# Letters to the Editor

## Transport Results for the Uniform Source Half-Space Problem

In a recent Note[1] in *Nuclear Science and Engineering*, Petrick, McDaniel, and Leonard applied the Wiener-Hopf technique to obtain the solution of the monoenergetic transport problem in a homogeneous, isotropically scattering half-space with absorption. The half-space was assumed to contain an isotropic, spatially uniform external source, and no neutrons were allowed to impinge upon the surface. In Part I of that Note, the authors computed the extrapolated endpoint for this problem. In Part II they defined, and calculated, an extrapolated endpoint which, when used as a boundary condition in a diffusion calculation, would lead to exact transport theory leakage from the half-space.

Three comments on that paper seem to be in order:

1. The extrapolated endpoint is seldom, if ever, used in practice in diffusion theory calculations as a boundary condition. The main reason for this is that the extrapolated endpoint, defined as the distance beyond the boundary at which the flux is assumed to vanish, is by virtue of its definition applied outside of the system under consideration. Hence, in any nonhomogeneous system there is a nontrivial ambiguity as to what material should be used in the region between the outside of the system and the point at which the flux is assumed to vanish. A secondary reason for the unpopularity of the extrapolated endpoint as a diffusion theory boundary condition at a free surface is that it does not smoothly generalize to the case of neutrons impinging upon the surface of a system.

The boundary condition generally employed in practice makes use of the linear extrapolation distance, defined as the absolute value of the ratio of the flux (asymptotic flux in transport theory) to its derivative in a direction perpendicular to the surface. This logarithmic derivative boundary condition, in contrast to that which makes use of the extrapolated endpoint, is applied at the actual surface of the system under consideration and readily generalizes to the case of impinging neutrons. The linear extrapolation distance and extrapolated endpoint are simply related, and the numerical results of Petrick et al.[1] should be converted to linear extrapolation distance form for maximum usefulness.

2. The rather complicated formulas of Petrick et al.[1] giving the results of the Wiener-Hopf analysis are really unnecessary. Davison[2] and Case, deHoffmann, and Placzek[3] give all of the data required to compute the extrapolated endpoint and linear extrapolation distance results for the uniform source half-space problem.

3. The same analysis of the uniform source half-space problem given by Petrick et al.[1] was given in this journal approximately ten years ago.[4] In particular, just as with the extrapolated endpoint in the paper by Petrick et al.,[1] this older paper gave numerical results for the linear extrapolation distance as well as for the diffusion linear extrapolation distance, i.e., that which forces a diffusion calculation to give transport theory leakage. This latter quantity was computed for both classical diffusion theory (a diffusion coefficient given by one-third of the neutron mean-free-path) and asymptotic diffusion theory (a diffusion coefficient corresponding to the discrete transport theory modes).

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[1] W. P. PETRICK, C. T. McDANIEL, and A. LEONARD, *Nucl. Sci. Eng.*, **50**, 388 (1973).

[2] B. DAVISON, *Neutron Transport Theory*, p. 79, Clarendon Press, Oxford (1957).

[3] K. M. CASE, F. deHOFFMANN, and G. PLACZEK, *Introduction to the Theory of Neutron Diffusion*, Vol. I, p. 131, U.S. Government Printing Office (1953).

[4] G. C. POMRANING, *Nucl. Sci. Eng.*, **16**, 239 (1963); also published as "On the Linear Extrapolation Distance," APED-4337, General Electric Co. (1963).