Describe how scientific knowledge grows according to the two doctrines inductivism and falsificationism. What unites and differentiates the two perspectives? Describe the terms "falsification" and "anomaly" and discuss the differences in viewpoint of science that these terms describe. Give example from the literature and from your own discipline.

If we ask a layman about how science works, they will likely contribute it to observations or experiments that implies a truth about our environment. This is the foundational theory behind inductivism: collecting observable facts from which we can induce scientific knowledge. There have been several strong arguments that demonstrates weaknesses in inductivism and among them is that no matter the amount of finite observable examples we collect, there is logically no objectively true conclusion about the infinite amount (Chalmers, 2013. p, 41-42). Perhaps on an attempt to correct inductivism and its inherent fallacies Karl Popper introduced the concept of falsificationism. Falsificationism proposes the idea that how the theory is introduced is not of importance, but rather that we should aspire to find counter examples that falsifies the proposed theories (Chalmers, 2013. p, 55-56). This doctrine has similarly been subjected to criticism. In many cases observations are theory dependent, e.g. a microscope's function is based upon previous knowledge and theory in various subjects such as optics. It is then impossible to say if an observation falsifies a specific theory or that the theory, with which the observation was collected, is falsified (Chalmers, 2013. p, 81).

We can view falsificationism as if built upon the errors of inductivism. The realization that we cannot prove a theory true, but that we are able to prove that a theory is wrong is the basis for falsificationism. This is theoretically true although as aforementioned difficulties occur when observations are theory bounded. All that is required for a falsification is a single true counter example which contradicts the theory (Chalmers, 2013. p, 57). There are many ways to unite these two doctrines in my opinion and they are not mutually exclusive. Popper does not limit researchers as to where ideas should come from, but rather that when a theory has been stated the aim is to falsify the theory. The ideas may therefore come from observations and in fact falsificationism does not suggest a method for constructing new theories. One can see ways to combine the two approaches to science and perhaps it could be argued that a combination more closely resembles how science is done in practice. The inductivist mindset is a data collecting of sort, by finding more data we can derive more accurate theories. In practice this may also work quite well which can be seen in fields such as machine learning and the success that is has endured, employing an inductivist mindset. The falsification mindset on the other hand generates a type of survival of the fittest of scientific theories and knowledge (Chalmers, 2013. p, 56). The fundamental viewpoint of how science should be progressed is essentially what differentiates the two in my view, inductivism on collecting data and falsification by trying to disprove theories. This creates two very different mentalities in the practical application of attaining scientific knowledge.

New scientific theories often have errors in its original form before being developed and refined and ignoring this fact and relying only upon falsificationism these theories would then be prematurely abandoned (Chalmers, 2013. p, 83-84). Perhaps it seems unnecessarily harsh and naive to falsify an entire theory based upon a single counterexample. Researchers often perform experiments that contradict established knowledge and therefore could falsify a theory, but the most likely cause is errors in the experiment rather than in the theory. Instead of seeing this in the view of falsification Thomas Kuhn described a view that there will always be results that contradict with theory which could occur due to mistakes by researchers or inaccurate instruments. These results should according to Kuhn be considered anomalies to established theory rather than falsifications. Only when anomalies become too many or too disruptive, will we conclude that the theory is broken, and something new is needed to describe the anomalies (Chalmers, 2013. p, 102-104). Kuhn also describes a different perspective in the view of science, that problems are solved within a framework, which he terms a paradigm (Chalmers, 2013. p, 111). A classic example would be the heliocentric compared to the geocentric view. The idea is that there exist underlying theories which are unquestioned that we build upon to grow the science of today, which he terms normal science (Chalmers, 2013. p, 101). Falsificationism and inductivism both include some perhaps simplified aspects of how science progresses as we have reflected on in this text. The ideas of paradigms, normal science and science as going through paradigm shifts offer a better explanation of the complexities of scientific progress (Chalmers, 2013. p, 97.) Falsification as well as inductivism still offer much practical value since I would argue that many fields apply this sort of mindset. Mathematics is for example an area where it is possible to argue that it follows the fundamentals of falsification quite well and theorems are falsifiable and stated precisely. Mathematics also follows paradigm shifts, however its progression is more simplistically viewed through the lens of falsificationism. Both inductivism and falsificationism are widely used and the ideas benefit the society immensely, nonetheless, the philosophy for understanding science that Kuhn has described has changed the world's conception of science to become more nuanced and complex.

References

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Mention some differences in today’s disciplines (mathematics, physics, biology, etc.) in terms of causality explanation and knowledge ideal. Relate these differences to the historical development of natural philosophy/science. Show examples from the course literature and/or your own discipline. Explain for Kuhn’s argument of why scientific revolutions tends to be invisible in the historical description and why this is necessary.

Throughout history the view of what science is has gone through major changes. Starting in Ancient Greece the quest for knowledge was divided into natural philosophy and practical knowledge where the former was the ideal and the latter was looked down upon. They strived for intelligibility and understanding their world but the pursuit for practical knowledge was entirely separated and mostly ignored. Believed to be impacted by their slave societies they viewed practical knowledge as inferior to the quest of understanding nature for the sake of intelligibility. As time progressed this viewpoint of natural philosophy developed as philosophers such as Bacon argued that it should encompass knowledge that mankind can utilize. Newton’s work also made the distinction between practical knowledge and understanding of nature trickier as his work arguably satisfied both. Today a blend of instrumentality and intelligibility are encompassed in the single word ‘science’ as in many cases there is no distinction between the two which Newton arguably showcased already during his time. (Dear, 2006. p, 8-14)

The concept of causation during the Ancient Greece as brought forth by Aristotle was explained by teleology which states that each process exists as means towards an end: the acorn exists to become an oak. However, in the same era during which the distinction of intelligibility and instrumentalism was questioned there was also an alternate viewpoint of causality explanation that was emphasized. (Dear, 2006. p, 8-14) It was the metaphor of the world working as a machine where everything had a mechanical causation. They did no longer view the formation of an acorn as being in the process to the goal of becoming an oak, but it is rather working as a clock and knowing the configurations we can predict what will happen next. (Dear, 2006. p, 15-17)

In my own discipline of mathematics this view of everything working because of mechanical causation is a tempting description and it fits well with the methods of explanations from mathematics and physics. To me the idea of having the world working as a clock touches upon the mathematical concept of randomness. If everything worked as a machine, nothing around us would be random. In statistics the results from tossing a dice is considered random, but if we knew the precise weight of the dice, combined with air resistance and the exact force with which the dice was tossed then it would likely be possible to generate a mathematical model to predict the result of the toss. The argument is then that what is random is really only an abstraction to that which is too difficult to predict. In this way I believe one can argue for the world working as a machine with complexities that limit us unable to compute future events, while Aristotle’s teleology seems to be an unsatisfactory explanation.

Comparing these causation explanations to scientific disciplines we can perhaps see some connections, where mathematics and physics follows the metaphor of a machine in the way that is possible and suggested to predict future events based from a set of initial conditions (Rose, 1997. p, 7-9). In contrast to biology which can be argued to see the world, perhaps unsurprisingly, as growing, living organisms that develops towards a goal of reproduction and survival which tends to a more teleological viewpoint than as a mechanical one (Dear, 2006. p, 15-17). The view on science has undergone what Kuhn terms, revolutions, and has evolved from the separatist view of Aristotle to the current intertwined science where research for knowledge and utility is almost interchangeable. The concept of terms being redefined, or their meanings reformed is a sign of theories going through revolutions and paradigm shifts (Kuhn, 1996. 136-143). For example, Einstein redefined the meaning of the word space and time without explicitly changing its definition. The difficulty is that only the latest and most established view is described in textbooks to students. This means that the changes the science has undergone and all the revolutions which have occurred before a concept reached its current form and meaning are invisible to the upcoming researcher. Textbooks is a tremendous resource for students to quickly become updated on a subject but in this way, it also arguably by necessity, hides many of the mistakes, reforms and revolutions. (Kuhn, 1996. 136-143)

Many engineering students have read calculus and classical mechanics after their first year and are able to quickly move on to learn classical and special relativity. Essentially compressing the development of hundreds of years of science into a year or two, is the effectiveness of modern textbooks. Textbooks constructs a view of science that is incorrect, showcasing constant, cumulative development. In addition, it means that textbooks must be rewritten after each major scientific discovery. This is misguiding to new researchers and hides the fact that scientific knowledge goes through phases of immense crisis, where nothing seems to make sense, to eventually be rebuilt to explain for previously unexplainable phenomena. (Kuhn, 1996. 136-143)

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