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# Elastic and inelastic scattering of $^{14}$N ions by $^{11}$B at 88 MeV versus that of $^{15}$N + $^{11}$B at 84 MeV

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**Abstract**

Full angular distributions for $^{11}$B + $^{14}$N elastic and inelastic scattering were measured at $E_{\rm lab}(^{14}{\rm N}) =$ 88 MeV ($E_{\rm c.m.} = 38.7$ MeV). The data were analyzed within the optical model and coupled-reaction-channels method which included the reorientations of $^{11}$B and $^{14}$N as well as the more important one- and two-step transfer reactions. The $^{11}$B + $^{14}$N optical potential parameters as well as deformation parameters of these nuclei were deduced. The $^{11}$B + $^{14}$N potential and data were compared with those of previously reported $^{11}$B + $^{15}$N data to explore isotopic differences in the scattering process. As has been

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shown in other cases of $^{11}$B scattering, the enhanced large-angle elastic and inelastic scattering data mostly arise from the ground-state reorientation of $^{11}$B.


*Keywords:* Nuclear Reactions $^{11}$B($^{14}$N, $^{14}$N), $E = 88$ MeV; measured particle spectra, $\sigma(\theta)$; deduced reaction mechanism features and Woods–Saxon potential parameters of the $^{11}$B + $^{14}$N potential using coupled-reaction-channels analysis

## 1. Introduction

Large angle elastic and inelastic scattering between light heavy-ion partners has been found experimentally to depend on the structure of the interacting nuclei. For example, while $^{11}$B + $^{12}$C shows an enhancement above that expected from pure potential scattering, it is even larger than can be generated by any coupled channels process that does not include the possibility of proton exchange between the target and projectile. In the case of $^{11}$B + $^{14}$C scattering the large angle cross section is more than a factor of two less, and is produced by a combination of potential scattering and reorientation of $^{11}$B [1]. A recent work reporting the results of $^{11}$B + $^{15}$N scattering carried out to explore the possibility of alpha particle exchange between these two nuclei demonstrated that again the large angle scattering was generated by a combination of contributions from potential scattering and reorientation of $^{11}$B with very little contribution from alpha particle exchange [2]. The present work reports the results of the scattering of $^{11}$B + $^{14}$N to explore further the systematics of the scattering between members of an isotopic chain. Since the contributions to the scattering from these isotopic affects show up primarily at large angles, this study was conducted in inverse kinematics by bombarding a $^{11}$B target with a $^{14}$N beam and then detecting both the projectile and recoil nuclei thus allowing the forward and large angles to be measured simultaneously.

In the present work, new data for the elastic and inelastic scattering of $^{14}$N ions by $^{11}$B at the energy $E_{\rm lab}(^{14}\rm N) = 88$ MeV ($E_{\rm c.m.} = 38.7$ MeV) are reported. These new data along with those previously published at the energies $E_{\rm lab}(^{14}\rm N) = 41$ MeV ($E_{\rm c.m.} = 18$ MeV), 77 MeV ($E_{\rm c.m.} = 33.9$ MeV), and 113 MeV ($E_{\rm c.m.} = 49.7$ MeV) [3] taken at forward angles, were analyzed with the optical model (OM) and coupled-reaction-channels (CRC) techniques. The $^{14}$N + $^{11}$B elastic and inelastic scattering channels, spin reorientation of $^{11}$B, $^{14}$N and most important transfer reactions were included in the coupled-channels scheme.

The paper is organized as follows. Section 2 contains a brief summary of the experimental procedure, Section 3 gives the results of the CRC calculations for describing the data and the last section provides a summary of results.

## 2. Experimental procedure

Angular distributions of the elastic and inelastic scattering of the $^{14}$N ions by $^{11}$B were measured simultaneously with the $^{11}$B($^{14}$N, $X$) transfer reactions, using the 88 MeV beam of $^{14}$N from the Warsaw University cyclotron U-200P. The details of the experimental set up and data taking system are described in Ref. [2].

The reaction products were detected by four silicon $\Delta E$–$E$-telescopes with 40 µm silicon $\Delta E$-detectors and 300 µm silicon $E$-detectors.