

Thinking About Space and Time: 100 Years of Applying and Interpreting General Relativity

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This fifteenth volume in the *Einstein Studies* series brings together twelve contributions, each about twenty pages long, devoted to the historical development and philosophical interpretation of general relativity.

Originating in a conference held in Bern in September 2017, the contributions reflect the interdisciplinary scope of the series, which encompasses scholarship on Einstein ranging from the history of physics and the philosophy of science to, more broadly, the place of modern physics within scientific culture.

As the editors emphasize in their introduction, Einstein's presentation, in November 1915, of the final form of his gravitational field equations marked as much a beginning as a culmination. At that point, no nontrivial solutions to the equations were yet known, relativistic cosmology had yet to be developed, and many of the theory's conceptual and philosophical implications remained to be explored. The volume focuses precisely on what followed: the development and reception of general relativity and the scientific and philosophical debates to which it gave rise.

The contributions are arranged so as to lead the reader gradually from the history of general relativity to the philosophical questions it raises. The volume opens with the 1955 Bern conference, held only a few weeks after Einstein's death, and examines the role it played in the postwar revival of general relativity and in the emergence of an international research community devoted to the subject. The chapters that follow return to the principles and heuristic considerations that guided the formulation of the theory before tracing some of its important subsequent developments. They examine Einstein's path to the field equations, including the tensions between the equivalence principle and the requirements of energy–momentum conservation, and then devote considerable attention to the beginnings of relativistic cosmology. The 1917 static model provides a point of departure for discussions of Mach's principle, the cosmological constant, and

the stability of cosmological models. This historical part concludes with a discussion of Einstein's later work, including possible connections between his research on gravitation and his thinking about quantum mechanics.

The second half of the volume takes a more distinctly philosophical turn, focusing on conceptual problems raised by general relativity. Several contributions examine the nature of spacetime, beginning with Hermann Weyl's "problem of space"—the question of why physical space has the particular geometry that it does—and extending to different ways of understanding the relationship between spacetime and the physical processes occurring within it. Others address the status of some of the principles underlying the theory: the equivalence principle, which connects gravitation with acceleration; Mach's principle, which relates inertial motion to the distribution of matter in the universe; and the geodesic principle, according to which freely moving bodies follow paths determined by the geometry of spacetime. Still other contributions ask in what sense general relativity itself requires interpretation. The volume also considers the relationship between general and special relativity and seeks to clarify how the former can account for the empirical success of the latter.

The book thus consists of a collection of specialized studies illuminating different aspects of the development of general relativity and its conceptual significance. Its emphasis is on historical, methodological, and philosophical perspectives rather than on the mathematical aspects of the theory as such. Neither an introduction to general relativity nor a continuous historical account of its genesis, the volume will be of particular interest to readers drawn to the history of twentieth-century physics, the philosophy of physics, and debates about the nature of spacetime.

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