INTEGRATIVE CONCEPTS OF 20th CENTURY SCIENCE

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Abstract: *The study undelines the features and the integrative concepts to discuss the 20th century that was the pinnacle of modernity, but also marked a crisis of scientism that ushered in an era of deconstructive transition also known as postmodernity. During the century in question, science and philosophy experienced a particular development, with most significant twists and turns. In the 20th century cognition in general and science in particular became the focus of thought and creation, technological achievements and technocratic determinations being themselves the object of investigation for philosophers, economists, politicians, socio-psychologists. Modernity, with its propensity for science and logic, is likely to be replaced by postmodernity, which also starts from scientific knowledge, but seeks to reform it, most likely, shaping a new scientific revolution in the area of communication science, cognition and computers.*

Keywords: *integrative concepts, crisis of scientism, object-subject, universal-individual, body-soul, mental-physical, ego, intentionality, complementarity, holism, logical-mental, identity-diversity, perception-intellect, trans-consciousness, trans-personality.*

Before we can define the role and the place of science at the beginning of the 21st century, we must consider the features and the integrative concepts of the paradigm or paradigms defining 20th century science. The past century was not only the time when science and technology gained absolute preeminence, but also the century of the philosophy of science. This major philosophical discipline sought to demonstrate the privileged position of scientific knowledge within human spirituality. Apart from representing the pinnacle of modernity, the 20th century was also marked by a crisis of scientism that ushered in an era of deconstructive transition also known as postmodernity. During the century in question, science and philosophy experienced a particular development, with most significant twists and turns.

The great discoveries and scientific and technological achievements in fields such as nuclear physics, relativist physics, quantum physics, cosmology, thermodynamics, chemistry, electronics, energetics, genetic cellular biology, medicine, cybernetics, communications, audio-

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visual and computer technology, Internet, computer science, economics, ecology, neurophysiology, cognitive sciences, robotics, A.I., psychology, sociology, and others, brought to the forefront philosophical ideas and concepts such as object-subject, universal-individual, body-soul, mental-physical, ego, intentionality, complementarity, holism, logical-mental, identity-diversity, perception-intellect, trans-consciousness, trans-personality and gave a distinct direction to contemporary philosophical trends. We can say that all directions in the speculative thought of this century touched upon scientific knowledge and technology, one way or another.

On the one hand, positivism, empiricism, analytical philosophy, realism, naturalism, neo-Kantianism, phenomenology, semiotics, structuralism, logical positivism-represented by thinkers such as Wittgenstein, Russell, Moore, Carnap, Quine, Strawson, Sellars, Husserl, Brentano, Merleau-Ponty, Levi-Strauss, Saussure, Bertalanffy, Hempel, Tarski-dealt with the logical nature of science, with the objectivity and the justification of truth, with the logical analysis of scientific language, with the methodology and the process of knowledge, with the role of empirical observation and reason in knowledge.

On the other hand, existentialism, psychologism, hermeneutics, social constructivism, post-structuralism, post-criticism, post-analyticism, neo-pragmatism, relativism, postmodernism-represented by Bergson, Dewey, Peirce, Heidegger, Sartre, Jaspers, Marcuse, Gadamer, van Frassen, Habermas, Scheler, Kuhn, Toulmin, Feyerabend, Bloor, Barnes, Rorty-approached the crisis of science, the historicity and the diverse manifestations of rationality and subjectivity, psychological determinations, scientific revolutions and paradigms, contexts and backgrounds, holist-complementarist visions, the organicism and the relativism of knowledge, social constructivism and ethno-methodologies, all with direct reference to science, to evaluation criteria, and to the position of the intellectual in the world.

It is obvious that in the 20th century cognition in general and science in particular became the focus of thought and creation, technological achievements and technocratic determinations being themselves the object of investigation for philosophers, economists, politicians, socio-psychologists. Modernity, with its propensity for science and logic, is likely to be replaced by postmodernity, which also starts from scientific knowledge, but seeks to reform it.

The most important epistemological principle of postmodernism states that science plays its own cognitive game and is unable to legitimize others. There is no absolute reason likely to show us the right way of looking at things. The investigation of ultimate reasons and justifications was typical for the modern era, while the admitted impossibility of finding them beyond language games and particular structures of the world remains central to postmodernist thought. Pragmatism made its comeback within postmodernist philosophy, especially when it comes to challenging cognitive absolutism.

Richard Rorty[1] contends that the problem lies not with science itself, but rather with the manner in which it was worshipped by realist philosophy. In order to be a purveyor of truths, science must refer so something located beyond itself, the way religion refers to the sacred. Science is not an abstract metaphysical term, while reality is precisely that. Science is a human endeavor which seeks to find the methods and the instruments of acquiring knowledge.

[1] Richard Rorty, *Objectivity, Relativism and Truth* (Cambridge: Cambridge Univ. Press, 1991).

However, it claims to go beyond the relativity of human existence. Rorty sought to analyze the connection between science, reason, and reality. The neutrality and the objectivity of science cannot be defended, for science is not a model of rational thought, but rather of solidarity. Scientists are not the high priests of knowledge, and the postmodernist stance even goes as far as challenging the idea of a single religion, grounded in the postulate of a supreme reality lying beyond the relative, mundane world, a reality which it alone could reach. R. Rorty adopts an anti-representational stance, relating natural science to the other manifestations of culture. He claims that science cannot reach a true and objective reality independent of the human language and psyche. It is just an activity among others (artistic, religious, etc.), helping us cope with reality.

While modernism relied on a critical epistemology generally defined by a defense of: 1) foundationalism; 2) the representational theory of language; 3) the reductionism and the autonomy of science, postmodernism is grounded in a post-critical and post-analytical epistemology that endorses: 1) the holistic, contextualist perspective; 2) the theory of natural language and of speech acts; 3) organicism and relativism, placing science on equal footing with the other forms of human spirituality.

The 20th century was the time of new syntheses. In all intellectual fields-from hard sciences to sociology, psychology, and economics-we are likely to witness a return to comprehensive thought, to general theories, to a rearrangement of components. And this because people have begun to realize that, obsessed as they are with the quantified detail taken out of context, with the in-depth investigation of increasingly narrow topics, they have come to know less and less about the bigger picture.

As contended by Nobel laureate Ilya Prigogine[2] in his *New Alliance,* the 20th century forces us to leave behind the tranquility with which we used to decipher the world. Science must become free from the ideological constraints of the European 17th century and seek a universal language before it can pool together all human knowledge. As scientific objectivity has been long defined by the absence of references to the observer, now we seek to acknowledge the existence of a subjective frame of reference. The 17th and the 19th century consecrated the dualism between subject and object, between the controller and the controlled. Nature, seen either as a clockwork mechanism, or as an engine, had been understood as a stable, objective reality. The 20th century brought about a metamorphosis of science, putting an end to such certainties. Man, part of the Universe, is equal to the other parts and cannot be understood unless approached as a component of the world. The stable and permanent norms that hinged on a separation between object and subject no longer hold water; the exclusive legitimacy of a certain model, that of the science of classical physics, can no longer be sustained.

The frequent occurrence in the language of various contemporary fields of terms such as *revolution, crisis, gap, change, conversion, prognosis, diagnosis, communication, information, mass media, message, organization, cybernetics, computer, system, integration, participation, globalism, complexity, ecology, value, humanism, liberty, holism, anthropology, hermeneutics, dialectics,*

[2] Ilya Prigogine and Isabelle Stengers, *La Nouvelle Alliance*. *Métamorphose de la Science* (Paris: Gallimard, 1979); English version: *Order Out of Chaos* (New York: Bantam, 1984).

archetype, paradigm, social structure, conceptual background, cultural form, future, progress, development, growth, diachronic, responsibility, creativity, complementarity, probability, space-time, quantity-quality, reversible-irreversible, discrete-continuous, causality-finality, symmetric-asymmetric, determinate-random indicates the change suffered by the set of integrative concepts within the cultural paradigm of the 21st century.

We are witnessing the emergence of phrases that are likely to become-like those of the Antiquity and of the Renaissance before them-representative for the nature of 20th century thought: *Everything is connected to everything else; The many become one and are increased by one; Man is part of the Universe, the same part as others; The whole of science is nothing more than a refinement of everyday thinking; Science and culture in a given civilization are therefore intimately interrelated; Knowledge is one. Its division into subjects is a concession to human weakness*.

A new approach to science, just as effective as that of the Newtonian paradigm, emerged within the scientific spirit of the 20th century. The starting point is represented this time by theories built on imaginary mental experiments. Mathematics no longer serves just to uncover laws, but it has come to invent models it then offers to the sciences. The postulation of these hypothetical models is based on the probability that some of them may be confirmed by facts. First and foremost, we are dealing with a change of direction: we no longer move from facts to theory, but rather from theory to facts. Other changes affect the understanding of the *objectivity,* the *rationality,* and the *progress* of scientific knowledge. Thus, it's not just that problematic theoretical aspects are not excluded from the field of science, but even the rationality of science is equated with the speculative capacity of constantly setting new problems, of criticizing and seeking new and surprising truths, truths that shatter well-structured cognitive constructs. For the first time, *criticism* becomes the main problem of science, while previously it had only served to eliminate errors, making thus possible the positive acumulation of truths. This time, it defines the very rationality of science, no longer sought at the level of complete objectivity and logic. The criteria of rationality, and implicitly those of cognitive progress, are sought in the very process of knowledge, either in terms of efficient problem-solving (Laudan), or in the succession of research programs (Lakatos), or in conceptual evolution (Toulmin).

The image of 20th century science was influenced by the manner in which Einstein understood and approached science. Quite significant in Einstein's case is precisely the shift in the epistemological paradigm. As indicated by Dirac, even if it was Lorenz who dealt with the mathematical implications of four-dimensional transformations, the fundamentals of space-time physics were defined; by Einstein, who thus changed the entire manner of doing research in the field of physics. In what concerns the general theory of relativity, Einstein's contribution meant a radical change in the ideas of physics (with the introduction of the curvature of space and the description of the gravitational field by unification with the electromagnetic field). The problems propounded by Einstein and those of quantum mechanics-with the famous Einstein-Bohr dispute-still dominate the field of physics. In 1905, Einstein published a study dedicated to the interaction between light and matter, discussing the wave and particle nature of light. In 1925-1926, Heisenberg, Bohr, Jordan, Dirac, and Schrodinger created quantum mechanics, which demonstrated that this feature defines both the atomic and the subatomic world. Also in 1905 Einstein brought a number of arguments in favor of the existence of atoms and molecules. In keeping with Bernoulli's kinetic theory, he demonstrated that molecular movement causes a perceptible displacement of tiny particles in a liquid. The observation made by Brown as early as 1828 was quantitatively substantiated by Einstein's theory. In both his texts Einstein employed static thermodynamics in a new fashion, examining the observable consequences of the deviations from the radiation-matter continuity.

Relativity, information, system, entropy are therefore key concepts of the emerging scientific paradigm. Entropy, or indeed the degradation of energy, the irreversible movement of natural processes towards a thermal balance that puts an end to all evolution, is now extrapolated to the field of biology to describe the movement from order to disorder, and Prigogine uses it to designate any source of innovation and development, or any factor likely to increase the complexity and the diversity of the Universe. The word 'entropy' has also begun to be used in astronomy, chemistry, economics, and social science. Information and creation lose their strictly anthropomorphic character and come to define the whole of matter: there exists in the universe a continuous fluctuation of states with a given direction, and at certain points a direction is chosen much in the same manner as subjective freedom manifests itself within spiritual innovation and creation.

Continuing and completing the concept of structure, that of *system* emerged alongside *complementarity*. The study of living forms and of human society brought about a spiritual metamorphosis which gave preeminence to the theory of systems in physics and in cosmology. The new perspective on the technologies and the energetics of the future, now largely seen as related to biology and environmental science, also come to support the epistemological principle whereby "Everything is connected to everything else." The theory of systems, coming to continue structuralism and holism, states the primacy of relations over elements and postulates that the whole cannot be reduced to its parts. The focus shifts from structural invariance towards the dynamic mechanisms of its constant actuation. We now seek to understand hierarchic ordering, self-organization, the process of adaptation by way of increasingly stable states, the diachronic nature of structural revolutions from the vantage point of the emergence of more complex systems (E. Laszlo's theory of evolutionary self-organization systems, Rene Thom's catastrophe theory). Increasingly meaningful are the interactions involving the material constituents of the Universe, leading to a new type of mathematical formalization. Starting from the general theory of systems, we seek to understand the organization of complex structures within subsystems, but also the organizational mutations occurred within the interaction between and the development of supra-systems. Concepts such as replication, invariance, mutation, selection, genetic code, phenotype, genotype, relation, hierarchy, comprehension, value, structure, function-all coming from the fields of biology or social science-are now used in other fields. The world is increasingly seen in terms of project and finality.

20th century mathematics saw the advent of fractal and chaos theory[3], which deals with the mathematical representation of dynamical systems such as the solar system, the human brain,

[3] See Deborah Madsen and Mark Madsen, "Fractals, Chaos and Dynamics: The Emergence of Postmodern Science," in *Postmodern Surroundings*, ed. St. Earnshaw (Amsterdam-Atlanta-Rodopi: Steven Earnshaw, 1994); J. D. Barrow and J. Tipler, *The Antropic Cosmological Principle* (Oxford University Press, 1986); K. J. Falconer, *Fractal Geometry: Mathematical Foundations and Applications* (New York: J. Wiley, 1990); H. Lauwerier, *Fractals: Images of Chaos* (London: Penguins, 1991); B. B. Mandelbrot, *The Fractal Geometry of Nature* (New York: Freeman, 1982)

atmosphere chemistry, or computers. The word 'fractal' comes from objects which seem broken and whose dimensions cannot be expressed in whole numbers. It was proposed by Mandelbrot in 1982 and by Lauwerier in 1991. The dynamical systems thus described are evolving physical and behavioral (actional) systems. Most such systems are chaotic and their state cannot be predicted in the conventional fashion. Although the movement of planets or human behavior are unpredictable, fractals seek to make possible the understanding of occurrences within the chaotic developments that do not abide by the laws of determinism. The new attitude with regard to scientific knowledge demands that these realities be approached within "the circumstances of their possible world." The various fields of science shifted their positions by reintegrating science as a relational model between phenomena and theories. Sciences are interconnected and none is more important than the others, the way mathematics and physics used to be considered during the modernist period. In the postmodern perspective, all fields of knowledge are placed on the same level, and thus social and literary studies are seen as equal to the hard sciences.

Thermodynamics and probability theory are other scientific disciplines typical for the type of knowledge generated in the 20th century and still present at the beginning of the present century. Thermodynamics belongs to the field of physics, but it has philosophical implications as it approaches the Universe as an energy structure. The second law of thermodynamics-which introduced the notion of 'time arrow'-is the major contribution to anti-reductionism, shifting the focus from substance to energy, relations, communication, and time. Elementary particles can be seen as constantly changing, ephemeral beings. Natural sciences describe a fragmented universe stretching from particle energy and cosmology to the realm of biology. As indicated by Prigogine, science has discovered that the dialogue with nature doesn't mean looking from the outside at a lunar desert, but rather the active exploration of a different order. Albeit born in the Antiquity, the idea of probability would only receive fundamental importance in the 20th century, in connection to the statistical understanding of the world and as seen in the case of quantum mechanics, economics, medicine, genetics, psychology, etc.[4]

The issue of *mind and consciousness* has emerged as another essential component of 21st century science, technology, and philosophy. The most ardent problems of conscious experience-with regard to feeling, qualia, and inner mental life-have now been raised by information science. Thus, some researchers contend that conscious experience is a physical process specific to the brain. Others, however, claim that it goes well beyond the physical and cannot be grasped by contemporary science. At best, its secrets will be pierced by a future, more comprehensive, science. It has been noticed that such confrontations are manifestly philosophical in nature, as they all start from an attempt to define the nature of consciousness. But this has been a typical concern of philosophy since its very creation. The reasons why consciousness has now become one of the main concerns of science must be sought within science itself. The great discoveries of the 20th century (relativity, quantum mechanics, genetic biology, neurophysiology, computer science, A.I.) reinstated consciousness as a central issue pertaining to mind philosophy and,

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and Angela Botez, "Paradigma postmodernă a cunoaşterii ştiinţifice (fractali, termodinamică, probabilităţi, Internet)," *Revista de filosofie* 1-2 (2001); Vasile Tonoiu, "Pledoarie pentru o filosofie fractalistă," *Revista de filosofie* 5-6 (1999).

[4] See Angela Botez, *Concepte integrative - antice, moderne, postmoderne* (Bucharest: Ed. Semne, 1996), 70.

furthermore, as the subject matter of a new philosophy of consciousness, or even of a science of consciousness.

The fact remains that so far all attempts at providing a scientific explanation of consciousness have failed, to the point where some researchers concluded that the question about consciousness must not be put only to the field of science. Before an answer could be found, the various branches of science (physics, biology, psychology, etc.) will have to be joined by philosophical and theological thought.

A central concept of mind philosophy-alongside ego, intentionality, mental events, occurrence, belief, reliability, representation, personality, perception, emotion, subjectivity-'consciousness' has become of tremendous interest because of the problems raised by new types of science: computer science and the science of cognition.

Cognitive sciences, which developed in close connection to cybernetics and A.I., drew attention to new philosophical issues. The birth of cybernetics as a science occurred starting from the observation of human thought patterns and from the mathematical expression of action principles. The rise of cognitive sciences followed a reverse path, as from the level reached by the mathematical models and the cybernetic languages of A.I. they moved on to models which reflect the workings of the mind or its connection to the physical in the case of human consciousness. The attempt to describe the status of cybernetic and cognitive sciences was one of the factors that favored the contemporary development of mind philosophy. Its roots can be found far back in the past, in the history of the philosophy of knowledge. Today we hear voices that reduce the philosophy of mind to the methodology of cognitive sciences, but also opposing claims, which argue that it is a philosophy in its own right, and not just a meta-science. The knowledge of consciousness must be scientific in nature, but also philosophical. If no scientific truth can be absolute, then the same applies to the truths about the human mind, with its ineffable psychological component.

Mind philosophy[5] is a philosophy of science which deals with the ontology, the epistemology, and the methods of the sciences belonging to the field of Artificial Intelligence and of neuroscience. Within it we find theories pertaining to the philosophy of consciousness which focus on those chapters of science that deal with consciousness. The conceptual definitions and the boundaries of this discipline are still work in progress, but there are numerous attempts to clarify, systematize, and critically analyze the philosophical or scientific theories on consciousness. Their very object, consciousness, tends to blur the boundaries between the scientific and the philosophical approaches. Still, we are witnessing the emergence of a new type of science known as neuroscience, with conscious experience as its object. Science has thus become the object of much philosophical speculation, in the framework of mind philosophy. Neuroscience compares computer programs and brain processes, noticing that some neurobiological investigations of the brain can help explain mental and even conscious phenomena. There is a debate here as well, between those who see consciousness as impervious to scientific scrutiny and those who see it as a possible object of scientific knowledge. The theory of the identity between mind and brain postulates that consciousness is a mental phenomenon

[5] See Angela Botez, *Filosofia mentalului. Intenționalitate şi experiment* (Bucharest: Ed. Ştiințifică, 1996).

generated by the brain. In his book *Is Consciousness a Brain Process?*[6] U. T. Place sought to solve the problems raised by the concept of consciousness which, just like that of disposition, defies behaviorist explanations. Consciousness could be seen as a behavioral disposition rooted in the brain. This would rule out the dualism involved in the perception of consciousness as an entity different from and opposed to neural matter. The remaining problem is whether one can grasp the qualia of consciousness, its ineffable qualitative specificity. The metaphysical and theological defense of the idea of a consciousness deprived of corporality is systematically present. Place himself believes that we can equate consciousness with a brain activity pattern provided that we can explain the introspective observations of the subject regarding the cerebral processes they are correlated with. It is clearly a fallacy to claim that statements about conscience are statements about brain processes, he contends. Many texts, developing forms of non-reductionist materialism or functionalism, have been written in keeping with this drive to avoid both reductionist materialism and mentalism.

The supporters of dualism-or indeed of a "pragmatic" dualism-argue that the psychology of daily life which operates with the notion of consciousness cannot be reduced to cognitive psychology as its specialized science. The manifestations of consciousness go far beyond what is investigated by identity theory. According to some, the limits of possible explanations derive not from the particular nature of consciousness as described by Thomas Nagel in his study "What Is it Like to Be a Bat?"[7] and similar to the Cartesian understanding of consciousness. Still, a naturalist interpretation of consciousness eliminates its qualitative specificity, leaving the issue somewhere at the crossroads between philosophical interpretation and scientific analysis. Descartes equated the issue of consciousness with that of mental states. As opposed to the events of the machine-body *(res extensa),* there are also inner events *(res cogitans)* with a special characteristic: consciousness.

Consciousness marked one of the main points of fracture between philosophical trends and psychological investigations, between materialism and idealism, reductionism and holism, positivism and hermeneutics, between behaviorism and introspectionism, and nowadays between those A.I. interpretations which accept the possibility of a robot having feelings and a consciousness (Daniel Dennett), and those which, distinguishing between consciousness and awareness, consider that computer programs might reach awareness (reaction to stimuli, integration of data, expression of mental states, access to individual states, focusing of attention, behavior control), but definitely not consciousness (D. Chalmers). A similar position is the one adopted by Searle, who speaks about the maximum to be achieved in terms of an A.I.: a so-called zombie, deprived of feelings, emotions, or consciousness[8]. There is also an anti-reductionist response to physicalism, represented by the personalism of Sellars[9] and Davidson.[10]

It must be said that the new scientific breakthroughs in biophysics, bio-informatics, neuroscience, cognitive and consciousness sciences, communication science, all of crucial

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[6] U. T. Place, "Is Consciousness a Brain Process?" in *Mind, Brains and Computers*: *The Foundations of Cognitive Science. An Anthology*, eds. R. Cummins and D. Dellarosa Cummins (Oxford: Blackwell, 2000).

[7] Th. Nagel, "What Is It Like to Be a Bat?" in *Mortal Questions* (Cambridge: Cambridge Univ. Press, 1979).

[8] See Şt. Trăuşan-Matu, *"Existenţă şi interpretare. Problema conştiinţei,"* în *Filosofie şi ştiinţe cognitive*, ed. G. G. Constandache (Bucharest: Ed. Matrix, 2000).

[9] W. Sellars, *Science, Perception and Reality* (London: Routledge, 1963).

[10] D. Davidson, *Essays on Actions and Events* (Oxford: Clarendon Press, 1980).

importance at this beginning of a new millennium, are uniquely related to a philosophical debate that has come to encompass physics, biology, technology, and philosophy itself.[11] The current methodological debates have come to unify the scientific approaches with the theoretical-metaphysical ones. The relationship between reductionism and anti-reductionism has been examined by scientists such as Francis Crick, Cristof Koch, Daniel Dennett, P. S. Churchland, P. M. Churchland, Roger Penrose, David Rosenthal, Owen Flanagan, K. H. Pribram, Skinner, Sperry, Searle, Sejnowski, Llinas, but also by philosophers like David Chalmers, Tim Crane, Jerry Fodor, P. M. S. Hacker, Rom Harré, Ted Honderich, D. H. Mellor, David Papineau.

We shall present here one of those personalities that have inserted philosophical ideas into scientific discoveries essential for the spiritual paradigm of the 21st century: Roger Penrose, a mathematics professor at Oxford University. He published numerous mathematical studies and, together with S. W. Hawking, he tried to offer a cosmological explanation of the Universe. In 1970 the two drew up a study called "The Singularities of Gravitational Collapse," which they published in the *Proceedings of Royal Society*.

In 1987 Penrose published a piece called "Quantum Physics and Conscious Thought" in the volume *Quantum Implications: Essays in Honour of David Bohm*. His main book-a scientific bestseller, lust like Hawking's *Brief History of Time* (1988)-is the 1989 *The Emperor's New Mind: Concerning Computers, Minds, and the Laws of Physics*.[12] The book reviews a number of issues pertaining to the theory of felativity, quantum mechanics, cosmology, but it deals mostly with what philosophers call the relationship between mind and body. Penrose proves to be not just an excellent physicist and mathematician, but also an outstanding philosopher of A.I. He challenged the exaggerated beliefs in the power of the A.I., arguing, like Searle before him, that it is mistaken to believe that in a few decades' time computers will equal the performance of the human mind. He contended that only science fiction fans can believe that the human mind is a "flesh computer" (as Marwin Minsky put it), that pleasure and pain, appreciation for beauty and humor, consciousness and free will could possibly be found in electronic robots, provided that sufficiently complex algorithms are there to capture human behavior. Penrose spoke against the reductionist belief whereby the machine-the A.I.-and the brain operate on the basis of knowable physical laws. He argued that the Platonic universe of pure mathematics and the physical world are both real, and their secrets, laid down in "God's book," cannot be fully discovered. In keeping with his philosophical realism, he claimed that while Mandelbrot's fractal structures are incomprehensible, they exist just like Mount Everest does. Penrose is one of the few physicists who believe that Einstein was right when saying that "his little finger told him that quantum mechanics was incomplete." Current philosophical speculations, Penrose said, deal with the Turing machine, with complexity theory, with the paradoxes of quantum mechanics, of formal systems, of Hilbert spaces, with "white and black holes," Hawking radiation, entropy, the structures of the mind, with Gödel's incompleteness theorem, they bring consciousness into the picture when asking questions such as "Are dogs and cats possessed of consciousness?," "Is it theoretically possible for a machine to teleport a person over great distances?," "Is there a level beyond quantum mechanics where the direction of time and the difference between right and left

[11] For more on this issue see *Filosofia conştiinţei şi ştiinţele cognitive*, eds. Angela Botez and Bogdan M. Popescu (Bucharest: Ed. Cartea Românească, 2002).

[12] Roger Penrose, *The Emperor's New Mind: Concerning Computers, Minds, and the Laws of Physics* (Oxford: Oxford University Press, 1989).

are imprinted?," "Are the laws of quantum mechanics essential for the workings of the mind?" In his introduction to Penrose's book *The Emperor's New Mind,* Martin Gardner gives a positive answer to the last two questions. His famous theory-*twistor theory*-about a space more complex than space-time underlies the belief that there is a field beneath that of quantum particles. This theory falls into the category of the hotly debated superstring hypotheses and of grand unifying schemes.

Penrose is very interested in mathematical games. In his youth, he discovered an "impossible object" called a *tribar* (a solid figure with self-contradictory elements). This figure was used by Escher in his lithographs *Ascending and Descending* and *Waterfall*. Later on, Penrose devised new geometrical forms, the so-called quasi-crystals. All of his discoveries in mathematics and physics drove him towards investigating the mysteries of existence and to the conclusion that the human mind is more than a collection of gears and cogs. Penrose found himself as an alter ego of the child from "The Emperor's New Clothes" when saying that "the emperor of the strong Artificial Intelligence theory is naked."

We can say that at the turn of the 21st century the specific feature of science comes from the emergence of new disciplines, closely related to neurosciences, quantum physics, genetic biology, A.I., and computer science. We can conclude that a new scientific revolution can be expected to occur in this area of communication science, cognition, and computers. It will most certainly lead to further mutations in the philosophical, social, and political thought of the new millennium.