Disbursements

Subscriptions to journals, including foreign postage	$ 55,020.68
Allowance to Pacific and Southwestern Divisions	2,358.00
Expenses of Washington office	23,879.56
Expenses of General Secretary	329.48
Expenses of Treasurer	200.00
Circularizing for new members	6,536.47
General and travel expenses—Indianapolis meeting	3,741.03
Expenses of [illegible] meeting	3,563.00
Expenses of [illegible] meeting	603.96
General and [illegible] meeting	2,959.44
Expenses of press service—Ottawa meeting	316.63
Preliminary expenses—Richmond meeting	1,028.96
Preliminary expenses—Milwaukee meeting	75.00
Preliminary expenses—Columbus meeting	40.00
Printing symposia	2,590.26
Life membership fees to Treasurer	1,100.00
Miscellaneous expenses	2,304.52
Expenses of Committee on Improvement of Science in General Education	1,314.56
Preparing and mailing radio broadcasts	3,878.87
Special journal subscriptions	2,454.00
Total expenditures	$114,294.42
Cash in banks	3,509.78
Cash in Treasurer's hands	12,042.45
Total	$129,846.65

REPORTS

DROPLET FISSION OF URANIUM AND THORIUM NUCLEI

THE fifth Washington Conference on Theoretical Physics, sponsored jointly by George Washington University and the Carnegie Institution of Washington, began January 26, 1939, with a discussion by Professor Bohr and Professor Fermi of the remarkable chemical identification by Hahn and Strassmann in Berlin of radioactive barium in uranium which had been bombarded by neutrons. Professors Bohr and Rosenfeld had brought from Copenhagen the interpretation by Frisch and Meitner that the nuclear "surface-tension" fails to hold together the "droplet" of mass 239, with a resulting division of the nucleus into two roughly equal parts. Frisch and Meitner had also suggested the experimental test of this hypothesis by a search for the expected recoil-particles of energies well above 100,000,000 electron-volts which should result from such a process. The whole matter was quite unexpected news to all present.

We immediately undertook to look for these extremely energetic particles, and at the conclusion of the conference on January 28 were privileged to demonstrate them to Professors Bohr and Fermi. It was subsequently learned that the particles had been observed independently by Fowler and Dodson at the Johns Hopkins University on the same day, by Dunning and coworkers at Columbia University on January 25 and by Frisch in Copenhagen two weeks earlier.

The experiments made in our Atomic-Physics Observatory at the Department of Terrestrial Magnetism of the Carnegie Institution of Washington are no doubt typical of similar experiments done at the other laboratories, but details of this work are not available to us. The experimental work here was done chiefly by my colleagues, R. B. Roberts, R. C. Meyer, L. R. Hafstad and N. P. Heydenburg.

For observations of the high-energy particles, an ionization-chamber, about five mm deep, was placed about three cm below the neutron-source and was so arranged that interchangeable copper disks about three cm in diameter could be placed on the collector, which was connected to a linear pulse-amplifier. The upper faces of these disks were then coated with the materials to be tested.

With the amplifier feeding a cathode-ray oscillograph the usual alpha-particle pulses were observed when a layer of uranium oxide was placed on the disk. On exposure to neutron-radiation from (Li + D) at 1,000 kv two additional groups of pulses were observed. The first group corresponded to the "neutron-recoils" from the air in the chamber, as previously measured with the same amplifier gain and without the uranium. These neutron-recoils gave pulses about four times the size of the alpha-particle pulses. The second additional group was 20 to 40 times larger than the largest "recoil"-pulse, thus coresponding to energies of 75 to 150 Mev released in the chamber, or 150 to 300 Mev total energy for each individual process. With paraffin surrounding source and chamber the yield was roughly 30 counts per min per μ A of 1,000-kv deuterons, which is a neutron-intensity corresponding to about 10,000 millicuries of radon-beryllium.

The yield from thorium was of the same order of magnitude.

No effect was observed from bismuth, lead, thallium, mercury, gold, platinum, tungsten, tin or silver with as much as 1/1000 the intensity of that from uranium and thorium.

No effect was observed with either uranium or thorium produced by the gamma rays from 3 μ A of 1,000-kv protons on lithium or on fluorine.

To determine roughly the energy-range of the neutrons involved in the fission-process, observations were made with the neutrons from several reactions, both with and without cadmium surrounding the ionization-chamber to filter out the thermal neutrons produced in the surrounding paraffin. Bearing in mind that the ratio of the counts with cadmium and without cadmium depends to a large extent on the amount of paraffin surrounding the source and chamber, the results of these tests may be deduced from Table 1 in which the relative number of "fissions" is given, with the total yield for

uranium and thorium with high-energy neutrons, being approximately equal, taken as 100 on an arbitrary scale.

Neutron-reaction	Maximum neutron-energy	Uranium		Thorium	
		No Cd	With Cd	No Cd	With Cd
	Mev				
Li + D ..	13.5	100	70	100	100
D + D ..	2.5	100	70	100	100
C + D ..	0.5	100	10	0	0

From these comparisons it apears that the uranium fissions are produced by different processes for fast and slow neutrons, the fast-neutron process requiring more than 0.5 Mev but less than 2.5 Mev for effective operation. For thorium, on the other hand, only the fast-neutron process is effective, but somewhat surprisingly it also appears to require between 0.5 and 2.5 Mev.

A few words with regard to our present knowledge on the efficiency of these processes may be in order. The capture of a neutron with the energy of one thirtieth of an electron-volt gives rise to the release of 200,000,000 electron-volts of energy, but the production of a single slow neutron requires the expenditure of approximately 3,000,000,000 electron-volts of energy by the bombarding beam in the most efficient process yet known (deuterons on beryllium at 9,000,000 volts).

It may also be of interest to record that the measurements on this extremely interesting new process in uranium and thorium were the first experiments carried out with our new 5,000,000-volt equipment for nuclear physics, aside from nuclear measurements performed for voltage-calibration only. We take pleasure in recording our obligation to Dr. John A. Fleming, director of the department, for his vigorous support of our program in fundamental physics.

M. A. TUVE

DEPARTMENT OF TERRESTRIAL MAGNETISM,
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SPECIAL ARTICLES

POSSIBLE AVITAMINOSIS K PRODUCED IN MICE BY DIETARY MEANS

RECENT work on the possible relation of a deficiency of the fat-soluble factor, vitamin K, to the bleeding tendency in obstructive jaundice,[1] and loss of coagulability of blood in bile fistula dogs[2] and bile fistula rats[3] suggests that an avitaminosis K might be produced in mammals by dietary means alone. However, as far as the present writer is aware, a hemorrhagic disease in mammals comparable to that in chicks[4,5,6] has not as yet been produced. Consequently, this brief report is being made of a bleeding tendency occurring in mice maintained on a diet low in vitamin K and prevented by supplementation with the vitamin in the form of an ether extract of alfalfa.

In connection with a series of experiments concerned with the nature of the raw egg-white syndrome as produced in mice, it was apparent that when the tails were clipped in order to obtain blood bleeding continued for a longer time than is normally expected. Comparison of the clotting time with that of mice on a stock diet of Dog Chow showed that it took approximately twice as long for the blood of the experimental animals to coagulate as it did for the stock mice.

The diet that was used to produce the syndrome was made up as follows: powdered egg albumin (Merck), 61 per cent.; cornstarch, 27 per cent.; brewer's yeast, 5 per cent.; salt mixture, 4 per cent.; cod liver oil, 2 per cent.; agar, 1 per cent. This diet is relatively low in fat and might, therefore, be expected to contain only a limited amount of the fat-soluble factor. In addition, the albumin which makes up a large proportion of the diet has been reported to lack vitamin K[7] and yeast has been found to contain little or none of this factor.[8] To determine whether a vitamin K deficiency did exist, bleeding time was determined by Duke's method, using the clipped tails of three groups of mice: (1) stock mice on Dog Chow, (2) mice on the basal diet described above, and (3) mice on the basal diet supplemented with an ether extract of alfalfa equivalent to 5 per cent. of the diet. The tests were done after the animals had been on the diets for four to five weeks. Typical results are given in Table I.

TABLE I

Diet	Number of mice	Average bleeding time, minutes
Dog Chow	8	4.6
Basal	17	10.8
Basal plus extract of alfalfa	14	4.9

[1] E. D. Warner, K. M. Brinkhous and H. P. Smith, *Proc. Soc. Exper. Biol. and Med.*, 37: 628, 1938.

[2] W. B. Hawkins and K. M. Brinkhous, *Jour. Exper. Med.*, 63: 795, 1936.

[3] J. D. Greaves and C. L. A. Schmidt, *Proc. Soc. Exper. Biol. and Med.*, 37: 43, 1937.

[4] H. Dam, *Biochem. Jour.*, 29: 1273, 1935.

[5] H. J. Almquist and E. L. R. Stokstad, *Jour. Biol. Chem.*, 111: 105, 1935.

[6] F. Schonheyder, *Nature*, 135: 653, 1935. Since this paper was submitted for publication it has been noted that H. Dam and J. Glavind (*Lancet*, 1: 720, 1938) referred to their unpublished experiments in which this condition was produced in rabbits and cured by vitamin K. They gave no details concerning the type of diet used nor the symptomatic picture that resulted.

[7] H. J. Almquist and E. L. R. Stokstad, *Jour. Nutrition*, 12: 329, 1936.

[8] H. J. Almquist, C. F. Pentler and E. Mecchi, *Proc. Soc. Exper. Biol. and Med.*, 38: 336, 1938.