NAGEL, Ernest (16 Nov 1901–20 Sept 1985), philosopher of science, was born in Bohemia, in what is now part of the Czech Republic. His parents' names are unknown. When he was ten years old, he immigrated to the United States In 1919 he became a U.S citizen He was educated in New York City, receiving his Ph.D. in philosophy from Columbia University in 1931. In 1935 he married Edith Alexandria Haggstrom; they had two children

Nagel wrote his dissertation on measurement and continued to be interested in the conceptual nature of measurement throughout his career Examples and discussion are to be found in many of his later articles. He wrote in the tradition of German mathematician Hermann von Helmholtz and German physicist and physiologist Otto Hölder, who had begun the formal work on the foundations of measurement in the nineteenth century. Those foundations are closely connected to the nineteenth-century history of geometry, a subject of interest to Nagel throughout his career. In a major historical analysis published in 1939, *The Formation of Modern Conceptions of Formal Logic in the Development of Geometry*, Nagel traced the importance of the introduction of projective geometry in the nineteenth century for later developments in the foundations of mathematics. He also later devoted one chapter and parts of other chapters to geometry in *The Structure of Science: Problems in the Logic of Scientific Explanation* (1961). The widely disseminated conventional views of geometry that were advocated by Jules-Henri Poincaré came under Nagel's scrutiny and received from him a close, detailed critique.

With "Principles of the Theory of Probability" (1939), published in the first volume of the *International Encyclopedia of Unified Science*, Nagel defended the frequency interpretation of probability He made, however, a sustained effort to survey the various alter-

natives and to deal with many of the problems that have been raised about the frequency interpretation. He was perhaps the first American philosopher to call serious attention to the important method of arbitrary functions in probability theory that began with Poincaré and was extended by Eberhard Hopf, George D. Birkhoff and others. This approach, based on relatively straightforward principles of physical symmetry, as in the case of roulette or coin-flipping, provided a detailed account of observed probabilistic phenomena as recorded in relative frequencies.

Among his generation of philosophers of science, Nagel was especially intent on critically examining the foundational claims made about quantum mechanics, particularly in relation to questions of causality. Characteristic of Nagel's analysis was his emphasis on the deterministic elements that remained in quantum mechanics, given the deterministic solutions of the Schrödinger equation, the fundamental equation of quantum mechanics. In "The Meaning of Reduction in the Natural Sciences" (1949), Nagel concentrated on another central topic in the foundations of physics: the possibility of reducing one physical theory to another. Using as his example the most important case within classical physics of such reduction, Nagel offered a detailed conceptual analysis of the attempts to reduce thermodynamics to statistical mechanics. Only toward the end of the twentieth century did much more extensive philosophical analyses begin to appear. Nagel's analysis broke new ground by showing how complex any real case of reduction is as opposed to the speculative generalities often to be found in philosophy.

But the full scope and intensity of Nagel's critical faculties as a philosopher were more fully displayed in his discussions of theories of induction proposed during his lifetime, especially by Rudolph Carnap and Hans Reichenbach. Both Carnap and Reichenbach advanced general theories of induction that in principle were meant to apply to scientific theories and their comprehensive use and assimilation of empirical evidence. Although Nagel saw merits in Carnap's and Reichenbach's different proposals, he doubted that an actual working scheme for the general quantitative confirmation of scientific theories could be developed. Typical of his philosophy was his detailed critique of the difficulties of philosophical schemes that seemed too grand in conception. Looking at the literature much later, it is easy enough to see that his general view is correct, even though Carnap's approach retains some currency in the conceptual framework of subjective probability. In any case, later philosophy has sustained Nagel's skepticism; no one expects to encounter the kind of formulation that would reduce a genuinely important scientific theory to Carnap's framework.

Nagel wrote about a wide range of issues in the philosophy of science, and it is not possible here to survey them all in detail. His most important book, *The Structure of Science*, remains perhaps the most detailed and authoritative exposition of the different kinds of explanations advanced in different parts of science. Characteristic of Nagel's critical approach to philosophy is his unwillingness to give any unified account of the nature of scientific explanations or the nature of scientific laws.

The nature of teleological explanations in biology became the focus of the John Dewey Lectures that Nagel gave at Columbia in 1977 and published in 1979 as *Teleology Revisited and Other Essays in the Philosophy and History of Science*. In some of the most detailed studies of alternative approaches to teleological explanations still to be found in the philosophical literature, he contends that the analysis of goal-directed processes in biology is in principle similar to the analysis of the structure of physical processes. Integral to his general philosophical outlook is the idea that goal-directed behavior of biological organisms forms as much a part of the natural world as the physical processes treated in classical and modern physics.

Nagel also wrote a great deal about the social sciences and tangled with many of the main issues that have been raised concerning their status. He was perhaps most concerned about the thesis that the social sciences are not sciences in the sense that the natural sciences are. The object of his criticism, the so-called *Verstehen* view of the matter has as a premise that empathetic understanding is required in any fully developed social science. Characteristically skeptical and critical, Nagel remarked that one need not be a psychotic in order to be a scientifically successful psychiatrist studying paranoia. While he did not lay down any methodological rules for arriving at scientific results in the social sciences, he argued that the same general standards characteristic of the other sciences be imported and used in the social sciences as well. In this connection he was especially persuasive in defending a probabilistic concept of causality and the reliance on statistical methods in the social sciences.

In the final chapter of the *Structure of Science*, Nagel defends the thesis that the same general critical apparatus of evidence and argument can be used in historical inquiry as in the scientific disciplines. Rather than an identity of method, the two fields share identity of general philosophical viewpoint toward acquiring knowledge about the world. Consistent with his other philosophical views, Nagel was critical of those historians who have tried to establish, on a speculative basis, general historical laws. In contrast, he was sympathetic with historians who attempt to propose tentative but intricate explanations of important historical events such as the French Revolution. Properly skeptical of finding a final and fully satisfactory explanation of complex historical phenomena, Nagel was nevertheless confident that good scholarship and thoughtful analysis can vastly increase our understanding of historical phenomena from an objective standpoint.

Almost all of Nagel's teaching career was spent at Columbia, where he was on the faculty from 1931 to 1970. From 1967 until his retirement in 1970, he held the position of University Professor at Columbia, where he continued to teach after his retirement. He received many honors from various institutions. He

was among the most prominent philosophers of science in the United States of his generation. In 1977 he was elected to the National Academy of Sciences, an honor conferred on very few philosophers. He died in New York City.

• The works of Nagel include "The Formation of Modern Conceptions of Formal Logic in the Development of Geometry," *Osiris* 7 (1939) 142–224, "The Meaning of Reduction in the Natural Sciences," in *Science and Civilization*, ed. Robert C Stouffer (1949), *Teleology Revisited and Other Essays in the Philosophy and History of Science* (1979), *An Introduction to Logic and Scientific Method*, with Morris R. Cohen (1934), *Sovereign Reason, and Other Studies in the Philosophy of Science* (1954), and *Logic without Metaphysics, and Other Essays in the Philosophy of Science* (1957). For an exposition of Nagel's approach to logic and scientific method, see Patrick Suppes, "Nagel's Lectures on Dewey's Logic," in *Philosophy, Science and Method Essays in Honor of Ernest Nagel*, ed. Sidney Morgenbesser et al (1969)

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