SPACE, TIME AND THE INTEGRATIVE SCIENCE

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„Feeling that I am alive, this means no effort; it's no burden for me. Though, different elements can be separated – mental, physical, chemical and others connected with all the scientific fields –, elements that are inside myself, whose continuity is evident. There is a mystery inside myself, a mystery of unity that's having the simplicity of the infinite, but reduces the immensity of the multitude to a very simple point."

(Rabindranath Tagore, "The Religion of the Poet" – Lyrical Anthology, 1998, POLIROM Iaşi)

Abstract: This paper presents a summary of the impact that the impetuous development of science and technology has had, emphasizing the trends and the role of scientific research and of scientific observation, even if the development of the science need also imagination, abstract thinking, intuition. The author shows how using the strength of the intellect one could conclude on the knowing the World and the Universe and how two fields of knowledge – Geometry and Astronomy – confirmed this hope, by transforming it into conviction. This paper underlines that is not enough to use in the knowing process only the structural information obtained directly through measuring, observing, experiencing; for a systemic knowing of the nature being necessary to capture also the phenomenological information, which was considered to be a fundamental process of the nature. The main problem for the science of today is the admission or non-admission of the existence of the mental, intuitive sense as an objective, physical, information reality. In this paper, the author demonstrate that the Space and the Time are two philosophical categories that are defining objective and universal forms of the existing of the moving material. In conclusion, this paper shows that the science is unitary; the study of the space and time concepts evolution emphasized the necessity of the integrative, systemic, interdisciplinary approach and that the space and time studies enlighten the existence of some problems that seem to be either contradictory or not solved yet.

Keywords: science and technology, rational thinking, structural information, knowing system, space and time, phenomenological information, the integrative, systemic, interdisciplinary approach.

In principal, the Science is looking for the truth[1], and for this reasons it uses a working method, which is not what Bacon, was thinking: "a long way to

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[1] Either simultaneously or in different periods in time, the scientists have defined the science in different ways. The differences appeared from either its development level or from a certain aspect of the

discoveries when researching". The scientific method is an entire serial of recommendations that can contribute to direct the explorer on his way through the "jungle" of the facts of his research.

In order to finalize the acknowledging process, in part of the sciences – physics, physiology – the researcher can make use of experiments; in other sciences – geology, astronomy – where he has no possibility to modify the conditions of the examined objects, the research is based on observation.

At the beginning, in order to demonstrate the rightfulness of the effected observations and of the experimental results, the scientist used the logical thinking, the mathematics, for both to ordinate the knowledge and to propose theories and models and schemes – even though partial schemes – in order to describe, to predict, to explain the experience. Later on, it was proved that the science need also imagination, abstract thinking, intuition – necessary for the human being to realize there are things to be discovered, but there are new things to be invented. Even since the age of Tales from Millet, some inhabitants from the cities of Asia Minor started to use the abstract thinking, with no connection with the religion[2] – which was one of the great discoveries of the Greek people. It was hoped that using the strength of the intellect one could conclude on the knowing the World and the Universe. Two fields of knowledge – Geometry and Astronomy – confirmed this hope, by transforming it into conviction. The belief that Math – the base of the structural science – exists in the nature and part of the system we use to describe the nature comes from the Greek thinking. The demonstrative Geometry was the axe of the Greek mathematics. Its method to start from incontestable axioms and from here to withdraw theorems using the deductive reason method has become the characteristics of the Greek philosophy. They were considering the Geometry of being the perfect combination between logic and beauty, of being of Divine origin. From here, the saying of Platon: "God is a perfect Geometer". However, the Greeks did not find a rapport between the Space and the Science of Geometry. But this rapport constitutes the basis of any classical science, from Galilei to Newton, and all the theoreticians of physics will maintain this rapport to the XIXth Century, no matter the differences on the definitions.

The specific of Geometry consists in the fact that it can be both an exercise of logical math, of structural science, but also it expresses the realities of the external world which can be perceived only based on a different way of perception – the

science the scientist has chosen to insist on it. For example, for Dampier the science was an organized knowing of the nature; for Lord Kelvin – what cannot be measured is not science; and Crowter defined it as the knowledge the human being can use to rule over the nature. The Science and Technology Human Resources Committee has defined the science as "an interconnected ensemble of attested facts and speculative theories, with the condition that the theories to be possible to be tested experimentally".

[2] Before the Vth century BC, the Greek religion had not formulated any creation theory, and that's why – in a certain way – the science has played the role of the religion, by initiating theories on the phenomena's origins.

phenomenological perception, the intuition. The Greeks must have inferred this, because the famous axiom Euclid stated in respect of the parallels is very much different from the other of his axioms – like "the whole is bigger than the part" – who is not evident at all, even if it seems that the future depended on it. The axiom of the parallels can be stated in a very rational way („through a certain point one can draw a parallel, and only one parallel, to a certain line") for us to be convinced that it is – from the logical point of view – very necessary, mainly when knowing that it can draw us coherent and important conclusions. But in the real world, things are different. Today, it is known that – logically speaking – there are possible different geometric alternatives, and the validity of the Euclidean Geometry[3] for measuring the Earth is only an experimental fact very well defined. Its validity for the whole Universe can be put very easy in a little doubt.

The Culture of the ancient Greeks[4] was formed between the walls of the citadels and it can be stated that almost[5] all the modern cultures have a stone and brick and cement cradle. The walls left deep marks in the human spirit. Boundary walls have been traced not only between nations, but also between sciences, between human being and nature. Inside the people there was born the deep suspicion on what exists beyond theses walls, walls made by the human beings. A long and strong fight was developed through the centuries up to the XIXth one, when it was finally admitted there is a lot more left beyond the imposed boundaries.

At the beginning of the IIIrd millennium it was not found yet an answer to the question if the science has an integrated character, if it can be represented by a tree or by a forest (Auguste Comte). Trying to get an answer, first it was changed the paradigm from the material pre-eminence to the energy one and then to the information; then it was concluded that there must be taken into systemic consideration both the structural side of the science and the intuitive, phenomenological one. The genius scientists posses not only the strength of observing, experiencing, measuring, but also intuition, creative imagination; they understand what remains hidden for the others, perceive the relationships between the apparently isolated phenomena, guess the existence of the unknown thesaurus. A renowned scientist feels instinctually in what direction he has to go to make a discovery. In the past, this

[3] It is the geometry where the Pythagoras theory is applied.

[4] The Greek science could be a continuation of the ideas and practices previously developed by the Egyptians and Babylonians; but the Greeks were the first ones who tried to identify, beyond the simple observations, the general principles from the basis of the Universe. As it was known in Egypt and Babylon, the science consisted in a collection of observations and recommendations that were needed for the practical applications.

[5] The European civilizations are citadel civilizations, stone civilizations; the Indian one belongs to the forest, to the alive creatures; the essence of the first could be the strength, the essence of the Indian – the reflection. The Indians' supreme hope consists in the human being harmony with the Universe.

was known as inspiration[6]. In a certain way, the intuition, the inspiration could be a very fast judgment[7], following sudden observations based on knowledge accumulated in the past. The clear-sighted[8] ones are perceiving events that are more or less far away in time and distance; they posses a quality that seems to exist in a rudimentary form in many people, quality that allows a more proper knowing that knowing through the feelings.

For a long time there were emphasized only the quantitative, measurable aspects of the science[9], but it was proved that is not enough to use in the knowing process only the structural information obtained directly through measuring, observing, experiencing. For a systemic knowing of the nature it is necessary to capture also the phenomenological information[10] – the experience – which was considered to be a fundamental process of the nature (Drăgănescu 1985, Chalmers 1996), non-reducible to the physical phenomena that are measurable, known; this phenomenological sense being a phenomena outward the structural science. The main problem for the contemporary science of today is the admission or non-admission of the existence of the mental, intuitive sense as an objective, physical, information reality. The structural science[11] has already reached the frontier where it is imposed its transformation into a new science, that combines in a whole both the structural and the phenomenological.

Mihai Drăgănescu has suggested (1990, 1993, 1995) a structural-phenomenological science, as an extension of the today structural science, which should be developed in order to explain the life, the mind, the consciousness and the quantum nature of the Universe. M. Kafatos (2000) in order to define the science that considers both the structural aspects and the phenomenological aspects of the reality proposed the integrative science concept. The integrative science must be based on a serial of fundamental principles like the ones suggested by Menas Kafatos and Mihai Drăgănescu in 1998 and also must find methods or a mathematics language to fit with the structural-phenomenological processes of the reality.

[6] The intuition discoveries should always be started from logic. In the daily life, as in the science, the intuition is a very strong knowing method, but a dangerous one. It is not easy sometime to differentiate it from illusion.

[7] Understanding the reality without using the rational thinking – confirmed in practice – seems to be inexplicable.

[8] The clear-vision existence, as the existence of the other meta-psychic phenomena, is contested by most of the scientists due to the fact that – for the present – these cannot be produced voluntarily, present uncontrollable characteristics and are rounded by superstitions, lies, illusions. The clear-vision existence was signaled in all the countries during all times, but there is no proof of my knowledge that the science has finalized any research in this field.

[9] P. A. M. Dirac(b.08/08/1902) – "The physics law must bear the beauty of the math".

[10] If we relate the phenomenological with the human being we get the experiment, the "quails". Generally speaking, the phenomenological is the sensitivity of the matter as a physical process and any elementary manifestation of this sensitivity is phenomenological information.

[11] Everything that is not phenomenological or is not perceived as being phenomenological or including phenomenological elements is structural. The structural science includes everything that can be described by using a mathematics model.

The Space[12] and *the Time*[13] are two philosophical categories that are defining

[12] Definitions of the *Space* concept can be found even since the pre-Socratics and probably in Pythagoras's writings. One of the first reflections concerning the space is found at the Neo-Platonic Greek philosopher Simplicius – "If space exists, where it can be found? Because any existing object is inside something, and anything inside something exists in a certain place. So the space will be in a certain space and so on up to the infinite; so the space does not exist (Simplicius citing Zenon in "Aristotel Physics", 562). In Plato's philosophy, the space is not clearly defined; it has not the character of an essence, it is only a "khora", a receptacle in which all the evident objects are appearing. The antic atomists (Democrit, Epicure) considered also that the space is a vide, infinite receptacle of the material atoms, while Aristotel considered it being the sum of the places the objects are occupying. For Descartes "the space or the interior place and the object contained by this space differ only in our minds. In fact, the same dimensions in length, width and breadth that constitute the space constitute also the object". (Descartes – The Philosophy Principles). Newton makes no confusion between space and the material substance, he thought that space was a real, absolute frame, that exists independently of the objects situated inside or of the events that are taking place; he also considered that an object can exist in an absolute rest. In a polemic correspondence he had with Clarke, one of the Newton's disciples, Leibniz refuses to consider that space is an absolute reality. According to Leibniz a distinction has to be made in the sense that the sensitive extension created by God – the space itself – is not a "substance" (material), but the order of the possible co-existences. Kant rejects the idea the space is an absolute reality. The space is an a priori frame of our perception, of the subjective conditions of our different world's representations. For Kant, space is a pure form of the sensitive intuition, a condition for the phenomena to be possible. "The space is a necessary a priori representation that constitutes the basis for all the external intuitions."

In the Romanian literature for the last 30–45 years, the space definition evolved as follows:

– Basic form of the material existence in which its movement in time takes place. The space is not a simple receptacle, but together with the time constitutes the ensemble we nominate as world, universe. (The Polytechnic Dictionary, Technical Publishing House, Bucharest, 1967).

– The space category emphasizes the order of the real world objects co-existence, their position, distance, size, form, and extension. (Small Philosophic Dictionary, Political Publishing House, Bucharest, 1973).

– Objective and universal form of the material existence, inseparable of the material, who has the aspect of a non-interrupted whole with three dimensions and express the order of the real world objects co-existence, their position, distance, size, form, and extension. (The Explicative Dictionary of the Romanian Language, Encyclopedic Universe Publishing House, Bucharest 1996).

Homogeneous and infinite environment where the sensitive objects are situated. Very rigorously, it is made the distinction between the space and aria: space has three dimensions, the aria – only two. The space notion is a quantitative one, impossible to be understood at the intellectual level; on the contrary – the aria is measurable and can be exactly defined through the relations between the objects. (Larousse, Philosophy Dictionary, Encyclopedic Universe Publishing House, Bucharest 1998).

[13] *Time* – a measured or measurable period, a continuum without any spatial dimensions. It is a theme for philosophic research and an object for mathematics and physical scientific investigations. We speak about time flow, time running. Time is the one who makes the present to become the past. In the Vth century, St. Augustine has drawn the attention on the fact that time is both the most familiar concept used when organizing the actions and the thoughts, but also something that cannot be perceived, cannot be defined. He used to say: "What then is the time? If nobody asks me, I know what time represents. If I want to explain someone who raises questions about time, I do not know what it is anymore." The philosophers found a meaning for the time by answering two questions: *1. what is the relationship between time and the physical world?* And *2. What is the relationship between time and consciousness?* Newton believed in an absolute time saying that time is the same for everyone, being like a container in which the universe exists and is changing the place. Time existence and its characteristics are independent of the physical universe. Philosophically speaking, with no reference to the science, it is considered that time has no beginning and no end, being linear and continuous. In fact, if persons miles away one from the other wants to compare the hours, either they should use the

objective and universal forms of the existing of the moving material. Our terms on space and time constitute basic characteristics on the map of our reality and the evolution of the semantic content of these characteristics is typical when justifying the necessity of promoting the concept of integrative science. The space and the time help us arrange things and events in the environment and there is no physics law not to need these concepts when being formulated, explained or understood.

Perceiving the space with the 5 human senses, together with the equilibrium sensation and the adaptability of the human body, makes the person being aware of his own position in relation with the objects around. Also, it gives him the profundity and distance sensations that are locomotion and orientation basic indicators. The idea of "up" and "down", "left" and "right", "oblique" is intuitive. Indeed, we posses a special organ – the semi-circular channels of the internal ear – whose role is to let us know what is the sense of "up", and if this organ is wrong we feel dizzy. The psychologists consider that the human being also posses some other native abilities that allow him the tri-dimensional perception of the space with the bi-dimensional eye retina. The individual must learn how to interpret the visual images in order to identify the space relations between the objects inside the visual field, and also must get the ability to evaluate the form of an object that is only partial visible. The human organism is able to receive stimuli that are warning him on various dangers when moving inside the space, and also to identify any move around. When an object is moving in relation with its observer or when the observer is moving in relation with the objects around him, the environmental stimulus are perceived as modified meaning that the change of the object position in relation with the eye is interpreted as a change on the image the object has on the retina, and not a change of the object form.

Technically speaking, it was invented "the plummet" to indicate the "down" direction and it was obvious that all the plummets were indicating the same

same watch or to synchronize their watches based on the stars location. The relativity theory adepts explored the possibility that the physics to demonstrate that time has a structure, is constituted from discrete particles (cronon) or it cyclic evolutes. The temporal structure of our experience is so coactive the human being has always dreamed to liberate him from it – the eternity desire being expressed in all religions, in the humanly surviving behavior through his operas or children. The imaginary liberation from the time bands is one of the most prolific themes in the fiction literature.

In the Romanian literature for the last 30 – 45 years, the time definition evolved as follows:

– Form of the material existence. The time exists objectively, independent of the human consciousness and will. The time is measurable and comparable; it is without beginning and without end. (The Polytechnic Dictionary, Technical Publishing House, Bucharest, 1967).

– The time category generalizes the succession or simultaneity of either material processes different states or of the material processes them when going ones into the others. (Small Philosophic Dictionary, Political Publishing House, Bucharest, 1973).

– A Universe dimension based on which the phenomena irreversible succession ordinates. (The Explicative Dictionary of the Romanian Language, Encyclopedic Universe Publishing House, Bucharest 1996).

Infinite medium, in which events succeed each other, frequently considered like a force that governs over the world and creatures. (Larousse, Philosophy Dictionary, Encyclopedic Universe Publishing House, Bucharest 1998).

direction. Eratostene must have realized that "up" and "down" are not absolute directions and that the plummet load tends to look for the center of the earth, but it was for Newton to explain this phenomena as a consequence of the attraction each particle of the earth is exerting toward the plummet load.

The extension of the idea of "up" and "down" so that to correspond to the spherical form of the earth is one of the first examples of a concept generalization based on an intuitive thinking. It is a remarkable performance of the imagination in realizing that what "up" and "down" mean for a certain person, for another one might define the horizontal direction – left and right. "It was the first one from a serial of such kind of exercises, the science asked the human being to make"[14].

In what concerns the time, we all know about the intriguing discrepancy between our personal time experience and the way time is described in the physics. Particularly speaking, we know about the existence of a perceptive privileged direction of time, where we are consciously able to assume the control of the present moment[15], the only moment that we have a direct perception of. We also know that in the modern physics, the time does not correspond with our experience: the physics laws are generally time reversible and do not make distinction between the past and the future by ignoring the concept of the present itself. These circumstances are denying the human common experience on time perception by transforming it into a simple datum with no significance for the scientific discussion. Also, in physics it is ignored the separation that exists in our minds between the past and the future: the past is considered fixed and definite, it could be recalled only in the memory; while the future is unknown and undetermined, it can be only approximately predicted by considering our existing knowledge on the cause – effect relationship.

Practically, there exist two divergent concepts of time: the "internal time", biological, own to each human being, strictly individual and quantitatively incomparable with any of other human beings; and the "external time" which is defined in the physics as being a fixed succession of equal instants, independent of any human perception, depending only on the presence of gravitational masses and relative velocities of the observers, it makes no difference between the past and the future by being used only as a parameter in the movement equations.

The classical physics were founded on both concepts – space and time – that were seen in an absolute way: the one of a tri-dimensional space with no dependent relation with the contained objects and being subordinated to the Euclidian

[14] The time three dimensions are the present, the past and the future. "These three instances exist for real in the soul and I cannot see them anywhere else: a present referring to the past: memory; a present referring to the present: perception; a present referring to the future: the waiting, hope" (St. Augustine, Confessions, around 400).

[15] James Clerk Maxwell (13/11/1831-05/11/1879) has published in 1864 "An Electromagnetic Field Dynamic Theory" where uses the Michael Faraday field notion as a base for the electricity and magnetism mathematics approach; in this paper the Maxwell equations are launched to describe the electromagnetic phenomenon. In 1873 he published "The Electricity and the Magnetism" which contains the electromagnetism basic laws, and suggests the existence of such phenomena like the radio waves, or the pressure caused by the light rays.

geometry laws; and the time – seen as a separate dimension, considered to be absolute and developing in a rhythm totally independent of the environing world.

The difficulties in the real understanding of the space and time appeared when Maxwell managed to determine the correct relations between the electrical measures and the magnetic ones. Maxwell's equations – in contradiction with the Newton's – involve the existence of an absolute rest, meaning that a group of objects that is in "resting" must behave in a different way compared to the same group of objects that is in a constant move.

To get out from this situation the Maxwell Theory must have been rejected – which probably would have happened if the famous experiment Michelson-Morley[16] from 1887 in order to detect the move of the Earth in the ether environment did not fail. The Contraction Law – presented by George Francis Fitzgerald and Hendrick Lorentz in 1892, explained the negative result of the Michelson-Morley experiment. According to this law, any moving object is contracting toward the moving direction with a small fraction of its length, while its width remains unchanged. For the usual speeds – very low by compared with the light speed – the contraction is very small, but no matter the size, it cannot be detected ever through a usual measuring due to the fact that the measure instrument will also get contracted. In addition, it is supposed that the clocks that are in move are delayed with a time fraction that is equal to the time fraction necessary for the contracted length to be covered by the rigid objects.

Jules-Henry Poincare[17] was the first to speak about the "relativity theory", but the theoretical approach by Hendrick Lorentz of the Maxwell's theory was an important contribution to the relativity theory, emphasizing that the light speed is the same one for all the observers[18].

Further to the relativity theory, there were reconsidered the known concepts about space, time and relative movement. It was for the geniality of Einstein to make scientists and philosophers think that geometry is not always inherent in the nature, but it was imposed by the mind, by the logical thinking. First, it became necessary to analyze the statements made by the moving observers in what concerns the object dimensions or the timing of the events. More, there is neither absolute simultaneity nor absolute chronology in time. In case two different events

[16] In 1887, Albert Michaelson (19/12/1852-09/05/1931) and Edward Morley (29/01/1838-24/02/1923) are measuring the light speed on two different directions, looking forward to determine this way the real movement of the Earth inside ether medium. The results did not prove the Earth is moving, but suggested the ether does not exist. Maxwell theory was saying there is all embracing ether that electromagnetic disturbances are spreading through.

[17] The re-known French mathematician, physician and philosopher Jules Henry Poincaré (29/04/1854-17/07/1912), brother of a former French prime minister, contested the priority that was given to the Einstein Relativity Theory due to the fact that he was the first one in researching it. The dispute was solved in 1921 in Einstein's favor, even though the relativity theory during those years was not unanimously accepted and for this reason it was not mentioned when Einstein was offered the Nobel Award for "services brought to the theoretical physics".

[18] Rigorously speaking, this is really true only when any type of acceleration is missing.

are taking place at big distance one from the other, it is possible for these events to happen in a certain order for a certain observer, but in a turnaround order for another observer, who is moving by the side of the first observer. The events that are happening in the same place have the same chronology for all the observers.

The relativity principle tells us how to treat the relative movement; it does not say how important is this type of move, nor that "everything is relative" The "restricted" relativity refers only to the constant speeds in a straight line and affirms that the fundamental physics laws have the same form for all the observers that pass by one another in a straight line in a uniform movement. The generalized relativity theory – drawn up by Einstein[19] – refers to any type of movement, saying that any fundamental physics law must have to be expressed in a form that is the same for all the observers, even for those who are moving accelerated one from another. The mechanics laws, who govern the phenomena associated with the moving objects, and the electrodynamics laws, the electricity and magnetism theory can be expressed in a unique relativist frame that contains both the 3 space dimensions and the time – as the 4^{th} coordinate, specifically related with the observer. In order to observe that the relativity principle is satisfied, we check if the equations of a theory look the same in all the coordinates systems, then we must take the space and time specifications out from a reference system and to put them into another reference system – and this movement between the two different reference systems and its mathematics expression are easy to be obtained using the classical geometry.

The real revolution brought by the Einstein theory was the abandon of the idea that the space-time reference system has any objective significance as a separate physical entity. By replacing this idea, the relativity theory defines the special and temporal coordinates as being elements of a language used by an observer to describe the environment. Further on, we are facing a new situation in the relativist physics: time is added to the other three coordinates, as the 4^{th} dimension. As long as the different reference systems transformation expresses each coordinate of a system as a combination of the coordinates of the other system, generally speaking a space coordinate from a system will be a combination of spatial and temporal coordinates in another system. Any change of the coordinates system is combining the space and

[19] In 1905, 30^{th} of June, Albert Einstein (10/03/1879-18/04/1955) submits to Annalen der Physik his first work on the restricted relativity theory, named "About the moving objects' electrodynamics" where it was affirmed that the light speed is constant, independent of conditions and state, for all the objects that are in relatively constant move and also that the objects relative speeds cannot overrun the light speed. With this paper Einstein doubts – philosophically speaking – the Newton theory: "neither the space nor the time can form a network by which either an object location or the time during what the object exists in that location could be measured in relation with. At 27^{th} September the same year, Einstein is publishing the second paper named "An object's inertia depends indeed on the stored energy?" where he launches the famous relation between mass and energy $E = mc^2$. Initially, Einstein theory was seen as a continuation of the Lorenz works, but Einstein went further with the radical aspect of his solution, of the impossibility of the ether existence, according to the basis problem of the total relativity of the space and time.

the time in a very well defined mathematics manner so that these two cannot be separated from now on due to the fact that what represent space for an observer will represent a combination of space and time for the other[20].

Einstein considered time was a dimension "like the other ones" – which is absolutely right in the relativity theory and in the quantum theory, and corresponds with all the modern physics and chemistry theories. An objective analysis emphasizes the fact that time cannot be a dimension exactly the same with the other three space dimensions. In the present conditions, it's not possible to stay in absolute rest nor can one go back in time. The irreversibility[21] of the time has caused ample debates during the XXth century. Both the quantum theory and the relativity one as like Newton or Maxwell laws are independent of the time flow direction.

According to the reversibility of the classical mechanics, if at a certain moment all the speeds of a system are going back in directions totally opposite to the previous ones, the system will re-live all his previous states in reverse order; so the probability of the decreasing evolutions should be exactly the same with the probability of the increasing evolutions. On the contrary, the classical thermodynamics coordinates a lot of physical and chemical phenomena that are time irreversible (for example, the heat goes only from the heated object to the cold one and not reversibly.

During the years 60s of the XXth century, the relativist kinematics, meaning the space-temporal geometry, became the universal frame of the physical theories (even at the quantum level) and for this reason in every point-moment the intrinsic separation of the space-temporal fields is no longer a bifurcation as it was in the Newton kinematics – "past" and "future"; but a trifurcating: "past", "future" and "somewhere else". This means that the material should be seen as being extensive both in space (traditional idea) and in time (a new approach).

O. Costa de Beauregard considered that the irreversibility problem is no longer "why the most probable the physical states are generated in the increasing probabilities order, and not in the decreasing ones", but "the physical states probabilities being

[20] In the classical physics it was considered that a stick has always the same length like when it is in a rest state. The relativity theory showed this is not true. An object length depends on the its relative to the observer movement and it changes with the speed of this movement. The change consists in the object contraction toward the moving direction. The stick has a maximum length in a reference system that exists in a rest state and becomes shorter as it's relative to the observer speed increases. In the high-energy physics experiments of "dispersion", when the particles are touching with very high speeds, the relative contraction is extreme so that the spherical particles are reduced to flat forms.

To ask which one is "the real" length of an object is like you ask which one is the real length of someone's shadow. The shadow is a projection of the tri-dimensional space points into the bi-dimensional plane and its length will be different depending on the different projection angles. Therefore, the length of a moving object is the projection of the quadric-dimensional space points into the tri-dimensional space and its length is different in dissimilar reference systems.

[21] The irreversibility is the main characteristic of the time. "This is what makes poets cry, what makes the "never" to have a funeral accent; and what gives to the never again seen things that extreme acuity full of lust and pain in which the existence absolute and the nothingness absolute seem to get so together up to their merger. The irreversibility is the testimony of a life that values once and nothing more." (L. Lavelle, "About the Time and the Eternity", 1945).

generally ordinate in relation with the time coordinated values, why the alive creatures are forced to explore the time coordinate toward the direction where the probabilities are in majority increasing ones and not toward the contrary direction?"

L.E. Boltzmann was writing that based on statistical foundations "(in a static universe) there should exist the same number of practically isolated regions with increasing entropy as with decreasing entropy"; then, he thought it is reasonable to consider that "the alive creatures time directions in these two different kind of regions are opposite, so that in both cases the biological time is following the direction of the increasing entropy." This means that the time coordinate and its material content are given once and for all. Norbert Wiener said that "information change between these regions" should be strictly prohibited, otherwise non-solvable problems will arise.

The cybernetic principles involvement in physics made necessary to reformulate the Carnot generalized principle: "inside an isolated system where observers exist, the sum non-entropy-information cannot become smaller". Based on this, O. Costa de Beauregard has put forward the postulate that "life involves essentially an information flow at the entrance", which together with the Carnot generalized principle justifies what Boltzmann has written. Actually, the Costa de Beauregard postulate stated in a more sophisticated way the fact that we learn from our experience. It cannot be possible – for example – to read a book from the last page to the first, this will mean that we know the book from before.

Both the quantum theory and the relativity one, as like Newton or Maxwell laws, are independent of the time flow. The relativity theory has emphasized that the space is not tri-dimensional, and the time is not a separate entity. Both of them are inseparable and intimate connected, forming together a quadri-dimensional continuity named "the space-time continuum"[22]. The relativity theory is crucial for describing the sub-atomic particles world. The world of the relativist physics forth dimension is where the matter and the energy are unified where the matter can appear as separate particles or as a continuous field. The scientists could "test" the world of the forth dimension – space-time – through a structural-phenomenological research[23], through intuition, but also through the abstract mathematics formalism

[22] Herman Minkovski (22/06/1864-1909) in his famous lecture introduced the space-time concept from 1908 that completed the relativity theory. "The vision over the space and the time that I wanted to give you before, you know it already from the experimental physics, and this is its strength. From now on the space by itself and the time by itself are destined to purely pass into the shadow and only a union of these two will maintain an independent reality."

[23] The relativity theory mathematics elegance and beauty does not help our intuition too much. As a rule, we do not poses a direct sensorial experience of the quadri-dimensional space-time, nor of the other relativist concepts; we only can observe the "image" of the quadri-dimensional space-time world into the tri-dimensional space, an image whose aspect differ upon the reference systems. Any time we study the natural phenomena that involve high speeds, it gets very difficult for us to analyze any connection between these concepts, both at the intuitive level and using the normal language. The moving objects look different compared to the rested ones and the clocks that are moving go with different speed. These effects seem to be paradoxical in case we do not realize that they are only projections of the quadric-dimensional phenomena, as like the tri-dimensional objects project the shadows. If we were able to visualize the forth quadric-dimensional space-time reality, nothing would seem paradoxical for us.

of their own theories, even though their visual imagination – like any other person's – is limited to the three sensorial dimensions.

The quadric-dimensional world of the relativity theory is not the only one example from the modern physics when the apparently contradictory and irreconcilable concepts seem to be nothing else but different aspects of the same reality. Maybe the most known case of such unification of contradictory concepts is the one that refers to the concepts of waves and particles in the atomic physics.

At the atomic level, the material has a dual aspect: it appears both as a particle and as a wave. Which one is dominant differs on a case-by-case basis: sometimes, the particle aspect is dominant; in other cases the particles behave more like waves. This dual aspect can be seen also in light and other magnetic radiation. This dual aspect of the material and the energy is the most surprising fact and caused a lot of interpretations. A lot of time was necessary for the physics to accept that the material is manifesting itself in different ways: the particles have also an ondulatory movement and the waves are acting like particles.

From structural point of view, the waves phenomena can be found in many different contexts of physics and can be described through the same mathematics formalities anywhere it is manifesting itself. The same math formulas are used for the description of light wave, guitar vibration, and sound wave or water wave. In the quantum theory, the same formulas are used to describe the particles associated waves – even though in this case there is a need for the phenomenological approach due to the fact that the waves are much more abstract. Here the waves are related with the statistical aspect of the quantum theory due to the fact that the atomic phenomena could be described only by using probabilistic terms. The probability for a particle to be contained in a certain quantity is called probabilistic function and the mathematics form of this quantity looks like a wave (being similar to the formula used to describe other waves). Though, the particles associated waves are not "real" tri-dimensional waves, like the water waves or sound waves; they are "probabilistic waves": an abstract structural quantity that exits in relation with the probability to find the particle in different places with different characteristics.

The introduction of the probabilistic waves has resolved–in a way–the paradox of the ondulatory behavior particles by putting them into a totally new context; but–in the same time–raised a new pair of contradictory concept, a fundamental pair: existence and non-existence. We cannot ever say that an atomic particle exists in a certain place in a certain moment in time, but nor we can say that particle does not exist. By being a probabilistic model, the particle represents the "trend" to exist in various places, different places for the same moment in time; or to exist in the same place for different moments in time – and this means a strange type of physical reality, located between the existence and the non-existence. The particle does not exist for sure in a certain place from the space, but for sure is not absent from there. It is not changing its position, but it does not

remain stuck there. What is changing is the probabilistic model and in this way the particles trends to exist in certain places from the space[24].

Being in the position to face the material reality that goes beyond the contradictory concepts (energy and material; particles and waves; movement and rest; existence and non-existence), the scientists had to adopt a structural-phenomenological way of thinking that allows the mind not to be fixed in the rigid, structural network of the classical logic, but to sustain the own point of view in continuous movement and oscillation. In the structural science the sub-atomic world appeared as a network of relationships between different parts of a whole. But the classical definitions derived from the macroscopic experience proved to be inadequate to describe the subatomic world. The concept of a distinct physical entity that exists in a certain place in a certain moment in time is an idealization that has no fundamental significance. By the structural-phenomenological, integrative approach, the concept of physical entity can be defined only in the terms of its connection with the whole, and this connection has a more statistical-probabilistic nature but being certitude. When describing the characteristics of such an entity by using the classical concepts – like location, energy, moment – we realize these are pairs of inter-relational concepts that cannot be simultaneous defined.

For a better understanding of the relation between the pairs of classical concepts Niels Bohr used the notion of complementarities[25]. He considered the particle's description and the wave's description as being two complementary descriptions of the same reality each one being partial correct and having a limited application area; each one being necessary for a full presentation of the atomic reality; both descriptions being applicable within the limits of the uncertainty principle.

The field concept was introduced in the XIXth century by Faraday[26] [26] and Maxwell when describing the forces that are manifesting between the electrical

[24] With the J. Robert Oppenheimer (22/04/1904-18/11/1967) words, this is expressed as follows: "If we ask, for example, if the electron position remains the same – we must answer "No"; if we ask, also, if the electron position in space is changing in time – we must answer "No"; if we ask, also, if the electron stays in that place – we must answer "No"; if we ask, also, if it is moving – we must say "No".

[25] The complementarily notion has become recently an essential part of the way of thinking of the nature, even though as a notion it was proved the complementarities exist for more than 2500 years. It played an important role in the antique China. Based on it, there was considered that intimately these contrary concepts are finding themselves in a polarity or complementarities relationship. The Chinese wiser represented this contraries complementarities through the archetype poles YIN (–) and YANG (+) and found in their dynamic interconnection the essence of the entire natural phenomena and human situations.

In 1947, as recognition for his scientific discoveries and his contribution to the Danish culture, Niels Henrik Bohr (07/10/1885-18/11/1962) was ennobled and he has chosen as escutcheon the T'ai-chi Chinese symbol that represents the complementary relation between the opposite archetypes YIN and YANG, together with the inscription "*Contrarians sunt complementa*".

[26] Michael Faraday (22/09/1791-25/08/1867). In 1831, independently of Joseph Henry he discovers that electricity can be induced by the magnetic field changes (the electromagnetic induction). In 1845 he identifies the connection between magnetism and light based on the observation that a magnetic field affects the polarity of the light inside the crystals; he launches the idea that light might spread in the form of electromagnetic waves.

charge and currents. In the classical Electro-dynamics, based on the theory of Faraday and Maxwell, the fields were primary physical entities that could be studied without referring to the material objects. The vibrating electrical and magnetic fields were able to travel into the space in the form of radio waves, light waves or other types of Electro-magnetic radiation. The relativity theory has brought elegance to the Electro-dynamics structure by unifying the concepts of electrical charges and currents, electrical fields and magnetic fields. Because any movement is relative, any charging (for example the electrical one) appears also like a current – in the reference system where it is moving by comparison with the observer – and as a consequence its electrical field can also appear as a magnetic field. Therefore, in the relativist theory of the Electro-dynamics the two fields are unified into a unique electromagnetic field.

In the relativity theory the field concept was associated not only to the magnetic force but also to the gravity force – fundamental force in the macroscopic world. The gravitational fields are created and "perceived" by the massive objects and the resulting forces are always attraction forces, contrary to the electromagnetic fields which are perceived only by the electrical charged objects and can produce both attraction and rejection forces.

The Einstein theory contains the implicit idea that the space neighboring an object that is gravitating around another object is in a way a non-Euclidian space[27] and from here that the Pythagoras theory is not rigorously exacts. The field's theory specifically applied to the gravitational fields represents actually the generalized relativity theory that's saying the influence of the massive objects on the neighboring space is much more perceived than the corresponding influence of a loaded object in the electrodynamics theory.

In the generalized relativity theory (1915) the two fundamentally distinct concepts – the material spaces and the vacuum spaces – which the Democrit and Newton atomism were based on are no longer separated. Anytime we will have a massive object there will be a gravitational field and this field will manifest itself by curbing the space from around the object. But we must not think that the field perceives the space and then it curbs it. The two aspects cannot be detected; in fact the field is the curb space! In the Einstein theory the gravitational field and the structure – or the space geometry – is identical, and the matter cannot be separated from its gravitational field and the gravitational field cannot be separated from its curb space. This way, the matter and the space are seen as inseparable and independent parts of the whole. The material objects not only determine the surrounding space structure, but also–at their own turn–they are essentially influenced by the neighborhood. Essentially, Einstein realized "the possibility of incorporating the gravity into the inertial manifestation of the moving material" and therefore only after firing debates his theory has become as appreciated and famous as Newton's.

[27] It is that space where the Pythagoras theory is not applied.

The unity and the inter-relation between the material object and the environment, that are structural studied at the macroscopic level with the general relativity theory, appear to be more significantly at subatomic level further to a structural phenomenological approach. The ideas about the classical field's theory were combined with those about the quantum theory in order to describe the interactions between the subatomic particles. Such a combination was not possible yet for the gravitational interactions due to the complicated math formula that the Einstein gravity theory developed[28], but the other classical theories of the electrodynamics field have joined the quantum theory into the "Electro-dynamic quantum" theory that describes all the electromagnetic interactions between the subatomic particles.

In the Electro-dynamic quantum theory the field can take the form of the quantum or particle and by this the classical contradiction between the solid particles and the neighboring space is completely rejected. The quantum field is intuited like a fundamental physical entity, a continuous environment that is present anywhere in the space. The particles are – in principal – local condensations of the fields, modular energy concentrations that appear and disappear, losing this way their individual characteristics and dissolving them into the surrounding field[29]. Through the structural phenomenological approach the modern science has found the answer to the old question if the material is constituted from individual atoms or from a not differentiated continuum. The field represents a continuum that is present anywhere in the space and – seen from the particle point of view – has a discontinuous "granular" structure. These two apparently contradictory concepts are this way unified and perceived as two different aspects of the same reality.

The space and time concepts have been having a long journey from the assumption that peoples will fall down from the Earth until nowadays, when there still exist different opinions in what concerns the space, the time and the gravity. In respect of the time, one says it flows too fast or too slow. There are experiments conducted over the time discontinuity (fragmenting). There are the extreme cases

[28] In the last 30 years of his life, Einstein tried unsuccessfully to unify the field's theory, which would have joined the general relativity theory and his space, time and gravity theory with Maxwell theory on electromagnetism. Progresses toward this unification were obtained later on, but in another direction. The present theory on the elementary particles and forces known as the physical particles "standard model" unified with the weak interactions magnetism, which determines the neutrons and protons transformation into radioactive processes. The standard model allows a similar description for the strong interactions that maintain the quarks inside the neutrons and protons and keep the neutron and protons inside the atomic nucleus. There are also ideas concerning the unification of the strong interactions with the weak ones and with the electromagnetic ones, but these ideas should become lucrative only when the gravitational forces will be included.

[29] Albert Einstein expressed this aspect as follows: "That's why we should see the material as being constituted from the space regions where the field is extremely intense… In the new physics type, there is no place for both the field and the material, because in fact the field is the only reality."

when the events that are taking place one after another seem to be separated by eternities or the time can be modified so that events from the past, present and from the future can become simultaneously accessible with no intervals in between to separate them so they are perceived as being in a serial. The space sense is also strongly affected. The space can appear as being amplified or compressed, condensed or rarefied, even change the number of dimensions. A tri-dimensional space can be studied as a bi-dimensional one (flat) can receive a new dimension, or it can be reduced to a non-dimensional point that exists only in the observer subconscious.

Initially, the Space – Time relation was affected by the moving speed increase; later on it was affected by the communicating speed. At the present, it's possible, that the Internet and the Tele-immersion to open new doors in analyzing this relation in the expectation of perceiving the simultaneity of the events.

The Tele-immersion[30] is a relatively new digital technology that combines the real image display with the interaction techniques of virtual reality. It approximates the illusion that a user is in the same physical space as other people, even though the other participants might in fact be hundreds or thousands of miles away, by this way a new medium for human interaction being created. For the moment, Tele-immersion is a lab technology that involves not only a new system of image capturing with minimum 7 cameras allocated to each visualized point, but also power-full, high capacity computers. At the moment, it is appreciated that the Tele-immersion is a technology almost 100 times more expensive than the video-conferencing – for this reason it cannot compete with anyone of the communication technologies. However, it is estimated that in the next 5–10 years Tele-immersion would become the main communication tool and at that moment it will substitute the business flights. Teams of engineers will develop joint design projects – however distant they will be one from the other; archeologists from around the world can be virtually present on a certain site where a historical discovery is taking place; technicians will be able to assist in a car reparation without being nearby.

Very different points of view can drive to identical (or quasi-identical) conclusions when we translate them into the possible observation level. The most near reality ones are the measuring, the structural experimental observations. Starting from these material results and adding the intuitions, phenomenological information one can reach high level abstractions and furthermore very progress

[30] In 1965 Ivan Sutherland who is widely regarded as the father of computer graphics proposed the procedure to obtain a display image to allow the user to experience an entirely computer-rendered space as if it were real. In 1968 Sutherland realized on a computer for the first time images of a virtual world. If in 1984 the first virtual programming language was created, in 1989 a digital product was created called "Reality built for two" who creates the impression that two participants, who in real world are located in different spaces (initially at a lower distance, then a much bigger distance) are sharing the same virtual world.

promising conclusions. The scientific method involves frequent and meticulous experiments and observations, also a structural, mathematics analysis using as a guidebook the existing by then theories and hypothesis. It is aiming to the intuitive formation of the concepts that are suggested by the experiments and observations, and further on to the development of hypothesis, theories and laws. The scientist has to believe that in nature there is certain rational order, without promoting the idea of the total determinism[31]. There are serious reasons to assume the determinism has no general spreading and – most probably – it is not extending itself on the very deep levels of the material.

During the XIXth century the physicians developed mechanical, structural models of the nature; models that were based on the Newtonian mechanics and which–even complex–were removed when the Maxwell electromagnetic theory appeared. The classical mechanic approach was based on the notion of solid, on indestructible particles that are moving inside the vacuum space. The mathematics model that was used more frequently in our days even though in a simple form it was used also by Galilee and according to some opinions – partially justified – the mathematics model constituted the base of the Greek cosmogony replaced the mechanical model. The Einstein works are the best example of using mathematics as a model. The modern science has driven not only to a complete vision on the "particles", but has transformed the vacuum space classical concept in the filed theory. This transformation started with the Einstein idea of associating the gravitational field with the space geometry, but became more prominent when the combination of the quantum theory with the relativity theory described the force fields of the subatomic particles.

Physical systems and signals modeling process involves a certain abstractization following which there can be eliminated information on the physical nature of the considered measures; knowing the physical nature of the modeled measures allows a correct interpretation of the results and the possible elimination of those who have no physical sense.

The analysis of the modeling process emphasizes the fact that building a mathematics model means to choose an attractive and elegant mathematics field that looks like the description of the studied physical phenomena and also to try to see if the mathematics algorithms agree – partially or integrally – with the studied phenomena. It's like someone would draw up some ideal maps, and then looking to find a city that fits with the map. "The understanding of the physical phenomenon is more important than its mathematics description. This does not mean the mathematics description is not important, but the understanding is more important".

[31] "Total determinism" refers to the "absolute determinism" or "mechanical determinism", category that corresponds to an old phase of the scientific and philosophic thinking. The modern concept of determinism includes also the statistical laws that govern the phenomena that take place "at the very deep levels of the material".

It seems there is no valid reason to assume that nature and the two philosophical concepts–space and time, who describe objective and universal forms which the moving material exists in–are only of structural nature in their essence; nor they do not have a mathematics support, because otherwise there could not be explained the progress that was made in their theory evolution. Reality has proved that the mathematics, structural models are very utile, even if the Einstein theory might have not told its last word in respect of space, time and gravity theory[32]. The fascinated problems raised by the Einstein theory would have not appeared if only the mathematic, structural model would have been used. But these problems referring to the deepness of the cosmos which has driven to remarkable progress could also be explained by the fact that Einstein used also his intuition, phenomenological information transformed into knowledge.

In order to explore new horizons in getting the truth about the space and the time, there is a need for systemic and integrative action, using both the structural knowledge and the phenomenological ones. Let's hope the future will confirm it.

CONCLUSIONS

1. The environment world discovery started with our perception on it by using our senses, that were evolving through natural selection into a world where avoiding the macroscopic objects has favored the species survival. Obviously, the observations, experimental measuring were the first scientific ways for knowing. The observation and measuring results, logical correlation, the mathematics thinking and then the intuitive knowing through the conscious perceiving of the phenomenological information have been new scientific ways for knowing that appeared during the ages, according as the scientific knowledge was accumulated; each one of the ways mentioned above being a qualitative step forward in the knowing process. Worth to mention that during this knowing process both structural and phenomenological information were perceived intuitively but – at the beginning – the structural information had priority. The study of the space and time concepts evolution emphasizes the fact that according **as the knowledge were accumulated the importance of the phenomenological information became bigger**; and the awareness of this type of information has become one of the major scientific achievements of the last decade of the XXth century.

[32] In the present, the main problem of the physics is that the quantum mechanics and the Einstein gravity theory are not compatible. Further to trials to "quantify" the gravity field numerous debates were taking place. Without a connection between the two theories it will not be possible to describe the "Big-Bang"–which it is supposed to be the beginning of our universe. Those who are working in the string theory field sustain they obtained by their research an "acceptable" connection between the two theories, but the others think of contrary. Life will show in the next years who were telling the truth.

2. **The science is unitary; the study of the space and time concepts evolution emphasized the necessity of the integrative, systemic, interdisciplinary approach**. The concept of a distinct physical entity that exists in a certain moment in time in a certain place into the space is an idealization that has no fundamental significance anymore. Through the structural phenomenological integrative approach, the physical entity concept could be defined only in the terms of its connection with the whole and this connection is of a more statistical-probabilistic nature then having the form of a certainty. When describing the characteristics of such an entity by using the classical concepts–like space location, energy, moment–we realize these are pairs of inter-relational concepts that cannot be properly simultaneous defined.

The space–time relationship had a dynamic evolution. Initially, it was considered that there was no connection between the tri-dimensional continuous space and the time – seen as a separate uni-dimensional continuum, completely homogeneous in its entire extension. Further to a more intense perception of the phenomenological information it was found out that **the space – time relation is deeply affected by both the relative movement increasing speed** – which determines the contraction of the dimensions in the moving sense and also the proportional reduction of the time flow speed – and **the communication speed – it's possible, that the Internet and the Tele-immersion to open new doors in analyzing this relation** in the expectation of perceiving the simultaneity of the events.

3. The space and time studies enlighten the existence of some problems that seem to be either contradictory or not solved yet:

• The laws describing the particles interaction or planets are the same both in the direct time, and in the reverse time. The world is made from molecules that at their turn are made from particles–whose individual behaviors can be described by laws that are not affected by the time flow sense. However, **the time irreversible flow sense is very important for our daily existence.**

• Einstein considered the time as being a dimension "like any other one", which is completely true in the relativity theory, in the quantum theory and corresponds to all the modern chemistry or physics theories. But an objective analysis emphasizes the fact that **time cannot be dimension exactly alike the other three space dimensions**. In the present conditions, it's not possible to stay in an absolute rest in time and one cannot go back on the time axe.

• The generalized relativity theory–that can be nominated as "the relative gravity theory" has brought fundamental changes in the terms of time and space, mass, energy, gravitation and acceleration. It incorporated into the same ruling all the mechanic, electromagnetic and gravity processes. Out of it, there remained the atomic and nuclear processes. It **left opened the debates on the field unitary laws able to explain both macro and microphysics processes.**

These doubts or non-clarified items leave the door opened for the **reconsideration of some concepts that today are immutable or for the new potential possibilities to be developed in order for the knowing process to be improved**.

4. There is the possibility that **the integrative science is only one step forward** in the knowing process. Looking for the truth has no ending. A scientific discovery does not represent a final point; it's a start to a total new zone. What an old generation did for our scientific knowledge does not loose its importance, does not become less fundamental or less revolutionary in the moment a new generation is replacing the old one. The sum of our knowledge doesn't look like what mathematics call a "convergent" series–where by studying a few terms we can deduct the general characteristics of the whole. The sum of our knowledge would better correspond to the "divergent" series-where the terms that are adding one after the other are not becoming smaller and smaller and we do not have any guarantee at all that the conclusions we get from the few known terms would be the same ones if we had more knowledge.

BIBLIOGRAPHY

1. Mihai Drăgănescu, *Ortofizica,* Editura Ştiinţifică şi Enciclopedică, Bucureşti, 1985.
2. Mihai Drăgănescu, Sisir Roy, *Pretopology, Quanta of space and the Fundamental Phenomenological Information of the Universe*, FORMA (Japan, Tokyo), vol. 19, No. 2, pp. 85–96, 2004.
3. Menas Kafatos, Mihai Drăgănescu, *Principles of Integrative Science,* Editura Tehnica, Bucharest, 2003.
4. Mihai Drăgănescu(b.06/10/1929, Romania), Menas Kafatos (b. 1945, USA) "*Generalized foundational principles in the philosophy of science"*, paper presented at the Conference on "Consciousness in Science and Philosophy", Carleston, Illinois, 6–7 Nov. 1998.
5. George Thompson (03/05/1892-10/11/1975), "Inspiration and Discovery", Romanian Encyclopedic Publishing House, Bucharest, 1973, p. 84.
6. George Thompson, idem 15, p. 97.
7. L. Lavelle, "About the Time and the Eternity", 1945.
8. O. Costa de Beauregard, Logic, Methodology and Philosophy of Science, Edited by Yehoshua, Bar-Hilel, North Holland Publ.Co, 1965.
9. L. E. Boltzmann(1844–1906) Vorlesungen uber Gastheorie, Vol. II, Leipzig, Barth, 1896.
10. Norbert Wiener (1894–1964), Cybernetics, New York, Wiley, 1948, p. 45.
11. H. Brillouin, Science and Information Theory, New York, Academic Press, 1956.
12. "The quadric-dimensional space of the restricted relativity is as objective and rigid as Newton' space", A. Einstein, Forum Philosophicum, t. 1, 1930, p. 173.
13. O. Onicescu(20/08/1892-19/08/1983) "On the Life Roads", Bucharest, The Scientific and Encyclopedic Publishing house, 1981, p. 164.
14. Mihai Drăgănescu, "Categories and functors for structural-phenomenological modeling", Communication at the Section for the Science and Technology of *information of the Romanian Academy, Bucharest, September 18, 2000.*
15. Mihai Drăgănescu, "Tudor Tanasescu and the Romanian Electronics Schools", paper presented at the "Tudor Tanasescu – 100 years from Birth" Symposium, Romanian Academy, Bucharest, 07/03/2001.