Letters to the Editor

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Neutron Diffraction and Nuclear Resonance Structure

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THE phenomena of neutron diffraction have been described and the present status of studies with monochromatic neutrons produced by this means have been given recently.[1] The first work in this laboratory in 1944 led to the characterization of the prominent resonance level in samarium. This level was found to obey the Breit-Wigner resonance formula within experimental error. Figure 1 shows the original data and the best fitting resonance curve. The deviation of some of the points at low energies are caused by higher order reflections.

Table I summarizes the characteristics of some of the resonances studied. The cross section σ_0 given is the total cross section at resonance and includes contributions from resonance and potential scattering. Gamma is the half-width of the resonance at half-maximum. The integral under the resonance may be considered as an index of the importance of the resonance.

In the cases of indium and rhodium, the resolution of the instrument was not sufficient to evaluate the true constants of the resonance. The cross sections tabulated, therefore, represent lower limits, and the resonance widths represent upper limits.

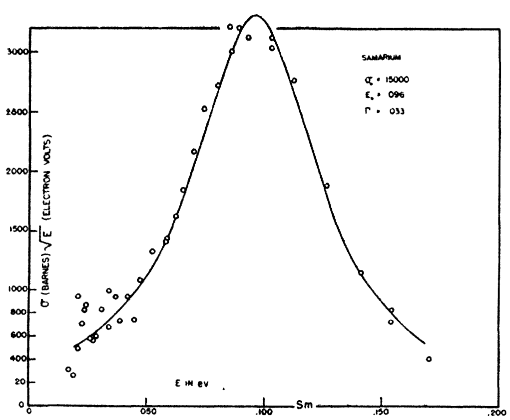

FIG. 1. Experimental results on the resonance scattering of neutrons on samarium. The solid line is the best fitting Breit-Wigner resonance curve.

TABLE I. Constants of neutron resonance levels.

Absorbing isotope	E_0	$\sigma_0 \times 10^{24}$	Γ	$\int \sigma E^{\frac{1}{2}} dE$
In^{115}	1.39	>15,000	<0.15	8300
Rh^{103}	1.30	>2,500	<0.13	1200
Sm^{149}	.096	93,000	0.035	3200
Eu^{151}	<.03	>3,000	?	
Eu^{153}	.54	20,000	0.075	3500
Gd^{157}	.044	190,000	0.05	6300

The resonance in gadolinium and the low lying resonance in europium fall in a region where the second order of the Maxwellian continuum interferes with exact measurement. The resonance energies in these cases are approximations only.

The isotopic assignments in the cases of samarium and gadolinium are based upon the work of Lapp.[2] The assignments for europium are based upon the activations in the spectrometer of europium samples with monoenergetic neutrons of the exact resonance energies and subsequent identification of the induced radioactivity. Neutrons of 0.03 ev produced a 9-hr. period (Eu^{152}, $T_{\frac{1}{2}}=9.4$ hr.) in an amount consistent with the measured flux and cross section. Neutrons of 0.54 ev produced a long-lived activity estimated from the flux and cross section to have a half-life of between 5 and 10 years (Eu^{154}, $T_{\frac{1}{2}}=5$–8 yr.).

The resonance integral $\int \sigma E^{\frac{1}{2}} dE$ appears to be a method of characterizing these neutron resonances in terms of relative importance. The range covered by these integrals is relatively large, so that the occurrence of three resonances (whose integrals differ only by a factor of two) in three isotopes differing by one proton and three neutrons is surprising. Further extension of this apparent series is prevented because of the instability of the nuclei involved.

[1] W. H. Zinn, Phys. Rev. **70**, 102A (1946); W. J. Sturm and S. Turkel, Phys. Rev. **70**, 103A (1946); E. Fermi and L. Marshall, Phys. Rev. **70**, 103A (1946); L. B. Borst, A. J. Ulrich, C. L. Osborne, and B. Hasbrouck, Phys. Rev. **70**, 108A (1946).
[2] R. E. Lapp, J. R. Van Horn, and A. J. Dempster, Phys. Rev. **70**, 104A (1946).

The Liquid Drop Model for Nuclear Fission*

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THE first extensive calculations on nuclear fission using the liquid drop model were made by Bohr and Wheeler.[1] The principal problem was to determine the potential energy surface, i.e., the potential energy as a function of the deformation parameters, and in particular the location of the saddle point giving the activation energy for fission. The deformation parameters were taken to be the coefficients a_n in the expansion of the radius vector in zonal harmonics (the surface of the drop is the locus $r=R\Sigma a_n P_n(\cos\theta)$. Bohr and Wheeler calculated the surface and Coulomb energies of the deformed drop out to fourth-order terms in a_2, including the coupling terms with a_4. Even in the case of the uranium isotopes, however, large deformations are needed to reach the critical shape corresponding to the saddle point. The few terms considered