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STUDY OF STRETCHED CONFIGURATION HIGH-SPIN STATES IN THE NICKEL REGION WITH THE(d,α) REACTION

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Previous studies of the (α,d)[1-3] and (d,α)[4,5] reactions have shown that, under suitable kinematic conditions, stretched configuration high-spin states are preferentially excited. This selectivity has been used in the present study of the (d,α) reaction on ^{58,60}Ni at 80 MeV bombarding energy to locate high-spin states in the final nuclei ^{56,58}Co. Of special interest were transitions with L=6 angular distributions which arise from the transfer of the proton-neutron pairs in the $(1f_{7/2})^2_{J=7,T=0}$ or $(1f_{7/2}1f_{5/2})_{J=6,T=0}$ configurations. A typical spectrum, taken with a ^{58}Ni target, is shown in Fig. 1. The dominant peak in the spectrum is the transition to the $J\pi = 7^+$ state in ^{56}Co at 2.28 MeV. This transition provides an experimental shape of an L=6 angular distribution (see Fig. 2) which can be used to identify other L=6 transitions. The transitions to the $J^\pi = 5^+$ states in ^{56}Co at 0.58 and 1.01 MeV exhibit clear L=4 angular distributions (see Fig. 3) which are quite distinquishable from the observed L=6 pattern. Besides the aforementioned transition to the 7^+ state at 2.28 MeV in ^{56}Co, the transitions to states at 2.37, 3.54 and 4.44 MeV also show L=6 angular distributions.

These results have been used to test the predictions of recent multiconfiguration shell-model calculations by Glaudemans et al.[6] based on two different interactions, the surface delta interaction (SDI) and a modified Kuo-Brown interaction (KB). Spectroscopic amplitudes were calculated for the transitions to the theoretical 5^+, 5^+_2, 6^+_1, 7^+_1, and 7^+_2 states in ^{56}Co using only the strongest components in the wave functions of the initial and final states. With these spectroscopic amplitudes distorted-wave Born approximation (DWBA) calculations were performed and

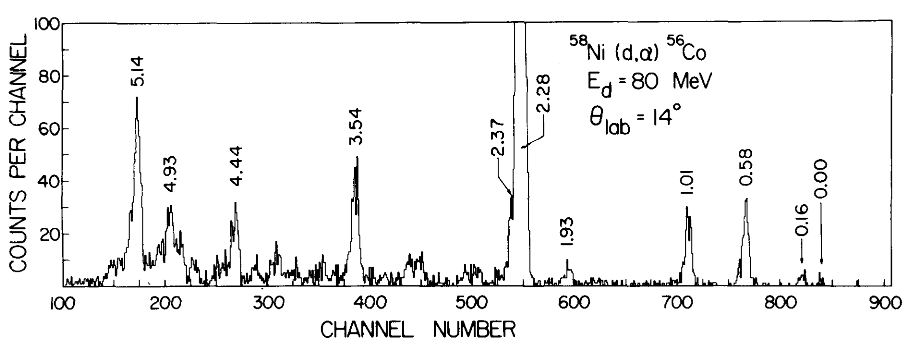

Figure 1. Alpha-particle spectrum for the ^{58}Ni(d,α)^{56}Co reaction taken with the QDDM magnetic spectrometer.

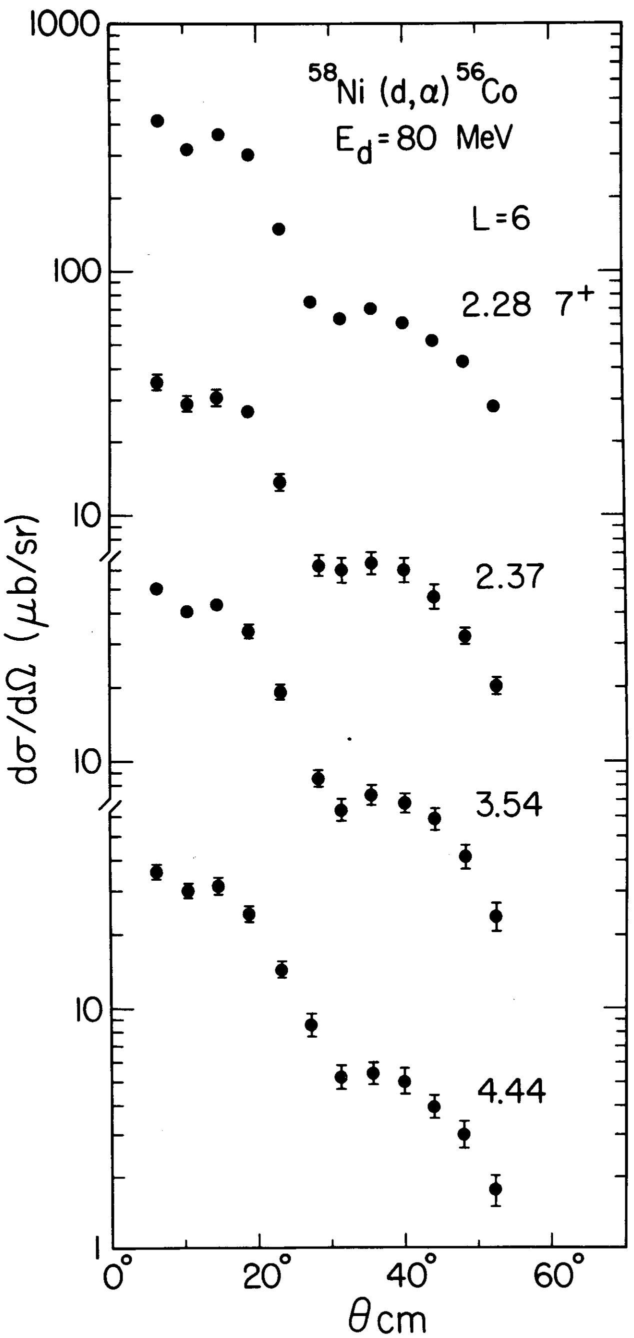

Figure 2. Characteristic L=6 angular distributions for the $^{58}Ni(d,\alpha)^{56}Co$ reaction.

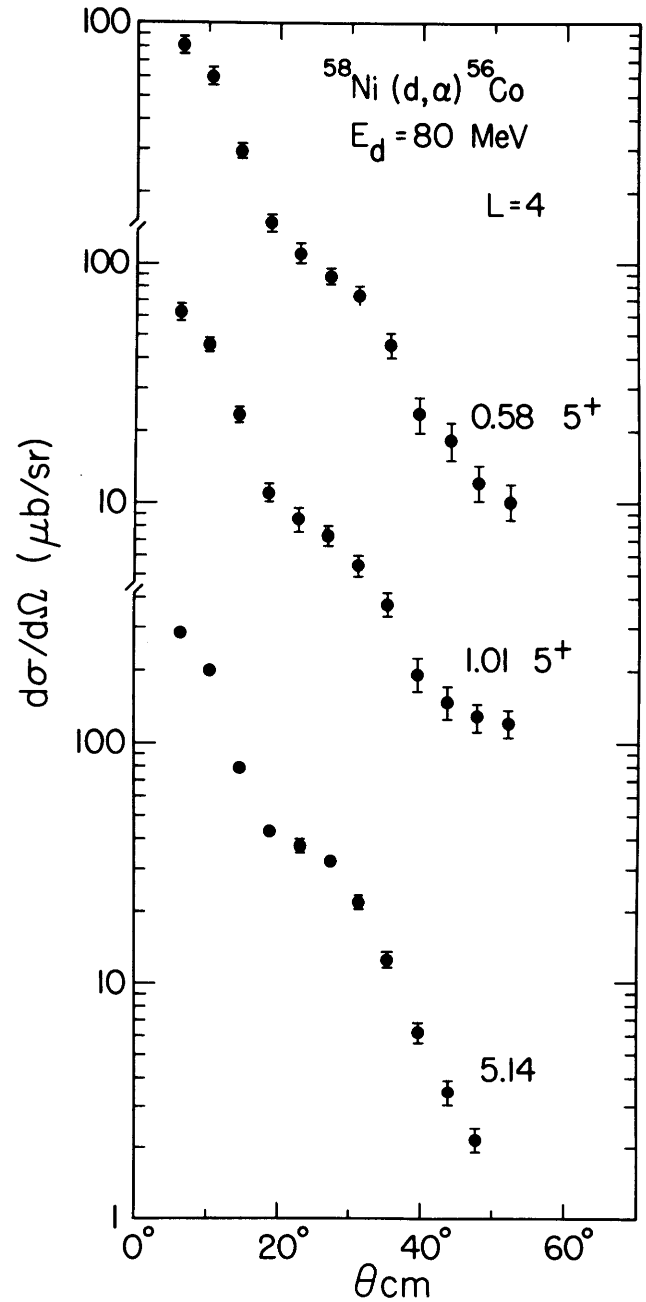

Figure 3. Characteristic L=4 angular distributions for the $^{58}Ni(d,\alpha)^{56}Co$ reaction.

compared to the data. The resulting ratios of the experimental and calculated transition strengths are shown in Table 1. The two interactions give quite different results. The SDI interaction essentially fails to account for the strength of the transitions to any of the high-spin states. The KB interaction predicts the relative transition strengths to the 6_1 and 7_2 states quite well but underestimates the strengths for the first two 5^+ states. In the $^{60}Ni(d,\alpha)^{58}Co$ reaction, the transitions to the states at 2.69, 2.94, and 4.79 MeV in ^{58}Co exhibit distinct L=6 patterns, whereas states at 0.03(5^+), 0.37(5^+) and 5.04 MeV are excited with clear L=4 angular distributions. A comparison of the observed L=6 transition strengths with the predictions of the two interactions shows that the SDI interaction splits the total $(1f_{7/2})^{-2}{}_{J=7,T=0}$ transfer strength into many little pieces. In contrast, the KB interaction predicts a localization of the 7^+ transfer strength that is in considerably better agreement with the experimental results.

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Table 1. $^{58}Ni(d,\alpha)^{56}Co$: Comparison of experimental transition strengths with microscopic DWBA predictions. The theoretical predictions are normalized to unity for the 2.28 MeV transition.

J^π_f	E_x(MeV)			σ_{exp}/σ_{th}	
	Exp.	SDI	KB	SDI	KB
5^+_1	0.58	0.67	0.58	3.96	1.80
5^+_2	1.01	1.45	1.20	4.12	2.48
7^+_1	2.28	2.68	2.29	1.00	1.00
6^+_1	2.37	2.24	2.29	0.27	0.83
7^+_2	3.54	3.72	3.70	6.20	0.93

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STUDY OF THE ($\vec{d}$,^{6}Li) REACTION

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The ($\vec{d}$,^{6}Li) reaction has been used for a number of years to study nuclear clustering phenomena.[1] However, such studies have been limited by their inability to distinguish between shapes of the angular distributions of different ℓ-transfers greater than about 4. Calculations which we have performed suggest that the vector analyzing powers obtained when such reactions are initiated with polarized incident deuteron beams might be extremely valuable in differentiating between much larger ℓ-transfers than could be done with the cross sections alone. This might extend the usefulness of such experiments into a much higher angular momentum domain.

We have therefore begun a program of study of the ($\vec{d}$,^{6}Li) reaction at E_d = 80 MeV. The polarized deuterons were produced by the IUCF polarized ion source, which gave a beam of about 50 nA on target. The beam vector polarization, typically about P_z =