

Synopsis

The following brief summaries, arranged here alphabetically by author, provide an introduction to each of the papers in this volume.

1. *Waves and Scientific Method.* **Peter Achinstein.** Laudan and Cantor maintain that there exists a methodological gulf between 19th century wave theorists of light, who employed a method of hypothesis, and 18th and 19th century particle theorists, who were inductivists. This paper examines how in fact wave theorists typically argued for their theory, in order to see to what extent their reasoning corresponds to the method of hypothesis or to inductivism in sophisticated versions of these doctrines offered by Whewell and Mill. It also examines how, given the methodology they actually employed, wave theorists could in principle deal with anomalies to their theory, particularly with phenomena, such as dispersion, which their theory could not explain.

2. *Communication and Cognition: Is Information the Connection?* **Colin Allen and Marc Hauser.** Donald Griffin has suggested that cognitive ethologists can use communication between non-human animals as a "window" into animal minds. Underlying this metaphor seems to be a conception of cognition as information processing and communication as information transfer from signaller to receiver. We examine various analyses of information and discuss how these analyses affect an ongoing debate among ethologists about whether the communicative signals of some animals should be interpreted as referential signals or whether emotional accounts of such signals are adequate. We discuss the food-calling behavior of a group of rhesus monkeys to develop these issues.

3. *The Common Cause Principle.* **Frank Arntzenius.** The common cause principle states that correlations have prior common causes which screen off those correlations. I argue that the common cause principle is false in many circumstances, some of which are very general. I then suggest that more restricted versions of the common cause principle might hold, and I prove such a restricted version.

4. *Experimental Tests for the Existence of Altruism.* **C. Daniel Batson.** A program of research is described that was designed to provide experimental evidence for or against the existence of human altruism. The research tested the empathy-altruism hypothesis—which claims that empathic feelings for a person in need evoke altruistic motivation to relieve that need—against egoistic alternatives. Over 25 experiments have been conducted. With remarkable consistency, results of these experiments conform to the predictions of the empathy-altruism hypothesis. There seems no plausible egoistic explanation for these results. It is tentatively concluded that the empathy-altruism hypothesis is true. More generally, it is suggested that experimental techniques employing deception, developed by social psychologists, may be ideally suited to answering value-laden questions about human nature raised by moral philosophers.

5. *Quantum Chaos and Semiclassical Mechanics* **Robert Batterman.** This paper discusses the problem of finding and defining chaos in quantum mechanics. While chaotic time evolution appears to be ubiquitous in classical mechanics, it is apparently absent in quantum mechanics in part because for a bound, isolated quantum system, the evolution of its state is multiply periodic. This has led a number of investigators to search for semiclassical signatures of chaos. Here I am concerned with the status of semiclassical mechanics as a distinct third theory of the asymptotic domain between classical and quantum mechanics. I discuss in some detail the meaning of such crucial locutions as the "classical counterpart to a quantum system" and a

quantum system's "underlying classical motion". A proper elucidation of these concepts requires a semiclassical association between phase space surfaces and wave-functions. This significance of this association is discussed in some detail.

6. *Old Quantum Theory: A Paraconsistent Approach*. **Bryson Brown**. Just what forms do (or should) our cognitive attitudes towards scientific theories take? The nature of cognitive commitment becomes particularly puzzling when scientists' commitments are) inconsistent. And inconsistencies have often infected our best efforts in science and mathematics. Since there are no models of inconsistent sets of sentences, straightforward semantic accounts fail. And syntactic accounts based on classical logic also collapse, since the closure of any inconsistent set under classical logic includes every sentence. In this essay I present some evidence that there really was a substantial cognitive commitment to OQT, and that some of its characteristics have a simple and straightforward explanation in terms of a model based on a form of paraconsistent logic.

7. *Why Empiricism Won't Work*. **James Robert Brown**. Thought experiments provide us with scientific understanding and theoretical advances which are sometimes quite significant, yet they do this without new empirical input, and possibly without any empirical input at all. How is this possible? The challenge to empiricism is to give an account which is compatible with the traditional empiricist principle that all knowledge is based on sensory experience. Thought experiments present an enormous challenge to empiricist views of knowledge; so much so that some of us have (cheerfully) thrown in the towel and embraced good old fashioned platonism. I'll try to explain why one brand of empiricism, namely John Norton's argument view of thought experiments, won't work.

8. *Waves, Philosophers and Historians*. **Jed Z. Buchwald**. Despite the substantial and important differences between Achinstein and Laudan, many historians of science would see little distinction between them. Both of these philosophers believe and strongly maintain that argumentation was a central aspect of the historical events involved in the establishment of wave optics. Contemporary historians would prefer to ask whether argumentation did much work at all — whether, that is, anyone ever actually persuaded anyone else to change a belief. I will attempt briefly to show that issues of skilled knowledge, tacit understanding, and novel instrumentation, rather than straightforward assertions based on the overt structure of the contending theories, offer a better way to understand what took place.

9. *How Foundational Work in Mathematics Can be Relevant to Philosophy of Science*. **John P. Burgess**. Foundational work in mathematics by some of the other participants in the symposium helps towards answering the question whether a heterodox mathematics could in principle be used as successfully as is orthodox mathematics in scientific applications. This question is turn, it will be argued, is relevant to the question how far current science is the way it is because the world is the way it is, and how far because we are the way we are, which is a central question, if not the central question, of philosophy of science.

10. *Dogs that don't bark in the night: How to investigate the lack of a domain of expertise?* **Dorothy L. Cheney and Robert M. Seyfarth**. Despite being excellent observers' of each others' behavior, vervet monkeys (*Cercopithecus aethiops*) appear to be surprisingly ignorant about the behavior of the species that prey upon them. In particular, they fail to attend to many of the visual cues created by their predators. One explanation for this lack of attentiveness is that natural selection has favored skills in the social domain that cannot be extended to non-social contexts. In this

paper, we review the ways that the term “domain” has been used in studies of children’s cognitive development. We then examine the extent to which hypotheses based on domain-specific adaptations satisfactorily account for patterns of predator detection in vervet monkeys. We contrast domain-specific explanations with more general explanations based on classical conditioning and the relative salience of visual and auditory cues. Finally, we examine vervets’ perception of causality and contrast their recognition of cause-effect relations in social and nonsocial contexts.

11. *Cosmic Censorship*. **John Earman**. The cosmic censorship hypothesis states that the general theory of relativity has built in mechanisms to prevent the formation of “naked singularities,” pathologies in the spacetime structure that lead to a breakdown in predictability and determinism. This paper discusses some attempts to turn the vague hypothesis into a precise conjecture. Evidence in favor of and against the conjecture is briefly reviewed. Finally the possibility of forming naked singularities via black hole evaporation due to Hawking radiation is discussed.

12. *Why a Little Bit Goes a Long Way: Logical Foundations of Scientifically Applicable Mathematics*. **Solomon Feferman**. Does science justify any part of mathematics and, if so, what part? These questions are related to the so-called indispensability arguments propounded, among others, by Quine and Putnam; moreover, both were led to accept significant portions of set theory on that basis. However, set theory rests on a strong form of Platonic realism which has been variously criticized as a foundation of mathematics and is at odds with scientific realism. Recent logical results show that it is possible to directly formalize almost all, if not all, scientifically applicable mathematics in a formal system that is justified simply by Peano Arithmetic (via a proof-theoretical reduction). It is argued that this substantially vitiates the indispensability arguments.

13. *What is Experimental about Thought Experiments?* **David C. Gooding**. I argue that thought experiments are a form of experimental reasoning similar to real experiments. They require the same ability to participate by following a narrative as real experiments do. Participation depends in turn on using what we already know to visualize, manipulate and understand what is unfamiliar or problematic. I defend the claim that visualization requires embodiment by an example which shows how tacit understanding of the properties of represented objects and relations enables us to work out how such objects might behave in a postulated world. This knowledge is that of embodied agents. That thought experiments require embodied participation is what makes them experiments rather than arguments. Unlike real experiments, from which ordinary perception has been displaced by instrumentation, thought experiments still appeal to relatively unmediated common sense, even when their purpose is to criticize or subvert common sense notions.

14. *Do Thought Experiments have a Life of their Own? Comments on James Brown, Nancy Nersessian and David Gooding*. **Ian Hacking**. All three authors range themselves against John Norton’s deductive analysis of thought experiments. Brown’s insight, Nersessian’s mental modelling, and Gooding’s embodiment, arise, in each case, from a major all-purpose philosophical theory. None reaches down to the specific level of thought experiments, which are small, rare, and precious. I urge attention to Wittgenstein’s remark that “the experimental character disappears when one looks at the process as a memorable picture.” Thought experiments are not experiments. They are static. They become fixed, more like jokes or optical illusions. Unlike real experiments, they have no life of their own.

15. *After Eurocentrism? Challenges for the Philosophy of Science.* **Sandra Harding.** Two themes in postcolonial science studies pose unusual challenges for philosophers of science. According to these accounts, the cognitive/technical core of Western sciences, not just their technologies, applications, and social institutions, is permeated by distinctive cultural and political commitments. In this sense, Western sciences are “ethnoscience.” Moreover, these analysts want to delink their societies’ scientific and technological projects from the West’s in order to develop fully modern sciences within their own culturally distinctive scientific traditions. This paper suggests some fruitful ways Western philosophers can take advantage of this opportunity to construct theories of science for Westerners that can interact more realistically and fruitfully with these postcolonial accounts.

16. *Dynamic Deliberation.* **William L. Harper.** Skyrms’ investigations of dynamic deliberation are traced through his book of 1990 and his subsequent investigation of dynamic deliberation based on inductive rules to his recent results about chaos generated by evolutionary game dynamics. It is argued that the dynamics studied in the book, and the inductive dynamics as well, need to be supplemented to yield the correct recommendation in an example game. Some features about information feedback are pointed out. Finally, it is suggested that more work is needed to assess whether Skyrms’ results about chaos have any interesting implications for plausible game theoretic representations of interactions among human agents.

17. *On the Scope and Force of Indispensability Arguments.* **Geoffrey Hellman.** Three questions are highlighted concerning the scope and force of indispensability arguments supporting classical, infinitistic mathematics. The first concerns the need for non-constructive reasoning for scientifically applicable mathematics; the second concerns the need for impredicative set existence principles for finitistic and scientifically applicable mathematics, respectively; and the third concerns the general status of such arguments in light of recent work in mathematical logic, especially that of Friedman et al. and Feferman et al. Some recent results (of Pour-El and Richards and of the author) are then presented bearing on the first question on the need for non-constructive analysis, especially for quantum physics. Despite the impressive work of Bishop et al. in constructive analysis, Hilbert’s objection to intuitionism still carries significant force, and may be decisive depending in part on one’s conception of “physics”

18. *Dutch Book Arguments and Consistency.* **Colin Howson.** I consider Dutch Book arguments for three principles of classical Bayesianism: (i) agents’ belief-probabilities are consistent only if they obey the probability axioms. (ii) beliefs are updated by Bayesian conditionalisation. (iii) that the so-called Principal Principle connects statistical and belief probabilities. I argue that while there is a sound Dutch Book argument for (i), the standard ones for (ii) based on the Lewis-Teller strategy are unsound, for reasons pointed out by Christensen. I consider a type of Dutch Book argument for (iii), where the statistical probability is a von Mises one.

19. *Testing Philosophical Claims about Science.* **David Hull.** Relativism notwithstanding, evidence can be brought to bear on the sorts of empirical claims that scientists make. If progress is to be made in the study of science, comparable effort must be expended to interpret meta-level claims about science in such a way that evidence can be brought to bear on them as well. This endeavor requires us to get scientists to adopt our meta-level positions so that we can see the effects that such an adoption has on science.

20. *On Aims and Methods of Cognitive Ethology*. **Dale Jamieson and Marc Bekoff**. In 1963 Niko Tinbergen published a paper, "On Aims and Methods of Ethology," dedicated to his friend Konrad Lorenz. Here Tinbergen defines ethology as "the biological study of behavior," and seeks to demonstrate "the close affinity between Ethology and the rest of Biology." Tinbergen identifies four major areas of ethology: causation, survival value, evolution, and ontogeny. Our goal is to attempt for cognitive ethology what Tinbergen succeeded in doing for ethology: to clarify its aims and methods, to distinguish some of its varieties, and to defend the fruitfulness of the research strategies that it has spawned.

21. *Probability Kinematics and Causality*. **Richard Jeffrey**. Making up your mind can include making up your mind about how to change your mind. Here a suggestion for coding imputations of influence into the kinematics of judgmental probabilities is applied to the treatment of Newcomb problems in *The Logic of Decision* framework. The suggestion is that what identifies you as treating judgmental probabilistic covariance of X and Y as measuring an influence of X on Y is constancy of your probabilities for values of Y conditionally on values of X as your judgmental probability distribution for values of X changes.

22. *A Philosophical Evaluation of the Chaos Theory "Revolution"*. **Stephen H. Kellert**. The scientific study of chaotic dynamics, popularly known as chaos theory, has been described by several writers as a revolution in the sense of Kuhn. I provide a definition of chaos theory and offer a brief description of this field of research. I then take up the question of whether or not chaos theory should be described as "revolutionary," in light of the fact that no well-developed science of nonlinear dynamics preceded it. In some respects, chaos theory may be fruitfully described as an "immature science," and the semantic view of theories helps to bring out some of its important features. Many aspects of this emerging field make it most appropriate to consider it a new style of scientific reasoning, analogous to statistical thinking as interpreted by Ian Hacking.

23. *Towards a Female-friendly Philosophy of Science*. **Janet A. Kourany**. For some time now feminists have been pointing an accusing finger at science, urging that the relationship between women and science has been far from a beneficial one for women. Indeed, science has generally excluded women from its most important activities, feminists have charged, science has tended to leave women largely invisible in its knowledge and research, and science has often portrayed women, and things feminine, in negative terms when it has considered us. I suggest that the philosophy of science has helped in various ways to keep these problems for women in science invisible and intact, and suggest a number of changes in philosophy of science to rectify the situation.

24. *Introduction to Presidential Address*. **Thomas S. Kuhn**. A brief epitome of the central shared and the central incompatible elements in Kuhn's and van Fraassen's philosophical viewpoints.

25. *The Scope of Bayesian Reasoning*. **Henry Kyburg, Jr.** The Bayesian view of inference has become popular in philosophy in recent years. *Scientific Reasoning: a Bayesian Approach*, by Colin Howson and Peter Urbach, represents an articulate and persuasive defense of the Bayesian view. We focus on the theme of that book, and argue that there are difficulties with Bayesianism, and alternatives worth considering. One of the most serious drawbacks to Bayesianism is the subjectivity that pervades most versions of it. We argue that this is an instance of a more general contem-

porary tendency to move away from claims of objectivity, and toward frankly subjective views. This results from a desire to find a deductive, incorrigible, basis for scientific inference. We claim that such a desire is doomed to frustration, but that does not spell the end of efforts to formalize inductive reasoning.

26. *Waves, Particles, Independent Tests and the Limits of Inductivism*. **Larry Laudan**. This paper seeks to show that Achinstein's recent attempt to establish that both parties to the wave-particle debate in 19th-century optics were Bayesian conditionalizers forces us to ignore several of the key conceptual issues in that controversy—not least the role of the *vera causa* principle and, more important still, the role of positive evidence in securing acceptance for the wave theory of light.

27. *The 'New' History of Science: Implications for Philosophy of Science*. **Rachel Laudan**. This paper surveys recent trends in the history of science, using quotations from works published in the last decade. It suggests that philosophers of science have not yet come to terms with those changes, indicates which might or might not lead to productive interchange, and concludes that history and philosophy of science are now further apart than at any time since the early 1960's.

28. *Taking Gender Seriously in Philosophy of Science*. **Helen E. Longino**. Using the author's social analysis of scientific knowledge, two ways of understanding the importance of gender to the philosophy of science are offered. Given a requirement of openness to multiple critical perspectives, the gender, race and class structure of a scientific community are an important ingredient of its epistemic reliability. Secondly, one can ask whether a gender sensitive scientific community might prefer certain evaluative criteria (or virtues of theory or practice) to others. Six such criteria (several of which are at odds with criteria accepted in mainstream science) are discussed. Their articulation prompts a series of philosophical questions, the answering of which would constitute one program (or more) of a gender sensitive philosophy of science.

29. *Acceptance in Bayesian Philosophy of Science*. **Patrick Maher**. Can Bayesians make sense of the notion of acceptance? And should they want to? This paper argues that the answer to both questions is yes. While these answers have been defended before, the way of making sense of acceptance offered here differs from what others have proposed, and the reasons given for why Bayesians should want to make sense of acceptance are also different.

30. *New Directions, Really?* **Gonzalo Munévar**. Sandra Harding's work on race and gender has been hailed as a shining example of the new directions that feminism offers to the philosophy of science. Unfortunately her "new direction" consists of a poor rehash of arguments for pluralism and of a confused view she calls "strong objectivity," which she proposes as a solution to the problem of reflexivity. Her proposal, however, not only fails to solve the problem but is motivated by a false dilemma. Moreover, her extension of her feminist views to "race issues" is condescending and racist.

31. *In the Theoretician's Laboratory: Thought Experimenting as Mental Modeling*. **Nancy J. Nersessian**. Thought experiments have played a prominent role in numerous cases of conceptual change in science. I propose that research in cognitive psychology into the role of mental modeling in narrative comprehension can illuminate how and why thought experiments work. In thought experimenting a scientist constructs and manipulates a mental simulation of the experimental situation. During this process, she makes use of inferencing mechanisms, existing representations, and

general world knowledge to make realistic transformations from one possible physical state to the next. The simulation reveals the impossibility of integrating multiple constraints drawn from existing representations and the world and pinpoints the locus of the required conceptual reform.

32. *A Paradox in Newtonian Gravitation Theory*. **John D. Norton**. Newtonian cosmology is logically inconsistent. I show its inconsistency in a rigorous but simple and qualitative demonstration. “Logic driven” and “content driven” methods of controlling logical anarchy are distinguished.

33. *Can We Reduce Causal Direction to Probabilities?* **David Papineau**. This paper defends the view that the asymmetry of causation can be explained in terms of probabilistic relationships between event types. Papineau first explores three different versions of the “fork asymmetry”, namely (i) David Lewis’ asymmetry of overdetermination, (ii) the screening-off property of common causes, and (iii) Spirtes’, Glymour’s and Scheines’ analysis of probabilistic graphs. He then argues that this fork asymmetry is both (i) a genuine phenomenon and (ii) a satisfactory metaphysical reduction of causal asymmetry. In his final section he shows how this reduction can account for the relevance of causal direction to human agency, and in particular for the fact that we can manipulate causes to influence their effects, but not vice versa.

34. *The Direction of Causation: Ramsey’s Ultimate Contingency*. **Huw Price**. The paper criticizes the attempt to account for the direction of causation in terms of objective statistical asymmetries, such as those of the fork asymmetry. Following Ramsey, I argue that the most plausible way to account for causal asymmetry is to regard it as “put in by hand”, that is as a feature that agents project onto the world. Its temporal orientation stems from that of ourselves as agents. The crucial statistical asymmetry is an anthropocentric one, namely that we take our actions to be statistically independent of everything except (what we come to call) their effects. I argue that this account explains the intuitive plausibility of Reichenbach’s principle of the common cause.

35. *Arguments in a Sartorial Mode, or The Asymmetries of History and Philosophy of Science*. **Robert J. Richards**. History of science and philosophy of science are not perfectly complementary disciplines. Several important asymmetries govern their relationship. These asymmetries, concerning levels of analysis, evidence, theories, writing, and training show that to be a decent philosopher of science is more difficult than being a decent historian. But to be a good historian—well, the degree of difficulty is reversed.

36. *Cognitive Ethology: Past, Present and Speculations on the Future*. **Carolyn A. Ristau**. Cognitive ethology began with Donald R. Griffin’s 1976 publication of *The Question of Animal Awareness*. More recently mutual influences can be found between cognitive ethology and comparative, developmental, experimental and cognitive psychology and philosophy of science and of mind. Present scientific work emphasizes: 1) animal cognitive capacities including discrimination, categorization, spatial knowledge, predator/prey relations such as “injury feigning” by birds, deception and attribution of intention, 2) communication, both natural systems and artificial “language” and cognition projects undertaken with apes, birds, and sea mammals and 3) the possibility of animal consciousness. For the future, one hopes for developments in those areas, more field research, conceptual and methodological bridges to other disciplines, and philosophical work on the theoretical foundations of cognitive ethology and naturalizing intentionality.

37. *Paraconsistent Logic: the View from the Right*. Peter K. Schotch. “The best known approaches to “reasoning with inconsistent data” require a logical framework which is decidedly non-classical. An alternative is presented here, beginning with some motivation which has been surprised in the work of C.I. Lewis, which does not require ripping great swathes from the fabric of classical logic. In effect, the position taken in this essay is representative of an approach in which one assumes the correctness of classical methods excepting only the cases in which the premise set is (classically) inconsistent.

38. *Chaos and the Explanatory Significance of Equilibrium: Strange Attractors in Evolutionary Game Dynamics*. Brian Skyrms. This paper discusses the explanatory significance of the equilibrium concept in the context of an example of extremely complicated dynamical behavior. In particular, numerical evidence is presented for the existence of chaotic dynamics on a “strange attractor” in the evolutionary game dynamics introduced by Taylor and Jonker [also known as the “replicator dynamics”]. This phenomenon is present already in four strategy evolutionary games where the dynamics takes place in a simplex in three dimensional space—the lowest number of dimensions in which such a strange attractor is possible. From a dynamical point of view, it is the attractor—rather than the equilibrium—that is of prime interest.

39. *From Vicious Circle to Infinite Regress, and Back Again*. Bas C. van Fraassen. The attempt to formulate a viable empiricist and non-foundationalist epistemology of science faces four problems here confronted. The first is an apparent loss of objectivity in science, in the conditions of use of models in applied science. The second derives from the theory-infection of scientific language, with an apparent loss of objective conditions of truth and reference. The third, often cited as objection to *The Scientific Image*, is the apparent theory-dependence of the distinction between what is and is not observable. The fourth and last is the loss of the possibility of objective evaluation of rationality in scientific methodology. It is argued that each of these problems is illusory.

40. *Is the History of Science Relevant to the Philosophy of Science?* Marga Vicedo. Philosophers have started to use the history of science to address some of their philosophical concerns. In this paper I point out some aspects of contemporary practice that require further consideration in order to achieve a more fruitful integration of history and philosophy: one, the limitations of using case studies; two, the need to articulate how we should use history as evidence. Specifically, I argue that to make progress in the debate about realism we will have to pay more attention to the role of historical evidence.

41. *“Weak” Cosmic Censorship*. Robert M. Wald. The “weak” cosmic censor conjecture states, in essence, that all singularities of gravitational collapse are hidden within black holes. A (relatively) mathematically precise, formulation of this conjecture is given, and the evidence concerning its validity within the context of classical general relativity is reviewed.