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A Summary of the Main Starting Points of Studying Problems in Physics

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***Abstract*-The starting points of studying problems in physics are varied according to different perspectives and methods. Based on the summary of these starting points, this paper discusses the main starting point of studying problems in physics. The specific content of the main starting points are elaborated in detail by analyzing specific examples, and the important role and the application situations of these starting points are also analyzed.**

Keywords: physics, problems, starting points, study

I. INTRODUCTION

Physics is the basis of other natural sciences, and contains a series of ideas and methods for analyzing and solving problem. Theorists have done a lot of researches on these ideas and methods, such as Ding Bangbing [1], Wang Jianguo[2], Shao Changpeng[3], and so on. But when facing a new problem, from what point of view to study it, namely, what is the starting point of studying problems? This question has not been studied systematically. The existing researches make the analysis only from a certain points of view, for example Jin Tieliang[4], Wang Benju[5]. The starting points of studying problems in physics are varied according to different perspectives and methods. Based on the summary of these starting points, this paper put foreword that the main start points used to study physical problems are as follow: the perspective of simplifying complex problems, the perspective of innovating on the basis of inheritance, the perspective of cutting the dress according to one's figure, and the perspective of taking advantage of the characteristics and showing flexibility. The important role and the application situations of these starting points are also analyzed in this paper.

II. THE PERSPECTIVE OF SIMPLIFYING COMPLEX PROBLEMS

Simplification of complex problems is one of the most basic and important starting points of studying problems in physics. This starting point can be divided into three main types: the way of grasping main factors and ignoring secondary factors, the way of studying special cases of complex problems, and the way of decomposing a complex problem into the superposition of several simple problems.

The way of grasping main factors and ignoring secondary factors is often referred to as the ideal model. The so-called ideal model is to seize main factors of complex problems and ignore secondary factors, thus simplifying practical problems. It is impossible to solve the problem without ignoring secondary factors because the reality is too complex. Because of this, the ideal model is widely used, not only in physics, but also in mathematics, economics, finance, geography, etc. It embodies the idea of approximately solving the problem. The ideal model is approximate to the reality, which will result deviation in actual practice. The significance of the ideal model is that it is successful and applicable if meeting our accuracy requirements with relatively small deviation; if not, the model needs to be modified. The general approach is to reconsider some important factors that are ignored. For an ideal model, there is the scope of application. Once beyond the scope, it will cause larger deviation, and the model needs to be further modified. For example, the ideal gas model is successfully applied in the study of pressure and temperature, but causes unacceptable deviation in the study of energy. When studying the energy problems, the ideal gas model needs to be modified, and the gas molecules should be considered as free and elastic particle groups. The ideal model is one of the most important methods in physics, and everyone who has studied college physics should master it. It is not only a basic method for research, but also a basic idea for analysis. When facing practical problems, we should first think about which are the main factors, which are the secondary factors, and then the actual problem is simplified by ignoring the secondary factors.

For a complex problem that is difficult to be dealt with, some valuable conclusions can be obtained by studying its special case that is easy to be solved, such a method called the special situation method. This method simplifies complex problems by studying the special situation which is easy to be solved. If a problem is too complex, and the main and secondary factors are difficult to be distinguished, the method can provide us a good starting point for study. It is a method which is widely used in physics. The quasi-static process in thermodynamics is a typical example. Strictly, the intermediate state of a thermodynamic process is non-equilibrium state without identified temperature and pressure, which is difficult to study. The quasi-static process is the special situation of the thermodynamics process, and any intermediate state is the equilibrium state. This has brought great convenience for us to study the thermodynamic process. Due to identified pressure and temperature as well as the ideal gas satisfying the state equation, it is easy to calculate the power, the heat and the entropy in the quasi-static process.

The way of decomposing a complex problem into the superposition of several simple problems is often referred to as the analysis and synthesis method. “Analysis" is the method to divide the whole object into several simple parts, aspects, factors or levels to investigate and research respectively. “Synthesis”, based on analysis, is the method to combine these parts, aspects, factors or levels to obtain their relationship. The analysis and synthesis method is widely used. For example, in math, any vector can be divided into the superposition of simple vectors along three axes directions. In physics, a complex motion can be divided into the superposition of simple motions by using the principles of motion superposition. The horizontal projectile motion is divided into the superposition of the freely falling body motion and the horizontal uniform linear motion. Similar examples in physics are very common. Big rivers are formed with small streams. The complex problems can be solved by completing a series of small problems. The analysis and synthesis method provides a way which is not the same as the ideal model and the special situation method. By decomposing the complex problem into a series of simple problems, the complex problem can be solved easily.

III. THE PERSPECTIVE OF INNOVATING ON THE BASIS OF INHERITANCE

The perspective of innovating on the basis of inheritance is a very important starting point of studying problems in physics. If there were only inheritance without innovation, science would not develop, and without inheritance, science would not develop very well because it is easier to walk farther along the road that has been trodden out by the predecessors. Therefore, when encountering new problems, people should study predecessor's practice of solving similar problems, and look for the reference from existing theories. The wave function theory is a very typical example. The wave properties of micro particles is strange to people, and the key of explaining the wave-particle properties of micro particles is how to describe the wave properties of microscopic particles. When studying this problem, Max Born did not abandon the existing theories, and inherited the general practice of describing waves, that is, the wave is represented by the variation of a physical quantity in time and space, and this physical quantity is the wave function which is known to all.

Physics preschoolers were very accustomed to study the problems from this starting point. In physics, a theory is often in form, or in thought, or in way of dealing with problems, etc., closely connected with another theory. This is the embodiment of innovating on the basis of inheritance. For example, although there are great differences between electric field and magnetic field, electrical theory and magnetic theory are highly symmetric. The Ampere loop theorem in magnetism corresponds to the Gauss theorem in electric field, and the electric field intensity vector corresponds to the magnetic induction intensity vector, and so on. Another example is the rigid body mechanics and the particle mechanics. Both of them maintain high symmetry in theory, concept, form, research ideas and so on. This is a very typical example of innovation on the basis of inheritance, and fully demonstrates that the physics predecessors, when studying new problems, are good at innovating on the basis of inheritance.

IV. THE PERSPECTIVE OF CUTTING THE DRESS ACCORDING TO ONE'S FIGURE

In physics, new theories are usually put forward from the perspective of cutting the dress according to one's figure. People often put forward new theories according to the conclusion of the experiment, just like cutting the dress according to one's figure. In layman's terms, how to explain the results of the experiment, and then new theory is put forward accordingly to just explain it. So if the new theory can explain an experimental discovery, even if it is explained very well, this can not prove that the theory is reliable, because the theory is likely to be put forward from the perspective of cutting the dress according to one's figure. Thus theory certainly can perfectly explain a phenomenon or an experiment. The practice is the sole criterion for testing theory. Only by explaining more experimental phenomena, can the theory be trusted. For example, the photon says can not be widely accepted by theorists, even if the photoelectric effect is explained perfectly by it. It was the successful explanation of Compton scattering that enabled the theorists to widely accept the photon says. This is why Compton scattering experiments are so important in the development of physics.

How to explain the results of the experiment, and then new theory is put forward accordingly to just explain it. Such an approach is capable of being misunderstood. There seems to be something wrong with this starting point, but in fact, its practical significance lies in putting forward a direction or an idea for people. Other researchers can analyze the problem under the guidance of this direction or idea, and verify it by further experiments. If the new theory withstands more extensive test of practice, it has been proved. The guiding significance of this starting point is obvious. It provides an important research idea for us to study problems, and is like giving a route map to a destination. The perspective of cutting the dress according to one's figure makes us find the direction in the complicated problems, and reveals the objective law hidden behind the phenomenon.

V. THE PERSPECTIVE OF TAKING ADVANTAGE OF CHARACTERISTICS AND SHOWING FLEXIBILITY

When improving and complementing others' theories, we can study problems from the perspective of taking advantage of the characteristics and showing flexibility. Physics predecessors are often good at using the characteristics of the research object. The introduction of the potential energy is a very typical example. The work of conservative force has nothing to do with the path, only related to the position, and the introduction of potential energy takes advantage of this characteristic. The introduction of potential energy simplifies the calculation of work of conservative force, because the difference between the potential energy of the two positions is the work of the conservative force, and the calculation of work is changed from integral operation to subtraction operation. The introduction of electric field intensity is also a typical example. How to introduce a physical quantity to describe the electric field? Physicists use the characteristics of the electric field when studying this problem. One of the important characteristics of electric fields is that the electric field has a force on the charge in it, thus, the received electric force of a unit positive charge is defined as the electric field intensity.

In physics the flexibility in studying problems is very high. As long as it is beneficial to the solution of the problem, it can be come out of thin air, and it can change in every possible way. For example, there is no power line or magnetic line in the electromagnetic field, but in order to study the problem conveniently, the power line and magnetic line are created to describe the electromagnetic field. Area is a typical scalar, but in order to study the problem conveniently, the area element is defined as vector, so that the calculation of flux becomes simple. Newton's law applies only to the inertial system, but in order to study the problem conveniently, the inertia force is introduced into the non-inertial system, and the Newton's law is reformed and can be used to analyze problems in the non-inertial system. There are many similar examples that embody the high flexibility of studying problems in physics. The implication of these examples is profound. With abandoning rigidity and showing a high degree of flexibility, a lot of difficulties can be solved. For example, when a theory can not solve the problem, can we think of a way to change our theory, and then the problem may be solved.

VI. CONCLUSION

There are many starting points of studying problems in physics. The perspective of simplifying complex problems is the most basic and most important starting point, and has played an important role in the process of solving many problems. When studying any problem, this starting point should be thought of at first. The perspective of innovating on the basis of inheritance is another important starting point, because it is easier to walk farther along the road that has been trodden out by the predecessors. So, we should study predecessor's practice of solving similar problems, and look for the reference from the existing theory. The perspective of cutting the dress according to one's figure provides us with a simple, direct and effective idea of studying problems. Although this starting point does not necessarily get the right theory, it provides a research idea for people to solve new problems at least. The perspective of taking advantage of the characteristics and showing flexibility are also the basic ideas of solving problems. If we are not good at using the characteristics of the research object, we can't make good use of what should be used. If we do not show flexibility in solving problems, we are usually unavoidable to hit the wall.

REFERENCE

[1] Bangbing Ding, Discuss On the application of analogy in physics research and Physics Teaching, The Science Education Article Collects 2009 12 183-184

[2] Jianguo Wang, Discuss on the methodology for physicists to study science, Journal of Ningbo Institute of Education 2006, 8(3)94-96

[3] Changpeng Shao, The thought and method of Physics Out of school education in China 2008,8 611-612

[4] Tieliang Jin, The way of transformation from practical problems to physical problems, Journal of Pingshan Normal College, 2004,19(2) 100-101

[5] Benju Wang, The application of mathematical methods in the study of Physics Journal of Panzhihua University, 2006, 23(1)