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Report of Committee on the Question of Neutrons Accompanying Alpha Decay.

R. W. Dodson and E. Segre

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In order to avoid predetonation in 25 or 49 bombs, it is necessary that the neutron emission in the gadget be below certain limits. Three mechanisms of neutron emission in a mass of 49 may be of importance.

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1) spontaneous fission (under investigation)

2) spontaneous emission of neutrons associated with the process of alpha decay

3) (α,n) reactions on impurities. A detailed experimental investigation on this subject was recently made by J. H. Roberts (CF-664).

Item number (2) is a hypothetical process, concerning which rumors have reached Los Alamos from Joliet. The present committee was formed to decide what can and should be done to investigate this process.

In the absence of other data, an upper limit can be set on the probability of process (2) in the case of polonium from the results of Roberts. His experiments were performed with a polonium sample (ca. 75 mc.) prepared by Prestwood. The sample had been purified, but not to ultimate limits. Roberts gives data on the neutron background as measured by BF_3 counters in paraffin, while a platinum target was exposed to the alphas from the polonium sample. From his data it appears that about one neutron was emitted by the source for every 10^8 alphas. If a corresponding yield of neutrons occurs with the alpha particles from 49, the neutron emission in 49 due to this cause would be about 2×10^6/min/kg., or about 200 times the maximum permissible intensity in a 20 kg. mass. It is not clear what fraction of the neutron background in Roberts' experiments was due to (2) and what, if any, to (2). However, it is clear that his results do not suffice to exclude (2) as an important reaction. It would seem desirable, therefore,

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to investigate the existence of (2), and, if found, its order of magnitude. Such an investigation could be made at present with Po or Rn, and obviously the significance of the results with respect to a gadget would depend on whether the process in question is associated with alpha decay in general, in a way more or less independent of the particular emitting substance. With the assumption that 49 has the same neutron emission per alpha by process (2) as the substance studied, such an investigation might show the existence of (2) in intensities sufficient to exclude 49 from consideration as a gadget material, might show (2) to be negligible, or might have an inconclusive result, depending on the sensitivity of the neutron detector used and the extent of contamination of the alpha particle source by light elements.

The two major problems in such an investigation are:

a) preparation of an alpha particle source of high intensity and high purity, and

b) obtaining a method of neutron detection of adequate sensitivity.

(a) Alpha particle source.—Two sources suggest themselves, radon (and its active deposit) and polonium. Radon would be advantageous because of the probable ease of its purification, the high intensities (perhaps a curie) obtainable, disadvantageous because a plant is required for its production. A well purified polonium sample of about 100 mc would probably be obtainable sooner, and this would seem a desirable source to use for preliminary experiments. It may be possible that purification of such a sample can be carried to a higher degree than in the case of the one used by Roberts. In such an investigation, the effect of impurities would probably be estimated by the constancy or variability of the neutron counter after successive purifications.

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In the event that a radon plant is desired at Los Alamos it is certainly of interest to consider its use for the present purpose. This is especially so since the detection of process (2) in an intensity corresponding to critical intensity in a mass of 49 may be just possible with a radon-active deposit sample and impossible with polonium in the amounts available.

(b) Methods of neutron detection.--Two methods for consideration are BF_3 counters and a Szilard-Chalmers reaction, both with slow neutrons. The maximum efficiency of detection with BF_3 counters reported by Roberts was 0.4% (five counters at 7 cm. from the source). It might be possible to double this figure without too great inconvenience by increasing the number of counters. A reasonably optimistic estimate of the efficiency of detection with a Szilard-Chalmers method (e.g. with an organic bromide) leads to a figure of 5-10%, or a large favorable margin over the BF_3 counter method.

How about raising this by reentrant cavity for source

Are these sensitivity figures for slow neutrons? — must flowing loss be added?

By very careful measurement with G-M counters it should be possible to detect a beta intensity of 10% of background, or say, 2 counts per minute. At 5% net efficiency this corresponds to 40 neutrons per minute, or with a 100 mg. Po sample, 1.8×10^{-10} neutrons per alpha particle, about three times the critical limit in a 20 kg. mass of 49.

On a basis of the above considerations, it is recommended that:

I. The Szilard-Chalmers reaction be experimentally investigated to ascertain if the expected sensitivity can be achieved, and if this is successful, that

These figures and recommendations probably OK

II. A highly purified polonium sample of strength 100 [illegible] be prepared and its neutron emission measured.

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III. If I. and II. indicate its desirability, the use of a radon source be considered.

cc to E. F. Bacher
E. Segre
E. W. Dodson

September 22, 1943

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9/23/43 Agreed to devote Po source to this work and to carry out recommended program. It was proposed however to use Po + B source for photographic work to compare with fission spectrum

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