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A Process of Negation and Foundation of Classical Physics

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Abstract: Classical physics was founded on an anti-Aristotelian expression and created the philosophical, theoretical, methodological and practical edifice to be able to adequately interpret all phenomena. But the omissions and weaknesses in interpreting the functioning of the microworld (atomic and subatomic fields) paved the way for a new scientific view of reality, that of quantum mechanics. Thus, classical physics limited itself to the interpretation of the macroworld.

Key words: classical physics, quantum mechanics, macroworld, microworld

1. Introduction

A point of reference in the creation of a new stigma is the opposition or ideological and theoretical overcoming of the previous one. The increase in content in physics after the 16th (1543, year of publication of Copernicus' De Revolutionibus) (Luminet, 2010) and 17th century (1687, year of publication of Newton's Philosophiae Naturalis Principia Mathematica) was seen by most natural scientists as a reversal of Aristotle's natural perception and interpretation of the world (Haden, 1959). For more than 2000 years, the Aristotelian view has prevailed in science, and it is believed that there are two sets of laws: One for the terrestrial sphere (earth) and the other for the celestial sphere (Lomas & Case, 2023), as, for example, for the sun and the other planets. It was Newton who demolished Aristotelian notions of physics by formulating the universal law of gravity that dominates both spheres. In fact, most of the laws of physics are universal and must be immutable (Davies, 2013).

The Newtonian worldview was mechanical in nature and led to the philosophy of determinism popularized by the French philosopher Rene Descartes. Newtonian-Cartesian concepts created the mind-body dichotomy as well as the dichotomy between subject and object, values and facts, emotion and thought, poetry and prose, and science and non-science. The methods of Newton and Descartes have made an enormous contribution to the development of science and technology and the consequent economic prosperity. Newton's mechanistic model and Descartes' reductionist approach had influenced the Western mind so much that the model also extended to the social sciences and human behavior (Louth, 2011).

2. Classical Physics

The principles and laws of natural phenomena have been studied since the beginning of historical times by both philosophers and scientists. The dominant worldview, before the twentieth century, was based on classical physics. This led to determinism and, more specifically, to a doctrine rooted in the philosophical thought of Rene

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Descartes of France (Koperski, 2019). According to Descartes, the universe was thought of as a giant clock machine that moves toward eternity, or in simpler terms, moves inexorably forward. According to her interpretation, the future is predetermined and fully predictable. All physical phenomena are accurately described by physical laws and, in principle, can be predicted from the past to the future, within the framework of classical physics, accurately.

The methodological and theoretical element of the new physics, which we call Classical Physics, was founded by Newton, Euler, Lagrange, Maxwell, Descartes, Kant et al (Kvasz, 2012). Apart from observation and experiment, the philosophical part of scientific expression was based on principles and axioms.

As Feyerabend states, “Kant’s codification of Newtonian science, the attempt by logical empiricists to ‘reconstruct’ or ‘explain’ science by translating it into uniform language, and the idea of a uniform scientific method centered on natural augmentation even further the impression of compactness” (Feyerabend, 2017).

So we ended up having a series of laws in physics based on Kant’s Causality Principle (Hutton, 2021). This principle can be summed up in two main proposals:

1st sentence: Everything that happens presupposes something from which it is produced according to a certain rule. This rule can be one or more laws.

2nd proposal: In the same system we have exactly the same results when the same causes act on it (Salmanlis, 1994).

According to Kant’s principle, when we know the state of a system at a definite moment we can determine its state at any prior or future moment, using the laws available to us (Hutton, 2021).

Newton’s law predicted eclipses of the Sun and Moon, and discovered new planets (Chalub, 2009), such as Neptune and Pluto.

The concept of reality in classical mechanics is based on Descartes’ ideas which are:

a) All material bodies occupy a perfectly defined space.

b) Two material bodies cannot simultaneously be in exactly the same place (Salmanlis, 1994).

But the axioms, which are basic propositions whose truth is indirectly proved, came to complete the edifice with which Newtonian physics was “expressed”.

Such are:

i) Space is Euclidean, homogeneous and isotropic.

ii) Time keeps the speed of its flow constant.

iii) The mass of a body is size unchanged.

iv) The energy of an isolated system is kept constant.

As Alexandre Koyré states, “the characteristics of the new science were the destruction of the old picture of the world and the geometry of space (Salomon, 2023) and in addition, the universe consists of a single infinite and uniform space called ‘Euclidean space’ whose properties can be described mathematically on the basis of Euclidean geometry” (Kanakis, 1999).

With all the above proposals, laws were discovered and theorems and theories were invented, such as Newton’s law, the theorem of conservation of momentum and energy, electromagnetic theory, etc.

As Feyerabend states, “scientific facts consist of skirmishes and compromises” (Feyerabend, 2017).

The deterministic — mechanistic perception that prevailed “saw” that all problems that might arise could be solved. And for what he could not, he expected that by discovering and building the right tools he could solve them.

So we ended up having:

• The area of operation of classical mechanics is the macroworld.

• Classical physics describes a particle (atom, particle) and a wave (light, electricity).

• Classical physics uses the language of calculus to describe the movement of objects.

• It is deterministic, that is, if we know the position and speed of the object at a given moment we can predict its future motion accurately.

• It is based on the idea of realism which means that objects have specific properties, such as position, velocity, that exist regardless of whether they are observed or not.

• Deterministic theory means that given the initial conditions of a system, future evolution can be predicted with absolute precision.

• It is a theory that means it is based on the concept of continuous quantities, such as position and velocity.

Towards the end of the 19th century, the idea was established that with Maxwell's equations we would be able to study universal radiation and material bodies would be interpreted according to the principles of Newtonian physics (Sebens, 2015).

Finally, the desire to abolish "authority" (Forman, 1971) found in Newtonian physics a mechanistic deterministic interpretation and domination of nature, i.e., a new "authority".

3. The Physics of the 20th Century

Physicists and philosophers experienced a very big surprise when their worldview was overturned by a physical theory called quantum mechanics. This event occurred in the first decades of the 20th century. In terms of classical physics, it is worth pointing out that while it can explain a wide range of macroscopic phenomena, such as the motion of billiard spheres as well as space rockets, it fails spectacularly when applied to microscopic phenomena. For example, we refer to the interpretation of phenomena such as proton-atom scattering or electron flow in a semiconductor. The world as it appears or as we perceive it through our senses is not what it really seems. Behind the apparent solidity of everyday objects lies a dark world of possibilities and uncertainty. This world, as we shall see, defies simple description since its foundations are very different from our everyday experience.

But nature has many elements to present and as science develops, new challenges will seek their solution. At the end of the 19th century, questions arose mainly in the microworld that classical physics could not solve and physicists claimed that with the progress of "tools" they could solve them. At the same time came the development of quantum theory (Plank, Einstein) and elementary quantum theory (Bohr, Sommerfeld), and some expectation appeared at the beginning (Passon, 2022).

Regarding the development of quantum physics there are 3 stages: the first stage is the introduction of the quantum hypothesis by Planck, which is known as quantization of energy ($E = h\nu$). The second stage is Bohr's earlier quantum theory, which played an important role as a bridge between Planck's quantum hypothesis and modern quantum mechanics. The third stage is the quantum theory of Heisenberg and Schrödinger. Neils Bohr introduced the idea of quantizing the angular momentum of electrons in their orbits around the nucleus based on Planck's quantization hypothesis. Bohr's quantum theory served its limited purpose in atomic spectroscopy. He failed to explain even the spectra of the hydrogen atom successfully. Sommerfeld managed to improve Bohr's atomic model. In addition, Bohr-Sommerfeld quantum theory was able to explain many things about atomic spectra (Eckerta, 2014). Among them is the fine structure of the hydrogen atom. However, the actual explanation of atomic spectra had to wait for full quantum theory.

At the same time, issues that required their resolution were:

- Radiance of the black-body;
- The photoelectric effect;
- The Compton effect.

The problems remained unsolved in their entirety and the phenomena at the individual and subatomic levels were incomprehensible.

Quantum mechanics, by the 1930s, had been accepted as the ultimate theory of matter and radiation in the microworld. Since then, he has penetrated many aspects of 20th-century physics and other disciplines, including quantum chemistry, quantum electronics, quantum optics, and quantum information science. Based on Bohr's Correspondence Principle, much of classical mechanics has been re-evaluated as the "classical limit" of quantum mechanics.

At the beginning of the 20th century, the "special theory of relativity", the "general theory of relativity" (Einstein), quantum theory, wave function and uncertainty theory (Heisenberg, Bohr, Jordan, de Brogle, Schrödinger) (Peres, 2002) succeeded in shattering the deterministic-mechanistic character of classical physics with the following theories:

- The two descriptions such as a particle and a wave are confused. A photon, an electron, an atom and another molecule are both waves and particles.
- The wave-particle duality describes the behavior of particles.
- Quantum mechanics is probabilistic (Weizsäcker, 1973), meaning that we can only predict the probability of an event occurring, not the exact outcomes. The probabilistic nature of quantum mechanics is not a temporary feature that will eventually be replaced by a deterministic theory, but instead must be seen as a final repudiation of the classical idea of "causality" (Boardman, 2013).
- Quantum mechanics is based on the idea of uncertainty which means that the properties of particles are not defined until they are measured (Busch, 2010). This means that, according to quantum mechanics, the act of observation can influence the outcome of an experiment.
- Quantum mechanics is a quantum theory based on the concept of discrete quantities, such as energy quanta. This means that the smallest unit of a physical quantity, such as energy or angular momentum, is not a continuous value but a discrete value.
- The relativity of time, the proof that space can be distorted and cease to be Euclidean.

The predictions of quantum mechanics have been verified experimentally with an extremely high degree of accuracy. According to the principle of correspondence between classical and quantum mechanics, all objects obey the laws of quantum mechanics, and classical mechanics is just an approach for large object systems. The laws of classical mechanics arise from the laws of quantum mechanics as a statistical average at the limit of large systems or large quantum numbers. Classical mechanics accurately describes most systems that can be easily observed. Objects that have a "normal" size (larger than a molecule and smaller than a planet), at a "normal" temperature (anywhere near room temperature), going at normal speed (0 m/s — anything significantly less than the speed of light) match the models defined in classical physics. Only when the observed system begins to violate these parameters do quantum factors come into play. An important aspect of quantum mechanical models is the fact that as conditions approach the "normal", the quantum mechanical model approaches the classical model.

4. Conclusions

The theorems and axioms on which Newtonian classical physics was based do not apply to quantum mechanics, which perfectly interprets the microworld and proves that, deterministic, mechanistic interpretation of nature and phenomena solves some issues and those of the macroworld.

Quantum mechanics opened an abyss between space-time and matter and closed the traditional abyss between observer and reality. Thus, the “destruction” of the image of classical physics reopens the question of the place of the individual-observer in the universe and the ancient Greek thought for a holistic approach to tomorrow returns.

Fortunately, quantum theory has rejected the worldview based on the Newtonian-Cartesian system and a “holistic” approach may emerge in the future to have a paradigm shift in the world. Ideas of unification in science and society will replace the individualist/reductionist worldview that fragmented the human race. Quantum theories support the cosmic spirit that permeates the universe and the relationships between individuals in global society (Pervushin & Pavlov, 2014).

It is worth emphasizing at this point that, perhaps in the future we will be able to perceive a more substantial connection between quantum mechanics and classical physics or even perhaps a generalized theory that will unify quantum mechanics and classical physics. Finding a correspondence between quantum mechanics and classical physics could therefore be a good topic for young scientists to ponder.

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