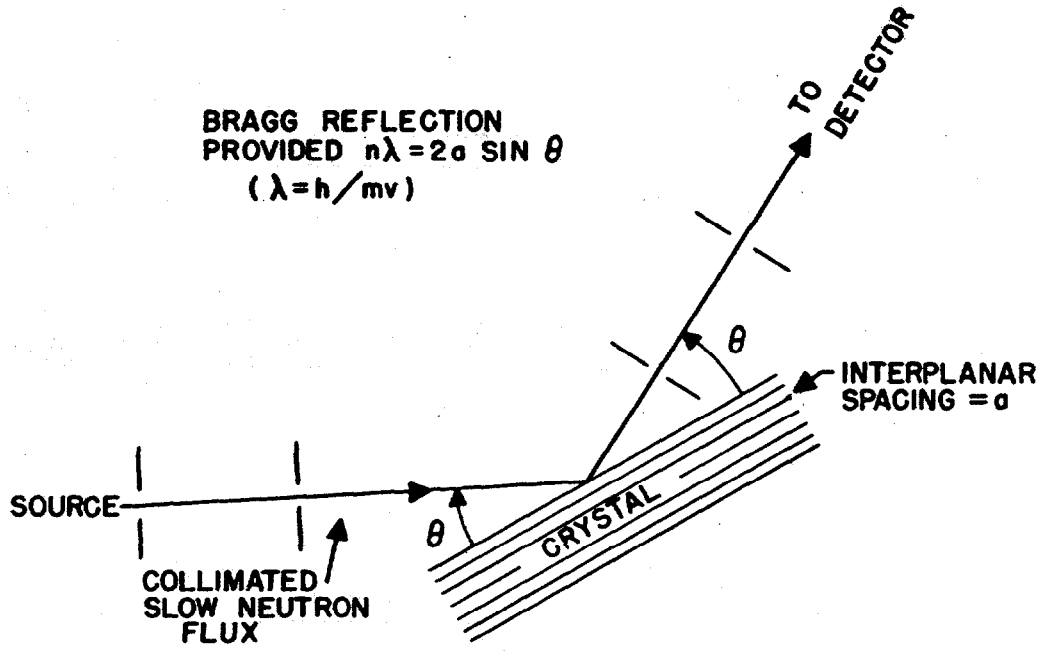

Figure 24. Scattering of neutrons by single crystal.

on a crystal. If the angle of incidence θ (angle between incident beam and crystal surface) is varied and for each value of θ the scattered intensity is measured with the detector, it is found that neutrons obey a Bragg-like formula:

$$n\lambda = 2a \sin \theta \qquad (5\text{-}12)$$

where
n = order of interference
a = interplanar spacing
λ = de Broglie wavelength of neutron (h/mv)

For first order interference, equation (5-12) may be solved for the neutron velocity v:

$$v = h/(2ma \sin \theta) \qquad (5\text{-}13)$$

This shows that if a beam of neutrons with a continuous range of velocities impinges on a crystal, those neutrons of the proper v for the angle θ will be reflected in a sharp beam at an angle equal to the angle of incidence. Neutrons with other velocities will simply be scattered in the material in a normal way.

One can easily check the fact that the reflected beam really contains those neutrons whose velocity is given by the Bragg formula by taking readings with and without a boron absorber in front of the detector for various angles. The boron cross section as a function of v is well known (Figure 9, page 18), so that from the observed σ versus θ curve, one can compute v versus θ. This latter would be found to be the Bragg relation, aside from complications due to higher order reflections, etc.

It is apparent that the combination of a crystal and neutron detector can be used* to analyze a beam of neutrons for its velocity distribution (in a manner analogous to the analysis of an x-ray beam for wavelength distribution). For example, the slowed-down neutrons emerging from a tank

*Neutron crystal spectrometry has been made possible using the high neutron flux from chain reacting piles, see Phys. Rev. 70:557 (1946); 71:752, 757 (1947).

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