

CHRISTOPHER RAY: *The Evolution of Relativity*. Bristol, Philadelphia: Adam Hilger, 1987. xii, 211 pp., figs, 4 portraits and bibliography.

This book is *not*, as its title misleadingly suggests, a historical account of 'the evolution of relativity', as f.i. the detailed study by Tonnelat¹, but rather a critical review about important concepts and principles in the context of the general theory of relativity in its various stages and variants after the initial formulation by Einstein in 1915. Its aim is *not* to give a well-balanced, chronological report on the gradual refinement and enfolding of the concept of relativity along the lines of the history-of-ideas-tradition, *but* rather to expose the meaning-variants of central points as they became evident in fairly recent literature about general relativity (GTR), quantum gravity (QG) and space-time-structures, continuing the tradition of authors as Grünbaum (1963-1973), Sklar (1974) or Friedman (1983).

The special theory of relativity (STR) is dealt with only marginally as limiting case of the generalised theory for vanishing gravitational fields (f.i. p. 60), and its roots in the theory of electrons and electromagnetism aren't touched at all². Ray selected "Ernst Mach and the search for simplicity" as his first topic to be discussed (chapter one): it was Mach's phenomenologically motivated demand that the property of inertia should be correlated with other principally observable facts, later termed 'Mach's principle' by Einstein (compare p. 37), which became of heuristic importance for the gradual formulation of GTR after 1907 up to the first canonical formulation in late 1915. But Ray also deals with Mach's critique of the Newtonian arguments for absolute space (and time), carefully examining Newton's original argumentation in a style similar to Hugh M. Lacey³ (3-11) and extensively reviewing the complex discussion about pros and cons of absolute space since Mach's *Mechanik* of 1883 (compare "Who's afraid of absolute space", p.37).⁴ Ray demonstrates how Mach's principle is subject to changes and various reformulations, f.i. by Sciama or Brans and Dicke (in due course of attempts to implement Mach's original demand in the framework of GTR), in Wheeler's geometrodynamics or Raine's integral reformulation of GTR (p. 39 f.).

In chapter two about "the foundations of the general theory of relativity", Ray discusses the principles of equivalence⁵ and covariance, again in juxtaposition of various senses (p. 61 f.) and including an attempt to give a fair account of the status of these principles judged from today's knowledge (pp. 71 ff.).

Since Ray's focus is not on historical issues, he happens to forget (or omit?) influential figures such as the physicists V.A. Fock or G. Mie, who both argued heavily against Einstein's demand of a complete equivalence of all frames of reference, but he correctly traces the triviality suspicion concerning general covariance back to Friedrich Kretschmann (1917) (p. 70). In connection with Mach's principle, he never mentions Hans Thirring's early (1918) inquiry about possible solutions of Einstein's field equations in harmony with Mach's original intention⁶. Therefore Ray can't

¹ *Histoire du principe de relativité*. Paris: Flammarion, 1971.

² See f.i. A.I. Miller, *Einstein's Special Theory of Relativity...*, London: Addison-Wesley, 1981.

³ *Brit. J. Phil. Sci.*, 21 (1970), 317-342.

⁴ Alluding to a penetrating study by J. Earman in *Australian Journal of Philosophy*, 48 (1970), 287-317; cited incorrectly (!) in Ray's bibliography, p. 197.

⁵ Compare J. Norton's recent paper in *Studies in History and Philosophy of Science*, 16 (1985), 203-246 and *erratum*, *ibid*, 17 (1987), 131, not considered by Ray because of very recent publication.

⁶ "Über die Wirkung rotierender ferner Massen in der Einsteinschen Gravitationstheorie", *Physik. Zeitschrift*, 19 (1918), 33-38, and "Errata", *ibid.*, 22 (1921), 29-30.

claim to have given a fairly balanced overview on the 'evolution of relativity', not even since 1915 as one could expect from his chapter 3 ("Mainstream Classical Relativity"). His selective procedure leads to a spotlight-like illumination of some points of special interest for physicists and philosophers of science. This limited task however is fulfilled excellently, without too much mathematical formalism and yet detailed enough to give a fine-grained picture of complicated matters such as f.i. causal effects of a topological hole (p. 136 f.), the meaning of the cosmic censorship hypothesis (p. 139) or the argumentation leading to the Hawking-process of emission of radiation from a black hole (p. 145 f.) (all picked up from his forth chapter: "Classical and Quantum Relativity"). Many useful technical reviews and/or terminological distinctions introduced by persons working actively in the field (f.i. Hawking, Wheeler or Will) are integrated into context. Some interesting points as f.i. the connection between cosmological constant and QED vacuum renormalization⁷ could not be dealt with in Ray's quite condensed accounts.

In his final chapter, entitled "Relativity – Dead or Alive?", Ray tries to integrate the result of his study into the ongoing debate among philosophers of science about the structure of scientific theories and their historical (r)evolution. He pleas *against* a static view of science, normally fixed in periods of tenacy and immunized hard-cores *à la* Lakatos and Kuhn and *for* a model of theories as "evolving, dynamic theoretical context" (p. 189) with ongoing proliferation of competing and mutually contradictory ideas gradually gaining in respectability⁸. Scientific theories should be seen in the sense of Duhem-Quine-Hesse's "network-view" (p. 190), and could be provisionally structured into mainstream-variations and supporting ideas and disputed marginal elements (see his table on p. 176).

In some cases, a little more concern about historical matters could have been built in easily: instead of citing Mach's books with the irrelevant years in which the translations appeared, he could have introduced labels combining it with the year of first appearance in original language; that is: not "*Knowledge and Error* (1976)" (p. 2) but '... (1905/1976)' etc. Some titles in the bibliography are incorrectly given in English translation although the papers were written in German⁹.

Perhaps in a second edition these minor slipshods might be improved; in toto Ray's book is highly recommendable for persons interested in a up-to-date review of the current horizon of knowledge concerning fundamental scientific problems dealt with in GTR and related theoretical contexts.

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⁷ First pointed out by Zeldovich, *Sov. Phys. Uspekhi*, 11 (1968), 381.

⁸ Examples would be the "increasing dominance of the Robertson-Walker solutions" in cosmology (p. 191) or the slow accomodation of the physicist's community to strange concepts such as black holes and naked singularities (f.i. p. 156).

⁹ See: Einstein (1913), (1918), Einstein and Grossmann (1914) and Kretschmann (1917).