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j-Shell Dependent Signature of (p,t) Analyzing Power in the ^{206}Pb 3+ State Excitations

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The (p,t) two-nucleon transfer reaction has long been a useful probe for the investigation of the two-particle correlation in nuclei. The angular distribution of one-nucleon transfer differential cross section is well known to be dependent upon the angular momentum transfer[1], hence the shape is a useful tool to get knowledge about the angular momentum state (l,j) of the single particle, from which nucleon is picked up. On the one hand, information about the total angular momentum state ($j=l\pm1/2$) was considered unobtainable from the (p,t) transfer reaction in contrast to the one-nucleon transfer case.

It is therefore somehow surprising that the (p,t) analyzing power A(θ) in the $0^+ \to 0^+$ transition sensitively reflects the j-shell difference in the nuclear wave function[2]. Additional finding of the j-shell dependent property of A(θ) has been found very recently and a brief report will be described in the other paper contributed to this Symposium[3].

The essence found there is that the sign of (p,t) analyzing power at forward angular region strongly depends upon either neutron being picked-up from $j=l+1/2$ or $j=l-1/2$ shell orbit. More surprisingly, its sign is alternative in accordance with one-step (p-t) or two-step (p-d-t) excitation mechanism. Therefore, the analyzing power is capable sensitively to clarify how much the two-step process contributes to the (p,t) excitation process.

One practical example is demonstrated in this paper for the ^{208}Pb(p,t)^{206}Pb transition at 22 MeV incident protons. Two final states are considered; E_x=1.34 MeV 3_1^+ and 3.12 MeV 3_2^+ . The nuclear wave function is known to be almost pure configuration[4], $[p_{1/2}^{-1}f_{5/2}^{-1}]3^+$ and $[p_{1/2}^{-1}f_{7/2}^{-1}]3^+$, respectively.

The differential cross section is shown in the bottom of Fig. 1. The most significant contribution arises from the two-step scalar component (2BS) through the bound-deuteron intermediate state. The one-step contribution is rather small, while the two-step through the $^3D_1+^3S_1$ (s=1) unbound-deuteron intermediate state gives the smallest contribution, which is shown as 2US1 in Fig. 1. The shape of angular distribution is a little bit different in between these two 3^+ states by reflecting difference in Q-value and shell orbit configuration ($f_{5/2}$ or $f_{7/2}$). The analyzing power, however, shows almost opposite sign at forward angular region, as seen in the top of Fig. 1, in accordance with one neutron shell difference ($f_{5/2}$ or $f_{7/2}$). It has been confirmed in the present calculation that when one-step contribution is increased by altering its interaction strength, the total A(θ) (the solid curve in Fig. 1) alternates its sign from positive to negative for 3_1^+ excitation and vice versa for the 3_2^+ excitation at forward angular region.

The experimental measurement has been performed very recently at Tsukuba Accelerator Center and now the data analysis is in progress[5]. The preliminary comparison of the data with the present calculation is quite consistent and support our present prediction.

References

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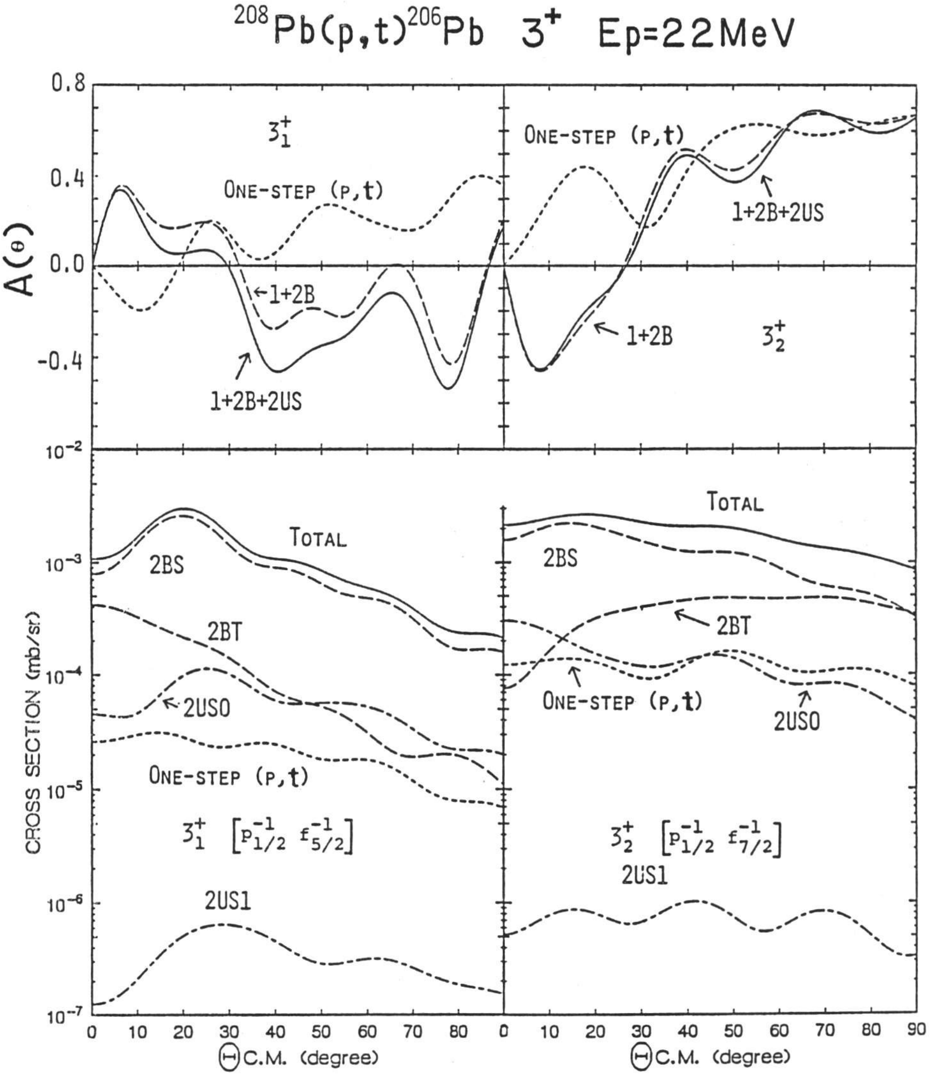

Fig. 1. Analyzing power functions and differential cross sections of the two 3^+ state excitations in $^{208}Pb(p,t)^{206}Pb$ reaction. 2BS shows the contribution from the bound-deuteron channel only with the L=0 (scalar) component in both the (p-d) and (d-t) steps in (p-d-t) calculation, while 2BT shows the contribution including the L=2 (tensor) component in one and/or both steps. 2US0 is the one from the $^1S_0$ (s=0) unbound-deuteron channel, while 2US1 shows the one from the $^3S_1+^3D_1$ (s=1) unbound deuteron channel only with the L=0 (scalar) component in both transfer steps.