刘昌奇个人事迹

基本情况	姓 名	刘昌奇	性 别	男	学习阶段	☐硕士 ☑博士	
	出生年月	1993.09	籍 贯	湖北武汉	方 向	中子物理与中子应用技术	
	所在学院	核科学与技术学院		所学专业	粒子物理与原子核物理		

目前，本人在校获取的已发表科研成果及已获得荣誉如下所示：

1. Monte Carlo simulation of fast neutron-induced fission of ^{237}Np

SCI 分区：二区；

影响因子：5.861；

发表时间：2019 年 6 月；

属名情况：1/16

第一单位：兰州大学

Chinese Physics C Vol. 43, No. 6 (2019) 064001

Monte Carlo simulation of fast neutron-induced fission of ^{237}Np *

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Abstract: The potential-driving model is used to describe the driving potential distribution and to calculate the pre-neutron emission mass distributions for different incident energies in the ^{237}Np(n, f) reaction. The potential-driving model is implemented in Geant4 and used to calculate the fission-fragment yield distributions, kinetic energy distributions, fission neutron spectrum and the total nubar for the ^{237}Np(n, f) reaction. Compared with the built-in G4ParaFissionModel, the calculated results from the potential-driving model are in better agreement with the experimental data and evaluated data. Given the good agreement with the experimental data, the potential-driving model in Geant4 can describe well the neutron-induced fission of actinide nuclei, which is very important for the study of neutron transmutation physics and the design of a transmutation system.

Keywords: neutron-induced fission reaction, fission process, Monte Carlo simulation, potential-driving model, ^{237}Np

PACS: 24.75.+i, 25.85.Ec, 21.60.Ka **DOI:** 10.1088/1674-1137/43/6/064001

2. Study on secondary electron suppression in compact D–D neutron generator

SCI 分区：四区；

影响因子：0.961；

发表时间：2019 年 5 月；

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第一单位：兰州大学

NUCL SCI TECH (2019) 30:86
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Study on secondary electron suppression in compact D–D neutron generator

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Received: 12 September 2018 / Revised: 4 November 2018 / Accepted: 9 November 2018 / Published online: 26 April 2019

Abstract A compact D–D neutron generator, with a peak neutron yield of D–D reactions up to 2.48×10^8 n/s is being developed at Lanzhou University in China for application in real-time neutron activation analysis. During tests, the problem of back acceleration of secondary electrons liberated from the neutron production target by deuterium ions bombardment was encountered. In this study, an electric field method and a magnetic field method for suppressing secondary electrons are designed and experimentally investigated. The experimental results show that the electric field method is superior to the magnetic field method. Effective suppression of the secondary electrons can be achieved via electrostatic suppression when the bias voltage between the target and the extraction-accelerating electrode is > 204 V. Furthermore, the secondary electron emission coefficient for the mixed deuterium ion (D_1^+, D_2^+, and D_3^+) impacting on molybdenum is estimated. In the deuterium energy range of 80–120 keV, the estimated secondary electron emission coefficients are approximately 5–5.5 for the mixed deuterium ion glancing incidence of 45° and approximately 3.5–3.9 for the mixed deuterium ion normal incidence.

Keywords D–D neutron generator · Secondary electron suppression · Secondary electron emission coefficient

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1 Introduction

Compact neutron generators based on ^{2}H(d,n)^{3}He (D–D) and ^{3}H(d,n)^{4}He (D–T) fusion reactions are among the most important neutron sources. With advantages over isotropic neutron sources in the radiation safety and the neutron output adjustability, they have important applications in scientific research and neutron application technologies, such as neutron imaging [1] and neutron activation analysis [2–4]. A compact D–D neutron generator (CDDNG) with a peak neutron output of up to 2.48×10^8 n/s is being developed at Lanzhou University for real-time neutron activation analysis [5].

The scheme of the CDDNG is shown in Fig. 1. The outline of the CDDNG is a cylinder with a length of 984 mm and a diameter of 234 mm. The CDDNG consists of an ion source, an extraction-accelerating electrode, a target assembly, a high-voltage insulator assembly, a vacuum vessel, and a vacuum system. Deuterium ions are produced from a duoplasmatron ion source. To simplify the mode of power supply and ensure the safety and reliability during operation, a negative high voltage is applied to the target, and the ion source is kept at ground potential. The gap between the extraction-accelerating electrode and the

3. Physical design and evaluation of a high-intensity accelerator-based D-D/D-T fusion neutron source

SCI 分区：二区；

影响因子：2.481；

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第一单位：兰州大学

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DOI 10.1140/epja/i2019-12848-5

THE EUROPEAN PHYSICAL JOURNAL A

Special Article – New Tools and Techniques

Physical design and evaluation of a high-intensity accelerator-based D-D/D-T fusion neutron source

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Abstract. A high-intensity accelerator-based D-D/D-T fusion neutron source (ZF-400) with a thick adsorption target is designed with an intensity of 10^{13} n/s. A high-current microwave ion source is used to produce a large current deuteron beam, and neutrons are generated by irradiating the deuteron beam on a deuterium-adsorption target or tritium-adsorption target. According to the particle-in-cell (PIC) code, the length of the whole high-current D^+ beam transport line is 500 cm, the D^+ beam transfer efficiency is up to 96%, and various components can match each other. On the rotating target, the D^+ beam spot size is about 20.0 mm with energy of 450 keV. Based on the heat conduction theory, the thick adsorption rotating target with water-cooling can withstand the D^+ ions beam with 450 kV/50 mA and ensure that the temperature is less than 200 °C. According to the multi-layer computing model, neutron energy spectra, angular distributions and yields for the thick target can be calculated with remarkable precision. The neutron energy spectra are non-mono-energetic neutrons for the ZF-400 neutron generator, the neutron angular distributions are anisotropic distributions, and they can provide neutrons with an intensity of 2.8×10^{11} n/s (D-D) and 1.4×10^{13} n/s (D-T), respectively, with the deuteron of 450 keV/50 mA.

1 Introduction

Recent decades have seen considerable attention to various properties of intense neutron sources produced by deuteron bombardment on thick light element targets [1–14], typical reactions include $^2H(d,n)^3He$ (D-D) reaction and $^3H(d,n)^4He$ (D-T) reaction. The characteristics of D-D and D-T neutron sources, such as neutron energy spectrum, angular distribution and integrated yield, should be investigated due to their importance in producing quasi-mono-energetic neutrons at lower bombarding deuteron energies [4,5]. Accelerator-based D-D/D-T fusion neutron sources are widely used in neutron physics and neutron application technology, ranging from nuclear data measurements [15,16], radiobiology [17], radiotherapy [18], radiography [19], neutron activation analysis [20], irradiation effect researches [21,22], etc.

Since 1950s, some countries have begun to develop neutron generators. Generally, a Cockcroft-Walton accelerator accelerates D^+ ions with $\sim 10^2$ keV, deuterons bombardment on deuterium-adsorption or tritium-adsorption target to produce neutrons. Lawrence Livermore National Laboratory (in the United States) developed the RTNS-II neutron generator, with neutron yield of 3.5×10^{13} n/s at the deuteron of 370 keV/150 mA [23,24]. The SNEG-13 neutron generator was developed in Russia, with neutron yield of 1.0×10^{13} n/s [25,26]. JAEA/FNS and OKATAVIAN was developed in Japan, with a neutron yield of $3.0 \sim 5.0 \times 10^{12}$ n/s [27,28]. DYNAGEN-IV was developed in Germany, with a neutron yield of 3.0×10^{12} n/s [29]. LANCECOT was developed in France, with a neutron yield of 6.0×10^{12} n/s [30]. In China, the Lanzhou University has been developing a series of high-yield neutron generators since the 1980s, ZF-300, built in 1988, with a neutron yield of 3.3×10^{12} n/s [31]. At present, a new high-intensity D-D/D-T neutron source, named ZF-400, is also being built in the Lanzhou University.

The ZF-400 neutron generator is designed to produce up to 5.5×10^{12} n/s by D-T fusion reaction using a Cockcroft-Walton accelerator providing D^+ ions at 400 keV with a beam current of 70 mA to a tritium-adsorption target rotating at 1500 rpm. Due to the space charge effect influences, the key issue in the transport line is transporting continuous deuterium beam with an inten-

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4.软件著作权：“基于双动能法核裂变物理实验数据分析[简称：NuclFEDA]”

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5. 国际核数据大会会议论文

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属名情况：2/9

第一单位：兰州大学

EPJ Web of Conferences **239**, 05015 (2020)   https://doi.org/10.1051/epjconf/202023905015
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Monte-Carlo calculation of fission process for neutron-induced typical actinide nuclei fission

Zheng Wei[1,2,*], *Changqi* Liu[1], *Chao* Han[1], *Zeen* Yao[1,2], *Yu* Zhang[1,2], *Junrun* Wang[1,2], *Xiaolong* Lu[1,2], *Xiaodong* Su[1,2], and *Dapeng* Xu[1,2]

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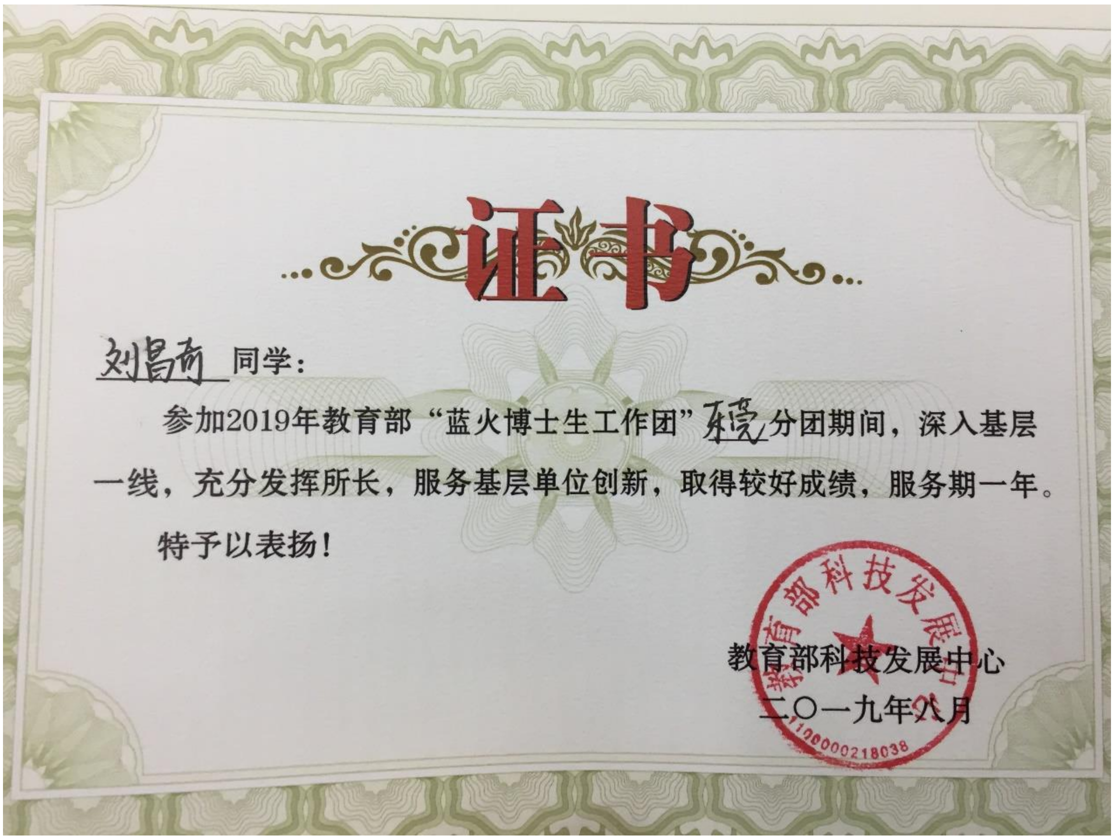
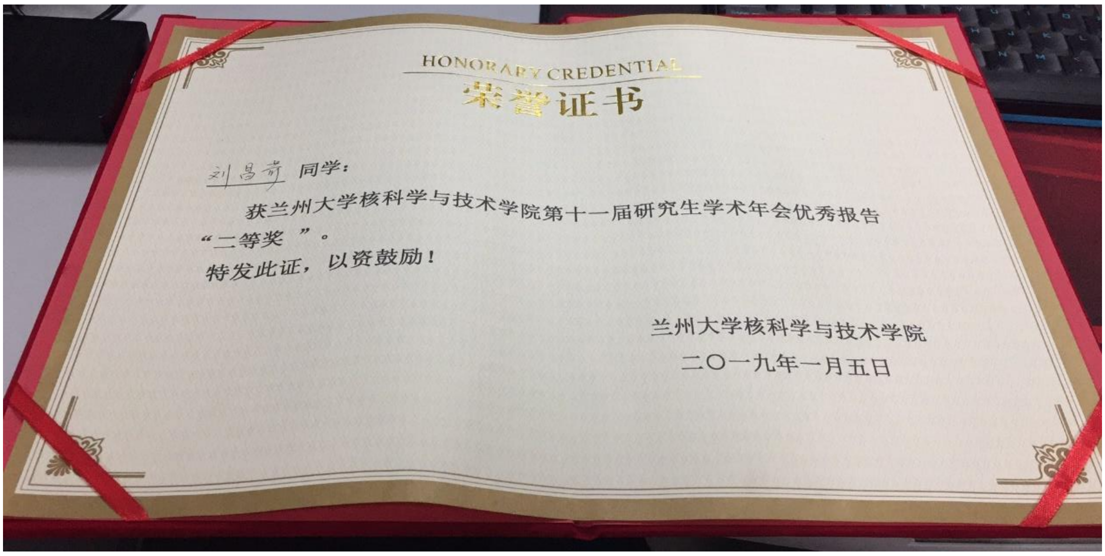
Abstract. A global potential-driving model with well-determined parameters is proposed by uniting the empirical asymmetric fission potential and the empirical symmetric fission potential, which can precisely calculate the pre-neutron-emission mass distributions for neutron-induced actinide nuclei fission. Based on the developed potential-driving model, Monte-Carlo code calculates the characteristics of fission reaction process for neutron-induced ^{241}Am fission. Typical calculated results, including yields, kinetic energy distributions, fission neutron spectrum and decay γ-ray spectrum, are compared with experimental data and evaluated data. It shows that the Monte-Carlo calculated results agree quite well with the experiment data, which indicate that Monte-Carlo code with the developed potential-driving model can reproduce and predict the characteristics of fission reaction process at reasonable energy ranges. Given the well predictions on the characteristics of fission reaction process, Monte-Carlo code with the developed potential-driving model can guide for the physical design of nuclear fission engineering.

6. 参加教育部举办的“蓝火计划”产、学、研博士生工作团活动，在中国散裂中子源开展为期一年的科研服务，并授予表彰



7. 参加 2019 年兰州大学核学院年会报告，荣获第二。



8. 参加 2020 年世界核大学课程，荣获结业证书。

9. 积极参加兰州大学篮球赛，作为院篮球队队长，与球队队员团结一致，2 次进入校篮球赛前八。

个人生活近照

个人成长事迹

我是兰州大学核科学与技术学院的博士研究生刘昌奇。自入校以来，我坚持对自己严格要求，在思想、生活、学习和工作上严格要求自己。在师长们的关怀与教导下，经过不懈努力及师门和同学的帮助，取得了一定的成绩，同时也得到了很多的经验教训，在平时的工作学习中事无巨细，必须倾力为之。以下是我的学习、思想、工作等个人事迹。请领导、老师予以评审考核，谢谢！

在思想品德方面，积极要求进步，积极向党组织靠拢。努力使自己做得更好，争取早日成为有利于社会的共产党员。

在课程学习方面，作为一名研究生，我深知知识的重要性，勤于思考、探求真知是我始终不变的信条。研究生期间完成了学校规定的学位和专业课程，并取得了优良的成绩。对自己的专业知识有了深入的了解，在一定程度上提高了自己的专业水平。同时，充分利用学校的各种有效资源，聆听各位名师的讲座，不断扩充自己的知识面，开阔自己的眼界。

在科学研究方面，经过研究生期间的学习，培养了我严谨的科学态度。而作为一名核技术专业研究型研究生，书本上的学习仍是远远不够的，我深知前沿知识的重要性，于是阅读大量科研文献，掌握了基本实验方法，能熟练运用科研工作软件，例如，Geant4、Garfield++、Root 以及 Comsol 等专业软件。另外，在老师们的关怀和指导下，本人博士期间，已发表了一篇 SCI 二区论文，影响因子

5.861，另外两篇 sci 目前在审，分别投稿于 Jinst 与 NimA。

在科研科普方面，“谈核色变”是目前社会大众对核领域的普遍看法，而真正处于这个领域的科研工作者才知道，在合理的防护下，我们能够有效、清洁、安全地利用核能，造福人类。于是，我在学习之余开展了很多核科普工作，在社交网络平台 BiliBili 上宣传核物理知识及核技术相关科普，目前阅读量已过万，有利于社会大众正确认识、了解核领域，消除大家“谈核色变”的主观意识。

在科研活动方面，本人参加了 2019 年教育部举办“蓝火计划”产、学、研博士工作团，在中国散裂中子源开展为期一年的科研服务工作，受到表彰，深刻意识到产、学、研链地重要性，为后续开展科研工作奠定基础。并参加 2019 年国际核数据大会，报告主题“Monte-Carlo calculation of fission process for neutron-induced typical actinide nuclei fission”。

进入博士三年级，是我人生中一个极为重要的阶段。在这里我更有了自信，我虽然平凡但我充实。在生活中，我乐于帮助其他同学，同学们有任何困难，我都能尽自己所能给予帮助，尽职尽责，我在各个方面都获得了巨大的进步，综合素质得到了很大的提高。在今后，我不可以躺在自己过去的成绩上睡大觉，我必须给自己定下更大的目标和计划，无论是在学习上还是生活上、工作更上一层楼，认真学习，努力工作，完善自身的各方面条件，做一个对社会有益的优秀博士研究生。

以上是本人的个人事迹材料，我要特别感谢学校领导的大力培养，老师的深入指导以及同学们在工作和生活中给我的支持和帮助。今后我要更加严格的要求自己，以求更好的表现，用成绩见证青春的无悔。请各位领导、老师加以评判审核，谢谢。

本人参与的核动力院项目

1. 多用途紧凑型中子发生器研究与设计，国防科技工业核动力技术创新中心项目, HDLCXZX-2019-HD-33, 35.00 万元, 2019.01-2020.11.

本人主要参与了紧凑型 D-D 中子发生器的研究设计和性能测试工作。在设计工作中，本人通过有限元分析方法，利用模拟仿真软件对 D-D 中子发生器内部的电磁场分布、二次电子抑制情况等进行了研究，最终给出了合理的设计参数；在测试工作中，本人利用 EJ309 液体闪烁体探测器以及 CAEN DT5725 数据获取设备开展了紧凑型 D-D 中子发生器的 n/γ 甄别工作，另外，根据探测器不同的摆放位置，测量、解谱得到了 D-D 中子发生器不同角度的中子能谱数据，最终对紧凑型 D-D 中子发生器的中子能谱、角分布以及 n/γ 场等性能参数进行了评估。

2. 基于主动中子空间强度分布的核燃料燃耗深度测量技术研究，中国核动力研究设计院探索创新基金项目, 90.00 万元, 2020.06-2022.12.

本人目前主要参与了前期的调研工作以及部分的模拟研究工作。在调研工作中，通过阅读大量相关文献，对国内外利用主动中子方法开展核燃料燃耗深度测量的相关研究进展、研究现状有了一定了解，最终撰写了一篇调研报告。在模拟研究工作中，根据核动力院某所老师的要求，计算了 252Cf 中子源诱发某锕系核素裂变产生的多种裂变碎片动能分布，以及多种轻质裂变碎片在某特定材料几何中的透射、吸收率等。计算数据将用于后续结项报告中。