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2.8 Analyzing Powers in ^{7}Li Induced 1-Neutron Transfer Reactions on ^{120}Sn at 44 MeV*)

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Using the 44 MeV polarized ^{7}Li beam at the Heidelberg MP-Tandem[1] the transfer reactions ^{120}Sn(^{7}Li, ^{6}Li)^{121}Sn and ^{120}Sn(^{7}Li,^{8}Li)^{119}Sn were studied simultaneously with the elastic and inelastic scattering[2]. In what follows we concentrate only on the stripping reaction. The ^{6}Li energy spectrum consists of one strong line corresponding to the ground state transition to ^{121}Sn and a well separated broad "bump" including transitions to many unresolved excited states. For both parts of this spectrum angular distribution of the analyzing powers $^{i}T_{11}$, T_{T20}, T_{20}, T_{21}, T_{T30} were determined, some of are displayed in Figs.1 and 2. (The superscript "T" refer to the use of the 'transversal coordinate system'). All data display rather smooth angular dependencies similarly to data for the elastic scattering which are dominated by Fresnel diffraction[2]. For such a situation the second rank tensor analyzing powers are connected by a simple relation[3,4]

$$T_{2q}(\Theta) = {}^{T}T_{20}(\Theta) \cdot Y_{2q}\left(\frac{\Theta+\pi}{2},0\right) \qquad (1)$$

Using the average value for $^{T}T_{20} = 0.3$ in relation (1) one gets a reasonable description of T_{20} and T_{21} for the ground state peak (solid lines in fig. 1). Moreover $^{T}T_{20} = 0.3$ follows from calculations within the peripheral model[4] using proper shell model spectroscopic factors for the $p_{1/2}$ and $p_{2/3}$ neutron in ^{7}Li[5].

For transitions with large Q-values eq. 1 has to be modified. This modification is mainly incorporated in an additional angular shift in the argument of Y_{2q} (eq. 1, $\Theta \to \Theta+\Delta\Theta$) which reflects in a semiclassical model a reorientation of the recoil momentum vector at the distance of closes approach. This angular shift is recognized from the zero crossing of T_{20} which for zero Q-value is predicted.

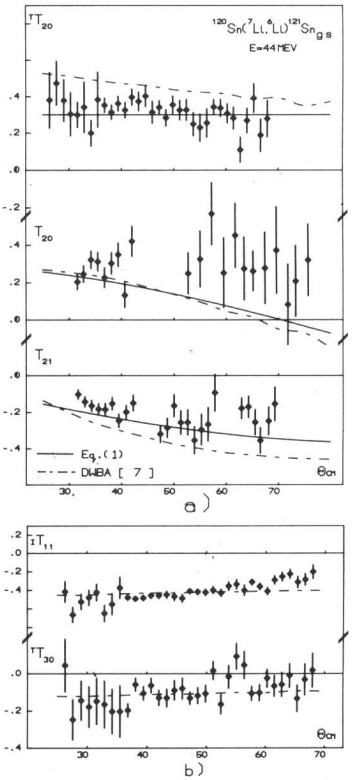

Fig. 1: Angular distributions of analyzing powers for the ^{120}Sn(^{7}Li, ^{6}Li)^{121}Sn(g.s.) reaction: a) 2nd rank tensors, b) odd rank analyzing powers.

by eq. 1 to occur at 70^{0} but for the continuum is shifted to 55^{0}. The shift angle $\Delta\Theta$ can be estimated from semiclassical arguments (solid line in Fig. 2). The peripheral model[4] also predicts such shifts in angle as a consequence of a Q-dependence in the recoil angular momentum.

The odd rank analyzing powers for all transitions (stripping and pickup exhibit rather flat angular distributions which are described quite well by standard theoretical models[7], provided that well defined quantum numbers can be assigned to the initial and final states.

In order to study the Q-value dependence in the continuum, the 'bump' in the ^{6}Li spectra was divided into 0.3 MeV wide bins and analyzing powers were calculated for each bin spearately. Fig. 3 displays the Q-value dependence of iT_{11} obtained for the angular range $35^0 < \Theta < 45^0$. The data agree well with the prediction[6]:

$$iT_{11} = \text{const.} \times \tanh - \frac{mv^2 - 2Q}{\hbar v k} \qquad (2)$$

(solid line in fig. 3), $1/2\ mv^2$ being the kinetic energy of the neutron at the distance of closest approach and $\hbar^2 k^2/2m$ the binding energy of the neutron in ^{7}Li. This relation was derived from the angular momentum matching in transfer reactions.

Coupled channel calculations using a CRC code FRESCO[7], including coupling to the elastic and inelastic projectile excitation channel show a slight dependence of the polarization observables on the deformation of the ^{7}Li projectile. Only weak influence of the coupling to the inelastic channels were found, except for T_{20} at backward angles where this coupling should be included in more accurate fits to the data.

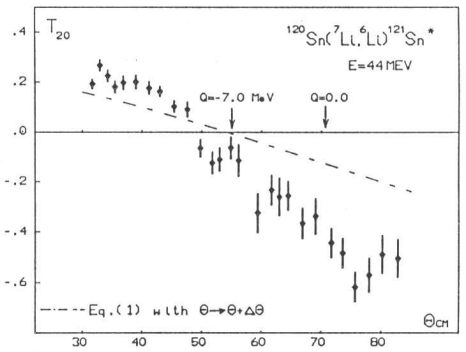

Fig. 2: Angular distributions of T_{20} for the continuum in the ^{120}Sn (^{7}Li, ^{6}Li)^{121}Sn reaction.

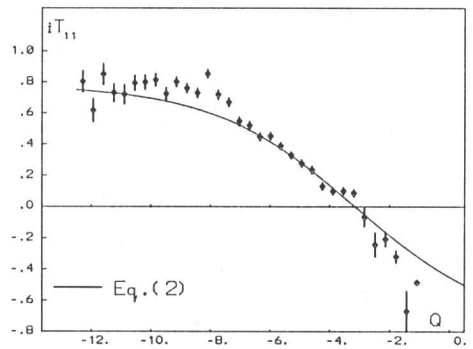

Fig. 3: Q-value dependence of $^{T}T_{10}$ for the ^{120}Sn(^{7}Li, ^{6}Li)^{121}Sn reaction.

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