CHAPTER II

COLLISIONS OF NEUTRONS WITH NUCLEI

2.1 GENERAL TYPES OF REACTIONS

One of the most important types of collision processes is the "scattering" process. A scattering process is characterized by the identity of one of the ejected particles with the incident particle. If a neutron collides with a target nucleus (in a later chapter we shall define in detail what constitutes a "collision") and after the collision a neutron is observed leaving the scene, then it may be said that the neutron has been *scattered* by the target nucleus. If the kinetic energy of the neutron before the collision is equal to the sum of the kinetic energies of the recoil nucleus and scattered neutron after such a collision then the process is called "elastic scattering." If the kinetic energy is not conserved, i.e., some energy goes into nuclear excitation, then the process is "inelastic scattering." Using the customary notation (see equation 1-1), these definitions may be summarized as follows:

Scattering process:	A (n,n)A*	
Elastic scattering:	A = A*	(2-1)
Inelastic scattering:	A* = excited state of A	

(A = target nucleus; A* = recoil nucleus)

For simplicity scattering processes are generally referred to as (n,n) processes.

In addition to the scattering process, collisions of neutrons with nuclei may result in the ejection of other particles or radiation, for example (n,γ), (n,p), or (n,α) reactions. The distinction between excited or stable resultant nucleus is not generally made.

There are other types of reactions ocurring when neutrons collide with nuclei the most important of which are the (n,2n) and (n, fission) reactions. In the (n,2n) reaction a neutron incident on a nucleus results in the ejection of two neutrons, the recoil nucleus being isotopic with the target nucleus. This reaction is always endothermic. The (n, fission) or (n,f) reaction will be discussed at length in a later chapter. In the (n,f) reaction a neutron collides with a nucleus and as a result fission occurs.

2.2 NEUTRON CROSS SECTIONS AS A FUNCTION OF ENERGY

The collision of neutrons with nuclei may be described in terms of the target presented by the nuclei to the incident neutrons. Target size is specified by "cross section" or so many square centimeters per atom. It has become the custom to express cross sections in "barns" with one barn defined as 10^{-24} cm^2/atom. If a beam of neutrons of density n neutrons per cubic centimeter all moving with a velocity v centimeters per second is incident on a nuclear target of area σ(cross section), then the number of neutrons hitting the target per second will be $nv\sigma$. This can be visualized by considering the target area σ to move with a velocity v through the neutron beam. In its motion the target will "sweep" out per second a volume $v\sigma$ in which there will be $nv\sigma$ neutrons, since there are n neutrons per unit volume.

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