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the photo-neutrons for an infinite amount of heavy water was calculated from the 10″ radius sphere measurements to be about 16.5 percent of the saturated delayed neutron activity. It is calculated that there must be of the order of one to two photons of energy above 2.2 Mev emitted per fission by fission products with half-lives greater than one second.

[1] This abstract is based on work performed under Contract No. W-35-058-eng-71 for the Manhattan Project.
[2] This abstract appeared in the Bulletin of the American Physical Society, Vol. 21, No. 6, dated November 29, 1946, but the paper could not be presented at the 275th meeting.

A10. Photographic Neutron Detection.* R. A. Peck, Jr., *Yale University*.—For the photographic method of neutron detection and energy measurement,[1] the Eastman fine grain alpha-particle emulsion is the only one readily available in this country. However, this exhibits a large pre-exposure background, which introduces ambiguity in the identification of the beginning of proton tracks. Preliminary "defogging" treatment is thus required. As shown by Perfilov,[2] the defogging oxidizer used (potassium permanganate) must be strong enough to remove background grains, yet not strong enough to desensitize the emulsion for proton detection. Within this concentration range, the $KMnO_4$ even exhibits a sensitizing effect, substantially increasing the visible length of proton tracks. The optimum treatment has been determined for the Eastman emulsion, an 18-minute bath in $KMnO_4$ of concentration 0.66 g/liter. A lead camera is necessary to shield the plates from the high gamma-ray background of the cyclotron. The Li(dn) reaction, investigated by Richards,[3] is used to determine the stopping power of the Eastman emulsion as a function of proton energy.

* This work is conducted as a part of O.N.R. contract N60NR44 Task Order V.
[1] Powell et. al., Proc. Roy. Soc. 183, 1, 64 (1944).
[2] Perfilov, J. Phys. U.S.S.R. X, No. 1, 1 (1946).
[3] Richards, Phys. Rev. 59, 796 (1941).

A11. Use of Threshold Detectors for Fast Neutron Studies. Bernard T. Feld,[1] R. Scalettar,[2] and L. Szilard.[3] *Metallurgical Laboratory, University of Chicago, Chicago, Illinois*.—Light element (n, p) and (n, α) reactions can be used to compare, qualitatively, the energy distributions of the fast neutrons emitted by various neutron sources. Experiments are described in which a Ra-α-Be and Ra-α-B neutron source are compared by observing their relative activation of a number of light element reactions. Table I summarizes the experimental results. The thresholds for the reactions were calculated by using the best available values of the isotopic masses. The probability for penetration of the Coulomb barrier by the product proton or alpha-particle was calculated from the Gamow formula. The relative values of the activities in the same column have no meaning, since the detectors were not intercalibrated.

Table I.

Reaction	Half-life	Calculated threshold (Mev)	Calculated energy for 0.1 penetration (Mev)	Calculated energy for 0.5 penetration (Mev)	Activity Ra-α-Be	Activity $S^{32}(n, p)P^{32}$ Ra-α-B
$S^{32}(n, p)P^{32}$	14.3*d*	.93	2.9	4.0	1.000	1.000
$P^{31}(n, p)Si^{31}$	170*m*	1.02	2.9	3.9	.63	.51
$Al^{27}(n, p)Mg^{27}$	10.2*m*	1.95	3.6	4.6	.29	.058
$Si^{28}(n, p)Al^{28}$	2.4*m*	2.69	4.5	5.5	.95	≤.017
$P^{31}(n, \alpha)Al^{28}$	2.4*m*	.90	6.6	8.3	.24	<.004
$Al^{27}(n, \alpha)Na^{24}$	14.8*h*	2.39	7.5	9.1	.079	<.003

[1] Now at the Massachusetts Institute of Technology, Cambridge, Massachusetts.
[2] Now at Cornell University, Ithaca, New York.
[3] Now at University of Chicago, Chicago, Illinois.

A12. The Scattering of Thermal Neutrons in Polycrystalline Materials. R. M. Langer and J. F. Daly, *Bureau of Ships*.—The data of Nix and Clement[1] on thermal neutron scattering in copper can be interpreted quantitatively in terms of the crystal grain size S, the amorphous mass scattering coefficient μ_a/ρ, the rocking angle $\Delta\theta$ through which a crystal grain can be rotated about the Bragg angle without losing its Bragg reflection effectiveness, and finally the crystal thickness S_0 required for a crystal at the Bragg angle to reduce a homogeneous neutron beam by a factor e. The effective mass scattering coefficient μ/ρ including the Bragg scattering is given by the expression

$$\mu/\rho=\mu_a/\rho+\frac{1-\exp[-(2S/S_0)]\,AJ\Delta\theta}{2SN}\left(\frac{2m^3}{\pi k^3T^3}\right)^{\frac{1}{2}}$$
$$\cdot\int_{h/2dm}^{\infty}\exp[-(mv^2/2kT)]v\left(v^2-\left(\frac{h}{2dm}\right)^2\right)^{\frac{1}{2}}\cdot dv.$$

Here J is related to the symmetry number of the crystal, ρ is the density, and the other symbols have their customary significance. The second term in the formula is about as large as the atomic mass scattering term μ_a/ρ for grain sizes S less than 10^{-2} cm in the three substances examined so far.

[1] F. C. Nix and G. F. Clement, Phys. Rev. 68, 159 (1945).

F1. Interferometry of Faster-Than-Sound Phenomena.* Rudolf Ladenburg, *Princeton University* (30 min.).—Interferometric measurements of supersonic ("faster-than-sound") gas streams enable one to determine the distribution of density, pressure, temperature and gas velocity in the stream throughout the field of view, provided the phenomenon under investigation is two-dimensional or has axial symmetry. Also the apparently discontinuous rise of density, pressure, velocity, etc., through a shock wave can be measured by interferometry. So far studied are: (1) Air flow around bullets in flight (Cranz, Schardin, and others); (2) homogeneous air-streams escaping through a Laval nozzle into the atmosphere ("open wind tunnel") and the air flow around various objects supported in the stream; (3) inhomogeneous air jets escaping from pressure tanks through various circular nozzles at pressure ratios up to 100 and (4) air flow and boundary layers in two-dimensional channel flow. New results with inhomogeneous air jets at widely varying pressure ratios have been obtained by letting the air discharge from a pressure tank into a vacuum tank. Of special interest is the change in the shock formation from a cone with oblique shocks to a kind of truncated cone where a strong plane shock intersects with two conical