Study of interaction mechanisms of alpha particles with 11B nuclei at low energies

N. Burtebayev1, Sh. Hamada2, Y. Mukhamejanov3, M. Nassurlla3, A. Morzabayev4,

S. Sakhiyev4, W.Trzaska5, A.Demyanova6, A. Ogloblin6, S.B. Sakuta, S.V. Artemov7

1 Institute of Nuclear Physics, Almaty, Kazakhstan

2 Faculty of Science, Tanta University, Tanta, Egypt

3 Al-Farabi Kazakh National University, Almaty, Kazakhstan

4 Eurasia National University, Astana, Kazakhstan

5University of Jyväskylä, Jyväskylä, Finland

6NRC Kurchatov Institute, Moscow, Russia

7Institute of Nuclear Physics, Tashkent, Uzbekistan

Email: nburtebayev@yandex.ru

Experimental angular distributions of alpha particles scattered from 11B nuclei were measured with extracted beam of isochronous cyclotron U-150M of Institute of nuclear physics (INP, Almaty, Kazakhstan) at energies E=29, 40, 50 MeV.

Thin metallic foils made of boron-11 isotope were used as targets. Target thickness was determined at INP UKP-2-1 linear accelerator. For this purpose 27Al(p,γ)28S reaction yield curves in the region of Ер =992 keV resonance [1] were measured using aluminum foil and sputtered target. The shift of the resonance in 27Al(p,γ)28S reaction, caused by the protons energy loss as passing through boron film, was 62,2 keV that corresponds to target thickness of 320 µg/cm2 (Figure 1). This method allowed determining the target thickness with an uncertainty not worse than 5%.

Nuclear reactions products were registered and identified using standard ΔE-E method realized on the basis of PC/AT personal computer. ORTEC silicon semiconductor detectors were employed as counters. Angular distributions of differential cross sections of registered alpha particles were measured in angular range of θlab=100-1700 with an increment 10-20 for the forward hemisphere and 30-50 for backward hemisphere. The registration system solid angle was 4,22∙10-5 steradian. The detector energy resolution at small angles was within (290) keV, at large angles it was within (350) keV, and was mainly due to cyclotron beam energy spread and target thickness.

Figure 1 – Energy spectrum of alpha particles scattered from 11B measured at INP U-150M accelerator at E=29 MeV.

The experimental data on alpha particles elastic and inelastic scattering leading to 4,445 MeV (5/2-) and 6,743 MeV (7/2-) states were analyzed within the framework of coupled channels method (Figure 2). The analysis was made with the employment of experimental data on α+11B scattering at Eα=40 and 50 MeV [2] in order to obtain reliable optical potential parameters. We obtained β2 and β4 deformation parameters which are in good agreement with literature data.



Figure 2 – Differential cross sections of elastic and inelastic scattering α+11B at Eα=29 MeV leading to 4,445 MeV (5/2-) and 6,743 MeV (7/2-) states (points) and theoretical calculations using coupled channels methods (curves).

Poor agreement of theoretical calculations for 6,743 MeV (7/2-) is probably due to necessity of more accurate determination of higher order deformation parameters

The results of current work will be used in future works for describing further excitation levels e.g. 8.56 MeV (3/2-) which according to predictions may have enhanced radius.

References:

1. Bulter J,W, Table of (p,γ) resonances by proton energy: E = 0,163 – 3,0 MeV, // U.S. Naval Research Laboratory, NRL Report, – 1959, – P, 5282-5299

2. N.Burtebaev, M.K.Baktybaev, B.A.Duisebaev, R.J.Peterson, S.B.Sakuta, Scattering of α particles on B-11 nuclei at energies 40 and 50 MeV.// Physics of Atomic Nuclei, - 2005, Vol.68, p.1303