

# PROCEEDINGS OF INTERNATIONAL CONFERENCE ON PHYSICS, MANDALAY (ICPM 2018)

Mandalay, Myanmar  
November 25-27, 2018



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INTERNATIONAL CONFERENCE ON  
PHYSICS, MANDALAY (ICPM 2018)**

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DEPARTMENT OF PHYSICS  
UNIVERSITY OF MANDALAY

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| <b>Contents</b> |                     |   | <b>Pages</b> |
|-----------------|---------------------|---|--------------|
| 1               | Yoshinori Akaishi   | Kaonic Nuclear Clusters a new paradigm<br>Of nuclear physics        | 1            |
| 2               | Kazuma Nakazawa     | Experimental Study of Double Hypernuclei                            | 8            |
| 3               | Parthapratim Biswas | Disorder by design: A swarm-intelligence approach                   | 16           |
| 4               | Kazuhiro Tanaka     | Major Accelerator Facilities<br>For Nuclear Physics In Asia Pacific | 25           |

| <b>THEORETICAL NUCLEAR PHYSICS</b> |                      |  | <b>Pages</b> |
|------------------------------------|----------------------|--|--------------|
| 1                                  | H. Kamada            | A Study of Lambda-n-n 3body resonance state<br>With recent Chiral NN potential   | 32           |
| 2                                  | Christoph Herold     | Exploring the Phase Diagram of Strongly<br>Interacting Matter  | 37           |
| 3                                  | Khin Swe Myint       | Theoretical Interpretation of the Nature of the<br>Observable $\Lambda(1450)$ Resonance                                      | 41           |
| 4                                  | Htun Htun Oo         | The $\alpha$ - $\Lambda$ folding potential   | 45           |
| 5                                  | Theingi              | Resonant States of Some Light Nuclei<br>in Alpha Nucleus Cluster Model with<br>Complex Scaling Method                        | 50           |
| 6                                  | Thida Wint           | Nucleon-Nucleus and Nucleus-Nucleus Scattering<br>in Eikonal Approximation and Higher<br>Order Corrections                   | 55           |
| 7                                  | Khin Mar Win         | Three $\Lambda^*$ Clusters as a Door way of Dark<br>Matter Candidate   | 60           |
| 8                                  | Aye Aye Min          | Production of ${}_{\Lambda\Lambda}^5H$ by Stopping $\Xi^-$ on ${}^7Li$<br>Target   | 65           |
| 9                                  | Mar Mar Htay         | Momentum Distribution of Decay Products<br>of $K^-$ ppn  | 70           |
| 10                                 | San San Mon          | Investigation of ${}_{\Lambda}^7He$ with Three-Body<br>t-t- $\Lambda$ Model  | 75           |
| 11                                 | Ei Shwe Zin<br>Thein | Evaluation of the Maximum Astrophysical<br>S Factor in Heavy-Ion Fusion Reactions by<br>Two Potentials Fitting Method        | 80           |
| 12                                 | Shwe Sin Oo          | The Effects of Relativistic Kinematics and<br>Retardation in Meson Mass Spectra  | 85           |
| 13                                 | Sandar Myint Oo      | $\Lambda N$ - $\Sigma N$ Coupling Effect in ${}_{\Lambda}^4H$ Hypernucleus   | 89           |
| 14                                 | Aye Thandar Htay     | One body Limit of Covariant Three-<br>Dimensional Equations  | 94           |
| 15                                 | Hla Hla Win          | $\Lambda\Lambda$ - $\Xi N$ Coupling Effect on $\Lambda$ - $\Lambda$ Interaction Energy<br>in ${}_{\Lambda\Lambda}^5H$ System | 98           |
| 16                                 | Cho Cho Win          | Comparison of the Radial Integrals of<br>Variational Wave Function for<br>a Two-electron System                              | 103          |

|    |                          | <b>Pages</b>  |     |
|----|--------------------------|---|-----|
| 6  | Moh Moh Kyi<br>Naing     | Study on ${}^5_{\Lambda}He^*$ with Three-body $\Lambda + t + p$ ,<br>$\Lambda + h + n$ and $\Lambda + d + d$ Models   | 485 |
| 7  | Nang Ei Ei Nyein         | Nuclear Shell Structure of ${}^{208}Pb$   | 487 |
| 8  | Nay Wah Aung             | Binding Mechanism of ${}^{208}_{\Xi}Pb$   | 489 |
| 9  | Shwe Zin Nyein           | $\Sigma^-$ Single-Particle Energy Levels in ${}^{40}_{\Sigma}Ar$  | 491 |
| 10 | Thae Thae Mar            | Analysis of $\Lambda$ (1405) Photo production Reaction<br>$\gamma p \rightarrow K^+(\pi\Sigma)^0$   | 493 |
| 11 | Thin Kyu                 | Theoretical Investigation on<br>${}^{12}C(K^-, p) {}^{11}_{K^-}Be$ Reaction   | 495 |
| 12 | Thu Thu Soe              | Theoretical Analysis on<br>$(\pi^{\pm}, K^+), (\gamma, K^+), (K^-, K^+), (K^-, \pi^-)$<br>Hyperon Production Reactions and<br>${}^{\Lambda}_Z X(K^-, \pi^-) {}^{\Lambda}_X$ Hypernuclear Production<br>Reaction | 497 |
| 13 | Ya Min Htet              | $\Lambda$ -Single Particle Energy Levels in ${}^{139}_{\Lambda}La$  | 499 |
| 14 | Zin Mar Htay             | Relation between Effective $\Lambda$ - $\Lambda$ Interaction<br>In Double- $\Lambda$ Hypernuclei and Hyperon<br>Superfluidity in Neutron Stars  | 501 |
| 15 | Hnin Nu Aye              | Determination of $\Lambda(1450)$ Quasi-Bound<br>State with Complex Rotation Method  | 503 |
| 16 | San Win                  | Investigation of Natural Radioactivity from<br>Small Scale Gold Mining Sites in Pinlebu<br>Township, Sagaing Region   | 505 |
| 17 | Shin Thant Lwan<br>Maung | Analysis on Gamma Spectraby NaI (TI)<br>Detector  | 507 |
| 18 | Myint Myint Win          | Synthesis and Characterization of Copper<br>Substituted Nickel Ferrite Nanoparticles by<br>Self-combustion Method   | 509 |
| 19 | Thazin Hlaing            | Study on the Structural Properties of ZnO<br>Thin Layer Annealed at Different<br>Temperature  | 511 |
| 20 | Win Naing Min            | Thrmoelectric Properties of Copper<br>Sulfide Nanoparticulate Films   | 513 |
| 21 | Win Myint Oo             | Electrochromic Properties of Molybdenum<br>Trioxide Films in Different Ionic Salt<br>Solution   | 515 |
| 22 | Myint Myint Maw          | Generating of a Sine Wave Using PWM<br>Technique  | 517 |
| 23 | Shwe Yi Phy              | IR Monitoring System for AC Panel<br>Controller   | 519 |

# Theoretical Investigation on $^{12}\text{C}(\text{K}^-, \text{p})_{\text{K}^-}^{11}\text{Be}$ Reaction

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## Abstract

The purpose of our research is to conduct theoretical study on production reaction  $^{12}\text{C}(\text{K}^-, \text{p})_{\text{K}^-}^{11}\text{Be}$  which populates kaonic nuclei  $^{11}\text{Be}_{\text{K}^-}$ . The KEK- E 548 and J-PARC E05 Experiments motivate us to perform our present theoretical work on kaonic nuclear study. Therefore we investigated the missing mass spectrum for the reaction  $^{12}\text{C}(\text{K}^-, \text{p})_{\text{K}^-}^{11}\text{Be}$  by using Green's function method. The missing mass spectrum were derived from the momentum of proton 1.0 GeV/c and 1.8 GeV/c. Our results are compared with the results of above two experimental results.

**Key words:** missing mass spectrum, Green's function method,  $^{11}\text{Be}_{\text{K}^-}$ .

## 1. Introduction

Kaonic nuclei are nuclei in which an antikaon is bound to ordinary nucleus by the strong interaction.  $\bar{\text{K}}\text{N}$  interaction is very strong that antikaon forms the dense state in the nucleus. Many studies of deeply bound kaonic nuclear state have been performed both theoretically and experimentally. In the KEK- E 548 Experiment [1] they studied the in- flight  $^{12}\text{C}(\text{K}^-, \text{N})$  reaction which produced kaonic nuclei  $^{11}\text{Be}_{\text{K}^-}$  and  $^{11}\text{B}_{\text{K}^-}$ . Recently, the J-PARC E05 [2] Experiment was performed with  $^{12}\text{C}(\text{K}^-, \text{p})$  reaction. The observed missing mass spectrum shows the significant yield in energy region  $-150 \leq \text{BE} \leq 100$  same as KEK-E548. Kishimoto et al., [3] studied the K-nucleus interaction by fitting the missing mass spectra  $^{12}\text{C}(\text{K}^-, \text{N})$  reaction obtained from E548 experiment. It is found that a potential depth of approximately -190MeV best reproduces the spectrum of the  $^{12}\text{C}(\text{K}^-, \text{n})$  reaction and approximately -160MeV best reproduces that of the  $^{12}\text{C}(\text{K}^-, \text{p})$  reaction. Their data clearly indicates that the  $\text{K}^-$  nucleus potential is strong with about -200 MeV depth. In our research work, we are going to conduct theoretical investigation into experimental spectra of both experiments E548 and E05.

## 2. Mathematical Formulations

We have analyzed KEK-E548 and J-PARC E05 missing mass spectra by using Green's function method for  $^{12}\text{C}(\text{K}^-, \text{p})_{\text{K}^-}^{11}\text{Be}$  reaction. The spectral function  $S(E)$  is given by

$$S(E) = \left( -\frac{1}{\pi} \right) \text{Im} \int d\vec{r} d\vec{r}' f^*(\vec{r}') \langle \vec{r}' | \frac{1}{E - H_{\text{K}^- \text{C}} + i\epsilon} | \vec{r} \rangle f(\vec{r}) \quad (1)$$

The differential cross section for missing mass spectrum of the reaction is given by

$$\frac{d^3\sigma}{dE_1 d^2\Omega} = \frac{(2\pi)^4}{2\hbar^2 c^2} \frac{E_1 k_1}{2k_0} |\langle t \rangle|^2 \frac{2\mu c^2}{\hbar^2 c^2} \left(-\frac{1}{\pi}\right) \text{Im} \left[ \sum_{\ell=0}^{\infty} (2\ell+1) \int dr dr' j_{\ell}^*(Qr') U^*(r') \right] \times \frac{u_{\ell}^0(r_{<}) u_{\ell}^+(r_{>})}{w(u_{\ell}^0, u_{\ell}^+)} j_{\ell}(Qr) U(r) \quad (2)$$

### 3. Results and Discussion

We studied theoretical analysis of the missing mass spectrum from  $^{12}\text{C}(\text{K}^-, p)_{\text{K}^-}^{11}\text{Be}$  reaction of a recent KEK- E548 and J-PARC E05 experiment. In our reaction model, the incident particle  $\text{K}^-$  is knock out the proton in the target  $^{12}\text{C}$  to form  $_{\text{K}^-}^{11}\text{Be}$  nuclide. The momentum of the incident  $\text{K}^-$  is  $1.8\text{GeV}/c$  and  $1.0\text{GeV}/c$ .

We have calculated the spectral function  $S(E)$  by employing Wood-Saxon potential  $U_{\text{opt}}(r) = \frac{V_0 + iW_0}{1 + e^{\frac{r-R}{a}}}$ , where,  $V_0 = -169\text{ MeV}$  and  $W_0 = -40\text{ MeV}$ .

We calculated the differential cross section of  $^{12}\text{C}(\text{K}^-, p)_{\text{K}^-}^{11}\text{Be}$  reaction for incident momentum  $1.8\text{GeV}/c$  and  $1.0\text{GeV}/c$  with angles  $\theta = 0, 10, 20$  and they are shown in figure 1. (a) and (b). We found that the bound states region is between  $0\text{ MeV}$  and  $100\text{ MeV}$  for scattered angle  $0$  degree and  $10$  degree but no bound state at  $20$  degree. It is observed that differential cross section is largest at binding energy of the  $_{\text{K}^-}^{11}\text{Be}$   $41.8\text{ MeV}$  for  $1.8\text{GeV}/c$  and  $1.0\text{GeV}/c$ .

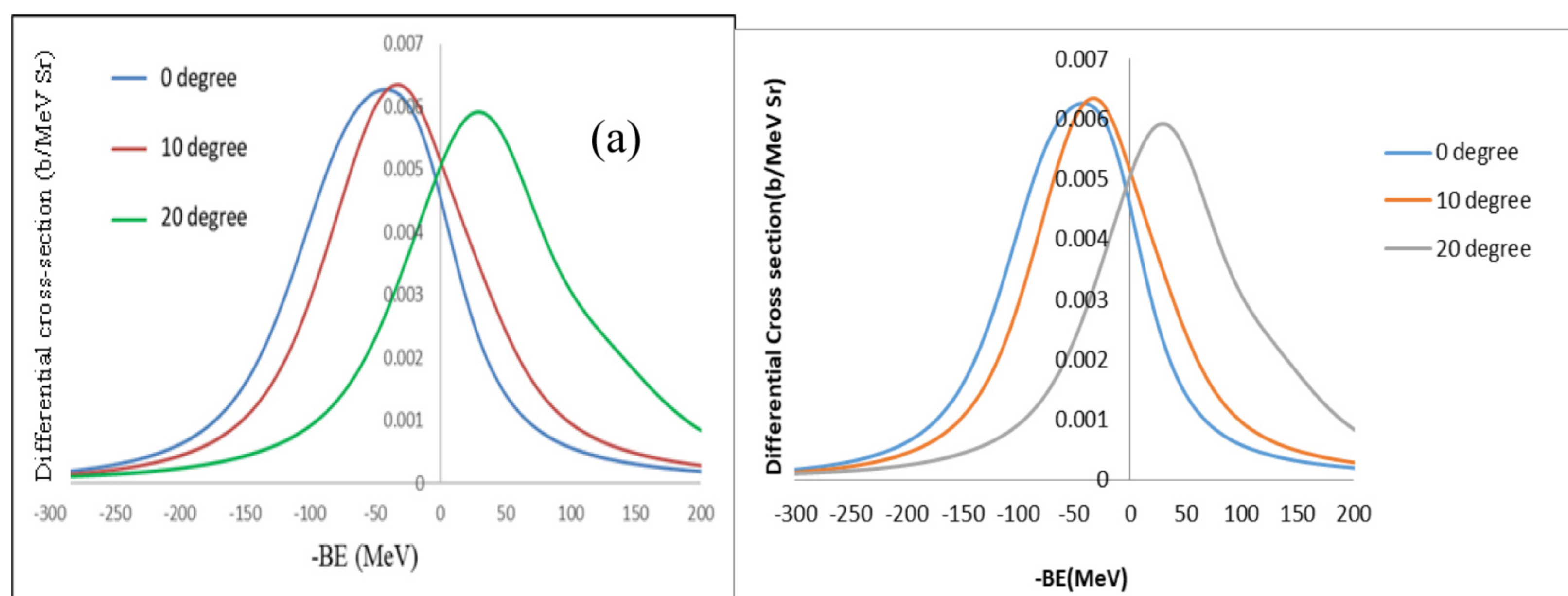


Fig.1(a) Differential cross section at various angles for incident momentum  $1.8\text{GeV}/c$

(b) Differential cross section at various angles for incident momentum  $1.0\text{ GeV}/c$ .

### Acknowledgements

We would like to thank ICPM2018 organization committee giving a chance to present our research work.

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