THE $^{14}C(p,n)$ REACTION AND THE INTERACTION STRENGTH RATIO $|J_{\sigma\tau}/J_{\tau}|$

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The relative energy dependence of spin-flip ($\Delta S = 1$) and non-spin-flip ($\Delta S = 0$) transitions in nucleon-nucleus inelastic scattering is illustrated in Fig. 1, which shows $^{14}C(p,n)$ spectra obtained at a scattering angle of 0° at four different bombarding energies. The $0^+ \rightarrow 1^+$ transition to the 3.95-MeV state in ^{14}N is mediated by the $V_{\sigma\tau}$ component of the effective nucleon-nucleon interaction, while the $0^+ \rightarrow 0^+$ transition to the 2.31-MeV isobaric analog state (IAS) is mediated by the V_{τ} component.

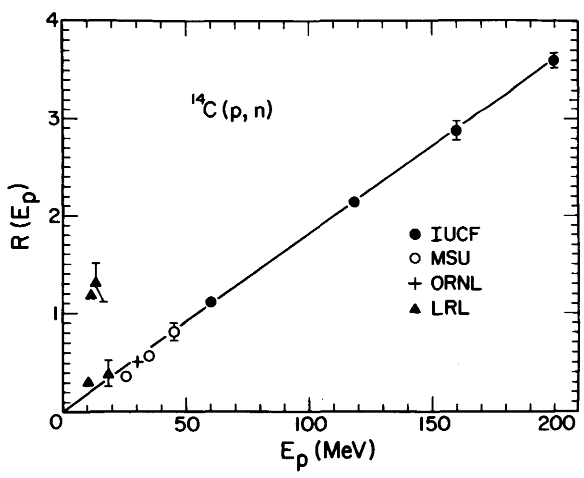

Figure 1. Spectra for the $^{14}C(p,n)$ reaction at $\theta=0°$.

The energy dependence exhibited in Fig. 1 may be quantified by making use of the proportionality between 0° (p,n) cross sections and the analogous Gamow-Teller (GT) or Fermi (F) β-decay transition strengths.[1] The quantity

$$[R(E_p)]^2 = [\sigma_{GT}(0°)/B(GT)K_{GT}]/[\sigma_F(0°)/B(F)K_F]$$

is defined in terms of 0° cross sections divided by the corresponding β-decay transition strengths.[2] The kinematic factors K_{GT} and K_F are given by $K = (E_i E_f/\pi^2)(k_f/k_i)$ and the β-decay transition strengths are related to measured ft values according to $B(F) + (1.25)^2 B(GT) = (6163.4 \text{ sec})/ft$, where $B(F) = N-Z$ for IAS transitions and is zero otherwise. In terms of the distorted-wave impulse approximation (DWIA), $R(E_p)$ may be interpreted as $R(E_p) = |J_{\sigma\tau}/J_{\tau}|(N_{\sigma\tau}/N_{\tau})^{1/2}$, where $J_{\sigma\tau}$ and J_{τ} are the Fourier transforms at momentum transfer q = 0 of the $V_{\sigma\tau}$ and V_{τ} components of the effective interaction and $N_{\sigma\tau}$ and N_{τ} are distortion factors. DWIA calculations indicate that the distortion-factor ratio does not differ significantly from unity, and thus $R(E_p)$ essentially represents the ratio of spin-flip to non-spin-flip interaction strength.

In Fig. 2 we plot the quantity $R(E_p)$ as determined by the $^{14}C(p,n)^{14}N$ reactions leading to the IAS and 3.95-MeV states for bombarding energies between 10 MeV and 200 MeV. The points for energies below 50 MeV are from work at other laboratories,[3-5] while the 200 MeV point is the result of a recent measurement at IUCF.[6] This new 200 MeV point agrees well with an earlier determination of $R(E_p = 200$ MeV) obtained from the $^{13}C(p,n)$ reaction.[2] The solid line in Fig. 2 results from a linear fit to (p,n) data obtained with several even-A targets (^{14}C, ^{26}Mg, and ^{42}Ca) and is represented by $R(E_p) = E_p/(55.0 \pm 1.0$ MeV).[6]

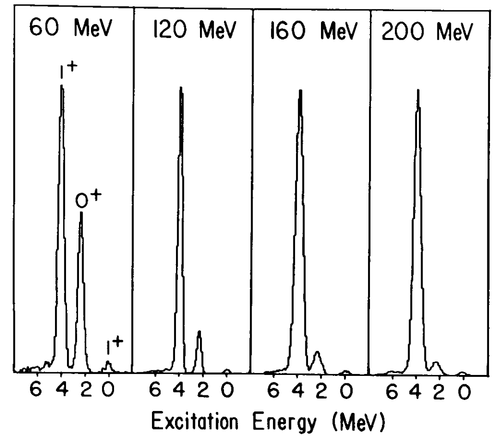

Figure 2. The quantity $R(E_p)$ as determined from the $^{14}C(p,n)$ reaction. The data are from work at four laboratories: Lawrence Radiation Laboratory (LRL),[4] Oak Ridge National Laboratory (ORNL),[3] Michigan State University (MSU),[5] and the Indiana University Cyclotron Facility (IUCF).[2]

1) C.D. Goodman et al., Phys. Rev. Lett. 44, 1755 (1980).

2) T.N. Taddeucci et al., Phys. Rev. C 25, 1094 (1982).

3) M.J. Saltmarsh, C.D. Goodman, and J. Rapaport, Bull. Am. Phys. Soc. 14, 1207 (1969); and unpublished report.

4) C. Wong et al., Phys. Rev. C 3, 1904 (1971).

5) T.N. Taddeucci, R.R. Doering, Aaron Galonsky, and Sam M. Austin, Bull. Am. Phys. Soc. 25, 728 (1980); T.N. Taddeucci, Ph.D. thesis, University of Virginia, 1980.

6) T.N. Taddeucci, Proceedings of the 1982 IUCF Workshop on the Interaction of Medium-Energy Nucleons in Nuclei, Bloomington, Indiana, 28-30 October 1982, to be published.