RECOIL DETECTION OF THE $^{9}Be(p,\pi^{o})^{10}B_{g.s.}$ THRESHOLD

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A detector of nearly 4π effective solid angle is attractive for study of low cross sections and especially so for π^{o} production where detection of the decay products of the π^{o} is cumbersome. Just above threshold, the π^{o} can carry off so little momentum that a stable product nucleus of the (p,π^{o}) reaction must be left moving at nearly 0^{o} at the full beam momentum. In the use of a thin ^{9}Be target, for example, more than half of the ^{10}B ions emerge with Q=5 at about 15 MeV and can be magnetically separated from the proton beam and detected with a silicon counter. A drift distance of 1.9 m, time resolution of 0.8 nsec and a pulse-selected beam (one short burst every 125 nanosecond) gives an unambiguous mass determination. An achromatic quad doublet employing opposing electric and magnetic gradients gives about 1 msr solid angle in the lab frame, constant over the range of recoil energies determined by target thickness. The quadrupole aperture is an elliptical cone, while the recoils of interest are confined within a right circular cone. In the region from 0.1 to 1 MeV above threshold, the collection efficiency decreases from 4π approximately as $1/k\pi$ while the cross section for ℓ=0 production rises as $k\pi$ due to phase space. The expected result is thus a nearly constant yield with a step increase at the threshold for each bound final state.

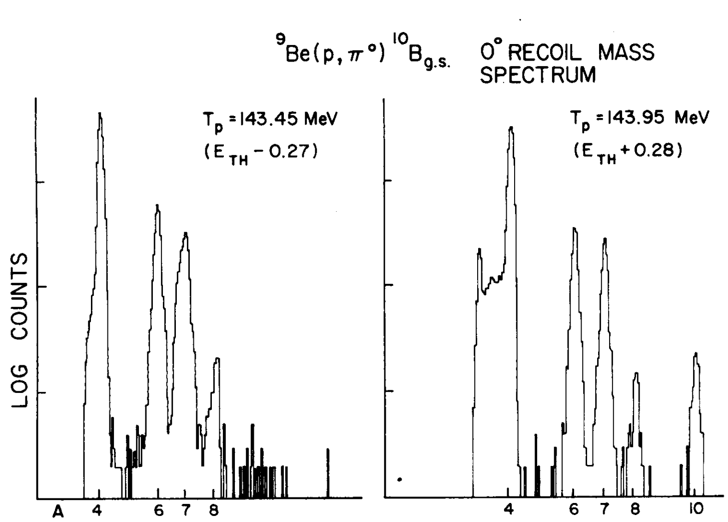

Figure 1.

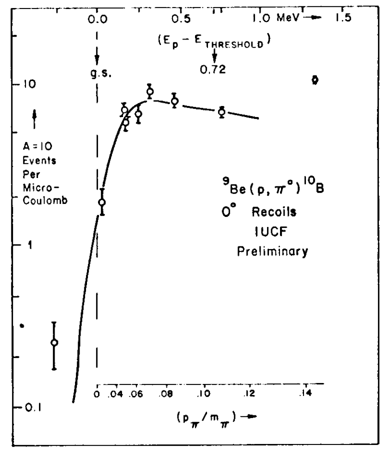

Figure 2.

The beam energy is changed in about 100 keV increments in about 10 minutes per change by adjusting a single outer trim coil shunt in the main cyclotron. Comparing the mass spectra obtained below and above threshold in Figure 1, we see a large increase in A=10 yield above 10 MeV. The excitation curve obtained to date is seen in Figure 2. The yield increases by about a factor of 30 within 0.1 MeV of the predicted threshold. A preliminary value for the total cross section for the point at about 0.2 MeV above threshold is about 5 nanobarns, giving a mass 10 event rate of about one count per second.

The measurements are being extended to the T=1 state at 1.7 MeV for isospin comparison with (p,π^{+}) data of Experiment 70 and to the (p,π^{-}) threshold. The latter measurement requires an ion chamber in front of the stopping detector to distinguish ^{10}C from ^{10}B. The technique has been proven feasible and has given the best check on the IUCF proton beam energy scale to date. It shows promise of giving reliable total cross sections within 0.2 MeV of threshold.