



3rd Almaty
International
Workshop



Nuclear Physics & Astrophysics Book of Abstracts

14-16 April, 2016

al-Farabi KazNU

Program and abstracts

**The 3rd International Workshop
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14-16 April, 2016
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process of scattering of ^{13}C ions on ^{12}C nuclei at energies close to the Coulomb barrier”

16:40 – 17:00 Daniyar Janseitov, N. Burtebayev, et al; “Elastic scattering of ^3He ions from ^{13}C nuclei in optical and folding models”

Program of III International Workshop “Nuclear Physics and Astrophysics”

Date: 15 April

Time table	Section 5. Astrophysics
09:00 – 09:30	<u>Ernazar Abdikamalov</u> , (Nazarbayev University); “Probing Core-Collapse Supernova Central Engine with Gravitational Waves”
09:30 – 10:00	Daniele Malafarina, (Nazarbayev University); “Bounces and exotic compact objects from gravitational collapse; Analytical insights into the strong field regime”
10:00 – 10:10	N. Burtebayev ¹ , Y. Mukhamejanov ¹ “Elastic and inelastic $^{11}\text{B}+d$ scattering”
10:10 – 10:20	N. Burtebayev ¹ , N.V. Glushchenko “Analysis of elastic and inelastic scattering of ^3He ions on ^9Be nuclei at energy 60 MeV”
10:20 – 11:00	Coffee-break
	Section 6. Nuclear Physics (Theory)
11:00 – 11:30	<u>P. Krasovitsky</u> , F. Pen'kov (INP); “Phase shifts of molecular resonance transparency”
11:30 – 11:50	Zhusupov M.A., Ibraeva E.T., <u>Kabatayeva R.S.</u> ; “Inelastic Proton Scattering on the Ground and Excited States of ^9Be Nucleus in the Framework of the Diffraction Multiple Scattering Theory”
11:50 – 12:20	M. Abishev (al-Farabi KazNU); “On cyclic reactions under thermal neutrons flux”
12:20 – 13:40	Break for Lunch
	Section 7. Physics and Astropysics
13:40 – 14:00	V.N.Melnikov (Russia, MSU, RUDN) to be announced

Inelastic Proton Scattering on the Ground and Excited States of ${}^9\text{Be}$ Nucleus in the Framework of the Diffraction Multiple Scattering Theory

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Be^9 is a stable light nucleus, it is strongly deformed and weakly-bound in the cluster channels. The binding energy is anomalous low in three-particle $\alpha + \alpha + n$ - channel ($\varepsilon = 1.57$ MeV) and two-particle $n + \text{Be}^8$ - and $\alpha + \text{He}^5$ - channels ($\varepsilon = 1.67$ MeV and $\varepsilon = 2.47$ MeV respectively), but in two-particle $\text{Li}^8 + p$ - channel its binding energy is too high and equals $\varepsilon = 16.9$ MeV. In the ground $3/2^-$ state of this nucleus the mean-square radius equals 2.44 fm, and there is no halo structure in the ground state. But in the excited $1/2^+$ and $3/2^+$ states one observes exotic structures such as halo since their mean-square radii equals to 2.83 fm and 2.976 fm respectively and it seems that when exciting the nucleus increases in size and gains the halo structure.

Elastic and inelastic (for the $J^\pi = 1/2^+$ level) differential cross sections in the framework of the Glauber theory were calculated by the authors at $E = 180$ and 220 MeV and compared to the experimental data. The goal of the present study is a calculation of the differential cross section of the inelastic scattering of protons with energy of 180 MeV to the excited $J^\pi = 3/2^+$ and $5/2^-$ states of the ${}^9\text{Be}$ nucleus in the framework of the Glauber theory and a comparison with the results obtained in other formalisms.

The Matrix Element of Scattering in the Glauber theory is defined by the formula

$$M_{if}(\mathbf{q}) = \sum_{M_i, M_f} \frac{ik}{2\pi} \int d^2\rho \exp(i\mathbf{q}\rho) \delta(\mathbf{R}_A) \langle \Psi_f^{JM_f} | \Omega | \Psi_i^{JM_i} \rangle$$

where ρ - is an impact parameter, which is a two-dimensional vector in the Glauber theory, \mathbf{R}_A - is a coordinate of the target nucleus mass center, Ψ - initial and final states wave functions of the target nucleus, k - are incoming and outgoing momenta of the proton, \mathbf{q} - is a momentum transfer in the reaction, Ω - is the Glauber multiple scattering operator.

Differential cross sections of the inelastic $p^9\text{Be}$ -scattering for the $J^\pi = 3/2^+$, $5/2^-$ levels at proton energies of 180 MeV are calculated and compared with the experimental data and with the calculation in the distorted waves method. The differential cross sections calculated in the framework of the Glauber multiple scattering theory agree with the available experimental data in the range of the forward angles for the $J^\pi = 3/2^+$ level and do not agree for the $J^\pi = 5/2^-$ level. Note that the Glauber theory has essential restrictions for energy and angle range of the particles scattered. Since the incident particles energy is not too large, then the results are reliable for forward scattering angles only. The calculation at large angles is beyond the Glauber theory accuracy.

The analysis of the profiles of the wave functions in $2\alpha n$ -models showed that in the excited $J^\pi = 3/2^+$, $5/2^-$ states the nucleus has different structures: diffuse with extended asymptotic (with long tail) in the $J^\pi = 3/2^+$ state and compact with short asymptotic in the $J^\pi = 5/2^-$ state. The calculation of the mean-square radii confirms this conclusion: 2.976 fm for the $J^\pi = 3/2^+$ state and 2.13 fm for the $J^\pi = 5/2^-$ state.

The analysis of the wave functions allowed one to connect them with the behavior of the cross sections and show the influence of the contribution of the wave functions different parts on the differential cross sections.