to Kiev. a placement

omit

First Munc

MUCL. S-61

from March

12-45

The first petition was signed by 59 members of the laboratory, among them:

Jasper B. Jeffries

Robert J. Moon

Austin M. Brues

K. S. Cole

Alexander Langsdorf, Jr.

David L. Hill

David B. Hall

Warren C. Johnson

Walter Bartky

James J. Nickson

W. H. Zachariasen

Elizabeth E. Painter

Richard Abrams

Raymond E. Zirkle

Herman Lisco

A. Wattenberg

Robert J. Maurer

F. L. Freedman

Robt. S. Mulliken

Karl Darrow

Leo Szilard

Jasper B. Jeffries

The second petition was signed by ~~59~~ 70 members of the laboratory, among them:

George A. Sacher

Robert S. Mulliken

John A. Simpson

Frank Foote

Robert L. Platzman

J. Ernest Wilkins, Jr.

[illegible]

E. P. Wigner

John P. Howe

~~Jasper B. Jeffries~~

Hoyland D. Young

June 11, 1945

The Secretary of War
Washington, D. C.

Dear Sir:

The undersigned were greatly pleased to learn that the names of A. H. Compton, E. Fermi, E. O. Lawrence, and R. Oppenheimer have been placed on a Panel to which a committee appointed by you may turn for advice.

The undersigned believe that along with the other projects, isotope separation by diffusion and by chemical means will continue to play an important role in the future development. H. C. Urey of Columbia University is eminently qualified to represent this field not only on account of his pioneering work in it, but also on account of the role which he played in furthering the wartime development represented by the uranium projects.

In view of the role which Dr. Urey has played in this development in the past and the importance of the project of which he was director, the undersigned are concerned about the fact that his name does not appear on the Panel. As a patriotic and upright citizen he has the fullest confidence of the undersigned.

Respectfully,

Milton Burton
A D Allen
Eugene P. Wigner
James I Watters
Winston M. Manning
Gale Young
James Franck.
W. H. Zachariasen
A J Dempster
William P. Jesse
R S Mulliken

O. Stern
J. C. Stearns
Walter Bartky
Frank Foote
Kenneth S. Cole
Leo Szilard
William Rubinson
Eugene Rabinowitch

June 6, 1945

Chairman of the Committee
on Nucleonics

Dear Sir:

Recently, we have been informed of the appointment of a National Committee to guide policy and programs in the field of nucleonics. In addition, a Panel, consisting of four scientists of high repute and who are thoroughly acquainted with nucleonics, has been appointed to serve in an advisory capacity. Since the problems which will arise inevitably will embrace a number of fields of science, in particular many aspects of chemistry; we, the undersigned, suggest for your consideration the addition to this Panel of a chemist of outstanding ability and judgment, and who is familiar with the chemical problems associated with nucleonics. Among the few outstanding chemists familiar with this field, Dr. Harold C. Urey of Columbia University is the best qualified for membership on the Panel.

Warren C. Johnson
David N. Hume
Waldo E Cohn
Spofford G. English
Raymond W Stoughton
Norman Elliott
Alvin M. Weinberg
L. W. Nordheim
E O Wollan

Charles D. Coryell
Henri A. Levy
G. E. Boyd
T. H. Davies
A H Snell
Harrison S Brown

COPY COPY

May 25, 1956

CONFIDENTIAL MEMORANDUM: ON A ROVING PROFESSORSHIP FOR LEO SZILARD

By: Dr. George W. Beadle, Division of Biology
California Institute of Technology

Dr. Bernard D. Davis, Department of Pharmacology
New York University, College of Medicine

Dr. Theodore Puck, Department of Biophysics, University of Colorado
Medical School

We are exploring the possibility of setting up a Roving Research Professorship or a Fellowship-at-large for Dr. Leo Szilard, at present Professor of Biophysics at the University of Chicago. We believe such a position would offer the best opportunity for full exercise of his remarkable talents; and in addition it should eliminate his serious retirement problem, whose genesis is described below.

As we visualize this position, it would formally associate him at the outset with our three departments -- an arrangement we would greatly desire. At the same time, since we are convinced that a maximum of flexibility will enable him to function most effectively, he would be left free to pursue his scientific interests at any research institute or university of his choice. Dr. Rollin Hotchkiss, speaking for the Rockefeller Institute for Medical Research, has proposed that this institution be included also in the plan; and we assume the University of Chicago would wish to continue its association with Szilard.

Officers of the National Science Foundation whom we have approached favor, both in principle and in this case in particular, the idea of creating such a position. The financial assistance we anticipate from this agency, however, will not cover a sufficiently long period, and so we are seeking additional funds from private foundations and individuals.

There are not many scientists for whom a Roving Professorship would seem appropriate, but we believe Szilard is one. In addition to producing a number of discoveries of the highest rank, Szilard has been an unusually effective catalyst in science. In recent years he has engaged extensively in visiting other laboratories, where he has been most generous in giving thoughtful and deep attention to the work in progress. He has a unique ability to grasp instantly the most varied problems, to seize upon their significant aspects, and to apply to them unusual imaginative and critical powers. These visits have often led to valuable new experiments and have given to many young biologists a much enhanced sense of the distinction between significant and trivial problems. The Roving Professorship we are trying to arrange would regularize such peripatetic activities and would at the same time provide the opportunity, if his interests so directed, for an extended period of work at a single institution.

In order to put the problem concerning Szilard in the proper perspective, we wish to refer here to a few historical facts.

More, perhaps, than any other single individual, Szilard was responsible for getting the United States government started on the development of atomic energy. The crucial discovery was made in March, 1939, when three groups working independently (Szilard and Zinn; Anderson and Fermi; Halban, Joliot, and Kowarsky) found that neutrons were emitted in the fission of uranium. This meant that some uranium-containing system might be able to sustain a chain reaction. Shortly thereafter Fermi, Szilard, and Anderson jointly showed that a uranium-water system came fairly close to sustaining a chain reaction, and it thus became clear that the liberation of atomic energy on an industrial scale might be at hand.

These results were obtained in the spring of 1939, yet for a period of eight months, stretching from June, 1939 to March, 1940, not a single experiment on the chain reaction was in progress anywhere in the United States. No one can tell how much longer this state of inactivity would have lasted had not Szilard become convinced in July 1939 that a chain reaction could be set up in a system composed of uranium and graphite.

Szilard convinced Einstein that this possibility must be taken seriously, and that the government ought to be so advised. On August 2, 1939, Einstein wrote to President Roosevelt:

> 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 new radium-like elements would be generated. Now it appears almost certain that this could be achieved in the immediate future.

Dr. Alexander Sachs personally transmitted Einstein's letter to President Roosevelt, together with a memorandum written by Szilard which contained information on which Einstein's letter was based.

In response to Einstein's letter, Roosevelt appointed a committee which first met in October, 1939. In March, 1940 this Committee made a $6,000. grant to Columbia University for the purchase of graphite, and only then did work on the chain reaction get under way.

A patent on the chain-reacting graphite-uranium system, subsequently issued to the government, named Fermi and Szilard as the inventors (see information released by the government and reported in the New York Times of May 8, 1955). This system was used in the pile that produced the first chain reaction at Stagg Field on the campus of the University of Chicago on December 2, 1942. And this system was also used in the Hanford plant which produced the plutonium for the atomic bomb. The same system is now used for electric power production in England. According to the <u>Times</u> report, "the patent is owned by the Atomic Energy Commission ... issuance of the patent establishes the priority of the Fermi-Szilard invention, and protects the government's interests."

Szilard did not profit financially from this invention, which he assigned to the government in 1943.

After the war Szilard joined the faculty of the University of Chicago and his main interest shifted to biophysics. He has made important contributions to this field. Jointly with Dr. Aaron Novick he developed the Chemostat, which permits the study of growing bacterial populations in a controlled steady state; and its use had led to important discoveries concerning mutations and adaptive enzyme formation.

At Chicago Szilard was initially attached to the Institute of Radiobiology and Biophysics, which had been established by Dr. Robert Hutchins when he was Chancellor. This Institute was recently discontinued, and on July 1, 1956, Szilard will join the Institute of Nuclear Studies of the University. While this assignment leaves him free to pursue his interests in biology, it does not provide an appropriate setting for these activities.

According to the present schedule, if he is retired by the age of 65, some seven years from now, Szilard would have to live on an income of $113 per month provided by Teachers' Annuity. (To this would be added social security benefits if he had no other earned income.) Szilard is in this anomalous position because he entered this country from Europe shortly before World War II, worked on a government project during the war, and did not take regular academic employment until 1946.

If the issue were merely Szilard's financial problem, he could perhaps solve it by taking a highly paid industrial position. Our concern, however, is to keep him active in basic science. This could be accomplished by setting up a fellowship-at-large providing for sufficiently long-term support. We believe we can count on assistant from the National Science Foundation amounting to a total of about $90,000. payable in five installments. An about equal amount would be needed from other sources in order to assure an adequate basic income during his lifetime.

We believe the absence of an age limit in this arrangement is appropriate in view of both the nature of the position and the person involved. A fixed retirement age is customary for scientists who hold an administrative position or occupy a fixed amount of laboratory space, but neither of these considerations pertains to a fellowship-at-large. And as long as Szilard holds such a position and requires laboratory facilities for his research he should be able to secure these on a short-term basis.

We believe it important to enable Szilard to continue to remain active in the field of science as long as possible, with adequate security, and under circumstances that permit him to be most effective. A fellowship-at-large without set age limit seems the best instrument for accomplishing this purpose. We would like to enlist the aid of interested parties in working out the details of such a plan and putting it into effect.

36.s.3

November 23, 1942

E. P. Wigner

L. Szilard

Enclosed is a memorandum which you wanted Monday morning. If you want to shorten it you could leave out the introduction on page 1, and the "production of radioactive poisons" on the second page. Also the summary could be left off. The rest, I am afraid, cannot be shortened without destroying the balance of the memorandum.

L. Szilard

CP-360 Copy of report handed to A.H.C. office Nov. 23-42

SHORT MEMORANDUM ON BISMUTH COOLED POWER UNIT

L. Szilard
November 23, 1942

SUMMARY

If simple but thorough metallurgical tests on the interaction of liquid bismuth with steel come out satisfactorily it will be possible to build a bismuth cooled power unit that would have high operational safety. Such a power unit can be expected to work with 1000 tons of graphite and 150 tons of uranium in the form of carbide or dioxide. More than one kilogram of 94 would be produced daily by such a power unit and it is estimated that a total of about 200 kilograms of 94 might be produced by each such power unit. This estimate of the total has a much smaller degree of certainty than the caluclated value of the daily production of 94.

Introduction

The proposal of using bismuth as a cooling agent was part of the original scheme of setting up a chain reaction in a uranium-graphite system. Experiments performed since that time have greatly strengthened the view that the neutron absorption of bismuth is sufficiently low to permit this application. The last experiment performed on 4 tons of bismuth at Chicago gives, according to Fermi, an about 1% loss in the multiplication factor, if the amount of bismuth in the pile is equal to the amount of uranium. This result bears out the contention that the commercial grade of bismuth, which was known to be of extraordinary purity, is sufficiently pure for our purposes. The chemical stability of a system composed of bismuth, graphite and uranium carbide, or uranium dioxide, at high temperatures, and in the presence of strong radiation, was one of the chief considerations in selecting this system of cooling. Compared to this the good heat transfer properties of liquid bismuth are of secondary importance. There is reason to believe that it is safe to have liquid bismuth in contact with steel and to pump it through steel pipes. This point has however to be further investigated before a decision of building a bismuth cooled power unit can be made.

The Use of a Bismuth Cooled Power Unit For:

a. production of 94.

The main purpose of operating a bismuth cooled power unit during the war is the production of about 1 ton of 94. This amount might be needed in order to win the war by means of atomic bombs, though one may hope that a smaller quantity will be sufficient. Assuming that about 1/4 of the U 235 contained in 150 tons of uranium in the power unit can be transformed into 94, 270 kg. of 94 could be obtained during the operation of the power unit. In order to produce this amount in about 200 days, it is necessary to produce about 1.3 kg./day and to dissipate about 1.3 million kw. This is quite feasible in a bismuth pile without straining matters.

b. production of radioactive poisons.

The bismuth cooled power unit could produce about 40 tons of radium equivalents in radioactive poisons outside the power unit by means of fully utilizing the neutrons which escape from within. This value holds for a time of operation which is equal to half life time of the product. Therefore some such quantity of radioactive material could be drained off every few days if a suitable product were chosen. However, a Szilard-Chalmers separation may have to be performed in order to reduce the bulk of the material which has to be transported, and this may require to put each time perhaps 15 tons of material through a chemical separation.

c. production of polonium and light sources for the armed forces.

About 10 tons of radium equivalent of polonium will be produced in 140 days of operation in the 150 tons of bismuth which will be used for cooling the power unit. Polonium mixed with a luminous compound gives a light source which is practically free from harmful rays and which can be used to serve as torches, to illuminate instruments, etc. The torches would be of very small weight and would give off light "permanently", the brilliance decaying to its half value in 140 days. 250,000 such torches, each dissipating about one watt, could be made from the quantity of polonium produced in 140 days of operation.

About four times this quantity of polonium could be produced outside the power unit but this would involve the exposure of many hundred additional tons of bismuth and may therefore not be expedient during the war.

In the post-war period the manufacture of polonium might become the first important industrial application of the chain reaction.

General Features of the Power Unit.

It is proposed to maintain a chain reaction in a cylindrical graphite pile 8 m. high and 9.5 m. in diameter, weighing about 1000 tons and containing about 150 tons of uranium in the form of uranium carbide. This graphite pile would be enclosed in hermetically sealed container filled with helium at normal pressure. Liquid bismuth would enter at the top of the pile having a temperature of about 300°C. and flow through grooves or bores in the graphite from top to bottom under the action of gravity leaving at the bottom at about 600°C. The pressure of the liquid bismuth would remain the same along the flow from the top to the bottom of the pile and would vary according to the volume which is pumped between 1 and 2 atmosphere gauge. The velocity of the vertical bismuth flow in the pile is estimated to be 4 m. per second. A flow of about 3.3 m^3 of liquid bismuth per second corresponds to a heat dissipation of 1.3 million kw, and a production of 1.3 kg. of 94 per day.

The uranium carbide is present in the form of aggregates weighing about 2 kg. Figure 30 shows one possible shape in which the uranium carbide could be used. According to the position of these aggregates in the pile, smaller or larger number of them are in series in a parallel flow arrangement. The principle of such a parallel flow arrangement is illustrated in Figure 3, C taken from an earlier memorandum. Since this figure relates to a helium cooled power unit, it does not show the dimensions which would be correct for bismuth cooling. In the case of bismuth we may have a vertical graphite column of 20 cm. x 20 cm. and the two vertical bismuth ducts have together an average cross section of 10 cm^2 near the axis of the pile. Near the axis of the pile the amount of bismuth is about equal to the amount of uranium, but closer to the periphery the relative amount of bismuth is less. Altogether about 100 tons of bismuth may be in the pile during operation.

Pumps.

The pumps lifting the liquid bismuth to about 10 m. height must have an output of about 3500 kw and assuming 50% efficiency they would have a power requirement of about 7000 kw.

Centrifugal pumps have been used for mercury under conditions of temperatures and pressures which are very similar to those required for the pumping of bismuth which will have a temperature of about 300°C. after passing through a heat exchanger. The General Electric Company has put at our disposal blueprints which could serve as a basis for further action. The Westinghouse Company expressed its willingness to design and build a centrifugal pump for our purpose and it was estimated that the designing work would take about three weeks and the actual building time about six months.

Another type of pump which would have certain advantages was designed by Einstein and Szilard and built and operated in 2 kw. units for mercury. This pump consists of a steel tube with an iron core and the liquid bismuth would flow through the annular gap between core and tube under the electrodynamic action of electric windings which are outside the steel tube. This pump has the advantage of having no moving parts, of requiring no lubrication or other service, and of representing an all sealed system with a minimum of danger of leaks. It has the disadvantage that it may have to be operated on a low frequency and may therefore require a converter. Our estimate for the efficiency at 12½ cycles is about 20% for units which have an output of about 300 kw. and which would accordingly require a power input of 1500 kw. Larger units may have a somewhat higher efficiency. The Westinghouse Company made a preliminary investigation into these questions and expressed its willingness to design such a pump if requested to do so. It was estimated that it would take about two months to complete the design.

Heat Exchanger

One may consider to have a heat exchanger at the bottom of the pile in which the heat is transferred from the bismuth to a bismuth-lead alloy having a melting point at 124°C. This alloy would then be pumped outside the pile and would transfer its heat to water.

Controls

It is proposed to control the bismuth cooled pile in a manner which does not necessitate the moving of "control rods" through stuffing boxes. Such an arrangement which contains no moving parts is illustrated in Figure 40. This shows a steel tube (of about 1 cm diameter and less than 0.5 mm. wall) going through the pile which communicates through an electrodynamic pump with a vessel outside the pile. (The tube in the pile is cooled by a bismuth stream indicated by arrows). This communicating system contains a low melting alloy containing bismuth, lead, tin, and cadmium (melting point 68°C) and if the electrodynamic pump is out of action, the steel tube in the pile is filled with this liquid alloy as shown in the figure. The chain reaction is started by switching on a variable transformer (Dreh transformator) which feeds the electrodynamic pump. The liquid is then pumped out of the steel tube in the pile into the vessel outside until the pressure difference becomes equal to the pressure produced by the pump. This pressure is controlled by the transformer which in turn is controlled by the radiation intensity in such a manner that the voltage of the transformer increases with decreasing radiation intensity. If there is a failure in the control arrangement the pump goes out of action and the absorbing liquid fills the steel tube inside the pile and stops the chain reaction. Several steel tubes are connected to the same electrodynamic pump and two or three such systems ought to be provided for the sake of operational safety. The power consumption at each such pump amounts to a few kilowatts.

Start of Operation

At the start of operation the graphite pile has to be heated up to a temperature above 300°C. Electric resistors can be used for this purpose and a few thousand kw. input is sufficient to heat up the pile within 24 hours. Since the bismuth pumps are not in operation during the heating up period, the electric installation required by the bismuth pumps is capable of taking care of the heating.

End of Operation

After operation of several months the chain reaction may be stopped but the bismuth circulation is maintained for another month or so. After that, by admitting liquid lead in a quantity approximately equal to the quantity of bismuth in the pile, the uranium can be cooled down before removal from the pile to about the melting point of the bismuth-lead eutectic, 124°C.

Materials

Either of the two uranium carbides or uranium dioxide could be used following designs which have been fairly well developed. Uranium dioxide has to be used in a sintered form and the technique for sintering has been worked out on a laboratory scale at Ames, Iowa. The preparing of uranium carbide and its casting into simple cylindrical shapes has also been worked out on a laboratory scale at Ames, Iowa. More complicated shapes would have certain advantages, such as the shape shown in Figure 30, have so far not been cast.

Uranium metal could possibly be used, for instance, inside of graphite tubes, but the use of uranium metal in this form has so far not been sufficiently studied and it is therefore uncertain whether the use of uranium in metal form would be practicable from the point of view of operational safety.

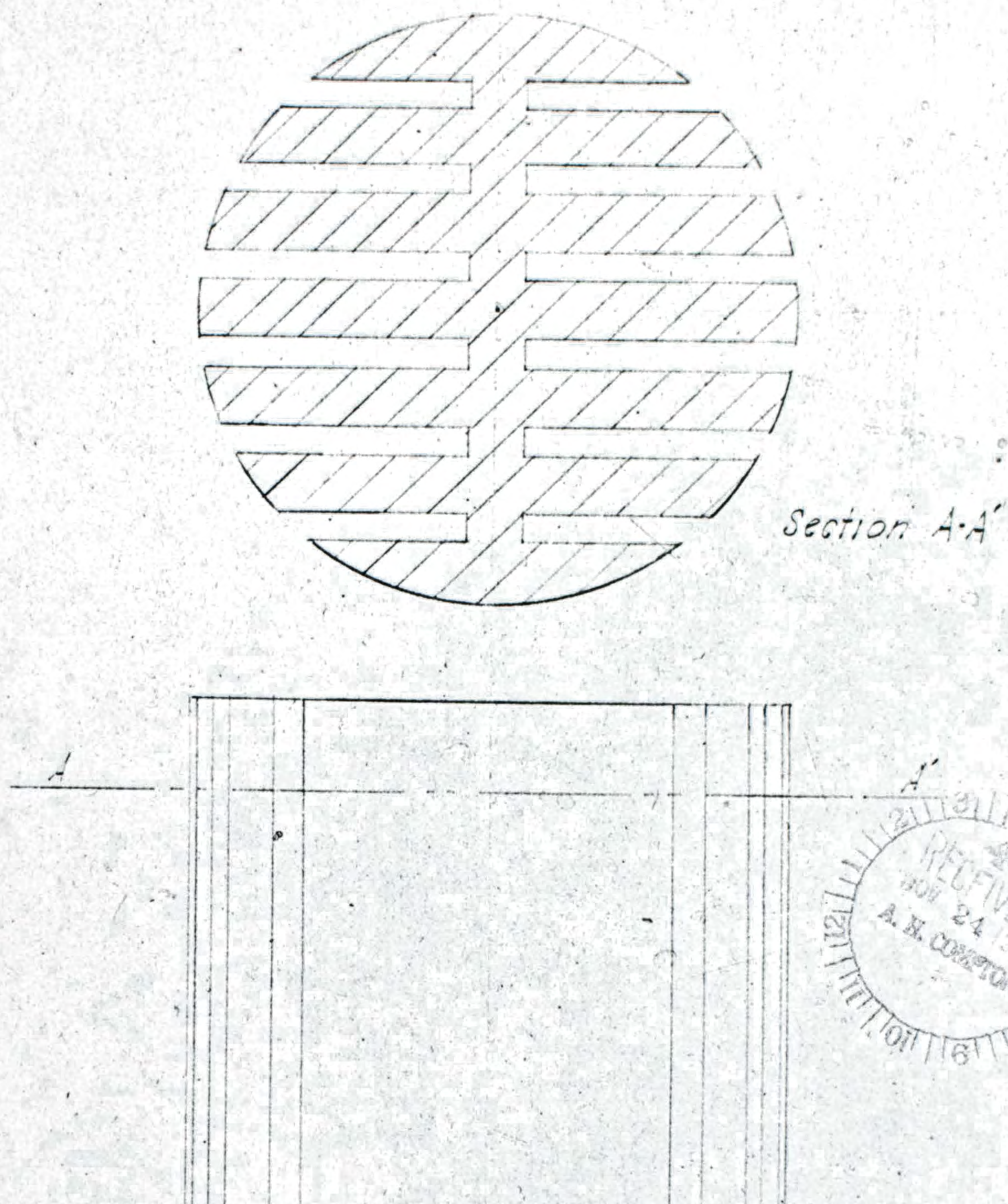
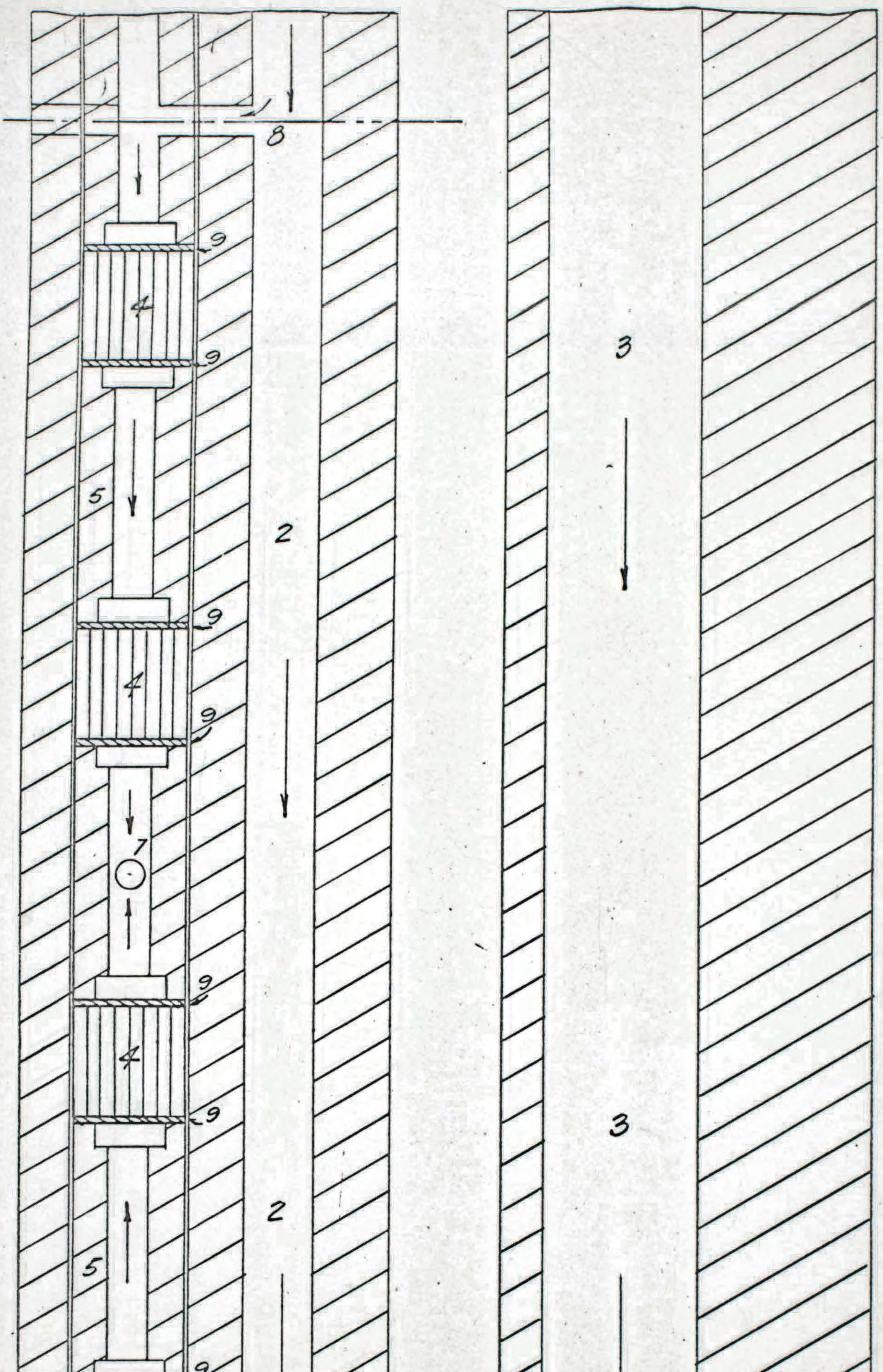


FIG. 30



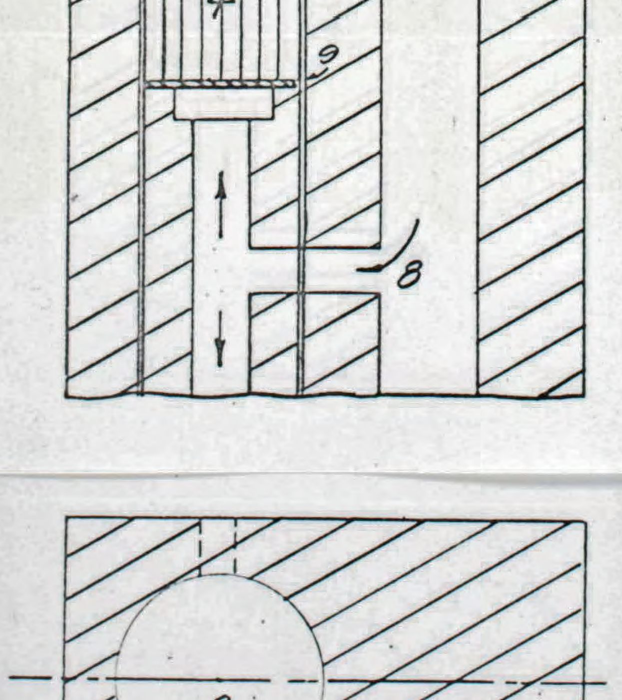


Fig. 3C

SECRET

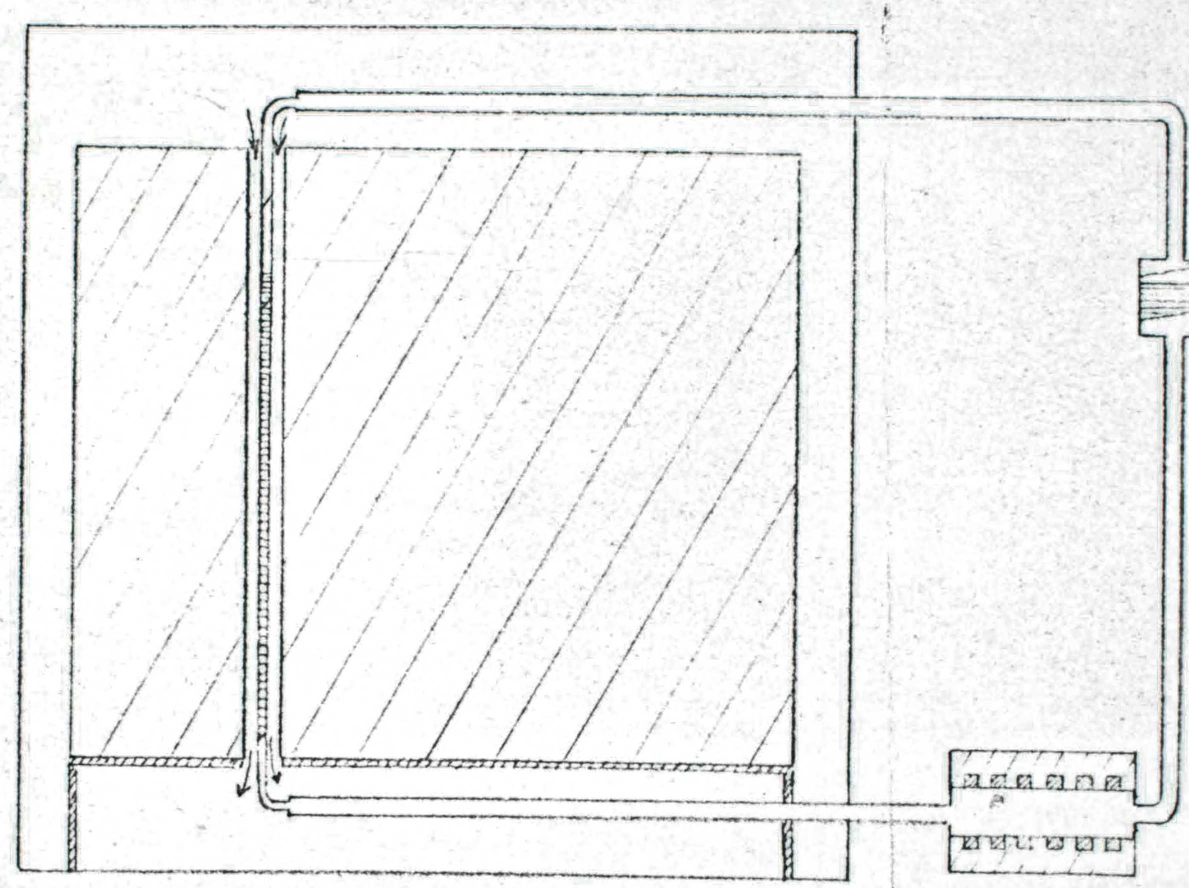


FIG 40

FORM L-8

THE UNIVERSITY OF CHICAGO
FOUNDED BY JOHN D. ROCKEFELLER
CHICAGO 37, ILLINOIS
OFFICE OF THE COMPTROLLER

5801 ELLIS AVENUE
TELEPHONE: MIDWAY 3-0800

FEB 3 1960

Mr. Leo Szilard
Enrico Fermi Institute
University of Chicago

Dear Mr. Szilard:

Under authority granted by the Board of Trustees of The University of Chicago, the Chancellor has adjusted your appointment effective January 1, 1960 to the following:

> Professor of Biophysics on indefinite tenure in the Enrico Fermi Institute for Nuclear Studies from January 1, 1960, to give service for the Enrico Fermi Institute for Nuclear Studies on a twenty-seven per cent time basisand for the United States Public Health Service Medical Research Project #558 on a seventy-three per cent time basis with total salary at the rate of $15,000 per annum.

This is a three-quarter appointment (3Q) as described in University Statute 16.

This appointment cancels and supersedes your previous appointment as of December 31, 1959.

If you wish to accept the appointment, please sign your name in the indicated place on the enclosed duplicate of this notice and return at once to the Office of the Comptroller.

The receipt of this acceptance will be required before the appointment is effective.

Very truly yours,

THE UNIVERSITY OF CHICAGO

By C. R. [signature]
For the Comptroller
Supervisor-Payrolls

NOTE.—All academic appointments to the staff of The University of Chicago are subject to (1) the provisions of the Statutes of the University as adopted or amended by the Board of Trustees, and (2) any reductions in salaries that may be enacted by the Board of Trustees.

af

[S-38]

Grant

03

Duplicate

THE UNIVERSITY OF CHICAGO
CHICAGO 37 · ILLINOIS
OFFICE OF THE VICE PRESIDENT · SPECIAL PROJECTS
5801 ELLIS AVENUE

4 October 1962

Dr. Leo Szilard
Hotel DuPont Plaza
1500 New Hampshire Avenue, N. W.
Washington 6, D. C.

Dear Dr. Szilard:

Transmitted herewith are your file copies of application material in connection with the renewal of Grant No. RG-6876-C2 submitted to Public Health Service 28 September 1962.

We will advise as soon as Public Health Service acknowledges that they have received the proposal.

Sincerely yours,

Irene E. Fagerstrom

Irene E. Fagerstrom
Assistant Vice President
(Special Projects)

Enclosures (3)
Proposal pp. 1, 2, 3
Notice of Research Project
Annual Invention Statement

P. S. We have just received notice from Public Health Service that your application was received 1 October 1962.

U. S. DEPARTMENT OF
HEALTH, EDUCATION, AND WELFARE
PUBLIC HEALTH SERVICE

APPLICATION FOR PREVIOUSLY RECOMMENDED YEAR OF RESEARCH GRANT SUPPORT
(A Privileged Communication)

APPLICANT: LEAVE BLANK EXCEPT FOR GRANT NUMBER		
TYPE	PROGRAM	GRANT NUMBER GM-05376-04

NOTICE OF RESEARCH PROJECT	INVENTION STATEMENT
☒ YES ☐ NO	☒ YES ☐ NO

1. TITLE OF RESEARCH PROJECT (limit to 53 letters and spaces)

Quantitative Studies of General Biological Phenomena

2. NAME AND TITLE OF PRINCIPAL INVESTIGATOR OR PROJECT DIRECTOR (Last, first, middle) — DEGREE

Szilard, Leo — Ph.D.
Professor of Biophysics

MAILING ADDRESS

1155 E. 57th Street
Chicago 37, Illinois

TELEPHONE NUMBER

Hy 3-6601

3. AMOUNT REQUESTED (Should be same as Item 9, Page 2)

$ 27,670

4. DATES OF GRANT PERIOD

FROM 1 Jan 1963
THROUGH 31 Dec 1963

5. NAME AND TITLE, CO-INVESTIGATOR (if any) — DEGREE

none

6. ADDRESS WHERE RESEARCH IS BEING CONDUCTED

The University of Chicago and other major research centers

7. NAME OF SCHOOL AND DEPARTMENT (or service if applicable)

Division of Physical Sciences
Enrico Fermi Institute for Nuclear Studies

8. NAME AND MAILING ADDRESS OF INSTITUTION SUBMITTING APPLICATION

The University of Chicago
5801 S. Ellis Avenue
Chicago 37, Illinois

9. NAME, TITLE AND MAILING ADDRESS OF FINANCIAL OFFICER TO WHOM CHECKS SHOULD BE MAILED

Mr. A. Wayne Giesemann
Bursar
The University of Chicago
5801 S. Ellis Avenue
Chicago 37, Illinois

10. TYPE OF INSTITUTION

☐ PUBLIC
☐ FEDERAL ☐ STATE ☐ LOCAL
☒ PRIVATE
☒ NON-PROFIT, IRS TAX EXEMPTION NO.________
☐ PROFIT

11. (LEAVE BLANK)

12. TERMS AND CONDITIONS

Any grant awarded on the basis of this application is subject to the following terms and conditions: (1) grant funds are to be expended solely for the research purposes described herein and in the award document and for related purposes; (2) the grant may be revoked in whole or in part at any time by the Surgeon General of the Public Health Service, provided that a revocation shall not include any amount obligated previous to the effective date of the revocation if such obligation was made solely for the purposes authorized in Clause (1); (3) all reports of investigations supported by the grant shall acknowledge such support; and (4) the applicant and principal investigator (project director) agree that, in accordance with Department of Health, Education, and Welfare regulations, 45 C.F.R. Parts 6 and 8, any invention arising out of the activities assisted by the grant shall be promptly and fully reported to the Surgeon General. Whether patent protection on such an invention shall be sought and how the rights in the invention, including rights under any patent issued thereon, shall be disposed of and administered in the public interest shall be determined either (a) by the Surgeon General or (b) where a separate formal institutional patent agreement has been reached by the Surgeon General with a nonprofit grantee institution, by such grantee institution in accordance with its own policies.

THE UNDERSIGNED ACCEPT AND AGREE TO THE ABOVE TERMS AND CONDITIONS

13. PRINCIPAL INVESTIGATOR OR PROJECT DIRECTOR (SAME AS ITEM 2)	SIGN IN INK ON ORIGINAL ONLY	DATE
14. OFFICIAL AUTHORIZED TO SIGN FOR INSTITUTION , Dean Division of Physical Sciences	SIGN IN INK ON ORIGINAL ONLY. (Type name and title below signature) W. B. Harrell, Vice President for Special Projects	DATE 9/28/62

APPLICANT: REPEAT GRANT NUMBER SHOWN ON PAGE 1 ⟶	GRANT NUMBER	
SUMMARY PROGRESS REPORT	GM-05376-04	
PRINCIPAL INVESTIGATOR (Name) Leo Szilard	SUMMARY OF ACCOMPLISHMENTS COVERING PERIOD	
INSTITUTION The University of Chicago	FROM 1 Sept 1961	THROUGH 17 Sept 1962

TITLE OF PROJECT (Repeat title shown in Item 1 on first page)
Quantitative Studies of General Biological Phenomena

In mammals, and also in the fruit fly, the somatic cells of the female contain two X chromosomes, while the somatic cells of the male contain only one. Accordingly, the cells of the female carry two homologous copies of each sex linked gene, whereas the cells of the male carry only one copy of each. This difference in "dosage" does not usually manifest itself in a phenotypic difference between the male and the female. Recent observations indicate that in the case of mammals, at some point of the embryonal development of the female, one of the two X chromosomes ceases to be functional in the somatic cells. This, on the face of it, could account for the fact that the double dosage of the sex linked genes in the female, as compared to the single dosage of the same genes in the male, does not lead to a difference in the phenotype. However, no such difference in phenotype exists in the fruit fly either, and yet I find that the phenomenon of "dosage compensation", which has been studied in the fruit fly by H. J. Muller, cannot be explained on the assumption that only one of the two X chromosomes is functional in the somatic cells of the female. In these circumstances it is necessary to look for another explanation for "dosage compensation" in the fruit fly. I propose to explain this phenomenon in the fruit fly by assuming that the relevant gene products in the fruit fly are under the control of repressors, in much the same way in which many enzymes are under the control of repressors in bacteria, and by further assuming that in the fruit fly the genes corresponding to the repressors (of those gene products which show "dosage compensation") are located on the X chromosome. These considerations are described in a paper, "The sex chromatin in mammalian cells, 'dosage compensation' in the fruit fly, and enzyme repression in bacteria," which is being circulated in preprint among those interested in this kind of problems.

Prepared for the Science Information Exchange.

Not for publication or publication reference.

U. S. Department of

HEALTH, EDUCATION, AND WELFARE

PUBLIC HEALTH SERVICE

NOTICE OF RESEARCH PROJECT

Quantitative Studies of [illegible]

PROJECT NO. (DO NOT USE THIS SPACE)

Submit with completed Application to: Division of Research Grants, National Institutes of Health, Bethesda 14, Md.

TITLE OF PROJECT:

Give names, departments, and official titles of PRINCIPAL INVESTIGATORS or PROJECT DIRECTORS and ALL OTHER PROFESSIONAL PERSONNEL engaged on the project. Include day-month-year of birth of principal investigators.

Leo Szilard
Professor of Biophysics
Enrico Fermi Institute of Nuclear Studies
The University of Chicago, 5801 S. Ellis Ave., Chicago 37, Illinois

NAME AND ADDRESS OF APPLICANT INSTITUTION:

SUMMARY OF PROPOSED WORK — (200 words or less — Omit Confidential data.)

In the Science Information Exchange summaries of work in progress are exchanged with government and private agencies supporting research in the bio-sciences and are forwarded to investigators who request such information. Your summary is to be used for these purposes.

In my paper (Proc. Nat. Acad. Sci. 46, 293, 1960), I postulated a simple biochemical mechanism upon which the "memory" may be based which manifests itself in the secondary antibody response. Professor Herbert Anker suggested in a "Letter" to Nature that memory in the central nervous system might perhaps be based on the same biochemical mechanism. A set of postulates has been formulated which would have to hold if this particular memory mechanism accounts for the phenomena of memory that manifest themselves in the central nervous system. It is proposed to examine whether it may be possible to account on the basis of these postulates for remembering a "sequence" and whether a memory trace, which corresponds to a sequence, could be localized in individual neurons.

SIGNATURE OF PRINCIPAL INVESTIGATOR or PROJECT DIRECTOR: Leo Szilard

Identify the Professional School (medical, dental, public health, graduate, or other) with which this project should be identified: Division of Physical Sciences

SCHOOL

INVESTIGATOR — DO NOT USE THIS SPACE

PHS-166
REV. 12-61

FORM APPROVED
BUDGET BUREAU NO. 105-R002.

S-38 D

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- To be inserted on page 2 of Progress Report

Statement of Accomplishment covering period
January 1, 1960 to September 30, 1960

A model for the control of the rate of production of repressible enzymes has been developed and this model is described in detail in "The Control of the Formation of Specific Proteins in Bacteria and in Animal Cells", Proceedings of the National Academy of Sciences, Volume 46 p.277 (March) 1960. This model assumes that in bacteria the repressor controls the rate of formation of the enzyme by the enzyme forming site, rather than the rate of formation of the enzyme forming site itself. Experiments which are at present being conducted in a number of different laboratories, with which the author maintains contact, might elucidate, within a year, whether this "premise" is correct.

The above-quoted paper also assumes that the repressor can attach itself to the enzyme and it is shown that accordingly the cell might have two stable states, a state in which the enzyme level is high and a state in which the enzyme level is low. The validity of this assumption does not depend on the above-mentioned "premise" and the assumption might provide the key to the understanding of a certain type of differentiation, discussed in the paper.

A second paper "The Molecular Basis of Antibody Formation", Proceedings of the National Academy of Sciences, Volume 46, p.293 (March) 1960 discusses the possibility that antibody formation - in the primary response - is based on this type of differentiation, triggered by the injection of an antigen into the rabbit. This theory can account for a number of phenomena listed in the paper, including the phenomenon of immune tolerance of the new-born rabbit. The explanation of immune tolerance is, however, again based on the "premise" that the repressor controls the rate at which the protein - in this case the antibody - is formed by the specific protein forming site. If future experiments should show that this "premise" is wrong, then the theory of immune tolerance would have to be modified and it is not as yet clear whether a satisfactory modification of the theory would be possible, in that contingency.

A theory for the dependence of the sex ratio at birth on the age of the father has been presented in "Dependence of the Sex Ratio at Birth on the Age of the Father", Nature, Volume 186 pp.649-650, (May) 1960, which is based on a theory of ageing previously presented by the author (Proc. Nat. Acad. Sc. 45,32. 1959). The theory accounts for the decrease in the ratio of boys to girls, with increasing age of the father, on the ground that a spermatogonium in which the X-chromosome suffers an "ageing hit" may not continue to give rise to sperm, whereas a spermatogonium in which the Y-chromosome suffers an "ageing hit" may continue to give rise to sperm.

The End

~~Confirmation copy.~~

1155 East 57th Street
Chicago 37, Illinois
February 27, 1945

W. A. Akers, Esq.
Department of Scientific and Industrial
Research
16 Old Queen Street
London, SW 1, England

For Biog.

Dear Mr. Akers:

I wonder whether you could perhaps help me in connection with an old matter arising out of my previous connection with Imperial Chemical Industries. I wrote about this to F. A. Lindeman (the present Lord Cherwell) in January 1938 and recently came across the copy of my letter. It occurred to me that the contents of my letter were perhaps not actually transmitted by Cherwell to Imperial Chemical Industries or their reply to my query may not have reached me and I feel that I ought to make another attempt to straighten out my records of this matter.

The story is as follows: In 1937 I worked at the Clarendon Laboratory at Oxford and had at that time a salary from Imperial Chemical Industries of, I believe, 400 pounds a year. Since from January 1938 on I intended to spend six months every year in America, a new arrangement was agreed upon under which I was supposed to receive, I believe, 200 pounds a year and spend six months at Oxford looking after some research (I had proposed that we build a betatron) which we planned to perform at the Clarendon Laboratory. Under this new arrangement I came to the United States in January 1938. My return to Oxford was first scheduled for July and later for the end of September.

At the time of the Munich agreement, however, I became doubtful whether in view of the impending war it would be wise to go on with the research program which we had drawn up and I asked by cable for a leave of absence without pay. Having decided against going through with our plans at Oxford I wrote F. A. Lindeman on January 13, 1939. In that letter I set forth my view that England would be at war in a very short time, that in the circumstances there were matters which had a prior claim on our attention, and that I would prefer to be free of the responsibility of looking after the research program which we had drawn up. With respect to Imperial Chemical Industries the letter contains the following passage:

"Since my collaboration in the work, for which you were good enough to win the support of Imperial Chemical Industries, would be of little value unless I gave the work my full attention, it seems best in the circumstances that I should not embark upon it. This being so, I do not feel that I am entitled to keep any payments which Imperial Chemical Industries may have made to me under the new agreement, i.e. after January 1st of last year. I should be grateful if you could perhaps communicate on this subject with Dr. Slade and tell him how very thankful I am for the help I had from Imperial Chemical Industries in the past, and how very much I regret that the deterioration of the international situation which occurred while I was abroad, makes it impossible for me to collaborate in the work which Dr. Slade kindly consented to support. If Dr. Slade wishes me to refund payments made to me after January 1st of last year, I shall be very glad to do so. In this case Dr. Slade will have to let me know the amount which actually has been paid to my account, and also to what account and under what heading he wishes me to transfer this amount."

I wonder whether you would be good enough to bring this matter to the attention of Imperial Chemical Industries? If I wrote to Imperial Chemical Industries I would not know to whose attention my letter ought to be addressed but I assume that you would know who within that organization is at present qualified to deal with this matter. As quoted above, I should be very glad to refund the sum in question. However, if for any reason this is not deemed to be desirable, then I would appreciate having a letter from Imperial Chemical Industries in which their wishes in this matter are set forth.

I hope you will not mind too much my troubling you with this matter as I am sure you will understand my desire to have a clear record of the facts.

Yours very sincerely,

Leo Szilard

Leo Szilard

P. S. I am inclosing a carbon copy of this letter for your convenience and for transmittal to Imperial Chemical Industries.

5-37
Dupe.

THE UNIVERSITY OF CHICAGO
CHICAGO XX · ILLINOIS 60637

OFFICE OF THE VICE PRESIDENT · SPECIAL PROJECTS
5801 ELLIS AVENUE

24 September 1963

Dr. Leo Szilard
c/o Dr. Martin Kaplan
World Health Organization
Palais des Nations
Geneva, Switzerland

Dear Dr. Szilard:

Attached are your file copies of the materials which were submitted on September 23, 1963 to NIH in behalf of your research project, GM-06876-05.

If we may be of further assistance, please advise.

Sincerely,

Irene E. Fagerstrom

Irene E. Fagerstrom
Assistant Vice President
(Special Projects)

cc: Dean A. A.Albert

Prof. Szilard?

21st August, 1963

Division of Research Grants
National Institutes of Health
Bethesda 14, Maryland

Gentlemen:

Attached is an application for continued support of research grant, GM-06876-04.

The papers listed below are at present privately circulated among scientists who may be assumed to be interested, as a result of work done under this grant. Ten multigraphed copies of each paper are enclosed with this application.

Sincerely yours

Leo Szilard

Leo Szilard

Papers

"On the Occasional Dominance of the 'Perceptible Phenotype' in Man", dated July 12, 1963.

"The Aging Process and the 'Competitive Strength' of Spermatozoa", dated July 25, 1963.

... the Science Information ... Exchange. Not for publication or publication reference.

U. S. Department of
HEALTH, EDUCATION, AND WELFARE
PUBLIC HEALTH SERVICE

NOTICE OF RESEARCH PROJECT

PROJECT NO. (DO NOT USE THIS SPACE)

Submit with completed Application to: Division of Research Grants, National Institutes of Health, Bethesda 14, Md.

TITLE OF PROJECT:

QUANTITATIVE STUDIES OF GENERAL BIOLOGICAL PHENOMENA

Give names, departments, and official titles of PRINCIPAL INVESTIGATORS or PROJECT DIRECTORS and ALL OTHER PROFESSIONAL PERSONNEL engaged on the project. Include day-month-year of birth of principal investigators.

Principle investigator: Leo Szilard, Professor of Biophysics in the Enrico Fermi Institute for Nuclear Studies at the University of Chicago. Born February 11th, 1898. No other professional personnel is engaged on the project.

NAME AND ADDRESS OF APPLICANT INSTITUTION: The University of Chicago
5801 S. Ellis Avenue
Chicago 37, Illinois

SUMMARY OF PROPOSED WORK – (200 words or less – Omit Confidential data.)

In the Science Information Exchange summaries of work in progress are exchanged with government and private agencies supporting research in the bio-sciences and are forwarded to investigators who request such information. Your summary is to be used for these purposes.

In a population, like for instance the population of the United States, within one cohort, the ages at death have a considerable scattering around the median value. The curve which gives for a cohort the number of deaths per year, as a function of the age, resembles a Gaussian with a standard deviation of about 10 years. Some of the scattering of the ages at death is likely to be due to the genetic differences between the individuals who make up the population and the remainder of the scattering must be attributed to non-genetic causes.

It is proposed to develop a method that would permit us to determine how much of the observed scattering of the ages at death is due to the genetic differences between individuals, i.e. to determine what the mean deviation of the curve, giving the number of deaths per year as a function of the age for a cohort, would be if there were no scattering of the ages at death, other than that which is due to genetic causes.

SIGNATURE OF PRINCIPAL INVESTIGATOR or PROJECT DIRECTOR: Leo Szilard

Identify the Professional School (medical, dental, public health, graduate, or other) with which this project should be identified:

SCHOOL: Research Institutes

INVESTIGATOR – DO NOT USE THIS SPACE

... SHEET FOR
...990 (REV. 2-62)

Name of Principal Investigator Szilard, Leo
Current Grant No. GM-06876-04
Current Grant Period 1/1/63 - 12/31/63

I. ESTIMATED CURRENT YEAR LEVEL OF EXPENDITURES:

The following table has been developed to help you in arriving at figures to be inserted in Column 3 of the detailed budget page. Please return this work sheet with your completed application for continuation support.

Budget Categories	Actual Obligations through 30 June 1963 (insert date)	Estimated Additional Expenditures through remainder of current grant period.	TOTAL ESTIMATE FOR ENTIRE CURRENT YEAR (Entries for Column 3 of Budget Page shown by "x")	
1. Personnel	$ 6,149.04	$ 6,944.96	$ 13,094.00	x
2. Movable Equipment	-			x
3. Consumable Supplies				x
4. Travel	1,740.16)			x
5. Other expenses on which indirect costs are allowed	1,436.88)	3,200.00	6,377.04	x
	68.10	100.00	168.10	x
6. Sub-total	9,394.18	10,244.96	19,639.14	-
7. Indirect Cost Allowance	1,409.13	1,536.74	2,945.87	-
8. Other expenses on which indirect costs are not allowed	-0-	-0-	-0-	x
9. TOTAL ESTIMATE	$10,803.31	$11,781.70	$22,585.01	-

- - - - - - - - - - - -

II. ESTIMATED UNOBLIGATED BALANCE AT TERMINATION OF CURRENT GRANT YEAR:

1. Total funds available in current grant for the entire year (include funds that were permitted to be carried over from prior year grant, if any) .... $ 32,670.00
2. Less total estimated expenditures under current grant (from line I.9., above) .... - 22,585.01
3. Estimated free balance at termination of current grant (1 minus 2) $ 10,084.99

III. PLANNED USE OF ANTICIPATED FREE BALANCE DURING COMING GRANT YEAR: (Public Health Service research grant policy permits any unspent funds UP TO $5,000 OR ONE HALF OF THE CONTINUATION GRANT, whichever is smaller, to carry forward to the continuation grant account and remain available for use during the continuation grant year. Explain below your planned use of the estimated free balance shown in item II.3.)
I anticipate to use the free balance during the coming grant year for secretarial services, communications, and travel expenses.

The increased office and secretarial expenses, as well as the increased travel expenses, are anticipated because, in pursuance of work relating to population genetics and vital statistics which I am about to begin (manuscript in preparation), I expect to have to step up communications with a number of different institutions, who are engaged in similar work.

(continue on reverse if more space is needed)

Grant Number
GM-06876-05

BUDGET JUSTIFICATION

4. TRAVEL

I plan to make two trips to Europe.

On one of these trips to Europe I plan to visit one of the three institutes listed below:

(a) The World Health Organization, Geneva, Switzerland

(b) The Institute of Genetics (Cavalli Sforza) at the University of Pavia, Italy.

(c) The National Institute for Medical Research (Peter B. Medawar), Mill Hill, London, England.

Work on population genetics which I am planning to perform will make it necessary for me to visit one out of these three places in Europe, in order to assemble data in vital statistics which are difficult to obtain in the United States.

On the other trip to Europe, I plan to visit the Institute of Animal Genetics (C. H. Waddington), at the University of Edinburgh, England. The purpose of this trip is to discuss and if possible to make arrangements for the insemination of female animals with mixtures of spermatozoa derived from two different males.

During the coming grant year I also plan to make three trips from the East coast to the Salk Institute for Biological Studies at La Jolla, California.

DO NOT TYPE IN THIS SPACE—BINDING MARGIN

... GRANT NUMBER SHOWN ON PAGE 1 →	GRANT NUMBER	
SUMMARY PROGRESS REPORT	GM-06376-05	
PRINCIPAL INVESTIGATOR (Name) Leo Szilard	SUMMARY OF ACCOMPLISHMENTS COVERING PERIOD	
INSTITUTION The University of Chicago	FROM 18 Sept 1962	THROUGH 21 Aug. 1963
TITLE OF PROJECT (Repeat title shown in Item 1 on first page) Quantitative Studies of General Biological Phenomena		

1.) It has been shown that the observed frequent occurrence of a striking resemblance between a child and one of its parents might be explained in one of two ways:

a) The perceptible phenotype might be determined by a number of different genetic loci, all of which are located on one pair of homologous autosomes. Such an autosome might possess a certain "strength" and a "strong" autosome might suppress the homologous autosome if it is substantially less "strong". (For details see the enclosed paper "On the occasional dominance of the 'perceptible phenotype' in Man", dated July 12, 1963.)

b) The genes which determine the perceptible phenotype might all be located within the same operon and different operons might be more strongly or less strongly repressed. This could then account for the observed resemblances, if one assumes that the perceptible phenotype is determined by the ratio of the quantities of the products of these genes in the diploid cell.

2.) An experimental method has been devised for determining whether the competition which exists between spermatozoa for fertilising an ovum might serve the purpose of protecting the ova against being fertilised by a spermatozoon which might contain genetic material that has deteriorated as a result of the aging process. The method devised consists in inseminating females with a mixture of spermatozoa, derived from two donors, and in determining how the fraction of the offspring which is derived from the older donor, decreases with increasing age differences of the two donors. (For details see the enclosed paper "The aging process and the 'competitive strength' of spermatozoa", dated July 25, 1963.) Arrangements for carrying out experiments of this type are at present under discussion.

Written by Liv.

M

Refer to: NIMH-R
December 19, 1958

Director, NIH
THROUGH : Director, NIMH

Director of Basic Research, NIMH-NINDB

Appointment of Professor Leo Szilard

I am very proud on behalf of the Program and the Institute to recommend the appointment of Professor Leo Szilard as a Biophysical Geneticist in this Program under Section 208 (g) of the Public Health Service Act, as amended, at an annual salary of $17,000, effective April 1, 1959.

Dr. Szilard, as you know, has contributed very importantly to the flourishing of science and technology in the United States since he came here first in 1933. He is, as you know, co-inventor of atomic energy along with Enrico Fermi, holding the first patent in this field in the history of the world. He was among the first scientists to recognize the implications of atomic energy both for military and peaceful uses. He was instrumental in encouraging our Government to engage in the pursuit of technologies based on theoretical work in which he had played an important part which led ultimately to the Manhattan Project and later to the Atomic Energy Commission.

Since World War II, Professor Szilard, whose initial training and profession was not atomic physics but was probability theory, has turned his talents to fundamental problems in biomedical sciences. Specifically, he devised means to examine accurately the rate of mutations among bacteria. This required the development of a specific instrument, the Chemostat, which he devised and perfected and which he and Professor Novick and others interested in biophysical genetics have exploited.

His interests extending beyond this have involved the problem of protein formation and replication, the biophysical and biochemical aspects of DNA and RNA and the problem of replication of genetic and somatic chromosomal materials. Specifically, he provided a theoretical advance which accounts very well for the probability of continuity and the mechanisms of error in the replication of genetic materials *in vitro* and *in vivo*.

Over a period of many years, Professor Szilard has had an abiding interest in the nervous system as a mechanism underlying neurological and psychological processes. He has had a great curiosity about the nature of sleep, consciousness, learning, memory, and ideation. Although he has seldom been in a community of scholars well versed in studies relating to the nervous system and behavior, he has tried to learn these things on his own and through interchange with scientists at scientific meetings. Prior to my coming to NIH, Dr. Szilard and I had several engaging discussions on the problem of central mechanisms relating to reward and punishment. He had agreed to be a consultant to the research program on the nervous system at UCLA School of Medicine under the general direction of Professor H. W. Magoun. When I came to the National Institutes of Health, he expressed an interest in continuing our association and becoming a consultant to this Program where his interest in the nervous system and behavior could be furthered. As a result of this mutually favorably opportunity, Professor Szilard was named a consultant to this Program on May 19, 1958. He has already spent approximately six months in residence, acting as full time consultant to this Program.

During his tenure as a consultant to the Basic Research Program, Professor Szilard has devised and carried through to a form suitable for publication, a theory which is very fundamental to the interests of the National Institutes of Health broadly conceived. This theory allows a determination of the number of latent mutations in our population. The theory allows the reasonableness of this determination to be checked by a variety of means, many of which would formerly seem to have been unrelated. This theory proposes for the first time a concept of "genetic faults," defines their approximate dimension, accounts for the difference between latent and overt mutations, indicates the likelihood of damage to chromosomal material in somatic cells as a result of exposure to background or to introduced radiation, defines the mechanisms linking genetic determinism to degenerative diseases and thus provides the first major comprehensive theory in the field of aging. This idea was conceived and developed and written up while Professor Szilard served as a consultant to our Program. Two papers have been written, one, a short form submitted to Nature, the second, the full paper already accepted for publication in the forthcoming issue of The Proceedings of the National Academy of Sciences. In my opinion, this contribution is of first order magnitude importance, not simply for our own Institutes but for the whole of NIH and the Public Health Service. Moreover, it is one of the major steps in biomedical conceptualization for which our entire scientific community may justifiably feel proud.

In the course of working as a consultant to this Program, Professor Szilard proved to be an intellectual catalyst to ongoing research and the fruitfulness of conceptual development in a large number of laboratories throughout the NIH community. He was an active participant in many seminars and discussion groups and because of his native abilities, was consistently able to cross from one discipline to another and obtain a footing in the root questions of almost any given field.

In the course of observing and evaluating Professor Szilard's contribution to our mission, I approached him with the possibility of his joining our staff for two reasons. One, the area of biophysical genetics is one in which our Institute specifically, and the NIH in general, is deficient. Secondly, because Professor Szilard had turned out to be such an advantageous contributor to the intellectual vigor of our community of scientists.

As to the need for increased knowledge in the field of biophysical genetics pertinent to understanding the nervous system, it is already recognized that approximately half of the total number of genes in our chromosomes are devoted to the organization and sequence of development of the nervous system. It is, therefore, extremely desirable that we develop the field of biophysical genetics and begin manipulating this genetic material with specific reference to the biological expression of genetic deficiencies and errors of development of the nervous system. We believe that Dr. Szilard is the best qualified scientist available to develop this area of research.

On the basis of Professor Szilard's broad range of interest in the nervous system, we can depend upon his continuing devotion to biophysical genetics making headway in the direction of explaining hereditarily determined defects as they relate to neurology and psychiatry.

None of the duties Dr. Szilard will perform will require or involve classified information.

Robert B. Livingston, M.D.

CURRICULUM VITAE

Name: Leo Szilard

Date and Place of Birth: February 11, 1898; Budapest, Hungary

Marital Status: Married, no children

Education:

1917-1919	Institute of Technology, Budapest
1919-1920	Institute of Technology, Berlin
1920-1922	University of Berlin, Ph.D. in physics

Positions Held:

1922-1925	Research in x-ray, Kaiser Wilhelm Institute, Berlin
1925-1933	Privatdozent for physics, University of Berlin
1933-1934	Research in nuclear physics, St. Bartholomew Hospital, London, England
1935-1938	Research in nuclear physics, Clarendon Laboratory, London
1939-1942	Research in atomic energy, Columbia University, New York
1942-1946	Chief Physicist, Metalurgical Laboratory, University of Chicago
1946-1958	Professor of Biophysics, University of Chicago

Military Service: None

Societies:

Fellow American Physicist Society
Fellow American Academy of Arts and Sciences

(A narrative curriculum vitae is attached)

Re - Dr. Leo Szilard July 16, 1958

Leo Szilard was born in 1898, in Budapest, Hungary, and obtained his Degree of Dr. Philosophy in Physics at the University of Berlin in 1922. In his Doctor's dissertation, he demonstrated the connection between the Second Law of Thermodynamics on the one hand and the relation of entropy and probability on the other. He became a privatdozent for Physics at the University of Berlin in 1925. His Habilitations-schrift is often quoted these days because it first established the relationship between entropy and "information," subsequently rediscovered by Shannon.

In the years following 1922, he worked experimentally at the Kaiser-Wilhelm-Institutes in Berlin-Dahlem in the field of x-ray research.

While a refugee from Hitler Germany in London, in 1933, he became interested for the first time in nuclear physics. Working for a two-month period during vacation-time in 1934, at the St. Bartholomew Hospital in London, he discovered, jointly with a staff member of the Hospital, Dr. Chalmers, the disintegration of beryllium by the gamma rays of radium. They found that if beryllium is exposed to gamma rays of radium, it is disintegrated and that slow neutrons are emitted in this process. This radium-beryllium neutrons source played subsequently an important role in the history of the chain reaction, as will be described below.

During the same two-month period, they also discovered what is now called "Szilard-Chalmers Reaction" which permits the separation of a radio-isotope from the stable isotope from which it is produced through neutron capture.

While in England, Szilard became associated with the Clarendon Laboratory at Oxford where he worked in the field of nuclear physics. In 1938, Szilard was in the United States at the time of the Muenich Crisis and, at that time, he resigned his position at Oxford and remained in the United States.

While still in England, he had recognized the possibility of a self-sustaining nuclear chain reaction that might be maintained if an unstable element could be found that would emit two neutrons for each neutron captured, and he had derived the general laws governing such a chain reacting system.

He learned in January 1939 of Otto Hahn's discovery of the fission of uranium. Hahn showed that uranium breaks into two heavy, charged, fragments when it captures a neutron. Szilard immediately thought of the possibility that neutrons might be emitted in this process and that a self-sustaining nuclear chain reaction might be set up in some system containing uranium. At once he borrowed $2,000 from personal friends, rented a gram of radium and made a radium-beryllium neutron source out of it. He thought that, if such a show neutron source was used to bombard uranium with neutrons, then the neutrons emitted in the fission process could be distinguished from the primary neutrons because they could be expected to have a much higher energy than the neutrons from the primary source. He teamed up with Walter Zinn at Columbia University and they demonstrated, on March 3, 1939, that about two neutrons were emitted in the fission of uranium for each neutron captured in this process. The same discovery was made independently and about the same time by Anderson-Fermi at Columbia University as well as Halban and Joliot in Paris.

Subsequently Szilard then worked as a guest of Columbia University until the end of June. During that period, Fermi and Szilard teamed up and carried out jointly with Herbert Anderson an experiment which showed that uranium-water system came close, but not close enough, to being able to maintain a self-sustaining chain reaction.

In July, 1939, Szilard recognized that a uranium-graphite system was much more favorable in this respect than the uranium-water system and that it was likely that a chain reaction could be set up in such a system. He was aware of the military possibilities inherent in this development and realized also that a world war was impending. Szilard communicated his results and his apprehensions to Albert Einstein and these communications resulted in a letter written by Einstein to President Roosevelt, dated August 2, 1939.

In February, 1940, Szilard sent a paper to the <u>Physical Review</u> appraising the possibility of maintaining a self-sustaining chain reaction in the uranium-graphite system and concluding that self-sustaining chain reaction should be possible in this system. At the Government's request, the publication of this paper was withheld.

In November, 1940, a Government contract was given to Columbia University for developing the Fermi-Szilard System and at that time, Szilard became a member of the Columbia University National Defense Research Staff. In January, 1942, Fermi and Szilard moved to Chicago to continue their work under contract with the Government in the so-called Metalurgical Laboratory of the University of Chicago. The first self-sustained chain reaction was set up at Chicago on December 2, 1942. The Patent issued to the AEC is the first patent issued in the United States in this general field and names Fermi and Szilard as joint inventors.

Szilard stayed with the Metalurgical Laboratory of the University of Chicago with the rank of "Chief Physicist" until the end of the war and then resigned to accept a position as Professor of Biophysics on the regular staff of the University of Chicago. This was a Research Professorship attached to the Institute of Radiobiology and Biophysics, which was one of the three research institutes created after the war by the University of Chicago. This Institute was lated dissolved, and Szilard was transferred to the Staff of the Enrico Fermi Institute for Nuclear Studies as Professor of Biophysics. He holds this position at present.

While at Chicago, Szilard developed jointly with Aaron Novick a method for studying mutations, induced enzyme formations and other phenomena in growing bacteria cultures, which is known as "The Method of the Chemostat." His work and interests centered on problems relating to mutations and induced enzyme formation in bacteria, antibody formation in mammals, and the general problem of protein synthesis.

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Dr. Leo Szilard

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4 Szilard, L. Über die Entropieverminderung in einem thermodynamischen System bei Eingriffen intelligenter Wesen. Zschr. Physik, 1929, 53: 840-856.

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*Some of Dr. Szilard's most important works still remain unpublishable, for reasons of national security.