PETER ACHINSTEIN: *Particles and Waves. Historical Essays in the Philosophy of Science.* New York, Oxford: Oxford Univ. Press, 1991. 337 pp.

This book, written by a philosopher of science, collects methodological studies of three historical episodes in nineteenth-century physics which all involve the postulation of unobservable entities to explain observed phenomena. Part I (essays 1-4) deals with theories of light and with the debate between adherents of Newtonian (particle) and Huygensian (wave) models of light, part II (essays 5-9) deals with Maxwell and the Kinetic theory of gases, and part III (essays 10-11) with the relation of theory and experiments in J.J. Thomson's cathode ray experiments. All but two of the eight non-introductory essays have already been published before in scholarly journals such as, e.g., *SHPS*. Although there is thus some redundancy when reading all the essays of a part one after another, this drawback is more than compensated by the independent readability of all the essays which are so condensed anyway, that it is refreshing once in a while to encounter an already familiar claim.

In part I, Achinstein studies the debates between particle theorists and wave theorists, inquires to what extent particle physicists were in fact influenced not only by Newton's physics but also by his methodological position on 'hypotheses' as reconstructed in essay 2, and the author checks whether the methods actually practised by particle and wave theorists in the nineteenth century can really be contrasted against a division between inductivists and supporters of the method of hypothesis, respectively, as has been claimed by Geoffrey Cantor and Larry Laudan (cf. 27ff. for references and for a critique of these claims). In essay 4 of this part, Achinstein shifts the discussion to the famous debate between Mill and Whewell about the legitimacy of the method of hypothesis, which is relevant to the debate about light insofar as both thinkers applied their views to the wave theory. In this essay, Whewell's and Mill's positions are both reconstructed in terms of probability theory, although none of them actually used this framework for expressing his ideas, but Achinstein is of the opinion that only the probabilistic version of their position can clarify certain ambiguities in their claims. We have to be aware, though, that what results is more a useful contribution to *current* philosophy of science and theories of explanation than a truly *historical* understanding of what Mill and Whewell had in mind.

In part 2 of his book, Achinstein turns to Marxwell's development of the kinetic theory of gases, and in particular, to the question of what function Maxwell's derivation of a distribution law for molecular velocities might have had in the light of the fact that this law could not be directly tested until the late 1920's with the rise of molecular beam experiments (cf. p. 183 for a reference). Achinstein's claim is that Maxwell's derivation did not fulfill any of the functions of theoretical derivations envisaged by conventional philosophy of science, in particular there was no empirical testing of his theory, nor did it explain any known empirical fact, but rather, the author argues, that this derivation helped Maxwell to discover some new theoretical propositions and to provide an additional theoretical foundation for other parts of his theory (cf. p. 191 for a logical scheme and p. 200 f. for a summary). The reviewer agrees with Achinstein's point that the traditional repertoire of philosophy of science has to be broadened to be able to account for a much richer variety of functions which theoretical derivations might have, but he misses a sharper, more fine-grained description of what is rather vaguely described as 'theory' in Achinstein's reconstructions.

Part III deals with cathode ray experiments and the discovery of the electron, and raises a lot of interesting questions related to experimental practice and the philosophical evergreen of theory-ladenness of observations. It climaxes in a series of theses on the "relationships [plural!] between theory, theoretical consequences, and experimental results" (cf. 308-316) which the reviewer can all strongly support from his own case studies involving the interaction of theory, instrumental design and theoretical commitments.

Achinstein writes with great clarity, neatly contrasting different possible reconstructions of the historical case studies under scrutiny, and carefully evaluating different approaches such as hypothetico-deductivism, inductivism, or Achinstein's own conception of modes of explanation. The historical parts of his reconstructions are well researched, including references to most of the recent pertinent literature on his subjects, and thus serving not only as well-defined platforms for his penetrating methodological analyses, but also as neatly condensed introductions to the primary and secondary literature. Quotes and other primary material, such as for instance fig. 1 reproducing Baden Powell's comparison of particle and wave explanations of 1833 (though without precise reference!), are very carefully selected throughout the book and include not only well-known quotes but fairly new and interesting material such as, e.g., on p. 40 Newton's intended preface for the 1704 *Opticks*, reprinted by J.E. McGuire in *BJHS*, *18* (1970), 178-186, or Newton's definition of 'phenomena', intended for the second edition of the *Principia*, but only published much later by McGuire in *AHES*, *3* (1966), 238-239.

The reviewer is of the opinion that Achinstein's *modus operandi* in the writing of this "philosophical work that treats methodological issues generated in actual scientific episodes" (p. 8) should prove exemplary for future case studies wanting to link philosophy of science and history of science in an equally fruitful manner.

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