(velocity meaning loss of ϵ per unit time). At the point ϵ, the number of neutrons in the volume element dxdydz which move out of the range of energies (between ϵ and $\epsilon + d\epsilon$) per unit time is:

$$[\xi v(\epsilon)/\lambda(\epsilon)] \cdot n(x,y,z,\epsilon)\, dxdydz$$

where the functional dependent of v and λ on ϵ has been indicated. The number per unit time moving into the top of the energy range at $\epsilon + d\epsilon$ is:

$$[\xi v(\epsilon + d\epsilon)/\lambda(\epsilon + d\epsilon)] \cdot n(x,y,z,\epsilon + d\ )dxdydz$$

$$\left\{ \xi \frac{v(\epsilon)n}{\lambda(\epsilon)} + \frac{\partial}{\partial \epsilon}\left[\xi \frac{v(\epsilon)n}{\lambda(\epsilon)}\right] d\epsilon \right\} dxdydz$$

The net increase per unit time of neutrons in the range $d\epsilon$ and in the volume element dxdydz is obtained by subtracting outgoing from incoming:

$$\text{Net increase} = \frac{\partial}{\partial \epsilon}\left[\xi \frac{v(\epsilon)}{\lambda(\epsilon)} n(x,y,z,\epsilon)\right] \cdot dxdydzd\epsilon \tag{6-22}$$

Combining equation (6-22) with equation (6-21) gives the slowing down differential equation. Since we are concerned with the steady-state (time-independent) neutron density, the sum of equations (6-21) and (6-22) must be zero:

$$D\nabla^2 n + \frac{\partial}{\partial \epsilon} K\left(\xi \frac{vn}{\lambda}\right) = 0 \tag{6-23}$$

$$\text{with } D = \frac{\lambda v}{3\left[1 - (\cos\phi)_{av}\right]} = \lambda_t v/3$$

$$\lambda = \lambda(\epsilon),\ v = v(\epsilon),\ n = n(x,y,z,\epsilon),\ = \log_e E$$

Equation (6-23) can be transformed into the same form as the classical heat conduction equation by the introduction of new dependent and independent variables. The dependent variable is the so-called "slowing down density" defined as:

$$q = \xi vn/\lambda \tag{6-24}$$

The name is descriptive. As pointed out earlier, the loss of ϵ per unit time per neutron is $\xi v/\lambda$ (Figure 38). Multiplied by the neutron density n, this is then the total loss in ϵ per unit time per unit volume per unit energy interval or, expressed differently, the number of neutrons per unit volume per unit time crossing any value ϵ on the ϵ axis. In the steady state, if q is integrated over all space, the number of neutrons crossing any value ϵ per unit time is certainly the number of neutrons fed into the system per unit time, i.e., a constant. Thus $\int q(x,y,z,\epsilon)dxdydz$ = constant for all ϵ. If q is substituted into equation (6-23), the result is:

$$\left\{ \frac{\lambda^2(\epsilon)}{3\xi\left[1 - (\cos\phi)_{av}\right]} \right\} \nabla^2 q + \frac{\partial q}{\partial \epsilon} = 0 \tag{6-25}$$

This is a simpler form than equation (6-23) since the differential operators only operate on q. The independent variable can be changed to further simplify the form. Let us introduce the independent variable τ, the "age" (often called the "Fermi age"):

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