The paradox in scientiphic discourse

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1. *Variety of paradoxes*

An important mechanism through which science develops is that of the use of paradoxes. Given their varied nature, a general theory of paradoxes has never been formulated. Although they can be classified into a variety of typologies, they must be treated as singular problematic cases every time they break into scientific discourse, and the interest of scientists is essentially aimed at evaluating the use made of paradox in different disciplinary fields.

Some paradoxes act as an impossibility to fill the depth of the ideas that the ego experiences and in some cases involve an infinite regression, such as in wanting to divide a portion of space into increasingly smaller parts. In other cases they involve undecidability generated by the oscillation between two poles, as when one wants to assign a truth-value to self-referential statements of the type "the following proposition is true; the preceding proposition is false." However, these are statements that have language itself as their object, words that speak about words and not about an empirical content. Rather problematic is the situation of undecidability deriving from the attempt to make a subject-object distinction in the unitary structure of thought that reflects on itself, of the ego which first and foremost has itself as the object of conscious perception. The phenomenon of consciousness is, evidently, the enigmatic crossroads of every theory of knowledge, and the property that characterizes it, I mean self-reference (on which I will argue extensively in chapter IV), could actually reflect the organizing principle of physical reality in its various structural levels in which feedback mechanisms operate.

There are also paradoxes that present themselves as real contradictions in logic, since they correctly derive from premises whose coherence no one would doubt. The contradiction detected in 1902 by Bertrand Russell (1872-1970) within Set Theory is well known. With this contradiction, which properly goes by the name of "Russell's antinomy" (see my article in Italian language "Le ombre di Gödel tra mondo matematico e mondo fisico", section 4), the crisis of the foundations in logic began. Then, after thirty years, Gödel's Incompleteness Theorem (above article , sections 5 and 6) came to lay bare the problematic condition of the entire logical-mathematical construction, both because within it there are problems that do not is able to solve, and because it does not have an incontrovertible criterion for establishing mathematical truth. The incompleteness theorem, although defined as "paradoxical" by some philosophers, in fact limits itself to touching the paradox without however falling into it.

Finally, there are paradoxes in physics. Some of them emerge as a clear perceptible disagreement between the object of sensitive experience and the discourse concerning it, between a given aspect of reality and the representation we make of it. An example is given by the ambiguous notion of particle-wave which, in the study of the quantum microcosm, does not allow us to interpret the nature of quantum reality with adequate images or concepts. Other paradoxes arise from an inconsistency of physical theory when its fundamental hypotheses are nullified by their own predictions. For example, it will be remembered how the notion of singularity, predicted by general relativity within a black hole formed following gravitational collapse, strips of meaning the unitary concept of space-time that characterizes the theory itself.

2. *Negative and positive aspects of paradoxes in logic and physics*

Some paradoxes in logic are a source of great concern because they undermine the credibility of the tool designed to verify the quality of the answers to the profound questions posed by philosophy.

Some paradoxes in physics constitute natural barriers to areas that are absolutely inaccessible to sensitive experience and represent the problem that is frustrating the objectives of fundamental physics and cosmology aimed at understanding the properties of the elementary structures of matter, space-time and their mutual connection .

Paradoxes in logic and physics make their appearance after more or less long periods of tranquility, putting into crisis or disintegrating old resistant ideas which end up being called into question and replaced by others destined to form a different interpretative framework. The new ideas adopted to avoid the loss of a conclusion of the scientific discourse are, however, destined to reconfigure another paradox, and therefore discussed and sooner or later replaced, and so on, according to a process of progressive theoretical deepening that requires interpretation.

In recent times, the belief in a positive role of paradox has been gaining ground, evaluating it as a fruitful element of the scientific territory. Its presence undoubtedly constitutes a challenge to the intellect, a stimulus to creativity, and is therefore also the tool capable of preventing the stagnation of prejudices. This reconsideration of the paradox places science in the position of continually calling itself into question, preventing it from establishing itself as dogma, and also seems to justify the unchallenged dominion that it has in fact assumed over the humanistic disciplines in contemporary history.

The idea of progress based on the fecundity of paradox has the power to make people believe that the scientific apparatus is guided by a fundamentally reliable conceptual framework which would only require a series of increasingly subtle course adjustments, and which is aiming with increasing approximation in right direction of a complete knowledge of nature.

However, scientific knowledge of nature, understood as the rational understanding of the development of physical processes, is considered by almost all rationalists to be an absolutely unattainable metaphysical goal. The belief that science has to proceed in the direction of this goal is corroborated by the suggestion of the quantity of cognitive and technological advantages that are gradually multiplying along its path, and the rampant optimism that derives from it is sufficient to elect it as the exclusive ideological guide of man towards the best of all possible worlds. But who are the actors and behaviors of this enterprise called "scientific knowledge" and what are their authentic purposes? In Popper's vision scientific knowledge can be considered as subjectless. It can be considered as a system of theories on which we work as masons work on a cathedral. The aim is to find theories that, in the light of critical discussion, come as close as possible to the truth. Thus the aim is to increase the truth content of our theories.

This conception of science imposes itself and spreads until it merges into the techno-scientific model of the West, which tends to recognize itself in an open evolutionary logic based on the idea of irresistible progress. With its power of seduction, the technological-scientific apparatus has today become a phenomenon of such proportions as to irreversibly involve and intertwine fields of interest of all sorts, from pure research to economics, culture, politics and military science. The scientific world can therefore be classified as a vast self-sustaining system that is difficult to analyse, but above all exposed to the uncontrollability typical of highly complex systems. Furthermore, so many anomalies have accumulated today within science, both in the narrow field of basic research carried out by the community of specialists, and in the field of applied and technological research with all its inevitable consequences in the psychological and social sphere, that we have to question the neopositivist myth inspired by the ideas of continuous progress and an open scientific society.

The first of these two ideas in fact seems unpromising, because the evolution of the current research program is in a regressive phase, while the second corresponds rather to a closed image and perhaps more similar to that outlined in the post-Popperian period by the philosopher Thomas Samuel Kuhn (1922), according to which scientific society is characterized by relative stability (normal science phase); it is essentially rigid and governed by habit, and every now and then it is disturbed by a crisis (revolutionary rupture) which is considered somehow surmountable in order to then recover the usual harmony. Stability and harmony are ensured by members of the scientific

community through the general sharing of a paradigm that will guide theoretical choices and experimental practice and, only after anomalies have accumulated to the point of opening a crisis, will a phase of discussions begin aimed at searching for other ideas that could be candidates for forming a new paradigm. This evolutionary process of science, however, is not as simple as it may seem, because, as Kuhn observes,

> within the scientific society there are various psychological and sociological factors that play a significant role in orienting, in both phases, both the theoretical choices and the experimental practice […].

In its entirety, the world of science appears to be a rather obscure phenomenon, suspect of irrationality, so much so that its interpreters clash over ways of thinking and human behavior that are no less paradoxical than those encountered by specialists engaged in the study of phenomena. physicists. The problematic element debated by philosophers of science and theoretical physicists engaged in epistemological questions is precisely rationality, its meaning and the role it plays within the evolutionary process of knowledge, a process which, as has already been observed, does not involve only theories, equipment and physical phenomena, but also the culture and habits of societies, groups of people and individuals. “Scientific behavior, taken as a whole,” states Kuhn, “is the best example we have of rationality”. But he also wants to clarify his position towards the scientific enterprise by observing

> that if history [...] leads us to believe that the development of science depends essentially on behavior previously considered irrational, we should then conclude not that science is irrational, but that our notion of rationality needs rectification somewhere .

Therefore, if the aim of today's science is to provide rational descriptions of the physical world, it must be explained what is meant by this expression. "Rational" could be defined as a description judged to respond to common sense and therefore widely shared by physicists, or a description which, despite being in conflict with common sense, is so functional on a predictive level as to overshadow the very need for rationality. . So far, the history of science has only given us examples of physical descriptions that have gradually revealed themselves as not responding to the requirement of rationality, and the same two master theories of this century, general relativity and quantum mechanics, could not claim a state of good health in fact of rationality, since the weight of their limits, their paradoxical aspects and therefore the need to overcome them have been felt for decades.

Before the crisis of foundations in logic and mathematics opened, rationality was accepted as an absolute and immutable principle of nature, considered the source of all inspiration of scientific thought. When science then came to deal with the so-called "oddities" of the quantum universe, the idea of rationality began to darken, and soon the positivists managed to build a highly original scientific theory capable of ensuring the best fruits ever harvested. first by man, paying the price of a renunciation of rationality. However, positivists will always be right in stating that the only sources of knowledge are our observational acts (measurements), and the equations with which they interpret quantum mechanics will have unchallenged dominance until some physicist is able to exhibit a better formulation than the probabilistic one.

The supporters of realism and causalism, despite intellectual efforts that have continued for about eighty years, have never provided any convincing scientific argument and, much less, experimental proof capable of undermining the principles of QM. We will then have to recognize the fact that the images that derive from sensitive experience are not adequate to describe the actual image of physical reality. Nonetheless, one should not necessarily conclude that its correct image cannot be captured in the networks of logical thought.

But how can an image of the world be defined as correct? The realist would base his definition of "correctness" on the notions of causality, three-dimensional space and time, drawing inspiration once again from the immediate intuitions of sensitive experience, and would consider as rationally correct a description that conforms to the way in which reality works. nature. But such a definition is "a posteriori", as it is what science sets itself as the ultimate goal of its research, a goal which, however, is believed to be unattainable.

From what has been said, it seems to emerge that the way science proceeds is itself a paradoxical phenomenon, so much so that the suspicion of its undue domination has arisen. If on the one hand science requires as fundamental a vigilant attitude of permanent disobedience to the evidence of judgments, welcoming the emergence of paradoxes, on the other hand it accepts to submit to the excessive power of an obscure "design" of nature which would constantly keep it in check , debasing it, human reason.

In the scientific field, the firm adherence to the idea of a positive function of the paradox clashes with the idea that we must definitively live with it. The fact of having to accept it as a dialectically contrastable but irrepressible reality would condemn humanity to benevolently suffer eternal intellectual discomfort. Many theoretical physicists are in fact openly happy with this condition of permanent aspiration towards an elusive truth. However, this is a position of thought that can be criticized because it involves two incompatible beliefs: on the one hand, the presumed rationality of nature and, on the other, the inexhaustibility of the process of deepening scientific theory. I would like to point out here that Einstein held both of these beliefs. He, who had recently finished formalizing the theory of general relativity, already recognized its incompleteness and wrote

[…] I have no doubt that the day will come when even this last description will have to give way to another, for reasons that we don't even suspect at the moment. I am convinced that this process of deepening theory has no limits

Nonetheless, Einstein was of the opinion that the universe is governed by simple, universal and eternal laws from which all forms of existence, including life and consciousness, descend. The search for a theory of complete unification of physical laws represented an intellectual tension that literally held his life and thoughts under siege.

However, Einstein was also of the opinion that the possible formulation of such a theory would in no case involve understanding the elementary laws of cosmic reality. Therefore, he shared with Popper the scientific commitment and the permanent incompleteness of the theory, but he reserved doubts about the general belief that the systematic progress of science corresponds to a progressive and irresistible approach to the truth.

3. ***Observations***

The statement that the primary task of science consists in tending towards the ultimate understanding of nature rather than reaching it, should be investigated critically, precisely because of its paradoxical aspect. The existence of a principle that governs all levels of reality but which is not accessible to the human intellect cannot be defended. Such a way of thinking does not differ much from the Kantian conception of dialectics. Rationalists, faced with the unpredictability of quantum processes imposed by the uncertainty principle, end up placing themselves in an ambiguous position when they declare that they aspire to know what they assume to be unknowable, as it is beyond any possible experience. The commitment of scientists, Planck claims, is

like an incessant race towards a goal that can never be reached, and which in principle cannot be reached. In fact, the goal is of a metaphysical nature [...] But isn't saying that science is chasing a ghost plane equivalent to declaring that all science is meaningless? Not at all. Because it is precisely this continuous struggle that gives rise and matures in ever-

increasing quantities the precious fruits that provide us with palpable proof, indeed the only proof, that we are on the right path and that we are perpetually approaching the unattainable distant goal.

I seem to see in this interpretation of science the weak point that does not allow it to overcome the current phase of stagnation and, in rejecting it, I will make some observations to argue that it makes further theoretical study impossible. Science, rather than recognizing in the paradox the signal of some flaw in the framework of human rationality, reaches a compromise, interpreting it as a fundamental constructive ingredient of the theory of knowledge.

Such an attitude of science towards paradox seems to have, to a certain extent, a similar relevance to the attitude taken by Georg Hegel (1770-1831) towards contradiction, in which he had seen the fundamental mechanism that unites the concepts of reason and the substance of reality in the same self-structuring process. But there is a profound difference. Hegel had intuited the principle of metaphysical truth in contradiction through genuine philosophical research, while today's science does not seem at all projected into the search for such a principle. Hegel intended to follow a coherent and rigorous philosophical path aimed at building a vision of reality based on the dialectics of the opposing categories of being and nothingness. “Contradiction is defended by the accusation of being only something that blocks thought, and overturned by Hegel into something opposite: the principle of uninterrupted transformation”. On the contrary, science takes an irritating position, to say the least, in affirming the positive role of paradox and then in showing concern as soon as the first alarming paradoxes come to block its path.

In fact, science has never liked the kind of paradoxes capable of threatening the reliability of physical theories and mathematics. Rather, it found itself needing to take action to somehow exorcise their presence.

Given that any attempt to logically resolve paradoxes turns out to be dangerous because it leads to real contradictions, science limits itself to getting around them with very unsatisfactory expedients, rather than seeing in them the signal of the need to re-discuss the entire conceptual framework at the basis of consolidated languages.

To avoid misunderstandings, I would like to point out that I have no objection to the re-evaluation of the paradox in a positive light, also because the role of science would thus find itself in a position to be called into question from time to time. However, I would also like to point out that the questionable, and perhaps even dangerous, aspect of science emerges from its decision to make paradox the ingredient that would keep it safe from dogmatic temptation. But be careful! His position is already dogmatic in assuming and propagating the belief that his destiny is marked by an indissoluble bond with the paradox, and in the implicit philosophical disengagement in understanding its genesis. The dogmatic position rejected by science therefore reappears as a desire for power and as an effective renunciation of questioning the only thing that remains to be discussed: its language, and with it its very dominion.

Having become aware of the great obstacles present in the theory of knowledge, science is therefore not at all convincing in stating that the paradox only exists for the time needed to overcome it and in continuing to think of it as permanent and metamorphic.

The paradox is now paralyzing any possibility of significant development of scientific thought, and I am personally convinced that it has now exhausted its function and that, therefore, we should now count on the possibility of unmasking it.

Upon reflection, the pressing presence of paradoxes in physics and mathematics is interpreted as an irrational property of nature that establishes an absolute limit to knowability, rather than as an effect of natural selection with a very precise and potentially traceable motivation in the course of the development of logical-philosophical thinking.

Critical rationalism, in presenting itself as a search for rational descriptions of the world, ends up being not very different from positivism. The epistemological positions of the two schools of thought are in fact anti-scientific because they both support the ultimate unknowability of nature, and differ only on the question of where to trace the horizon of man's cognitive power. For

positivists the horizon of knowledge stops coinciding with the quantum uncertainty principle, while for rationalists it can move indefinitely beyond the gaze of current experience. Worse still, while the positivist tends to adopt an instrumentalist attitude by declaring himself rather disinterested in questions concerning the truth of a theory, the rationalist rejects such an attitude and introduces an element of irrationality in invoking Reason and in declaring at the same time that this it will never belong to him.

Rationalists are firmly convinced that there is a reality out there and that this can be traced back to a rational explanation, and yet their language finds itself paralyzed in the face of the absurdities deriving from the study of the quantum world. They do not accept the completeness of the theory concerning that world because in it a dynamic procedure is adopted, called “wave function collapse”, which contains an element of irrationality. But what do they propose in its place? They propose the belief that sooner or later it will be possible to reformulate the theory, freeing it from irrational assumptions and, at the same time, the belief that it will be followed by another formulation and then yet another and so on, because every formulation will always contain a paradox that will require to be eliminated to make way for another, according to a process of endless deepening. But then, isn't this hypothetical evolution of the theory, like the current quantum theory, founded on an element of irrationality constituted by the permanence of an element (the figure of the paradox) whose nature can never be understood?

How can we believe that science, seen from such a perspective, represents the exclusive guide towards the most reasonable of possible worlds? Kuhn's belief (certainly also shared by Popper) that the way science proceeds reflects the best example of rationality should be expressed in different terms, for example by simply stating that such a procedure is perhaps one of the least dangerous behaviors and, all all in all, also one of the most interesting from the point of view of solving problems of man's adaptation to the environment. However, if we want to make it a question of coherence, the way science proceeds is not only obscure in the absence of an objective norm of rationality, but it even turns out to be anti-scientific within all the ways of thinking compared so far.

If irrationality could not be eliminated in any way within the scientific enterprise, then the anarchism proposed by the Austrian philosopher Paul K. Feyerabend (1924-1994) would be preferable, which opposes the falsely reassuring method of official science

the only principle that can be defended in all circumstances and at all stages of human development. It's the "anything goes" principle..

Upon closer inspection, both the regulative principles of critical rationalism (taking into account the fallibility of theories, being open to change, being confident in the indefinite growth of knowledge, etc.) and those of positivism (founding theories on observations, counting on accuracy of measuring instruments, remember that there is an absolute limit to measurement, etc.), in addition to promoting a reductive image of science, they nullify the possibility of its purpose and, finally, favor controversial and mutually incompatible ideas such as progress, uncertainty and the approximation to the truth, and fuel passions such as the will to power and the gratification deriving from the comforts of research and personal recognition.

Everyone agrees on the belief that paradoxes prevent the stagnation of ideas. It is true that the philosophical-scientific vision of the world evolves. However, I would like to observe that the presence of paradoxes in logic and physics has only allowed thought to multiply its ideas and increase its imaginative capacity, and not necessarily to come close to knowing the world "as it is in itself". Furthermore, there are no sufficient reasons to exclude the possibility of understanding that the paradox has a historical origin and that this can be identified. In fact, the evolutionary process of human experiences may have been promoted, instead of by a metamorphic and unavoidable paradox, by an inevitable and unsuspected error within our thought pattern; an error so subtle, so invisible and virulent that it kept all of humanity in check for centuries.

One might think that in Western culture the complex philosophical-scientific apparatus has grown originating from an incoherent set of categories of thought and logical principles established by philosophical man, who obviously cannot make his appearance on earth with a pre-packaged baggage of intuitions , impeccable concepts and reasoning capable of illuminating his intriguing relationship with the world.

The exercise of this apparatus, understood as a self-regulating and self-sustaining process in terms of ideas-actions, would represent the natural history of the West and at the same time the history of man's alienation from the unitary understanding of cosmic reality.

The underlying inconsistency present in the conceptual framework prepared by man, awakening from time to time in the guise of a paradox, would have the power to provoke thought by setting ideas in motion, and inducing him to prepare a series of tools aimed at overcoming it. This process would ultimately result in a growing availability of practical advantages for humanity to the point of making it exercise undisputed dominion over the environment, as well as increasing its confidence in the validity of its way of thinking. However, it would not allow her to pursue, except in an illusory form, the purpose expressed by her original vocation: the understanding of cosmic reality.

In this plausible scenario of Western thought it seems credible that the persistence of paradoxes for so long possesses the greatness of a function with its own precise meaning: finding the path that leads to a complete understanding of the logic with which reality operates is possible, but before succeeding in this undertaking you have to endure for a long time not knowing in which direction you are going.

Contemporary science adopts the assumption of the rationality of nature as a regulatory criterion for its path, but finds itself clashing with quantum indeterminism which can be interpreted as an intrinsic property of nature or as a signal of incompleteness of the theory. The question of rationality therefore remains unresolved, and is continuing indefinitely in terms of an unproductive comparison: on the one hand the classical logic with two values, and on the other the quantum logic based on the principle of the non-excluded third, due to the incomprehensible notion of "superposition of states", which many physicists feel justified in adopting following the results of highly tested experiments, such as that of interference with the two slits (described in the first chapter).

Science, if it intends to resolve this conflict and if it does not want to limit itself to the pragmatic attitude of the positivists based only on utilitarian research, has no other choice than to reopen the dialogue with philosophy in the hope of being able to identify the original source of all paradoxes.

On the other hand, almost all great scientific revolutions have had their roots in profound philosophical considerations. Let us remember for example Einstein, who before formulating his theories did not worry so much about deepening his acquisitions in physics and mathematics but rather about reading philosophers such as Hume, Leibniz, Kant, Goethe, Mach. His underlying interest was to reflect on the meaning of the concepts of space, time and causality. Looking around with new eyes, he came to ask himself some fundamental questions and managed to revolutionize knowledge of the physical world by finding an explanation capable of unifying two physical concepts, mass and energy, until then considered independent. Furthermore, his studies on Brownian motion validated the atomic theory of matter, while his work regarding light quanta made it possible to understand the existence of a relationship between mechanical and electromagnetic phenomena. Therefore, thanks to the Special Theory of Relativity, Einstein managed to achieve a partial unification of mechanics and electrodynamics. Since then, the great scientist of the century began to dream of the project of a physical theory of complete unification.

It is clear, however, that scientists today engaged in the search for a unitary explanation of the physical laws that govern macrocosm and microcosm find themselves facing much more difficult philosophical problems, because they do not really know where to start, having lost those cardinal references that in physics and mathematics were considered certainties until Einstein's time. There will probably be ideas, questions and hypotheses that will be preserved, but others that will have to be rediscussed and probably rejected because they are recognized as erroneous.

I believe that it makes little sense to express a concept of approximation if the content of the related goal cannot be determined: in this case, the true vision of nature that no one possesses. The pragmatist states that a theoretical description is true when it agrees with reality, and anyone who used ordinary logic would affirm the same thing; however, the pragmatist would not mean the same thing that others would mean by using the words agreement and reality. The definition that the philosopher William James gives in agreement will be instructive: "..it can only mean being guided either directly to it (reality) or in its vicinity, or to be placed in such functional contact with it as to be able to manipulate it directly, or by be able to manipulate something connected to it better than if we disagreed." (Quote from Pragmatism: a new name for some old ways of thinking. Philosophy lectures given by William James, Longmans, Green & Co., 1907, page 212).