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GASTON BACHELARD'S THEORY OF 'COGNITIVE OBSTACLES' IN THE CONTEX OF THE QUESTION ON CONDITIONING OF THE SCIENTIFIC KNOWLEDGE DEVELOPMENT

To begin with a historical finding: the term 'cognitive obstacle', introduced by a French philosopher Gaston Bachelard to the pioneer interpretations of quantum physics, became relocated by Georges Canguilhem, his student, onto the epistemology foundation of biological sciences, whereas by Althusser onto the basis of the assumptions of Marxist philosophy[1]. However, it was Bergson who took the advantage out of the term 'material obstacle' so as to highlight the creative character of *life urge* breaking the resistance of inert matter[2]. I have an impression that in spite of the different theoretical contexts, which the term obstacle was assigned to, it does display some essential common feature, that is, it fulfils the dynamic and differentiating function, and at the same time, it makes the situations' description more complicated, situations to which they were referred to, as it will be possible for us to convince ourselves[3].

[1] Compare D. *Lecourt, Bachelard o ule jour et la nuit. Un essai du materialisme dialectique*, Paris 1974, p. 13

[2] Bergson tended to use terms such as 'skipping' the obstacle, 'going it round' or 'passing ' it interchangeably in order to highlight the fact that the life urge is taking newer and newer forms in the deprived of any theology of the evolution movement of the new life forms shaping; compare idem, *Ewolucja twórcza*, translation: F. Znaniecki, Warsaw 1957, pp. 95–96, 240.

[3] In a different place I have tried to show that the inspiriting character of the obstacle interaction in action includes also, and even above, all the situations connected with human self-realization in the culture, compare A. Dubik, *Filozofia i opór*, Toruń 2003, pp. 31–122.

However, if we asked – without going into details of Bachelard's epistemology – what an obstacle is as it is, one could say with a huge probability that, after thinking it over, it is nothing (in the meaning which philosophy gives to the word 'to be'). However, we are not always prone to remember that the *Ontic nothing*, which displays itself only in the act as a kind of a difficulty or restriction, fulfils also the theoretical cognition and axiological function. We know also that obstacles tend to appear crosswise, as for our actions, making the way to our aims longer and more complicated, sometimes even making it impossible, but at the same time they make our aims more valuable, as valuable as they would not be if they could be easily reached without any effort, as if somebody cast a magic spell on them[4]. It is also widely known, that the positive aspect of usually negatively valued restrictions in actions, is basically expressed in the fact that the effort connected with their overcoming lies at the basis of all innovative enterprises, owing to which we have the chance to look *ex post* at bothering us problems from the new point of view, with the new aspect. It is especially visible when writing the article: we have got some introductory aim, which in the time of reaching it in practice encounters some difficulties to solve. The solution to the difficulties is usually bothersome and time absorbing, but let us find new directions of searching which we cannot realize at once. If it were not for the difficulties, our action would stop being creative and get a monotonous character and become a routine activity.

It is not a task of mine to dispute on Bachelard's science philosophy which has already had sectional expressions in several outlines, articles and reviews which have been revealed in after-war Poland[5]. However, it is necessary for me to make some reference to it before I start to present his concept of cognitive obstacles.

Science, thinking, an obstacle, a mistake, breaking – the terms set up the general climate or aura of Bachelard's theory-cognition reflection, one grown on the fascination of superb discovery of 'unknown world' (*monde inconnu*) of microphysics, discoveries performed in the first decades of last century (quanting,

[4] As G. Simmel says the value of something which is not easily reached, is not ready but it is gradually growing owing to the size of essential sacrifice and resignation from everything which is not on our way; compare idem, *Filozofia pieniadza*, translation A. Przyłębski, Poznań 1997, p. 45 and n.

[5] One of the first articles on Bachelard's philosophy released in Poland in the period after the II WW is published in "Myśl Filozoficzna" outline by Stefan Amsterdamski entitled *Uwagi o racjonalizmie* by G. Bachelard (1956). Some findings on Bachelard one can also find in Bronisław Baczka's essay *Współczesna filozofia francuska w encyklopedii* ("Studia Filozoficzne" 1958) released two years later. At the turn of the 60s and 70s of the last century one can notice growing interest in the philosophy of the French thinker, one finds new outlines by Romuald Łoziński, Henryk Chudak, Jan Błoński, Lech Witkowski, Jerzy Krakowski, Barbara Skarga, Maciej Kociuba, Jerzy Kaczmarek and the latest by Damian Leszczyński.

relativity)[6]. The fact that the aspect arises from something new in the scientific cognition started to seize the thoughts of Paris intellectuals to such an extent that it took them half a century of intensive studying, and it proves the intention of creating modern – directed antifundamentaly and antipositively – epistemology that can meet the requirements of 'the new scientific spirit'[7]; epistemology appearing from a double opposition: the opposition against traditional vision of thinking based on some over-time ability, and the opposition against restrictions of traditional empiricism and rationalism. This is where the Bachelard's lack of trust comes from, trust in any 'philosophy of philosophers', who by referring to specific ways of cognition – in a kind of eidetic *look inside* or mystical intuition – try to impose their system vision of the world as the only valid[8]. This is where his famous idea of 'cutting' (coupure) or 'rupture' (rupture) of mature science with popular cognition and prescientific cognition comes from, an idea asking for validity of cognitive reflection on truthful claims, one developed outside the borders of 'scientific city' (cite). This is also the root of rationalism 'placement' requirement according to separate type of Sciences, such a rationalism questioning the traditional version of rationalism that refers to reality *in general.* This is also where the dispersion of any system philosophical constructions come from, constructions for the benefit of varied pluralistic interpretations of individual theories, concepts, and even scientific terms.

After the points that makes Bachelard's epistemology more familiar to us, I would like to ask a question so that I could go further: How to make an ordinary reader be interested in the new microphysics' discoveries and indicate them something which they have never seen visually? One can interest the reader by skilful confrontation (according to the rule similarities and differences) of the new and the unknown with what is known and checked and one without any effort and control can think about it. Looking closely at the matter, we can see that Bachelard was aware of the difficulty of microphenomena description, not suited to our macroscopic environment. Even in his first doctor study he admitted without any misunderstandings that the phenomena 'rape' our suppositions, that they seem to be

[6] I leave the key question in the study by Dominique Lecourt, whether the intention was finally realized, compare idem, *Bachelard ou le jour et la nuit*…, p. 56.

[7] Compare, G. Bachelard, *La Formation de l'esprit scientifique. Contribution a une psychanalyse de la connaissance objective*, Paris 1969, p. 7. In Polish translation the study, where the concept of cognitive studies was presented in the most detailed way, was released entitled *Kształtowanie sie umysłu naukowego. Przyczynek do psychoanalizy wiedzy obiektywnej* (translation, D. Leszczyński, Gdańsk 2002).

[8] 'W Fizyce nie ma drogi królewskiej, drogi filozoficznej'; comp. G. Bachelard, *Etudes,* Paris 1970, p. 58.

shown by 'basic resistance' that they offer to our thinking[9]. Contrary to Emil Meyerson, a supporter of the continuity of intellectual achievements, Bachelard tried to prove that understanding a microparticle as a similarity of 'a little body' makes the understanding more complicated rather than easier. Starting with the 'tops' of scientific knowledge rather than with the initial beginnings, he seemed to highlight – and this is very essential – the continually renewed cognition effort, one that is going upstream towards the solidified obviousness, of which the model exemplification is the colloquial language suited to the world of objects, made spacious, a matter to which Bergson, appreciated by him, paid attention to. However, it was even Blaise Pascal, which should be recalled by us, who possessed keen consciousness of unfinished worlds hidden in an atom, who claimed that 'instead of experiencing the very clean concepts of the matter we try to colour them by our characteristics'[10] Three centuries later Bachelard goes further, much further, by promoting the concept of 'colour-deprivation' of the natural vision of the world and giving it the only colour, the central one, in his epistemology. Distrustful towards the tradition that shows ready solutions, our philosopher emphasizes the need and necessity of 'redefining' and 'improving' the concepts that refer to the sphere of something which besides the coupling of the axiom physical theory and experimental technology, seems to be simply 'unimaginable'. What it vital, somebody who would, by chance, walk into a physical laboratory and ask a physician a question on what a temperature measuring thermometer for atomic nucleus[11] looks like, obviously would be laughed at. Such a person would not be aware that going deep into the microworld physicians must be pleased with indirect consequences of searched phenomena, something of a kind of cracks of Geigner's meter or a dark fixed spot on a photographic plate[12].

We are approaching the *clou* of the problem. The very characteristic feature, not so much of the cognitive obstacle but of wider perspective associated with the postulate of its breaking or conquering, is that it lets us free from the routine we got used to in our everyday lives. Bachelard greatly highlighted the fact that nearly everything opposes the discoveries of contemporary for him physics: from very trivial metaphors of everyday language through the conditioning of biological and social character of 'personified 'object to the layers of acquired knowledge, layers that hide varied habits that we believe are natural only because we very often take

[9] Comp. G. Bachelard, *Assai Sue la connaissance approchee*, Paris 1981, p. 249, 284.

[10] Compare B. Pascal, *Mysl*i, translation T. Żeleński, Warsaw 1972, p. 56, 60.

[11] Compare Bachelard, *Materialisme rationnel*, Paris 1980, pp. 136–137, 215–216.

[12] Compare F. Capra, *Tao fizyki. W poszukiwaniu podobieństw miedzy fizyką współczesną a mistycyzmem Wschodu,* translation P. Macura, Kraków 1994, p. 62.

advantage out of them[13]. Bitter reflections were made by him in his first doctor thesis *Essais sur la connaissance approchee* dated 1928. As he was trying to prove, a kind of an intellectual conversion connected with thinking against fixed habits is essential if we want to initiate the contact with so far only growing scientific thought (*dans son etat naisant*[14]), a thought that is being shaped on the border of knowledge and lack of it, a thought that has not managed yet to become a scheme and got stuck in a picture. It was not a secret to Bachelard that, similarly, like the scientific cognition, which never starts with the zero start point, the human mind does not resemble, to any extent, Locke's *blank card* with virgin mark made by a sense experience. In the modern theory-cognitive optics the mind is always burdened with the past of the idea which it should try to conquer in order to initiate the contact with the atomic world or the subatomic one which is outside the sensual perception. So now we can think why Bechelard could say in a virtually paradoxical spirit that at that level knowledge, which is shaped by contemporary quantum physics, 'the mind will act against itself', trying to overcome everything that seems to be an obstacle to its development[15].

Although Bachelard was fighting with being attributed the ambitions of presenting some systematic and exhaustive classification of factors that slower the procedure of cognitive processes, he distinguished and described in *La Farmation* a few kinds of cognitive obstacles that suit 'daily' (conscious) as well as 'night' (nonconscious) colours of our coexistence with the world. He pointed out at that point that they seem to have polymorphic and self-renewed character. Being the reason of cognitive mistakes they 'float', as Skarga suggests, not only from the outside, from complication and evanescence of observed phenomena or from the weakness of senses and human mind; they have become also an integral element of cognitive act, the obstacles rise in his mind on the grounds of the necessity because understanding the world is a light which brightens only a very part of a shadow[16].

And this is how, shortly speaking, the cognitive obstacles according to Bachelard are presented[17]: The philosopher finds that thinking about popular opinions

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[13] Compare G. Bachelard, Kształtowanie się umysłu naukowego, p. 20.

[14] Compare G. Bachelard, *Essai sur la connaissance approchee,* p. 25

[15] Compare G. Bachelard, *Le Rationalisme appliqué,* Paris 1970, p. 15.

[16] Compare B. Skarga, *Bachelard – kowal słów* [in:] *Archiwum Historii i Mysli Społecznej*, v. 30, Warsaw 1984, p. 212.

[17] Polish commentators seem to ignore this part of Bachelard's considerations. The only exception is the full of meaning article by Barbara Skarga who is certainly sure that before Bachelard there was nobody 'who treated the numerous aberrations with such a seriousness, aberrations which did not seem to be like that for contemporary writers. They say more about human mind, a human being work than the theories which we are more prone to believe to be true'. Although Skarga highlights

('social' opinions' as Nietzsche used to say) as a burden is one of the most essential cognitive restrictions, what is more, the same thing happens in the case of the surplus of erudition or excess of form over the meaning characterizing the specific feature of XVII and XVIII century thesis by perpetual researchers[18]. Discussing the literature of the mentioned age, Bachelard tries to prove that the thought of the researchers was concentrated on easier concepts which, in spite of being extraordinary, were the subject to several lively social discussions and entertainments. Far from the accounts and theorems, striking the contemporary reader with its triviality and thought's prosaism of the researches, the literature seemed to be deep in the darkness of empiric cognition, unable to correct itself and it did pass the borders of the vision of the natural world where one lives in, moves and acts. Bachelard collides the situation with the requirements of contemporary science in order to prove that the latter one characterized by educated scientific society and technical knowledge, became a difficult and demanding one when comparing to its adepts of long education period; there is nothing obvious in it, everything is theory rooted, 'technically produced', 'constructed'[19]. In general, one can say that the intuition of those researchers did not use to reach the aim simply because they referred to problems incorrectly presented, and that the two factors: popular opinions and solving scientific problems must have got separated in the period of scientific development.

Another Bachelard's cognitive obstacle is the surface analogies and general unreasonable opinions like: 'all human beings are mortal' or 'all bodies fall down'. As he says, the general opinions did play a positive role in the development of science, however presently they limit the development by creating the impression of understanding, they suppress questions, do not motivate to thorough theory reflection. Presently, the scientist is not interested in the general truths transferred from century to century and from generation to generation. No respected physician is going to defend the Aristotle's thesis that light bodies, smoke and fire trying to reach their natural kingdom rise up, whereas heavy bodies in the natural way are

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the most representative cognitive difficulties for the French philosopher's attitude, ones which accompany the human mind as its shadow or negative; at the same time she limits it to one or two-sentenced characteristics, which may make one feel insufficiency, compare B. Skarga, *Bachelard – kowal słów*, p. 217.

[18] The thing is that Bachelard does not call the name of Nietzsche in *La Formation* , the two of them seem to share the same opinion that the so-called 'public opinion' is nothing more than the sum of mind laziness of individual citizens because the fact that everybody has the same opinion means that nobody has an opinion. Compare J. Ortega y Gasset, *Dehumanizacja sztuki i inne eseje*, translation P. Niklewicz, Warsaw 1980, p. 36.

[19] Compare G. Bachelard, *Kształtowanie się umysłu naukowego*, p. 19 and n.

trying to find the ground, however he or she can say repeating Newton that all bodies in vacuum fall down with the same speed.

Another different factor which blocks the cognition is too extensive unifications such as the unity of the Creators act, the unity of the Nature's plan or the logical unity; the first ones are associated with the religious beliefs, beliefs which were not the distinguished subject of Bachelard's interest, the latter ones became the subjects of a separate chapter of the book *Le Rattionalisme applique* [20]. Obviously he would agree without a second thought with W. James's opinion that such magical words–spells as God, the Nature or History provide, at small expanses, a key to solve the mystery of the world to those who need such explanations: people of that kind leave the connection with the experience and the rational discussion consider a useless talking[21]. Such a monistic perspective is strange to Bachelard, who paid attention to the activity of the dialectic 'differentiation' of the reality, reality continually susceptible to complement and not to its 'reduction' to the vital *features* as Emil A. Meyerson, the creator of the concept of the rationalizing in the way of 'identifying', his main theory adversary in France. However, this is a separate concept, so I just want to mention it[22].

The next obstacle for Bachelard is the criterion of utility, if too restrictively applied as the universal explanatory rule because for pragmatism-oriented minds only the utility is understandable, only the utility explains something. As an effect, everything which is out of useful applications submitted to the unity of the aim and means, everything which cannot be practically applied is left in the sphere of non-existence as something irrational, not worth any interest. The history of the scientific discoveries proves however that several of the discoveries were made owing to unselfish cognitive passion of younger, as far as the age is concerned, researchers.

The requirements of exactness and precision became an obstacle as well, requirements applied where they are useless, as it is in the case of temperature measurement of the environment to the twelfth point after the comma. It is good to know what can be left out. The number size is never automatically objective; each century has its own precision scale accepted by the method of measurement and the speed of the experimental equipment[23]. What is the thing that can differ the

[20] Compare G. Bachelard, *Le rationalisme applique*, Paris 1970, pp. 82–101.

[21] Compare W. James, Pragmatyzm. *Nowe imię paru starych stylów myślenia*, translation M. Szczubiałka, Warsaw 1998, p.71.

[22] In the given concept compare A. Dubik, *Tożsamosc i opór. Główne kategorie epistemologii Emila Meyersona*, Toruń 1995, pp 157–174.

[23] Compare G. Bachelard, *Kształtowanie się umysłu naukowego*, pp. 278–285.

precision scale from the differences that are between typical weight scales and modern mass stethoscope – Bachelard is wondering.

But the obstacles have also got the didactic aspect, not appreciated by Polish commentators, who present the work of the French thinker taking into account one of two of his philosophic reflection (very rarely both of them): epistemological and esthetical. However we know that Bachelard was inspirited not only by the nature sciences but also by several years of being a secondary school teacher, later on the academic professor's experience; he admitted that he feels more of an educator than a philosopher[24]. And the French commentators highlighted the fact that by his modern version of pedagogy of a 'new look', of which the outline one can find in his articles, he overtook his century[25]. Although this is not a good place to reconstruct Bachelard's opinions on this matter, I do want to mention a few factors so as to show what his opinion was on the restrictions in the process of education.

The key to understand Bachelard's pedagogy, one that keeps in distance to standard educational problems is, a word that seems to be harmless, that is an objection (contre). The pedagogy, one that has the roots in the opposition to everything that limits the cognition need, opposes consequently all the school teaching forms of textbook knowledge, forms of typically 'theory school' in education, petrified forms of thinking and intellectual laziness. One can notice the objection on several levels, e.g.: in connection with pointing at the danger associated with locating the trust (naïve one and non-critical) in the sphere of so-called our 'deep beliefs', or too much extensive fascination of mind experience picturing which makes it more difficult for the student to obtain the access to new abstractive ideas. In the same way as the education develops itself through breaking first illusions the teacher should mitigate the students' lively interests in the real picture of the world. Bachelard is also worried about manifestations of erudite knowledge multiplying only for the simple reason that is knowledge accepted by some university competitions, which leads to some kind of intellectual narcissism[26]. The society seems to complete the process of human mind and imagination closing owing to the influence of metaphysics of popular language, collective imagination and distinguished social training. We can see – as he wrote – how the imagination

[24] Compare G. Bachelard, *Le rationalisme applique*, p.12

[25] Compare G. Jean, *Bachelard, l'enfance et la pedagogie*, Paris 1983, p. 22.

[26] Compare G. Bachelard, *Kształtowanie się umysłu naukowego*, p. 64, 21; G. Jean, *Bachelard, l'enfance et la pedagogie*, pp. 192–197.

develops at a little child, and at the same time we never check how it dies at an adult's mind[27].

At that point one can see a wider digression. The youth and childhood motif, referred to the scientific culture, one finds in the works of several other philosophers and contemporary epistemologists; e.g. Jaspers referred to children's witty questions, where he found the manifestation of the self-contained need of 'philosophy-making'; Kuhn tried to prove that the most essential discoveries have been made by the youth because our minds when aging seem to prefer the knowledge that have been acquired and leave out everything that is contrary to it; Feyerabend criticised the 'professional educators' for not introducing new methods of learning[28]. I am deeply convinced that Bachelard goes further because not only does he protect the concept on the limited utility of even the most checked methods of education, but also he tries to convince us that we can revive the state of intelligent youth – without any danger of fooling our mind or mistaking the virginity with naivety. As he says it is enough to, like students do, admit that we do make mistakes and make an effort to correct it; as it is said the one who thinks he or she never makes mistakes always does it. Nothing is more strange to Bachelard than the power of infallible authority of teachers who being afraid of a failure fool the young people minds by depriving them of innovative imagination which, by some chance, they still have. That is the reason for requesting the teachers not to teach with the use of only theory information but try to make students take the advantage out of their imagination and creation, e.g. by studying the history of scientific discoveries. Making relative the traditional opposition the one who teaches and the one who is taught (in the category of empathy and changing the society rooted roles), Bachelard was depicting the picture of children playing, children who after 'starring' as generals do not have any problems to change into being soldiers[29]. The place of one-way relation, in the strengthening power of educational optics, going along the popular axis: from the omnipotent Professor to the ignorant student, takes the attitude of open dialog, giving right to the student to preserve intellectual autonomy[30]. However the relation of master and student seems to be something more than a typical psychological fact; it is, as Gil writes, the leading norm

[27] Compare G. Bachelard, *Poetyka marzenia*, translation L. Borgowski, Gdańsk 1998, p. 9.

[28] Compare K. Jaspers, *Wprowadzenie do filozofii*, tramslation A. Wołkowicz, Wrocław 1995, pp. 6–7; T.S. Kuhn, *Struktura rewolucji naukowej*, translation S. Amsterdamski, Warsaw 1968, pp. 22––23, 166–167; P.K. Feyerabend, *Przeciw metodzie*, translation S. Wiertlewski, Wrocław 1996, p.163.

[29] Compare G. Bachelard, *Kształtowanie się umysłu naukowego*, pp. 310, 315–319.

[30] Compare G. Bachelard, *Le Rationalisme applique*, p. 76.

of culture development[31]. In general, Bachelard supports the progressive version of pedagogy, one that includes the aspect of mistake existence, constructive role of scientific abstraction and the strategy of dialog between the master and the student, a dialog which is not limited.

And now come to the point of 'substantial obstacle' derived from the same nature of mind anchored in physical and affective organization of a subject, one that makes experiments (let me use the word repeating Merleau-Ponty 'having the physicality'). Undoubtedly, Bachelard made a great effort presenting several individual historical examples which prove that the subscientific thought, rooted in the life urge, easily referred to the *inside* of the assigned objects. To make it more detailed, it is about the impression of substantial depth, an impression associated with the natural conviction – several different forms – that something which is the most valuable is hidden under several layers and reaches the very inside of the point, and what is more, actually is the inside. In alchemists opinions any protection is less valuable than sheltered matter, whereas they thought valuable everything which had to be found with a use of a special *key*, taken out from the inside to outside like diamonds from the mines[32]. Although the word 'inside' may explain a lot of, as Bachelard writes, in the scientific studies it makes the delusion of understanding, one which is similar to popular Molier's maxim saying that opium makes us fall asleep because is has a power to make one fall asleep[33]. Bachelard, exposing the barrenness of the often verbal explanations displaying everything which is hidden, explanations that say more about the dominating need of alchemist mind's possession than about his studies, makes an effort to reach the biological conditions of cognition[34]. This is the reason why he refers to the central concepts of Freud's psychoanalysis: the term of unconsciousness, instinct, suppression. The coupling of epistemological studies with the psychoanalyzes concept, even in the period before the Second World War, was appreciated by the French commentators[35]. It should be added that although in Bachelard's opinion the contemporary science has something to do with the whole series of rationally programmed and technically created 'surstantiation' or 'exstantiation' (he uses the

[31] Compare D. Gill, *Bachelard et la culture scientifique*, Paris 1993, p. 61.

[32] Compare G. Bachelard, *Kształtowanie się umysłu naukowego*, p. 158

[33] Ibidem, p. 130–131

[34] I leave out the point of the influence of Freud's thoughts on epistemological studies by the author of *La Formation.* I only mention in the strong effort of alchemists to change lead into gold, an effort accompanied by long and monotonous work, he does find delusive traces of *libido* interaction; compare idem, *Kształtowanie się umysłu naukowego*, chapter *Libido and objective knowledge.*

[35] As Dominique Lecourt highlighted, 'Bachelard eut l'audace, en 1938, d'introduire la psychanalyse dans lepis-temologie'; compare idem, *Bachelard ou le jour et la nuit*…, p.121.

terms interchangeably), it would be a mistake to think that the natural human tendency for substantializing of the phenomenon dies with the development of positive knowledge; it does interact in the form of identified obstacle, as in the case of the myth on hidden treasure that lights only hearts of scientists, no longer their minds[36].

And now we come to another obstacle, one that is generated by the picturesqueness of a direct experience; an obstacle of thought, felt and heard. However, at that point a digression seems to be indispensable. As Władysław Tatarkiewicz wrote, the natural world picture of objects full of colours, smells, shapes and voices is for us 'natural' only because we experience it in everyday life, reaching it does not force us to make a great effort. One must think deeply to realize that the features of the objects that surround us are culturally, psychologically and biologically conditioned, and that they depend on our mind, emotional states, the structure of the sense organ and even age and sex[37]. As an analogy one can say that finding, hidden under the apparent simplicity of an object, complicated theoretical and experimental beings in the kind of phones, received according to the new way of existence, the science create a new picture of the world, quite different from the natural one. Bachelard, inspired by the discoveries of microphysics, tried to prove, as anyone before him, that the suitable feature of the scientific thought is keeping the distance from the experienced world; contradiction and its colour-depravation, instead of taking the advantage out of it. And now owing to the power of going the way of negation (dialectical one), one finds that in the epistemology which interests us, the contemporary studies arenot a continuation of the past studies, in the same way as the scientific experiment is not a continuation of ordinary observation; between the two levels of cognition occurs a kind of an epistemological 'breaking'. However, to make it possible, a solid scientific base had to be created, one that is based on checked methods and research techniques, modern universities, laboratories, libraries and publishing houses. To make it short, it was essential to create a specialized 'scientific city' within a 'social city'. To revise: in the discussed aspect the popular cognition is not an innocent one since it is unable to explain what we cannot prevent from looking at; it becomes an obstacle in the science, a science which is created by breaking with the popular cognition and by its criticism.

Among several examples of the scientific criticism presented by Bachelard in his literary work, two of them seem to be especially significant. The first one refers

[36] Compare G. Bachelard, *Filozofia, która mówi nie. Esej o filozofii nowego ducha w nauce*, translation J. Budzyk, Gdańsk 2000, pp. 81, 175–180.

[37] Compare W. Tatarkiewicz, *Droga do filozofii i inne rozprawy filozoficzne* [in:] *Pisma zebrane*, v. I, Warsaw 1971, p.13 and n.

to the revolutionary discoveries by Nicolaus Copernicus (notabene the patron of the University in Toruń, a place where the author of the written words works), who was not convinced to the certification of our sensual feelings, and on these grounds negated centuries-long thesis on the immobility of the Earth. The consequences of the discoveries were disastrous for theology, but inspiriting for the astrological researches. One can also encounter an opinion that verifying the heliocentrical theory required the reference to a totally different picture of the world, where a human being and their cognitive abilities are seen in a new way[38]. The second example of the scientific criticism, one that has been mentioned above, is determined by an intrigued Bachelard's question, one of them which was an inspiration on the grounds of the essential achievements of the contemporary philosophy of the science: 'What an immobile photon is?'[39]. Making harm to our intuitions, the photon lost the static features of a being, features which were traditionally imposed on the word *being* by philosophy, a being identified with something that lasts and is preserved in time. For a contemporary physician the photon is an energy beam, deprived of the rest mass described in precise calculations, so it is something which is not understandable for most people. In the optics the atom's idea by Demokrytes, and the atom's idea as the smallest material particle, is nothing more than a kind of an epistemological 'term-obstacle'[40]. We are willing to think the concept of an atom as understandable only because it refers to concrete qualities of the objects world, qualities associated with one another in a space-time way and casually[41], in the same way as we *understand* the interaction between atoms only because we reduce them to the picture of billiard balls crashing. However acting like that makes us a victim of unconscious associations; we depict a picture being convinced that we explain something, but at the same time we push the scientific knowledge into the sphere of non-existence. In Bachelard's opinion if we make a kind of semantic vibration than we can benefit much more saying that the photon is a kind of an energetic 'object-movement' which is situated in the 'sphere of influence' or, even better,: that it is a '*sum of criticism*' of which the initial picture was subjected'[42]. Taking the advantage out of language ambiguity, logical tension and neologisms purposely, the 'word-smith' (the term comes from Barbara Skarga) behaves as if

[38] Compare P.K. Feyerabend, *Przeciw metodzie*, p. 117.

[39] Compare G. Bachelard, *Epistemologie. Tertes choisis par Dominique Lecourt*, Paris 1974, p.60.

[40] Ibidem, p. 59

[41] Compare W. Tatarkiewicz, *Droga do filozofii i inne rozprawy filozoficzne*, p.13 and n

[42] Compare G. Bachelard, *Epistemologe*…, pp. 52,60; *Filozofia, która mówi nie. Esej o filozofii nowego ducha w nauce*, translation J. Budzyk, Gdańsk 200, p. 144.

he or she wanted to include in his or her speeches ferments working on differentiation, thesis-making of language meanings[43]. We could continue the presentation of cognitive obstacles, develop the mentioned aspects or introduce new ones. However I am going to stop at that point in order to take care of the question announced in the second part of the outline: What is, in Bachelard's opinion, the main factor of the scientific progress? What is it that makes, in spite of the tradition dominated by the direct cognition and the awkwardness of the popular language, the scientific mind able to break radically with its past and widen its control over the spheres that so far have been able to avoid jurisdiction? There are some proved rights which let us think that for the author of *La Formation* such a factor was the abstractive mathematical formula. To make it more detailed, it is about the imagination of the scientist shaped by the mathematics and promoted to the rank of the only invariability in the scientific cognition (I have been discussing it in a different point[44]). In Bachelard's epistemology we can notice a very original concept of 'terms improvement'[45] during the development of scientific knowledge, however not on the ground of the rigorist exactness of the logical deduction, which could lead to barren formalism but because of the specification of scientist's mind functioning, a scientist actively engaged in the scientific training. The inner dynamics of the concept is described by the tension between the pictures and the following them mathematical relations, that is: between the terms entangled in the layer of picturesqueness, the terms that benefit owing to the science which is being eliminated (however not completely) by the restrictions of mathematical network of relations. Bachelard tries to prove, even in *L'Essai*, that 'even in the most exact minds just the inside of the term is dominated by pictures. Setting free the forms from the layer of initial matter, the layer which was left[46] by an accident seems to be a never-ending task. And because the bare human imagination depicts the reality in an imperfect and falsified way (although sometimes it seems to be a sophisticated poetic form), the first cognition occurs to be the falsified cognition which needs correcting . And, respectively, the imagination, the mathematical education underwent, supports the development of the scientific knowledge, and what is more, it is an essential condition of the development; but for it the mind would be

[43] It would be the same attitude as Feyerabend's opinion that when we try to interpret new scientific discoveries we are forced to call for known speech models which do not include them but which must be used in an inappropriate way, deprive of the shape, give it a new form in order to suit them to new situations. Compare P.K. Feyerabend, *Przeciw metodzie*, p. 26.

[44] Compare A. Dubik, *Tożsamość i opór…*, pp. 168–174.

[45] Compare G. Bachelard, essa sur la connaissance approche, p. 17 and n.

[46] Ibidem, p. 23

ruled all the time by the same rules and aprioristic categories. The mathematical formulas, ones that are 'administrated' by a great potential of rationality, are for Bachelard ' the source of all precise metaphors'[47] – metaphors that have something to do with Kant's 'imaginativeness', the principle that revives and introduces the mind's power into action[48].

So as to depict the discontinuity of the development of subscientific cognition into scientific cognition and the relations between the picture knowledge and the knowledge dominated by the mathematics, I would like to refer below to two examples, especially well-known to Bachelard, examples of the history of the scientific cognition. The first of them is associated with the initial interpretations of the electricity phenomena, the second one with evolution of the term 'mass' in the years' time.

Firstly the phenomenon of electricity was interpreted according to a simple rule: you think what you can see. One could see in electricity a kind of glutinous fluid according to the rule of analogy of pieces of dust stuck to the walls of an electrified dish. In the period after the discovery of the Leyden jar, the electricity was a subject of lively social conversations and exciting entertainments such as experiencing the shock caused by the flow of the electric spark through a ring crested by people keeping hands of one another or toast making in electrified glasses. What is more people believed that it did have a positive influence on the diseases such as infertility and impotence. The examples are not the only ones in *La Formation,* there are many more of them and they seem to be very educational because they prove that, in a very easy way, new scientific discoveries yield to the rationalizations, ones that mistake, referring to the everyday sphere of life. The situation seems to change rapidly at the moment of moving from the sphere to the sphere of abstract thinking; treating the electricity as a part of the mathematical network of rules limiting the scope of its inappropriate appliance, and at the same time, it occurred to exclude from the sphere of physical science the outside people without any special preparations. Finally one has to remind that the measure of the operational skills of scientific terms is, as for Bachelard, the power of violating, reshaping their initial meanings – in the case this is electricity as a glutinous fluid for the sake of Ohm's abstract right. One should add here that the deductions of our philosopher concerning conceptualization and reconceptualization of scientific terms were much earlier before the known Kuhn's thesis on the non-propor-

[47] Ibidem, p. 54.

[48] Compare B. Skarga, *Przyszłośc i interpretacje. Z warsztatu historyka filozofii*, Warsaw 1987, p. 131.

tionality of the scientific achievements placed in the opposite 'paradigm'. One could make claims to Richard Rorty based on the fact that he credited the honour of breaking the (neo) positivistic doctrine to the author of *Struktura rewolucji naukowej* too quickly, a doctrine associated with the 'non-changeability of meaning rule'[49].

The most spectacular example of the scientific terms' meaning transformation and the sign of progress one finds in the pieces of Bachelard's work *La Philosophie du non* (1940), the meanings concerning the evolution of the word's meaning 'mass'[50]. As one can find out, initially the mass was identified with a concrete spacious quality according to the simple rule: the bigger the better. However the first cognition, as all the first cognitions, included a mistake, one which needed correcting. Together with finding out the disproportion between the quality and the body's mass it turned out that it is not always the rule that the bigger something is the more valuable it is and what really matters is the intensity. At that stage of cognition, one that was patronized by the realistic philosophy, the term of mass stayed still as a term-obstacle and the subject of variable vaporizations. The situation did not change with the coming of the positivistic era which was associated with the use of body scales. The first biggest cognitive turning point happen to start, according to Bachelard, with the beginning of Newton's mechanics which questioned the realistic conviction on a very simple character of the mass term, introducing it to the corpus of 'notional body' (corps de notions) consisted of three notional 'atoms' which defined one another. In that way the mass (m) was reduced to the quotient of the force (F) and acceleration (a), which enabled one to characterize each of the notions on the base of the two that were left (F=m/a). The next cognitive turning point happen to start with the discovery of the mechanics of Dirac who applied the term of 'negative mass', a term which was completely non-assimilated on the popular cognition ground.

One can notice that the development of physical sciences is being accomplished together with the transformation of the picturesque sense of notions which lose its direct understanding but at the same time gain some precision. The process of the development is set by the change of phases from the prescientific realism through positivism and classical rationalism up to peculiar 'overrationalism' (a term of Bachelard); and on the highest phase, one that corresponds to 'a new scientific spirit', the scientific mind started to multiply even the most daring questions like:

[49] Compare R. Rorty, *Filozofia a zwierciadło natury*, translation M. Szczubiałka, Warsaw 1994, pp.240–245, 288–296.

[50] In the Polish language study the book's title is *Filozofia, która mówi nie* (translation J. Budzyk, Gdańsk 2000).

Why the mass should not be negative? Maybe at that point one could define some convergence with the thesis of Jean Piaget that says that the development of cognition is accomplished during the way of several cognitive 'decentrations' defined, in the historical context by the movement from the Aristotle's geocentrism to Newton's physics and then to the theory of relativity by Einstein, whereas in the individual context by setting free from the partiality of one's own point of view[51].

In that way the concept of the terms of scientific cognition development in Bachelard's philosophy seems to be presented in a very general outline. Approaching the end of the considerations, one can give up to the temptation of defining a few general notes. One can say that the innovation of the epistemological attitude of the *La Formation* author could be characterized, on the one hand, by the original concept of obstacles which oppose the scientific cognition development and direct its process, and on the other hand, questioning on the possibilities of the scientific existence of a subject, its way of existence in the physics consciousness. Moving the concept from the ontological level to the theory condition one (widened by the frame of the didactic and psychological considerations), Bachelard tries to prove that the objectivity of the scientific cognition subject is not equal to the elimination of the cognition subject, and what is more, quite contrary requires taking into consideration, as he was writing, 'the psychology of depsychologization'. Proceeding through several next approximations, the science constructs a kind of an 'overobject' (surobjet) by means of 'theory-experiment' character, means which need a large rational potential collection. What really matters in Bachelard's epistemology is not a static picture of *an object in itself* (identified in philosophy with the whole of the quality values of which some are promoted as the initial values, whereas other ones as changeable accessories)' but it is the psychological 'reality effect' that is created by the 'oversubject' in the scientist consciousness, a scientist that is involved in the process of scientific training. Finally the 'overobject' seems to appear in the scientist consciousness as a new structure of meanings, as a sense wreathed each time by the picturesqueness layer; Bachelard seemed to highlight, as we have mentioned, the continually renewed cognition effort in spite of the domination of the sensual pictures. A double role of the human imagination in the scientific cognition corresponds with the expression, one that is negative and positive, as one could be convinced by observing the first rationalizations of the electricity phenomena and the term 'mass'. The unusually essential issue, which occurs

[51] For example, in connection with the change from the 'egocentric' language to 'socialized' one in the development of the child's intelligence; compare J. Piaget, *Mądrość i złudzenia filozofii*, translation M. Mikłasz, Warsaw 1967, p. 149; idem, *Mowa i myślenie u dziecka*, translation J. Kołudzka, Warsaw 1992, p. 39 and n.

to be a platform between the epistemological and aesthetic current of the French philosopher's reflection, can be expressed, in other words, that the *bare* imagination is powerless and dangerous. It is powerless because it seems not to feel any impulses to effective work if it is not directed by the mathematical abstraction; it is dangerous because it happens to be willing, because of the lack of the mathematical coordination, to the creation of the speculative visions. George Canguilhem has formulated it in an excellent way by commenting on the thought of his master, saying that there is a source of dreams and illusions in the human inside, a renewable source of which presence makes the mind contradict and improve. However, in spite of the fact that all the mistakes result from the non-educated imagination, it is the imagination, as for Bachelard, that is the expression of 'overhumanity; but for it, one would not be a human being neither in the science nor in the poetry[52].

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