TRENDS OF THE RESEARCH IN THE FIELD OF NON-LINEAR PROCESSES

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Abstract. At the same time with the science and technology development, the solving of some complex problems is imposed. Under this aspect the nonlinear process as well as, the uncertainty interference and the measures random character, have to be considered. Thus, the solitude theory is an example of nonlinear process that has to be solved. Also, intervenes the necessity to concretize the researches not only in the macroscopic domain, but also in the microscopic one, like entropy.

Science will always try to discover the truth beyond passion and faith. According to Karl Popper the main characteristic of the science is that it cannot be uncertain. With the actual evolution of physics the statement of K. Popper is not certain enough.

The understanding of a process is the abstraction of an enormous number of observations that try to create a concrete image of a process.

However, the perception of the creation should not be looked up in the proper creation, but in concepts having a certain level of abstraction.

In a way, to make science is an art, but in the same time, science represents a rigorous logical field that depends on a logical reasoning.

The reasoning of a scientific cognition depends on its logical confirmation. Once the reasoning rules are specified according to a series of interferences laws based on the adequate application of the regulations, the certainty, a new sentence with truth value is obtained. This is what grants such a great trust in the mathematic relations.

Mathematics is necessitarian but most of the time the models of necessitarian mathematics do not show *predictability*.

Despite all the successes the scientists are asking questions and are looking for real, more viable and more general answers at the same time.

The relationship between the chance and the necessitarian feature of the solution has concerned scientists as Ilya Prigogine and René Thorn.

According to René Thorn necessitarian laws can be obtained for processes with a given aleatory repartition.

Schrödinger states that we can give a complete necessitarian explanation on any decision. What creates unfulfilments is the seeming difficulty between the necessitarianism and our free will.

An important issue is the influence of the initial conditions. Henri Poincaré showed in 1908, the role of the non-predicability of some decision, arguing that a less important cause can have a great effect; we consider this effect to be owed to the chance.

The initial sensitivity is characteristic especially at the microscopic level. It is observed at the macroscopic level as well, at a large class of systems named chaotic systems. It is said that a system has a chaotic behavior if the trajectories initiated from the initial states estrange one from another in time according to an exponential function of the time.

A heated fluid passes from disorder to order at a certain time point. We have an *open, wasteful* structure.

The kinetic theory of the gases opened up the way for the statistical mechanics. The latest researches on the disorder refer to the necessitarian chaos. The order notion is esoteric in nature.

Order is the reflection of devine rationality. The term *kosmos* means order.

We were involved by the modern considerations of the disorder to determine its scientific basis.

In fact, order and disorder, hazard and necessity, are indissolubly linked.

Each open system simultaneously contains an order element and a degenerating order one that will and up by defeating the first. By these means death is inseparable from life. We produce the society that had produced us.

The notions of cause and effect become complex as the retroactive loop notion introduced by N.Wiener appears.

An elementary particle is inseparable from the field representing its matrix. The complexity, with its own rules, is the principle of the actual.

Autonomy without dependence cannot be conceived. This is observed at the cultural level as well.

The aleatory is present at any level, starting with particles and ending at the social level.

D'Espagnat distinguishes the empirical reality from the independent reality. The empirical reality represents the assembly of phenomena. The independent reality forms a whole, spatially and temporally being situated outside. It is the matrix of the values created by human being in multiple fields as arts, science, etc.

It is known that light has a double appearance: format wave and corpuscular. This *corpuscle-wave* complementary exists for any moving particle, too.

According to a Heisenberg priciple the simultaneous cogniton of a particle's position and speed cannot be proven. Therefore the trajectory notion has no significance.

The electrons lose their individuality in the favor of the electronic cloud for which only density can be calculated, e.g., the probability of presence depending on the localization. The statistic aspect of the quantic laws is dominant.

To describe a quantic system, new concepts, very different than the classical ones, are employed. They have a mathematic character. Therefore, the term of wave function, different from the waves from the classical physics, is used. In fact, it is a way of allowing to determine the status and the evolution of a quantic system.

The role of the observer is introduced. Knowing becomes an act of participation. It is demonstrated that a particle is always coupled to something else. The issue of singular particles is unsolved.

With all the progress, cosmology does not solve the problem of the beginning of the universe. The zero moment is an inaccessible asymptotic value. Below 10^{-43}, we are in the quantic era.

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When studying temporally reversible laws of dynamics, the difference between past and future is made. The difference between past and future is partially a primitive concept.

Ilya Prigogine mentions that transition between levels involves violation of the symmetry; the existence of the irreversible processes at the microscopic level, as they are described in cinematic equations, does not revere the symmetry of the canonical equations, and the dissipative structures do not revere the space-time symmetries.

The role of the observer frequently came back in the quantic mechanics literature. Regardless of the future progresses the role of the observer is essential.

The theoretic reversibility results from classic or quantic mechanics that surpass the measuring possibilities carried out with a finite precision.

The observed irreversibility is a characteristic of the theories that consider the nature of the observations.

The limitation of the necessitarian laws means passage from a closed universe where everything is given, to a new one opened to fluctuations and innovations.

We can conclude that the difference between past and future continues even in an equilibrium system at the macroscopic level. Is not the non-equilibrium that creates the time arrow, but this equilibrium is the one impeding the time arrow, always present at the microscopic level, to have macroscopic effects.

More from the microscopic than the macroscopic point of view, the equilibrium state is enforced as a singular state.

The second law of thermodynamics shows that any closed system tends to disorder in time. Preoccupations in the biological process have developed in the last years. The measure that has to be taken into account is the entropy that leaves the possibility to explain the uniqueness of the physical process. This measure has appeared in the analysis of the irreversible macroscopic processes; afterwards entropy was introduced in statistical physics and in quantic mechanics.

Because entropy represents the parameter of a system's state, the variation from a state to another (directly or inversely) of a system has the same significance, being equal with the difference between the entropy's value of the two states.

Because entropy's growth is irreversible, thermodynamics introduces a significance of the time in worls's evoluation. The asymmetry imposed by this law

involves directionality. In the same time the causality concept has a directional significance too.

The microscopic model of the entropy is associated with the *time arrow*.

The time arrow has a significance given by the correlations flow determined by the collision between particles.

Is not the non-equilibrium that creates the time arow, but this equilibrium is the one impeding the time arrow, always present at the microscopic level, having macroscopic effects (Ilya Prigogine).

It is known that the only scientific domain that can work with a great number of particles is the statistical mathematics. Enrico Fermi has applied statistical mathematics in the analysis of the thermodynamic equilibrium.

The modality of analysis of nonlinear dynamics will use more and more this method of calculation in the future.

A system will always develop by the means of its entropy growth.

The value of entropy is determined using the statistics and the repartition of probability in classical physics.

It is worthwhile to mention that the significance of the entropy is multilateral: probability, information volume, disorder, time asymmetry.

a) as in classical thermodynamics, entropy characterizes the state of the isolated systems and allows the determination of the systems, as they transform into a new system while undergoing some changes. The second low of thermodynamics, which formulates the principle of entropy's growth for irreversible processes, allows the explanation of the evolution of any isolated macroscopic system.
b) At the microscopic level, the estimation of a system's state using entropy requires the usage of the relation:

$$S = k \cdot \ln W$$

where k is the Boltzman constant, and W is the number of quantic state that characterizes real macroscopic sizes with the same value.
In statistical physics entropy is related to the informational entropy which represents the measure of the indetermination of the communication.

The communication is expressed by the dimensions x_1, x_2, x_3, x_n and by the probabilities referring to those dimensions P_1, P_2, P_3, P_n, when $P_k = 1$, the rest of the probabilities are 0, the entropy $S_n = 0$ and the transmitted information is correct and therefore there is no uncertainty.

The value of entropy is maximum when all the P_k values are equal and the transmitted information is maximum.

The issue of dynamics entropy of the chaos is very interesting. It is considered that the analysed system is determined. In the same time the initial uncertain measures can lead to a change of the initial configuration of the system after

several repetitions. In this case it is important to determine the measure that indicated the level of disorder in the evolution of the system's development.

The measure is the metric entropy, named Kolmogorov's entropy aswell (K = entropy). It represents the main characteristic for stating the chaos; it equals 0 during normal developments, infinite for aleatory systems and has a constant positive value for a determined chaos.

The uncertainty state shows up in the human field too; the spatial-temporal support having quantic properties could constitute the basis of the research in this field.

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The research of non-linear processes represents the aim of the solitons theory too.

The basis of this theory is the observation of Bertrand Russell whom, while studying a wave along a channel from Edinburg, observed that the wave did not changed its shape. Russell had continued the studies on this solitary wave that will prove useful in quantic mechanics, fluids mechanics, physics of elementary particles, biophisics, theory of dynamic systems, etc. and will lead to the elaboration of a solitons theory.

The *solitons theory* represents: elaborating, analyzing and solving some non-linear movement equations that allow solutions of localized wave as are the solitary waves. These waves have the non-linear superposition property they are elementary solutions in which the solutions of the non-linear differential equations are decomposed. In the same time, the *cnoidal theory* is useful in the field of non-linear processes, and refers to an inverted method o spreading.

The cnoidal functions have a larger significance than the sinus and cosine functions; therefore the modulus *m* of the cnoidal function, which varies between 0 and 1, can obtain a sinus function (m = 0), Strokes function (m = 0.5) or soliton function (m = 1).

The theory of solitons and the cnoidal theory can be applied in a vast domain of the non-linear processes.

The flow through arteries is analyzed as an example.

It should be mentioned that the first equations that describe a non-linear model for the blood flow has been presented in 1775 by Euler.

The blood composition is complex; it contains particles (red blood cells, leucocytes, blood platelets). It will be considered that the blood flow in bigger arteries is generated by a two-solitons type of wave. The tube through which the blood flows is an elastic one, with thin walls, infinite long and straight; the blood is modeled as a micropolar incompressible fluid. The effect of a haematocrit increases on the speed amplitude and on the microturn is theoretically analyzed.

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Along with the special evolution of the scientific knowledge, the interference of the uncertainty and of the aleatory reflects in the dialogue field. Than, in *fuzzy* logic the growth of a system's complexity is accompanied by the decrease in the statements precision.

Therefore an enunciation for this system can become imprecise, undetermined, as is more semantically consistent.

To transmit the knowledge we use a referential presentation employing a terms language consisting of a conceptual structure with prestablished relations between concepts as, by definition, the concept is related to the term.

The definition concerning the concept and not the words include the cognitive knowledge.

The language is a fundamental way for the human being to know and master a field. It represents the link between thinking and talking, between the way of expressing and communicating the thinking.

In reality the interference of the uncertainty and of the aleatory reflects in the dialogue field. Heisenberg, while refering to the expression of measures or phenomena, says: "while we give up since the beginning to give a univocal meaning to the words in religion, in nature science we start with the hope that sometimes, in a faraway future, will be possible to give the words an univocal, well determined mean".

In the same time, N. Bohr underlines the difficulty to establish a cleary enough language in modern physics.

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It is remarkable the role of phylosophy in the interpretation of new accomplishments in the scientific research field. A first question is whether philosophy is a science. N. Berdialw considers that *philosophy is by no means a science and should not be scientific in any way.* Bergson reverberates the idea that philosophy as a creating act is not a science.

The research methodology varies in science and philosophy. Science mainly uses interference, while philosophy uses intuition.

However, some philosophers interpret some achievements of the science in a less profound way. By these means I mention Petre Botezatu whose preoccupations in philosophy are considered notable.

Petre Botezatu, refering to W. Heisenberg who gave a probabilistic interpretation of quantic physics, presents an epistemological analysis of the probability theory.

The method of probability cannot determine the genesis way of the event Petre Botezatu says. As an adept of a universal determinism he takes into discussion the existence of the causality in the frame of a statistical view. He says that causality – the main piece of the classical determinism – is considered only

qualitatively in modern physics. In the same time he shows that there is incoherence own by the quantic mechanics expressed in the *Copenhaga doctrine.*

Petre Botezatu proposes the dissociation between the quantic philosophy and quantic physics, in fact the sparation between the scientific truth and the philosophical assumption.

Anyway, the creation of a quantic philosophy is unusual. The tendency to refer to a positive theory of knowledge to which some physicists from the first period have joined (M. Planck, Rutherford, P. Langevin) is the today's tendency of some philosophers to be preoccupied in physics.

I felt that the philosophers moving in the realm of infinite without the precautions and experiences of the mathematicians were like ships in a dense fog in a sea full of dangerous rocks yet blissfully unaware of the dangers (Born).

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Can we predict the future of science? To predict frequently means a form of illusion. In the same time there is a permanent wish of scientists, of philosophers to study the future of science.

In the next fifty years there will be a major revolution in mathematics. Influenced by the computers, changes in bioscience and financial-economical fields will be imposed. Changes of the *sample* notion that represents the central concepts in mathematics, are predicted. Computers will induce a profound reviewing of this concept.

Because of the physics problems' complexity it is thought that some laws will be reviwed. Concomitantly, one of the future preoccupations of the scientists will refer to the origin and the nature of conscience. The issue is if science will be capable to answer this question.

In technical terms, this activity enters the chaotic field. In fact the chaos is composed of a number of rythmical elements.

It is necessary to study to which extent science will solve some issues regarding the quality of our lives. Science has to contribute to the assurance of a durable development.

It is clear today that there is coherence between science, technology and financial preoccupations and this is an issue that will prevail.

The research of the Universe will develop. We will conclude that we are not the only beings capable of thinking and creating. The discovery of extraterrestrial intelligence will produce an intellectual shock.

The rapid evolution of mathematics and physics will allow new discoveries in the biology field.

In the next twenty years the knowledge in different science fields will be richer and more profound. By all means, there will be an intellectual leap bigger than the one occurring in the last period of physics, biology and informatics field evolution.

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