Understanding Philosophy of Science

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I. INTRODUCTION

Science holds a unique position in society, enjoying high prestige compared to other institutions. People trust scientists and view science as an objective and rational inquiry. Courts rely on expert witnesses who are scientists, and medicine often claims to be evidence-based. Science's influence extends to various aspects of modern life, from justice to health and safety, engineering, and more. Even if individuals lack in-depth scientific knowledge, their lives are greatly affected by it. This underscores the importance of understanding and thinking about science. Given the vast specialization within sciences, cooperation among individuals is essential for its development and application.

The philosophy of science is a field of that explores fundamental aspects of science without delving into the ethics, policy, or detailed history of scientific disciplines. It is not concerned with ethical questions related to scientific research or the practical considerations of funding and societal implications of science. It seeks to define what science is and address the demarcation problem, determining what qualifies as scientific and what does not. It often centers on the study of scientific methods, known as methodology of science.

Epistemology, a branch of philosophy, delves into questions related to knowledge and justification. Knowledge is typically seen as justified true belief, where belief in a proposition must be true and justified. Justification is often associated with following scientific methods to assess beliefs.

The philosophy of science intersects with epistemology, addressing questions like the nature of the scientific method, the role of evidence in supporting theories, and whether scientific theory change is rational. Additionally, it explores the scope of scientific knowledge, which extends from the present to the distant past, revealing insights about the world, from astrophysics to biochemistry.

Scientific theories not only describe observable phenomena but also explain why they occur. This involves attributing unobservable causes to observable effects, such as Newton's explanation of gravity. Laws of nature are central to scientific understanding, but their nature, causation, and the meaning of scientific explanation pose philosophical questions.

The studied book focuses on a central question: should we believe in the existence of unobservable entities posited by scientific theories, like electrons? This question underpins the debate between scientific realism (which asserts belief in such entities) and scientific antirealism (which confines belief to observable aspects). Addressing this issue requires addressing epistemological and metaphysical inquiries, including the nature of observability and the essence of scientific realism.

II. A (NOT-SO) FRIENDLY DISCUSSION

As a mental exercise, we could imagine two persons discussing about the validity of the scientific method. One is a hard believer of science, while the other is an absolute skeptic. Lets address the basic: None of them is a scientist, neither a theologian.

The believer (Alice) tells the skeptic (Bob) about the marvelous phenomena of the world around us: How everything is made of atoms and things are mostly empty space, how time and space began with a big explosion, etc. However, Bob replies with the distinguished sentence: How can you believe all of this bull****. He argues how all of this believing can be made up by people that easily could be lying; and how he regards the believers of science as people following a new modern religion, where no one can question its sayings.

Here I would like to address both positions. From the perspective of Alice, she understands that science is not made up. There are schemes to follow to proceed with investigation, which will lead us to, desirably, unbiased observations about natural phenomena, and furthermore, predictions. This is what we call **scientific method**. On the other hand, Bob is skeptic for a reason, and there are certain episodes that partly confirm this assumption. We can recall the many episodes of "bad science" performed by some uncritical scientist, to whom we can attribute some of the mistrust in science. However, the fact that we could distinguish "good science" and "bad science" is part of the scientific method advocated by Alice. **Bad science can be detected by the implementation of the scientific method itself**. The discussion between Alice and Bob ends when neither of them can further argue about its positions due to lack of knowledge.

If we think about the history of science, we can argue how much its different branches has specialize. There no longer exist polymaths that work on theory and experiments at the same time such as Thompson or Rutherford. As the foundations of science are rock solid, making new science means to tackle a small problem in the frontier of knowledge. This highly specialized restrictions makes science a **highly elitist task**. The knowledge required, the tools, and even the language is widely inaccessible to the vast majority of people; we can recall that the number of physicist around the world is less than a million.

A necessary task for a scientist is to communicate, to land their knowledge in a more mundane language, in order to reach more people. The work of a scientist is futile if it is not for the betterment of people's lives. So let's not allow

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more people like bob to exist.

III. A BIT OF HISTORY

During the late sixteenth and seventeenth centuries, significant developments occurred in various scientific fields, in what is is called *the scientific revolution*. This movement had profound consequences to the world and boosted the development of areas such as astronomy, physics, and physiology. Notably, the study of mechanics, which involves the motion of matter under the influence of gravity, was revolutionized.

It started by the studies of Galileo Galilei, and ended with the publications of Isaac Newton groundbreaking contributions to physics, enabling accurate predictions of physical systems' behavior. The Scientific Revolution also saw the development of powerful new technologies like the telescope and microscope. A major aspect of this intellectual transformation was the rejection of Aristotle's philosophy, which had dominated Western thinking for centuries.

The Copernican Revolution, which asserted that the Earth revolved around the Sun (heliocentrism) rather than having the Earth at the center (geocentrism), played a significant role in this shift. Copernicus' work simplified astronomical calculations, and Johannes Kepler's contribution with elliptical orbits further refined these ideas. Isaac Newton later incorporated gravitational forces into this model.

The birth of these models also brings the search for a way to prove these models correct. The debate about what such a procedure might consist of, which happened during the scientific revolution, was the beginning of the modern debate about scientific method. This method is a direct contrast to the *scholastism*, doctrine which imposes dogmatically the workings of the world, based on the ideas of Aristotle of the motions of bodies. In this way, the Earth and the heavens were completely different in their nature. The Earth and all things on and above it, up as far as the Moon, were held to be subject to change and decay and were imperfect; everything here was composed of a combination of the elements of earth, air, fire and water, and all natural motion on the Earth was fundamentally in a straight line, either straight up for fire and air, or straight down for water and earth. The heavens, on the other hand, were thought to be perfect and changeless; all the objects that filled them were supposed to be made up of a quite different substance, the fifth essence (or quintessence), and all motion was circular and continued forever.

The text also touches on the philosophical implications of the Scientific Revolution: When Copernicus writes about the heliocentric model, the introduction to the book was written by his friend Osiander. He declared that the motion of the Earth was a convenient assumption made by Copernicus but which need only be regarded as a mathematical fiction, rather than being taken literally as asserting that the Earth really was in orbit around the Sun. This is an early example of the philosophical thesis of instrumentalism, according to which scientific theories need not be believed to be true, but rather should be thought of as useful or convenient fictions. On the other hand, to be a realist about Copernicus' theory is to think that it should be taken literally and to believe that the Earth really does orbit the Sun. **Realists, unlike instrumentalists, think that scientific theories can answer metaphysical questions**.

The Catholic Church's response to heliocentrism is mentioned, highlighting the conflict between the new scientific ideas and established religious doctrine. Heliocentrism not only conflicted with the Aristotelian picture of the universe and rendered its explanations of motion inapplicable, it also conflicted with the traditional understanding of the Book of Genesis and the Fall of Adam and Eve, the relationship between the Earth and the Devil on the one hand and the Heavens and God on the other, and so on.

The consequence of this was that if one were to adopt the Copernican theory, a great deal of what one took for granted was thrown into doubt.

IV. THE PROBLEM OF INDUCTION

The text discusses the problem of induction as presented by David Hume. Induction is the process of making generalizations based on past experiences. The text explores two key questions: (1) whether induction accurately describes how science is practiced and (2) whether induction can provide a rational basis for justifying beliefs.

Hume distinguishes between two types of propositions: relations of ideas (which are logically necessary, like mathematical truths) and matters of fact (which are based on experience and are not logically necessary). He argues that our knowledge of matters of fact is derived from our sensory experiences and that there is no a priori knowledge of such facts.

Hume's view of causation is central to his argument. He contends that our belief in cause and effect is based on constant conjunction - the observation that certain events are consistently associated with others. However, he argues that there is no inherent necessary connection between cause and effect, and we have no rational basis for assuming that future events will always resemble past events.

Hume concludes that our inductive reasoning is circular and lacks a rational foundation. He suggests that our beliefs in the uniformity of nature and cause and effect are driven by human passions and habits, rather than by reason. Consequently, Hume's skepticism challenges the rationality of scientific knowledge and suggests that it lacks a solid basis.

In summary, the text discusses Hume's problem of induction, which questions the validity of using past experiences to make predictions about the future and highlights the lack of a rational foundation for such practices.

V. INDUCTIVISM AND HISTORY

The text discusses the problem of induction in the context of inductivism as a theory of scientific methodology. It highlights that resolving the problem of induction is essential to justify inductive reasoning, not just in science but in everyday knowledge as well. The text then raises the question of whether the account of scientific method proposed is a plausible reconstruction of the actual history of science.

The author suggests that if the practice of science diverges significantly from the inductivist model, especially in the development of the best scientific theories, it may indicate that the inductivist account is flawed. There's a circularity in this dilemma because philosophers of science generally have a commitment to the rationality and justification of scientific knowledge. They aim to understand the source of justification for scientific theories.

The text emphasizes that the philosophy of science should consider historical evidence and not solely rely on scientists' statements about their work. It uses the example of Newton's laws of motion and gravitation to illustrate that even famous scientific theories may not align perfectly with the inductivist model. Newton's laws included theoretical concepts like mass and force, which were not directly inferred from observational data, and his laws seemed inconsistent with Kepler's laws.

The text concludes by noting that creative thinking and motivations other than pure data-driven inference have played a significant role in scientific discoveries, challenging the idea that all scientific theories are derived solely from observational evidence. This indicates that philosophy of science needs to reach a "reflective equilibrium" between prephilosophical beliefs and the results of philosophical inquiry, ensuring that the best science is not dismissed as bad science due to theoretical discrepancies.

VI. FALSACIONISM

Falsificationism asserts that for a theory to be considered scientific, it must be formulated in a way that allows it to be potentially proven false through empirical testing or observation. Unlike verificationism, which suggests confirming evidence as the criterion for scientific validity, falsificationism focuses on the ability of a theory to withstand attempts at falsification. According to Popper, a scientific theory gains strength not by accumulating supporting evidence but by surviving rigorous attempts to disprove it. This emphasis on falsifiability distinguishes genuine scientific theories from those that lack empirical vulnerability, contributing to a more rigorous and objective scientific method.

VII. POPER'S CRITIQUE OF MARXISM AND PSYCHOANALYSIS

The passage delves into the profound influence of Karl Popper on the philosophy of science during the twentieth century, particularly highlighting his notable concept of falsificationism. Popper's ideas not only left a lasting impact on philosophical discourse but also found resonance among scientists, leading to his esteemed membership in the Royal Society of London, a renowned scientific association.

At the core of Popper's philosophy is falsificationism, a concept he developed in his pursuit of demarcating genuine science from pseudo-science. Falsificationism posits that a theory is considered scientific if it is falsifiable, meaning it can be subjected to empirical testing and potentially proven false through observation or experimentation. This criterion sets the stage for a rigorous scientific method, where theories must withstand the crucible of falsifiability to be considered valid.

The passage underscores Popper's critical examination of prominent intellectual movements, particularly Marxism and psychoanalysis. Despite initial attraction to these theories, Popper grew disillusioned and labeled them as pseudoscientific. He sought to elucidate the reasons behind his classification, pointing out the theories' lack of precision in predictions and susceptibility to confirmation bias.

A significant aspect of Popper's philosophy emerges in his critique of theories with broad explanatory power. He contends that theories like Marxism and psychoanalysis, due to their generality, can easily accumulate positive instances, creating an illusion of support. Popper raises concerns about the absence of precise predictions in these theories, noting that their broad claims make them impervious to empirical refutation.

The passage also alludes to the broader context of the demarcation debate within the social sciences, particularly during the Enlightenment era. It was a time marked by optimism about applying scientific methods to understand human behavior and societal dynamics.

In essence, the passage paints a comprehensive picture of Karl Popper's contributions to the philosophy of science, his critique of pseudo-scientific theories, and his advocacy for the centrality of falsification over confirmation in the scientific method.