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Descriptive Imaginary Evolution and the Functions of Conflict in the Science and Culture of Knowledge Society [*]

Abstract: Knowledge society represents a type of society in which scientifically based knowledge influences a large diversity of domestic life aspects. Highly encouraged by the emergence of information society, knowledge society becomes nowadays an increasingly present reality, having as one of the main features the strong relation between science and culture. Therefore, changes in the plan of continuously evolving scientific representations could have significant cultural impact in knowledge society. We will try to investigate the cultural influence of radical changes in the evolution of scientific representations, using the concept of descriptive imaginary. As an example of "scientific conflict" with important cultural consequences on long term, we will analyze the dispute between Albert Einstein and Niels Bohr regarding the indeterministic character of quantum reality. Although such a dispute took place in a historical period in which knowledge society was not at all so real as it is today, our endeavor will try to emphasize the positive role of conflict in science and the contrast between such a function and the tensions created at the cultural level, namely in philosophy, by the new perspective on reality raised by such disputes, which are today even more numerous than in the past.

Keywords: aesthetics, artistic imaginary, knowledge society, postmodernism

1. Conflict in Science and Culture

Conflict is a tough word, with multiple connotations. In fact, this concept has multiple effects in culture, in mass-media, in business, in politics. In spite of any Public Relations strategy, quite often the conflict remains a feature of the political regime or the public administration. In literature, in poetry and almost

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in any type of cultural manifestation conflict catalyzes passions, creates delusions, changes hierarchies and triggers innovative processes.

Generally speaking, from a political point of view, one could say that conflict becomes more visible in democratic societies than in authoritarian ones. But in this respect only the *visibility* of conflict varies, not its *presence*. Of course, there could be drawn a connection line between conflict and corruption. Consequentially, on the one hand, we could be tempted to say that the occurrence of public conflict is directly proportional to the corruption degree of a certain society. On the other hand, we can also observe another peculiarity: the rarer is conflict in less corrupted societies, the more severe are its consequences when such an event takes place and is finally unveiled.

From a more general point of view, one could easily theorize the negative functions of conflict in society. Elections, reforms and any other important public events could face anytime the negative consequences of conflict, the most disturbing one being the emotional storm triggered usually by such an episode. Angry, conflictive people become quite frequently hysterical and less rational, which could severely affect any democratic debate. Because of that, in many contexts conflict is an event that should be carefully avoided, if possible, in order to gain a state of general equilibrium.

However, one should not forget the positive functions of conflict. Surprisingly, maybe the most obvious one regards politics. Democratic regimes could benefit, in the same time, from the self-regulatory consequences of conflict. Sometimes, the political system regains its equilibrium precisely through conflict, at least in democratic societies where a public conflict could unveil unforgivable deviations from morality by public personalities. Anybody could remember in this respect the Watergate conflict, which became a scandal with important political consequences. However, the present work is not dedicated to politics. Our endeavor will try to emphasize the positive function of conflict in science.

Obviously, we have to justify the importance of this category of conflicts at the social level, because at first glance, scientific communities seem to form restrained elite, far less visible than others. In this respect, one should not forget the huge influence of science in contemporary society. In the whole modern period this influence became manifest through technology. As a direct product of the scientific endeavor, technology changed dramatically people’s life in fields such as sanitation, medical care, agriculture, commerce. Political life was also highly influenced by technology, because the means of warfare changed from weapons to transportation. But military technology also had an important cultural impact, if we take into account the spreading of European cultures process, triggered by colonial wars.

However, another effect of modern technology seems to have the highest influence upon contemporary society: the development of information exchange process. Starting with the extension of international commercial routes and ending with the Internet, the informational profile of human society changed dramatically, making possible the birth of the so-called information society, which becomes an important component of knowledge society in continuous development nowadays. One of the causes for such a phenomenon may be the fact that "in the last ten years, the convergence between technologies of urban life and new communications technologies has been remarkable." (Holmes 2005, 3).

In fact, postmodernism could not even be understood today in its various aspects without paying attention to information society as a component of the postmodern condition. Of course, in scientific communities conflict is not as harsh as it is usually in politics. But sometimes politics mixes with science. In this case, in our opinion, one should be aware of the fact that not every conflict related to issues associated with science is a scientific conflict. For instance, the fight for copyright and paternity of an invention is not a scientific conflict; rather it is a legal one that affects the scientific community. Nor the fight for a public position in a scientific institution could be considered a scientific conflict. Scientific conflict refers strictly to scientific issues (theories, explanatory hypothesis, and interpretations of experimental data) and usually takes the form of a scientific controversy or dispute. Such a dispute becomes more spectacular when scientific prestige of the personalities involved is at stake, together with their influence on scientific community in terms of allocated resources, continuity of some specific directions of research and so on. In spite of the fact that the language used is quite technical and undoubtedly civilized, such scientific disputes could be as spectacular as any other form of public controversy or public conflict.

2. A Philosophical Turning Point in the History of Physics

The conflict we chose to discuss in this paper represents such a spectacular dispute between two important scientific personalities, being an event with deep consequences at multiple levels.

First of all, it influenced the development of new research directions in contemporary physics. Second, this event can be linked indirectly to some important technological progress that occurred as a consequence of the theoretical breakthrough favored by it. Third, beyond the technological level, those theoretical breakthroughs had also some important implications regarding our view about universe, about reality, in terms of the possibility of our ontological and epistemological approach of it.

The main characters involved in this dispute were Albert Einstein and the Danish physicist Niels Bohr, while the context of the dispute started to develop in strong association with a delicate problem: the relation among the concepts used in quantum theory and the classical notions regarding the world in which we live. Just this problem has been the main concern for Werner Heisenberg in his article published in 1927 in the German magazine *Physikalische Zeitschrift*. This article constituted the first formulation of the famous principle of indeterminism. Heisenberg begins his discussion with a reference to Einstein's

Relativity theory, in which Einstein was forced (largely due to experiences similar to that of Michelson and Morley regarding the measurement of the speed of light on different directions) to leave the old classical concepts about measurement of time and distances, in favor of new and unintuitive ones. Heisenberg believed that a similar situation was created in the field of quantum theory.

Consequently, he started to look for those concepts of classical mechanics that were not useful any more in describing the behavior of elementary particles at the atomic level. While Einstein attacked from the relativistic viewpoint the classical notion of *simultaneity* of two events happening at a given distance, Heisenberg attacked a basic notion of classical mechanics: that of *trajectory,* usually used in describing the movement of any material object.

In classical mechanics, the *trajectory* signifies the road crossed by a body that is moving in space (Mach 2001, 110). The limit case, used in mathematical calculations, is that of a body reduced to a no dimensional point that goes on a "road" reduced to a mathematical line without thickness. The belief of the classical physicists was that this limit case is the best description of the motion of a particle, and that in practice we can approach to it without limit, by decreasing the experimental errors regarding the coordinates and the speed of the particle in motion (Gottlieb 1999, 119).

Heisenberg's objection to this point of view was that the existence of quantum phenomena turns up the situation described above. The justification of Heisenberg's attitude can be clarified using an ideal experiment, the so-called *gedankenexperiment* - that had been used by the Copenhagen school headed by Bohr to illustrate the principle of indeterminism proposed by Heisenberg (Heisenberg 1984, 72).

In that experiment, the purpose is to determine the trajectory of a particle with mass in terrestrial gravitational field. The basic premise is that the examined particle has entirely a classical behavior. A sealed room must be built in which we have to take out the last molecule of air. On the wall of this room we have to install a small gun, **C**, which shoots a shell of mass *m* and of speed *v* in horizontal direction. On the opposite wall of the room, a small theodolite, **T**, is placed, which can be oriented towards the falling particle, in order to follow it. The room is illuminated by an electric lamp, **B**, from the ceiling. The light of the bulb is reflected by the falling particle which enters into the tube of the theodolite, the position of the particle being marked, either on the retina of the eye, either on a photographic plate (Gamow 1969, 104).

Because the experience is an ideal one, we have to take into account all the effects that may disturb the motion of the particle, beyond the fact that the air was evacuated from the room. Thus, the light itself — which is reflected in the tube of the theodolite and through which an observer can track the trajectory of the particle - exerts on the particle a certain pressure that will lead to a deflection from its expected, parabolic trajectory. The question is whether such a disruption can be made infinitely small, to highlight precisely the trajectory of the particle.

We have to do it, step by step, and to estimate from the beginning only ten positions of the particle; we can turn on the bulb only of ten times during the falling process and, in this way, we can eliminate the effect of the light pressure in a time when the particle is not observed. Suppose that, at the first trying, the effect of ten shocks caused by reflected light deviate the light too far from the expected trajectory. We find then a remedy very easily. We have to reduce the intensity of light by a necessary factor, because in classical physics there is not a lower limit for the amount of radiant energy that can be emitted in a firing, as a limit of the sensitivity of the receiver of reflected light. Reducing intensity, we can decrease the total disturbance during the flight of the particle, up to a lower value ε, no matter how small we would like to choose. If we decide to increase the number of times we observe the position, for a more precise definition of the trajectory, we will need to turn on the bulb a hundred times during the flight. The effect of radiation pressure throughout the flight will grow properly and the total disturbance can become larger than ε. To cope with the situation, we will use a ten times weaker bulb and a ten times more sensitive receiver. The following steps will require us to do a thousand, ten thousand, one hundred thousand of measurements, etc. using the weaker bulbs and more sensitive detectors (Gamow 1969, 105).

On the line, we can get an infinite number of observations, without disturbing the trajectory with more than ε. It should be taken into account also another aspect. No matter how small it may be the point on the move, its optical image on the screen may not be smaller than the wavelength λ of the used light, due to the diffraction phenomena. This impediment can be corrected in its turn by rectifying λ and using instead of visible light, an ultraviolet light, x-rays and γ rays, increasingly tougher. In classical physics, because there is not a lower limit for the length of the electromagnetic waves, the diameter of each diffraction image can be done by it, no matter how small we want. By doing this, we can observe a road, however fine we want, without disturbing the total movement by more than ε. For example, within classical physics we can build, from the conceptual point of view, the notion of trajectory as a line, Euclidean properly. However, Heisenberg supports that, by this Euclidean way of building, the notion of trajectory of a particle has no correspondence with reality, and it is precisely because of the existence of photons, of these "power portions" which divides any radiation.

Indeed, the smallest amount of energy carried to us by a "glimpse of light" is equal to hν, which corresponds to a mechanical impulse hν/c. In the reflection of the glimpse by theodolite, a part of this impulse will be communicated to the particle, changing the time of it with:

$$\Delta p \simeq \frac{h\nu}{c}$$

In this way, the increasing of the number of observations determines the extension of the trajectory disturbance beyond any limit, and the particle, instead of moving along a parable, will execute a Brownian motion, being bowled to and fro, in all directions, through the room. The only way to minimize the disturbing is the decreasing of ν, which, owing to the relation λ = c/ν, means the increasing of the wave length until it comes into the size of the room. Then, instead of seeing small sparks which jumping here and there on the entire surface of the screen, we see a system of large diffraction spots, overlapping, which will cover the entire screen. So, by this method, we can't get anything that resembles mathematical lines.

"The only possible alternative is to seek a compromise. We will need to use photons with a frequency that is not too high and with a wavelength that is not too large. Since the indeterminism Δq, in establishment by us, to the new position of the particle, is λ = *c/ν*, we get:

$$\Delta p \simeq \frac{h\upsilon}{c} = \frac{h}{\lambda}$$

or

$$\Delta p \Delta q \simeq h$$

That is the famous relation of Heisenberg indeterminism. Expressing otherwise, this relationship becomes:

$$\Delta v \Delta q \simeq \frac{h}{m}$$

which shows that deviations from classical mechanics are important only in the case of very small masses." (Gamow 1969, 107-108).

For example, if for a gunshot the imprecision of the speed coming out on the pipe of a gun is about 0.3 meters per century, and the imprecision of the position is comparable to the diameter of the atomic nucleus, things are quite different in the case of the electron. The uncertainty over its kinetic energy is comparable to the total energy of connecting an electron into the atom. It is unreasonable to draw the orbits of electrons into the atom along the lines because the widths of these lines will be comparable to the diameters of Bohr quantum orbits (Kojève 1990, 30). This is why, in the new theories, the notion of atomic orbit was replaced with that of orbital: an area in which the electron is found with a specific probability and it moves with a presumptive speed.

It must be said that this conclusion was the subject of a vast amount of criticism, mostly from the followers of the so-called hidden variable theories, one of the most well-known being the physicist David Bohm. For him,

> "the demonstration of Heisenberg relations on the maximum possible accuracy of the canonical conjugate measurement uses the assumption that measurements must involve only processes that comply with the general laws of the actual quantum theory. Thus, in the well-known example of the microscope with gamma rays, he assumed the position of an electron is measured sparkling on the particle a gamma

> ray, and then collected by a lens or by a photographic plate. This dispersion is, fundamentally, a Compton effect; the demonstration of Heisenberg's principle depends essentially on the assumption that Compton effect comply with the laws of quantum theory (therefore conserving the energy and the impulse in the "indivisible" process of dispersion, the wave character of the scattered quanta when passing through the lenses and the incomplete determinism of corpuscular blot on the photographic plate). Rather, any such a demonstration must be based on the assumption that, at any stage, the process of measuring will satisfy the laws of quantum theory. Thus, if we suppose that Heisenberg's principle has a universal validity is the same thing, ultimately, to assume that the general laws of the quantum theories are generally valid. But this assumption is now expressed in terms of external relations of the particle with the gauge and not in terms of the intrinsic characteristics of the particle itself." (Bohm 1993, 72).

The idea behind such deterministic viewpoints is that Heisenberg's indeterministic principle is only a measure of the limited degree of knowledge the physicists have about the realities of sub-quantum level, level whose causal structure could be unveiled sometime, in the future, through the identification of the so-called "hidden variables" (Bohm 2003, 80). To give an ontological sense to the indeterministic principle was considered in the 1940s-1950s a metaphysical heresy (Kemble 1937, 33).

In his turn, David Bohm has built, in 1957, the formal support for a deterministic interpretation of quantum theory in agreement with all experiments which had been undertaken until that point (Bohm 1995, 166-167). What prevented Einstein to fully subscribe to the ideas of Bohm (which, actually, were brought to a definitive form only in 1957) was the fact that they were associated with a non-local interpretation. That interpretation is placed against the idea of relativity, according to which nothing can move in the universe faster than light (Bohm 1995, 166-167).

Perhaps, if Einstein had lived up to the 1980s to take contact with the conclusions of the Allain Aspect experiment, he would have helped advance a Broglie-Bohm approach in which the particles are considered also corpuscles *and* waves, unlike Bohr's complementarities in which they are the corpuscles *or* the waves. James T. Cushing argues that, even if that interpretation would have benefited from the attention of the scientific community and also from subsequent refinements, it could be a viable alternative to the Copenhagen interpretation.

> "Thus, if the fate of the causal interpretation had taken a completely different turn in 1927, if it had been accepted against that of Copenhagen, and if it had had the resources to embower the essential generalizations for an empirical adequacy of wide coverage, we would have reached today a very different vision about the world of the micro-phenomena. If someone had wanted to present the Copenhagen version as being only as appropriate experimentally, but with all its counter-intuitive and bizarre aspects, who would have listened? It is important to us to

> realize that this story is not *ad hoc* (in the sense that these causal models do not grow from the successful results of a rival program, as the sole justification) and no mere fantasy. […] The Copenhagen interpretation came, the first, on the top of the mountain, however, and for the most of the practitioner scientists it does not make sense to get up there." (Cushing 2000, 369).

In fact, for some physicists, what was hard to be accepted was the inherent probabilistic character of Quantum Mechanics (Omnés 1999, 15). Unlike Classical Thermodynamics, where the Probabilism is just a form of mathematical description of some essentially deterministic processes, in Quantum Mechanics, both because of the non Separability, and the special character of quantons (corpuscular and undulatory), the very physical phenomenon described has a probabilistic character (Ziman 1969, 135). The most dramatic result of this is that in Quantum Mechanics the best knowledge of a whole does not imply the best possible knowledge of its parties. This idea obsessed Erwin Schrödinger as early as in 1935.

Returning to the principle of uncertainty, we can notice that the adepts of the hidden variables theories consider it as referring to the inability to measure accurately, both the position and the impulse of an electron. This is largely due to the terminology used in its name, not too inspired, as Basarab Nicolescu observed:

> "Very often, Heisenberg's relations are called « uncertainty relations ». I can only agree with Jean-Marc Lévy-Leblond when he sets against this terminology, because it is really a very bad one, even if it has historical reasons. Using the term of uncertainty, someone could think that there is some uncertainty regarding our gauges or the knowledge we have of the quantum events. This is absolutely false. Quantum events have, by definition, a given extension in space or in time. The illusion of uncertainty, of imprecision, comes again from the classical interpretation of quantic events. If there is uncertainty and imprecision, it looks just on the classical concepts" (Nicolescu 2002, 19).

The real significance of the uncertainty principle is that there is no electron to have both a precise position and impulse. This idea, with profound ontological implications, emerges from all three precocity formal approaches of Quantum Mechanics, either it is the Undulatory Mechanics, of Heisenberg-Born-Jordan matrices or Dirac's q numbers (Heinz 1985, 55). In fact, the latter had reached such a conclusion from its calculations even before Heisenberg.

> "The mathematical understanding of Heisenberg relations is in the noncommutativity of the operators associated with the position and with the moving quantity of a quantum particle. Each operator is assigned a set of inherent values. There is not one, but several inherent values, each having a certain probability of

> manifestation. It will say that the physical state corresponds to an overlapping, to a package of waves. So a measurement may determine, in principle, the obtaining of different results. Obviously, however, that only one of those results will be achieved effectively in an experimental measurement. In other words, the act of measurement cancels the plurality of the possible values of the pointed physical observability.This process is called the reduction of the wave package. The profound nature of the reduction is very obscure, because the fundamental laws of Quantum Mechanics seem to cease acting in the measurement process. Before measurement, the system is described by a wave package, but after the measurement it is assumed to be in a state with a well-determined value of pointed observability. There is, thus, a discontinuity in the evolution of the state – this evolution ceases to be deterministic in the quantum sense of the word." (Nicolescu 2002, 18-19).

At that time, that is to say in the 1920–1930s, the uncertainty relations have caused a shock, some physicists firmly rejecting them, others doing severe compromises by accepting them. The insistence on the use of the classic, macroscopic, language, in the description of the experimental results gives an incontestable operational, neopositivist character to Copenhagen interpretation (Prigogine 1992, 32). In front of the total novelty of the quantum phenomena is talking about a half-measure, about a compromise.

He had a particular historical justification: "the Copenhagen interpretation has allowed physicists not to devote all the efforts of the interpretation problems and to focus on the achieving of the concrete, technical results, which led to the extraordinary development of Quantum Physics. But today the maintaining of the non critical attitude towards this interpretation represents a break in the understanding of Quantum Physics. It is symptomatic that only a tiny minority of physicists are most interested in these interpretation problems of Quantum Physics." (Nicolescu 2002, 19).

What the adepts of the Copenhagen interpretation of Quantum Mechanics may strike is the unpublished character of the proposed conceptualizations, conceptualizations that insist on maintaining of a classical language in the circumstances where the quantum level of the real is characterized by a distinct dynamic of the interactions with the consciousness of the observer. Among the critics of the Bohr approach we can mention Putnam, Bohm and Omnès. If for Putnam (Putnam 2005, 615-634) Bohr's operationalist attitude severely decreased the chance to clarify some of the essential philosophical aspects of Quantum Mechanics, Bohm and Omnès looked for the constructive solutions for overcoming the above-mentioned conceptual dilemma. David Bohm (Bohm 1993, 23) relies on a deterministic holism with "hidden variables", while Roland Omnès (Omnès 1999, 15) based his account on a minimal reconstruction of Copenhagen interpretation where the decoherence and the non-locality of the quantons are the concepts which remove many of the classical interpretation paradoxes.

3. Einstein *versus* Bohr

The most famous incident regarding the indetermination principle is related to Einstein's opposition. It refers to the writing of the indetermination relationship in four coordinates. Thus, in a Cartesian coordinate system, the well-known relationship:

$$\Delta p \Delta q \simeq h$$

becomes:

$$\Delta p_x \Delta x \simeq h$$
$$\Delta p_y \Delta y \simeq h$$
$$\Delta p_z \Delta z \simeq h$$

Because in the relativity theory the time (written in the form of *ct*) is considered as the fourth coordinate, and the energy (written in the form of *E/c*) is regarded as the fourth component of the impulse, a new relationship of uncertainty appears:

$$\Delta E \Delta t \simeq h$$

It is precisely this relationship that was the subject of the discord between Einstein and Bohr at the VIth Congress of Solvay in 1930, Einstein claiming that he can demonstrate its incorrectness (Thomson 1973, 47). "His argument was very ingenious. Considering a box that has a slot in one of the walls, the slot which can be opened or closed by a door controlled by a clock from the inside of the box. The box is filled with radiations. We weigh up the box. We open the door for a short interval in which only a single photon comes out. We weigh up again the box a little later. From the difference of the gravity we can conclude the energy of the photon using the equation $E = mc^2$. So (in principle), it can be determined arbitrary precisely both the energy of the photon and the time of the passing of the photon, that it is in conflict with the relationship of the time-energy uncertainty" (Pais 2000, 394).

Bohr found an answer to Einstein after a night of restlessness. Bohr found that Einstein had not taken into account the fact that the process of weighing involves the changes induced by the moving of the box in a gravitational field, the same thing that happens to the grocer when he uses the scale. The impreciseness due to the movement of the box generates uncertainty in the determination of the mass, and, thus, of the photon energy. When the box is moved, the clock inside it will work slightly differently because the progress of the clock depends, to a very specific mode, on its position in a gravitational field. Similarly, the impreciseness due to the moving of the box generates uncertainty in the movement of time. "Using the relation of the position-impulse uncertainty as a starting point, Bohr shows that the uncertainties of the energy and of the time are in accordance with the relationship of the time-energy uncertainty. Everything was in order." (Pais 2000, 395).

The next episode of the controversy between the two physicists took place in 1935, the moment that Einstein, together with Boris Podolsky and Nathan Rosen, proposed an alternative to the Bohr's complementary, which he called an "objective reality". The central idea was that Copenhagen interpretation of Quantum Mechanics is incomplete, given the fact that there must be a mechanism of the subtle and deterministic clock which keeps the Universe moving, the mechanism which just seems to be uncertain and unpredictable at the quantum level where it is described on the basis of statistical variations (Gribbin 1991, 182).

The article describes another mental experiment that goes away from the two particles which are originally in the interaction and which it "flies" further in opposite directions. None of them any longer interacts with anything else, until the time the experimenter decides to investigate one of them. Each particle has its own impulse and its own position in space. Even within the rules of quantum theory, we are able to measure the total impulse of a pair of the particles and the distance between them while they are close to one another. When we decide later to measure the impulse of one of the particles, we know automatically that should be the impulse of the other, because the total impulse of the pair must remain unchanged. The same we can do it referring to the position of the particles related to the position of the pair at the initial moment. The uncertainty principle states that the physical measurement of the particle's impulse **A** destroys the precise knowledge of the particle position **A**, namely that the measurement of the position of this particle disturbs the impulse, which remains unknown to us. For Einstein, Podolski and Rosen, it would be possible, however, to find simultaneously the position and the impulse of **A** particle by directly measuring its position and by indirectly discovering its impulse by measuring the impulse of **B** particle and its decreasing from total impulse of the pair, knew it originally. It would be impossible to defend, they saw, that **A** particle (precisely impulse – the imprecise position or vice versa) would depend on, in a way, of the type of measurement (position or impulse) that we choose to make in connection with **B** particle.

How can we "know" about the **A** particle, the moment of having a well-defined impulse or a well-defined position depending on what we measure at **B** particle? It would be as if, in the quantum world, a measurement realized *here* on a particle affects the pair of this particle located *there*, which would mean a blatant violation of causality due to an instantaneous mysterious communication at the distance – what it was called, also, *non-localization* or *remote action*. The conclusion of the article was that, for those who accept Copenhagen interpretation, the reality of the position and of the impulse, in one of the systems depends on the process of the measurement achieved over the other physical system that does not disturb the first system in any way. Einstein believed that any reasonable definition of reality would not be able to afford it (Pais 1982, 456 *apud* Gribbin 1991, 183).

This is the point in which the adepts of Copenhagen interpretation had divergent positions besides the authors of the article. No one denies the logic of the reasoning, but most physicists could not reach a common position on what it is meant by a "reasonable" definition of reality. Bohr and his colleagues believed acceptable a reality in which the position and the time of the particle do not have any objective meaning until they are measured, no matter what measurements have been carried out on the other particles. The question should not surprise us, if we do the subtle observation that for Bohr

> "[…] the physical theory is not related to an « intrinsical » reality, but to the experience. We did not understand that the idea of objective reality would have abandoned. If for Einstein an objective physical description may be true even if there is not any observer, for Bohr a physical description is objective in terms of that it is invariant to the exchange of the observers. It is operated for designating such objectivity with the term of a *weak objectivity*, in relation to strong objectivity which the independence of the physical description implies not only of the feelings of the observers, but also to the means of investigation used." (Celmare 1993, 66).

It asserts a choice between a world of objective reality and one of the quanta. Those who, along with Einstein, opted for a world of objective reality have remained until today a minority among physicists (Gribbin 1991, 182-183).

4. Some Final Remarks

Beyond all the technical details, the significance of the described historical episode is quite a rich one, for at least two reasons. First, this "conflict" reflected a profound split within the evolution of the descriptive representations used by physicists to "picture" the world. The personalities involved in this conflict of opinions were first rank scientists with great influence upon important research programmes in their times. Therefore, we can consider this conflict as being a "public conflict" with regulatory functions within the scientific community. Even today, the subject of the conflict remains a rich one for multidisciplinary investigations, from quantum physics to philosophy.

Seccond, we can see this conflict as symptomatic for the state of spirit of scientists regarding the problem of determinism in contemporary physics. The consequences of the epistemological and ontological mutations within scientific discourse were really important not only for the scientific community, especially if we take into consideration the wide range of interpretations and speculations triggered in postmodern society by the rise of various interpretations of Quantum Mechanics, as it happened with many other scientific theories (Wheen 2004, 84).

But in this case, the very concept of reality is involved; therefore the cultural reverberations of this conflict were and still are significant, especially in postmodern times. Einstein and Bohr opposed two fundamental ways of representing, describing and understanding ontologically the features of the physical real. At stake in their dispute was, indirectly, something from the core set of principles that define the contemporary natural science as a rational and experimentally oriented endeavour of human mind, oriented towards the problem of understanding reality. Therefore, the conflict mentioned above offered the possibility of identifying and formulating one of the most important scientific problems of our times. In this way, using a concept developed by Michel Meyer, we could say that, beyond the regulatory function within scientific community, this conflict had also a problematologic function within contemporary society.

References

BOHM, David. 1995. *Plenitudinea lumii şi ordinea ei*. Bucureşti: Editura Humanitas.

BOHM, David. 2003. *Sfârşitul timpului.* Bucureşti: Editura Herald.

BOHM, David and HILLY, B. J. 1993. *The Undivided Universe.* London and New York: Routledge.

CELMARE, Ştefan. 1993. *Perspective epistemologice.* Iaşi: Editura Universităţii „Al. I. Cuza" Iaşi.

CUSHING, James T. 2000. *Concepte filosofice în fizică: relaţia istorică dintre filosofie şi teoriile ştiinţifice.* Bucureşti: Editura Tehnică.

GAMOW, George. 1969. *30 de ani care au zguduit fizica: istoria teoriei cuantice.* Bucureşti: Editura Ştiinţifică.

GOTTLIEB, Ioan et al. 1999. *Mecanică cuantică.* Bucureşti: Editura Bit.

GRIBBIN, John. 1991. *In Search of Schrödinger's Cat: Quantum Physics and Reality.* Berkshire: Transworld Publishers.

HEISENBERG, Elisabeth. 1984. *Inner Exile*. Basel: Birkhäuser.

HOLMES, David. 2005. *Communication Theory: Media, Technology, Society*. London: Sage Publications.

KEMBLE, Edwin C. 1937. *The Fundamental Principles of Quantum Mechanics*. New York and London: McGraw-Hill Book Company, Inc.

KOJEVE, Alexandre. 1990. *L΄ idée du déterminismedans la physique classique et dans la physique moderne.* Paris : Le livre de poche.

MACH Ernst. 2001. *Mecanica: expunere istorică şi critică a dezvoltării ei.* Bucureşti: Editura All Educational.

NICOLESCU, Basarab. 2002. *Noi, particula şi lumea.* Iaşi: Editura Polirom.

OMNÉS Roland. 1999. *Interpretarea Mecanicii Cuantice*. Bucureşti: Editura Tehnică.

PAGELS, Heinz. 1985. *L΄univers quantique*. Paris: InterEditions.

PAIS, Abraham. 2000. *Niels Bohr: omul şi epoca, în fizică, politică şi filosofie,* Bucureşti: Editura Tehnică.

PRIGOGINE, Ilya. 1992. *De la existenţă la devenire.* Bucureşti: Editura Ştiinţifică.

PUTNAM, Hilary. 2005. *A Philosopher Looks at Quantum Mechanics (Again), in British Journal for the Philosophy of Science* 56: 615-634. London: Oxford University Press.

THOMSON, George. 1973. *Inspirație şi descoperire*. Bucureşti: Editura Enciclopedică Română.

ZIMAN, J.M. 1969. *Elements of Advanced Quantum Theory.* New York: Cambridge University Press.