# INTEGRATION OF GENERAL PHYSICS EXPERIMENTS WITH MATHEMATICAL SIMULATION

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## I. INTRODUCTION

Mathematical modeling in the subject area, and in particular in physics, with the advent of high-speed computers, allows solving problems that, in principle, could not be solved by analytical methods. The "computational experiment" term comes into use along with a full-scale physical experiment. The transfer of computerization to the educational sphere is primarily due to the wide computing and presentation capabilities of computers. The main problem of using computers in subject education is not to complicate the learning process. We have extensive experience in the use of modeling of physical processes in teaching [1-3]. Let's demonstrate this with a simple model.

Consider the ideal gas model. Its construction requires knowledge of only the laws of conservation of energy and momentum. This is enough to illustrate the “maxwellization” of molecular velocities and to introduce the concept of energy temperature [3]. The initial configuration of molecules can be chosen to be regular, and the velocities can be set to be the same and visually demonstrate how the movement of molecules is randomized as a result of collisions. You can also display the instantaneous and average energies of molecules and notice that the instantaneous energy fluctuates strongly, and the average takes the same definite value regardless of the selected molecule (Fig. 1). This particular value is the energy temperature. Of course, in a similar way, you can present more complex models that require the use of finite-difference methods, Monte Carlo methods.

There are problems in physics (percolation theory, cellular automata, fractals, kinetic growth models) that are difficult to study and understand without visual modeling. The use of computer modeling makes it possible to implement the deep thought of Confucius in teaching: I hear and forget, I see and remember, I do and comprehend. Consider another example from our educational practice: the application of simulation in a physics laboratory practice.

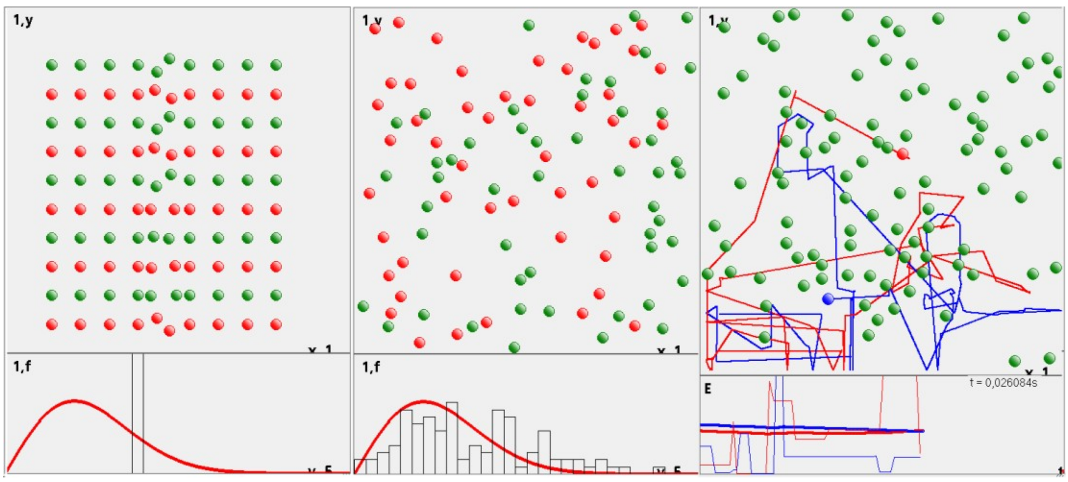


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Figure 1. An ideal gas model to demonstrate the concept of “temperature” and “Maxwell distribution” (1- initial configuration; 2- velocity distribution; 3- interpretation of the concept of “temperature”)

## II. LABORATORY PRACTICE AND MODELING

Physics is an experimental science. That is why laboratory practice takes an important place in teaching. At the same time, the laboratory implementation of physical processes during teaching is limited by technical capabilities. In this regard, considering the rapid development of computer technology (CT), computer modeling can be a good addition to the workshop. The traditional application of CT tools is process visualization, processing of experimental data. By extending this application to a computational experiment, learning efficiency can be improved. In this workshop, we limited ourselves to a few works, the implementation of which is possible on a unified installation. On the one hand, this allows one to reduce the cost of equipment, on the other hand, to show the connection between physical phenomena of various nature. We used the phenomenon of electromagnetic induction, both for diagnosing of process parameters and for studying the phenomenon itself [4, 5]. A unified setup for laboratory workshops and demonstrations in general physics (oscillations and electromagnetism) was developed. A distinctive feature of the proposed setup is related to simultaneous excitation and detection of linear and nonlinear oscillations and generation of dissipative forces with the aid of electromagnetic induction and Ampere force. The system allows integration of laboratory works with the simulation of the investigated processes and automation of the process of work execution and data processing. Low cost allows the purchase of several installations and the implementation of frontal laboratory work and lecture demonstrations.

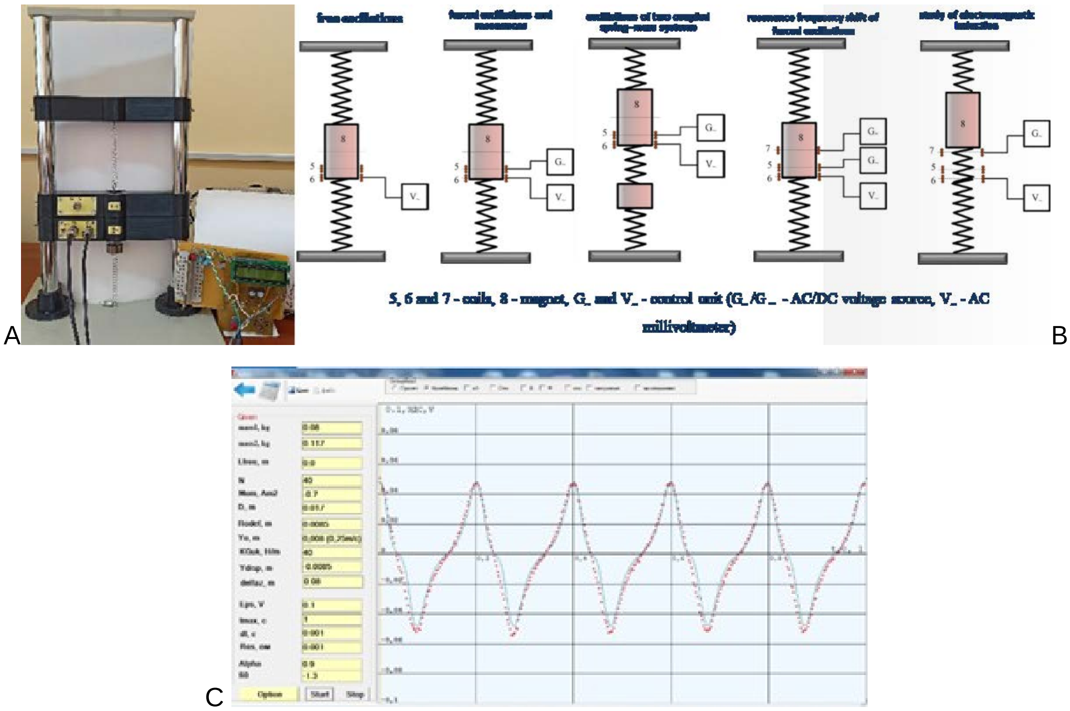

Figure 2. A – the experimental setup, B – arrangements of laboratory works, C – example of integration of laboratory work with the simulation of the investigated processes

III. CONCLUSIONS

The modeling possibilities are as varied as the developer's fantasy is. It is important that the computer application does not complicate the understanding of the process under study. The possibility of combining a natural experiment and a process model can give an effective educational result.

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