Quantum Mechanics and its epistemological implications

by Antonio Portaluri

On October 24th, 1927, the world's most important physicists met in Brussels for what is known as the fifth edition of the Solvay Conference.

The focus of the discussion was the new Quantum Mechanics, to which most of the people present at the meeting had contributed but about which they had contrasting opinions. On the one hand, Niels Bohr and Werner Heisenberg claimed they had provided the new science with a definite structure, not subject to further modifications, while on the other, eminent figures such as Erwin Schrodinger and Albert Einstein believed that the theories put forward by the so called Copenhagen School, of which Bohr and Heisenberg were the most important exponents, were incorrect or at least incomplete.

In particular, the divergence of opinions emerged with reference to the theoretical conclusions. In order to be confirmed, in fact, Quantum Mechanics demanded a radical revision of the classical concept of the "reality of the physical world" because, with the introduction of the indeterminacy principle, the existence of a "real substratum" - hidden behind what Heisenberg defined “*the world statistically perceived” -* was excluded:

*"A quantum world doesn't exist. There exists only an abstract description of Quantum Mechanics."* (Niels Bohr)

The problems about the phenomena observed in the subatomic microcosm began when it was experimentally proved that it was impossible to measure the position and speed of the electron around the nucleus of the atom due to the dual nature of wave/particle with which the electron appeared to the observer. Einstein, who admitted the existence of the problem, nonetheless refused to accept the theoretical conclusions reached by the exponents of the Copenhagen School.

*I still believe in a model of reality which represents the very things, not simply the possibility of their occurrence. (Albert Einstein)*

According to Einstein, the apparently paradoxical character of the phenomena observed inside the structure of the atom wasn't enough to justify the existence in nature of bodies that might defy the laws of classical physics. He disputed the indeterminacy principle on the ground that its formulation, subordinating the observed object to the observer, was at odds with the common sense view that our sensory impressions must be based on a reality existing as such, regardless of the observer.

As a matter of fact, the nature of quantum phenomena had forced the physicists to deal with theoretical issues that, until then, had seemed alien to the scientific debate, such as the principle of reality or the limits of man's knowledge. In order to solve this dispute, it seems appropriate to look back to the 17th century, when the early fathers of the scientific revolution asked themselves the same kind of questions; even more so because such questions have so far remained unanswered, in spite of a long period of time when the scientific enterprise has nourished the dream of unveiling all the mysteries of nature.

The modern era of philosophy opened with the Cartesian reflection on the limits and possibilities of human knowledge. Until then, the previous scientific tradition had pursued the Aristotelian quest to discover the essence of all that exists *out there* in the world. However, the problem of the subject, from which the questions originate, had never been posed. Yet, starting from the 17th century, owing to the development of new currents of thought in Europe such as rationalism and empiricism, the question of knowledge became a central issue in the philosophical debate.

From Descartes to Kant, the human faculty of reason had become an object of investigation with the aim of discovering its nature and revealing its secrets. In the attempt to illustrate our mental processes of knowledge formation, it was said, for instance, that there is, on the one hand, an inductive way to access the real world (that is starting from perception), as claimed by the English philosopher John Locke and, on the other hand, a deductive way (that is starting from the idea), as argued by Descartes.

Later on, Kant arrived at a reconciliation between the two conflicting positions by introducing the well-known *a* *priori synthetic judgement*. Kant asserted that our perception of reality is determined by preexisting innate categories which, by giving shape to the chaotic stream of sensory data, define “*a priori*” the possibilities of human knowledge.

This resulted in a dramatic metaphysical move as it marked the end of human ambition to get to know the world as it is, allowing only for the possibility to access the *phenomena,* in other words, reality as it appears through our cognitive structure. This change of perspective, known as the Copernican Revolution in philosophy, represented a shift from ontology to epistemology, from the attempt to know reality as such, to the study of the nature of human knowledge. However, Kant himself was not prepared to accept the consequences of his own revolution since, by postulating the existence of an intangible reality called *noumenon*, he preserved the classical subject/object distinction and therefore remained well inside the dualistic philosophical tradition.

Throughout his life Einstein remained loyal to this tradition as he refused to question his deterministic approach; he was convinced that, to agree with the theoretical conclusions of Quantum Mechanics, would imply giving up the certainties of the "classical" conception of physics. However, when in 1905 he published his "*Theory of General Relativity*", Kant’s theoretical edifice collapsed when it was proved that *time* was not an absolute entity flowing regardless of the physical world, but appeared to be deeply entangled with space, forming with it the so called “space/time” continuum. Therefore, on the basis of the Theory of Relativity, *time* could not be considered an "*a priori*" condition of human experience, but rather an “*a posteriori”* consequence, relative to the observer’s perspective and position in space, and dependent on the universal constant of the speed of light.

Later on, with the advent of the above-mentioned quantum phenomena – to which the categories of cause and substance are inapplicable - resorting to *Kantian Criticism* as the foundation of contemporary science appears to be inappropriate. Nevertheless, after more than two hundred years since its publication, most contemporary philosophers of science still consider the *Critique of Pure Reason* a theoretical justification for the scientific enterprise therefore rejecting any alternative theory as irrational or likely to lead to nihilism or solipsism.

Had he been present at the Conference of Solvay, professor Georg Wilhelm Friedrich Hegel would have probably agreed with Niels Bohr’s interpretation. In his *Einleitung* - the introduction to his work "*The Phenomenology of Spirit*" - he argued that the idea of a "real world" existing *per sé,* regardless of the observer, is flawed with regard to the prejudice that "the real thing" is considered to be external to the subject. According to Hegel, the separation of the thinking subject from the real world (the *Being* in metaphysical terms) was a common trait of all the previous philosophical tradition. The German philosopher, on the contrary, claimed that both the subject, that he called the *Subjective Spirit*, and the object, the *Objective Spirit*, are part of the same dialectical process that results in a synthesis where the initial opposition is finally resolved.

In the light of the above considerations, Hegel's complex philosophical system appears to be straight forward in its essence. It seems incredible, if we think about it, that most of the problems of the previous philosophical tradition originated from the belief that the phenomena we experience come from an external world, while the observer is supposed to be outside this reality. As a consequence, once this dualist view set in, the "*Spirit*", that Hegel called "*Geist*", was not considered to be part of nature, but a different substance that we call “mind". Such prejudice is so deeply rooted in the scientific tradition, that it is now taken for granted that the modes of investigation of natural sciences are not applicable when we try to explore the properties and faculties of the mind. It also explains why the current epistemological orthodoxy is reluctant to consider psychology a scientific discipline.

Those who theorized about the principles of Quantum Mechanics rejected this form of dualism in favour of a vision which considered the subject and the object as parts of the same reality. At the beginning of the 1930s, the destinies of two great thinkers crossed: they were W. Pauli, one of the founding fathers of Quantum Mechanics, and C. G. Jung. At first sight, this seems to be simply a coincidence, but in the light of the well-known principle of synchronicity, we prefer to think that these two great minds met because the *spirit of the time* was announcing that a new form of truth was emerging. When an era declines and gives way to a new horizon for human experience, any attempt to understand the new world according to the criteria of the old paradigm is doomed to failure (Kuhn). Therefore, new expressions were introduced in the scientific vocabulary such as "*theory of relativity*", "*indeterminacy principle*, "*chaos theory*", "*probability fields*”, "*incompleteness theorem* ", in order to fit the new scientific discoveries.

The world where Pauli and Jung came from was divided into two separate and distinct realms: the matter, governed by the absolute space-time, and the world of psyche, confined inside the subject. Even though they started their research from different perspectives, the two scientists met in a new dimension where the borders of the two realms disappeared allowing for a new conception which, beyond any form of dualism, aimed at finding the unity of “all there is”.