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COMPACT MOCK FISSION NEUTRON SOURCES

WORK DONE BY:

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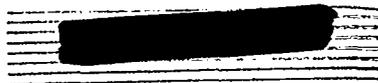
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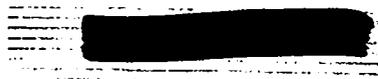


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ABSTRACT

In LA-65 evidence was given that polonium alphas on boron trifluoride gas gave a neutron spectrum which was a close approximation to the fission neutron spectrum. A more compact and convenient source would consist of an intimate mixture of polonium and a solid whose nuclear properties were similar to BF_3 gas. The compound NaBF_4 approximates these requirements, but the measurements here reported of this mock fission spectrum show a deficiency of high-energy neutrons. Hence a second source with 2% BeF_2 added was examined and the results indicate an improvement in the mock up. The average energy is still lower than the fission neutron spectrum so it would probably be advantageous to add even more Be to future mock sources.

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COMPACT MOCK FISSION NEUTRON SOURCESPreparation of Sources

The sources were prepared by D. Martin. Details of the preparation will be published in a separate report.

Yield of Sources

The strength of Source #1 (Po-NaBF₄) has been measured by R. Walker of the R-3 group to be $\sim 1.3 \times 10^5$ neutrons per sec per curie of polonium. Eight curies of polonium were available for the preparation of the second source but the neutron yield as measured by Walker was only $\sim 0.8 \times 10^5$ neutrons per sec per curie of polonium. This difference indicates that not all the polonium was distilled into the source and/or that the mixing of the polonium with the other solids was not very thorough. This latter view is supported by the fact that the neutron yield of this source decayed much less slowly with time than the activity of the polonium. Presumably more intimate mixing occurred upon standing and thus partially compensated for the decay in polonium activity. The physical dimensions of the eight-curie source were a cylinder 0.25" diameter by 0.25" in height.

Neutron Spectra

The neutron spectra of the sources were examined by measuring the ranges in photographic emulsions of the recoil protons projected at small angles ($<15^\circ$) to the incident neutron direction. Details of this method are discussed in earlier reports on spectrum measurement^{1,2}.

1) Richards, H. T., Phys. Rev., 59, 796 (1941).

2) Richards, H. T., et al., LA-60, LA-84.

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For the present measurements plates were exposed at such a distance from the source that an angle of $\approx 10^\circ$ was subtended at the region of the plate in which recoil tracks were measured. The lengths of about 1400 recoil tracks from Source #1 (Po-NaBF₄) and about 1000 tracks from Source #2 (Po-NaBF₄ + 2% BeF₂) were measured by Speck using the same criteria of acceptability as adopted in our earlier measurements of the fission spectrum^{2,3}). The results have been plotted in energy intervals and corrected for geometry and cross section in the same manner as the fission-neutron measurements.

The results are plotted in Fig. 1. In order to compare the mock source with the fission-neutron spectrum, the latest photoplate data LA-200 is included on the same graph. The spectra have all been normalized to equal areas.

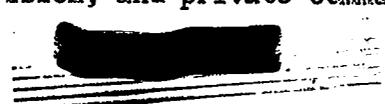
Discussion

The average energy of mock Source #1 (Po-NaBF₄) is 1.9 Mev while the addition of the BeF₂ to mock Source #2 raises the average energy to ~ 2.24 Mev. Source #2 was originally designed to mock the data of LA-84 where the average energy of the fission neutrons was supposed to be ~ 2.27 Mev. The later data given in LA-200 indicate that the average fission-neutron energy is somewhat higher (~ 2.6 Mev). Using the Po-Be spectrum reported in LA-111 and the yield data from Robert's measurement (CN-1190) we estimate that about 4% BeF₂ added to the NaBF₄ might give a better mock up of the LA-200 data.

Some experimental checks on the present mock fission spectrum measurements are provided by Hanson's measurements⁴⁾ of $\overline{\sigma}_f(25)$ and $\overline{\sigma}_f(28)$ for the neutrons from

3) Richards, H. T., LA-200

4) LAMS-193, Progress Report No. 5 of Research Division, and private communication.



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these two mock fission sources. Table I lists the results of his measurements and also the $\bar{\sigma}_f$ as computed⁵⁾ from the present spectra.

TABLE I

	$\bar{\sigma}_f(28)$		$\bar{\sigma}_f(25)$		$\frac{\bar{\sigma}_f(28)}{\bar{\sigma}_f(25)}$	
	Computed from Spectrum	Measured by Hanson	Computed from Spectrum	Measured by Hanson	Computed	Measured by Hanson
Mock Fission #1	.288	.28	1.346	1.32	.214	.21
Mock Fission #2	.346	.31	1.333	1.32	.259	.23

The computed and measured values are in surprisingly good agreement especially since a similar comparison of computed and measured values for the 25 fission spectrum (see LA-200) seem to indicate that the photoplate spectrum gave more high-energy neutrons than could be accounted for from the experimental $\bar{\sigma}_f$.

5) Private communication - G. Richman

