

MEASUREMENTS OF (p, π^-) REACTIONS NEAR ZERO DEGREES

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The recent discovery¹ of an extraordinary concentration of (p, π^-) strength in a small 3-7 MeV excitation region has prompted a series of systematic "bump" studies^{2,4} involving a large number of targets at energies of 191, 200, and 206 MeV and at angles of 0° and 30° - 150° for the best candidates ^{18}O , ^{48}Ca , and ^{90}Zr . Some few data was acquired for ^{13}C , ^{18}O , ^{26}Mg , and ^{48}Ca angular distributions. The most striking feature of these studies are the one or two "bumps" observed in the (p, π^-) spectra with cross sections 1-2 orders of magnitude greater than the ground state transitions and comparable in magnitude to the strong (p, π^+) transitions commonly observed. In Figs. 1a-c are shown some representative zero degree spectra taken with the QQSP at a proton energy of 191 MeV (E201). Additional zero degree data at 166 MeV on the same target nuclei have yielded new information on the energy dependence of these reactions and has aided in developing rather complete angular distributions at these two energies for the best "bump" candidates.

The occurrence of these enhanced coherent pionic transitions may have important implications regarding the production mechanism and high momentum components of the nucleus. In the initial publications¹ of the "bumps" the role of two-particle one-hole states in the context of a two nucleon model were discussed. Dillig⁵ and Gibbs⁶ have developed target emission models which are suitable for calculating the angular distributions and asymmetries of the "bump" once their configurations have been identified. The energy dependence of the reaction is of interest within the context of these models as noted by Gibbs⁶ and Soga⁷ since the 2p-1h

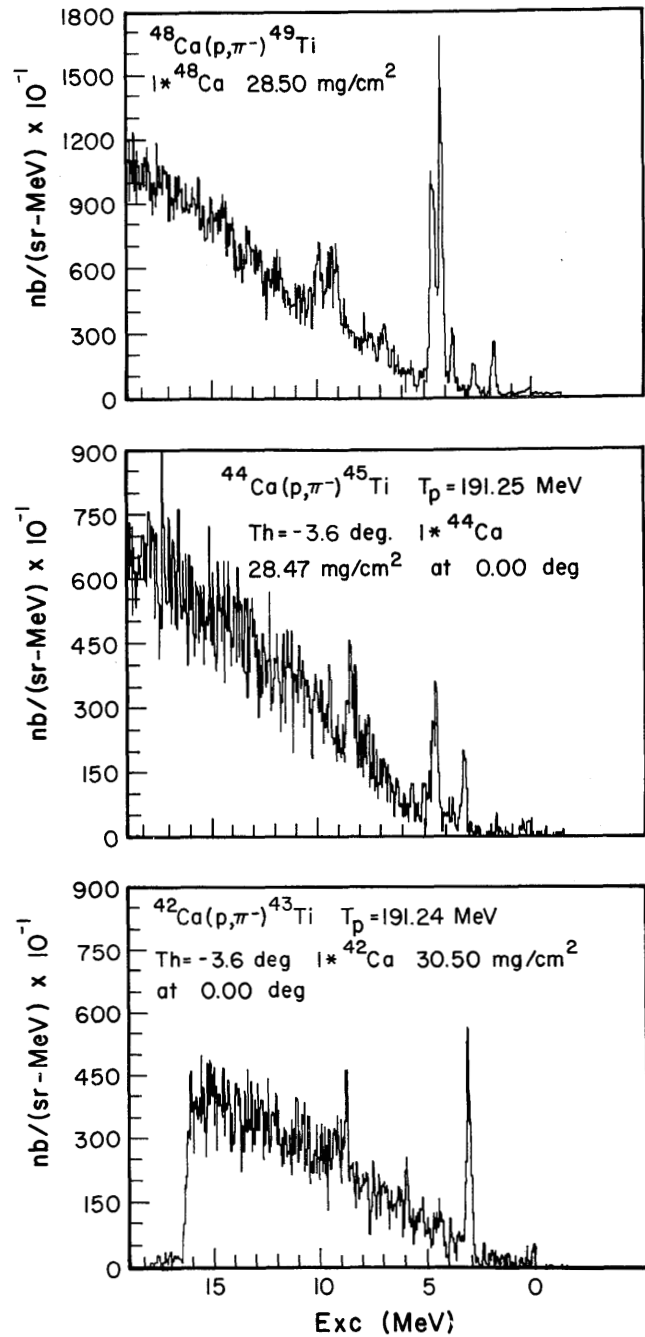


Figure 1a,b,c. Pion spectra obtained with the QQSP at $\theta_{\text{cm}}=3.6^\circ$, $E_p=191$ MeV for the ^{42}Ca , ^{44}Ca and ^{48}Ca (p, π^-) reactions.

behavior is quite different than the transitions to single particle states.

A summary of the results of E201 are: 1) the QOSP was tested and run at zero degrees making it fully operational, 2) high resolution π^- spectra were obtained with FWHM = 120-140 keV (see Figs. 1a,b,c), 3) the ground state transitions were observed for the best "bump" candidates allowing for a more accurate energy calibration ($\pm 60-80$ keV), 4) the continuum was measured up to an excitation of ~ 18 MeV, 5) the focal plane efficiency was measured using the ${}^7\text{Li}(p,\pi^-){}^8\text{B}$ reaction, and 6) the efficiency of the system was checked using the ${}^9\text{Be}(p,\pi^-){}^{10}\text{C}$ g.s. transition. The spectroscopic quality of the data is exemplified by our measurement

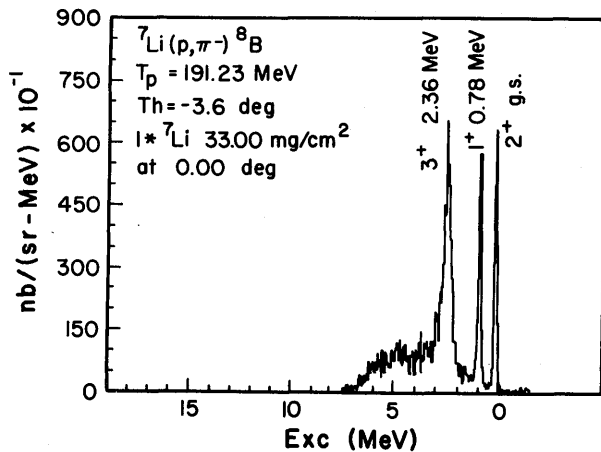


Figure 2. Pion Spectrum of the ${}^7\text{Li}(p,\pi^-){}^8\text{B}$ reaction at $E_p=191$ and $\theta_{\text{cm}}=3.6^\circ$. The level widths of the $1^+(0.776$ MeV) and $3^+(2.363$ MeV) states were measured to be 26 ± 5 keV and 370 ± 26 keV, respectively.

of the ${}^7\text{Li}(p,\pi^-){}^8\text{B}$ reaction as shown in Fig. 2. Three levels are known in ${}^8\text{B}$; these are $2^+(\text{g.s.})$, $1^+(0.78$ MeV) and $3^+(2.36$ MeV). The widths of the 1^+ and 3^+ states were measured previously to be 40 ± 10 keV⁹ and 390 ± 40 keV¹⁰, respectively. The 1^+ level width was measured in the ${}^6\text{Li}({}^3\text{He},n){}^8\text{B}$ reaction and the 3^+ level width in the ${}^{10}\text{B}(p,t){}^8\text{B}$ reaction. In the present study we have measured the 1^+ and 3^+ level widths to be 26 ± 5 keV and 370 ± 26 keV, respectively, by comparison of these level widths with the ground state level width whose resolution was 123 ± 9 keV.

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