Letters to the Editor

Comments on "A Pulsed Neutron Experiment with Beryllium by the Use of a Gamma-Ray Flash from an Electron Linear Accelerator"

In a recent paper, Aizawa et al.[1] reported some interesting results on the decay of neutron pulses inside beryllium assemblies. They extended earlier studies to smaller assemblies and to longer times. From their measurements, they conclude that their results contradict the limit suggested by this author.[2] They also doubt the physical basis of the assumptions involved in deriving that limit. In this connection, we would like to make the following observations:

1. In an earlier paper, Zhezherun[3] also observed that his measured value of the decay constant in BeO exceeded the limit proposed by this author. However, from his previous measurements[4] of the energy variation of the total cross section of neutrons in BeO, he found that the values of the cross section at Bragg peaks were sample dependent and always less than (or equal to) the corresponding theoretical values. (A similar effect was noticed in graphite by Khubchandani.[5]) Therefore, for a given material one would expect the value of λ_{tr} at $E = E_0$ (for notation, see Ref. 1) to be, in general, larger than the corresponding calculated value, and hence the slope of the λ_K curve, which has to be determined by taking the observed value of λ_{tr} at $E = E_0$, would also be larger than the theoretical slope. It is, therefore, not surprising that some experimental points, particularly those for large B^2, should lie above the theoretical limiting curve for λ_K. This point was also brought out during discussions on Zhezherun's paper.[3] We feel it will be of considerable interest if the total cross section of neutrons near the first few Bragg peaks could be measured for samples of the material used by Aizawa et al.[1]

So far, nothing seems to indicate that the limit set by this author is in contradiction with experimental data. If anything, they can be used to comment, at least qualitatively, on the state of crystallinity of the material.

We completely agree with Aizawa et al.[1] that for $B^2 > B_c^2$, the decay constant must ultimately tend to λ_{lim}. However, in our paper,[2] we consider only the pseudomode and, provided it exists (it may not under certain conditions), we feel it will be bounded by λ_K.

2. We do not agree with Aizawa et al.,[1] or for that matter with Corngold,[6] that there is no physical justification for λ_K. In the first instance, the limit was deduced from purely physical arguments[2] but there is not much point in repeating them here. Later work, particularly by Corngold and his co-workers,[7,8] established the correctness of the limit (Corngold calls it λ_{el} and has derived a more general expression for it). More recently, Matsumoto[9] discussed the bounded Boltzmann equation in detail. Using his method of inelastic scattering expansion, he analyzed the pulsed neutron problem and found that "the pseudo mode presented by $\phi_{th}^{(0)}$ was found to approach the eigen spectrum of the thermal bounded equation. This circumstance supports Kothari's concept of the pseudo-mode."

L. S. Kothari

University of Delhi
Department of Physics and Astrophysics
Delhi-110007, India

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[3] I. F. ZHEZHERUN, *Proc. IAEA Symp. Neutron Thermalization and Reactor Spectra*, Ann Arbor, **2**, 379 (1967).

[4] I. F. ZHEZHERUN, I. P. SADIKOV, and A. A. CHERNISHOV, *Sov. At. Energy*, **13**, 250 (1960).

[5] P. G. KHUBCHANDANI, *Nucl. Sci. Eng.*, **8**, 172 (1960).

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[9] T. MATSUMOTO, *J. Nucl. Sci. Technol. (Japan)*, **9**, 453 (1972).

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As to the total cross section of beryllium metal used in our experiment,[1] which was made from metal beryllium powder (-200 mesh) vacuum pressed at high temperatures, we have already finished the measurement of the cross section of the sample itself. We are now preparing to publish a paper entitled "Temperature-Effect of Thermal Neutron Scattering Cross Section of Beryllium." For reference we show here, as Fig. 1, a preliminary graph of the total cross section at room temperature, in which the measured cross section is in good agreement with the calculated one near the Bragg peaks; it is also in good agreement with the data shown in BNL-325 (Ref. 2). Then it is clear that there is no sample dependency on the cross section of beryllium metal; usually the grain size is so

[1] O. AIZAWA, H. KADOTANI, K. KANDA, Y. FUJITA, and S. ITO, *Nucl. Sci. Eng.*, **50**, 38 (1973).

[2] D. J. HUGHES and R. B. SCHWARTZ, "Neutron Cross Sections," BNL-325, Brookhaven National Laboratory (1958).