

Single Nucleon Transfer and Charge Exchange Reactions
for ^{48}Ti Incident on ^{42}Ca and ^{26}Mg *

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In order to study quasi-elastic nucleon transfer reactions in the medium mass region experiments were performed using the QQDQ magnetic spectrometer and a ^{48}Ti beam from the UNILAC at GSI. Angular distributions were taken for the reactions $^{48}\text{Ti} + ^{42}\text{Ca}$ and $^{48}\text{Ti} + ^{26}\text{Mg}$ at an incident energy of $E_{\text{Lab}} = 385$ MeV. Additionally the reaction $^{48}\text{Ti} + ^{42}\text{Ca}$ was studied at the grazing angle and $E_{\text{Lab}} = 300$ MeV. The projectile-like reaction products could be identified unambiguously with an energy resolution of about 1.3 MeV.

The general mass-flow in the measured isotopical distribution for both systems tends towards lower masses which can be understood by considering ground state Q-value systematics and differences in Coulomb, centrifugal and nuclear potentials (driving potential). Since the measured spectra may contain contributions from other reaction products with succeeding particle decay their shape may be different from the primary distributions. Therefore, in general, the measured energy spectra have to be corrected for this effect before being compared with theoretical models. However, the reconstruction of the primary spectra is rather dependent on assumptions about the evaporation process. The correct treatment is very difficult. In the experiment reported here preferentially evaporation of one and two nucleons occurs. Using particle separation energies and reaction kinematics, regions in the measured energy spectra can be marked which are particle stable or which are contaminated by one or two particle decay. The cross section of the reaction products far from the injection channel is essentially built up by the different contributions produced by sequential particle decay and the stable part in these energy spectra is negligible. Contrary to this the cross section for the few nucleon transfer channels is mainly covered by the stable part of the measured energy spectrum which in general is below $E_x = 15$ MeV. Under restriction to low excitation energies, the contribution from sequential particle decay to a certain channel can be excluded and the fraction which decayed to lower masses can be neglected.

The directly produced parts of the spectra of the few nucleon transfer channels show a gross structure specific to each reaction channel which persists as a function of scattering angle and for each incident energy measured. Figure 1 shows the spectra of the four single nucleon transfer channels for the system $^{48}\text{Ti} + ^{42}\text{Ca}$ at $E_{\text{Lab}} = 300$ and 385 MeV near the corresponding grazing angle. Hitherto, such spectra have been interpreted as quasi-elastic transfer to continuum states¹ and have been described using a semi-statistical model². Contrary to this approach, we have proposed a model involving single particle states in both of the outgoing nuclei which may be excited simultaneously³. The cross sections

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calculated within this core excitation model are shown in fig. 1 for each transfer channel as a smooth line. The normalization parameter, N , determines the absolute magnitude of the predicted cross sections and takes into account the approximations used in the DWBA method. The overall correspondence between the model predictions and the data is very gratifying in all cases. The missing strength at higher excitation energies may be due to more complicated particle-hole excitations and transfer after inelastic excitation as a multistep process which are not included in the model. Similar results can be obtained for the corresponding reaction channels in the system $^{48}\text{Ti} + ^{26}\text{Mg}$ for all angles measured.

As an application of this model the single charge exchange (SCX) reaction $^{42}\text{Ca}(^{48}\text{Ti}, ^{48}\text{Sc})^{42}\text{Sc}$ has been described as a two-step process using a coupled-channel DWBA code. This channel can be produced in three ways, (i) via the $^{48}\text{Ti} + ^{41}\text{Ca}$ channel, (ii) via the $^{47}\text{Sc} + ^{42}\text{Sc}$ channel and (iii) as a direct process via the $\tau\tau$ interaction. Since the first two branches have similar magnitudes the calculated cross section of way (i) is multiplied by a factor of 2 (contained in the normalization parameter N'). Figure 2 shows the energy spectrum of the SCX channel $^{48}\text{Sc} + ^{42}\text{Sc}$ together with the calculated 2-step cross section. The correspondence between experiment and calculation is rather satisfactory bearing in mind the problems at higher excitation energies in the one-step calculations.

The third way using the direct process via the $\tau\tau$ interaction is under way to be calculated at present.

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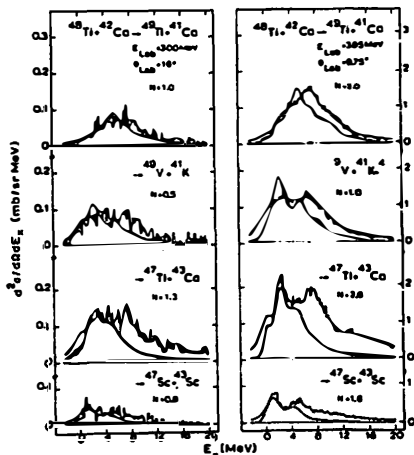


Fig.1: Double-differential cross section for the single nucleon transfer channels measured. The smooth line corresponds to the model calculations.

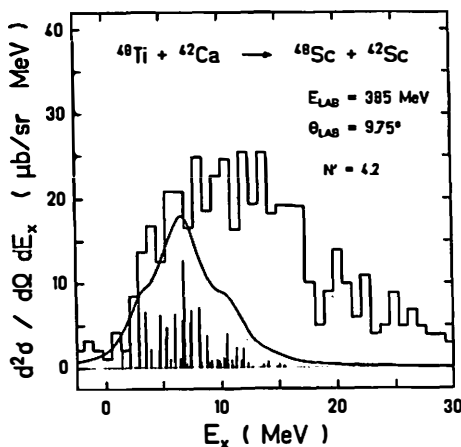


Fig.2: The measured and calculated cross sections of the SCX-channel $^{48}\text{Sc} + ^{42}\text{Sc}$. The strength for the individual levels is indicated by vertical lines in units of $\mu\text{b}/\text{sr}$.