to decide what values to use for those physical quantities of uranium which were very poorly known at that time. Values were so adjusted to each other as to just about permit a chain reaction in the limiting case of the carbon absorption corresponding to a cross section of 0.01 x $10^{-24}cm^2$. This adjustment was achieved by proper choice of a value for the resonance absorption.

The publication of this paper was delayed in 1940 at the request of the author. Over six years have now elapsed since it was written and naturally, the paper is outdated in many respects. In these circumstances, an attempt was made to cut down somewhat its length without adding to its original contents. A few footnotes were added to draw attention to some of the shortcomings which have in the meantime become evident.

1946 Version of paper
in the U.S.

S b s 1 Corrected

May 15, 1946

IN PLACE OF A SUMMARY

L. Szilard

Remarks added May, 1946.

It became first apparent to the author in July, 1939 that there is a serious possibility of maintaining a chain reaction in a system composed of uranium and graphite. At that time we had only very imperfect knowledge of the values of the nuclear constants involved but this did not stand in the way of making a comparison between a heterogenious uranium-carbon system and homogenious uranium-water system. The comparison showed that if a homogenious water-uranium system can be constructed which comes very close to be chain reacting, then it should be possible to make a heterogenious carbon-uranium system chain reacting, provided that the absorption of carbon is lower than $.01 \times 10^{-24}$, which happened to be the experimental upper level for carbon absorption, at that time. An experiment previously completed in June 12, 1939, indicated that a uranium-water system could come reasonably close to be chain reacting and the Government was advised of this situation in October, 1939.

In January, 1940, experiments, made by Halban, Joliot, Kowarski, and Perrin, on uranium-water systems, became known. One of the uranium-water systems investigated by them came very close to be capable of maintaining a chain reaction, and one could see that such systems could accordingly get close to be chain reacting for the optimum concentrations. In the opinion of the author, this made it almost certain that a chain reaction can be set up in a uranium-carbon system under practically attainable conditions, if the capture cross-section of carbon had a value of, say, about one half of the experimental upper limit quoted above, i.e., .005.

In order to get somewhat oriented as to what the useable ratios of carbon

to uranium and what the geometrical dimensions might be, some rough formulae to which such a simple theory leads, the author had to decide what values to use for those physical quantities of uranium which were very poorly known at that time. Values were so adjusted to each other as to just about permit a chain reaction in the limiting case of the carbon absorption corresponding to a cross section of $0.01 \times 10^{-24} cm^2$. This adjustment was achieved by proper choice of a value for the resonance absorption.

This paper was therefore written in an attempt to obtain a rough idea as to the optimal composition, geometrical dimensions, and other characteristics of such a chain reacting system. The publication of this paper was delayed in 1940 at the request of the author. Over six years have now elapsed since it was written and naturally, the paper is outdated in many respects. In these circumstances, an attempt was made to cut down somewhat its length without adding to its original contents. A few footnotes were added to draw attention to some of the shortcomings which have in the meantime become evident.

May 16, 1946

IN PLACE OF A SUMMARY

L. Szilard

Remarks added May, 1946.

It became first apparent to the author in July 1939, that there is a serious possibility of maintaining a chain reaction in a system composed of uranium and graphite. At that time we had only very imperfect knowledge of the values of the nuclear constants involved but this did not stand in the way of making a comparison between a heterogeneous uranium-carbon system and homogeneous uranium-water system. The comparison showed that if a homogeneous water-uranium system can be constructed which comes very close to be chain reacting, then it should be possible to make a heterogeneous carbon-uranium system chain reacting, provided that the absorption of carbon is lower than .01 x 10^{-24}, which also happened to be the experimental upper level for carbon absorption at that time.

Since earlier (12) an experiment completed in June had indicated that a uranium-water system could come reasonably close to be chain reacting and the Government was advised of this situation in October, 1939.

No further experiments in this field were undertaken at Columbia Univ., or for that matter, anywhere in the U.S. between June 1939 and Mar. 1940 but in January, 1940, experiments made by Halban, Joliot, Kowarski, and Perrin, on uranium-water systems, became known in this country. One of the uranium-water systems investigated by them came close to be capable of maintaining a chain reaction, and one could also see that such systems could get exceedingly close to be chain reacting for the optimum concentrations. In the opinion of the author, this made it certain that a chain reaction can be set up in a uranium-carbon system under practically attainable conditions, if the capture cross-section of carbon had a value of, say, about one half of the experimental upper limit quoted above, i.e., .005.

Thus it appeared ~~of interest~~ important to try to obtain a rough idea as to the optimal composition, geometrical dimensions, and other characteristics of such a chain reacting system and this was attempted in the present paper. Over six years have now elapsed since it was written and naturally it is outdated. A few footnotes were added to draw attention to some of the shortcomings which have become evident in the meantime. Some parts of the paper have been condensed or left out entirely in an attempt to shorten it without adding anything to its original contents.

May 17, 1946

IN PLACE OF A SUMMARY

L. Szilard

Remarks added May, 1946.

In July 1939, it became first apparent to the author that there is a serious possibility of maintaining a chain reaction in a system composed of uranium and graphite. At that time there was only very imperfect knowledge of the values of the nuclear constants involved but this did not stand in the way of making a comparison between a heterogeneous uranium-carbon system and a homogeneous uranium-water system. The comparison showed that if a homogeneous water-uranium system can be constructed which comes very close to be chain reacting, then it should be possible to make a heterogeneous carbon-uranium system chain reacting, provided that the absorption of carbon is lower than $.01 \times 10^{-24}$, which also happened to be the experimental upper level for carbon absorption at that time.

The United States Government was advised of this situation in October 1939. No direct experimental evidence on a uranium-carbon system was available at that time, but experiments completed in collaboration with H.L. Anderson and E. Fermi, earlier in June 1939, had reliably indicated that a water-uranium system can indeed come reasonably close to be chain reacting. No further experiments on such systems were undertaken at Columbia University, or for that matter anywhere in the United States, between June 1939 and March 1940. But in January 1940, an experiment performed by Halban, Joliot, Kowarski, and Perrin, on uranium-water systems became known in this country. One of the uranium-water systems investigated by them came close to be capable of maintaining a chain reaction and one could also see that such systems could get exceedingly close to be chain reacting for the optimum concentrations. In the opinion of the author, this meant that we can expect a chain reaction in a uranium-carbon system under practically attainable conditions, if the capture cross-section of carbon had a value of, say, about one half of the experimental upper limit quoted above, i.e., .005.

Thus it appeared important to try to obtain a rough idea as to the optimal composition, geometrical dimensions, and other characteristics of such a chain reacting system and this was attempted in the present paper. Over six years have not elapsed since it was written and naturally it is outdated. A few footnotes were added to draw attention to some of the shortcomings which have become evident in the meantime. Some parts of the paper have been condensed or left out entirely in an attempt to shorten it without adding anything to its original contents.

SBS 16

May 17, 1946

IN PLACE OF A SUMMARY

L. Szilard

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Remarks added May, 1946.

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SBS 16

May 17, 1946

IN PLACE OF A SUMMARY

L. Szilard

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METALLURGICAL LABORATORY
P. O. Box 5207
Chicago 80, Illinois

May 17, 1946

Dr. Leo Szilard
c/o Farrington Daniels
Director of Metallurgical Laboratory

Re: Case No. S-1051
Serial No. 664,145
Filing Date April 23, 1946

Dear Dr. Szilard:

Your patent application identified above has been filed in the United States Patent Office. You no doubt will receive from the Patent Office a notice of issuance of an order of Secrecy under Public Law 700 together with a request that the application be tendered for the use of the United States Government. You will also receive a receipt to be filled in and returned to the Patent Office in Washington.

Kindly execute and return the receipt to the Patent Office. Do NOT tender the invention in this application to the Government as requested by the notice, as you have already assigned the invention to the Government as represented by the Director of the Office of Scientific Research and Development.

If you should receive a request for tender from some other Government agency, please send such request to me or to Captain Robert A. Lavender, 1530 P St., N.W., Washington 25, D.C. A tender by you to some other Government agency would only complicate matters in view of the fact that you have already assigned the invention to the Government.

Very truly yours,

Raymond S. Chisholm

Raymond S. Chisholm, Lt. Cmdr. USNR
O.S.R.D., Chicago Patent Group

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S.b s 15

D

5816 Blackstone Avenue
Chicago, Illinois
May 20, 1946

Professor John T. Tate
University of Minnesota
Minneapolis, Minnesota

Dear Professor Tate:

I am enclosing a somewhat shortened version of my paper, Divergent Chain Reaction in Systems Composed of Uranium and Carbon, which I believe was received by the Physical Review on February 16, 1940. In view of the long time that has elapsed, I have added some notes in the form of an appendix and also a new summary, under the dateline of May, 1946.

I did not add anything to the paper, but abbreviated some passages and others are entirely left out. There is however one exception, a few days after I sent you the manuscript I discovered an error on page 21 and wrote a new page 21. While I am not sure that I sent you the replacement at that time, I had a photo copy made which I mailed to myself and it carries the postmark of February 21, 1940. I enclose that page as a documentary proof of the date of the change, but I would appreciate it if you would return it after examining it. In view of this change, I propose that the date of the paper be changed from February 16, 1940 to February 21, 1940. Perhaps you would let me know whether this procedure is satisfactory to you.

Since I last wrote you I have studied the Declassification Guide, issued by the Army (incidentally it is a secret document), and I am now satisfied that there is nothing in the paper which, under those rules, would have to remain classified as secret. I would therefore appreciate it if the paper were set to print and if I could obtain a galley proof at your earliest convenience.

I have incidentally sent a copy of the paper, through the Metallurgical Laboratory, to the appropriate army authorities, asking them to let me know if they have any objections to any passages contained in the paper. If there should be such an objection, I would make the correction in the proof, but I don't anticipate any.

Very sincerely yours,

Leo Szilard

LS:jjp
encl.

Feld ?

May 27 19 46

The Editors of THE PHYSICAL REVIEW acknowledge receipt of the following manuscript: Divergent Chain Reaction in Systems Composed of Uranium and Carbon by Leo Szilard

Information concerning the publication of this article will be sent as soon as possible.

JOHN T. TATE, Editor
THE PHYSICAL REVIEW,
University of Minnesota,
Minneapolis 14, Minnesota

(with 1946 reivsions) 5b51 D

Nuclear Chain Reaction in a System Composed of Uranium, Beryllium and Carbon.

In a previous paper dated Febr 14th 1940 I have attempted to show that we may expect to be able to maintain a nuclear chain reaction in a system composed of uranium and carbon. The purpose of the present paper is to point out that we may perhaps obtain a considerable improvement of the efficiency of the system for the purpose of a chain reaction by introducing beryllium into the system. An appreciable fraction of the neutrons emitted from the uranium which is split by thermal neutrons appear[1] to have energies above 1.7 MEV., the binding energy of neutrons in beryllium, ~~has about this value~~, and hence we may expect that an appreciable fraction of the fission neutrons can produce an additional neutron by knocking out a neutron from beryllium. In the circumstances, by introducing beryllium into the system in such a way that it is exposed to the fast neutrons emitted from uranium we may obtain a significant increase from this knock-out process in the total number of neutrons generated in the system per thermal neutron which is absorbed by the uranium in the system.

In the above mentioned paper particular attention was given to a system consisting of a lattice of uranium spheres embedded in a large mass of graphite. Formulae were derived for a lattice in which the distance between two uranium spheres is large compared to the radius of a single uranium sphere. Under these conditions, and within the limits of the approximation used in deriving these formulae, one finds the optimal radius for the uranium spheres by determining the value of R for which the expression

$$(20)\qquad \varepsilon = \frac{A^2}{B^2}\,\frac{1}{1+R/B}\,\frac{1}{\dfrac{\lambda(C)}{RG\sqrt{\dfrac{3\sigma_a(U)}{\sigma_s(U)}}-\lambda(U)}+\dfrac{1}{1+R/A}}$$

becomes a maximum. Using uranium at a density of 16 gm per cc and graphite at a density of 1.7 gm per cc we take at room temperature the values involved as follows: A = 53.5 cm corresponding to $\sigma_c(C) = 0.0033$; B = 6.5 cm; $\lambda(C) = 2.44$ cm; $\sigma_a(U) = 5.5$; $\sigma_{sc}(U) = 11$ corresponding to $\lambda(U) = 2.25$ cm

For a value of R = 5 cm we have $G \cong 1$ and we find from (20) $\varepsilon \cong 24$ which is a value close to the maximum. The corresponding value for the fraction of the neutrons which are absorbed as thermal neutrons by the uranium spheres in the lattice is given by

$$(26) \qquad q_m \cong 1 - 2\,\frac{-1+\sqrt{1+\varepsilon}}{\varepsilon} \cong 0.67$$

and for the ratio of the volumes of uranium and carbon we have

$$(33a) \qquad \frac{4\pi R^3}{3}\Big/ V \cong \frac{1-q_m}{6}\,\frac{R^2}{B^2}\,\frac{1}{1+R/B} \cong \frac{1}{40}$$

giving a ratio of weights of uranium to carbon about 1 to 4

Beryllium may now be introduced into such a system by surrounding each uranium sphere with a spherical shell of beryllium metal 4 - 5 cm thick. The density of beryllium is about 1.8 gm per cc, and the amount required would be about equal in weight to the amount of uranium and perhaps one tenth of the amount of graphite.

Thus the beryllium would be located at a site where the thermal neutron density is low, ~~and the average thermal neutron density is low~~ and the average thermal neutron density within the beryllium would be less than one half of the average thermal neutron density in the graphite. Moreover, the number of beryllium atoms would be about one tenth of the number of carbon atoms, and in the circumstances a much larger thermal neutron absorption cross-section per beryllium atom can be tolerated for beryllium metal with its impurities than can be tolerated per carbon atom for graphite. Since the fraction of neutrons absorbed is given by q_m, an absorption cross-section of

$$\sigma_c(Be) = \xi\,\sigma_c(C)$$

would lead to a loss of $\frac{\xi}{20}\alpha_m$ neutrons. Since we have

(25) $$\alpha_m \cong \frac{1-q_m}{2} \cong$$

we would have a loss of perhaps 5% if we had an absorption in beryllium six times as large per beryllium atom as the absorption in graphite per carbon atom, i.e. if we had $\sigma_c(Be) =$

A fast neutron emitted from an uranium atom within the sphere will go through the beryllium shell once and may pass through the shell again after one or more collisions with carbon atoms. During its passage through the beryllium shell it will suffer collisions with beryllium atoms. The energy of such a fast neutron will decrease by every collision with either beryllium or carbon. This process of slowing down will limit the total number of neutrons which may be liberated by a fission neutron moving in beryllium.

In order to get a better picture of this limitation we may assume for the sake of argument that one half of the fission neutrons has an initial energy above the dissociation energy of beryllium, and that the cross-section for the disintegration of beryllium is one third of its total cross-section (and one half of its elastic collision cross-section). A fission neutron would then in its first collision with a beryllium nucleus on the average knock out 0.166 neutrons. If we further assume, rather arbitrarily, that the fission neutrons withstand two elastic collisions with beryllium with undiminished capacity for the disintegration of beryllium, but that after the third elastic collision their energy is below the threshold, we find that a fission neutron moving entirely in beryllium would liberate about $0.5\left(\frac{1}{3}+\frac{2}{9}+\frac{4}{27}\right) = 0.35$ neutrons and not more.

In our arrangement collisions will take place with carbon atoms

as well as beryllium atoms , and accordingly the total number of neutrons liberated from beryllium by one fission neutron would be smaller. It should be emphasized though that a value of 0.2 would already be very significant since it would raise ν , the value of the neutrons generated in the system per thermal neutron absorbed in uranium, from a value between 1.5 and 2 to a value between 1.8 and 2.4. The data available at present do not permit to estimate the increase in ν which we may expect from the introduction of beryllium into a system composed of uranium and carbon. Experiments using 75 to 150 lbs. of beryllium are in preparation for the purpose of clearing up this point.

It is easy to understand why uranium layers of finer thickness embedded in paraffine are preferable to layers of an infinitely small thickness, i.e. to a homogenous mixture. If the thickness of a very thin layer of uranium is increased the thermal neutron absorption of the layer increases proportionally to the thickness. The absorption for resonance neutrons of uranium, however, increases more slowly than proportional to the thicknesses at which the thermal neutron absorption is still increasing proportionally to the thickness. This is due to the fact that for not too thick uranium layers the resonance absorption is mainly due to the first sharp resonance line of uranium. At larger thickness the absorption of thermal neutrons ~~fxi~~ flattens out and there is a thickness which is optimal from the point of view of ratio of the thermal absorption and the resonance absorption of uranium. This optimum may be even more marked and more favorable for lumps of uranium than for flat layers of uranium. Since the range of the thermal neutrons in paraffine ~~wax~~ is of the same order of magnitude as the range of resonance neutrons, and since the thickness of the paraffine layers which may be sandwiched between uranium layers must not be made large compared to the range of the thermal neutrons, systems of this type may be considered as quasi homogenous since the velocity distribution of the neutrons will not vary very much within the system.

While the question whether ~~kkx~~ a chain reaction can be maintained in such a system remained open it appeared of interest primarily from the point of view of possible practical applications to raise the question whether a chain reaction could be maintained in a system composed of uranium and carbon. Even if it were possible to maintain a chain reaction in a system in which the neutrons are slowed down by hydrogen the rate at which the chain reaction could be maintained would necessarily be limited by the fact that hydrogen containing substances

decompose or evaporate at moderately elevated temperatures. If carbon can be used in the place of hydrogen for slowing down the neutrons for the purpose of the chain reaction, there would be no such limitation of the chain reaction rate, and it would be possible to have a sufficiently high temperature gradient available for dissipating the heat which would be generated.

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THE PHYSICAL REVIEW
REVIEWS OF MODERN PHYSICS

Conducted by
THE AMERICAN PHYSICAL SOCIETY
JOHN T. TATE, *Managing Editor*

University of Minnesota, Minneapolis 14, Minn., U. S. A.

July 25, 1946

Dr. Leo Szilard
5816 Blackstone Avenue
Chicago, Illinois

Dear Dr. Szilard:

The Editors of THE PHYSICAL REVIEW have raised objections to the publication of the revised form of your pre-war article on "Divergent Chain Reaction in Systems Composed of Uranium and Carbon". They have decided that the only course open to them is to publish the paper in the form in which it was originally submitted. This they are prepared to do if it meets with your approval.

Sincerely yours,

John T. Tate

John T. Tate,
Editor

JTT:B

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ARMY SERVICE FORCES
UNITED STATES ENGINEER OFFICE
MANHATTAN DISTRICT
OAK RIDGE, TENNESSEE

IN REPLY
REFER TO SIDLI-81

25 July 1946.

Mr. Leo Szilard,
Argonne Metallurgical Laboratory,
P. O. Box 5207,
Chicago 80, Illinois.

Dear Mr. Szilard:

The following of your reports are being withheld from declassification at the present time because of U. S. Patent Office objections:

"Divergent Chain Reaction in Systems of Uranium and Carbon (Report A-55)"

"Additional Notes for Report A-55"

The papers are also among several that have brought up a question of interpretation of the present Declassification Guide as it applies to nuclear characteristics and pile theory. In order to insure uniformity in the material being released all controversial papers are being withheld from declassification pending final decision on these questions. It will be necessary for us to withhold your papers for this reason as well as the objections raised by the Patent Office.

We regret our inability to make speedy declassification of your papers, but hope you will bear with us until the two questions above are resolved.

For the District Engineer:

Very truly yours,

Alton P. Donnell

ALTON P. DONNELL,
Major, Corps of Engineers,
Declassification Officer.

3652

1156 E. 57th Street
Chicago, Illinois
August 12, 1946

Mr. John T. Tate, Editor
The Physical Review
University of Minnesota
Minneapolis, 14, Minn.

Dear Mr. Tate:

Many thanks for your letter of July 25th.

I shall be pleased to have the paper published in the form in which it was originally submitted. May I however ask two specific questions?

1) In my last letter to you I sent you the photo copy of one page which was postmarked, February 21, 1940. Would it be acceptable to you to have the text of this page used in the paper and that the date of the paper be accordingly shifted to February 21, 1940?

2) Is it acceptable to you that the notes added and dated 1946, be attached to the paper in order to bring the reader up-to-date, or make such corrections as appear appropriate in the light of the later developments. In these notes I am of course limited to what can be revealed in view of the continued secrecy.

The photo copy which was enclosed in my last letter is a document which might at some later date be needed by the Government in connection with a patent application which they have filed in my name. Perhaps (after making a photo copy for your files) you would return the original photo copy to me, preferably by registered mail.

I had a letter from the Army asking me not to publish this paper for the time being and mentioning some such things as objections by the U. S. Patent Office. I do not understand what they mean and will try to clear up this matter as soon as possible.

Sincerely yours,

Leo Szilard

IIIbs 3

SECRET

THE UNIVERSITY OF CHICAGO

DATE

TO Dr. Szilard

DEPARTMENT

FROM W. Eberhardt

DEPARTMENT Patent

IN RE: Case 2172

Stalled to Dr. Fermi on the phone this morning & he told me he was willing to sign this case with you. He has carefully checked the case and will sign the papers as soon as forwarded to him with your signatures. It will then be sent immediately to Washington and filed.

W. Eberhardt

bbs 18

RESTRICTED

METALLURGICAL LABORATORY
P. O. Box 5207
Chicago 80, Illinois

6 June 1946

Dr. Leo Szilard
c/o Director of Metallurgical Laboratory
University of Chicago

Re: Case No. S-98
Serial No. 669,524
Filing Date May 14, 1946

Dear Dr. Szilard:

Your patent application identified above has been filed in the United States Patent Office. You no doubt will receive from the Patent Office a notice of issuance of an order of Secrecy under Public Law 700 together with a request that the application be tendered for the use of the United States Government. You will also receive a receipt to be filled in and returned to the Patent Office in Washington.

Kindly execute and return the receipt to the Patent Office. Do NOT tender the invention in this application to the Government as requested by the notice, as you have already assigned the invention to the Government as represented by the Director of the Office of Scientific Research and Development.

If you should receive a request for tender from some other Government agency, please send such request to me or to Captain Robert A. Lavender, 1530 P St., N.W., Washington 25, D.C. A tender by you to some other Government agency would only complicate matters in view of the fact that you have already assigned the invention to the Government.

Very truly yours,

R. S. Chisholm

Raymond S. Chisholm, Lt. Cmdr. USNR
O.S.R.D., Chicago Patent Group

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1155 East 57 Street
Chicago 37, Illinois
October 18, 1946

Alton P. Donnell
Major, Corps of Engineers
Office of the District Engineer
Manhattan District
War Department
Oak Ridge, Tennessee

Dear Major Donnell:

In response to your letter of July 23, 1946 I wish to set forth the following.

The paper "Divergent Chain Reaction in Systems of Uranium and Carbon" was submitted to the Physical Review in February, 1940, before the Government gave any support to the work on uranium. Consequently, this paper falls in no way under the jurisdiction of the Manhattan District. My reason for submitting this paper to the Director of the Metallurgical Laboratory and asking him to consult with the Manhattan District was my desire to learn if there is information in this paper which, in the opinion of the Manhattan District, would, if published, be detrimental to the national defense. I would appreciate it if you would let me know just what information contained in the paper would fall into that category. Unless you can give me a specific statement as to the information which would be detrimental, I shall be unable to take your wishes in this matter into consideration.

Your letter of July 23, 1946 mentions objections "on the part of the United States Patent Office". I am quite unable to understand what you mean by that phrasing. Again, if the United States Patent Office has certain objections, I would wish to be informed of those objections so that I can take them into consideration in deleting the offending passages from the paper.

I am sure you will appreciate that since this paper does not come under the jurisdiction of the Manhattan District, considerations of uniformity in the material which is being

released are not relevant in this case, but only considerations as to whether or not the paper contains information which, if made public, would have an unfavorable effect on our national defense position.

Very truly yours,

Leo Szilard

SBS 16

Argonne National Laboratory
P.O. BOX 5207
CHICAGO 80, ILLINOIS
BUTTERFIELD 1400

December 5, 1946

To: Dr. Leo Szilard

From: Hoylande D. Young

We are returning at last the reports you submitted for declassification last May. These reports, "Divergent Chain Reactions in Systems Composed of Uranium and Graphite," and "Additional Notes for Report A-55," have now been declassified, a copy of the Manhattan District's authorization letter being enclosed.

Please note, as is indicated in the accompanying letter, that everyone concerned expresses regret over the considerable delay in the release of your reports.

Argonne National Laboratory
By Hoylande D. Young by es
Hoylande D. Young

1155 East 57 Street
Chicago 37, Illinois
October 18, 1946

Alton P. Donnell
Major, Corps of Engineers
Office of the District Engineer
Manhattan District
War Department
Oak Ridge, Tennessee

Dear Major Donnell:

In response to your letter of July 25, 1946 I wish to set forth the following.

The paper "Divergent Chain Reaction in Systems of Uranium and Carbon" was submitted to the Physical Review in February, 1940, before the Government gave any support to the work on uranium. Consequently, this paper falls in no way under the jurisdiction of the Manhattan District. My reason for submitting this paper to the Director of the Metallurgical Laboratory and asking him to consult with the Manhattan District was my desire to learn if there is information in this paper which, in the opinion of the Manhattan District, would, if publicized, be detrimental to the national defense. I would appreciate it if you would let me know just what information contained in the paper would fall into that category. Unless you can give me a specific statement as to the information which would be detrimental, I shall be unable to take your wishes in this matter into consideration.

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Very truly yours,

Leo Szilard

THE PHYSICAL REVIEW
REVIEWS OF MODERN PHYSICS

Conducted by
THE AMERICAN PHYSICAL SOCIETY
JOHN T. TATE, *Managing Editor*

University of Minnesota, Minneapolis 14, Minn., U. S. A.

August 20, 1946

Dr. Leo Szilard
1155 E. 57th Street
Chicago, Illinois

Dear Dr. Szilard:

This is in reply to the questions you ask in your letter of August 12. It will be acceptable to have the text of the photostated page included in your manuscript. I am returning it herewith.

Some notes dated 1946 might be acceptable. They should, however, be kept to a minimum and confined largely to explanations or corrections which are desirable in order not to mislead the reader.

Sincerely yours,

John T. Tate

John T. Tate,
Editor

JTT:B
Enc.

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1155 E. 57th Street
Chicago, Illinois
August 12, 1946

Mr. John T. Tate, Editor
The Physical Review
University of Minnesota
Minneapolis, 14, Minn.

Dear Mr. Tate:

Many thanks for your letter of July 25th.

I shall be pleased to have the paper published in the form in which it was originally submitted. May I however ask two specific questions?

1) In my last letter to you I sent you the photo copy of one page which was postmarked, February 21, 1940. Would it be acceptable to you to have the text of this page used in the paper and that the date of the paper be accordingly shifted to February 21, 1940?

2) Is it acceptable to you that the notes added and dated 1946, be attached to the paper in order to bring the reader up-to-date, or make such corrections as appear appropriate in the light of the later developments. In these notes I am of course limited to what can be revealed in view of the continued secrecy.

The photo copy which was enclosed in my last letter is a document which might at some later date be needed by the Government in connection with a patent application which they have filed in my name. Perhaps (after making a photo copy for your files) you would return the original photo copy to me, preferably by registered mail.

I had a letter from the Army asking me not to publish this paper for the time being and mentioning some such things as objections by the U. S. Patent Office. I do not understand what they mean and will try to clear up this matter as soon as possible.

Sincerely yours,

Leo Szilard

THE PHYSICAL REVIEW
REVIEWS OF MODERN PHYSICS

Conducted by
THE AMERICAN PHYSICAL SOCIETY
JOHN T. TATE, *Managing Editor*

University of Minnesota, Minneapolis 14, Minn., U. S. A.

July 25, 1946

Dr. Leo Szilard
5816 Blackstone Avenue
Chicago, Illinois

Dear Dr. Szilard:

The Editors of THE PHYSICAL REVIEW have raised objections to the publication of the revised form of your pre-war article on "Divergent Chain Reaction in Systems Composed of Uranium and Carbon". They have decided that the only course open to them is to publish the paper in the form in which it was originally submitted. This they are prepared to do if it meets with your approval.

Sincerely yours,

John T. Tate

John T. Tate,
Editor

JTT:B