Dominance of Tensor Correlations in High-Momentum Nucleon Pairs Studied by (p, pd) Reaction

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Key points

- The tensor interactions acting mainly between a proton and a neutron in a nucleus
- The observation of the isospin character of $p-n$ pairs at large relative momentum

Experimemtal details

- The $^{16}O(p, pd)^{14}N$ reaction at high energy and at small deuteron scattering angle
- This experiment was performed at the West-South (WS) course of the Research Center for Nuclear Physics (RCNP)
- The primary cyclotron facility : the newly constructed GRAF (Grand-RAiden Forward mode) beam line

Image

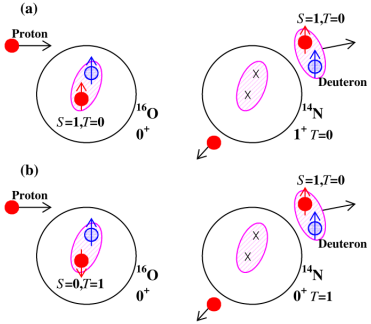

Figure: The pickup mechanism of a neutron dominates when a scattered deuteron is observed at small angles

- 2 channels: $S, T = 1, 0$ and $S, T = 0, 1$
- the reaction occurs with a $S, T = 1, 0$ pair $\rightarrow$ the final state of the residue: $T = 0$

Experimental results

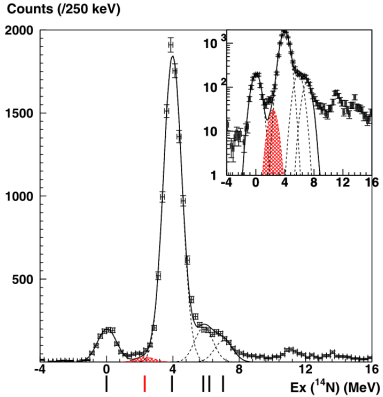

Figure: The excitation energy spectrum of $^{16}O(p,pd)^{14}N$, the yield of the first excited state of 2.31 MeV (red hatched area) is much lower than that of the 3.95 MeV state (the second excited state)

Interpretation

The 3-body triple differential cross section for $^{16}O(p, pd)^{14}N$

$$\frac{d^3\sigma}{d\Omega_p d\Omega_d dT_d} = S_d F_k \frac{d\sigma}{d\Omega_{p+d}} \sum_{\Lambda L} |T_L^\Lambda|^2$$

where

F_k: kinematic factor

S_d: the spectroscopic factor for deuteron in ^{16}O

$\sum_{\Lambda L} |T_L^\Lambda|^2$: the transition matrix

L, Λ: the relative angular momentum and its projection

Interpretation

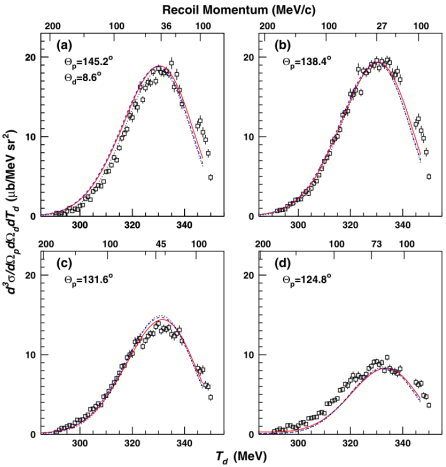

Figure: The results of the DWIA calculations for the 3.95 MeV state with $L = 0$ transition: the triple differential cross sections of $^{16}O(p, pd)^{14}N$ as a function of deuteron energy(or the averaged recoil

Interpretation

- The state at 2.31 MeV $\rightarrow$ $T = 1$, in which case a correlated p-n pair has $S, T = 0, 1$ (3.95MeV $\rightarrow$ $T = 0$)

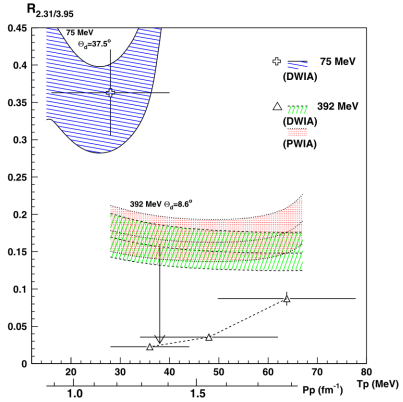

Figure: Ratio of cross section for 2.31 to 3.95 MeV in the sharing energy spectra of protons in the $^{16}O(p, pd)$ reaction

Interpretation

- The red-dotted area: the results of the plane-wave impluse approximation(PWIA)
- The green-hatched area: the results of the DWIA calculations
- The ratio is not significantly different from that for DWIA, showing that the effect of distortion is small for the ratio.

Summary

1. The cross sections of the $^{16}O(p, pd)^{14}N$ reactions were measured for 392-MeV incident protons, where the neutron pickup reaction dominates.
2. A strong relative reduction of the first excited state cross section compared to that of the second excited state was observed (^{14}N), which is expected to be due to the tensor correlations.

Thank you!