BASICS OF MODELING ON EXPERIMENTS IN QUANTUM PHYSICS

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ABSTRACT

This article presents the concept of emerging modern information technology as the simplest means of understanding quantum physics, in particular the laws of the micro universe. It was analyzed that computer-aided modeling combines all the basic didactic features necessary for the experiment and thus enhances the effectiveness of training.

Keywords: Information technology, quantum physics, modeling.

INTRODUCTION, LITERATURE REVIEW, METHODOLOGY

It is well known that the use of modern information technology is the best tool for laboratory classes and it opens wide opportunities for increasing the effectiveness of training sessions [1]. Based on this approach, information technology emerges as the simplest means of understanding quantum physics, in particular the laws of the micro universe. This opportunity will make it easier for students to understand the basic principles of quantum physics and to create an enabling environment to demonstrate the practical significance of this theory.

The use of information technology or computer-based models makes it possible to combine physical experiments with natural processes. Consequently, modeling differs from traditional methods by demonstrating effective experiments [2].

Computer-based modeling combines all the basic didactic features necessary for the experiment, thereby enhancing the effectiveness of training. For example, we can use computer modeling in quantum physics to study the photoelectric effect. Since two labs are usually performed by students, one works on an experimental device and the other works on a computer model. The results obtained in the defense of laboratory work are then compared and discussed. In addition, laboratory studies devoted to the study of the fine structure of emission spectra (zinc, mercury, sodium) can be complemented by a computer model to study the Zeeman effect. The large-scale laboratory setup for the Zeeman effect involves a number of complex and expensive tools. For example, after measuring the yellow sodium doublet, students can study it on a computer model. This combination of experimental and computer experiments ideally complements each other.

Note that these laboratory equipment are very rare devices. We studied the basics of modeling modernized quantum physics labs for the natural and mathematical specialties of pedagogical institutions. As a result of the study, we have come to the conclusion that certain requirements are required to achieve high efficiency of the experiment [1]. In addition, computer modeling (software) should be able to meet the requirements of universality, adequacy, accuracy, and efficiency capabilities [2].

The universality of computer software modeling is evaluated based on how complete the features of a real object. Any computer modeling program roughly describes the properties of an object and is able to simplify the real situation.

The accuracy of a computer program is determined by the degree of compatibility of the parameters obtained by mathematical operations with the actual measured values of the physical event or object. The modeling program should provide an opportunity for reliable results, as well as being able to accurately reflect the characteristics of the object that is most important for learning purposes. Students' knowledge and skills must be taken into account when working with a computer modeling program. Therefore, this program must also meet the availability of information that must be provided to students.

Today, the use of Monte Carlo method in modern nuclear physics, including the study of the mechanism of nuclear reaction, remains very important [3]. The creation of high-energy accelerators of the hadrons and nucleus, and the creation and use of detectors to record reaction products require considerable material costs. There is also a need to compare statistical data of large-scale experiments with the use of mathematical calculations, taking into account experimental conditions and the results of theoretical models.

The algorithmic program of the models created and developed using the Monte Carlo method is based on the standard model of strong and low-power interactions (various phenomenological models).

The most popular of these programs are ISAJET (Interactions at High Energies Monte Carlo), PYTHIA (Monte Carlo Software Programming Processes Elementary Frequency Predictions), FRITIOF (Model for Very High Energy Hadronic Collisions). These programs provide an opportunity to explain all areas of impulses transmitted in nuclear reactions (from strong scattering of quarks and gluons to the formation and destruction of hadrons).

Currently, the HIJING (Heavy Ion Jet Interaction Generator) generator, based on the Monte Carlo method of modeling the hadron-nuclei and nuclei-nuclei interactions, is successfully used [5]. The HIJING generator is used to model strings and quenching in quark-gluon plasma during high-energy nuclear interactions. This HIJING model allows calculating the formation of strings fragmentation in hadronic collisions based on the PYTHIA package, in combination with the KCD and FRITIOF models. This model is designed to test the initial conditions for heavy relativistic ion collisions [6].

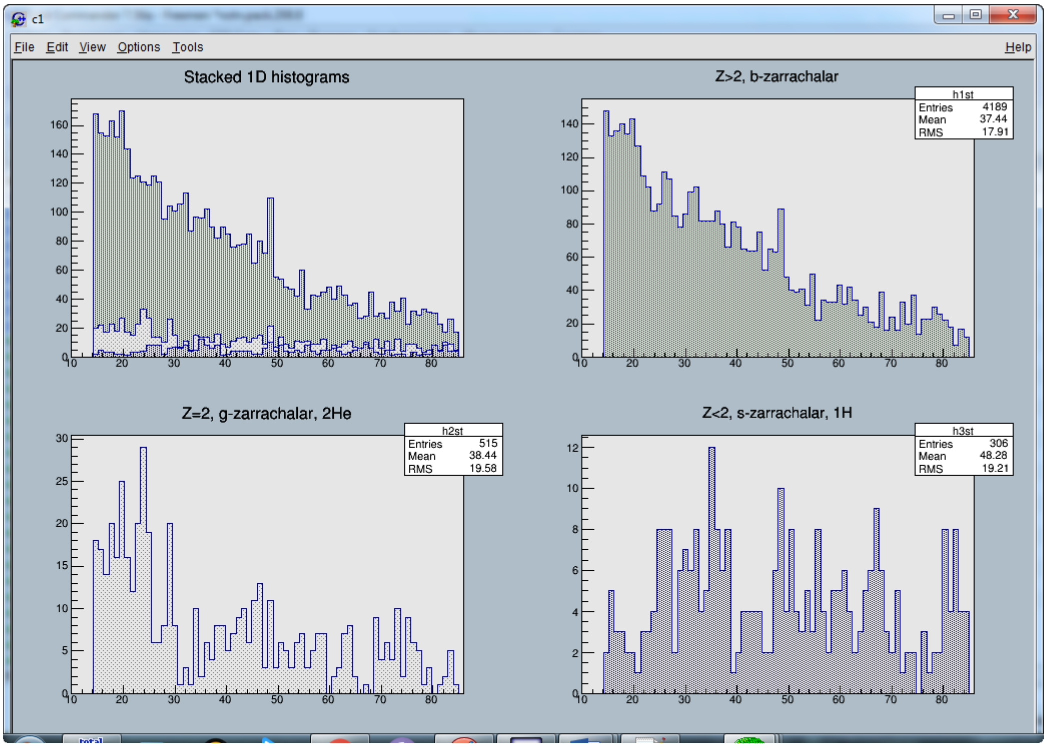
One of the models for modeling nuclear reactions and theoretically predicting reaction results due to inelastic collisions of nuclei accelerated around 5 GeV energy is the Quark-gluon net (QGNM) model. The algorithm for this model is based on Monte Carlo method, which is based on 1/N model of narrow-type phenomenological models representing the amplitude of processes and quantum hadronization processes in quantum chromodynamics.

Different topological diagrams appear when spreading the amplitude of the hadron processes in 1/N (where N-quarks smell or number of colors). At high energies, these diagrams respond to the Redje exchange processes on the t - channel. Also in the modeling program, the process of exchanging several pomerones was performed through complex topological applications. In the topological distribution diagrams, the space-time dependence of the quark-gluon strands on the formation and absorption is adjusted.

RESULTS, DISCUSSION

In the calculations, we use the longitudinal impulse distribution function of quarks and the quark decomposition function into the hadrons that exhibit different asymptotic manifestations. The modeling is carried out in three stages: selection of the quark-gluons net formation of a certain number and type; to determine the constituent part of the hadron impulse and the transverse impulse of the constituents; to model the interruptions of the ridge through the formation of the hadrons.

The QGNM model can also describe the formation of the hadrons, including u, d- and s-quarks. This model incorporates a perturbative approximation to represent the process of generating strange particles in the field of ultra-high energy [6]. The calculations obtained by the QGNM model were compared with the results obtained in the nuclear collisions irradiated with a pulsed proton of 4.2GeV / s in a 2-meter propane vapor chamber (synchrophazotron). The accuracy of the measurement in the magnetic field of secondary particles is 12%. The angles were measured at 0.5 ° accuracy. The maximum error in the measurements was 30%.



One of the results of a program component that allows graphically studying the results of particle sorting recorded on a photo-emulsion plate

The picture below shows the characteristics of secondary particles that arise in the core nuclear interactions studied with the photoemulsion. These results are compared with the results obtained by the mounted Carlo method. The results of the experiments and Monte Carlo calculations were consistent.

The experimental results were compared with the QGNM model to study the mechanism of collision between the particle and the nucleus. For example, in [7], the R+R impulse is 19.2 GeV/s, the pulse R + Ar and R + Xe are 200 A GeV/s, and the impulse at (d, Ne, S)+(C, Ta) The mechanism of interaction of 4.2 A GeV / s with an R + S pulse of 4.2 GeV/h was studied on the basis of the QGNM model. The QGNM model shows the average values of the kinematic characteristics of secondary charged particles in non-plastic collisions with carbon nuclei of pulses p, d, He, and carbon nuclei with 4.2 GeV/s for the secondary protons: multiplicity (97.3 ± 0.5), impulse and The accuracy of the order (98.1 ± 0.8) and (92.2 ± 1.2)% on the transverse pulse is respectively. – - The difference between the mean values of the values obtained by the analysis of the results of the experimental characteristics and the values obtained by theoretical calculations of the QGNM does not exceed 3–5%.

CONCLUSIONS

In conclusion, the QGNM model can adequately represent the process of colliding light nuclei accelerated at energies not exceeding 5 GeV. Adapting the model to higher-energy nuclear reactions requires experimental conditions, taking into account many physical factors that affect the process, and further improving the algorithmic program. Thus, in this work, we have analyzed the feasibility of demonstrating quantum physics experiments based on computer modeling and how we can apply them in practice.

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