LA REPORT 111

[redacted]

C.3

July 21, 1944

This document contains 6 pages

ENERGY SPECTRUM OF Po-Be NEUTRONS

WORK DONE BY:

Pfc. Lyda Speck

REPORT WRITTEN BY:

Hugh T. Richards

Physics - Nuclear Reactions

ABSTRACT

Recoil protons in photographic emulsions have been used to measure the energy distribution of the neutrons from a Po-Be source. The inferred neutron spectrum has a broad maximum and in the interval 2-4 Mev and has an average energy of about 4.1 Mev. There are a few neutrons above 10 Mev. In contrast with other earlier measurements of this spectrum[1,2,3,4], relatively few neutrons are found in the energy region below 2 Mev. The spectrum of Ra-Be sources may be roughly inferred from the present data if the different energy of the Ra alpha particles is taken into consideration.

---

1) Dunning, Phys. Rev., 45, 586 (1934)
2) Blau, J. de Phys. et Rad., 61 (1934)
3) Bonner and Mott-Smith, Phys. Rev., 46, 258 (1934)
4) Bernadini and Bocciarelli, Accad. Lincei, Atti, 24, 132 (1936)

ENERGY SPECTRUM OF Po-Be NEUTRONS

INTRODUCTION

Because of the large yield, compactness, constancy, and spherical symmetry, Ra-Be and Po-Be have been widely used in laboratories as neutron sources. Despite their wide use there was little accurate knowledge of the energy distribution of the emitted neutrons. Early measurements[1,2,3,4] agreed only with respect to the presence of high energy neutrons. Because of the conflicting data concerning the spectrum and because neutron measuring techniques have greatly improved in recent years, a new measurement of the energy spectrum was deemed worthwhile. Ra-Be sources were used in the first attempts but the photographic plates were fogged by gamma rays before sufficient neutrons could be recorded. Hence a Po-Be source[5] was used for the measurement.

Experimental Arrangement

160 micron thick Ilford halftone emulsions were placed 15 cm from the 3/8" x 1/4" Po-Be source (100 millicuries) and exposed for two days. The processing and measuring techniques have been described in earlier reports of neutron energy measurements by the emulsion technique[6,7].

---

5) Loaned by G. Farwell

6) Richards, H. T., LA-60, 84, 85

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

Results

1000 recoil proton tracks on these plates have been measured. These data have been plotted in energy intervals, corrected for n-p scattering cross-section and for geometry (greater chance of long tracks leaving the emulsion and hence not being acceptable for measurement) in the same manner as was done on the other recent neutron spectra studies by the emulsion technique[1]. The neutron spectrum thus inferred from the recoil proton data is plotted in Fig. 1.

Discussion

Since the scurce consists of an intimate mixture of Po and Be, neutrons will be recorded which were emitted at all angles relative to the bombarding particles. Furthermore, since the beryllium particles are thick relative to the range of the impinging alpha particles, the disintegrations will not be produced by monochromatic alphas. These two factors will tend to obliterate any sharp groups of neutrons which would correspond to possible excited levels of C^{12}. The present data corroborate these conclusions and throw doubt on the many neutron groups reported by the earlier workers.

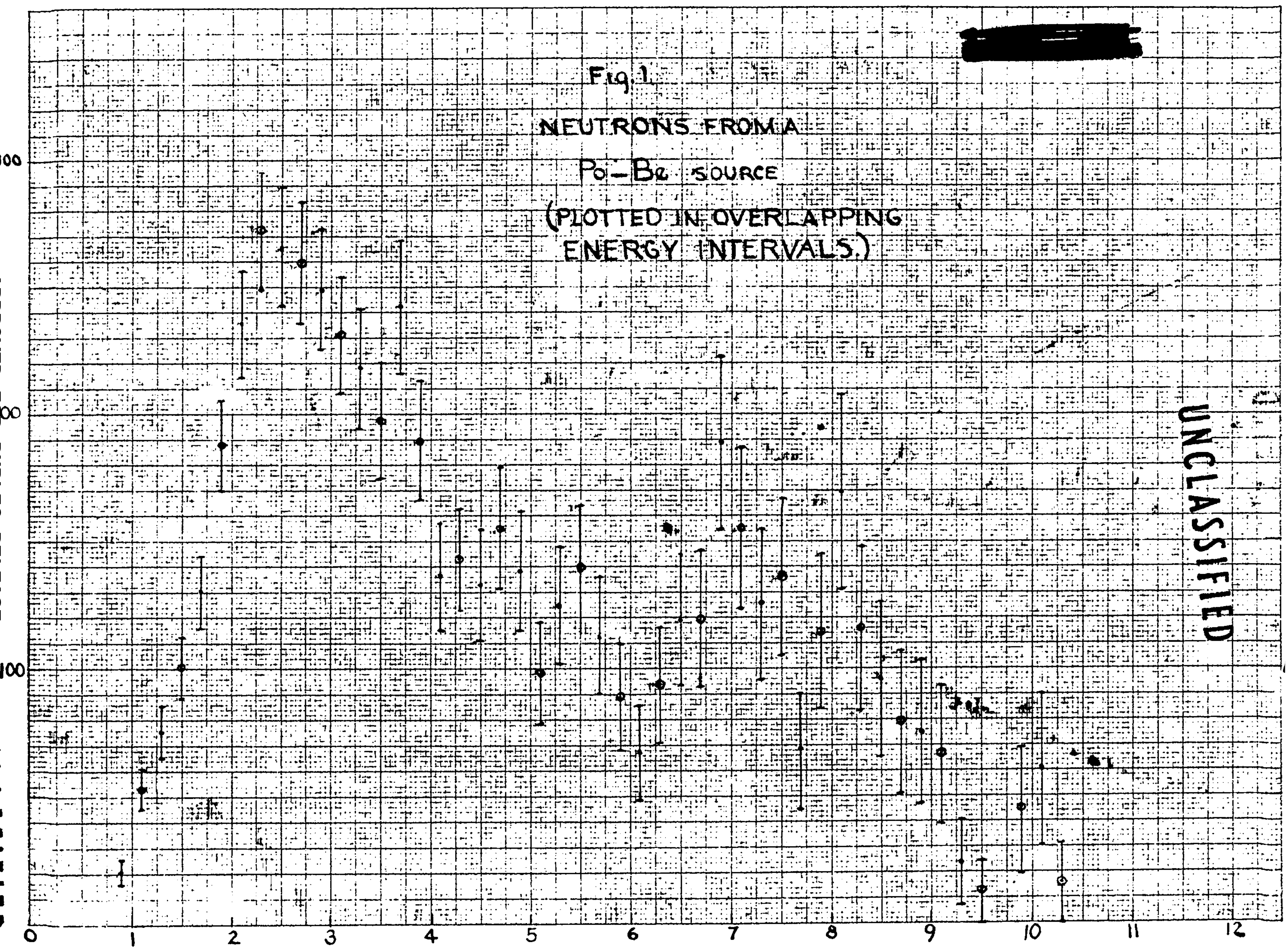
From mass values, one should expect the spectrum to extend to about 11 Mev The longest track in the present data was about 10.25 Mev, but the geometry is so unfavorable for recording these very long tracks that it is not unlikely that there may be a few higher energy neutrons. Also if the transition to the ground state of C^{12} is not very probable, it might be difficult to detect the high energy limit of the spectrum. Another possibility is that the stopping power of the emulsion relative to air (calibrated in the interval from 0.9-3.7 Mev) may increase significantly at the higher energies.

The relatively small number of neutrons below 2 Mev appears to be in marked disagreement with earlier measurements[1,2,3,4]. However, this disagreement is not as much as is indicated by a casual comparison of data since the early workers made no attempt to correct for n-p scattering cross-section or for the fact that usually their geometry (cloud chambers, etc.) discriminated greatly against high energy recoils. Also no particular attempt was made to keep scattering material to a minimum.

The average energy of the present spectrum is about 4.1 Mev. This is in satisfactory agreement with the "effective" energy of 4.4 Mev for Ra-Be neutrons which Christy and Manley[8)] deduce from the absorption coefficient of these neutrons in water since, as they point out, their method weights the more energetic neutrons and results in an effective energy which is greater than the average energy. Also a Ra-Be source will have some neutrons of considerably higher energy than a Po-Be source because of the more energetic alphas which are present.

---

8) Christy, R. F., and Manley, J. H., CF-209



APPROVED FOR PUBLIC RELEASE

UNCLASSIFIED

APPROVED FOR PUBLIC RELEASE