

# Research on Interdisciplinary Integration in College Physics Teaching: Taking Nuclear Physics as an Example

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**Abstract:** In university physics teaching, interdisciplinary integration is an important way to promote the development of comprehensive subject knowledge and ability. Taking nuclear physics as an example, by integrating mathematics, chemistry and engineering disciplines, students can have a deep understanding of the basic principles and applications of nuclear physics. Through case analysis, experimental teaching and field investigation of nuclear physics, teachers can understand the correlation between nuclear physics and other disciplines, and cultivate students' critical thinking, problem-solving ability and team spirit. This interdisciplinary integration of practice and exploration can promote the students' overall quality and lay a solid foundation for their future academic research and career development.

**Keywords:** university physics; interdisciplinary integration; practice; exploration

## 1. Introduction

In the modern society, the boundary of knowledge is increasingly blurred, and the intersection and integration between disciplines have become a trend. Interdisciplinary integration can combine the knowledge of different disciplines with theories to help students to understand and apply what they have learned more comprehensively. As a complex subject, nuclear physics major involves the knowledge and skills of physics, mathematics, chemistry, engineering and other disciplines. Only relying on the traditional subject separation teaching mode, cannot fully meet the students' comprehensive understanding of nuclear physics knowledge and the cultivation of practical ability. Through the interdisciplinary integration of teaching methods, we can promote the development of nuclear physics students' comprehensive abilities. Students can master a wider range of knowledge and skills in the cross-study of multiple disciplines, develop interdisciplinary thinking skills and problem-solving skills, and lay a solid foundation for their future academic and professional development. Therefore, for the teaching of nuclear physics major, the interdisciplinary integration teaching has an important background and significance. This paper aims to explore the practice and exploration of interdisciplinary integration teaching in university physics teaching, in order to provide useful enlightenment and reference for the teaching of other subjects[1].

## 2. Significance of interdisciplinary integration in physics teaching

Interdisciplinary integrated teaching refers to the integration and combination of the knowledge, theories, methods and skills of multiple disciplines to build an interdisciplinary teaching environment and learning experience. It goes beyond the traditional discipline boundary and promotes students' all-round development and in-depth understanding through the mutual penetration and crossover between disciplines[2].

### 2.1 The impact of interdisciplinary integration on students

First, we will improve our comprehensive ability. Interdisciplinary integration teaching can help students understand and apply knowledge and concepts in different disciplines and develop students' comprehensive abilities, such as critical thinking, creativity and problem solving. Second, all-round development. Through interdisciplinary learning, students can be exposed to a wider range of knowledge, cultivate interest and understanding in different fields, and promote all-round development.

Third, practical application. Interdisciplinary integration teaching can help students combine theoretical knowledge with practical problems, develop practical ability and innovative thinking, and prepare them for future career development<sup>[3]</sup>

### ***2.2 Application and challenges of interdisciplinary integration in physics teaching***

First, in the design of teaching content, it is necessary to integrate physical knowledge with knowledge of other disciplines, for example, the concepts and methods of mathematics, chemistry, computer science and other disciplines can be introduced into the teaching of physics, which gives students a more comprehensive interdisciplinary vision. Second, teaching method innovation is emphasized. Teachers can adopt interdisciplinary teaching methods such as problem-driven learning and experimental practice, which guide students to actively participate in practice and exploration, and deepen their understanding and application of physical concepts<sup>[4]</sup>.

However, interdisciplinary integration also faces some challenges in physics teaching: first, teachers' professional knowledge and ability. Teachers need to have interdisciplinary knowledge and ability, and to be able to integrate and impart the content of multiple disciplines, which puts forward higher requirements for teachers' professional development. Second, the subject boundary is blurred. Interdisciplinary integration teaching may blur the boundaries between disciplines, and it is a challenge for students and teachers to balance the relationship and importance between different disciplines. Third, teaching resources and time constraints. Interdisciplinary teaching needs sufficient teaching resources and time, including experimental equipment, interdisciplinary curriculum arrangement, etc. How to make full use of the limited resources is a problem that needs to be solved.<sup>[5]</sup>

## **3. Teaching status and problems of nuclear physics major**

### ***3.1 Characteristics and actual requirements of the nuclear physics major***

First, combine theory with practice. Nuclear physics major requires students to master the theoretical knowledge of nuclear physics, and to be able to conduct experimental research and data analysis. Second, interdisciplinary intersection. Nuclear physics involves many disciplines, such as physics, mathematics, computer science, etc., and students need to have comprehensive subject knowledge and ability. Third, it is widely used. Nuclear physics is widely used in energy, medicine, environment and other fields, and students need to have the ability to solve practical problems.<sup>[6]</sup>

### ***3.2 Shortcomings and shortcomings of the existing nuclear physics courses***

First, theory is disconnected from practice. Some nuclear physics courses are too theoretical and lack of practical links, and students have insufficient understanding of the practical application of nuclear physics. Second, the discipline boundary is closed. The nuclear physics course focuses mainly physics and rarely involves interdisciplinary content, which cannot meet the needs of students. Third, the teaching method is single. Some nuclear physics courses pay too much attention to theoretical derivation, lack of heuristic teaching methods and practical activities, and it is difficult to stimulate students' interest in learning and creativity.

### ***3.3 The potential of interdisciplinary integration in nuclear physics teaching***

First, comprehensive application and practice. Through interdisciplinary integration, nuclear physics courses can apply the knowledge and methods of physics, chemistry, mathematics and other disciplines to practical problems to help students understand and solve nuclear physics problems in the real world. Second, interdisciplinary intersection and expansion. Interdisciplinary integration can introduce the concepts and methods of other disciplines, broaden the academic horizon of nuclear physics students, and promote the cultivation of interdisciplinary thinking and ability. Third, innovation and application ability training. Interdisciplinary integration teaching can stimulate students' innovative thinking, cultivate their practical and application ability in the field of nuclear physics, and prepare them for future research and career development. By applying the ideas and methods of interdisciplinary integration teaching, the teaching content of nuclear physics can be enriched, the teaching quality can be improved, and the students' learning needs and training goals can be better met.

#### **4. Interdisciplinary integration of nuclear physics and mathematics**

##### ***4.1 The fundamental role of mathematics in nuclear physics***

First, the construction of the theoretical framework. The establishment and development of nuclear physics theory needs the support of mathematics, such as calculus, linear algebra, differential equations and other mathematical tools are widely used in the establishment and solution of theoretical models of nuclear physics. Second, data analysis and simulation. Nuclear physics experiments involve massive amounts of data, and mathematical statistical theories and methods can help nuclear physicists to reasonably analyze and process the data, and obtain accurate results. Third, the deduction and solution of the physical equations. The physical equations in nuclear physics are often complex systems of differential equations, and mathematical analytical and numerical solutions can be used to solve these equations, resulting in the physical description of the system.

##### ***4.2 Application of mathematical knowledge in nuclear physics practice***

First, the wave-function description. Wave functions in quantum mechanics are important concepts in nuclear physics, and the representation and calculation of wave functions require the use of mathematical tools such as complex numbers and matrix theory. Second, analyze the nuclear reactions. In nuclear physics experiments, it is necessary to calculate and analyze different types of nuclear reactions. Mathematical differential equations, integration and other methods can help to understand and predict the characteristics of nuclear reactions. Third, the data were fit with the image processing. Experimental data in nuclear physics experiments need to be fitted and processed, and mathematical curve fitting, least squares and other methods can help to extract physical information and features in experimental data.

##### ***4.3 Exploration of teaching strategies and methods***

First, integrated curriculum design. Teachers need to design a curriculum that integrates nuclear physics and mathematics, and then incorporates the concepts and mathematical tools of nuclear physics, which can help students understand and apply the role of mathematics in nuclear physics. Second, hands-on projects. It is necessary to introduce practical projects, which require students to use mathematical knowledge to solve nuclear physics problems, such as data analysis, simulation and calculation, which can improve students' practical application ability and innovation ability. Third, cooperative learning. Teachers should encourage students to learn together, solve mathematical and nuclear physics problems through discussion and cooperation, promote communication and cooperation among students, and strengthen the cultivation of interdisciplinary thinking and ability. Through the exploration of these teaching strategies and methods, we can promote the interdisciplinary integration of nuclear physics and mathematics, improve students' understanding and application ability of nuclear physics and mathematics, and cultivate professionals in the field of nuclear physics in the future.[7]

#### **5. Interdisciplinary integration of nuclear physics and chemistry**

##### ***5.1 The intersection of chemistry and nuclear physics***

First, the radionuclide studies. Nuclear physics and radiochemistry work closely together to study the synthesis, separation, radiation effects of radionuclides, and the migration and transformation of radioisotopes in the environment and biological systems. Second, the nuclear fuel cycle. Nuclear physics and nuclear chemistry cooperate closely in the nuclear fuel cycle. Nuclear physics studies the fission process of nuclear fuel, while nuclear chemistry is responsible for the fuel purification and reprocessing process. Third, nuclear medicine and radiotherapy. Nuclear physics and nuclear chemistry play important roles in nuclear medicine and radiotherapy. Nuclear physics studies the production of nuclide and radioactive decay processes, while nuclear chemistry is responsible for the preparation of radiotracers and drugs.[8]

##### ***5.2 Application of chemical principles in nuclear physics experiments***

The detectors used in nuclear physics experiments involve the selection and preparation of chemical

materials to obtain sensitivity and response to radiation. The sample preparation process in experiments often requires the use of chemical experimental techniques, such as solution preparation, solvent extraction, etc. In the process of data analysis in nuclear physics experiments, it is often necessary to be applied to chemical statistics and image processing methods to extract effective physical information.

### ***5.3 Teaching case sharing and practical experience sharing***

First, the experimental design and operation. A series of experiments can be designed that involve the intersection of nuclear physics and chemistry, such as the synthesis of radioisotopes, chemical separations, and radiation measurements. II Research topics and paper reading. Teachers should not only guide students to read the relevant classic papers in the cross-disciplinary research field, but also encourage students to explore the connotation of nuclear physics and nuclear chemistry. Research Project Discipline Integration Practical Course: teachers should design interdisciplinary integration practical course, which requires students to work together in small groups to complete the integrated project of nuclear physics and nuclear chemistry, such as nuclear waste treatment, nuclear medicine applications, etc. Through the sharing of these cases and practical experiences, it can promote the interdisciplinary integration of nuclear physics and chemistry, cultivate students' interdisciplinary thinking and ability, and better cope with the future development and challenges of nuclear physics and chemistry.[9]

## **6. Interdisciplinary integration of nuclear physics and chemistry**

### ***6.1 Importance of engineering in the research and application of nuclear physics***

First, the design and construction of experimental equipment. Nuclear physics experiments require complex equipment and instruments, and the engineering discipline provides relevant techniques and methods to help design and build experimental equipment to ensure the effective conduct of experiments. Second, radiation protection and safety. The research and application of nuclear physics involves radiation. The engineering discipline has professional knowledge and technology in radiation protection and safety to ensure the safety of the research and application of nuclear physics. Third, nuclear power plants and nuclear energy engineering. Nuclear power plant is a typical combination of nuclear physics and engineering. The engineering discipline plays a key role in the design, construction and operation of nuclear power plants to ensure the safety and sustainable development of nuclear energy.

### ***6.2 Combination of nuclear physics experiments and engineering technology***

First, equipment design and optimization. The design of nuclear physics experiment equipment needs to take into account the experimental requirements, data acquisition, detection efficiency and other factors. With the help of the knowledge and method of engineering technology, the equipment design can be optimized and the experimental effect can be improved. Second, data acquisition and control. A large amount of data in nuclear physics experiments needs to be collected and processed. Engineering technology plays a key role in the design of data acquisition system and the development of control system to ensure accurate data acquisition and control. Third, radiation protection and safety measures. Radiation protection and safety in nuclear physics experiments are crucial. Engineering technology provides the implementation and design of relevant radiation protection measures and safety facilities to ensure the safety of laboratory personnel and the environment.

### ***6.3 Introduction of teaching projects and practice cases***

First, equipment design and optimization experiments. We want to guide students to design and optimize nuclear physics experimental equipment, consider experimental requirements, expected results and equipment efficiency in practice, and exercise students' engineering design ability. Second, data acquisition and control practice. Teachers should organize students to carry out the data acquisition and control system practice project, which requires students to design and implement the experimental data acquisition and control system, and carry out actual data acquisition and processing. Third, radiation protection and safety courses. Radiation protection and safety courses are offered to let students understand the principles and methods of radiation protection, design radiation protection measures, and simulate the implementation of practical radiation safety measures. Through the

guidance of these teaching projects and practice cases, the interdisciplinary integration of nuclear physics and engineering can be promoted, and students' engineering design ability, Practical ability and safety awareness can be cultivated, preparing them for their future in nuclear physics and engineering related fields.

## **7. Evaluation and prospect of interdisciplinary integration teaching**

### ***7.1 Evaluation indicators and methods of interdisciplinary integration teaching***

First, there is a need to improve students' integrative skills. Evaluate the knowledge and skills that students gain from integrated interdisciplinary instruction, including an increased ability to understand and apply multiple disciplines. Second, connection and application between disciplines. Teachers should assess whether students can synthesize knowledge from different disciplines to solve practical problems or conduct innovative research. Third, students' participation and interaction. In interdisciplinary integrated teaching, it is necessary to improve the enthusiasm of students' participation and the quality of interaction, such as group work, discussion and presentation. Fourth, practical outcomes and innovations. Teachers should evaluate students' practical achievements and innovations, including project reports, experimental data, research papers, etc. Evaluation of interdisciplinary integration teaching can use a combination of quantitative and qualitative methods, such as questionnaire survey, student work evaluation, group discussion and observation, etc.

### ***7.2 Students' feedback and effectiveness of interdisciplinary integration teaching***

Student feedback on interdisciplinary integration teaching is generally positive, because it helps to improve the practicality of learning, develop comprehensive abilities, and increase the connection and application of knowledge. According to the cases in practice, students generally say that interdisciplinary integrated teaching is conducive to enhancing comprehensive quality, cultivating innovative thinking and teamwork ability. At the same time, they also better understand the relationship and application of disciplines through interdisciplinary integration teaching, and improve the effectiveness and interest of learning.

### ***7.3 Development prospects and challenges of interdisciplinary integration teaching in the future***

Interdisciplinary integrated teaching has a broad development prospect in the future, which can promote students' all-round development and cultivate comprehensive ability and interdisciplinary thinking. However, there are also some challenges: first, the professionalism of teachers. Interdisciplinary integrated teaching requires teachers to have interdisciplinary knowledge and teaching experience, and teachers need to conduct professional training and promotion to better guide students in integrated learning among disciplines. Second, teaching materials and curriculum resources. Interdisciplinary integration teaching requires the appropriate teaching materials and curriculum resources, which require cooperation and resource sharing among different disciplines to meet students' learning needs. Third, the evaluation system and the recognition degree. The evaluation system and recognition of interdisciplinary integrated teaching need to be further improved and promoted in order to better evaluate students' comprehensive abilities and learning outcomes. The key to addressing these challenges is the active cooperation and support of teachers and schools, as well as the continuous improvement and innovation of the methods and practices of interdisciplinary integrated teaching. Through joint efforts, interdisciplinary integrated teaching will provide students with a broader development space and application value.

## **8. Conclusion**

Interdisciplinary integration teaching can promote the intersection and integration between disciplines, help students to fully understand and apply the knowledge of nuclear physics, and cultivate the interdisciplinary thinking ability. The importance of engineering discipline in the research and application of nuclear physics cannot be ignored. Engineering technology can provide key design and support for nuclear physics experiment and application. Interdisciplinary integrated teaching can cultivate students' practical ability, innovative consciousness and safety awareness through the guidance of teaching projects and practical cases, so as to prepare them for their future development in the field of nuclear physics and engineering.

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