Study of neutron transfer in ^{6,7}Li+^{124}Sn

V. V. Parkar[1,2,*] A. Parmar[3], Prasanna M.[4], V. Jha[1,2], and S. Kailas[5]
[1] *Nuclear Physics Division, Bhabha Atomic Research Centre, Mumbai - 400085, India*
[2] *Homi Bhabha National Institute, Anushaktinagar, Mumbai - 400094, India*
[3] *Sardar Vallabhbhai National Institute of Technology, Surat - 395007, India*
[4] *Department of Physics, Rani Channamma University, Belagavi - 591156, India and*
[5] *UM-DAE Centre for Excellence in Basic Sciences, Mumbai-400098, India*

Introduction

Weakly bound nuclei are characterized by dominant cluster structures and a loose binding with respect to the breakup into these clusters. Various processes such as, elastic scattering, complete and incomplete fusion, inclusive and exclusive breakup, transfer have been studied in reactions around Coulomb barrier energies using WBP [1, 2]. In particular, the stable WBPs such as, ^{6}Li, ^{7}Li and ^{9}Be on several targets have been extensively used for such measurements. Many new features have been highlighted from these studies, which were not observed with strongly bound projectiles (SBP) [2].

In the present work, we study one neutron stripping and pickup cross sections measured in ^{6,7}Li+^{124}Sn system [3, 4]. The neutron transfer reactions are important in context of explanation of copious α emission for ^{6,7}Li nuclei measured at energies around the Coulomb barrier. The neutron transfer reactions drive the processes such as breakup which provide the additional source of α production in these reactions. In addition, neutron transfer channels are expected to provide important coupling effects that may be necessary to explain the fusion behaviour for these systems at energies below the Coulomb barrier. The mechanism of both 1n stripping and 1n pickup reactions has been investigated through Coupled Reaction Channel (CRC) calculations.

*Electronic address: vparkar@barc.gov.in

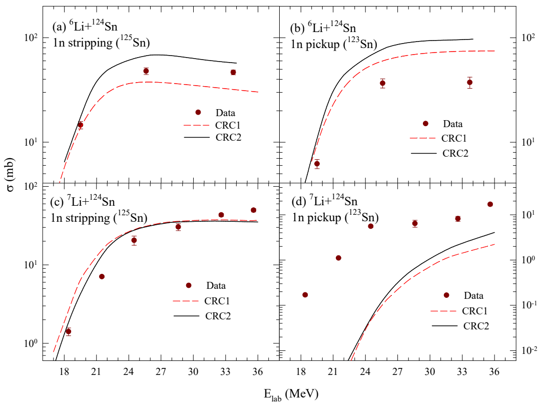

FIG. 1: 1n stripping and pickup cross sections measured in ^{6,7}Li+^{124}Sn are compared with the CRC calculations.

Coupled Reaction Channel (CRC) Calculations

Coupled Reaction Channel calculations were performed using the code FRESCO (version FRES 2.9) [5]. Both phenomenological global optical model potentials for ^{6,7,8}Li[6–8] and microscopic São Paulo potentials [9, 10] have been used. The calculations with phenomenological potentials are referred as CRC1 and those with microscopic potentials are referred as CRC2.

Apart from this, binding potentials of the fragment and core for the projectile and target partitions are required. The potentials binding the transferred particles were of Woods-Saxon volume form, with radius 1.25A$^{1/3}$ fm and diffuseness 0.65 fm, with 'A' being the mass of the core nucleus. The depths were adjusted to obtain the required binding energies of the particle-core composite system. The spectroscopic information required in projectile and target partitions is taken from available literature [11–13].

Results and Discussion

1n stripping and 1n pickup cross sections measured in ^{6,7}Li+^{124}Sn systems are shown in Fig. 1 (a-d) respectively along with the present calculations. The cross sections of both 1n stripping and 1n pickup are found to be higher in ^{6}Li as compared to ^{7}Li case. As can be seen from the figures, the calculations for 1n stripping agree with experimental data for both the ^{6,7}Li projectiles. However, for 1n pickup, the calculations overestimate the experimental data for ^{6}Li while underestimate in case of ^{7}Li. The reason for disagreement for 1n pickup case may be due to lack of information on states and their spectroscopic amplitudes for the ^{123}Sn residual nucleus. CRC1 and CRC2 calculations provide almost equivalent predictions with small deviations between them for the ^{6}Li projectile systems. In view of significant cross sections, specially for the stripping reactions, it is expected that these neutron rearrangement channels may provide alternate pathways of α production for ^{6,7}Li projectiles.

Acknowledgments

The authors V.V.P. and S.K. acknowledge the financial support from Young Scientist Research grant and Senior Scientist programme, respectively, from the Indian National Science Academy (INSA), Government of India, in carrying out these investigations.

References

[1] L. F. Canto, P. R. S. Gomes, R. Donangelo, J. Lubian, and M. S. Hussein, Phys. Rep. **596**, 1 (2015), and references therein.
[2] V. Jha, V. V. Parkar, and S. Kailas, Phys. Rep. **845**, 1 (2020), and references therein.
[3] V. V. Parkar *et al.*, Phys. Rev. **C 97**, 014607 (2018).
[4] V. V. Parkar *et al.*, Phys. Rev. **C 98**, 014601 (2018).
[5] I. J. Thompson, Comp. Phys. Rep. 7, 167 (1988).
[6] Y. Xu, Y. Han, J. Hu, H. Liang, Z. Wu, H. Guo, and C. Cai, Phys. Rev. C **98**, 024619 (2018).
[7] Y. Xu, Y. Han, J. Hu, H. Liang, Z. Wu, H. Guo, and C. Cai, Phys. Rev. C **97**, 014615 (2018).
[8] X. Su, Y. Han, H. Liang, Z. Wu, H. Guo, and C. Cai, Phys. Rev. C **95**, 054606 (2017).
[9] L. C. Chamon, D. Pereira, M. S. Hussein, M. A. Candido Ribeiro, and D. Galetti, Phys. Rev. Lett. **79**, 5218 (1997).
[10] L. C. Chamon, B. V. Carlson, L. R. Gasques, D. Pereira, C. De Conti, M. A. G. Alvarez, M. S. Hussein, M. A. Candido Ribeiro, E. S. Rossi, and C. P. Silva, Phys. Rev. C **66**, 014610 (2002).
[11] S. Cohen and D. Kurath, Nucl. Phys. A **101**, 1 (1967).
[12] C. R. Bingham and D. L. Hillis, Phys. Rev. C **8**, 729 (1973).
[13] D. G. Fleming, Can. J. Phys. **60**, 428 (1982).