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Brief Reports

Brief Reports are short papers which report on completed research or are addenda to papers previously published in the **Physical Review**. *A Brief Report may be no longer than 3½ printed pages and must be accompanied by an abstract and a keyword abstract.*

Diffractive angular distribution for ^{16}O(π^+, π^-)^{16}Ne(g.s.)

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The 164-MeV angular distribution for the non-analog double charge exchange reaction ^{16}O(π^+, π^-)^{16}Ne(g.s.) has been measured and is found to be basically diffractive. This is contrasted with the previously measured analog distribution for ^{18}O(π^+, π^-)^{18}Ne (double isobaric analog) which is not diffractive.

NUCLEAR REACTIONS ^{16}O(π^+, π^-)^{16}Ne(g.s.); $E_\pi = 164$ MeV, $\theta = 0°\text{–}50°$; measured $\sigma(\theta)$, non-analog transition, eikonal fit to angular distribution.

An intriguing observation in pion double charge exchange (DCX) is the existence of large non-analog cross sections for (π^+, π^-) reactions on $T=0$ nuclei.[1,2] As seen in the oxygen isotopes at 164 MeV, cross sections for ^{16}O ($T=0$) are nearly as large as those for ^{18}O ($T=1$). This result is in conflict with expectations that transitions to double-isobaric-analog states (DIAS) would dominate because of the high degree of overlap between initial- and final-state wave functions.

With rare exception,[3] all previous treatments of DCX completely ignore excitation of non-analog final states. The non-analog process has important consequences for the interpretation of double-analog DCX on $T=1$ nuclei, particularly when $T=1$ targets can be viewed as $T=0$ cores plus two neutrons.

In addition to other interesting features,[2] the angular distribution for DCX on ^{18}O has a peculiar shape at 164 MeV, but not at 292 MeV. The anomalous shape is observed at the bombarding energy (164 MeV) at which the non-analog process from ^{16}O has greatest strength. It thus became of interest to measure the angular distribution for DCX on ^{16}O at the same energy.

The measurements were performed at the Clinton P. Anderson Meson Physics Facility (LAMPF) using the EPICS pion spectrometer facility. The small-angular DCX apparatus[2] was installed and ice targets of 2-g/cm^2 areal density were used to maximize count rates consistent with acceptable resolution. Absolute normalizations were determined by comparing π^+-p elastic scattering, under the same conditions, with phase-shift calculations. Target-thickness effects were checked by comparing yields with a 0.25-g/cm^2 ice target. The measured absolute cross section scale is believed accurate to ±15%.

The measured angular distribution is shown in Fig. 1. There is a sharp falloff from forward angles with a distinct minimum near 32°, then a short rise to a second maximum near 45–50°. This shape is in striking contrast with that for ^{18}O, which is shown for comparison. The ^{16}O angular distribution is well

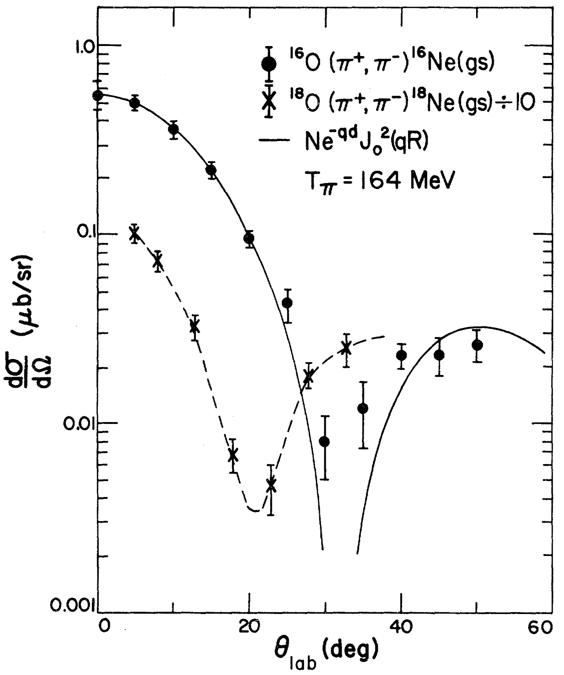

FIG. 1. Comparison of 164-MeV angular distributions for the DCX reactions $^{16,18}O(\pi^+,\pi^-)^{16,18}Ne(g.s.)$. The solid curve is an eikonal calculation explained in the text. The dashed line merely outlines the ^{18}O data.

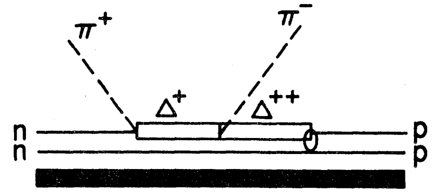

FIG. 2. A proposed (Ref. 5) single-step process for non-analog DCX.

described by an eikonal form,[4] $\sigma(\theta) = Ne^{-qd}J_0^2(qR)$, shown by the solid line in Fig. 1. For this curve the parameters are $d = 1.2$ fm and $R = 3.3$ fm, which is a reasonable value for the strong absorption radius of ^{16}O.

The diffractive nature of this angular distribution suggests that DCX on ^{16}O is a single-step process involving only one basic amplitude. In Ref. 5, this amplitude is suggested to result from the process outlined in Fig. 2, viz., DCX on a neutron, turning it into a Δ^{++} in the final state. It is clear that any single-step DCX process must involve a Δ. Any theoretical treatment of DCX on $T = 1$ nuclei must be able to correctly account for non-analog DCX on the core ($T = 0$ nuclei) before it has any hope of success.

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