Letters to the Editor

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Communications should not in general exceed 600 words in length.

Slowing Down of Low Energy Neutrons in Water

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THE slowing down in water of the fast neutrons emitted by a Rn-α-Be source has been studied extensively by many investigators, particularly by Amaldi and Fermi.[1] Figure 1a, taken from their work, shows how the intensity inside water of neutrons of thermal energy (C neutrons) and neutrons of an energy of a few ev (D, A+B, I, in order of increasing energies) varies with the distance from the source. The striking feature, that at large distances from the source the curves for C and resonance neutrons are rather similar, was explained qualitatively as due to the fact that the average mean free path for scattering of the fast primary neutrons which have energies up to 12 Mev is of the order of 5 cm, whereas that of the resonance neutrons is less than 1 cm, and the diffusion length of the C neutrons is 2.1 cm. At some distance from the source, equilibrium conditions are approached: The character of the curves is now governed in the main by the largest of these three values, i.e., the mean free path of the primary neutrons, and hence the intensities of resonance and C neutrons decrease in a similar manner. This implies that the intensity of the resonance neutrons does at no point in the water become negligible compared with that of the C neutrons. This important result has often been considered as quite generally true, independent of the neutron source used.

However, a different situation might be expected when the neutron source emits neutrons of low, and preferably homogeneous, energy. For neutrons of a few hundred kev energy, the mean free path for scattering in water is about 1 cm, only a little larger than for resonance neutrons, but well below the diffusion length of C neutrons. For such primary neutrons, one might therefore expect to find much less similarity between the Amaldi-Fermi curves for resonance and C neutrons. This is borne out by the following experiment.

As a neutron source we used the photo-neutrons produced in beryllium by the hard γ-rays of radio-yttrium (100*d*). The RdY, of an initial intensity of about 30 millicuries Ra equivalent, was produced in the 60-inch Berkeley cyclotron by the reaction $\mathrm{Sr}(d, 2n)\mathrm{Y}$.[2] The RdY+Be neutrons have an energy of 220±20 kev, as determined from the energy of the recoil protons by Scharff-Goldhaber.[3] The C and D neutrons were measured with an indium foil detector (54 min.) and the I neutrons with an iodine detector ($\mathrm{PbI_2}$). The results are shown in Fig. 1b. It is seen that at a large distance from the neutron source, the intensity of the resonance neutrons decreases much faster than that of the C neutrons. In this way one can obtain C neutrons practically free from resonance neutrons.

We have observed similar effects with other photoneutron sources. A detailed report of this work will appear in due course.

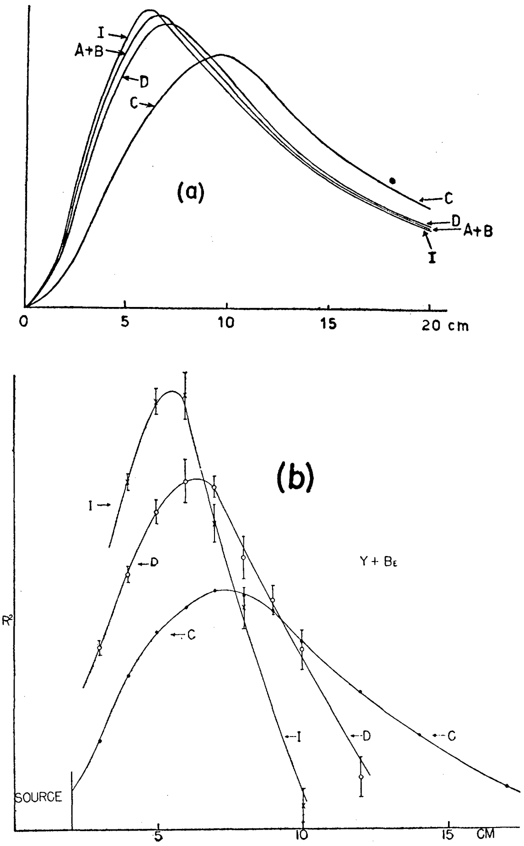

FIG. 1. Ordinates = activation $\times r^2$. Abscissae = r = distance of detector from center of source. The units of the ordinates are chosen so that each curve includes the same area. (a) Taken from Amaldi and Fermi, reference 1, p. 918, Fig. 7. Rn-α-Be neutrons; (b) RdY+Be neutrons.

The radio-yttrium source was produced in Berkeley by the late Dr. C. Pecher. We wish to thank Professor E. O. Lawrence for generously permitting us to use this valuable source indefinitely.

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[1] E. Amaldi and E. Fermi, Phys. Rev. **50**, 899 (1936).
[2] C. Pecher, Phys. Rev. **58**, 843 (1940).
[3] G. Scharff-Goldhaber, Phys. Rev. **59**, 937A (1941); see also J. R. Richardson, Phys. Rev. **60**, 188 (1941); J. R. Downing, M. Deutsch, and A. Roberts, Phys. Rev. **60**, 470 (1941).