DEUTERON DETECTION EFFICIENCY OF Ge TELESCOPES

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Intermediate energy protons and deuterons sometimes deposit less than their full energy in Ge detectors. Substandard pulse heights result when detected particles undergo inelastic interactions or exit prematurely from the telescope after multiple scattering or large-angle elastic scattering. Corrections for such losses must be made when Ge counter telescopes are used to measure absolute cross sections.

Carlson et al.[1] measured the fraction of 25 to 50 MeV protons lost in inelastic processes. They also calculated this quantity from 0 to 150 MeV, and values to 500 MeV were given by Janni.[2] No similar data exist for deuterons. Moreover, elastic losses must be considered for both protons[3] and deuterons, and these losses depend upon the telescope geometry when the particle range exceeds the detector radius.

A CD_2 target was bombarded with 160 MeV protons, and protons and deuterons from elastic p+d scattering were detected in coincidence. Losses were determined from analysis of the two-dimensional energy spectra. For deuteron loss measurements the two telescopes had identical defining aperatures. However, the two-body kinematics give $d\theta_d/d\theta_p \approx 0.6$. Thus the detection of a full-energy proton signal indicated that the associated deuteron went cleanly through its aperture without scraping the edges. Events lying in that strip in the E_p-E_d plane corresponding to full proton energy deposition were analysed. The deuteron loss factor is just the ratio of deuterons depositing less than full energy to the total number of events. Proton loss measurements were similar except that the deuteron telescope's solid angle was only 0.14 times as large as that of the proton telescope; thus the deuteron telescope controlled the effective solid angle.

The deuteron loss fraction was measured for 35 to 90 MeV deuterons detected in a telescope having two counters of nominal thickness 2 and 11 mm, and for 105 MeV deuterons in a telescope whose first two counters were 13 and 15 mm thick. All detectors have a 25 mm useful diameter. The loss fraction increased from 0.041 ± 0.004 at 35 MeV to 0.20 ± 0.01 at 105 MeV.

Proton losses of 0.137 ± 0.004 at 80 MeV and 0.25 ± 0.01 at 130 MeV were measured in a telescope containing three counters 13, 15, and 15 mm thick. These inclusive (inelastic plus elastic) losses exceed the inelastic loss factors of 0.084 and 0.157, respectively, given by Janni.[2]

1) F. Carlson et al., Nucl. Instr. and Meth. 188, 465 (1981).

2) J.F. Janni, Technical Report AFWL-TR-65-150, Air Force Weapons Laboratory, Kirtland, New Mexico, 1966.

3) J.N. Palmieri and J.C. Wolfe, Nucl. Instr. and Meth. 76, 55 (1969).