UCRL - 337

UNIVERSITY OF CALIFORNIA

Radiation Laboratory

TWO-WEEK LOAN COPY

This is a Library Circulating Copy which may be borrowed for two weeks. For a personal retention copy, call Tech. Info. Division, Ext. 5545

BERKELEY, CALIFORNIA

DISCLAIMER

This document was prepared as an account of work sponsored by the United States Government. While this document is believed to contain correct information, neither the United States Government nor any agency thereof, nor the Regents of the University of California, nor any of their employees, makes any warranty, express or implied, or assumes any legal responsibility for the accuracy, completeness, or usefulness of any information, apparatus, product, or process disclosed, or represents that its use would not infringe privately owned rights. Reference herein to any specific commercial product, process, or service by its trade name, trademark, manufacturer, or otherwise, does not necessarily constitute or imply its endorsement, recommendation, or favoring by the United States Government or any agency thereof, or the Regents of the University of California. The views and opinions of authors expressed herein do not necessarily state or reflect those of the United States Government or any agency thereof or the Regents of the University of California.

Copy 2

UCRL 337

UNCLASSIFIED

UNIVERSITY OF CALIFORNIA

Radiation Laboratory

Contract No. W-7405-eng-48

SUMMARY OF THE RESEARCH PROGRESS MEETING

March 31, 1949

H. P. Kramer

Berkeley, California

INSTALLATION	No. of Copies
Argonne National Laboratory	10
Armed Forces Special Weapons Project	1
Atomic Energy Commission, Washington	2
Battelle Memorial Institute	1
Brookhaven National Laboratory	10
Bureau of Ships	1
Carbide & Carbon Chemicals Corporation (K-25)	4
Carbide & Carbon Chemicals Corporation (Y-12)	4
Chicago Operations Office	1
Columbia University (Dunning)	1
Columbia University (Failla)	1
General Electric Company, Richland	7
Hanford Operations Office	1
Iowa State College	1
Kellex Corporation	2
Knolls Atomic Power Laboratory	4
Los Alamos	6
Massachusetts Institute of Technology (Gaudin)	1
Massachusetts Institute of Technology (Kaufmann)	1
Mound Laboratory	8
National Advisory Committee for Aeronautics	2
National Bureau of Standards	2
Naval Radiological Defense Laboratory	2
NEPA Project	1
New York Operations Office	8
North American Aviation, Inc.	2
Oak Ridge National Laboratory	12
Patent Advisor, Washington	1
Sandia Base	2
Technical Information Branch, ORE	15
UCLA Medical Research Laboratory (Warren)	1
University of California Radiation Laboratory	6
University of Rochester	2
Western Reserve University (Friedell)	4
Sylvania Electric Products, Inc.	1

INFORMATION DIVISION
Radiation Laboratory
Univ. of California
Berkeley, California

SUMMARY OF THE RESEARCH PROGRESS MEETING

March 31, 1949

H. P. Kramer

Scattering of 90 Mev Neutrons by Nuclei. S. Fernback.

R. Serber and the speaker have developed a model of the nucleus that serves well to explain the interaction between nuclei and neutrons of energy 90 Mev. At present, an attempt is being made to extend the validity of the model to higher energies.

A nucleus is thought of as a transparent sphere of radius R that possesses an absorption coefficient K and an index of refraction k_1.

If k is the propogation vector of the neutron wave outside the nucleus, then $k + k_1$ is its propogation vector inside and

$$k_1 = k \left[(1 + {}^{V}/E)^{1/2} - 1 \right]$$

where V is the potential inside the nucleus and E is the energy of the incident wave. For V = 30 Mev and E = 90 Mev, $k = 2.08 \times 10^{13}$ /cm. and $k_1 = .32 \times 10^{13}$ / cm.

The absorption coefficient K is equal to the product of the number of nucleons in unit volume and the total cross section of the nucleus for neutrons:

$$K = A\sigma / \tfrac{4}{3} \pi R^3$$

where

$$\sigma = \frac{[Z\, \sigma_{np} + (A-Z)\sigma_{nn}]}{A}$$

The value of K is fairly constant for all nuclear matter. For elements with the same number of neutrons and protons, $K = .24 \times 10^{13}$/cm.

The collision radius R is proportional to the cube root of the mass number:

$$R = r_o A^{1/3}$$

Experimentally, r_o has been determined to be equal to 1.37.

If a plane neutron wave is thought to impinge on the nuclear sphere one can calculate the absorption and scattering cross sections with the aid of the transmitted amplitude a, where

$$a = e^{(-\frac{k}{2} + ik_1)s}$$

$$\sigma_a = 2\pi\int_0^r (1 - |a^2|)\rho d\rho, \sigma_a = \pi R^2 F (K,R).$$

$$\sigma_s = 2\pi\int_0^r |1 - a|^2 \rho d\rho, \quad \sigma_s = \pi R^2 G (KR,k_1R).$$

In this calculation, the effect of refraction is neglected. For small values of Kr, $\sigma_a \cong$ A and the limit as Kr approaches zero of σ_s is zero. The limit as $Kr \rightarrow \infty$ of $\sigma_s + \sigma_a$ is πR^2.

A detailed description of the model and the checks that have been made is contained in "The Scattering of High Energy Neutrons by Nuclei." by S. Fernbach, R. Serber, T. B. Taylor. Dec. 28, 1948, UCRL 262.

X-ray Spectrometer. G. Barton.

Some time ago it was reported that an x-ray spectrometer was under construction. The apparatus has now been virtually completed. The main features of its design are shown in Fig. 1.

A guide magnet steers a beam of β rays against the substance whose x-ray spectrum is to be analyzed. The sample is mounted on a circle tangent to a bent crystal diffractor. The radius of curvature of the crystal is twice the radius of the circle so that the rays incident on the diffractor are focused at a point where they produce an interference pattern. When it is desired to view the interference maximum corresponding to a certain wavelength, the sample is moved round the circle until the required line is seen in focus. The distribution of lines identifies isotopes contained in the sample and their intensities indicate the relative abundance.

Instead of exposing a photographic plate at the focal point to measure the

intensities by optical means, the ionization that the x-rays of a given wave length produce in a Geiger Muller tube is used to determine the relative number of quanta. This method has several advantages. It is about 20-30 times as fast as the photographic plate technique in the analysis of tracer quantities of material. Moreover, if a mechanical oscillograph is attached to the G. M. tube a trace like that of Fig. 2 can be recorded and the half-life of the line can be determined by means of it.

The crystal is 8 μ in thickness and its radius of curvature is 21 inches. It is held in a steel clamp. The curvature has now been adjusted to a sufficiently constant value to permit the focussing of such different wave lengths as those of the x-rays from Mb and Ta.

If it is desired to assay very minute quantities of an element it is necessary to increase the intensity of the entire x-radiation from the sample so that the radiation from the small quantity exceeds the threshold of the G. M. tube which operates at a 1 percent efficiency. This is accomplished by increasing the electron current that produces the x-rays in the sample. This current can be varied by changing the voltage between 10 and 115 kv. For example, in order to observe the K line from Cd^{107} of Fig. 2 that is produced in the bombardment of $Ag^{107,109}$ the electron current had to be increased to 22 kv.

A definite improvement in the operation of the machine could be achieved if it were possible to find a suitable crystal with a higher reflection coefficient.

LMB/5-19-1949
Information Division

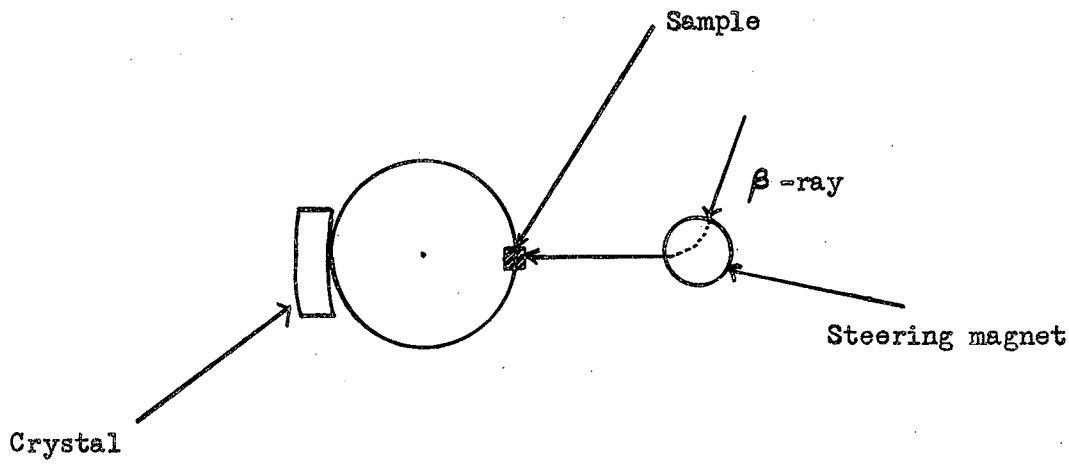

Figure 1

X-ray Spectrograph

Figure 2 has been omitted.