INTRODUCTION

When solving the problems concerning various fields of science ranging from physics and biology to economics and education, the formation and conservation of the functional organization, its development and self-complication is both the goal of the study and its paramount stage (Haken, 2006). The following two examples are peculiar here. The first one concerns the problems related to the development and preparation of materials with structural-sensitive properties and various ordering degrees. In the majority of cases, the most important one is the creation of the required spatial or spatial-temporal ordering. Another example is the operation of living organisms and related simulation of ordered structures in biological objects. The question about the optimal ordering and organization is also topical when studying the global problems, i.e. energy, ecological and other problems, which require immense resources (Mar'yan & Szasz, 2000). The trial-and-error method is not appropriate here. More reasonable is the way of knowledge of inherent properties of the system and the regularities of its evolution. In this case it is difficult to overestimate the importance of self-organization and ordering formation laws in physical, biological and other systems.

That is why an interdisciplinary field of science has been created, i.e. new theory of self-organization or synergetics, which explores the general principles of the formation of spatial, time and spatial-temporal structures in thermodynamically open systems of different nature away from the equilibrium state (Haken, 2006). Thus, the first cause beneficial for the creation of synergetics was the exit out of

framework of the classical (equilibrium and linear) thermodynamics and the subsequent necessity of the description of highly non-equilibrium systems.

The second cause of synergetics creation is the necessity to analyze various complicated processes by means of new mathematical methods when solving a series of scientific and technical problems (Vorontsov & Miller, 1995). One is forced to deal more frequently with non-linear phenomena where more intense external actions result in the qualitatively new behavior of the system (Nicolis & Prigogin, 1989; Yurkovych, Seben & Mar'yan, 2017).

Non-crystalline materials are here the specific example. It should be noted that the principal trends in the practical application of non-crystalline solids (i.e. vitreous and amorphous materials) have been defined clearly so far (Mott & Davis, 1979). More ample use of such solids and the quest of new areas of their application require fundamental scientific researches, which in the future will give new ideas for applied development. The main tendencies of fundamental studies of non-crystalline solids start from the analogy with the well-known structure and properties of crystalline solids and liquids, while non-crystalline solids are considered as disordered systems (Mar'yan, Kikineshy & Szasz, 2001).

At considerable deviations of the system from the equilibrium state and under the influence of the substantial external fields the dominant role is played by synergetic effects and by the energy transformation mechanism that can be studied by means of the ideas of non-equilibrium thermodynamics (Kauffman, 1993). From this standpoint, the creation of non-crystalline solids is the self-organizing process accompanied by the formation of ordered structures on the macroscopic scale. Such an approach to non-crystalline solids is in the initial state. Hand in hand with this, it enables one to describe the formation of non-crystalline solids, their structure and the peculiarities of the interaction with the external fields based on the unified physical principle. The solution of this problem correlates with the simulation of the vital activity of living objects (Mar'yan & Szasz, 2000).

The present work is dedicated to the studies on formation of the ordered structures and hyper sensibility in the different-nature systems (non-crystalline solids, intelligent materials, information and communication systems, education) by invoking the ideas of synergetic and computer modeling. Contrary to a number of known books on the order-disorder problem, this book contains both mathematical background and a number of experimental facts, concerning glasses, water, and bio-matter. An important problem of the influence of different fields on the metastable matter is successively analyzed in many aspects, and leads to understanding of the essential importance of investigations in this direction, especially for living objects and for the metastable matter in general.

From this perspective, education is seen as a living organism, for which it is possible to achieve a minimum level of dissipative processes and a comprehensive information perception (Yurkovych, Seben & Mar'yan, 2017).

Innovative teaching of physics and computer modeling of physical phenomena, as well as application of these methods by teachers, are the focus of special attention in scientific literature (Christian & Esquembre, 2007; Potter & Peck, 1989; Sladek, Pawera & Valek, 2011). However, special training of future physics teachers on numerical modeling of physical phenomena, bibliographic data in the pedagogical literature, as well as in educational practice are encountered less often (Guri-Rosenblit, 2010). For example, the curriculum of training future teachers of physics in all five Slovakian universities does not contain this subject. Students and future teachers can get acquainted with the problem of computer modeling of physical phenomena while studying special subjects such as "Digital technologies in teaching physics", "Computer Information Technologies in physics" (http://www.fpv.umb.sk/katedry/katedra-fyziky/studium/bakalarske-studium/).
A similar situation with mastering these methods is observed in other universities.

In the process of teaching physics, attention is focused on a significant amount of material and its unstructured character (Özcan, 2015; Hodson, 2014; De Cock, 2012; Fojtík, 2013), insufficient relationship and correlation with other disciplines

(Hestenes, 2010; Huffman, 1997) and practical application (Reif & Heller, 1982). It points to the need for information perception in higher educational establishments, especially in teaching physics at an intuitive level, using visualization means, modern advances in programming – object-oriented programming (Guri-Rosenblit, 2010;Yurkovych, Seben & Mar'yan, 2017).

The aim of the investigation was the implementation of the educational experiment based on the positive impact of the applied measures aimed at creating the optimal object of professional competence of future physics teachers. The study objective was to determine the impact of implementing innovative approaches on the willingness and interest of future physics teachers to independently conduct computer simulations of physical phenomena (González, 2017).

The material of this book is divided into chapters so that from chapter to chapter the considered problems become more and more clear, and appropriate mathematical models of self-organizing processes – more visual. Each chapter starts with a brief, popular scientific presentation of the developed concept without a loss of strictness. In the appendix, the data, calculations and results of calculations are presented, allowing the readers possessing the necessary mathematical apparatus to evaluate the reliability and persuasiveness of arguments in favor of the mathematical models used.

Adapted to use the modern level of the latest information technologies: information exchange in the Internet network, development of mobile telecommunications and related technologies, level of abstraction and synergy of object-oriented algorithmic programming languages, formation of self-sufficient systems - smart environment: smart home, intelligent car, smart phone. So it may be interesting for the professionals, working in this field of science, and for those readers, who just try to comprehend deep interconnections in the materials science and living objects without mathematical proving.

That is why this book will be useful for a wide community of scientists and engineers working in the fields of material science, and also for teachers of natural sciences.

Most of results outlined in this book have been obtained and developed by the authors.