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The Implementation of Ideological and Political Education in the Course of Thermodynamics and Statistical Physics

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Abstract: Thermodynamics and Statistical Physics (hereinafter referred to as TSP) is one of the core professional courses of physics. Like other theoretical physics courses, TSP involves plenty of phenomena of abstract concepts and complex formulas, which makes this course difficult and complicated for students. The ideological and political education or (ideological and political) construction of the curriculum represents new requirements for teaching reforms in current higher education. How to integrate ideological and political education into the teaching of TSP so that the two can complement each other and promote each other is the core issue of the construction of ideological and political education in TSP. This article first analyzes the advantages for ideological and political education in the TSP course, and then discusses the approach to combining ideological and political education with theoretical and knowledge teaching. It is suggested to apply scientific thoughts, scientific spirits of scientists, and excellent characters in TSP course to cultivate ideological and moral characters for students, so as to achieve the integration between professional physics curriculum and ideological and political education, and cultivate high-quality talents that the new era needs.

1. Introduction

The construction of ideological and political education for physics professionals is the focus of the current teaching reform in the major. The Thermal Dynamics and Statistical Physics (hereinafter referred to as TSP) is one of the core professional courses for senior physics students. Therefore, how to implement ideological and political education in the teaching of TSP is the core issue in the current teaching reform of this course. Generally, teaching methods should demonstrate the characteristics and educational value in the contents of TSP. However, the current ideological and political education in TSP is still be trapped in problems such as insufficient depth of educational concepts and insufficient display of the characteristics of the course, which greatly reduces the effect of the ideological and political education in the course. Hence, on the basis of improving the teaching contents and methods of TSP, it is necessary to convey the connotations of ideological and political

education, and fully excavate the ideological and political elements of the course, so that students are able to obtain ideal ideological and political education in the process of knowledge learning and quality training. This article explores the implementation strategy of ideological and political education based on the characteristics of the TSP course. The following paragraphs will first analyze the advantages of ideological and political education in the TSP course, and then point out the approach to combing knowledge teaching and ideological and political education.

2. Advantages of Ideological and Political Education in the TSP Course

2.1 The TSP Course Cultivating Scientific Research Spirits for Students

It is well-known that mathematics makes people thorough, and science makes people profound. If one studies a set of theories for a long time or engages in research projects, the scientific thoughts and the spirits of scientists will affect his or her soul subtly, which will not only bring changes in his or her ways of thinking and lifestyles, but also will develop various healthy working and life habits. TSP is a summary of the laws of thermal phenomena on the basis of long-term practices of physicists, a theory that is formed after rigorous reasoning, and a new field of knowledge developed by scientists after continuous exploration, discovery, and confusion. The current system of thermodynamics and statistical physics is constructed by scientists such as Carnot, Joule, Gibbs, Clausius, Boltzmann, Bose, Fermi, Einstein, and Debye after repeated affirmations and denials. In front of the authority of classical theories, it is their innovative spirits and unremitting efforts that make science continue to progress. It can be said that there is no statistical physics today without innovation and questioning spirits. Therefore, it is self-evident that the TSP course is important for cultivating students' innovative spirits. Innovative spirits are an inexhaustible driving force for the development of a country and a nation. As a frontier group of new technologies and new ideas in the society, college students shoulder the responsibility and mission of promoting social progress, and cultivating their innovative spirits is an inevitable requirement for higher education.

2.2 The TSP Course Revealing Materialism and Dialectic View for Students

Dialectical materialism is a compulsory course in ideological and political education for contemporary college students. As a natural science course, the TSP course also includes materialism and dialectic view. For example, the primary viewpoint in Marxist epistemology is the practice principle, which points out that practice is the only criterion for testing truth. In the process of exploring theories of thermodynamics and statistical physics, this basic principle is also applicable. According to the classic theorem of equipartition of energy, the heat capacity of a solid should be a constant and has nothing to do with temperature. However, comparing the theoretical result with the experiment result will find that the two agree well in the room temperature and high temperature range. In addition, in the low temperature range, experiments have found that the heat capacity of a solid decreases rapidly with temperature. When the temperature approaches absolute zero, the heat capacity also tends to zero. This fact cannot be explained by the classical theory. Moreover, there are free electrons in metals. According to the theorem of equipartition of energy, the heat capacity of free electrons should have the same magnitude as the heat capacity of ion vibration. However, the experimental result is that when the temperature is greater than 3K, the heat capacity of free electrons is completely negligible. This is another fact that the classical theory cannot explain. Afterwards, Einstein has applied Boltzmann distribution to successfully explain the fact that heat capacity decreases with decreasing temperature. In 1928, Sommerfeld has successfully explained the problem of electron heat capacity based on the Fermi distribution. For another example, according to dialectical materialism, the law of the unity of opposite universality reveals the universality of

contradiction, that is, everything has two sides. The balanced radiation field is a typical example, in which electromagnetic waves have wave-particle duality.

2.3 The TSP Course Nurturing Scientific Thinking for Students

In the teaching process of the TSP course, attention should be paid to cultivating students' scientific thinking. Various scientific thinking methods are used in the research of thermodynamics and statistical physics, such as hypothesis, equivalent substitution method, scientific induction method, deductive method, etc. Among them, scientific induction plays a broad and important role in exploring the laws of statistical physics. It refers to using induction method to propose and establish hypotheses in scientific research, and abstract and generalize the relationship between things on the basis of experiments. It represents means and modes of understanding things from individual to general, from special to universal, from empirical facts to the inherent regularity. For instance, the second law of thermodynamics is summarized on the basis of a large number of experiments. When studying the density of states, people can first study the simple one-dimensional situation, then to the two-dimensional free particles, and finally to the general three-dimensional free particles. The application of scientific induction methods in the teaching of thermodynamics and statistical physics can greatly stimulate students' creative thinking. It is necessary to pay attention to consciously guiding students to boldly summarize and guess in classroom teaching, and cultivate their innovative spirits and abilities.

3. The Approach to Combing Knowledge Teaching and Ideological and Political Education

3.1 Focusing on the Scientific Spirits Contained in the TSP Course

Taking the textbook Thermodynamics and Statistical Physics (Sixth Edition) compiled by Wang Zhicheng as an example. The textbook introduces classical thermodynamic viewpoints and statistical conclusions based on classical physics in the thermodynamics section, such as the study of the heat balance radiation field, the application of the classical theorem of equipartition of energy in the theory of the heat capacity of solids, etc. Nevertheless, many of those conclusions are inconsistent with experimental results. Especially, the black body radiation problem will cause the so-called ultraviolet catastrophe. The phenomenon of black body radiation reveals the wave-particle duality of light, and then the wave-particle duality of particles. It was not until the concept of quantum came into existence that people developed the theory of quantum statistics, which revealed the difference between theoretical and experimental results. This is a process of breaking the traditional thinking patterns. It is also a long process of daring to think and take actions. Without the spirits of scientific pioneers to challenge authority, without their courage to boldly breaking old and exploring new, it is impossible to achieve scientific understandings nowadays, and to obtain a series of breakthrough results brought by quantum statistics. Therefore, teachers should pay attention to digging out history materials in the TSP course, and introduce to students the scientific research background and mental process of physicists, which is of great significance to the realization of the ideological and political teaching goals of the course.

3.2 Focusing on the Marxist philosophy Thoughts Contained in the TSP Course

It can be said that Marxist philosophy is the most popular ideological and theoretical system in the world today, and it has a decisive effect on the formation of the world outlook, ideological outlook, and values of college students. Microscopic particles should abide by quantum statistics. Identical particles are indistinguishable. Since the establishment of quantum theory, the debate about its

philosophical thinking has never stopped. Under the wave-particle duality, the wave nature of light is interdependent and inter-connected, but at the same time it is mutually exclusive and separated. This is a manifestation of the imbalance principle of contradiction. When the indistinguishability of microcosmic identical particles is connected with the principle that there are no two identical leaves in the world, the main ideas in quantum statistics will spark off with Marxist philosophical thoughts, triggering students' philosophical thinking. With repeated experience, students' thinking abilities will reach a new height.

3.3 Focusing on the Patriotism of Scientists Contained in the TSP Course

In the history of the development of thermodynamics and statistical physics, the scientific spirits and scientific research methods of scientists are a wealth left to the world, and at the same time, some noble characters displayed by scientists such as patriotism, simple life, and hard work also affect people. Teachers should fully excavate the moral education value of physics history in the teaching of the TSP course, and try the best to implement patriotic education for students. In the history of phase change research, Landau is definitely one of the most important scientists. He is an outstanding physicist who grew up and worked in the former Soviet Union in a socialist country, which is rare in the world history. Landau is talented and has made fruitful achievement, such as the ten commandments of Landau. After a brief study in Europe, Landau was not attracted by the life in the Western world and did not consider personal gains and losses. He was determined to return to his motherland, the Soviet Union, to work and serve his country. Landau is not only an outstanding scientist but also an excellent patriot. Similarly, a large number of scientists such as Shi Yigong, Rao Yi, as well as Yang Zhenning and Yao Qizhi who have given up American citizenship and join the Chinese Academy of Sciences have returned China after studying abroad. Teachers should carry out patriotism education based on those examples, and concentrate on the contributions of Chinese scientists to thermodynamics and statistical physics. For example, in the experimental verification of Maxwell's distribution law, Chinese scientist Ge Zhengquan has also made outstanding contributions.

4. Conclusion

Curriculum construction is the main method for education. Traditional ideological and political courses always seem to be too preached and deliberate. The subtle ideological and political education in professional courses is gaining more recognition. For example, incorporating ideological and political elements into the TSP course can not only enrich the contents of the course, significantly improve teaching effects, but also cultivate students' innovative thinking and spirits, enhance national and institutional self-confidence, and improve their personal quality. In conclusion, knowledge teaching and ideological and political education can complement each other, so as to better achieve the purpose of teaching and educating students.

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