

a companion piece from the mathematical angle, telling us what orientability is all about. The key lesson is that you cannot pour wine into a Klein bottle. And while R Srinivasan's series continues to explore the question "How cold can you get?"

Thomas Samuel Kuhn
Historian and Philosopher of Science

When Gil Scott Heron sang "*The revolution will not be televised*", he seemed to have political revolutions in mind. But the words might very well characterise the invisible scientific revolutions that Thomas Kuhn wrote about. Science text books, Kuhn said, systematically mislead readers by presenting scientific progress as a linear process of accretion that may be compared to the addition of bricks one-by-one to a wall. That, however, might not be the way science actually develops. What text books fail to reveal, and many scientists still fail to appreciate, is the existence and nature of revolutions in the scientific enterprise. This was the subject of Thomas Kuhn's tome, *The structure of scientific revolutions*, for which he is best remembered.

Thomas Kuhn died on June 20, 1996, at the age of 73. But his controversial work, first published in 1962 and now available in 25 languages, can still provoke heated debates among scientists and philosophers alike.

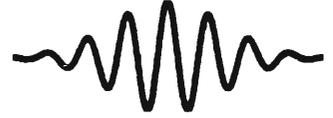
Kuhn first conceived of *Structure* as a graduate student in theoretical physics. A fortuitous opportunity to teach the history of science to

non-scientists at Harvard caused him to re-examine his concepts of scientific progress. This effort completely undermined what he had come to believe during his training as a scientist. In *Structure*, published fifteen years later, Kuhn employed the history and development of the physical sciences to present his polemic.

Kuhn's leitmotif, the notion of *paradigm*, is the framework of concepts within which scientists work and interpret their observations. For the most part, scientists carry out what Kuhn calls 'normal' science, working within the paradigm using the tools and concepts that it provides. This is largely puzzle-solving, aiming little at producing "major novelties, conceptual or phenomenal." So, then, how does science progress? Observations of anomalies that do not conform to the paradigm challenge it, and then evolve ultimately into a crisis that needs to be resolved. An example of this is the work of Barbara McClintock, who challenged the dominant paradigm that 'genes are stable entities' when she proposed the presence of transposons (*Resonance*, October, 1996). According to Kuhn, scientists enmeshed in a paradigm may employ the same vocabulary



Vivek Borkar's delightfully written "How low can you sink?" tells us about algorithms for global minimisation problems. Here we learn at last what the birds and bees are good at: spotting and homing in on global minima!



but yet perceive a situation differently; meaning that their view points are *incommensurable*. Thus, from among the competing paradigms there emerges a victor that now dons the robe of the dominant paradigm within the scientific community. The extraordinary process by which this change in commitments occurs is what Kuhn calls a *scientific revolution*. The result is a sequence of revolutionary events separated by periods of normal science and it is this pattern that we call modern science.

Kuhn's notion of competing paradigms suggests that scientific concepts are not necessarily based on 'reality'. During the period of competition, a stronger theory begins to dominate while something important may get sacrificed in the change. By emphasising that a scientist brings to work his or her beliefs, personal history, culture and training in science, Kuhn shattered the image of an objective, context-free science. Furthermore, as science evolves, its trajectory is not toward a 'truth' or toward anything in particular. But, "Need there be such a goal?" asks Kuhn. Does not the progress of science from any given point derive from its state of knowledge at that time and can we not abandon the notion of one objective true account of 'nature'?

The response to Kuhn's *Structure* from scientists, philosophers and historians of science has varied from vehement attacks by some to exaltation by others. He has been criticised on the grounds that his theory of competing paradigms applies mainly to the field of physics. Another accusation is that the term paradigm has 22 different meanings in *Structure*. In more general terms, his paradigm model of science ignores political and economic interests of society that often deeply influence and completely alter the direction in which a sub-field of science proceeds. But most relativists within science studies who view scientific interpretations as dependent on time and place, in other words, perspective, have embraced his ideas as the cornerstone of their work and, in the words of philosopher David L Hull, have adopted Kuhn as their patron saint.

In spite of the objections to his thesis, Kuhn will be remembered for many years to come because his courageous and inspiring work challenged and radically altered our understanding of science. He will also be revered by those of us whose own world view has been transformed by the Kuhnian paradigm.

Sujatha Byravan

