The Structure of Scientific Revolutions

Stages of a Paradigm Shift:

In his 1962 book The Structure of Scientific Revolutions, Kuhn explains the development of paradigm shifts in science into four stages:

Normal science – In this stage, which Kuhn sees as most prominent in science, a dominant paradigm is active. This paradigm is characterized by a set of theories and ideas that define what is possible and rational to do, giving scientists a clear set of tools to approach certain problems. Some examples of dominant paradigms that Kuhn gives are: Newtonian physics, caloric theory, and the theory of electromagnetism. Insofar as paradigms are useful, they expand both the scope and the tools with which scientists do research. Kuhn stresses that, rather than being monolithic, the paradigms that define normal science can be particular to different people. A chemist and a physicist might operate with different paradigms of what a helium atom is. Under normal science, scientists encounter anomalies that cannot be explained by the universally accepted paradigm within which scientific progress has thereto been made.

Extraordinary research – When enough significant anomalies have accrued against a current paradigm, the scientific discipline is thrown into a state of crisis. To address the crisis, scientists push the boundaries of normal science in what Kuhn calls “extraordinary research”, which is characterized by its exploratory nature. Without the structures of the dominant paradigm to depend on, scientists engaging in extraordinary research must produce new theories, thought experiments, and experiments to explain the anomalies. Kuhn sees the practice of this stage – “the proliferation of competing articulations, the willingness to try anything, the expression of explicit discontent, the recourse to philosophy and to debate over fundamentals” – as even more important to science than paradigm shifts.

Adoption of a new paradigm – Eventually a new paradigm is formed, which gains its own new followers. For Kuhn, this stage entails both resistance to the new paradigm, and reasons for why individual scientists adopt it. According to Max Planck, "a new scientific truth does not triumph by convincing its opponents and making them see the light, but rather because its opponents eventually die, and a new generation grows up that is familiar with it." Because scientists are committed to the dominant paradigm, and paradigm shifts involve gestalt-like changes, Kuhn stresses that paradigms are difficult to change. However, paradigms can gain influence by explaining or predicting phenomena much better than before (i.e., Bohr's model of

the atom) or by being more subjectively pleasing. During this phase, proponents for competing paradigms address what Kuhn considers the core of a paradigm debate: whether a given paradigm will be a good guide for future problems – things that neither the proposed paradigm nor the dominant paradigm are capable of solving currently.

Aftermath of the scientific revolution – In the long run, the new paradigm becomes institutionalized as the dominant one. Textbooks are written, obscuring the revolutionary process.

Commensurability is a concept in the philosophy of science whereby scientific theories are commensurable if scientists can discuss them using a shared nomenclature that allows direct comparison of theories to determine which theory is more valid or useful. On the other hand, theories are incommensurable if they are embedded in starkly contrasting conceptual frameworks whose languages do not overlap sufficiently to permit scientists to directly compare the theories or to cite empirical evidence favoring one theory over the other. Discussed by Ludwik Fleck in the 1930s, and popularized by Thomas Kuhn in the 1960s, the problem of incommensurability results in scientists talking past each other, as it were, while comparison of theories is muddled by confusions about terms, contexts and consequences.

The second coauthor of the thesis of incommensurability is Thomas Kuhn (the first one is Feyerabend), who introduced it in his 1962 book, The structure of scientific revolutions, in which he describes it as a universal property that defines the relationship between successive paradigms. Under this meaning incommensurability goes beyond the field of semantics and covers everything relating to its practical application, from the study of problems to the associated methods and rules for their resolution. However, the meaning of the term was continually refined throughout Kuhn's work, he first placed it within the field of semantics and applied a narrow definition, but later he redefined it in a taxonomic sense, wherein changes are found in the relationships between similarities and differences that the subjects of a defining matrix draw over the world.

In The Structure of Scientific Revolutions Kuhn wrote that "the historian of science may be tempted to exclaim that when paradigms change, the world itself changes with them". According to Kuhn, the proponents of different scientific paradigms cannot fully appreciate or understand the other's point of view because they are, as a way of speaking, living in different worlds. Kuhn gave three reasons for this inability:

Proponents of competing paradigms have different ideas about the importance of solving various scientific problems, and about the standards that a solution should satisfy.

The vocabulary and problem-solving methods that the paradigms use can be different: the proponents of competing paradigms utilize a different conceptual network.

The proponents of different paradigms see the world in a different way because of their scientific training and prior experience in research.

In a postscript (1969) to The Structure of Scientific Revolutions, Kuhn added that he thought that incommensurability was, at least in part, a consequence of the role of similarity sets in normal science. Competing paradigms group concepts in different ways, with different similarity relations. According to Kuhn, this causes fundamental problems in communication between proponents of different paradigms. It is difficult to change such categories in one's mind, because the groups have been learned by means of exemplars instead of definitions. This problem cannot be resolved by using a neutral language for communication, according to Kuhn, since the difference occurs prior to the application of language.

Kuhn's thinking on incommensurability was probably in some part influenced by his reading of Michael Polanyi who held that there can be a logical gap between belief systems and who also said that scientists from different schools, "think differently, speak a different language, live in a different world."