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Analysis with Proximity Potentials of ^{8}Li Elastic Scattering by ^{9}Be, ^{12}C, ^{13}C, ^{14}N, ^{27}Al, ^{51}V, ^{58}Ni and ^{208}Pb

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Abstract: In the present study, we show a new and comprehensive analysis of the elastic scattering cross sections of ^{8}Li by ^{9}Be, ^{12}C, ^{13}C, ^{14}N, ^{27}Al, ^{51}V, ^{58}Ni and ^{208}Pb target nuclei. For the first-time, the real potential based on the optical model is obtained by using proximity potentials which consist of Broglia and Winther 1991 (BW 91), Aage Winther (AW 95), Bass 1973 (Bass 73), Bass 1977 (Bass 77), Bass 1980 (Bass 80), Christensen and Winther 1976 (CW 76), Ngô 1980 (Ngo 80), Proximity 1977 (Prox 77), Proximity 1988 (Prox 88) and Siwek-Wilczynski-Wilczynska (SWW). The theoretical results are compared both experimental data and with each other. The similarities and differences of the potentials investigated are discussed and alternative potentials are put forward.

Keywords: Nuclear potential, proximity potential, optical model

1 Introduction

The choice of the nuclear potential is very important in defining the interaction of the two nuclei. So, depending on the structure of this potential, the reaction observations may change. For example, in the sufficiently high absorption of heavy-ion scattering reactions, the tail part of the optical potential is directly related and the inside of the potential does not play an important role [1]. In this manner, different nuclear potentials such as Woods-Saxon, Woods-Saxon Squared, Yukawa, Gauss, Double Folding etc. have been proposed and investigated by using various theoretical approaches [2,3,4,5,6,7]. They have given agreement results with the experiment data for some nuclear reactions, but there are still deficiencies for the general. Moreover, due to the excess of parameters of the applied potentials and the ambiguity of these parameters, investigation of nuclear potentials is still one of the hottest topics of nuclear physics. Thus, the introduction of alternative potentials will be both useful and important in the analysis of nucleus-nucleus interactions.

^{8}Li as a radioactive nucleus is an important nucleus in the field of nuclear physics. ^{8}Li is generated in the radiative-capture reaction [8] and presents a neutron-rich structure. ^{8}Li has been studied widely both experimentally and theoretically. In this respect, Aygun [9] has tried to obtain a global potential set for the reactions with ^{8}Li nucleus by using the double folding model. Although the theoretical results are compatible with the experimental data, they are clear to develop. Thus, achieving consistent results with the experimental data using alternative potentials will be important in explaining nuclear interactions with ^{8}Li.

In the present study, our aim is to introduce alternative potentials in explaining ^{8}Li-nucleus interactions. For this purpose, we investigate ten various nuclear potentials such as Broglia and Winther 1991 (BW 91) [10], Aage Winther (AW 95) [11], Bass 1973 (Bass 73) [12,13], Bass 1977 (Bass 77) [14], Bass 1980 (Bass 80) [10], Christensen and Winther 1976 (CW 76) [15], Ngô 1980 (Ngo 80) [16], Proximity 1977 (Prox 77) [17], Proximity 1988 (Prox 88) [17] and Siwek-Wilczynski-Wilczynska (SWW) [18,19]. These potentials are evaluated in the analysis of the elastic scattering cross sections from ^{9}Be, ^{12}C, ^{13}C, ^{14}N, ^{27}Al, ^{51}V, ^{58}Ni and ^{208}Pb target nuclei of ^{8}Li which is an important nucleus for both nuclear physics and astrophysics. For the first-time, a simultaneous and comprehensive analysis of these potentials is carried out for the ^{8}Li-nucleus interactions.

A summary of nuclear potentials and theoretical process is given in next section. Section 3 provides the results and discussion. Finally, section 4 presents the summary and conclusions.

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2 Theoretical Process

2.1 Nuclear Potentials

Here, the nuclear potentials used for the real part of the optical model are introduced. For this purpose, ten different nuclear potentials which consist of BW 91, AW 95, Bass 73, Bass 77, Bass 80, CW 76, Ngo 80, Prox 77, Prox 88 and SWW are investigated.

2.1.1 **Broglia and Winther 1991 (BW 91) potential**

The first examined proximity potential is Broglia and Winther 1991 (BW 91) potential [10,20] given by

$$V_N^{BW\,91}(r) = -\frac{V_0}{\left[1+\exp\left(\frac{r-R_0}{a}\right)\right]} \mathrm{MeV}, \qquad (1)$$

where

$$V_0 = 16\pi\frac{R_1R_2}{R_1+R_2}\gamma a, \quad a = 0.63\,\mathrm{fm}, \qquad (2)$$

and

$$R_0 = R_1+R_2+0.29, \quad R_i = 1.233A_i^{1/3} - 0.98A_i^{-1/3} \ (i=1,2), \qquad (3)$$

with surface energy constant γ is

$$\gamma = \gamma_0[1-k_s(\frac{N_p-Z_p}{A_p})(\frac{N_t-Z_t}{A_t})]. \qquad (4)$$

γ_0 and k_s are taken as 0.95 MeV/fm^2 and 1.8, respectively.

2.1.2 **Aage Winther (AW 95) Potential**

The second type potential applied for the real part is the same as BW 91 potential except for [11,20]

$$a = \left[\frac{1}{1.17(1+0.53(A_1^{-1/3}+A_2^{-1/3}))}\right] \mathrm{fm}, \qquad (5)$$

and

$$R_0 = R_1+R_2, \quad R_i = 1.2A_i^{1/3} - 0.09 \ (i=1,2). \qquad (6)$$

2.1.3 **Bass 1973 (Bass 73) Potential**

The third type potential investigated from proximity potentials is given by [12,13,21]

$$V_N^{Bass\,73}(r) = -\frac{da_sA_1^{1/3}A_2^{1/3}}{R_{12}}\exp(-\frac{r-R_{12}}{d}) \ \mathrm{MeV}, \qquad (7)$$

where

$$R_{12} = 1.07(A_1^{1/3}+A_2^{1/3}), \quad d = 1.35\,\mathrm{fm} \text{ and } a_s = 17\,\mathrm{MeV}. \qquad (8)$$

2.1.4 **Bass 1977 (Bass 77) Potential**

Another potential analyzed for the real part is in the following form [14,20]

$$V_N^{Bass\,77}(s) = -\frac{R_1R_2}{R_1+R_2}\phi(s=r-R_1-R_2) \ \mathrm{MeV}, \qquad (9)$$

where

$$R_i = 1.16A_i^{1/3} - 1.39A_i^{-1/3} \ (i=1,2). \qquad (10)$$

The universal function $\phi(s=r-R_1-R_2)$ is shown as

$$\phi(s) = [A\exp(\frac{s}{d_1})+B\exp(\frac{s}{d_2})]^{-1}, \qquad (11)$$

where $A = 0.030\,\mathrm{MeV}^{-1}$ fm, $B = 0.0061\,\mathrm{MeV}^{-1}$ fm, $d_1 = 3.30$ fm and $d_2 = 0.65$ fm.

2.1.5 **Bass 1980 (Bass 80) Potential**

Bass 1980 (Bass 80) potential is the same as Bass 77 potential form except for the function $\phi(s=r-R_1-R_2)$ given by [10,20]

$$\phi(s) = [0.033\ \exp(\frac{s}{3.5})+0.007\ \exp(\frac{s}{0.65})]^{-1}, \qquad (12)$$

and

$$R_i = R_s(1-\frac{0.98}{R_s^2}), \quad R_s = 1.28A_i^{1/3} - 0.76 + 0.8A_i^{-1/3}\mathrm{fm} \ (i=1,2). \qquad (13)$$

2.1.6 **Christensen and Winther 1976 (CW 76) Potential**

The other type of proximity potentials evaluated with this work is assumed as [15,21]

$$V_N^{CW\,76}(r) = -50\frac{R_1R_2}{R_1+R_2}\phi(r-R_1-R_2)\,\text{MeV} \qquad (14)$$

where

$$R_i = 1.233A_i^{1/3} - 0.978A_i^{-1/3}\text{fm} \quad (i=1,2). \qquad (15)$$

The universal function $\phi(s = r - R_1 - R_2)$ is

$$\phi(s) = \exp(-\frac{r-R_1-R_2}{0.63}). \qquad (16)$$

2.1.7 **Ngô 1980 (Ngo 80) potential**

Ngô 1980 (Ngo 80) is another proximity potential used in the analysis of nuclear interactions. It is written by [16]

$$V_N^{Ngo\,88}(r) = \overline{R}\phi(r-C_1-C_2)\,\text{MeV} \qquad (17)$$

$$\overline{R} = \frac{C_1C_2}{C_1+C_2}, \quad C_i = R_i[1-(\frac{b}{R_i})^2+...], \qquad (18)$$

$$R_i = \frac{NR_{ni}+ZR_{pi}}{A_i} \quad (i=1,2), \qquad (19)$$

$$R_{pi} = r_{0pi}A_i^{1/3}, R_{ni} = r_{0ni}A_i^{1/3}, \qquad (20)$$

$$r_{0pi} = 1.128 \text{ fm}, \; r_{0ni} = 1.1375 + 1.875\text{x}10^{-4}A_i \text{ fm}. \; (21)$$

The universal function $\phi(s = r - C_1 - C_2)$ (in MeV/fm) is assumed as

$$\Phi(s) = \begin{cases} -33+5.4(s-s_0)^2, \text{ for } & s < s_0, \\ -33 \exp[-\frac{1}{5}(s-s_0)^2] \text{ for } s \geq s_0, \\ s_0 = -1.6 \text{ fm} \end{cases}$$

2.1.8 **Proximity 1977 (Prox 77) potential**

Nuclear potential with Proximity 1977 (Prox 77) [17,22] is parameterized by

$$V_N^{Prox\,77}(r) = 4\pi\gamma b\overline{R}\Phi(\zeta = \frac{r-C_1-C_2}{b})\,\text{MeV}, \qquad (22)$$

where

$$\overline{R} = \frac{C_1C_2}{C_1+C_2}, \quad C_i = R_i[1-(\frac{b}{R_i})^2+...]. \qquad (23)$$

R_i, the effective radius, is

$$R_i = 1.28A_i^{1/3} - 0.76 + 0.8A_i^{-1/3}\text{fm} \quad (i=1,2). \qquad (24)$$

γ, the surface energy coefficient, is

$$\gamma = \gamma_0[1-k_s(\frac{N-Z}{N+Z})^2] \qquad (25)$$

where N and Z is total number of neutrons and protons, respectively. Also, the value of γ_0 is 0.9517 MeV/fm^2 and k_s is 1.7826 [23]. The universal function, $\Phi(\zeta)$, can be written as

$$\Phi(\zeta) = \begin{cases} -\frac{1}{2}(\zeta-2.54)^2 - 0.0852(\zeta-2.54)^3, & \text{for } \zeta \leq 1.2511 \\ -3.437 \exp(-\frac{\zeta}{0.75}), & \text{for } \zeta \geq 1.2511 \end{cases}$$

2.1.9 **Proximity 1988 (Prox 88) potential**

In Proximity 1988 (Prox 88) potential, the new values of γ_0 and k_s have been used and taken as 1.2496 MeV/fm^2 and 2.3, respectively [10]. The other parameters of the potential have been considered to be the same as Prox 77 potential.

2.1.10 **Siwek-Wilczynski-Wilczynska (SWW) Potential**

Siwek-Wilczynski-Wilczynska (SWW) potential within the framework of the liquid drop model and with the WS potential is shown as [18,19]

$$V_N^{SWW}(r) = -\frac{V_0}{\left[1+\exp\left(\frac{r-R_1-R_2}{a}\right)\right]} \qquad (26)$$

where

$$V_0 = b_{\text{surf}}[A_1^{2/3} + A_2^{2/3} - (A_1+A_2)^{2/3}], \; b_{\text{surf}} \approx 17 \text{ MeV}, \qquad (27)$$

and

$$R_i = 1.128A_i^{1/3}(1-0.786A_i^{-2/3}) \quad (i\text{=}1,2), \qquad (28)$$

with

$$a = \frac{V_0(R_1+R_2)}{16\pi\gamma R_1R_2}. \qquad (29)$$

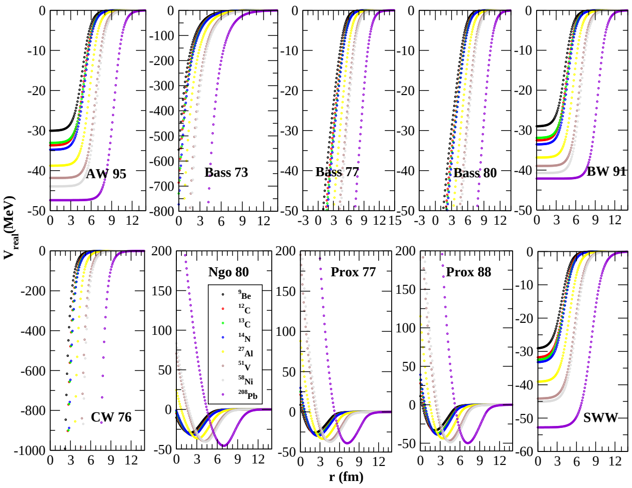

Fig. 1: Distance-dependent changes for ^{8}Li+^{9}Be, ^{8}Li+^{12}C, ^{8}Li+^{13}C, ^{8}Li+^{14}N, ^{8}Li+^{27}Al, ^{8}Li+^{51}V, ^{8}Li+^{58}Ni and ^{8}Li+^{208}Pb reactions of AW 95, Bass 73, Bass 77, Bass 80, BW 91, CW 76, Ngo 80, Prox 77, Prox 88 and SWW potentials.

2.2 Optical Model

The theoretical calculations in our work are based on the optical model. In this way, total interaction potential for interacting nuclei can be shown by

$$V_{total}(r) = V_C(r) + V_N(r), \tag{30}$$

where $V_C(r)$ is Coulomb potential shown by [1]

$$V_C(r) = \frac{1}{4\pi\varepsilon_\circ}\frac{Z_P Z_T e^2}{r}, \quad r \geq R_c \tag{31}$$

$$= \frac{1}{4\pi\varepsilon_\circ}\frac{Z_P Z_T e^2}{2R_c}\left(3 - \frac{r^2}{R_c^2}\right), \quad r < R_c, \quad R_c = 1.30(A_P^{1/3} + A_T^{1/3}), \tag{32}$$

and $V_N(r)$ is nuclear potential. While the proximity potentials defined above are used to produce the real part of the optical potential, the imaginary part is taken as the Woods-Saxon potential in the following form

$$W(r) = -\frac{W_0}{\left[1 + \exp\left(\frac{r - R_W}{a_W}\right)\right]}. \tag{33}$$

The code FRESCO has been applied in the optical model calculations [24].

3 Results and Discussion

The distance-dependent variations of proximity potentials used for the real potential in our study have been shown comparatively in Fig. 1. It has been observed that when the change of the potentials is examined, they are different from each other according to both shape of potential and target nucleus. The values of the imaginary

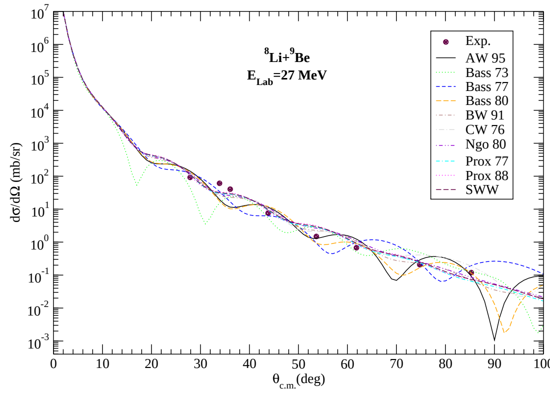

Fig. 2: The elastic scattering cross sections in comparison with the experimental data of the ^{8}Li+^{9}Be reaction for AW 95, Bass 73, Bass 77, Bass 80, BW 91, CW 76, Ngo 80, Prox 77, Prox 88 and SWW potentials at E_{Lab}= 27 MeV. The experimental data have been taken from [25].

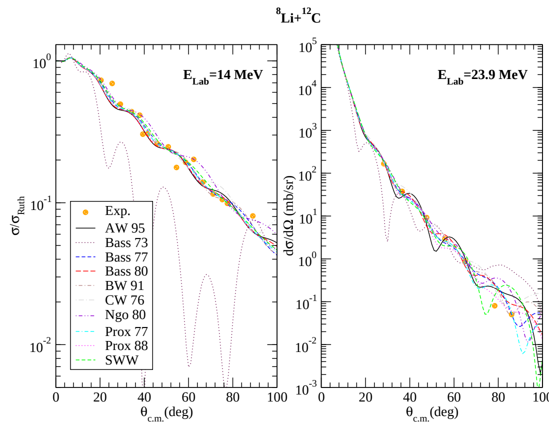

Fig. 3: The same as Fig. 2, but for the ^{8}Li+^{12}C reaction at E_{Lab}= 14 and 23.9 MeV. The experimental data have been taken from [26, 27].

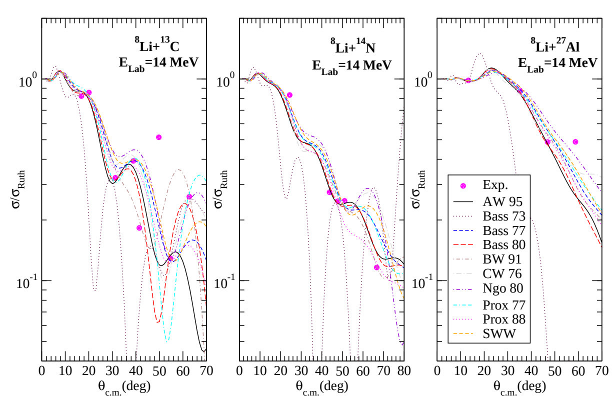

Fig. 4: The same as Fig. 2, but for the ^{8}Li+^{13}C, ^{8}Li+^{14}N and ^{8}Li+^{27}Al reactions at E_{Lab}= 14 MeV. The experimental data have been taken from [26].

Table 1: W_0 values of the imaginary potentials for the AW 95, Bass 73, Bass 77, Bass 80, BW 91, CW 76, Ngo 80, Prox 77, Prox 88 and SWW potentials used in the elastic scattering analysis of the ^{8}Li+^{9}Be, ^{8}Li+^{12}C, ^{8}Li+^{13}C, ^{8}Li+^{14}N,^{8}Li+^{27}Al, ^{8}Li+^{51}V, ^{8}Li+^{58}Ni and ^{8}Li+^{208}Pb systems at various incident energies.

					W_0(MeV)						
Reaction	Energy (MeV)	AW 95	Bass 73	Bass 77	Bass 80	BW 91	CW 76	Ngo 80	Prox 77	Prox 88	SWW
^{8}Li + ^{9}Be	27	8.70	11.5	6.30	8.90	13.4	14.2	14.0	17.0	19.0	17.0
^{8}Li + ^{12}C	14	10.8	6.00	8.70	11.4	8.40	11.0	6.00	10.4	12.0	7.90
	23.9	7.20	8.50	8.50	10.5	8.00	14.0	7.00	8.00	8.20	6.20
^{8}Li + ^{13}C	14	6.00	6.00	8.00	5.00	2.80	11.2	4.50	3.50	9.10	6.40
^{8}Li + ^{14}N	14	12.5	2.00	7.30	11.5	5.50	6.50	3.60	7.30	6.00	5.00
^{8}Li + ^{27}Al	14	5.20	6.20	6.10	6.00	6.00	5.00	6.00	9.00	7.00	6.00
^{8}Li + ^{51}V	18.5	14.0	15.0	1.40	13.0	11.9	13.9	14.5	5.50	1.10	10.0
	26	24.4	25.8	18.0	25.6	23.2	25.8	25.2	16.0	25.9	17.0
^{8}Li + ^{58}Ni	19.6	15.8	18.8	16.7	15.5	16.0	15.8	15.8	16.0	15.6	16.5
	20.2	17.8	20.0	20.1	16.3	19.5	18.8	20.0	18.9	17.6	19.8
^{8}Li + ^{208}Pb	25.33	19.7	13.4	18.4	18.2	18.4	18.4	18.6	18.4	18.4	18.4
	30.01	7.70	3.00	8.00	6.80	7.70	7.30	8.60	7.70	7.40	7.30

Table 2: The same as Table 1, but for r_w values.

					r_w(fm)						
Reaction	Energy (MeV)	AW 95	Bass 73	Bass 77	Bass 80	BW 91	CW 76	Ngo 80	Prox 77	Prox 88	SWW
^{8}Li + ^{9}Be	27	1.36	1.36	1.36	1.36	1.36	1.36	1.36	1.36	1.36	1.36
^{8}Li + ^{12}C	14	1.34	1.34	1.34	1.34	1.34	1.34	1.34	1.34	1.34	1.34
	23.9	1.34	1.34	1.34	1.34	1.34	1.34	1.34	1.34	1.34	1.34
^{8}Li + ^{13}C	14	1.20	1.20	1.20	1.20	1.20	1.20	1.20	1.20	1.20	1.20
^{8}Li + ^{14}N	14	1.30	1.30	1.30	1.30	1.30	1.30	1.30	1.30	1.30	1.30
^{8}Li + ^{27}Al	14	1.30	1.30	1.30	1.30	1.30	1.30	1.30	1.30	1.30	1.30
^{8}Li + ^{51}V	18.5	1.30	1.30	1.30	1.30	1.30	1.30	1.30	1.30	1.30	1.30
	26	1.30	1.30	1.30	1.30	1.30	1.30	1.30	1.30	1.30	1.30
^{8}Li + ^{58}Ni	19.6	1.38	1.38	1.38	1.38	1.38	1.38	1.38	1.38	1.38	1.38
	20.2	1.38	1.38	1.38	1.38	1.38	1.38	1.38	1.38	1.38	1.38
^{8}Li + ^{208}Pb	25.33	1.38	1.38	1.38	1.38	1.38	1.38	1.38	1.38	1.38	1.38
	30.01	1.38	1.38	1.38	1.38	1.38	1.38	1.38	1.38	1.38	1.38

potential parameters for each nuclear reaction examined, have been given in Table 1 (for W_0), Table 2 (for r_w) and Table 3 (for a_w). In addition, Table 4 lists the cross sections (σ) according to potentials for all reactions.

The theoretical calculations of the elastic scattering angular distributions of ^{8}Li nucleus from the light to medium and heavy nuclei have been carried out for ten different potentials. The first investigated nuclear reaction is ^{8}Li+^{9}Be at 27 MeV. The theoretical results have been displayed as compared with the experimental data in Fig. 2. It has been observed that the results of Bass 80, Prox 77 and Prox 88 potentials are slightly better than the results of the other potentials and are in good agreement with the experimental data. ^{8}Li+^{12}C reaction as light target nucleus example has been investigated at 14 and 23.9 MeV energies. The results have been shown as compared with the experimental data in Fig. 3. The worst results have been obtained for Bass 73 potential at both energies. At 14 MeV, the results of Bass 77, BW 91, Prox 77, Prox 88 and SWW potentials are very similar to each other, but the results of the Prox 77 potential are slightly better than the others. At 23.9 MeV, the results of Bass 77, BW 91, Ngo 80 and Prox 77 potentials are in better agreement with the data than the results of the other potentials. Prox 77 potential, which is common for both energies, has given good agreement results with the data. The elastic cross sections of ^{8}Li+^{13}C, ^{8}Li+^{14}N and ^{8}Li+^{27}Al reactions which are other light nucleus examples have been obtained, for the first-time, by using proximity potentials at incident energy of 14 MeV. All the theoretical results have been presented together with the experimental data in Fig. 4. Similar to the ^{8}Li+^{12}C reaction, the worst results in these reactions have been obtained for Bass 73 potential. However, the best results

Table 3: The same as Table 1, but for a_w values.

		a_w(fm)									
Reaction	Energy (MeV)	AW 95	Bass 73	Bass 77	Bass 80	BW 91	CW 76	Ngo 80	Prox 77	Prox 88	SWW
^{8}Li + ^{9}Be	27	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98
^{8}Li + ^{12}C	14	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90
	23.9	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90
^{8}Li + ^{13}C	14	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50
^{8}Li + ^{14}N	14	0.60	0.60	0.60	0.60	0.60	0.60	0.60	0.60	0.60	0.60
^{8}Li + ^{27}Al	14	0.60	0.60	0.60	0.60	0.60	0.60	0.60	0.60	0.60	0.60
^{8}Li + ^{51}V	18.5	0.60	0.60	0.60	0.60	0.60	0.60	0.60	0.60	0.60	0.60
	26	0.60	0.60	0.60	0.60	0.60	0.60	0.60	0.60	0.60	0.60
^{8}Li + ^{58}Ni	19.6	0.84	0.84	0.84	0.84	0.84	0.84	0.84	0.84	0.84	0.84
	20.2	0.84	0.84	0.84	0.84	0.84	0.84	0.84	0.84	0.84	0.84
^{8}Li + ^{208}Pb	25.33	0.91	0.91	0.91	0.91	0.91	0.91	0.91	0.91	0.91	0.91
	30.01	0.91	0.91	0.91	0.91	0.91	0.91	0.91	0.91	0.91	0.91

Table 4: The same as Table 1, but for σ values.

		σ(mb)									
Reaction	Energy (MeV)	AW 95	Bass 73	Bass 77	Bass 80	BW 91	CW 76	Ngo 80	Prox 77	Prox 88	SWW
^{8}Li + ^{9}Be	27	1868	2178	1679	1867	2042	2073	2050	2161	2224	2155
^{8}Li + ^{12}C	14	1616	1820	1498	1625	1501	1594	1348	1566	1632	1448
	23.9	1680	1958	1682	1796	1676	1897	1590	1660	1685	1543
^{8}Li + ^{13}C	14	1140	1555	959	1077	970	1035	885	902	1003	892
^{8}Li + ^{14}N	14	1198	1408	1036	1162	1053	1024	915	1031	1047	947
^{8}Li + ^{27}Al	14	977	1411	887	968	926	885	826	916	926	852
^{8}Li + ^{51}V	18.5	1087	1417	751	1082	1038	1071	996	895	677	976
	26	1645	1882	1544	1658	1616	1648	1590	1511	1638	1526
^{8}Li + ^{58}Ni	19.6	1489	1745	1498	1485	1487	1484	1461	1485	1483	1495
	20.2	1598	1827	1637	1568	1628	1616	1622	1614	1593	1632
^{8}Li + ^{208}Pb	25.33	278	237	263	262	263	263	264	263	264	265
	30.01	649	542	657	619	649	636	673	646	639	637

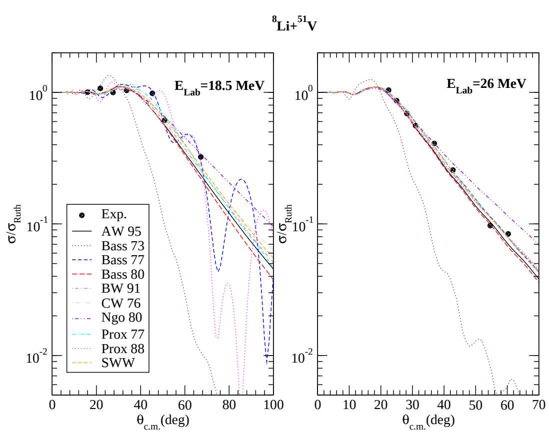

Fig. 5: The same as Fig. 2, but for the ^{8}Li+^{51}V reaction at E_{Lab}=18.5 and 26 MeV. The experimental data have been taken from [28,29].

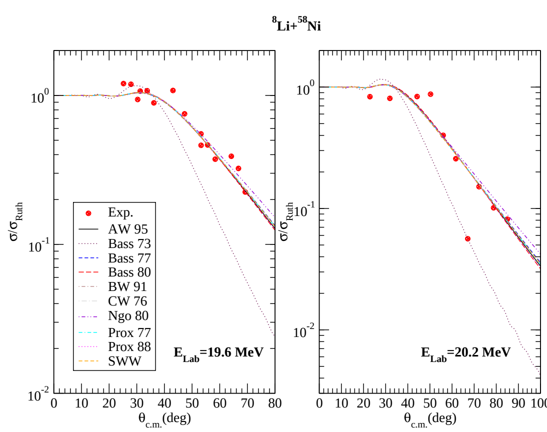

Fig. 6: The same as Fig. 2, but for the ^{8}Li+^{58}Ni reaction at E_{Lab}=19.6 and 20.2 MeV. The experimental data have been taken from [26,30].

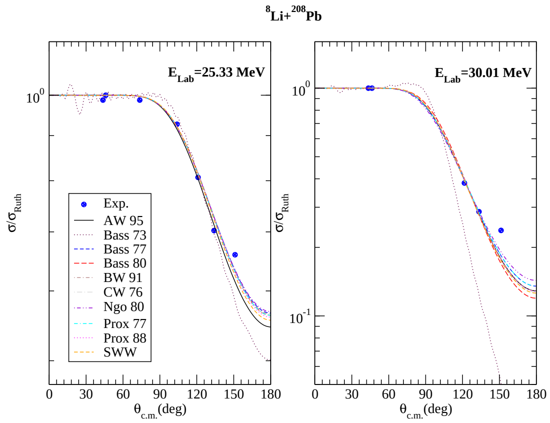

Fig. 7: The same as Fig. 2, but for the ^{8}Li+^{208}Pb reaction at E_{Lab}= 25.33 and 30.01 MeV. The experimental data have been taken from [31].

have been obtained with Prox 77 potential for ^{8}Li+^{13}C reaction and AW 95 potential for ^{8}Li+^{14}N reaction. The ^{8}Li+^{27}Al reaction have close results. It is useful to note that the theoretical results acquired with the help of the potentials studied in all three reactions are consistent with the experimental data.

The ^{8}Li+^{51}V (at 18.5 and 26 MeV) and ^{8}Li+^{58}Ni (at 19.6 and 20.2 MeV) reactions as medium heavy nuclei have been examined for ten various potential approaches. The theoretical results obtained for these nuclear potentials have been displayed as compared with each other as well as the experimental data in Figs. 5 and 6, respectively. The most consistent results with the experimental data for ^{8}Li+^{51}V system have been acquired with Ngo 80 potential at 18.5 MeV. However, at 26 MeV, the results of Bass 77, BW 91, Prox 77 and SWW potentials which show a similar behavior with each other are in very good agreement with the data and are better than the results of the other potentials. For ^{8}Li+^{58}Ni reaction, the results of the other potentials except for Bass 73 and Ngo 80 potentials are very similar at both 19.6 and 20.2 MeV and are in good agreement with the experimental data. On the other hand, it has been seen that the worst theoretical results of ^{8}Li+^{51}V and ^{8}Li+^{58}Ni reactions are found for Bass 73 potential.

Finally, ^{8}Li+^{208}Pb as heavy nucleus reaction has been investigated at 25.33 and 30.01 MeV. The elastic scattering cross sections have been acquired and shown in Fig. 7. Similar to the results of previous reactions, the most inconsistent results with the experimental data have been obtained for the Bass 73 potential at both 25.33 and 30.01 MeV. On the other side, the results of the other potentials have displayed very similar behavior with each other in general sense and are in good agreement with the experimental data at incident energies of 25.33 and 30.01 MeV.

The cross sections (σ) of the reactions investigated using ten different nuclear potentials have been listed in Table 4. Our results have been compared with the literature [9]. In this context, Aygun [9] have reported as 2103 mb for ^{8}Li+^{9}Be reaction at 27 MeV, 1623 mb for ^{8}Li+^{12}C at 14 MeV, 1203 mb for ^{8}Li+^{27}Al at 14 MeV and 1445 mb for ^{8}Li+^{58}Ni at 19.6 MeV. In our study, we have acquired in the range of $1679 \leq \sigma \leq 2224$ mb, $1348 \leq \sigma \leq 1820$ mb, $826 \leq \sigma \leq 1411$ mb, $1461 \leq \sigma \leq 1745$ mb, respectively. As a result of this, we can concluded that our cross sections are in agreement with the results of Aygun [9].

4 Perspective

In the present study, the elastic scattering angular distributions of ^{8}Li projectile from eight different target nuclei such as ^{9}Be, ^{12}C, ^{13}C, ^{14}N, ^{27}Al, ^{51}V, ^{58}Ni and ^{208}Pb have been analyzed within the framework the optical model. The real part of the optical potential has been obtained by using ten kind nuclear potentials while the imaginary potential has been determined with the WS potential. It should be remarked that a comprehensive analysis of the proximity potentials has been performed, for the first-time, with this work. Alternative potentials from the comparative analysis of our results have been put forward. It has been seen that the potentials are in good agreement with the experimental data. However, it has generally been found that the Prox 77 potential gives better results with the experimental data than other potentials. In addition, the worst results for all the reactions have been found for Bass 73 potential. Thus, it can be said that the theoretical results depend on the shape of the potentials investigated in our study. Also, we can deduce that the alternative potentials demonstrated with this work which have given consistent results with the experimental data can be used in situations where it is difficult to determine the real potential. We think that similar studies for other different nuclei will give important and useful results.

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