Double Folding Model Calculation Applied to the Real Part of Interaction Potential*

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Abstract The calculations of nucleus-nucleus potential are carried out in the framework of double folding model with M3Y-Reid and M3Y-Paris effective nucleon-nucleon (NN) interactions. The exchange part of the interaction, which is taken to be of finite range and the density dependence of NN interaction, is accounted for in the folding procedure. The results are used as the real part of the optical potential for heavy ion scattering. Besides, some general aspects of the folding model are reviewed and its theoretical processes are discussed. The calculated potentials with all kinds of NN interactions are compared. It is shown that the real parts of the optical potential for a large number of systems are obtained satisfactorily with our double folding model. Therefore, this work provides a promising way for a systematic and comprehensive double folding calculation of heavy ion interaction potential.

Key words heavy ion reaction, double folding model, nucleon-nucleon interaction, halo nuclei

1 Introduction

The understanding of peripheral heavy ion (HI) collision processes in general, elastic scattering in particular is an important part of an overall understanding of heavy ion reactions. One of the most widespread approaches to this problem is based on the use of an optical potential for the description of the elastic scattering of two heavy ions. The optical model approach is both flexible and relatively familiar. While many of the systems of HI scattering may be understood in terms of empirical parameterizations of nuclear optical potential and its variation with bombarding energy, nucleon number, etc., a satisfactory microscopic understanding of HI collisions should be founded on the underlying nucleon-nucleon (NN) interaction. Within the framework of an optical model description of HI scattering this means calculating the nuclear optical potential from the NN interaction.

Customarily phenomenological Woods-Saxon forms are used for both the real and imaginary parts of the optical potential. However, it would be desirable to relate the nucleus-nucleus nuclear interaction to the nucleon-nucleon nuclear interaction. The nuclear potential may be obtained by integrating a nucleon-nucleon interaction over the matter distributions of the two colliding nuclei. This approach is called the folding model and has been reviewed by Satchler and Love[1]. Among various models for the potential of interaction between two nuclei, the folding model has been widely used to generate the real parts of HI optical potentials. This model represents the leading term in the expression for the optical

Received 12 October 2006
* Supported by National Natural Science Foundation of China (60275092, 10375095)
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potential. The success of this approach in describing the observed elastic scattering of many systems suggests that it produces the dominant part of the real optical potential[1, 2].

In the present work we compile the double folding model, which covers the density independence NN interactions, divided into M3Y-Reid, M3Y-Paris effective NN interactions and the density dependence NN interactions. Our purpose here is to check our program if it is applicable to calculate the real part of nuclear interaction potential. We do not attempt to justify formally the use of a folding model for fitting HI elastic scattering. Rather, to test the new program we check some cases to compare them with the results from references. The real parts of nuclear interaction potential for α+^{40}Ca, ^{16}O+^{16}O and ^{6}He+^{12}C systems are calculated in the present work using the new double folding program. The calculations have used the density independent and the density dependent NN interactions, and are divided into two versions: the exchange part is a δ function and the other is not δ function. Finally we have also discussed some features of the folding model and summarized these results together with a discussion of the validity of this program and possible applications.

2 Double folding model

In the folding model, the nuclear interaction v is taken to be a sum of effective (two-body) NN interactions v_{12} between nucleon 1 in the projectile and nucleon 2 in the target,

$$v = \sum v_{12} \ , \tag{1}$$

It is to consider interchange of the two interacting nucleons. This process has been called knock-on exchange because in nucleon scattering from nuclei it results in a target nucleon being ejected and replaced by the projectile nucleon following their mutual interaction. Including this knock-on exchange is equivalent formally to replacing

$$v_{12} \longrightarrow v_{12}(1-P_{12}) \ , \tag{2}$$

where P_{12} is the operator that exchanges all coordinates of these two nucleons. In this approximation the folding potential is written as

$$v(r) = v^{\mathrm{D}} + v^{\mathrm{E}} \ . \tag{3}$$

Here v^{D} and v^{E} are direct potential and exchange potential, respectively. If the knock-on exchange potential could be estimated quite accurately by adding a zero-range pseudo-potential to the interaction v_{12} in the formula (5), one can replace v_{12} by

$$v'_{12} = v_{12}(1-P_{12}) \longrightarrow v_{12} + \hat{J}(E)\delta(r) \ . \tag{4}$$

In the double folding model the real part of the interaction potential is written as

$$v(r) = \int \mathrm{d}^3 r_1 \int \mathrm{d}^3 r_2 \rho_1(r_1) v_{12}(s = |\boldsymbol{R} + \boldsymbol{r}_2 - \boldsymbol{r}_1|) \rho_2(r_2), \tag{5}$$

where, for simplicity, we have ignored spin and isospin. Here $\rho_1(r_1)$ and $\rho_2(r_2)$ are the matter densities distribution of the projectile (P) and target (T) nuclei ground states normalized so that

$$\int \rho_i(\boldsymbol{r}_i) \mathrm{d}\boldsymbol{r}_i = A_i \ , \tag{6}$$

v_{12} is the NN interaction between two nucleons. The vector $\boldsymbol{R}+\boldsymbol{r}_2-\boldsymbol{r}_1$ corresponds to the distance between two specified interacting points of the projectile and target, whose radius vectors are $\boldsymbol{r}_1$ and $\boldsymbol{r}_2$, respectively. $\boldsymbol{R}$ denotes the vector between the centers of mass of the two nuclei. This geometry is illustrated in Fig. 1.

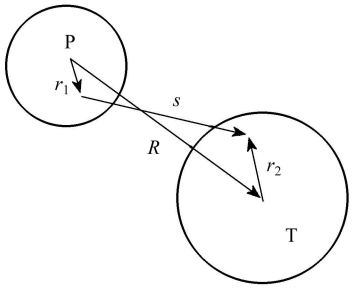

Fig. 1. The coordinate system used in the double folding model. The vector between the centers of the projectile (P) and target (T) nuclei is denoted by $\boldsymbol{R}$, while r_1, r_2 are the radius vectors of points separated by s in the nucleon distributions of the projectile and target nuclei.

2.1 Density independence interaction

It remains necessary to have a realistic effective NN interaction before the success of the folding model

can be reliably assessed. A popular choice for the effective NN interaction is two of the M3Y interactions which were designed to reproduce the G-matrix elements of the Reid[3] and Paris[4] NN potentials in an oscillator basis. We refer to these as the M3Y-Reid and M3Y-Paris interactions, respectively. These density independence M3Y interactions have been used with some success in folding model calculations of the HI optical potential. Explicit forms follow below. The direct parts are:

$$\text{M3Y-Reid}: v_{00}(r) = \left[7999\frac{\mathrm{e}^{-4r}}{4r} - 2134\frac{\mathrm{e}^{-2.5r}}{2.5r}\right]\text{MeV}, \tag{7}$$

$$\text{M3Y-Paris}: v_{00}(r) = \left[11062\frac{\mathrm{e}^{-4r}}{4r} - 2538\frac{\mathrm{e}^{-2.5r}}{2.5r}\right]\text{MeV}, \tag{8}$$

and the knock-on exchange parts are:

M3Y-Reid:

$$\hat{v}_{00}(r) = \left[4631\frac{\mathrm{e}^{-4r}}{4r} - 1787\frac{\mathrm{e}^{-2.5r}}{2.5r} - 7.847\frac{\mathrm{e}^{-0.7072r}}{0.7072r}\right]\text{MeV}, \tag{9}$$

M3Y-Paris:

$$\hat{v}_{00}(r) = \left[-1524\frac{\mathrm{e}^{-4r}}{4r} - 518.8\frac{\mathrm{e}^{-2.5r}}{2.5r} - 7.847\frac{\mathrm{e}^{-0.7072r}}{0.7072r}\right]\text{MeV}. \tag{10}$$

However, many other calculations use the zero-range pseudo-potential of formula (4) to represent the knock-on exchange. The results of $\hat{J}_{00}(E)$ using the Reid interaction and the Paris interaction can be expressed as

$$\text{M3Y-Reid}: \hat{J}(E) \approx -276[1-0.005(E/A)]\text{MeV}\cdot\text{fm}^3, \tag{11}$$

$$\text{M3Y-Paris}: \hat{J}(E) \approx -590[1-0.002(E/A)]\text{MeV}\cdot\text{fm}^3, \tag{12}$$

where E/A is the bombarding energy per projectile nucleon in MeV.

2.2 Density dependence interaction

However, refractive nuclear scattering is characterized by the observation of 'rainbow' features, which were seen first for α-particles[5, 6] and later for other light HI systems[7—9]. Here, the simple M3Y-type interactions failed to give a good description of the data. This has motivated the inclusion of an explicit density-dependence into the original M3Y interactions, to account for the reduction in the strength of the interaction that occurs as the density of the surrounding medium increases. It has long been recognized that the effective interaction between two nucleons in a nucleus depends on the density of the surrounding medium. Indeed, this density dependence is required for nuclear matter to saturate rather than collapse. Saturation requires that the attraction weakens as the density increases.

A variety of density dependence interactions have been introduced. Here we discuss some based on the M3Y interactions of the preceding section. It is assumed that the radial dependence is independent of the density and energy, so we can use a factored form

$$v(\rho, r) = f(\rho)v(r), \tag{13}$$

where $v(r)$ is the original M3Y interactions (including the knock-on pseudo-potential) described in the preceding section. The density dependence adopted is

$$f(\rho) = C[1+\alpha\mathrm{e}^{-\beta\rho} - \gamma\rho]. \tag{14}$$

In the course of these applications to scattering data, it was found necessary to introduce an additional mild energy dependence over that provided by localizing the exchange potential[10]. This is parameterized as a linear function

$$g(E) = [1-\gamma'(E/A)], \tag{15}$$

with γ'=0.002MeV^{-1} (Reid) or 0.003MeV^{-1} (Paris). The full interaction now has the form

$$v(\rho, E, r) = g(E)f(\rho)v(r)\ . \tag{16}$$

2.3 Double folding process

In the folding model because there is integration over two densities, the formula (5) is often called double folding. Although involving a six-dimensional integral, it is very simple to evaluate if v_{12} does not depend on the densities. Then we use Fourier transform to work in momentum space.

$$V(k) = \iint \mathrm{d}\boldsymbol{r}_1\mathrm{d}\boldsymbol{r}_2\rho_1(r_1)\rho_2(r_2)\int v(\boldsymbol{R}+\boldsymbol{r}_2-\boldsymbol{r}_1)\mathrm{e}^{-\mathrm{i}\boldsymbol{k}\cdot\boldsymbol{R}}\mathrm{d}\boldsymbol{R} = \iint \mathrm{d}\boldsymbol{r}_1\mathrm{d}\boldsymbol{r}_2\rho_1(r_1)\rho_2(r_2)\int v(r_3)\mathrm{e}^{-\mathrm{i}\boldsymbol{k}\cdot(\boldsymbol{r}_3+\boldsymbol{r}_1-\boldsymbol{r}_2)}\mathrm{d}\boldsymbol{r}_3 =$$
$$\int \rho_1(r_1)\mathrm{e}^{-\mathrm{i}\boldsymbol{k}\cdot\boldsymbol{r}_1}\mathrm{d}\boldsymbol{r}_1\int \rho_2(r_2)\mathrm{e}^{-\mathrm{i}(-\boldsymbol{k})\cdot\boldsymbol{r}_2}\mathrm{d}\boldsymbol{r}_2\int v(r_3)\mathrm{e}^{-\mathrm{i}\boldsymbol{k}\cdot\boldsymbol{r}_3}\mathrm{d}\boldsymbol{r}_3 = \tilde{\rho}_1(\boldsymbol{k})\tilde{\rho}_2(\boldsymbol{k})\tilde{v}(\boldsymbol{k})\ . \tag{17}$$

Thereby reducing the integral to a product of three one-dimensional integrals. When v_{12} depends on the densities, equally simple forms can be obtained. It is also reduced the integral to a product of several one-dimensional integrals like formula (17). In the density dependent term one simply replaces each $\rho_i(r_i)$ by

$$\rho_i'(r_i) = \rho_i(r_i)\mathrm{e}^{-\beta\rho_i(r_i)}, \tag{18}$$

$$\rho_i''(r_i) = \rho_i(r_i)\times\rho_i(r_i). \tag{19}$$

In our program the Fourier transform is given by

$$\tilde{f}(k) = 4\pi\int_0^\infty f(r)j_0(kr)r^2\mathrm{d}r\ , \tag{20}$$

when $k=0$, $\tilde{f}(0) = 4\pi\int_0^\infty f(r)r^2\mathrm{d}r$, for delta function the Fourier transform by $F(v\delta(r)) = v$. With inverse transform

$$f(r) = \frac{1}{2\pi^2}\int_0^\infty \tilde{f}(k)j_0(kr)k^2\mathrm{d}k. \tag{21}$$

In order to obtain conveniently the real part of nuclear optical potential, firstly all of the terms (including densities and the effective NN interaction) are transformed to momentum space by Fourier transform. Then the potential is shown in the momentum space just like the formula (17). At last we can acquire the real part of nuclear potential when the potential is transformed from the momentum space to coordinate space by inverse Fourier transform. In our calculation there are two versions. One is that the knock-on exchange potential is a zero-range pseudo-potential, the other is that the calculation follows the formula (3). The effective NN interactions are also divided into M3Y-Reid and M3Y-Paris types in every version, including density independence and density dependence NN interaction potentials. For the second version, the direct part can be obtained by using the formula (20) and (21). While the exchange part is calculated by

$$v^{\mathrm{E}}(r) = 4\pi C\mathrm{g}(E)\int_0^\infty G_0(r,s)j_0(K(r)s/M)\hat{v}_{00}(s)s^2\mathrm{d}s. \tag{22}$$

Here $K(r)$ is the local momentum of relative motion, M is the reduced mass number, where

$$K^2(r) = \frac{2\mu_\alpha}{\hbar^2}[E_\alpha - v(E_\alpha,r) - v_{\mathrm{c}}(r)], \tag{23}$$

$M = m_{\mathrm{P}}m_{\mathrm{T}}/(m_{\mathrm{P}}+m_{\mathrm{T}})$, m_{P} and m_{T} are mass number of projectile and target, respectively. $\mu_\alpha = 931.5\times M$, is the reduced mass, its unit is MeV. The total folding potential is

$$v(E_\alpha,r) = v^{\mathrm{D}}(E_\alpha,r) + v^{\mathrm{E}}(E_\alpha,r), \tag{24}$$

the Coulomb potential[11] is

$$v_{\mathrm{c}} = \begin{cases} \dfrac{Z_1Z_2e^2}{2R}\left(3-\dfrac{r^2}{R^2}\right) & r<R \\ \dfrac{Z_1Z_2e^2}{r} & r\geqslant R \end{cases}, \tag{25}$$

e^2=1.44，$R = 1.2\times A_2^{\frac{1}{3}}$, A_2 is the mass number of target nucleus,

$$G_0(r,s) = \frac{1}{2\pi^2}\int_0^\infty \{f_{\mathrm{a}}(k,s)f_{\mathrm{A}}(k,s) + \alpha\bar{f}_{\mathrm{a}}(k,s)\bar{f}_{\mathrm{A}}(k,s) - \gamma[f_{\mathrm{a}}(k,s)\tilde{f}_{\mathrm{A}}(k,s) + \tilde{f}_{\mathrm{a}}(k,s)f_{\mathrm{A}}(k,s)]\}j_0(kr)k^2\mathrm{d}k\ , \tag{26}$$

$$f_{\mathrm{a(A)}}(k,s) = 4\pi\int_0^\infty \rho_0^{\mathrm{a(A)}}(r)j_1(k_{\mathrm{Fa(A)}}(r)s)j_0(kr)r^2\mathrm{d}r, \tag{27}$$

$$\bar{f}_{\mathrm{a(A)}}(k,s) = 4\pi\int_0^\infty \rho_0^{\mathrm{a(A)}}(r)\exp(-\beta\rho_0^{\mathrm{a(A)}}(r))\times j_1(k_{\mathrm{Fa(A)}}(r)s)j_0(kr)r^2\mathrm{d}r\ , \tag{28}$$

and

$$\tilde{f}_{\mathrm{a(A)}}(k,s) = 4\pi\int_0^\infty \left[\rho_0^{\mathrm{a(A)}}(r)\right]^2 j_1(k_{\mathrm{Fa(A)}}(r)s)j_0(kr)r^2\mathrm{d}r. \tag{29}$$

$$k_{\mathrm{F}}(r) = \left\{\left[\frac{3}{2}\pi^2\rho(r)\right]^{2/3} + \frac{5C_{\mathrm{s}}[\nabla\rho(r)]^2}{3\rho^2(r)} + \frac{5\nabla^2\rho(r)}{36\rho(r)}\right\}^{1/2}, \tag{30}$$

$C_{\mathrm{s}} \cong 1/4$. Thus we can obtain the exchange part $v^{\mathrm{E}}(r)$, then the total nuclear potential $v(r) = v^{\mathrm{D}}(r) + v^{\mathrm{E}}(r)$.

3 Calculation of the real part of heavy ion systems

In the following, we use the double folding program to calculate the real parts of nucleus-nucleus scattering for several systems. The interactions are divided into density independence M3Y-Reid interaction, and density dependence DDM3Y1, BDM3Y1, CDM3Y2, CDM3Y4 and CDM3Y6 interaction. From the above process, the basic inputs to a folding calculation are the nuclear densities of the colliding nuclei and the effective NN interaction. We have calculated nuclear densities, by means of some available nuclear models (for example, Hatree-Fock calculation) or directly from electron scattering data. In the present work, we examine a few representative cases about the real part of nuclear potential. These data are very helpful to test the new folding program and its basic ingredients.

3.1 α+^{40}Ca system

The system had already been calculated using the double folding model by J. Cook[12]. In our program the real part of interaction potential is calculated by the double folding program for 40MeV α+^{40}Ca. The density distributions of α and the target ^{40}Ca are defined as the function $\rho_1(r) = 0.4229\exp(-0.7024r^2)$ and the Woods-Saxon function $\rho_2(r) = 0.1688/[(1+\exp(r-3.58))/0.55]$, respectively. The effective NN interaction is used as the density independence M3Y-Reid interaction, in which all of parameters are taken as the same as that from J. Cook's calculation[12]. Our calculated potential is very agreeable with Cook's result in Fig. 2. It is shown that the program with the density independence mode could be applied to the HI optical potential calculation at relatively low energy.

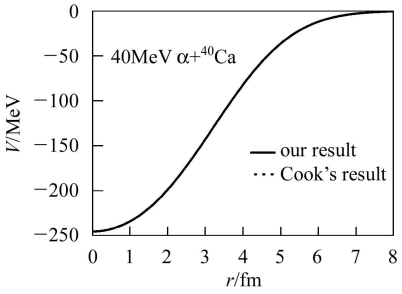

Fig. 2. Radial shapes of the folded potential for the α+^{40}Ca system at $E_{\rm lab}$=40MeV, which was calculated using the M3Y-Reid interaction (solid line) and Cook's result is shown by the dashed line for comparison.

3.2 ^{6}He+^{12}C system

The structure of neutron halo nuclei is an important research topic in recent years. Because the optical potential is the basic input integral in many calculations of various reactions, the optical potential of halo nuclei attracts much attention now a day. The parameters of optical potential can be extracted from the elastic scattering. The angular distribution of elastic scattering for the system ^{6}He+^{12}C has been measured. So it is meaningful to investigate the optical potential of the halo nucleus ^{6}He. In this case we calculate the real part of the interaction potential with the folding model which includes the effective interaction CDM3Y6. The ground state matter density of ^{12}C is taken as a two-parameter Fermi function, with ρ_0=0.207fm^{-3}, $C_{\rm P}$=2.1545fm and $a_{\rm P}$=0.425fm[13]. The halo-type density for ^{6}He is obtained from Ref. [13], with the Gaussian density reproduced rms radii of 2.2fm (ro density). The result is plotted in Fig. 3. Our calculated result is very alike that of Ref. [13] except that the depth of the solid line is larger than that of Ref. [13]. However, the sensitive region of optical potential lies at 3—5fm for fitting the elastic scattering data. The differences between the two in the region are less than 1%. Due to using almost all of the same parameters, including

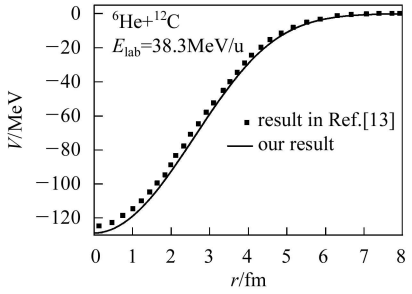

Fig. 3. Real folded potentials calculated with the CDM3Y6 interaction and the Gaussian ro density for ^{6}He+^{12}C at 38.3MeV/u (solid line), compared with the result in Ref. [13] (points).

not only the densities of the ^{6}He particle and the ^{12}C one, but also the effective NN interaction, it is shown that the new folding program about density dependence NN interaction is proved to be reliable and applicable.

So we also calculate the real part of the interaction potential of 38.3MeV/u ^{6}He+^{12}C, which includes the effective NN interaction BDM3Y1 (Paris) or CDM3Y6, folded with the matter density of a halo type for ^{6}He, denoted as fc6, obtained by three-body model calculations[14]. The other Gaussian density, reproduced rms radii of 2.54fm, is also used instead of the fc6 density to generate the folding potential. Results given by the real folded potential are plotted in Fig. 4.

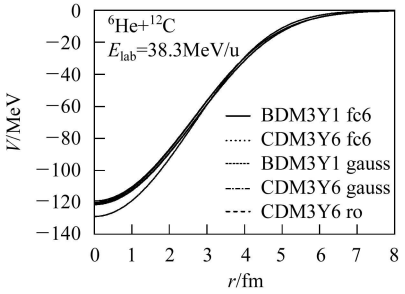

Fig. 4. Real folded potentials calculated with the CDM3Y6 and BDM3Y1 interactions for ^{6}He+^{12}C at 38.3MeV/u.

We compare the results calculated with BDM3Y1 and CDM3Y6, and with the different densities for ^{6}He. Both BDM3Y1 and CDM3Y6 with the same density for ^{6}He (Gaussian form or fc6 form) give nearly the same potential. The potential of CDM3Y6 with the Gaussian ro density for ^{6}He is deeper than that with Gaussian density for ^{6}He in the region of below about 3fm, inversely, is shallower than that with Gaussian density for ^{6}He in the region of above about 3—7fm. We also compare the folded CDM3Y6 potential by fc6 density with that by Gaussian density (both densities have the same rms radii). The potential by Gaussian density is deeper than that of fc6 density in the region of below about 4fm. From the above results it is shown that the different densities for halo nuclei lead to the different potentials.

3.3 α+^{40}Ca and ^{16}O+^{16}O systems

An accurate folding analysis of α nucleus refractive scattering can be a very effective method to determine the incompressibility of cold nuclear matter. From this analysis, we obtain the result of the folded potential for the α+^{40}Ca system at $E_{\rm lab}$=104MeV, plotted in Fig. 5. The densities of α and ^{40}Ca are taken as the same as what we have mentioned above but the NN interaction is used as density dependence interaction. Their incompressibility coefficients K are 176, 204, 228, 252 and 270 for DDM3Y1, CDM3Y2, CDM3Y4, CDM3Y6 and BDM3Y1, respectively[15]. In contrast to α-nucleus scattering, the elastic scattering of HI is usually of peripheral character. Thus it is also of interest to test new folding program developed in the present work against the ^{16}O+^{16}O system. The real parts of interaction potential are folded with the DDM3Y1, CDM3Y2, CDM3Y4, CDM3Y6 and BDM3Y1, which include the matter density of the colliding nucleus ^{16}O, denoted as two-parameter Fermi distribution

$$\rho(r)=\rho_0/[1+\exp(r-c)/a]\ , \qquad (31)$$

with parameters suggested by electron scattering data[16]. The folded results are shown in Fig. 6.

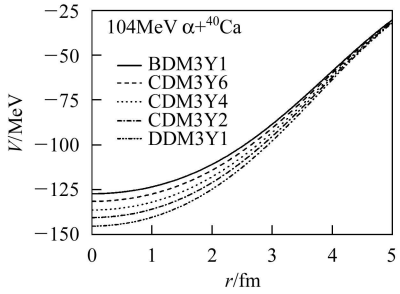

Fig. 5. Radial shapes of different folded potentials for the α+^{40}Ca system at $E_{\rm lab}$=104MeV which were calculated using the various density dependence M3Y-Paris interactions[15].

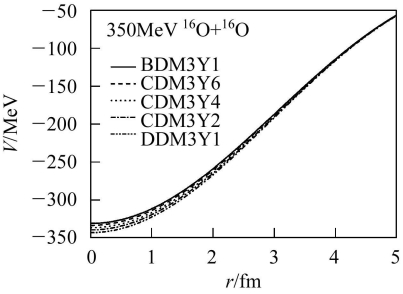

Fig. 6. Radial shapes of different folded potentials for the ^{16}O+^{16}O system at $E_{\rm lab}$=350MeV which were calculated using the various density-dependence M3Y-Paris interactions[15].

From Fig. 6 one can see that the changes of the folding potentials are the same as those of the Fig. 5, with the NN interactions, the potentials are getting deeper according to the sequence BDM3Y1, CDM3Y6, CDM3Y4, CDM3Y2 and DDM3Y1, and hence with the various values of associated incompressibility K of cold nuclear matter. In α+^{40}Ca system, we have a density as high as $\rho \simeq 2\rho_0$ in the center of ^{4}He nucleus, and $\rho \simeq \rho_0$ in the center of ^{40}Ca nucleus, given by the above form used in our folding model. ρ_0 is a saturation density of nuclear matter, $\rho_0 \simeq 0.17\text{fm}^{-3}$. This means that the total density for a α particle overlapping a target nucleus may reach as much as $3\rho_0$. From Ref. [15] one can see that for the α+^{40}Ca system the overlap density begins to approach $3\rho_0$ already at a separation of r=4fm. In ^{16}O+^{16}O system, we expect that the total density of a ^{16}O nucleus overlapping a ^{16}O target nucleus may be as much as $2\rho_0$. One can see that the highest overlap density which can be reached in this occurs when r is less than about 3fm from Ref. [15]. This difference leads to a different picture of the folded potentials (caused by the higher density profile of α nucleus) obtained for these two cases, the differences between five type interactions for α+^{40}Ca system are much greater than those of ^{16}O+^{16}O system. The observed phenomena are similar to the results of Ref. [15]. This change can affect the elastic scattering for α+^{40}Ca system at 104MeV[15]. However, for ^{16}O+^{16}O system at 350MeV, this has much less effect on the elastic scattering. On the other hand it is also shown that the new program can calculate rightly the real part of interaction potential at the various NN interaction.

In summary, we have introduced explicitly some generalized and realistic calculation process of the double folding model, including the density independence interaction and the density dependence interaction in various types. The new program is applied to calculate the real parts of interaction potential of several HI reaction systems, including the halo nucleus reaction, at low and medium energies. All of the results are agreeable with those from references. In this way, we present the real folded potential of neutron-halo nucleus ^{6}He on ^{12}C target including BDM3Y1 and CDM3Y6 NN interaction and three kinds of densities for ^{6}He in order to find information for elastic scattering of halo nuclei. We find that both of NN interactions lead to the same folded potential with the frame of Gaussian density and fc6 density. With the analysis of ^{6}He we show that they are well suited to the elastic scattering of halo nuclei. At the same time we also probe the sensitivity of the real part of interaction potential to different forms of the density dependence. We find that the sensitivity of HI system is less than that of α system because the maximum overlap density in HI system is less than that formed in α system. Above all, our present double folding model shows clearly the realistic results of folding model calculations for various systems. It is reliably suited to calculate the real folded potential and allows us to apply it to explore HI elastic scattering, especially for halo nuclei.

We thank Pang Danyang for the meaningful discussion. We also thank the financial support from China Postdoctoral Science Foundation.

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双折叠模型对相互作用势实部的计算*

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摘要　用双折叠模型计算了核核碰撞的相互作用势, 其中核子–核子相互作用势采用M3Y-Reid和M3Y-Paris形式, 交换部分考虑了有限力程的密度依赖的核子–核子相互作用, 程序用于重离子散射光学势实部的计算. 回顾了折叠模型的普遍特征和讨论了理论计算过程, 对各种类型的核子–核子相互作用下计算的相互作用势进行比较, 发现双折叠模型对大部分系统相互作用势的实部取得了满意的结果. 因此这个工作为重离子相互作用势的折叠计算提供了很好的方法.

关键词　重离子反应　双折叠模型　核子–核子相互作用　晕核

2006 – 10 – 12 收稿

∗ 国家自然科学基金(60275092, 10375095)资助

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