Angular distribution for the 8He(d,t)7Heg.s. reaction

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E. Yu. Nikolskii,[*1] A. S. Denikin,[*2,*3] A. A. Korsheninnikov, H. Otsu, H. Suzuki,[*4] K. Yoneda, H. Baba, K. Yamada, Y. Kondo,[*5] N. Aoi, M. S. Golovkov,[*2] A. S. Fomichev,[*2] S. A. Krupko,[*2] M. Kurokawa, E. A. Kuzmin,[*6] I. Martel,[*7] W. Mittig,[*8] T. Motobayashi, T. Nakamura,[*4] M. Niikura,[*9] S. Nishimura, A. A. Ogloblin,[*6] P. Roussel-Chomaz,[*8] A. Sanchez-Benitez,[*7] Y. Satou,[*5] S. I. Sidorchuk,[*2] T. Suda, S. Takeuchi, K. Tanaka, G. M. Ter-Akopian,[*2] Y. Togano,[*10] and M. Yamaguchi

[Nuclear reactions, d(^{8}He,t)^{7}He, unstable nuclei]

Previously, we have reported on the measurement of the excitation energy spectrum of ^{7}He nucleus in the one-neutron $d(^{8}\text{He},t)^{7}$He transfer reaction at the RIPS facility. The reaction was studied at forward laboratory angles $\theta_{lab} \approx (11°–22°)$ using the ^{8}He 42 MeV/u beam and a deuteron target.[1)] In the spectrum of tritons, a strong peak corresponding to the ground state (g.s.) of ^{7}He was observed. Figure 1 shows the angular distribution for the ^{7}He$_{g.s.}$ state extracted from the experimental data.

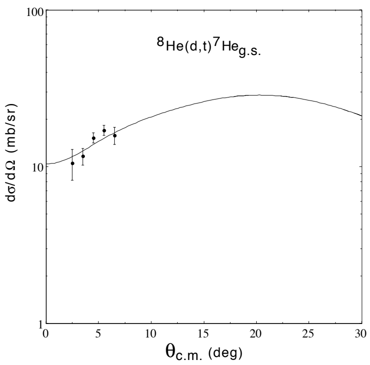

Fig. 1. The angular distribution for the ^{8}He$(d,t)^{7}$He$_{g.s.}$ reaction. The error bars are statistical only. The curve is the DWBA calculation.

The differential cross sections were analyzed with the DWBA approach using the code DWUCK5.[2)] The initial parameters of Woods-Saxon optical model potentials (OP) were obtained in two steps: (i) we performed optical model fitting of the elastic scattering data from the ^{8}He(p,p) reaction at E$_{lab}$ = 15, 26, 32.5, 66, and 72 MeV/u[3)] and obtained OP parameters for E$_{lab}$ = 42 MeV/u by linear interpolation; (ii) by analyzing the ^{6}Li(p,p), ^{6}Li(d,d) and ^{6}Li(^{3}He,^{3}He) scattering data[4)] at 25 MeV/u, we determined the tendency of changes in OP under projectile variation and applied it to the case of the deuteron-induced reaction. For the final t–^{7}He channel, the OP for the ^{6}Li(^{3}He,^{3}He) system was used. Taking the spectroscopic factors (SF) $SF[t = n + d] = 1.5$[5)] and $SF[^{8}He = n + {}^{7}He] = 4$ (assuming 4 neutrons in $p_{3/2}$ state, see also[6)]), we obtained a good description of the angular distribution with the normalization factor of 1.4–1.5. We found that no normalization was needed when the parameters for the imaginary part in the exit channel were slightly varied (within less than 10%) to fit to the absolute cross section. The result of the corresponding calculation is shown in Fig. 1 by a solid line, and the optical parameters are given in Table 1. The obtained OP were used to estimate the DWBA cross section for the $d(^{8}\text{He},^{3}\text{He})^{7}$H reaction which was simultaneously measured in this experiment.[7)]

Table 1. Optical potential parameters.
$U(r) = -V_0 f(r, r_V, a_V) + 4a_W W_D \frac{d}{dr} f(r, r_W, a_W)$,
$f(r, r_i, a_i) = \{1 + exp[(r - r_i A^{1/3})/a_i]\}^{-1}$

	V_0 (MeV)	r_V (fm)	a_V (fm)	W_D (MeV)	r_W (fm)	a_W (fm)
d+^{8}He	97.2	1.11	0.817	10.5	2.33	0.45
t+^{7}He	89.7	1.03	0.790	8.8	1.50	0.70
n+^{7}He	*)	1.30	0.750	–	–	–
$n + d$	*)	1.25	0.600	–	–	–

*) varied to reproduce the experimental separation energy.

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*1 On leave from Kurchatov Institute, Russia
*2 Joint Institute for Nuclear Research, Russia
*3 International University "Dubna", Russia
*4 Department of Physics, University of Tokyo
*5 Department of Physics, Tokyo Institute of Technology
*6 Kurchatov Institute, Russia
*7 Departamento de Fisica Aplicada, Universidad de Huelva, Spain
*8 GANIL, Caen Cedex, France
*9 Center for Nuclear Study, University of Tokyo
*10 Department of Physics, Rikkyo University