

文献整理

Glauber模型有关内容

HIGH-ENERGY COLLISION THEORY

R. J. Glauber
Department of Physics
Harvard University

Glauber的讲义，比较原始的内容。

Glauber模型有关内容

PHYSICAL REVIEW C 78, 024611 (2008)

Analysis of deuteron elastic scattering from $^{6,7}\text{Li}$ using the continuum discretized coupled channels method

Tao Ye and Yukinobu Watanabe*

Department of Advanced Energy Engineering Science, Kyushu University, Fukuoka 816-8580, Japan

Kazuyuki Ogata

Department of Physics, Kyushu University, Fukuoka 812-8581, Japan

Satoshi Chiba

Advanced Science Research Center, Japan Atomic Energy Agency, Tokai, Naka, Ibaraki 319-1195, Japan

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The continuum discretized coupled channels (CDCC) approach is applied to analysis of deuteron elastic scattering from $^{6,7}\text{Li}$ in the energy range from 10 to 50 MeV. Phenomenological neutron and proton optical potentials that are essentially important in the CDCC calculation are determined from the present optical model analysis of differential cross sections of nucleon elastic scattering, neutron total cross sections, and reaction cross sections of $^{6,7}\text{Li}$ for energies from 5 to 50 MeV. The CDCC result provides satisfactory agreement with experimental data, particularly at forward angles. The obtained nucleon optical model potentials are found to describe reasonably well both nucleon and deuteron elastic scattering from $^{6,7}\text{Li}$ for energies up to 50 MeV.

DOI: [10.1103/PhysRevC.78.024611](https://doi.org/10.1103/PhysRevC.78.024611)

PACS number(s): 25.45.De, 25.40.-h, 24.10.Eq, 24.10.Ht

Kyushu University发展的这个系统的开端，使用CDCC计算氘核的弹性散射，其研究背景是国际聚变材料辐照设施的需求（International Fusion Material Irradiation Facility, IFMIF）。

Glauber模型有关内容

PHYSICAL REVIEW C **80**, 014604 (2009)

Analysis of deuteron breakup reactions on ${}^7\text{Li}$ for energies up to 100 MeV

Tao Ye and Yukinobu Watanabe*

Department of Advanced Energy Engineering Science, Kyushu University, Fukuoka 816-8580, Japan

Kazuyuki Ogata

Department of Physics, Kyushu University, Fukuoka 812-8581, Japan

(Received 7 May 2009; published 9 July 2009)

Inclusive nucleon spectra from deuteron breakup reactions on ${}^7\text{Li}$ are analyzed in terms of the continuum discretized coupled channels theory for the elastic breakup process and the Glauber model for the nucleon stripping process. Both theoretical models use the same phenomenological nucleon optical potential of ${}^7\text{Li}$ and have no other free parameters. The calculations reproduce well a prominent bump observed around half the incident energy in experimental inclusive spectra of 40-MeV (d, xn) and 100-MeV (d, xp) reactions at forward angles. The analysis shows that the stripping process is more important than the elastic breakup process in deuteron breakup reactions on ${}^7\text{Li}$.

DOI: [10.1103/PhysRevC.80.014604](https://doi.org/10.1103/PhysRevC.80.014604)

PACS number(s): 24.10.-i, 25.45.-z, 24.50.+g

在这篇文章中开始使用Glauber模型对NEB截面进行计算。

Glauber模型有关内容

PHYSICAL REVIEW C

VOLUME 54, NUMBER 6

DECEMBER 1996

Breakup reactions of the halo nuclei ^{11}Be and ^8B

Kai Hencken and George Bertsch

Institute for Nuclear Theory, University of Washington, Seattle, Washington 98195

Henning Esbensen

Physics Division, Argonne National Laboratory, Argonne, Illinois 60439

(Received 25 July 1996)

We calculate the nuclear induced breakup of ^{11}Be and ^8B using a more realistic treatment of the diffraction and stripping processes than in previous work. The breakup is treated in the eikonal approximation with a profile function calculated from a realistic optical potential at low energies and from free nucleon-nucleon cross sections at high energies. This treatment gives a good description of measured breakup cross sections, as well as the longitudinal momentum distribution of the corelike fragments, which is narrower than predicted in the transparent limit. The real part of the potential is found to be significant and enhances the diffractive breakup at low energies. [S0556-2813(96)01712-8]

PACS number(s): 25.60.Gc, 24.10.-i, 25.70.Mn

Ye Tao使用的Glauber模型中的一些公式推导细节。

在A. Mehndiratta, P. Shukla, The Glauber model and heavy ion reaction and elastic scattering cross sections, Nuclear Physics A 961 (2017) 22-36, 中也涵盖一些推导的过程, 和一些模型的评论。

Glauber模型有关内容

PHYSICAL REVIEW C **84**, 054606 (2011)

Analysis of inclusive (d, xp) reactions on nuclei from ${}^9\text{Be}$ to ${}^{238}\text{U}$ at 100 MeV

Tao Ye

Institute of Applied Physics and Computational Mathematics, Beijing 100094, China

Shintaro Hashimoto*

Advanced Science Research Center, Japan Atomic Energy Agency, Ibaraki 319-1195, Japan

Yukinobu Watanabe

Department of Advanced Energy Engineering Science, Kyushu University, Fukuoka 816-8580, Japan

Kazuyuki Ogata

Research Center of Nuclear Physics (RCNP), Osaka University, Ibaraki 567-0047, Japan

Masanobu Yahiro

Department of Physics, Kyushu University, Fukuoka 812-8581, Japan

(Received 26 April 2011; published 4 November 2011)

Inclusive proton emissions from deuteron-induced reactions on ${}^9\text{Be}$, ${}^{12}\text{C}$, ${}^{27}\text{Al}$, ${}^{58}\text{Ni}$, ${}^{93}\text{Nb}$, ${}^{181}\text{Ta}$, ${}^{208}\text{Pb}$, and ${}^{238}\text{U}$ at an incident energy of 100 MeV are analyzed using the continuum discretized coupled-channels theory for the elastic-breakup process and the Glauber model for the neutron-stripping process in order to investigate deuteron-breakup processes over a wide range of target mass numbers. The effects of Coulomb interactions are taken into account to give a proper description of proton emissions at forward angles. Moreover, the phenomenological moving-source model is used to estimate evaporation and preequilibrium components in inclusive (d, xp) spectra. The calculation reproduces fairly well a prominent bump observed around half the incident energy in experimental (d, xp) spectra for light and medium nuclei at forward angles of less than 20° whereas the calculation underestimates the bump component as the target atomic number increases. The underestimation is likely due to the fact that the eikonal approximation used in the Glauber model becomes worse due to strong Coulomb interactions. It is shown that the Glauber-model calculation for the neutron-stripping process leads to an improvement of this discrepancy by substituting the eikonal phase shift for the quantum phase shift given by the optical-model calculation.

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PACS number(s): 24.10.-i, 25.45.-z, 24.50.+g

... as the target atomic number increased. The analysis revealed that the stripping process is more dominant than the elastic-breakup process for light and medium target nuclei and that the elastic-breakup process is considerably enhanced due to the effect of the Coulomb breakup for heavy target nuclei. It was found that the underestimation seen in the inclusive (d, xp) spectra for high-atomic-number nuclei is improved by replacement of the eikonal S matrix with the quantum S matrix in the Glauber-model expression. This suggests the importance of the noneikonal effect in (d, xp) reactions with high-atomic-number nuclei even at an incident deuteron energy of 100 MeV. Thus, more quantum mechanical approaches beyond the semiclassical Glauber model will be necessary to describe accurately inclusive (d, xp) reactions for high-atomic-number nuclei at relatively low incident energies below 100 MeV.

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这篇中在CDCC与Glauber模型中增加了Coulomb相互作用的影响，对Glauber来说直接加上一个库伦相移；另外使用quantum S矩阵代替了eikonal S矩阵

Glauber模型有关内容

PHYSICAL REVIEW C **70**, 034609 (2004)

Momentum distributions in stripping reactions of radioactive projectiles at intermediate energies

C. A. Bertulani¹ and P. G. Hansen^{1,2,*}

¹*Department of Physics and Astronomy, Michigan State University, East Lansing, Michigan 48824, USA*

²*National Superconducting Cyclotron Laboratory, Michigan State University, East Lansing, Michigan 48824, USA*

(Received 7 July 2004; published 24 September 2004)

The theory of one-nucleon removal in the stripping reaction (inelastic breakup) on a light target is extended to cover two-dimensional momentum distributions of the reaction residues with the use of realistic profile functions for the core-target and nucleon-target interactions. Examples of the calculated projected parallel- and transverse momentum distributions are given. The transverse momentum distributions, projections on a Cartesian axis perpendicular to the beam direction, show an interesting intermingling of the stripping reaction with elastic scattering of the reaction residue on the target. We also obtain doubly differential distributions of the cross section on the parallel- and transverse-momentum variables. The distributions depend strongly on the value of the magnetic quantum number m . They will be of importance for evaluating acceptance corrections in experiments, and they lead to alignment with the possibility of anisotropic emission of subsequent gamma rays, an interesting spectroscopic tool. Experimental data for proton stripping of ^8B agree with our calculations.

DOI: 10.1103/PhysRevC.70.034609

PACS number(s): 21.10.Jx, 24.50.+g, 25.60.-t, 27.20.+n

上一篇中提到的如何考虑添加库仑相互作用的影响。

Glauber模型有关内容

OPTICAL MODELS IN THE RESOLVED RESONANCE REGION

C. H. Johnson
Oak Ridge National Laboratory
Oak Ridge, Tennessee 37831, USA

ABSTRACT

Using modern time-of-flight facilities the resolved resonance region can be extended upward to about 1 MeV for nuclei with $A < 60$ and for heavier nuclei near closed shells. A careful measurement both on and off resonances followed by an R-matrix analysis yields partial wave scattering functions which are easily energy averaged for comparison to those from an optical model. A comparison of average scattering functions of opposite parities can provide information on surface effects because the wave functions for different parities are out of phase at the surface. Thus, a unique supplement is made to the information that can be obtained from other types of measurements for both the bound region and higher energies.

使用的quantum S矩阵来自这篇文章以及其包括的代码ECIS。

Glauber模型有关内容

Analysis of deuteron breakup reactions for energies up to 100 MeV

Yukinobu Watanabe^{1,a}, Tao Ye¹, and Kazuyuki Ogata²

¹ Department of Advanced Energy Engineering Science, Kyushu University, Kasuga, Fukuoka 816-8580, Japan

² Department of Physics, Kyushu University, Fukuoka 812-8581, Japan

Abstract. Inclusive nucleon spectra from deuteron breakup reactions on ${}^7\text{Li}$ and ${}^{12}\text{C}$ up to 100 MeV are analyzed by using the continuum discretized coupled channels theory for elastic breakup process and the Glauber model for nucleon stripping process. The preequilibrium and evaporation components are estimated phenomenologically in terms of the moving source model. The calculation reproduces a prominent bump observed around half the incident energy in experimental inclusive spectra at forward angles quite well. The present analysis clarifies that the stripping process is more dominant than the elastic breakup process in deuteron breakup reactions on ${}^7\text{Li}$ and ${}^{12}\text{C}$.

process. Moreover, it was confirmed that the Glauber approximation is satisfied even at relatively low energy of 40 MeV because the stripping reaction takes place predominantly in the peripheral region of the target nucleus ${}^7\text{Li}$ and the potential depth between deuteron and ${}^7\text{Li}$ around the surface is sufficiently smaller than the incident energy.

这里给出的对于较低入射能量时，Glauber模型表现比较好的原因是，由于入射能量要明显高于原子表面处势的深度。而Stripping主要与这部分的形状有关。

Glauber模型有关内容


ELSEVIER

Energy Procedia 71 (2015) 219 – 227



The Fourth International Symposium on Innovative Nuclear Energy Systems, INES-4

Development of a calculation code system for evaluation of
deuteron nuclear data

Shinsuke NAKAYAMA^{a,*}, Shouhei ARAKI^a, Yukinobu WATANABE^a,
Osamu IWAMOTO^b, Tao YE^c, Kazuyuki OGATA^d

这篇的内容主要是加入了考虑了束缚态的情况，
虽然我们的计算中没有涉及这部分内容，但可以
用作发展过程的参考。

Glauber模型有关内容

PTEP

Prog. Theor. Exp. Phys. **2012**, 01A206 (44 pages)

DOI: 10.1093/ptep/pts008

The continuum discretized coupled-channels method and its applications

Masanobu Yahiro^{1,*}, Kazuyuki Ogata^{2,*}, Takuma Matsumoto^{1,*}, and Kosho Minomo^{1,*}

¹*Department of Physics, Kyushu University, Fukuoka 812-8581, Japan*

²*Research Center of Nuclear Physics (RCNP), Osaka University, Ibaraki, Osaka 567-0047, Japan*

*E-mail: yahiro@phys.kyushu-u.ac.jp; kazuyuki@rcnp.osaka-u.ac.jp; matsumoto@phys.kyushu-u.ac.jp; minomo@phys.kyushu-u.ac.jp

Although this model calculation successfully reproduces the experimental data at small angles, we found some problems of the Glauber model calculation for the neutron stripping. The Glauber model calculation shows that the peak position in the emission spectra shifts to high energy as the emission angle increases, and fails to reproduce the experimental spectra at large angles; see Ref. [188]. Furthermore, inclusive (d, xp) spectra for heavy target nuclei are underestimated by the model calculation [191] because the Glauber model cannot treat Coulomb breakup effects accurately. These may suggest a limitation of applying the Glauber model. Therefore, it is desirable to apply the eikonal reaction theory (ERT) described in Sect. 6 to the evaluation of the stripping process. This may eventually make it feasible to *predict* nucleon production from deuteron induced reactions.

ECDC

6. Proposal of the eikonal reaction theory that makes CDCC applicable to inclusive reactions

CDCC is highly reliable for describing exclusive reactions but is not applicable to inclusive cross sections such as a neutron removal cross section. In this section, we present an accurate method of treating inclusive reactions within the framework of CDCC. According to the method, the nuclear and Coulomb breakup processes are consistently treated by CDCC without making the adiabatic approximation to the Coulomb interaction, so that the removal cross section calculated never diverges. This method is referred to as the *eikonal reaction theory (ERT)*. This section consists of a brief review of Refs. [143] and [144], and a new application of ERT to two-neutron removal reactions.

3.2. Validity of the Glauber model

The Glauber model is based on the eikonal approximation for NN scattering and the eikonal and adiabatic approximations for nucleus–nucleus scattering. The condition for the eikonal approximation to be good for NN collisions in both free space and nucleus–nucleus scattering is that

$$v(\mathbf{r})/e \ll 1, \quad ka \gg 1, \quad (3.3)$$

where e (k) is the kinetic energy (wave number) of the NN collision, \mathbf{r} is the relative coordinate between two nucleons and a is the range of the realistic NN interaction v . Obviously, this condition is not well satisfied, because v has a strong short-range repulsive core; for example, $v \sim 2,000$ MeV at $r = 0$ for the AV18 force [94]. In fact, the eikonal approximation is not good for NN scattering at intermediate energies, as shown in the left panel of Fig. 2. To avoid this problem, a slowly-varying function such as the Gaussian form has been used as a profile function in the Glauber model [95].

ECDCC

Ogata, K. and Yahiro, M. and Iseri, Y. and Matsumoto, T. and Kamimura, M. (2003). New coupled-channel approach to nuclear and Coulomb breakup reactions. *Phys. Rev. C.* 68. 064609.

Ogata, K. and Hashimoto, S. and Iseri, Y. and Kamimura, M. and Yahiro, M. (2006). Determination of S17 from 8B breakup by means of the method of continuum-discretized coupled channels. *Phys. Rev. C.* 73. 024605.

Glauber模型有关内容

Iwamoto也涉及有类似的工作，比如其开发的CCONE系统，为Nakayama等人的工作提供了pre-equilibrium与compound nucleus过程的数据。其使用的方法是the exciton and Hauser-Feshbach models。



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Nuclear Data Sheets 131 (2016) 259–288

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The CCONE Code System and its Application to Nuclear Data Evaluation for Fission and Other Reactions

O. Iwamoto,^{1,*} N. Iwamoto,¹ S. Kunieda,¹ F. Minato,¹ and K. Shibata¹

¹*Nuclear Data Center, Japan Atomic Energy Agency, Tokai-mura, Ibaraki 319-1195, Japan*
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A computer code system, CCONE, was developed for nuclear data evaluation within the JENDL project. The CCONE code system integrates various nuclear reaction models needed to describe nucleon, light charged nuclei up to alpha-particle and photon induced reactions. The code is written in the C++ programming language using an object-oriented technology.

最近的一些工作

Shinsuke Nakayama, Naoya Furutachi, Osamu Iwamoto, and Yukinobu Watanabe, Role of breakup processes in deuteron-induced spallation reactions at 100–200 MeV/nucleon , PHYSICAL REVIEW C 98, 044606 (2018)

Nakayama, S., Iwamoto, O., Watanabe, Y., & Ogata, K. (2021). JENDL/DEU-2020: deuteron nuclear data library for design studies of accelerator-based neutron sources. *Journal of Nuclear Science and Technology*, 58, 805 - 821.

Iwamoto, O. (2022). Calculation of recoil nucleus spectrum in the presence of multi-particle emission in nuclear reaction with Monte Carlo method as an extension of CCONE code. *Journal of nuclear science and technology*, 59 (10), s. 1232–1241.

最近的一些工作

Wakasa, T., Goto, S., Matsuno, M., Mitsumoto, S., Okada, T., Oshiro, H., & Sakaguchi, S. (2017). Neutron production cross sections for (d, n) reactions at 55 MeV. *Progress of Theoretical and Experimental Physics*, 2017.

Nakayama, Shinsuke and Kouno, Hiroshi and Watanabe, Yukinobu and Iwamoto, Osamu and Ogata, Kazuyuki. (2016). Theoretical model analysis of (d, xn) reactions on ^9Be and ^{12}C at incident energies up to 50 MeV *Phys. Rev. C*. 94. 014618.

Nakayama, S., Iwamoto, O., & Watanabe, Y. (2019). Consistent description of light composite particle emission in deuteron-induced reactions. *Physical Review C*.

最近的一些工作

Description of inclusive $(d, d'x)$ reaction with the semiclassical distorted wave model

Hibiki Nakada,^{1,*} Kazuki Yoshida,² and Kazuyuki Ogata^{3,1}

¹Research Center for Nuclear Physics (RCNP), Osaka University, Ibaraki, Osaka, 567-0047, Japan

²Advanced Science Research Center, Japan Atomic Energy Agency, Tokai, Ibaraki 319-1195, Japan

³Department of Physics, Kyushu University, Fukuoka 819-0395, Japan

Background: The description of deuteron-induced inclusive reactions has been an important subject in direct nuclear reaction studies and nuclear data science. For proton-induced inclusive processes, the semiclassical distorted wave model (SCDW) is one of the most successful models based on quantum mechanics.

Purpose: We improve SCDW for deuteron-induced inclusive processes and clarify the importance of the proper treatment of the kinematics of the deuteron inside a nucleus.

Methods: The double differential cross section (DDX) of the inclusive deuteron-emission process $(d, d'x)$ is described by one-step SCDW.

Results: The calculated DDXs of $(d, d'x)$ reproduce experimental data by taking into account the changes in the kinematics of the deuteron due to the distorting potential, in the small energy-transfer region and at forward angles.

Conclusion: It is confirmed that the proper treatment of the changes in the kinematics of the deuteron inside a nucleus is necessary to reproduce experimental data. The effect of the changes on the DDX of $(d, d'x)$ is significant compared to the proton-induced inclusive process $(p, p'x)$ because of the stronger distortion effect on the deuteron.

DEURACS employs the Glauber model [13] to circumvent the difficulty; the eikonal and adiabatic approximations allow one to describe NEB as a combination of neutron elastic and proton nonelastic processes, and the latter can easily be evaluated by using the closure property of the proton scattering matrix [14, 15]. The validity of the Glauber model is, however, rather questionable at low incident energy and/or for large momentum and energy transfer. In fact, the agreement between the result of DEURACS and experimental data for (d, nx) at middle emission angles is slightly flawed compared with that at forward angles [12]. Although the neutron emission cross section is forward-peaked and the “deviation” is not very serious for practical use, the description of NEB of deuteron without using the eikonal and adiabatic approximations will be an important subject of nuclear reaction study. Recently, the Ichimura-Austern-Vincent

approximations will be an important subject of nuclear reaction study. Recently, the Ichimura-Austern-Vincent (IAV) model [16] has successfully been applied to NEB in several cases [8, 17, 18]. It should be noted, however, that in the IAV model for (d, nx) , the kinematics of the neutron are not affected at all by the nonelastic processes for which the proton and A undergo. In this sense, the three-body kinematics are not treated in a fully consistent manner in the IAV model.

光学势与实验文章


PHYSICAL REVIEW C 73, 054605 (2006)

Global deuteron optical model potential for the energy range up to 183 MeV

Haixia An and Chonghai Cai*

Department of Physics, Nankai University, Tianjin 300071, China

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Nuclear Physics A 713 (2003) 231–310


www.elsevier.com/locate/npe

Local and global nucleon optical models from 1 keV to 200 MeV

A.J. Koning^{a,*}, J.P. Delaroche^b

光学势与实验文章

PHYSICAL REVIEW C, VOLUME 63, 014610

Inclusive proton production cross sections in (d, xp) reactions induced by 100 MeV deuterons

D. Ridikas,* W. Mittig, H. Savajols, and P. Roussel-Chomaz
GANIL, BP 5027, F-14076 CAEN Cedex 5, France

S. V. Förtsch, J. J. Lawrie, and G. F. Steyn
NAC, P.O. Box 72, 7131 Faure, South Africa
(Received 24 June 2000; published 20 December 2000)

DEUTERON BREAK-UP IN THE FIELDS OF NUCLEI AT 56 MeV

N. MATSUOKA, M. KONDO, A. SHIMIZU, T. SAITO and S. NAGAMACHI †
Research Center for Nuclear Physics, Osaka University, Suita, Osaka 565, Japan

and

H. SAKAGUCHI, A. GOTO †† and F. OHTANI
Department of Physics, Kyoto University, Kyoto 606, Japan

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其他模型