HS 312 – Introduction to Science and Technology Studies

Lecture 5

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Outline

- What makes knowledge scientific?
- Science = Progress?

Rethinking history of science

- Thomas Kuhn – *The Structure of Scientific Revolutions* (1962)
- Science is merely what scientist do
- Too simple progressivism – attempts to construct/see what we now believe to be the truth as more rational, more natural, teleological
- Normal Science – is the science done when members of a field share a recognition of beliefs about theories, important problems, methods for solving

Normal Science

- Classical or Newtonian physics paradigm – preference for causal explanations, precise quantitative predictions, world as composed of material particles (that collide due to forces acting in straight line), laws of motion and gravitation, standard mathematical techniques, accounts for friction/resistance
- Paradigm examples – Ptolemaic astronomy, Phlogiston theory of combustion, Daltonian chemistry (theory of differing atomic weight of elements), fluid flow theory of electricity (electricity is a material fluid), caloric theory of heat (heat is a material fluid), particle optics (light is a collective of fast moving particles), relativistic physics (time between events is relative to frame of reference), quantum physics (energy possessed by objects/waves comes in discrete units)

Normal Science

- Puzzle-solving – everyday practice of science is a conservative activity, problems are to be solved within the terms/rules of the paradigm; unsolved problem is an anomaly
- In periods of normal science the paradigm is not open to serious question
- Socializing practitioners – Students learn from textbooks; they have lengthy periods of training, and are generally asked to solve well-understood and well-structured problems
- We can talk of progress as worldviews and frameworks are shared

Revolution

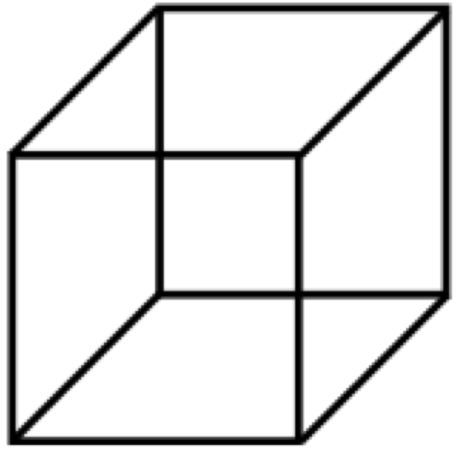
- Period of *crisis* – anomalies accumulate and become real problems; scientists question the fundamental principles of their discipline, and might consider alternatives to the framework;
- If alternative is created, young scientist adopt it
- Non-progressive – revolutions build and destroy, as pre-revolutionary paradigm will fail to make sense in new
- Incommensurable – the meanings of theoretical terms change with revolutions

Revolution

- SSR showed that science primarily advances through shifts in theory and not by the accumulation of knowledge

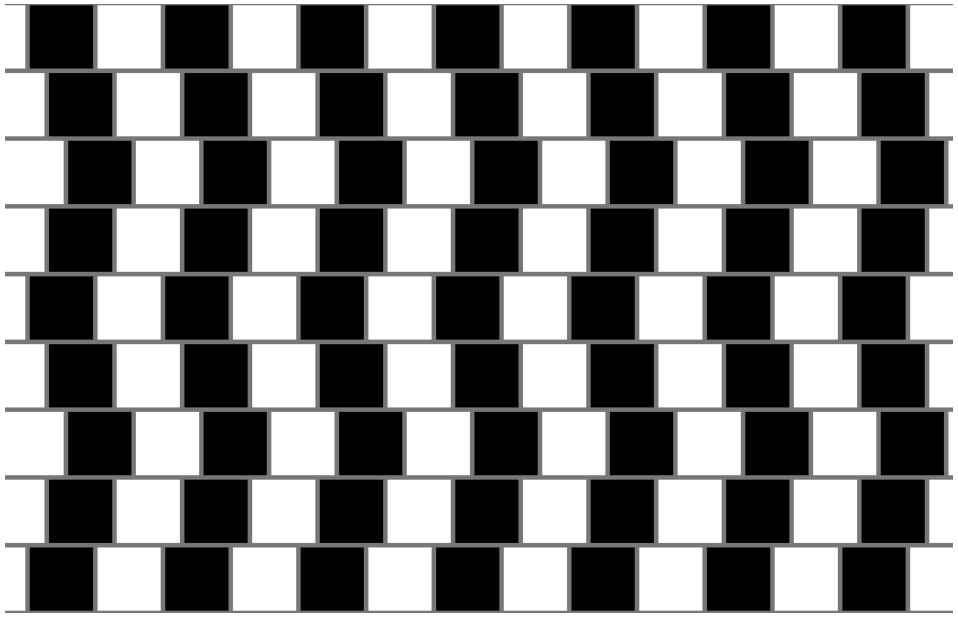
  i.e. shift from one adequate paradigm to another

- Radical implication – Science creates different partial views that can be considered to contain truth only by people who hold those views!



Revolution

- Paradigms change should result in widespread changes in the meanings of key terms; none from one paradigm would map neatly onto those of another
- Indoctrination – paradigms even shape observations; no raw observation - we do not see dots and lines in our visual fields, but instead see more or less recognizable objects
- Theory-dependence of observation – during revolutions people stop seeing one way, and start seeing another way (like a Gestalt)



Our brain processes raw visual input (dots, lines, colors) into meaningful objects using perceptual organization. This happens through Gestalt principles like proximity, similarity, and closure.
Example:
When you see a bunch of dots arranged in a circular pattern, you don't perceive them as individual dots but as a whole circle. Similarly, when looking at a drawing made of lines, you recognize a face rather than just separate lines.
This shows how our brain organizes simple visual elements into structured, recognizable objects.

Objections to Kuhn's thesis

- Semantic incommensurability – Meanings of terms do change, but not so much that claims in which they are used cannot typically be compared
- Kuhn – incommensurability as 'incomplete communication' or 'difficulty of translation'
- If no radical incommensurability then no radical paradigm division
- Key components rarely change together – instruments, theories, and experiments change at different times
- Science thus maintains stability and *ad hoc* unity

Ad hoc means something created for a specific purpose, often without prior planning or a general framework. It is usually temporary and not meant to be a permanent solution.
Example:
A company needs to analyze customer data quickly, so they create an ad hoc report instead of setting up a full-fledged analytics system.

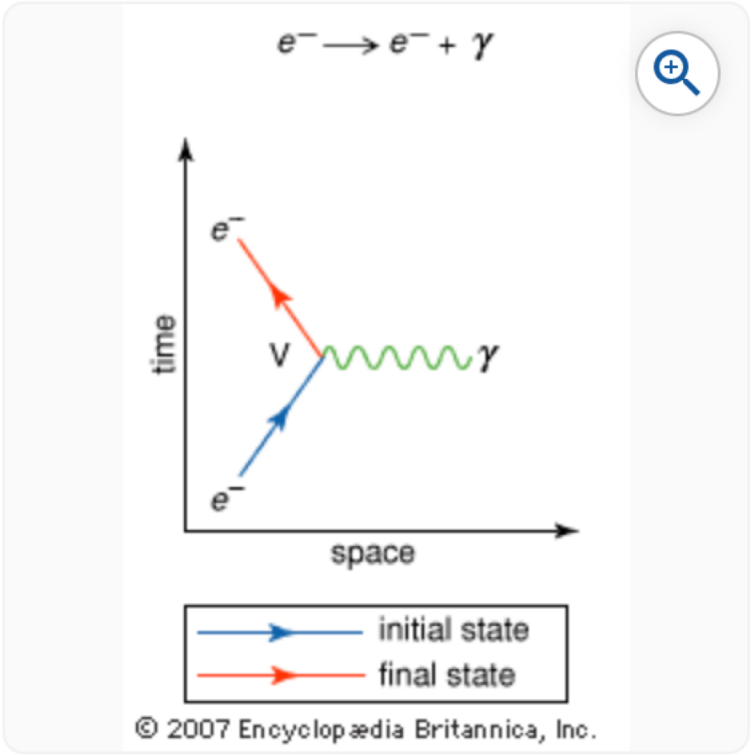
Communicating Among Social Worlds

- To what extent people across disciplines/boundaries can communicate?
- Epistemic cultures – different orientation to object of research, patterns of interaction, and meanings e.g. molecular biology vs. evolutionary ecology vs. neuropathology
- The question is – How people from different areas interact, and produce a degree of unity for science?

Communicating Among Social Worlds

A pidgin is a simplified language that develops when people who do not share a common language need to communicate, usually for trade or work. It has limited vocabulary, simplified grammar, and is not a native language for anyone.
Example:
Tok Pisin in Papua New Guinea: It evolved from English mixed with local languages for trade.

- *Trading zones* – an area where scientific practices interact via simplified languages or pidgins e.g. Feynman diagrams
- Specialities can collaborate even if cultures and practices do not agree on problems or definitions
- Boundary objects – objects can form bridges across boundaries, allow for a certain amount of coordination of actions without large measures of translation e.g. sketches and engg drawings
- Incommensurability sometimes thus can be overcome
- Though sciences are disunified but has some stability – the question is how?



Feynman diagram Feynman diagram of the interaction of an electron with the electromagnetic forceThe basic vertex...(more)

Summary

Scientists work within paradigms, which define what problems to study, what methods to use, and how to interpret results.
These paradigms shape research, collaboration, and scientific progress more than general moral or behavioral ideals.
For example, physics in the Newtonian era revolved around mechanics and gravitation, while modern physics operates under quantum mechanics and relativity.
Thus, scientific communities are structured around knowledge frameworks rather than universal ethical codes.

- SSR: Scientific communities are importantly organized around ideas and practices, not around ideals of behaviour
- Organised from the bottom up (not as functionalism argues)
- Changes in theories driven by changes in vision (and not data, as positivism argues)
- Anomalies are typically set aside (not as falsification argues) except during revolutions
- History of science is not an uninterrupted story of progress but of only change
- Thomas Kuhn's SSR has profoundly affected how we think about and study science and technology

Thank you