Elastic scattering and total reaction cross section for the $^{6}He+^{58}Ni$ system

Cite as: AIP Conference Proceedings **1625**, 184 (2014); https://doi.org/10.1063/1.4901790
Published Online: 17 February 2015

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Elastic Scattering and Total Reaction Cross section for the $^{6}He+^{58}Ni$ system

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Abstract. Elastic scattering measurements of ^{6}He +^{58}Ni system have been performed at the laboratory energy of 21.7 MeV. The ^{6}He secondary beam was produced by a transfer reaction ^{9}Be (^{7}Li, ^{6}He) and impinged on ^{58}Ni and ^{197}Au targets, using the Radioactive Ion Beam (RIB) facility, RIBRAS, installed in the Pelletron Laboratory of the Institute of Physics of the University of São Paulo, Brazil. The elastic angular distribution was obtained in the angular range from 15^0 to 80^0 in the center of mass frame. Optical model calculations have been performed using a hybrid potential to fit the experimental data. The total reaction cross section was derived.

Keywords: Elastic Scattering, radioactive nuclei, reaction cross section.
PACS: 25.60.Bx, **25.60.Dz, 25.70.Bc**

INTRODUCTION

The availability of low energy secondary beams of exotic beams such as ^{6}He, ^{11}Be, ^{11}Li and others, allows the study of their properties such as the nuclear halo, the cluster structure and their low binding energies and how those characteristics would affect the reactions induced by those nuclei [1].

The possibility of performing scattering experiments with exotic projectiles is a powerful tool to determine the nuclear matter radius distribution, information of the nuclear force, and to study the effect of the low binding energy on the reaction mechanisms [2]. The scattering of halo nucleus on medium mass targets have been one of the major topic interests, especially for ^{6}He. This nucleus exhibits two valence neutrons and an alpha particle core in its structure and is an example of a three-body system. Due its nature, ^{6}He can be easily deformed in collisions, which increases the neutron transfers and breakup probabilities even at energies around the coulomb barrier.

Recent works have been demonstrated that there is an enhancement of the total reaction cross sections for weakly bound and unstable systems such as $^{7,9}Be+^{27}Al$

XXXVI Brazilian Workshop on Nuclear Physics
AIP Conf. Proc. 1625, 184-186 (2014); doi: 10.1063/1.4901790

^{6}Li,^{7}Be+^{58}Ni, ^{6}He+^{64}Zn, ^{6}He+^{120}Sn, ^{7}Be,^{6}Li+ ^{12}C when compared with tightly stable projectiles such as ^{4}He or ^{16}O [1-8].

The ^{6}He is a radioactive nucleus that has a small breakup threshold energy of S_n= 0.973 MeV (into ^{4}He+2n) and is particularly interesting since its core could explain the alpha particle production observed in the scattering of ^{6}He on heavy targets such as ^{120}Sn [9]. Moreover an energy dependence on the surface imaginary optical potential part has been observed, which indicates that, as the energy decreases, the reactions become more peripheral for the ^{6}He+^{120}Sn [10].

New elastic scattering angular distribution for the ^{6}He+^{58}Ni system are presented in the present work. An optical model analysis has been performed, in order to search for fingerprints of the small binding energy of the ^{6}He on the total reaction cross section.

EXPERIMENT DESCRIPTION

The measurements have been performed in the RIBRAS system (*Radioactive Ion Beams in Brasil*) at the São Paulo 8UD Pelletron accelerator [11,12]. The ^{6}He secondary beam was produced using a primary target of ^{9}Be (12 μm), by the ^{9}Be(^{7}Li,^{6}He)^{10}B production reaction. The ^{6}He beam was selected and focused by the first solenoid of the RIBRAS system. Secondary targets of ^{58}Ni (2.0 mg/cm^2) and ^{197}Au (4.5 mg/cm^2) were used in this experiment. The ^{197}Au target was used for normalization purposes. The detection system consisted of 4 silicon telescopes ΔE-E (20-1000 μm).

A two-dimensional spectrum is presented at the Figure 1 and as can be seen the elastic ^{6}He peak is clearly separated from the contaminants, alpha particles and ^{7}Li(2+). The laboratory energy was E_{lab}= 21.7 MeV and refers to the energy in the middle of the secondary target.

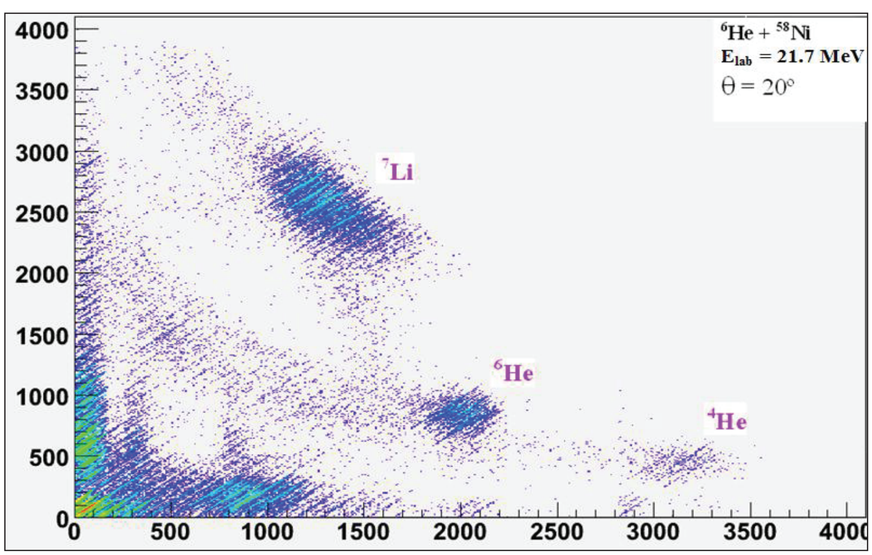

Figure 1– A two-dimensional ΔE-E spectrum obtained at 21.7 MeV. The axis are in channels.

ANALYSIS AND RESULTS

In Figure 2 we present the $^{6}He+^{58}Ni$ experimental angular distribution and an optical model calculation (dashed line). The double folding São Paulo Potential [13] with a normalization was used as the real part of the optical potential. The imaginary part has been taken as a volume Woods- Saxon (WS) form factor. The real part normalization and the imaginary depth have been adjusted to fit the data. A χ^2 analysis was performed and the imaginary geometry was kept fixed with r_0 =1.25 fm and a=0.85 fm.

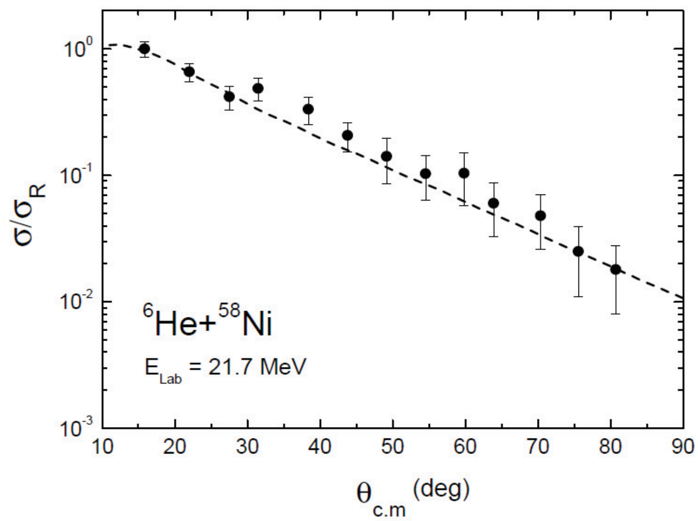

Figure 2– $^{6}He+^{58}Ni$ elastic angular distribution (see text for details).

The total reaction cross section obtained from this analysis was 2203 mb, which indicates an enhancement in comparison with stable systems.

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