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Proton Polarization Measurements with a New Polarimetry Installation

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Laval polarimetry installation has evolved throughout the years. From a setup based on two silicon polarimeters[1], a completely new versatile system has been designed with a dedicated scattering chamber; it can operate either with silicon or carbon analyzers, in different geometries, for more flexibility and reliability, depending on energy ranges and particular reactions under study[2,3].

Routinely, during polarization measurement experiments, the $^{2}H(^{3}He,\vec{p})^{4}He$ reaction is used to verify the affective analyzing powers calculated from known values of elastic scattering analyzing power data off the analyzer in use. Furthermore, two of Laval polarimeters equipped with carbon analyzers have been mounted and used at the LBL-88 inch cyclotron. Proton polarization from $^{12}C(p,\vec{p})^{12}C$ elastic scattering has been measured at 24.1 MeV to calibrate the polarimeters which were also run for polarization measurements in the $^{9}Be(^{3}He,\vec{p})^{11}B$ and $^{13}C(^{3}He,\vec{p})^{15}N$ reactions to verify previous polarization measurements on those reactions[2,4].

The polarimeter is designed so that data reduction takes advantage of the geometric mean to cancel out, as it has been shown[5], false asymmetries induced from differences in detector efficiencies and solid angles. To achieve that, it is clear[5] that two polarimeters must be run simultaneously on both sides of the beam at symmetric angles. For that purpose, side counters inside a polarimeter (Fig. 1) are mounted on a pivot allowing their interchange by a 180° rotation around the analyzer symmetry axis. That rotation is performed from outside the scattering chamber with mechanical devices bound to polarimeters, to keep them under vacuum. The actual design, with a ΔE detector placed in front of the analyzer (carbon) or as analyzer (silicon), allows always an excellent background elimination and particle identification[2].

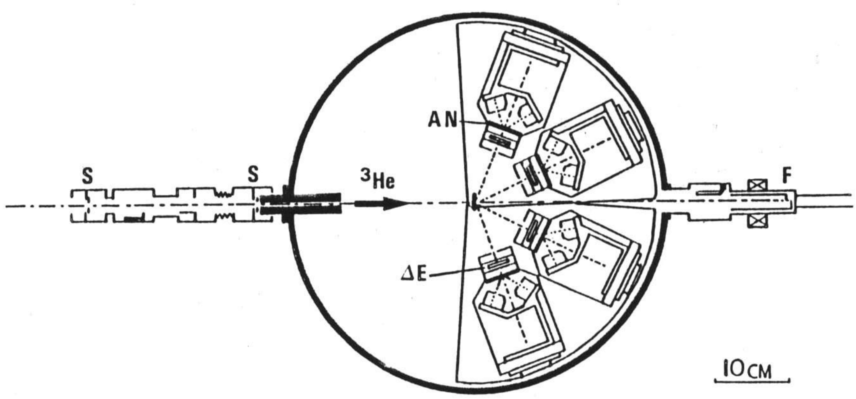

Fig. 1. Layout of the Laval scattering chamber with two pairs of polarimeters located at symmetric angles. The polarimeters are shown with a C analyzer (AN) and a passing detector (ΔE). The split Faraday cup (F) and readings from the slits (S) are used in the automatic beam centering system.

On-line data acquisition is effected with triple coincidence requirement between the ΔE and E energy signals and a relative time signal between them. On-line or off-line analysis can be performed on data by setting gates on the energy channels and the time spectrum. That way, clean bidimensional energy spectra are built and used for peak integrations. In the case of the calibration $^2H(^3He,\vec{p})^4He$ reaction initiated at 9 MeV (6 MeV deuteron energy for $^3He(d,\vec{p})^4He$), results are presented on Fig. 2a and compared to two previous independent measurements from other groups[6,7]. Data points are shown from runs with solid and gas targets; also presented are two simultaneous measurements with two pairs of polarimeters at different angles (36^0 and 92^0). All four polarization values illustrated here are obtained from experimental asymmetries, using calculated effective analyzing powers for the polarimeters, and show good agreement with independent measurements. Figure 2a expresses that quite convincingly.

Two new polarization measurements were also carried out in Berkeley with the same polarimeters on the $^{13}C(^3He,\vec{p})^{15}N$ and $^9Be(^3He,\vec{p})^{11}B$ reactions. Figure 2b shows obvious agreement between the new data point and our previous polarization measurements on ^9Be target[2,8]. In the case of ^{13}C target, the new measurement matches also the Laval data[4]. This work was supported by National Sciences and Engineering Research Council of Canada; the Ministery of Education of Quebec and the Nuclear Sciences Division of the U.S. Department of Energy.

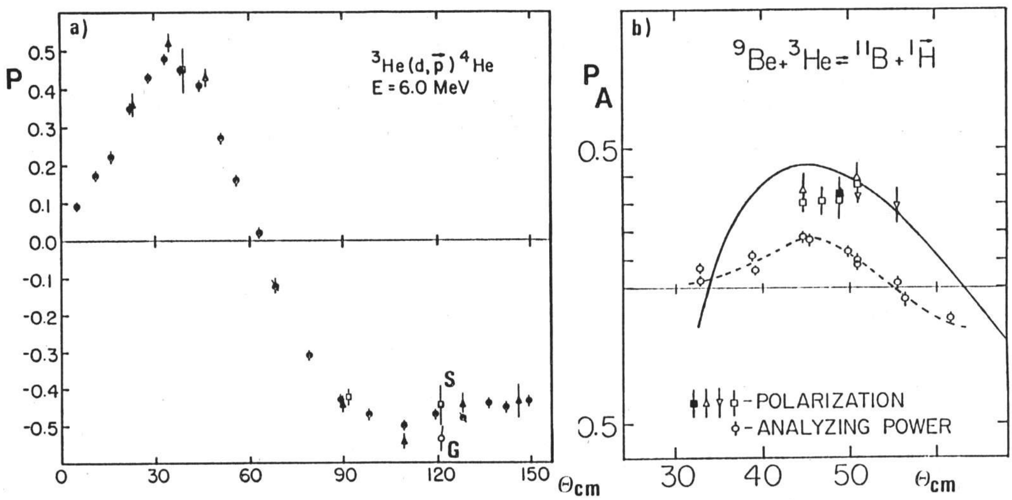

Fig. 2(a). Polarization in the $^3He(d,\vec{p})^4He$ and $^2H(^3He,\vec{p})^4He$ reactions at the same c.m. energy. Dots (•, ref. 7) and triangles (▲, ref. 6) are data from $^3He(d,\vec{p})^4He$ at 6 MeV. The open symbols are present results at 9 MeV ^3He energy: solid (S, $(CD_2)_n$) and gas (G, D_2) targets, and rotating solid target at 36^0 and 92^0. (b) Polarization and analyzing power data for the $^9Be(^3He,\vec{p})^{11}B$ reaction at 13.7 MeV. The new data point (■), result of a partial analysis of measurements made in Berkeley, confirms previous values represented by the solid line (polynomial fit to data[8]) and open squares and triangles[2].

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