section of uranium, and the density of slow neutrons as determined with an indium detector.

Both these calibrations gave the result that about 70 percent of the fissions were being recorded under the operating conditions of our experiments. This slight reduction in counting efficiency is no doubt to be attributed to discrimination against those fission fragments which traverse only a corner of the ionization chamber. It is of course apparent that high precision in the evaluation of this percentage efficiency is not required for our interpretation of the final result; however, the effect of small variations (± 10 percent) in amplifier gain on this efficiency calibration was investigated and found negligible, showing that the working region approximated a plateau.

Two separate linear amplifier and ionization chamber outfits were used for two independent series of spontaneous fission experiments. At frequent intervals during all measurements the over-all gain of the amplifier was checked by the use of a pulse generator and voltage divider box or by re-testing the efficiency of counting slow-neutron induced fissions in uranium.

The series of measurements with one amplifier and chamber gave zero spontaneous fission counts in 139 hours of operation. With the other amplifier set-up, 209 hours of observation gave zero counts. These results enable us to say something about the spontaneous fission disintegration constant of 94^{239}, or, more conveniently, about the half-life for spontaneous fission corresponding to this disintegration constant. In the two experiments taken together zero counts were obtained in 348 hours. From the weight of the sample (3.5 micrograms) and the efficiency of the apparatus for counting fissions (70 percent), one can calculate that for a half-life of 10^{13} years the mean time between counts would be about 20 hours and for a half-life of 10^{14} years the mean time between counts would be about 200 hours. The probability of obtaining zero counts in 348 hours is about 10^{-8} for 20 hours mean time between counts, and about 0.2 for 200 hours mean time between counts. Therefore, it seems fairly safe to say that the half-life of 94^{239} for spontaneous fission is of the order of 10^{14} years or greater.

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Determination of Absolute Neutron Intensities

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We have developed a method of measuring the number of neutrons emitted from a given source and used it to determine the neutron intensity of a laboratory standard consisting of 100 mg of radium surrounded by 85 g of beryllium metal. We made use of the main principle of Amaldi and Fermi's well-known method, which consists in slowing down all the neutrons emitted from the source before they are counted. However, we avoided the use of a number of constants and some difficult approximations, which appeared in the original form of this method.

Our procedure consisted essentially of two steps.

(*a*) *Determination of the ratio R of the number of neutrons activating a* $MnSO_4$ *solution*[1] *with and without the presence of an absorber* (consisting of finely powdered manganese).—The volume of the solution was chosen so large that 1 percent of the neutrons was allowed to escape. After irradiation the solution was thoroughly stirred and the decay of its radioactivity observed by means of a large thin-walled Geiger counter (initial activity without absorber 1110 counts/min. above the background of 200 counts/min., with absorber 850 counts/min.).

(*b*) *Determination of the number of neutrons* (N_a) *captured by the absorber per unit time.*—After irradiation a fraction of the well-mixed Mn powder was filled into paper shells. These "thick" samples were placed alternately around a thin-walled Geiger counter and their initial activities were determined (6185 counts/min.).

In order to determine the number of disintegrations per gram of manganese (specific activity), we irradiated some manganese powder with neutrons from a very strong source and filled a known amount of it into a paper shell as before. With another part we prepared a thin layer (16 mg/cm^2) between two pieces of scotch tape, which was placed in a defined position relative to the counter. A similar layer, made of a known amount of fine uranium metal powder, was placed in the same position for standardization. For the calculation of the specific activity of the managanese samples the number of UX_2 nuclei decaying per sec. per gram of uranium was assumed to be 12220.[2] A correction of 2.5 percent was found to be necessary to allow for the slightly stronger absorption of the UX_2 beta-rays in the glass wall of the Geiger counter and in the scotch tape. By multiplying the specific activity of the manganese absorber with the total weight of the absorber (523 g), we obtained N_a and $N=N_a/(1-R)$ where N is the total number of neutrons emitted from our source.

The result was $N=(8.6\pm 0.8)\times 10^4$ neutrons per sec. The error was calculated by adding up all standard deviations from the mean of the several measurements, which were made for each individual quantity.

The intensity of this laboratory standard has been compared with that of a Ra-α-Be source (see following letter by Gamertsfelder and Goldhaber).

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[1] The method of "physical integration" was first described by H. L. Anderson, E. Fermi, and L. Szilard, Phys. Rev. **56**, 284 (1939).

[2] Calculated from data given by A. F. Kovarik and N. J. Adams, Jr., J. App. Phys. **12**, 296 (1941), and by A. O. Nier, Phys. Rev. **55**, 150 (1939).

A Reproducible Neutron Standard

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For some time a need has been felt for a simple, reproducible standard of neutron intensity. It is known that the most commonly used neutron sources, those obtained by mixing Rn or Ra with Be powder, are not reproducible.[1] By contrast it would appear that a photoneutron source, obtained by irradiating Be with Ra γ-rays under exactly defined geometrical conditions, could