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Letters to the Editors

Effective Thermal-Neutron Cross Sections for Materials with Grain Structure (Addendum)

In a recent publication[1] a method has been given for the calculation of effective thermal-neutron cross sections when the fuel is in the form of small spherical grains dispersed throughout a homogeneous moderator. The grain shielding factor has been defined in Eq. (1) of Dyos and Pomraning[1] as

$$\Gamma(E) = \bar{\phi}_f(E)/\bar{\phi}_m(E), \qquad (1)$$

where the suffixes f and m refer to the fuel and moderator regions of the associated cell. Equation (1) is only strictly applicable to a definition of effective cross sections given by

$$\sigma_{\text{eff}}(E) = \Gamma(E)\sigma(E), \qquad (2)$$

provided the volume of the grain is much less than the volume of the cell. When the grain occupies an appreciable volume fraction of the cell, but not sufficient to violate the assumptions made by Dyos and Pomraning[1], then the grain shielding factor, as used in Eq. (2), should be replaced by

$$\Gamma(E) = \bar{\phi}_f(E)/\bar{\phi}_c(E), \qquad (3)$$

where $\bar{\phi}_c(E)$ is the average neutron flux in the cell and is given by

$$\bar{\phi}_c(E) = V_f\bar{\phi}_f(E) + V_m\bar{\phi}_m(E). \qquad (4)$$

In Eq. (4), V_f and V_m are the ratios of the volume of the fuel and moderator regions-to-the volume of the cell.

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[1]M. W. DYOS and G. C. POMRANING, "Effective Thermal Neutron Cross Sections for Materials with Grain Structure," *Nucl. Sci. Eng.*, **25**, 1, 8 (1966).

On the Neutron Flux Distribution Through a Resonance

In a study of the asymmetry of the neutron flux distribution through a resonance, Goldstein[1] has depicted the qualitative behavior of the second-order flux for a strongly absorbing resonance in a concentrated system. He also comments on the shift of the flux minimum to energies above the resonance energy for a strongly scattering resonance in a dilute system. The point does not seem to have been made that in the latter circumstances the flux can rise above its off-resonance value in the vicinity of one collision interval below the resonance center. Figure 1 shows the qualitative behavior of the flux, the notation being that of Goldstein.

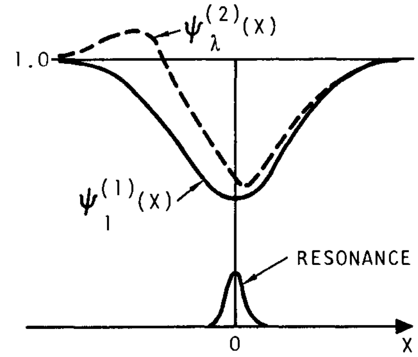

Fig. 1. $\psi^{(2)}(x)$ for $\alpha_\lambda| > 0$ $(\beta_1^2 > \beta_1^2)$.

The condition for the neutron flux to be greater than unity at one collision interval below the resonance center can be obtained analytically from Eq. (7) of Goldstein's work[1]. Using the notation of this reference, we see that $x = -\delta$ gives $\psi_\lambda^{(2)}(x) > 1$ provided $\beta_1^2 > \beta_0^2$, i.e.,

$$\Gamma_n s - \Gamma_\gamma \sigma_p > 0$$

and

$$\frac{\delta}{\beta\lambda} \tan^{-1} \frac{\delta}{\beta\lambda} > \frac{\Gamma(s + \lambda\sigma_p)}{\Gamma_n s - \Gamma_\lambda \sigma_p} \, \frac{\delta^2}{1 + \delta^2} \quad .$$

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[1]R. GOLDSTEIN, *Nucl. Sci. Eng.*, **19**, 3, 359 (1964).