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THE SO-CALLED CARTESIAN AND NEWTONIAN RATIONALISM IN THE CONTEMPORARY MATHEMATICAL-NATURAL SCIENCES

In contemporary mathematical and natural sciences it is possible to notice many aspects of the 17th century Cartesian and Newtonian rationalism. To a considerable degree, it refers to methodology. The Cartesian deduction method or Newtonian new concept of hypothesis as well as his concept of science have successfully been applied in contemporary mathematics, physics, physical chemistry and biology. However, it is necessary to highlight that presently, the notions of atomism, mechanism, time, space or the essence of life are understood in a different manner when compared to the times of Descartes or Newton. What is more, the Cartesian and Newtonian rationalism has also been perceived differently by different thinkers and philosophers since the 17th century.

I. Cartesian rationalism

A primary aim of the French thinker of the seventeenth century – Descartes – was to build the new, certain knowledge. He claimed that in the first place it was necessary to disregard everything dubious. This stand has come to be known as methodological skepticism. Descartes argued that it was necessary to reject the statements regarding existence for they were based on sensory statements or, in other words, all the knowledge prevailing so far had to be rejected on the ground of being uncertain. Descartes used to say: *Perhaps we are only dreaming of the world.* He claimed that what people think may be a dream or a mistake. According to Descartes, only one thing was certain: the fact that we think. It is possible to be mistaken but only when one is thinking. One cannot be certain whether exterior things really exist. On the other hand, one can be absolutely certain that

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people think. Hence, a famous statement of Descartes: *Cogito ergo sum*, which means *I think, therefore I am.* He writes:[1]

> (...) The simple meaning of the phrase is that if one is skeptical of existence, that is in and of itself proof that he does exist (...)

It means that I am a creature who thinks and thinking is a fact that is absolutely certain. Therefore, thinking itself constitutes a certain axiom, based on the experienced fact that was the base for Descartes to build the new, certain knowledge supported by the method of deduction.[2]

The Cartesian rationalism reveals two principle trends:

I. Axiomatic deductive
II. Mathematical physical

I. The axiomatic deductive trend

This trend postulates the creation of philosophy based on clear and plain truth.[3] Such philosophy should be constructed using the simplest and most certain notions, the ones which cannot be put into doubt. Such notions are revealed by axioms (postulates). While reasoning with the use of the method of deduction, they are used to educe the whole knowledge. On the other hand, the first step to take is to put everything into doubt to escape errors. Logical reasoning is of a primary role in the process. Its failure results in erroneous axioms and the knowledge based on them will also be erroneous.

Starting from the stated axiom of his philosophy *Cogito ergo sum*, Descartes built his tree of knowledge with mathematics being its roots. Being absolutely certain, analytic geometry and arithmetic constitute the base for they rely on the simple notions out of which everything can be educed. The roots of mathematics lead to physics, which is the stem of the tree. Other sciences are the tree's branches; the principle ones are mechanics, medicine and ethics.

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[1] R. Descartes, *Discourse on the Method and Meditations on First Philosophy*, (trans.) Elizabeth S. Haldane, Digireads.com.publishing, 2005. http://books.google.pl/booksid=7b73a_4RVoMC&printsec=frontcover&dq=descartes+discourse+on+the+method&source=bl&ots=ateszC89oR&sig=mjwJ1KA7zDs86pVf_xj9RTL3-e0&hl=pl&ei=hpmGS4a_FsbD_gb43rSzDw&sa=X&oi=book_result&ct=result&resnum=5&ved=0CCsQ6AEwBA#v=onepage&q=i%20think&f=false (assessed 23 February, 2010).

[2] *Ibid.*

[3] *Ibid.*

I.1. The application of the axiomatic deductive aspect of the Cartesian rationalism in contemporary mathematical and natural sciences

In contemporary science certain theories in the fields of mathematics, physics, physical chemistry or theoretical biology have been educed from axioms based on empirical data. Below are a few examples to follow.

Examples of scientific theories based on axioms (postulates).

I. Quantum physics/chemistry is based on four postulates:
   1. It qualifies the probability of finding a particle in the element of space under consideration.
   2. Every observed dynamic quantity of a system is corresponded by a certain linear hermitonian operator.
   3. If a system remains in a stationary state described by the wave function Y which is also the function of the operator P, the measurement of the observed mechanical quantity, which is corresponded by this operator, must result in such value p that fulfills the equation:

$$PY = py$$

   4. The expected value is counted up on the basis of the function Y.

II. Albert Einstein's theory of relativity is based on two postulates:
   1. All laws of physics (Nature) have the same form in all the inertial systems of the frames of reference.
   2. Velocity of light in empty space is similar for all observers in inertial systems of reference.

III. Irreversible thermodynamic is based on a few postulates. The most important ones are as follows:
   1. Local formulation of the principle of thermodynamic II.
   2. Hypothesis of local equilibrium.
   3. The Onsanger postulate.
   4. Cross effects.
   5. The alternation relations.

IV. The principle of thermodynamic III is based on two postulates:
   1. The Nernst postulate – a difference of the total entropy of products and the total entropy of substrates of the reactions taking place in the system near the temperature of absolute zero is zero.
   2. The Planck postulate – in the temperature of absolute zero the entropy of every perfectly uniform body of the finite density is zero.

V. Statistic thermodynamic is based on the following postulate:

   The entropy S is the function f of the thermodynamic probability W

$$S = \mathrm{f}(W)$$

VI. Darvin's theory of evolution is based on the following postulates:
   1. Life is old and has lasted for billions of years (it has been estimated that the oldest organisms – stromatolites are 3.5 billion years old).
   2. Life started from one or several simple organisms (dating showed the presence of such organisms in rocks).
   3. Natural selection, being the main mechanism of the evolution, means the preservation of the organisms which are better adjusted in the fight for existence; advantageous combinations of features survive.

Below are a few examples taken form the field of mathematics:

I. For two-dimensional Euclidean geometry a typical model is the Cartesian space based on the arithmetic axioms where:
   - a point has been interpreted as an ordered pair of real numbers (that is, formally $Pu(x)$ is recognized as true if and only if x is a pair of such numbers)
   - a straight line has been interpreted as a collection of the pairs (x,y), fulfilling the equation $(y_A - y_B)(x - x_B) - (x_A - x_B)(y - y_B) = 0$
   - a relation "a point is on the straight line" as a relation of the attachment to the set.

II. Euklides called the axioms of geometry postulates. Currently, the notions "axiom" and "postulate" are synonyms in mathematics (and not only in mathematics).

Euklides proposed the following postulates:
   - ***Postulate I.***
     A straight line segment can be drawn joining any two points.
   - ***Postulate II.***
     Any straight line segment can be extended indefinitely, to form a straight line.
   - ***Postulate III.***
     Given any straight line segment, a circle can be drawn having the segment as radius and one endpoint as center.
   - ***Postulate IV.***
     All right angles are congruent.
   - ***Postulate V.***
     If two lines are drawn which intersect a third in such a way that the sum of the inner angles on one side is less than two right angles, then the two lines inevitably must intersect each other on that side if extended far enough.

III. The axiom of the continuity of the set of real numbers states that every non-empty and in advance limited subset of the set of real numbers has an upper bound. Alternatively, every non-empty and from below limited subset of the set of real numbers has a lower bound. The axiom has to reflect our intuition that the number axis is continuous; it does not have any "holes" – if any "place" is pointed out at the number axis, it is corresponded by a certain real number.

IV. Axioms of the ZF theory:
- Axiom of extensionality. Two sets are equal if and only if they have the same elements.
- Axiom of existence. There is a set to which no element belongs (this is an empty set).
- Axiom of pairs. Every two sets have a set whose elements are these two sets.
- Axiom of union. For any set x there is a set containing every set that is a member of some member of x and nothing else.
- Axiom of infinity. There exists a set such that the empty set is its member and, whenever a set y is its member, then its memebr is the sum of y and the set of one element, whose only elelement is y.
- Axiom of substitute (also called the axiom of excision). Intersection of any set and class defined by any formula is a set.
- Axiom of power sets. Every set x has its power set or, in other words, a set whose members are all subsets of the set x.
- Axiom of regularity. Every non-empty set x contains a member y such that x and y are disjoint sets.

V. Archimedes' axiom

This is an axiom formulated by Archimedes according to which, given two magnitudes having a ratio, one can find a multiple of either which will exceed the other. It results in the infinity of the straight line. To put it in other words, every pair of positive real numbers **a** and **b** has a natural number **n**, so that $\mathbf{a} < \mathbf{n} \cdot \mathbf{b}$.

Considering the Cartesian tree of knowledge introduced deductively, it is possible to state that contemporary the tree may be captured in the following way. Currently, the principle root of the knowledge making the basis of the structure of the matter is comprised by the phenomena of electromagnetic effects with a universal and absolute velocity of light. According to the contemporary physicist and cosmologist, Stephen Hawking, such phenomena are responsible for the production of matter particles, that take place in the space in black holes.[4] Considering the properties of the electromagnetic effects and the quantum field theory nearby the event horizon,

[4] S. Hawking, *Nature* **248**, 1974, pp. 30–31.

Hawking arrived at the conclusion that there should exist a certain quantum process relying on the constant creation of virtual pairs (particle – antiparticle) on the surface of the event horizon under the influence of the gravitation field. Contemporary, the stem of knowledge may be constituted by quantum mechanics, the laws governing at the level of elementary particles. It is possible to assume that quantum mechanics gives a raise to all other natural sciences: the whole classical physics, chemistry or biology are connected with the processes taking place at the level of elementary particles. Such sciences can be assumed to be the branches of the tree. And what is the position of mathematics? Nowadays, mathematics can be considered as a characteristic tool to describe different physical and chemical processes acting at the molecular level.

II. The mathematical physical trend

Descartes chooses a mathematical method to base his mechanical and rational philosophical system on. He writes that "sciences such as astronomy, music, optics, mechanics, among others, are called branches of mathematics".[5]

Descartes calls mathematical knowledge the knowledge which is reached as the result of the reason; science is only comprised by certain and obvious knowledge. For him, a scientific character is only revealed by analytic geometry and arithmetic, which are the archetype of universal mathematics.

Giving an example of wax,[6] Descartes shows that extensibility is the attribute of all bodies in Nature, whereas infinite divisibility is the attribute of extensibility. This is the basis for his assumption that bodies cannot be made of atoms for atoms are indivisible by nature. Therefore, he rejects the theory of atomism. Descartes considers movement to be the only change taking place in every body. According to him, bodies possess geometric properties and are only subjected to mechanical changes. Hence, Descartes postulates that all kind of phenomena are treated as movements. That view of him which gave a rise to the mechanistic theory of nature, which is a universal theory for the whole nature. For Descartes, life is a purely mechanical process, caused by material impulses taking place in blood; accordingly, animals are machines; the behavior of animals and people is purely mechanistic. He assumed that the amount of movement in the universe is stable. That assumption gave rise to his law of the preservation of movement. According

[5] R. Descartes, "Rules for the Direction of the Mind", (in) *The Philosophical Writings of Descartes*, (trans.) John Cottingham, Cambridge: Cambridge University Press, p. 19.

[6] See R. Descartes, *Meditations on First Philosophy*, *op. cit.*

to Descartes, whole matter in the space remains in a constant circulation likewise a precise whirl.[7]

Associating substantiality with extension, Descartes introduced the notion of space as the indefinite continuum.[8] This is a theoretical construction which allows for the explicit definition of the location of every single body with the help of the respective coordinates on the axis. This is the so-called Cartesian system of reference.

I.2. How does the Cartesian mathematical physical concept refer to contemporary mathematical and natural sciences?

Albert Einstein's theory of relativity is a purely mathematical theory deduced from the two postulates based on experience. The theory states that time, space, movement, speed, weight and length of an object are relative; they depend on the system of reference. The theory assumes the appearance of relativistic effects for objects in motion, whereas motion is grasped not dynamically but as a static process. Relativistic effects cannot be observed for a little speed which is characteristic for our everyday life, but they become obvious when the speed of the object starts approaching velocity of light.

These effects have been proved experimentally in the accelerators for elementary particles or super-quick planes. The theory also assumes the existence of objects in space which have an unimaginable weight or their gravity is so strong that absolutely everything is irretrievably retracted there, even light. Einstein himself did not believe that such objects can really exist in the space. However, the existence of such objects has been proved and it is known that black holes (as they are called) really exist. Experimental facts that confirm the presence of black holes are as follows: the existence of x-rays radiation in the place where a black hole occurs, curving of the light rays nearby this object, impetuous acceleration and curving of the trajectory of a star nearby a black hole. The existence of space-time tunnels appears from the equations of the theory of relativity. Such a tunnel may exist in the black hole's interior. So far no experiment has proved the anticipations of these equations, they are still to be confirmed in the future. The above-mentioned example results in the conclusion that mathematics may describe and anticipate the already existing phenomena in nature and describe nature, which is in accordance with the concept of Descartes.

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[7] See R. Descartes, *Principia Philosophiae*, Amsterdam, 1644.

[8] *Ibid.*

Descartes suggested the infinitive divisibility of bodies in nature. Nowadays it is known that atoms are not the smallest, indivisible matter particles. They consist of quarks (it has been experimentally proved); quarks, in turn, are presumably made up of strings (it has not been confirmed yet). Contemporary atomism is a theory of elementary particles. A contemporary theory of space-time fluctuations, formulated by Hawking, shows the picture of matter as opposed to the atomistic approach.[9] Therefore, one may acknowledge that the concept of Descartes was close to the contemporary physics of elementary particles.

Contemporary, the Cartesian system of reference is the most frequently used system in contemporary mathematics or physics. A point (points) is (are) fixed at the respective axes which describe their position. However, apart from the Cartesian system of reference, other systems of reference have been applied: polar, cylindrical, spherical, geographic, and geodetic ones. The Cartesian system can easily be transformed into another type of the system of reference. Every system of reference is a certain adopted system in the space-time; it reflects the relativism of the object's position.

What can be said about the Cartesian mechanistic materialism as used contemporary? According to the theory of relativity, time and space are closely connected with each other making the space-time. In the space-time movement seems to be static, as a process, with no dynamics. On the other hand, in quantum mechanics every matter particle's movement appears to be the so-called phase of the way, that is, it seems to be static. Living organisms are comprised of atoms and other matter particles, whose movement has a static character and appears in the form of the packed wave. If movement has a static character, it is impossible to discuss any changes. It results in the statement that life cannot be perceived as a purely mechanistic process. Therefore, the data taken from quantum mechanics of the XX Century and the theory of relativity are inconsistent with the concept of movement and mechanism of Descartes of the XVII Century.

II. Isaac Newton's rationalism

Isaac Newton's rationalism is different from the rationalism of Descartes. Newton argued that phenomena were the subject of science whose aim was the search and establishment of relations between them, the so-called

[9] S. W. Hawking, "Space-time foam", in *Nuclear Physics.*, **B144** (1978), pp. 349–362.

laws. He also highlighted causal relations between different phenomena. He excluded the search for transcendental causes of different phenomena from the range of science. For example, while studying weight, physics has to establish what laws it is subjected to, taking no interest in its nature. Basing on the experimental facts, he formulated his famous laws of mechanics. Newton understood natural history as the description of phenomena.

Newton pointed out a close connection between experience and deduction. He claimed that mathematical principles have a philosophical significance. He formulated the phenomenal and descriptive theory of science. Contrary to Descartes, Newton supported atomism.

According to Newton, nature makes the whole of the phenomena which are subjected to the laws of mechanics; what is more, all phenomena can be translated by the laws of mechanics. That assumption gave rise to the philosophical trend known as mechanistic materialism. Nevertheless, Newton failed to explain the movement of planets by the laws of mechanics. The main principles of mechanic materialism and the basic principles of mechanics (taught at every primary school) as well as his insight into space, time and matter were revealed in Newton's famous work *Philosophiae Naturalis Principia Mathematica*.[10]

According to Newton, movement constitutes the main characteristics of the world; the world is made up of movement and the system of the world constitutes a harmonious entity of movements – this statement can be recognized as the basic assumption of the Newtonian and Cartesian mechanism, which is about a constant movement of atoms which decides about the properties of the body. For Newton, there is no upper boundary of the sign transmission, therefore, any movement may take place at any speed. Movement take place according to classic laws of dynamics. Movement of the whole is a sum of the movements of certain parts.

For Newton, gravity is a universal force dispersing in space at the indefinite speed; that is, a universal force taking place between atoms. Only objects which are macroscopically given a (rather huge) mass are subjected to gravity. It refers exclusively to the inertial system. The force of gravity is active at a distance through empty space.

Newton was the first to introduce the notion of hypothesis in the sense of the assumption adopted to explain a certain phenomenon or a certain

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[10] I. Newton, *Philosophiae Naturalis Principia Mathematica*, Londini, 1687. http://books.google.pl/books?id=x-_K1KGZvv4C&printsec=frontcover&dq=Newton,+Philosophiae+Naturalis+Principia+Mathematica& cd=1#v=onepage& q=& f=false (assessed 23 February, 2010).

problem. Newton wrote that everything which cannot be deduced from phenomena is called a hypothesis.[11] He rejected the preceding Aristotelian question regarding the aim of the phenomenon on the ground that it was completely inexperienced.

II.1. Significance of Isaac Newton's rationalism in contemporary mathematical and natural sciences

Based on the Newtonian principle of finding laws between the already existing phenomena, many contemporary and well-known natural laws enveloping physics, physical chemistry or biology have been formulated. In contemporary science experimental facts are frequently connected with rational deduction. Likewise, Darvin's theory of evolution is based on the observations made by Darvin during his five-year voyage across the world in the ship called "Beagle"; quantum mechanics is rooted in the experimental observations (discontinuity of x rays, experiments with two gaps through which a particle enters); the theory of relativity is a consequence of the discovery of absolute velocity of light that took place by the end of the XIX Century.

Newton argued that mathematical principles sometimes may have a philosophical significance. This is well illustrated by Einstein's equations of the theory of relativity or equations of quantum mechanics.

Newton may be recognized as a precursor of the phenomenological description of events. The constitutive rules can describe empirical laws of nature. It refers to contemporary nature sciences. In science, especially in physical chemistry, certain theories are based on phenomenological constitutive rules. These are classical thermo-dynamics, the theory of phase transition, a phenomenological description of Brown's movements, a phenomenological description of the adsorption phenomenon, etc. The phenomenological description refers also to sociological life or psychological behavior. H. L. Dreyfus essay entitled "Phenomenological description versus rational reconstruction" shows that "phenomenology can describe how people are drown to act appropriately in a world". In conclusion Dreyfus writes: "...the constitutive rules that analysis discovers play a causal role in creating the everyday social reality phenomenology describes".[12] Searle himself observes the "construction of social reality".[13] He provides a "simplified version of the

[11] *Ibid.*

[12] L. Dreyfus H., Phenomenological description versus rational reconstruction, *Revue internationale de philosophie*, 2001/02, no 216, p. 181–196.

[13] Searle J. R., The Construction of Social Reality, New York: The Free Press, 1995.

hierarchical relations between the different types of fact", begins from brute physical laws and mental facts and finishes on institutional facts. "One may have to get over following the rule one started with in order to cope most successfully."

While considering the Newtonian concept of atomism, currently it is known that atoms are not the smallest matter particles. It is considered that between atoms there is no empty space – there always exist corresponding fields.

Presently, it is known that the laws of mechanics cannot explain all natural phenomena, especially biological, mental or social processes. Newton's laws of mechanics in physics itself are not universal; they oblige only at a certain range of speed. Movement of the whole of the object does not constitute the sum of the movements of its certain parts.

II.2. How is Newton's mechanism applied contemporary?

The principles of Newton's mechanism oblige contemporary, but only when used for a small speed which is present in everyday life; that is, the speed where no relative effects are obvious. The principles of Newton's mechanism are not applied to a very big speed, which is close to velocity of light. Therefore, they are not universal. The laws of Newton's mechanism cannot be used to explain planets' movement or the movement of electrons in the atom. Neither can they be used to explain biological or mental processes. Newton himself acknowledged that planets' movement cannot be explained by the principles of mechanism. Currently, planets' movement is explained by Einstein's theory of relativity, whereas electrons' movement is explained by quantum mechanics. Gravity is not a universal force dispersing in the space at the unlimited speed; it refers neither exclusively to the inertial system nor to empty space. Currently, it is assumed that empty space does not exist. Hence, the factual state is different from what Newton used to think. Nowadays it is known that gravity is the force that curves the space-time and is strictly dependent on the mass of the object. What is more, currently gravity is not considered at the level of atoms. There is a serious problem with the gravity at the level of elementary particles. Recently there has been developing the so-called quantum theory of gravity aiming at unifying the force of the gravity with the three remaining interactions.

It is also known that the unlimited speed of the object does not exist. The maximum speed is 300 thousands km/s, which is distributed only by light and other types of electromagnetic waves, objects with no mass. At the same time, this is the maximum speed of the transmission of signals. No object which has a mass (even electrons or other elementary particles) can move quicker than light; what is more, they can never reach this speed. Movement itself is currently perceived statically and not dynamically.

II.3. The application of the concept of Newton's hypothesis in contemporary mathematical and natural sciences

The concept of hypothesis as proposed by Newton is a modern notion that refers to contemporary mathematical and natural sciences. Below are several examples of the so–called Newton's hypotheses in science:

I. Example from the field of physics:

Aim: to explain the nature of matter

Assumption: Hypothesis of de Broglie, forwarded in 1924: corpuscular-wave dualism does not only refer to light but it also refers to all matter particles.

This hypothesis has been fully proved experimentally – the experiment with two gaps through which a particle enters: it can enter only through one gap, which is characteristic for the particle, or it can enter through two gaps at the same time, which is a characteristic feature of the wave.

II. Example from the fields of physics and cosmology

Aim: to explain the appearance of the Universe, time and matter

Assumption: The existence of groups of fields called the Higgs fields. There is a point in one place where the value of the Higgs field is the lowest. There appears an unstable state. In the process of quantum tunneling there appears a negative pressure of the vacuum, which leads to the impetuous decompression – cosmological inflation (a phase of the unimaginably rapid expansion of the Universe) which results in the conclusion that the whole Universe was initially concentrated in the extremely small territory connected by the cause-and-effect links.

It is assumed that the so-called Big Bang took place and gave rise to the beginning of the space, time and matter.

Probable evidence:

The consequence of Big Bang is the presence of heterogeneous microwave radiation of the background even in the furthest places in space.

III. Example from the field of biology

Aim: to explain the appearance of living organisms

Assumption: Darvin's postulate regarding the appearance of all living organisms on the Earth from the common ancestor/a common bank of genes.

Facts in favor:

- universality of the genetic code,
- homogeneity of biochemical mechanisms,
- a phylogenetic tree reconstructed on the basis of molecular data.

IV. Example from the field of biology:

Aim: to explain the fact why descendant organisms resemble parental organisms.

Mendel's assumption made in 1866: organisms' inherited features are conditioned by the existence of separate "hereditary factors". The assumption was checked experimentally through growing pea plants. Basing on the result of the experiments, Mendel formulated two principles of heredity: the law of segregation and the law of independent assortment.

In 1910–1912 Morgan and his colleagues discovered chromosomes where hereditary factors were located – genes.

In 1953 Watson and Crick discovered the elements of heredity: acid DNA and RNA.

III. The evaluation of the Cartesian and Newtonian rationalism by other thinkers and philosophers

Blaise Pascal, a physicist and philosopher of the XVII Century, pointed out the limitations of the rational knowledge. But he did not reject the Cartesian trust in the rational cognizance. According to Pascal the intuition is needed in mathematics.[14]

George Berkeley heavily criticized the thought that reason is a source of cognizance. He argued that to exist means to be perceived; there exist only things which can be perceived.[15]

According to Immanuel Kant, a thinker of the XVII Century, pure reason is a system of the a priori principles which constitute a necessary condition for cognizance to take place.[16] Certainly, Kant's approach differs from the one presented by Descartes who claimed that reason is the first principle of cognizance.

According to Kant, thinking or, in other words, reason includes two functions:

- The ability to create notions – reason – transcendental analytic,

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[14] See B. Pascal, *Thoughts*, (trans.) W. F. Trotter, New York, Cosimo Books, 2005. http://books.google.pl/books?id=h_XUkAvW1tEC&printsec=frontcover&dq=pascal+thoughts&cd=1#v=onepage&q=&f=false (assessed 23 february, 2010).

[15] See G. Berkeley, *A Treatise Concerning the Principles of Human Knowledge*, New York, Cosimo Books, 2005. http://books.google.pl/books?id=jzQ0jZQLyqUC&printsec=frontcover&dq=berkeley&cd=1#v=onepage&q=&f=false (assessed 23 February, 2010).

[16] See I. Kant, *Critique of Pure Reason*, (trans.) J. M. D. Meikljohn, London. http://books.google.pl/books?id=DoIA4SlN-OEC&printsec=frontcover&dq=kant+critique&cd=1#v=onepage&q=&f=false (assessed 23 February, 2010).

- The ability to draw consequences form experience – reason – transcendental dialectic.

Descartes does not make such a difference.

In his famous work entitled *Critique of Pure Reason*, Kant qualifies the notions of numbers and space to the category of the a priori notions, which means that they are independent from experience and, when related to experience, they have the organization role, giving a form to the experiences.[17] He thinks transcendentally, differently from Newton, though similarly to the way that is characteristic to Descartes. According to Kant, the properties of numbers and space are also given to people not though the contact of some exterior things; instead, he assumes that they are the only possibility. Kant is convinced about the uniqueness of the Euclidean geometry. He ascribes the range of "spacial structure" with the quality of science to it. Contrary to Newton, Kant points out transcendental cognizance or, in other words, the cognizance of the principles of cognizance which preceed experience in the *a priori way.*

Taking a stand regarding Newton's hypotheses, Kant states that objectively significant are only those hypotheses that have been verified experimentally or confirmed. The success of the experimental science are contrasted with the uncertainty of metaphysics.

Albert Einstein, a physicist of the XX Century, rejected the approach of Newton regarding the way of creating the basis of science. He did not believe it was possible to prove any scientific hypothesis fully enough to make it a certain and unshaken theory. For him, every formulation of the laws of science was a defective work of the researcher's intuition. He was convinced that a single hypothesis should constantly be subjected to criticism on the basis of the newly created ideas or effects of the experiments. Referring to Newton's notion of space, Einstein states: "A four-dimensional space of the detailed theory of relativity is as stiff and ruthless as the Newtonian space".[18]

Einstein treats space as the product of the theory. Referring to the concept of the Cartesian continuum, he states:

> Along with the perception of the relativism of synchronism, there has taken place a fusion of space and time into the homogeneous continuum in such a way in which the three dimensions of space were joined into a homogeneous continuum.[19]

[17] *Ibid.*

[18] See A. Einstein, *The world as I see it*, http://www.lib.ru/FILOSOF/EJNSHTEJN/theworld_engl.txt.

[19] *Ibid.*

In the methodological sense, Einstein supports the Cartesian method of deduction, rejecting induction. He writes: "The inductive scientific method [...] is replaced by deduction groping in the dark."[20]

It is known that since the times of Hegel nobody has tried to create philosophical systems based on the strict rationalism for the task of finding a perfect set of basic axioms, capable of the effective interpretation and description of the whole human knowledge, has been impossible to perform. It applies to mathematics as well as physics, physical chemistry or biology.

SUMMARY

In contemporary science we can see many aspects of the 17th century Cartesian-Newtonian rationalism. To a considerable degree it refers to the methodology. The Cartesian's deduction method or Newtonian new concept of hypothesis as well as his concept of science have been working well in mathematics, physics, physical chemistry and biology. However, presently, the notions of atomism, mechanicism, time, space or the essence of life have some other meaning than in the times of Cartesio or Newton. Cartesian and Newtonian rationalism is understood differently by some other thinkers and philosophers coming both from the 17th century and later times.

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[20] *Ibid.*

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