SPIN-FLIP STRENGTHS IN $^{12}C(p,p')^{12}C$ AT 122 MeV

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The $^{12}C(p,p')^{12}C$ reaction has been studied at a bombarding energy E_p = 122 MeV in order to investigate in detail the terms in the effective interaction on the microscopic treatment of inelastic scattering. The object has been to determine the strengths V_σ and $V_{\sigma\tau}$ (and ranges of a Yukawa radial dependence) by comparing the cross sections to the $J^\pi = 1^+$ states at 12.71 MeV (T = 0) and 15.11 MeV (T = 1) with calculations of the reaction mechanism.

These states would appear to be good candidates for identifying the strengths. The wave functions appear to be well described by simple $(p_{3/2}^{-1}\ p_{1/2})$ excitation of the ^{12}C ground state. No other 1^+ states in fact are known. Any isospin mixing of the states is at the 1% level.

Previous efforts at lower energies have been hampered by difficulties in fitting angular distributions. The shapes favor L = 2 excitation, whereas the calculations suggest the transition should be dominated by L = 0. This suggested that tensor interactions could be very significant. For this reason, our study has included data for the $^{14}N(p,p')^{14}N$ reaction to the 0^+, T = 1 state at 2.31 MeV. Nuclear structure reasons imply that central interactions should give a small cross section so that this transition becomes sensitive in large part to tensor contributions. As a further constraint on the treatment of the reaction mechanism, data for the 2^+ states at 4.44 MeV (T = 0) and 16.11 MeV (T = 1) in ^{12}C have been obtained.

Data were acquired in two separate runs. The ^{12}C data were mostly obtained on the first run. The elastic cross sections showed poor behavior at angles $\theta < 20^\circ$. These were repeated and corrected in a second run. The absolute cross sections for all states agreed to within 4%, the difference being understood in terms of a change in Faraday cups.

In the first run, the 2.31-MeV state in ^{14}N could not be seen for angles $\theta < 22^\circ$ due to severe background difficulties from the elastic peak. This was remedied in the second run by placing a thick block at the appropriate position of the focal place of the magnetic spectrograph in front of the helix detector. Data now cover the range 6-48°(Lab). The absolute cross section is being determined by a combination of several methods.

The calculation of the reaction mechanism has gone beyond our original thoughts. An effective interaction has been constructed in the impulse approximation from the T-matrix elements derived from the nucleon-nucleon phase shifts at 140 MeV in a manner similar to that of Bertsch et al.[1,2]. This interaction includes a sum of Yukawa terms with different ranges to reflect meson exchanges other than pions. The calculations therefore contain <u>no</u> free parameters.

The calculations include the central interaction, a spin-orbit term V_{LS}, a tensor term, and all exchange effects. A comparison with the data for ^{12}C is shown in Fig. 1. Initial comparison may be made for the 2^+ states. The calculations have been renormalized by factors shown on the figure. For the 4.44 MeV state this is in agreement with expected effective-charge factors. The tensor term is unimportant. For the 16.11 MeV state, the renormalization might reflect the inadequacy of the assumed wave function. The tensor term is very important in producing the correct shapes, but enhances the cross section by a large amount.

The 1^+ state at 15.11 MeV is well fitted. The tensor term improves the shape and has little effect on cross sections. The V_{LS} term is small. The main difficulty occurs for the 12.71-MeV state. A calculation without the tensor term (renormalized) produces good agreement out to 30°. Reasonable agreement with the ^{14}N data has also been obtained. Explicit calculations of some two-step cross sections show that they are small, being about 10% of the yields of the 1^+ states.

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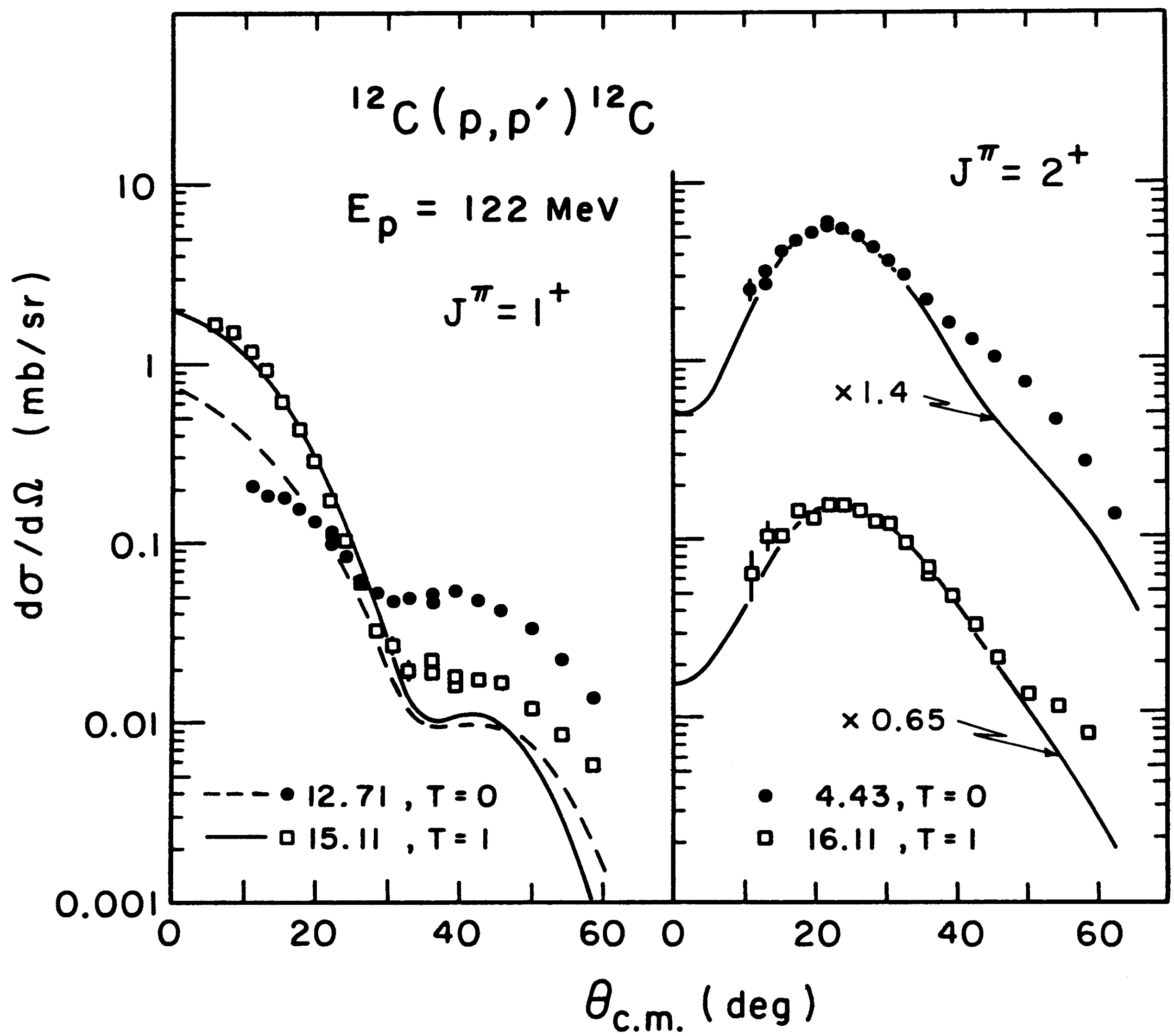
1) G. Bertsch et al., Nucl. Phys. A284, 399(1977).

2) W.G. Love et al., Phys. Letters (to be published).



$^{12}C(p,p')^{12}C$
E_p = 122 MeV
$J^\pi = 1^+$
$J^\pi = 2^+$
×1.4
×0.65
12.71 , T = 0
15.11 , T = 1
4.43, T = 0
16.11 , T = 1
dσ/dΩ (mb/sr)
10
1
0.1
0.01
0.001
0
20
40
60
$\theta_{c.m.}$ (deg)

Figure 1.