Comments on Moore's Letter "On the Physical Criteria for the Limiting Critical Frequency of Neutron Waves"

In his letter, Moore[1] has commented on the criteria for determining the critical frequency in the case of neutron waves propagating through a crystalline medium. We find it hard to agree with his criticality condition [Eq. (6) of his letter].

The Boltzmann equation in the diffusion approximation in a source-free region [Eq. (1) of Ref. 2] is linear in neutron flux, $\Phi(E, \mathbf{r}, t)$ and hence, if different types of sources (steady plus sinusoidally modulated) are present at the boundary of the medium, at any point in the medium the flux will just be a sum of the fluxes obtained by solving Eq. (1) of Ref. 2 with the two sources considered individually. This fact has been used by all workers[3-7] to separate the time-independent problem from the time-dependent problem. It is always implied that in an actual situation the amplitude of the time-dependent part of the source will be smaller than the steady source so that the total neutron flux, at any point and at any time, is never zero or negative. In all theoretical studies, one has therefore considered only the time-dependent part of the neutron flux. Hence, the statement by Moore that "Indeed if this were so, the neutron density would become periodically negative at any frequency" is not quite valid. It is always implied that the static part of the flux will always be present in any experimental situation. Further, since $\alpha(\omega) > \alpha(0)$, if the static part of the flux dominates over the wave part at small distances from the source, then it will dominate at all distances.

Apart from this, the criterion suggested by Moore,[1] in Eq. (6) of his letter, involves an arbitrary parameter (he calls this "not completely arbitrary"), $A'(\omega)$, which depends upon "the relative distribution of neutrons between the dc and ac components of the total neutron density." This would imply that ω_0^* will depend upon the ratio of ac and dc components and would loose all importance. Equation (6) of Ref. 1 also involves x on the right-hand side, as $\exp[\alpha(0) - \alpha(\omega_0^*)]x$. This term can be made to go to zero by taking x large enough $[\alpha(\omega) > \alpha(0)]$ and hence it would imply that $\phi(\theta, 0) = 0$ for all θ. These difficulties arise because Moore has, to our mind, incorrectly tried to mix up the two components of neutron flux that arise from different types of sources.

Moore has suggested an alternative criterion, given by Eq. (7) of his letter. Since the details of this are not yet available to us, we would not like to comment on it. However, at first sight, this equation seems to be dimensionally incorrect. Also, his suggestion that one plot Σ_T as a function of $\theta = \omega/\xi$ is a little confusing since θ, as defined here, is the wave velocity, which has nothing to do with neutron velocity, of which Σ_T will be a function.

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