Bibliography

Philosophy of Science, Annotated

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Prepared for Seminar on Theory Construction and Analogical Reasoning, cotaught with Bruce Buchanan

BOOKS

A. Old but with selections still worth reading

John Stuart Mill, *A System of Logic*, Book III, "Of Induction"  an old but useful source, especially for the methods of experimental inquiry, a discussion of their limitations and the role of hypotheses and analogical reasoning

William Whewell's *Theory of Scientific Method*, ed. Robert Butts (University of Pittsburgh, 1968)  a good selection from Whewell's numerous writings; see especially Whewell's idea of a "consilience of inductions," namely cases in which a single hypothesis explains two classes of different kinds of facts. For example, Newton's hypothesis of the existence of the force of universal gravitation explains both Kepler's laws and laws of falling bodies.

Charles Peirce: *Selected Writings*, ed. Philip Wiener (Dover, 1958)  this book is one of several that contain selections from Peirce's writings in philosophy of science. Especially pertinent is his work on abduction (also called retroduction) which, he argued, is a method of reasoning that is different from induction and deduction; it yields new hypotheses.

J. M. Keynes, *A Treatise on Probability* (London, 1921), Chs.18 and 19 on analogical argument

B. Classics of Twentieth Century Philosophy of Science

Carl Hempel, *Aspects of Scientific Explanation* (Free Press, 1965)  contains essays that are usually taken as definitive statements of the logical empiricist analyses of science; particularly relevant is "The Theoretician's Dilemma: A Study in the Logic of Theory Construction."


Ernest Nagel, *The Structure of Science* (Harcourt-Brace, 1961)  another logical empiricist classic with more material on biology and social science than *Aspects.*

Karl Popper, *The Logic of Scientific Discovery* (actually Logik der Forschung which is better translated *Logic of Scientific Investigation*) (Hutchinson, 1959)  this statement of falsificationism may be the most influential philosophy of science work of the twentieth century; it is logical empiricist in character but stresses falsification rather than confirmation; does more with modus tollens than one would have thought possible.

Thomas Kuhn, *The Structure of Scientific Revolutions*, 2nd ed. (Chicago, 1970)  a different paradigm in philosophy of science: less concern with the logical form of science and
more with scientific change; argues that changes occur as the result of revolutionary change of world view; vague and much criticized but very influential, especially in the soft sciences.

_Readings in the Philosophy of Science_, ed. Baruch Brody (Prentice-Hall, 1970)
a bit dated but still the best single collection of articles by diverse authors; a heavy emphasis on logical empiricism and its critics but some newer material also, including one of Feyerabend’s saner articles “How to be a Good Empiricist—A Plea for Tolerance in Matters Epistemological,” and an absolutely essential article by N. R. Hanson “Is There a Logic of Scientific Discovery?”

_Criticism and the Growth of Knowledge_, ed. Imre Lakatos and Alan Musgrave (Cambridge, 1970)
a collection of articles discussing Kuhn’s work and also a definitive piece by Lakatos “Falsification and the Methodology of Scientific Research Programmes” in which a more sophisticated Popperian position is used in discussing the growth of scientific knowledge.

C. Other books

_Current Research in Philosophy of Science_, ed. Peter Asquith and Henry Kyburg (Philosophy of Science Association, East Lansing, Michigan, 1979—may be ordered directly from PSA) this book was the result of a recent conference to determine the state of the field. It and the PSA volumes (also published by the Association), which are proceedings of the biennial meetings, are a good way of finding out about current research in the field.

Max Black, _Models and Metaphors_ (Cornell, 1962) argues for an “interactional” view of metaphor: both things become changed as a result of the metaphorical relation.

Richard Blackwell, _Discovery in the Physical Sciences_ (Notre Dame, 1969) a disappointing book that is nonetheless useful as a guide to some of the discovery literature; it is very poor when Blackwell tries to develop his own view.

Ronald Giere, _Understanding Scientific Reasoning_ (Holt, Rinehart and Winston, 1979) a new textbook with a very narrow view of science but useful for its flawed, but still interesting, attempt at providing a formalism for testing theories and causal hypotheses.

Clark Glymour, _Theory and Evidence_ (Princeton, 1980) the newest attempt at confirmation theory; has a strong logical empiricist flavor.

Norwood Russell Hanson, _Patterns of Discovery_ (Cambridge, 1965) one of the very few books in philosophy of science dealing with the logic of discovery (rather than the logic of justification) but the discussion of retroduction was superceded by Hanson’s article “Is There a Logic of Scientific Discovery?”

Rom Harre, _The Principles of Scientific Thinking_ (Chicago, 1970) a bit dated but quite useful for Ch. 2. “Models in Theories,” which contains some useful distinctions and a somewhat baroque classification of different types of models.

Mary B. Hesse, _Models and Analogies in Science_ (Notre Dame, 1970) although written in an annoying dialogue style, this book has been influential in discussions of models and analogies and has made standard the terminology of positive, negative and neutral analogy; she stresses the importance of neutral analogy in theory construction.

Larry Laudan, _Progress and Its Problems, Towards a Theory of Scientific Growth_ (University of California, 1977) a new book currently getting a lot of attention that argues that the growth of science is to be seen as the solution of empirical and conceptual problems; much of the book consists of old ideas expressed in new terminology.

W.H. Leatherdale, _The Role of Analogy, Model and Metaphor in Science_ (North Holland, 1974)
a useful introduction to the diverse views on the topic; a large, eclectic bibliography.

*Scientific Discovery, Logic and Rationality and Scientific Discovery: Case Studies,* ed. Thomas Nickles (Reidel, 1980)
These volumes are the proceedings of a good conference in 1978 and include very recent discussions on logic of discovery work in philosophy of science.

*The Structure of Scientific Theories*, ed. Frederick Suppe, 2nd. ed. (University of Illinois Press, 1977)
This book is the proceedings of a conference in 1969 with an extremely useful "Introduction" that traces the history of much of twentieth century philosophy of science and, in the second edition, has a very useful "Afterward-1977" that updates that history and discusses some very recent work, especially on the problems of theory structure and the growth of scientific knowledge.

a vague and diffuse book that does too much but has sections that are very suggestive, especially in Chs. 2 and 3 on the evolution of intellectual disciplines and their explanatory goals

**ARTICLES** (in alphabetical order)

a useful article for considering the additions necessary to simple induction in order to get a universal generalization; uses Guy-Lussac's law as an example.

a dense article that takes on many complex problems of twentieth century philosophy; the first section is useful for the claims about the roles of metaphors in scientific theories; later sections defend a causal theory of reference.

a long article that proposes a schema for hypothesis construction and traces an episode of theory change.

discusses why Bateson was able, when many of his contemporaries were not, to see the new conceptions of Mendelism as promising for future work; proposes several general reasons for regarding new ideas as promising for future research.

Lindley Darden and Nancy Maull, "Interfield Theories," *Philosophy of Science* 44 (1977) 43-64.
discusses Darden's concept of a scientific field and discusses the generation and function of theories that bridge two different fields of science; examples are from twentieth century biology: the chromosome theory of Mendelian heredity, the operon theory of gene regulation and the theory of allosteric interaction.

discusses ways that study of case studies has provided alternatives to some positivistic categories for discussing science: fields provide a broader category than theory; theory construction and modification replaces the dichotomy between discovery and justification; and interfield theories provide an alternative to derivational reductions as an analysis of progress and unification in science.


Gary Gutting, "The Logic of Invention," in Scientific Discovery, Logic, and Rationality, ed. T.
Nickels (Reidel, 1980), pp. 221-234.

a good discussion of the relations between a hypothetico-deductive mode of inference and an
abductive (reductive) one; argues for the importance in discovery of the following: heuristic
principles (analogy and simplicity), scientific intentions (goals of the scientific activity),
and cosmological principles (e.g. matter has an atomic structure)

Gary Gutting, "Science as Discovery," in Revue Internationale de Philosophie, Revue Trimestrielle,
argues that methods of discovery are also methods of justification; proposes that discovery takes
place in a question-context constituted by three main types of elements: empirical facts to be
explained; theoretical concepts, laws and models; and methodological considerations such as
"heuristic tricks" (e.g. fruitful oversimplifications, intuitively helpful analogies), mathematical
and experimental techniques and substantive assumptions about the nature of the world and of scientific
inquiry (search for conservation laws; look for reductive explanations; prefer simpler hypotheses).

Norwood Russell Hanson, 1960, "Is There a Logic of Scientific Discovery?" in Current Issues in the
Philosophy of Science, ed. H. Feigl and G. Maxwell (Holt, Rinehart, Winston, 1960), pp. 20-42,
reprinted in Readings in the Philosophy of Science, ed. Baruch Brody (Prentice Hall, 1970), pp. 620-
633.
now a classic article in the logic of discovery literature which discusses Hanson's view of Pierce's
abductive (reductive) inference as a means of inferring a plausible hypothesis of type H; this
articles supercedes ch. 4 of his book, Patterns of Discovery.

N.R. Hanson, "Retroductive Inference," in Philosophy of Science, The Delaware Seminar, v. 1, ed.
argues that the hypothetico-deductive(HD) and retroductive(RD) modes of inference are
conceptually (not merely psychologically) different; HD is top down argument; RD is bottom up
argument.

more like a classification of discovery acts than an anatomy, e.g., discover an X, discover X, discover
that X, discover an X as a Y, etc.

Gerald Holton, Thematic Origins of Scientific Thought: Kepler to Einstein (Harvard Press, 1973) and
argues that scientists are often guided by very general themata (e.g. simplicity) in their work;
unfortunately presents no way of evaluating themata

Carl Kordig, "Discovery and Justification," Philosophy of Science 45 ((1978)110-117
argues that the context of discovery should be broken down into two parts: the initial thinking up
of a hypothesis and the judgment that it is plausible and worthy of test. The former he relegates to
psychology to study; the judgment of plausibility he argues follows reasoning patterns similar to
those in the context of justification, both of which are subjects for philosophy of science.

on microfiche cards)
an excellent article criticizing Hanson's work and proposing a more developed view of discovery as
beginning with a vague idea which gets elaborated in further work.

Thomas Nickles, "Theory Generalization, Problem Reduction and the Unity of Science," in PSA
argues that problem reduction is an important component in scientific progress; proposes some kind
of step of generalization in theory formation; this view may have relations to the pattern of
reasoning in (Darden, 1978) but neither Nickles nor Darden has fingered out exactly what the
relations are.

begins development of a typology of constraints on problem solution in science.


Kenneth Schaffner, "Logic of Discovery and Justification in Regulatory Genetics," *Studies in the History and Philosophy of Science* 4 (1970) 349-383, an excellent article that argues for a unitary logic of scientific inquiry in both discovery and justificatory contexts; analyzes the discovery of the operon theory of gene regulation and shows the importance of analogical and deductive reasoning in the discovery of new hypotheses.

Dudley Shapere, "Scientific Theories and Their Domains," in *The Structure of Scientific Theories*, 2nd ed., ed. Frederick Suppe (University of Illinois Press, 1977) discuss the concept of a scientific domain as a group of related items to be explained by a single theory; discusses patterns of reasoning leading to the formation of new scientific domains.