# Recent evaluation activities in JCPRG

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**Abstract**

Evaluation of experimental nuclear reaction data is important and unavoidable for application. The Hokkaido University Nuclear Reaction Data Centre (JCPRG) performes evaluation on low-energy nuclear reactions of light nuclei based on cluster models. In this paper, we introduce the recent evaluation works on $^7$Li + n reaction and $\alpha + \alpha$ and $\alpha$ + n scatterings.

## 1 Introduction

Nuclear reaction data are essential for research and development in nuclear physics, astrophysics, nuclear engineering, and radiation therapy. The data obtained in different experiments are more or less different from each other though they must be the same in ideal conditions. In other words, two sets of experimental data of the same reaction cannot be identical due to statistical and systematical errors. In order to reduce such dispersions and to obtain the best estimates, the data must be theoretically evaluated and then applied in the application fields. Therefore evaluation of such data is important and unavoidable.

The Hokkaido University Nuclear Reaction Data Centre (JCPRG) started such evaluation of nuclear data as one of main tasks a few years ago. In the JCPRG, we study low-energy nuclear reactions of light nuclei based on cluster structures around the energy region of the threshold of the compound nucleus. In this paper, we introduce our recent evaluation works on $^7$Li + n reaction and $\alpha + \alpha$ and $\alpha$ + n scatterings.

## 2 Analysis of $^7$Li + n reaction using CDCC

The Li + n reactions are important not only due to fundamental research interest but also from the application point of view. Lithium isotopes will be used as a tritium-breeding material in deuterium-tritium fusion reactors. Therefore the cross sections of elastic and inelastic neutron scattering reactions on $^7$Li are evaluated by using the Continuum-Discretised Coupled Channels method (CDCC) [1]. The $^7$Li nucleus is described as the $\alpha$ + t cluster model. The complex Jeukenne-Lejeune-Mahaux effective nucleon-nucleon (JLM) interaction [2] is used for the interaction between $^7$Li and neutron within a density folding procedure. In this analysis, the elastic and inelastic cross sections for incident energies from 11.5 to 24.0 MeV could be reproduced with one normalization parameter for the imaginary part of the JLM interaction (Fig. 1) [3]. On the other hand in the

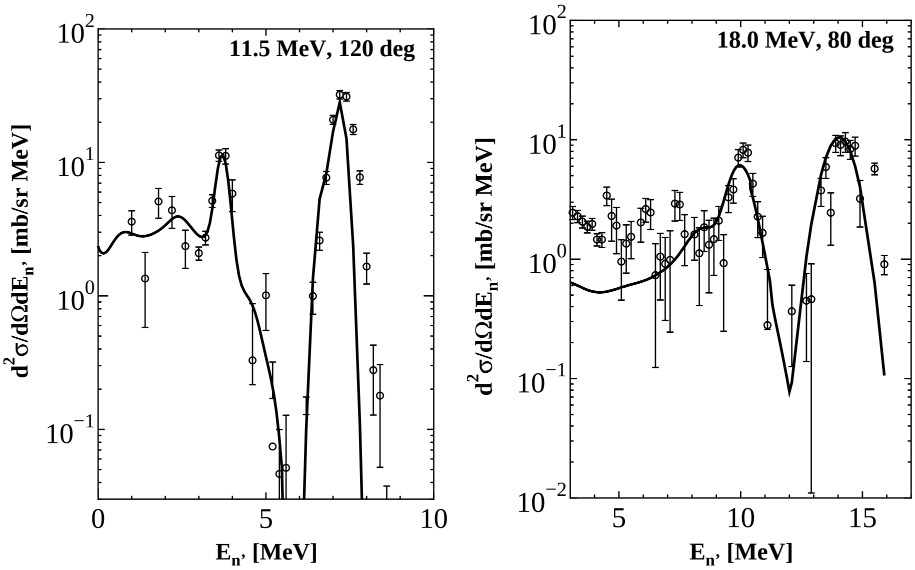


Fig. 1: Double differential cross sections of $^{7}$Li + n at $E_{\mathrm{n}} = 11.5$ and 18.0 MeV at 120 and 80 degrees, respectively. The experimental data are taken from Ref. [4].

low neutron energy region, which corresponds to high excited states of $^{7}$Li and four-body breakup channels such as 2n + d + $\alpha$, the calculated cross section underestimates the experimental data for all energies and angles.

In the previous work [5], we also showed that the CDCC with JLM gives a good reproduction for the $^{6}$Li + n reaction data. From those results, we concluded that the CDCC analysis based on the cluster model gives promising results for evaluation of nuclear data on light nuclear reactions. We are planning to develop the present approach for evaluation studies in a wider region of nuclear reactions.

## 3 Analysis of $^{8}$Be and $^{5}$He using CSOCM

The decomposition of resonance contributions in scattering phase shifts is very useful to understand the effects of associated resonance and continuum states simultaneously. In order to investigate such decomposition, the complex scaled orthogonal condition model (CSOCM) [6] was applied for the two-body scatterings, $\alpha + \alpha$ for $^{8}$Be and $\alpha$ + n for $^{5}$He.

In Fig. 2, the scattering phase shifts of the $\alpha$ + n scattering is shown [7]. The observed data are well reproduced. In Fig. 3, the decomposition of resonance and continuum contributions are shown for the $3/2^{-}$ and $1/2^{-}$ phase shifts of the $\alpha$ + n scattering. In both $3/2^{-}$ and $1/2^{-}$ phase shifts, the continuum contributions present the very similar behavior. However, the resonance contributions are different and then their cross sections show different energy distributions due to interference between resonance and continuum contributions [8].

## 4 Summary

In this paper, we introduced the recent evaluation works in the JCPRG. The evaluation using CDCC and CSOCM was performed for $^{7}$Li + n reactions and $\alpha + \alpha$ ($^{8}$Be) and $\alpha$ + n ($^{5}$He)

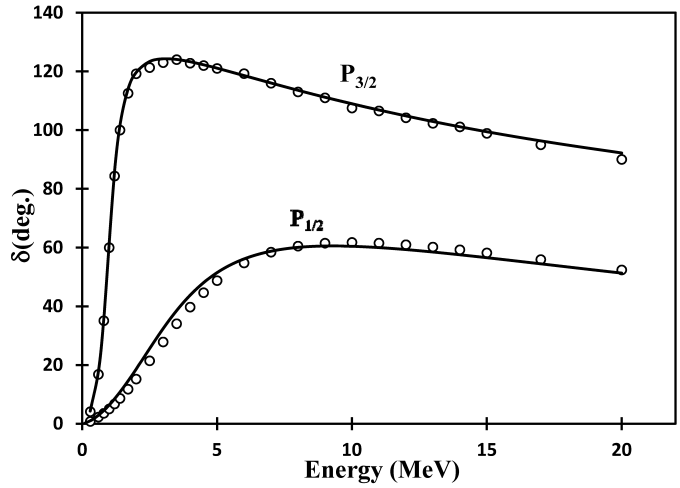


Fig. 2: The decomposition of the $p_{3/2}$ and $p_{1/2}$ scattering phase shifts (solid lines) of the $\alpha$ + n scattering. The open circles denote the experimental data [9].

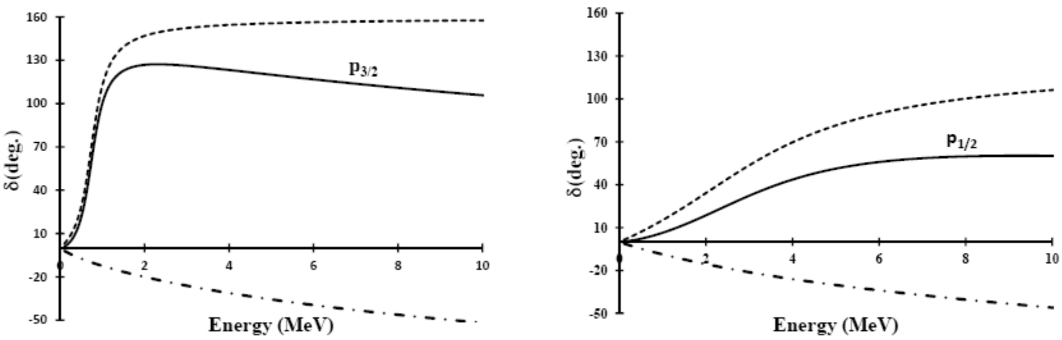


Fig. 3: The decomposition of the $p_{3/2}$ and $p_{1/2}$ scattering phase shifts (solid lines) of the $\alpha$ + n scattering. The dashed-line and dashed-doted lines present the terms of resonance and continuum, respectively.

scatterings. The results can reproduce experimental data well. We continue evaluation of nuclear reaction data for application.

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