The effect of continuum coupling on elastic scattering of $^{7}Li+^{64}Ni$ and a comparison with $^{6}Li+^{64}Ni$

Md. Moin Shaikh [1*], Subinit Roy[1],

[1]Nuclear Physics Division, Saha Institute of Nuclear Physics, Kolkata -700064, INDIA

* *email: moin.shaikh@saha.ac.in*

Introduction: It was observed that $^{6}Li+^{64}Ni$ system [1] has an evidence of breakup of the projectile in the energy variation of the effective potential strengths describing the elastic scattering at energies near the barrier. This experimental observation was theoretically explained through the effect of coupling to the α+d continuum of ^{6}Li [2]. Inspired by this work we have tried to explain the previously measured angular distributions of elastic scattering of ^{7}Li (α =2.47 MeV) on ^{64}Ni target at five projectile energies from 14.3 MeV to 26.4 MeV. The measured angular distributions were analyzed with phenomenological optical model potential which gives unusual behavior of strengths of real and imaginary potential, unlike the behavior observed for heavy targets. We performed continuum discretized coupled channel (CDCC) calculation for the elastic scattering of ^{7}Li from ^{64}Ni target at incident energies of 14.3, 15, 16.3, 19.3 and 26.4 MeV. Experiment was carried out at TIFR/BARC Pelletron facility.

Analysis: A To study the breakup coupling effects for ^{7}Li, CDCC calculation have been performed using the code FRESCO, version fres-v29[3]. The ^{7}Li nucleus is considered to have a two body cluster structure of α + t with breakup threshold at 2.47 MeV and an excited bound state at 0.48 MeV. The continuum above breakup threshold was discretised into energy bins of width ΔE= 2 MeV which is suitably modified in presence of resonant states. The relative angular momentum L=0 to 3 between the clusters *α* and *t* were considered in the calculation for the continuum states. The resonant states, 3.5^{-}(ε_{rel}= 2.16 MeV) and 2.5^{-}(ε_{rel} =4.21 MeV) are present in the L=3 continuum. The effective coupling potentials were generated in the cluster folding approach using the global α and t optical potentials. The binding potential between the α+t clusters were considered to be L-dependent[4]. We used re-normalized global optical potential [5] in the calculation with re-normalization factors of N_R=0.70 and N_I =2.50. The parameters for t+ ^{64}Ni potential were taken from Ref. [6] and were kept unmodified.

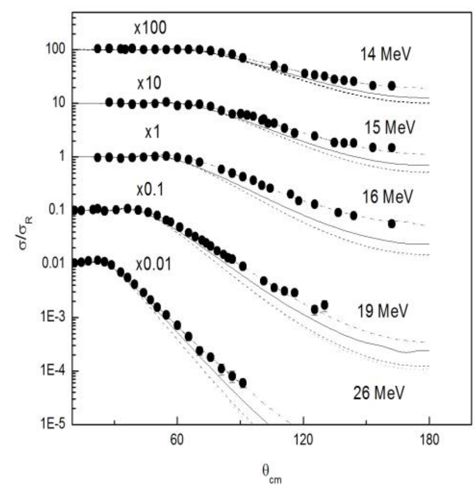

Fig. 1 Elastic angular distribution of $^{7}Li+^{64}Ni$. The dash doted curve represent the prediction of phenomenological potential. The experimental data points are represent by bullet. The solid, doted and dashed curve represents theoretical calculation with coupling between continuum, bound excited state and ground state and, coupling between bound excited state and ground state and without coupling respectively.

Results: In Fig. 1, measured angular distributions have been presented along with the phenomenological optical model fits and the CDCC predictions. It is obvious from the figure that the coupling to the α and t continuum of ^{7}Li has yielded an improved description of the data compared to the uncoupled situation. But still the model calculation with all the dominant bound, resonant and non-resonant couplings under predicts the data. Potential behaviour of $^{7}Li+^{64}Ni$ is shown in Figs. 2 and 3. The closed circles represent the values of the real and imaginary potentials, evaluated at the radius of sensitivity from the optical model fit to the data. The error bars represent the range of deviation of the potential, corresponding to distinct sets of

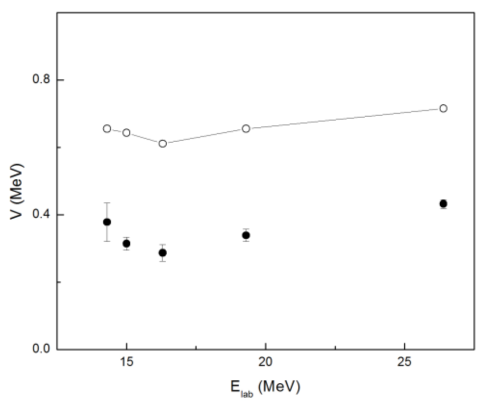

Fig. 2 Threshold behavior of real strength at average crossing radius for OMP with error and CDCC calculation (open circle) for ^{7}Li+^{64}Ni

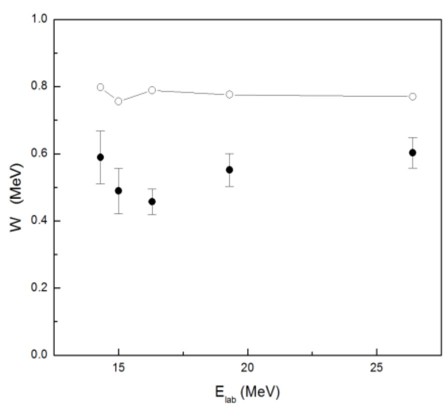

Fig. 3 Threshold behavior of real strength at average crossing radius for OMP with error(close circle) and CDCC calculation (open circle) for ^{7}Li+^{64}Ni.

parameters giving values close to $\chi^2_{min} + 1$. The open circles represent potential behaviour obtained from the CDCC calculation.

In Table 1, a comparison of the breakup cross sections from different relative angular momentum bins from CDCC calculation for ^{7}Li and ^{6}Li has been presented. Calculated breakup cross sections show that L=0 bin is the dominant contributor for ^{7}Li whereas for ^{6}Li L=0 and L=2 bins are the major contributors to breakup.

L (h/2π)	**σ (^{6}Li→α+d)(mb) Q=-1.47 MeV**	**σ (^{7}Li→α+t)(mb) Q=-2.47 MeV**
0	30.75	12.02
1	4.72	2.88
2	15.43	3.67
3	7.29	1.92

Table 1 Contribution to the α breakup cross section from cluster states with angular momentum L at 26 MeV bombarding energy.

Discussions and Conclusions :

It is observed that Breakup coupling act differently for ^{7}Li from ^{6}Li with medium mass target ^{64}Ni. The distinction is not unexpected because they have difference in the breakup threshold and structural between them. The presence bound excited for ^{7}Li may be a important parameter which is not present in ^{6}Li. We also hoping for dominance of another reaction channel like transfer to the continuum may play a major role in defining the threshold behavior of the optical potential.

Acknowledgments:

We thank Dr. S. Kailas and Dr. A. Kumar of NPD, BARC for providing us the global α+^{64}Ni optical potential values used in the present calculation. One of the author (M. M. Shaikh) acknowledges CSIR for their financial support vide File No. 09/489(0084)/2010-EMR-I.

References:

[1] M. Biswas, et al., Nucl. Phys. A 802, 67 (2008).

[2] M. M. Shaikh and S. Roy, Proceedings of the DAE Symp. on Nucl. Phys.656 56 (2011).

[3] I.J. Thompson, FRESCO (Version RES2.9), (2011).

[4] J.Tostevin, et al., Phys. Rev. C 65,024617 (2001).

[5] A. Kumar, et al., Nucl. Phys. A 776, 105 (2006).

[6] D. Y. Pang, et al., Phys. Rev. C 79, 024615 (2009).