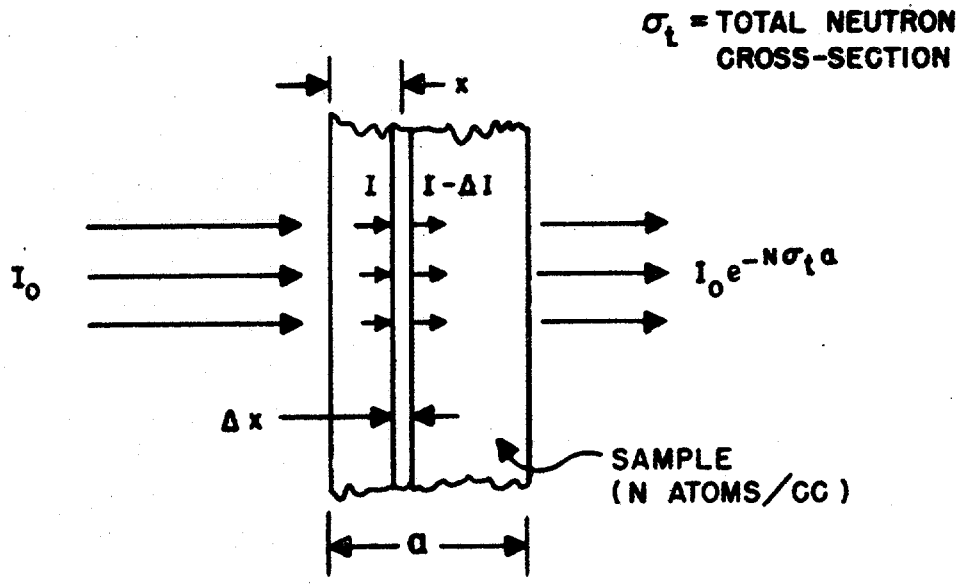

Figure 5. Exponential absorption law.

It is apparent that in the absorber (Figure 5) a layer of thickness Δx has a parallel beam of I neutrons/sec/cm^2 incident on it. If N is the number of absorber atoms per cubic centimeter then N Δx nuclei per square centimeter are presented as "targets" for the incident neutron beam. From equation (2-4) it is apparent that the number of processes which will occur per unit area per unit time is σ_t nv times the number of nuclei per unit area N Δx. Since nv is just the incident neutron flux I this means that

Number of neutron collisions per unit area per unit time in layer $\Delta x = \sigma_t I N \Delta x$ (2-6)

where $\sigma_t = \sigma_{total}$ = cross section for all collision processes

Now, any collision removes the neutron from the parallel beam so the above is just $-\Delta I$, the decrease in beam intensity. Equating and solving yields the familiar exponential law:

$$-\Delta I = \sigma_t I N \Delta x$$

$$-\Delta I/I = N\sigma_t \Delta x \qquad (2\text{-}7)$$

$$I = I_o e^{-N\sigma_t a} \quad \text{(integrating)}$$

$$\text{or} \quad \sigma_t = \frac{\log_e(I_o/I)}{N a}$$

where I_o is the incid ; beam intensity (at x = 0) and a is the thickness of the sample. The last equation expresses the total cross section in terms of experimentally measurable quantities. The total cross section σ_t may be defined as

$$\sigma_t = \sigma_{elastic} + \sigma_{inelastic} + \sigma_{absorption} \qquad (2\text{-}8)$$

where $\sigma_{absorption}$ includes all processes in which a neutron disappears, i.e., (n,γ), (n, α), (n,p,), etc.

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