TENSOR POLARIZED DEUTERON CAPTURE BY THE HYDROGEN ISOTOPES

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Tensor polarized deuteron capture in light nuclei is a useful and clean technique to determine the D-state of the residual nucleus. Measurements of the cross-section, vector analyzing power A_y and tensor analyzing power A_{yy} are in progress for the stable hydrogen isotopes. During the last year the data acquisition rate of the apparatus used in the measurement of the $^2H(d,\gamma)^4He$ reaction has been significantly improved to meet the demands of this experiment: measure (to good precision) the tensor analyzing power for a process with a 1 nb/sr cross section using detectors with singles rates of over 2 MHz. It was soon realized after the first run (October, 1983) that this measurement was not feasible in a reasonable amount of beam time with the existing experimental apparatus.

A design goal of an order of magnitude increase in the count rate was chosen. Due to the high singles rates (and consequent pileup) in the recoil detectors the ultimate gain in the count rate will probably be about a factor of six. This should result in measurements of A_{yy} that have a statistical uncertainty of about +/- .04 for the maximum in the cross section (about 1.5 nb/sr in the lab).

The major change was the construction of a new double-sided scattering chamber and the consequent switch to a left-right geometry. With this chamber all eight photon detectors can be placed at angles appropriate to ^4He detection in the hodoscope detector and there is now enough room to increase the solid angle for each detector by moving the detectors in toward the target by 22 cm. There was a gain of 2.1 in the solid angle per detector with the overall gain in the summed photon solid angle being 2.8 from both effects. Since these improvements resulted in an increase in the real/random ratio the luminosity could be then increased by a factor of two. This gives an overall improvement of 5.6 in the acquisition rate for real events. An additional benefit is that the analyzing powers can now be calculated for the four different combinations of detector orientation and beam polarization. Systematic errors can obviously be detected and corrected much more easily in this new detector configuration than in the old single-sided chamber. Another change was that the hodoscope recoil detector could be placed in vacuum, eliminating the scattering and energy loss associated with the vacuum windows.

About twenty shifts were used in July 1984 to test the new system with the $^1H(d,\gamma)^3He$ reaction and to take some preliminary $^2H(d,\gamma)^4He$ data and carbon background measurements. These $^1H(d,\gamma)^3He$ data should be published soon. Upon replay it was obvious that the new hodoscope was not suited for studies of the $^2H(d,\gamma)^4He$ reaction since the first plane, which is most sensitive to the helion-deuteron energy loss difference, did not have adequate resolution for clean separation of the various particle species. This variation in resolution was caused by the variation of the light transmitted to the phototube because of attenuation within the scintillator. (This first plane was only .25 mm thick.) By changing the incident deuteron energy to 95 MeV the thickness of this first plane could be increased 40% due to the 40% increase in the range of the recoiling ^{4}He nucleus. This then reduces the numbers of reflections for each ray and consequently improves the resolution.

This new recoil detector was tested during a run in December 1984. A 120 MeV alpha beam was used to establish uniform gains for all detectors and to give a reference point for a pulse height as a function of energy and particle species. The major portion of the run was devoted to taking data with both CH^2 and CD^2 targets to check the time and energy response of the hodoscope and to determine the maximum luminosity allowed by the detectors. The detector response was very good, with an energy resolution of 10% in the thick (1.5 mm) planes and 20-30% in the thin (0.6 mm) plane. The time response was about 800 psec (FWHM). This poor performance was due to the low bias voltage required to eliminate gain shifts; at significantly higher bias voltages the time response decreased to 400 psec.

With this successful test of the new recoil detector the hardware development phase of this experiment should be at an end. After analysis of the data taken during these last development runs the minimum tolerable ratio of real to random events will be known, setting the allowed luminosity of the data acqusition runs. These production runs should begin in May 1985.

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