and each collision being followed by one mean free path (λ) movement. As shown in equation (6-18), λ_t and λ are related by the equation:

$$\lambda_t = \frac{\lambda}{1-(\cos\phi)_{av}} \tag{6-19}$$

For isotropic scattering, equation (6-4), since $(\cos\phi)_{av} = 2/(3A)$, the relation between the transport mean free path and the mean free path is:

$$\lambda_t = \frac{\lambda}{1-\frac{2}{3A}}$$

When $A >> 1$, I $\lambda_t \simeq (1+\frac{2}{3A})\lambda \simeq \lambda$. As in kinetic theory, the neutron current density S is related to the diffusion coefficient by:

$$S = -D \ n \quad (\text{neutrons/cm}^2/\text{sec}) \tag{6-20}$$

This is a vector equation, with S in the direction of the gradient. Notation is standard: $n = \text{grad } n = i_x(\partial n/\partial x) + i_y(\partial n/\partial y) + i_z(\partial n/\partial z)$ with i_x, i_y, and i_z the unit vectors in the x, y, and z directions. Consider the face dydz of the volume element at (x,y,z). The neutron current out of this face (in the negative x-direction) is $D(\partial n/\partial x)$ so that the number of neutrons per unit time in the energy range between ε and $\varepsilon + d\varepsilon$ going out of the face dydz at (x,y,z) is $D(\partial n/\partial x)\, dydzd\varepsilon$. . At the opposite face at (x + dx, y, z) the number of neutrons per unit time in the energy range $d\varepsilon$ coming into the volume element(negative x-direction) is:

$$D\left(\frac{\partial n}{\partial x} + \frac{\partial^2 n}{\partial x^2}dx\right) dydzd\,\varepsilon$$

The net gain of neutrons per unit time in the volume element is thus $D(\partial^2 n/\partial x^2)\, dxdydzd\,\varepsilon$. Taking other pairs of faces and adding up, we obtain:

$$\begin{array}{l}\text{Neutrons in energy range between} \\ \varepsilon \text{ and } \varepsilon + d\varepsilon \text{ diffusing into the} \\ \text{volume dxdydz per unit time}\end{array} = D \ {}^2 n \ dxdydzd \tag{6-21}$$

with ^{2} the Laplacian $= (\partial^2/\partial x^2) + (\partial^2/\partial y^2) + (\partial^2/\partial z^2)$.

Now consider the other source of neutrons, those in the volume element which are slowed down to the proper energy range (between ε and $\varepsilon + d\varepsilon$). The number of collisions of a neutron in unit time is v/λ. If this is multiplied by the average change in ε per collision, that is by ξ, the result $\xi v/\lambda$ is the loss of ε per unit time. Representing values of ε as points on a straight line, Figure 38, a neutron can be visualized as moving down the ε line with a velocity $\xi v/\lambda$

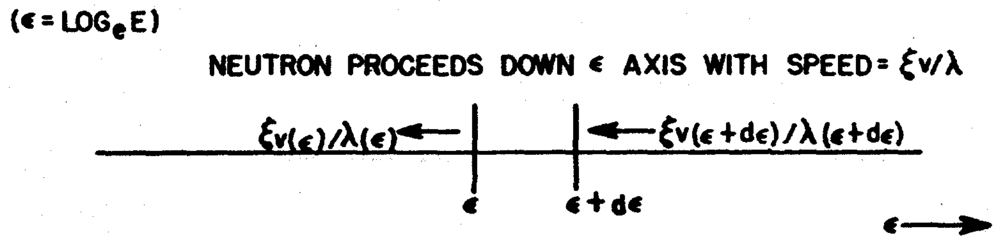

Figure 38. Slowing down of neutrons: appearance on ε axis.

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