Physics 419
Lecture 15: Kuhn, Paradigms and Falsification
March 16, 2021

1 Themes

- Kuhn on Paradigms
- Categories: Nelson Goodman

2 Nature of Scientific Theories: Are different ways of thinking really different?

We have studied a key upheaval in the classical world: the transition from Newton to Einstein. We want to study in general how such revolutions occur and how should we view the displaced theory when a new one comes along that seems to be more in line with experimental observations. This sort of problem has a long history that started of course with Aristotle. What we will do today is analyse the key ingredients in the proposal laid out by T. S. Kuhn. In analysing scientific revolutions, Kuhn introduces the notion of a paradigm.

Paradigm: Universally recognized scientific achievements that for a time provide model problems and solutions to a community of practitioners. Scientists who work within an established paradigm are doing normal science. For example, Robert Hooke in establishing Hooke's law that for a harmonic spring, the force to stretch the spring scales as a linear function of the displacement from equilibrium was working within the Newtonian paradigm. According to Kuhn, normal science consists largely of men and women engaging in mop-up operations "by extending the knowledge of those facts that the paradigm displays as particularly revealing, by increasing the extent of the match between those facts and the paradigm's predictions, and by further articulation of the paradigm itself." Kuhn also claims that a scientific community is defined by the shared paradigm to which it ascribes. Does this argument seem circular? How do paradigms come about? However, they come about, we must deal with the nettling question: What is the relationship between a scientific theory and the physical world?

We touched on this question in the first lecture in which we introduced the notion of the realist and instrumentalist interpretations. Question: Are theories simply "man-made interpretations of given data"

according to Kuhn. If so, what does this say about experiments. Recall anytime we perform an experiment, we must do so within the context of some theoretical framework. Hence, since experiment relies on theoretical constructs and theories are simply man-made interpretations, then are experimental observations equally man-made fabrications. Clearly we could get around this problem if we could establish that our theoretical constructs are presuppositionless; that is there are no implicit or explicit assumptions. But this would be impossible and this is the principal reason why the Baconian inductive school perished as it soon became clear that presuppositionless observations were impossible. Does this then leave the scientific enterprise in the same state as other disciplines, such as literature and stress management? If knowability is coloured by the social fabric, does science make progress in any real sense? Much of the remainder of Kuhn's Sturcture of ... is focused on answering this sort of question. While the social context cannot be removed from science, we should keep in mind that science ultimately is about explicating nature. Theories heavily laden with social baggage do not last, for example the notion that oxygen is phlogisticated air. There are two kinds of facts, social and brute facts. Brute facts are true whether or not we are around and they never get explained. There are also brute physical facts that are explainable but are not related to social constructs, for example, the statement, "there is snow on Mt. Kilimanjaro." Social facts require an agreed upon framework for them to even exist, for example a dime is ten pennies, or touchdowns are worth 6 points are all social facts. That the oxygen atom has 8 electrons is a brute fact (not a brute physical fact because this never gets explained). However, that oxygen is phlogiston was never any kind of fact. Science is about understanding the brute physical facts of nature. Paradigms describe a certain set of related brute physical facts. An important aspect of constructing a paradigm is the principle of uniformity, namely that the future will resemble the past. The revamped Humean argument against uniformity is due to Nelson Goodman. Goodman's key point is that any inductive generalization from the past to the future will depend crucially on the categories one chooses to arrange things in the world. His famous example of emeralds illustrates how two people can approach exactly the same evidence with different categories and come to different conclusions about future examples entirely because of differences in their classification scheme.

3 Nelson Goodman: Grue and Bleen

Consider emeralds. All emeralds thus far have been green. Hence, we have good reason to believe that all emeralds are green. Equivalently, all non-green objects are not emeralds. Goodman claims that we could look at the uniformity of the colour of all known emeralds and reach the conclusion that all emeralds are

'grue.' Grue is a new predicate introduced by Goodman. It applies to all things examined before some time (lets say the year 2025) just in case they are green but other things just in case they are blue. So if one looks at a grue object after 2025, that object will be called blue although grue objects before 2025 are all called green. Clearly someone who calls emeralds grue will not agree with someone that all emeralds are green because grue objects after 2025 will all look different from things which are green. They will in fact be blue. There is the analogous predicate 'bleen,' for objects which are blue before 2025 but green afterwards. There is an enormous literature on 'grue' and 'bleen' and several criticisms. But I think Goodman comes out fairly well: 'to say that valid predictions are those based on past regularities, without being able to say which regularities, is thus quite pointless. Regularities are where you find them and you can find them anywhere. Hume's failure to recognize and deal with this problem has been shared by his most recent successors.' (In Goodman, Problems and Project (Bobbs-Merill, Indianapolis, 1972), p. 388). Consider those well-versed in grue and bleen. A grue observer before and after 2025 will see regularities whereas someone not versed in grue and bleen will see only differences. Grue and bleen observers will generalize about the future differently than we will. Their talk will be unintelligible to us. That is, we do not share a common perspective. Hence, what is anomalous to us is completely normal to them. How then do we view anomalies in scientific theories? Is it just a problem of vantage point? If it is, then what is the rational basis for deciding between paradigms? The key point is that unless we know precisely how the future will resemble the past, we can have no assurance about generalizations on the basis of uniformity.

4 Changing Paradigms

This diversion on grue and bleen sets the stage for analysing paradigm shifts. Theories fall when observations do not agree with them. Kuhn's point is that there is an essential tension between paradigms. The reason why new paradigms arise is that their are experimental observations which the accepted paradigm does not explain. Hence, different paradigms do not explain the same observations. As in the example of grue and bleen, those functioning under differing paradigms do not share the same perspective. Consequently, their is a certain incommensurability between paradigms. That is, what was unaccounted for in one paradigm falls out naturally in another. Kuhn also claims in the first printing of Structure of ... that the basic building blocks change their meaning when a new paradigm is ushered in. For example, space and time are inseparable in the Einsteinean world but quite separate according to Newton. Further, space is curved in GR but flat according to Newton. Kuhn claims that those working under two different paradigms cannot talk to one

another. They might use the same words but they are thinking fundamentally different things. Goodman's example of grue and bleen cannot be applied directly here because space was always curved. But it does serve to illustrate that the lack of a shared perspective results necessarily in different parties disagreeing on what anomalies are real. Based on this breakdown of communication, Kuhn claims that there can be no rational way to decide which paradigm to choose. Hence, science simply changes without progress to any truth-oriented goal. This part of Kuhn's treatise is particularly unsettling. In the postscript published 6 years after the first printing, he claims this is not what he said in the first place though this is precisley what his words imply in the first printing. Probably, the surest way to see that science makes progress is to take note that once certain claims have been falsified (to quote Popper) they cease to be believed. Falsification of scientific theories eliminates the ones that do not work. But when is a theory falsified? Was Newton's theory falsified when it was discovered that the orbit of Uranus predicted by Newton did not agree with experiment? It suggested an anomaly which was resolved when Neptune was discovered. Hence, the question of when a scientific theory is falsified is real.