Lecture 22
Kuhn on Anomalies

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Thomas Kuhn

1922: Born in Cincinnati.

1949: Ph.D. in physics from Harvard.

Professor at Berkeley, then Princeton, then MIT.

1962: *Structure of Scientific Revolutions.*

1996: Died in Cambridge, MA.

How science develops

1. **Diversity.** In any scientific field, if you go back far enough in history, you find a time when there was very little agreement. *Example:* theories of light before Newton.
2. **Paradigm.** An outstandingly successful achievement that is universally accepted. Used by subsequent scientists as a model for how to do science. *Example:* Newton's theory of light.
3. **Normal science.** Scientific work based on an accepted paradigm.
4. **Scientific revolution.** The old paradigm is replaced by a new one. *Example:* Newton's theory of light was replaced by the wave theory of Young and Fresnel.
5. **Normal science.**
6. **Scientific revolution.**

   ⋮

Anomalies

Paradigms never explain all the facts

To be accepted as a paradigm, a theory must seem better than its competitors, but it need not, and in fact never does, explain all the facts with which it can be confronted. (17–18)

Example (mentioned 38, 81)

- The moon's apogee is the point where the moon is farthest from the earth. Newton assumed it is stationary and deduced that the force holding the moon in orbit around the earth is proportional to $1/d^2$.
- The apogee isn't really stationary; it goes forward $3°3'$ per revolution of the moon. But Newton said: *This motion of the apogee arises from the action of the sun (as will be pointed out below) and accordingly is to be ignored here.*
- When Newton calculated the effect of the sun, he got only half the observed motion ($1°31'28''$).
- For 60 years after publication of the *Principia*, mathematicians tried to resolve the discrepancy, without success.
- In 1750, Clairaut showed that the mathematics being used was wrong and that with the correct math Newton's theory gave the observed motion.

Anomalies don't cause a paradigm to be rejected

- Kuhn calls facts that seem not to fit the paradigm *anomalies*.
- *During the sixty years after Newton's original computation, the predicted motion of the moon's perigee* remained only half of that observed. As Europe's best mathematical physicists continued to wrestle unsuccessfully with the well-known discrepancy, there were occasional proposals for a modification of Newton's inverse square law. But no one took these proposals very seriously, and in practice this patience with a major anomaly proved justified.* (81).
- One thing that keeps scientists busy in normal science is working on resolving anomalies.

*Point where the moon is closest to the earth.

Comparison with Popper

- Newton had a failed prediction regarding the motion of the moon's apogee.
- Popper said that when a prediction fails, the scientist should either (a) reject the theory, or (b) propose a new auxiliary hypothesis that makes new testable predictions.
- Newton did neither of these things; he left the motion of the moon as an unsolved problem, an anomaly. Other leading scientists took the same attitude.
- So even the best scientists don't conform to Popper's rules.
- If theories were abandoned when they have anomalies then every paradigm would be abandoned (if Kuhn is right that paradigms always have anomalies).

Requirements for a scientific revolution

1. The anomalies must be severe and prolonged, resisting all attempts to deal with them. (This causes a sense of crisis, which leads scientists to investigate alternative theories.)
2. A better alternative paradigm must be available.

[Note] what scientists never do when confronted by even severe and prolonged anomalies. Though they may begin to lose faith and then to consider alternatives, they do not renounce the paradigm that has led them into crisis. They do not, that is, treat anomalies as counterinstances, though in the vocabulary of philosophy of science that is what they are . . . Once it has achieved the status of paradigm, a scientific theory is declared invalid only if an alternate candidate is available to take its place. No process yet disclosed by the historical study of scientific development at all resembles the methodological stereotype of falsification by direct comparison with nature. (77)

Explanation in terms of probability (not in Kuhn)

Anomalies normally don't cause a paradigm to be abandoned.

A paradigm became that by having unprecedented success. This is evidence that the paradigm is probably correct for the most part. Therefore an anomaly is more likely to be due to some oversight than to the falsity of the paradigm.

Severe and prolonged anomalies create a sense of crisis.

If, over a long period of time, all attempts to resolve an anomaly fail, that makes it unlikely that the anomaly is due to an oversight. Hence the paradigm is probably wrong.

Paradigms aren't abandoned without a better alternative.

Even if the paradigm is probably wrong, it has been very successful in the past and so will probably continue to be successful in many applications; it is better than nothing.

Questions

1. Do good scientists behave in accordance with Popper's rules of scientific method? Support your answer with an example.
2. What must happen in order for scientists to give up a paradigm, according to Kuhn?
3. Can the following claims of Kuhn be explained in terms of what is probable given the evidence? Justify your answers.
   (a) Anomalies normally don't cause a paradigm to be abandoned.
   (b) Severe and prolonged anomalies cause a sense of crisis.
   (c) Paradigms aren't abandoned without a better alternative.

Reference

Thomas S. Kuhn.
The Structure of Scientific Revolutions.
University of Chicago Press, 1962.
2nd ed. (1970) merely added a postscript.
3rd ed. (1996) merely added an index.
Limited access at Amazon Online Reader.
Numbers in parentheses are page numbers of this book.