MATHEMATICAL AND PHYSICAL PAPERS

IN TWO VOLUMES

VOLUME I

MATHEMATICAL AND PHYSICAL PAPERS

BY

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PREFACE

MANY years ago an invitation came to the writer to adapt a collection of papers on electrodynamic theory into the form of a book for the Cambridge University Press. Some preparations were then made: but the material was felt to be incomplete, and its further development was delayed by administrative and other public duties that fell to his lot, and continued in various forms over twenty years. The project has now been resumed with a wider scope: about half of the present collection of papers is of electrical character, the other half being mainly General Dynamics and Thermodynamics including the dynamical history of the Earth, Formal Optics, and Geometry.

It may seem to be late to take up this thread: but among types of reasons that might be alleged, there is the circumstance that the history of progress of electrical theories towards a coherent system is still unwritten and possibly is hardly yet ripe for formulation. The systematic materials for it that are readily accessible are not plentiful: while every investigator bears the stamp of the domicile in which he has been brought up, of its contemporary literature and point of view with which he has been specially familiar. It might have been possible by condensations to reduce the electrical half of this volume by perhaps one-quarter of its extent. But, in deference to the advice that was open to him, the writer has abstained from that course. It was urged that out of regard for future historical interests, the order of succession in years should not be blurred. And, moreover, the governing motive for the production of memoirs in formal physical theory, the progressive clarification of the writer's own outlook, may be worth preserving.

In the present collection the names that recur most frequently are, after Faraday, those of Ampère, Helmholtz, Kelvin, Maxwell, also for the earlier time Stokes and Kirchhoff, for the later Rayleigh. They built the foundations for the present electric age: their theoretical message, the most fundamental since Newton, has now gone over largely, in simplified form, into the electrotechnic domain, where seizing in recent times on the practical possibilities opened up by the detection and identification of the free electron by Thomson, it is still the main guide in marvellous modern developments. The most interesting, even tantalizing, recent kaleidoscopic theoretical glimpses of an ordered under-world, emerging from an extensive field of correlations in atomic spectroscopy, in connection with the cardinal

phenomenon of the disintegration of atoms as discovered and very closely systematized by Rutherford at the beginning of the century and later, form a special domain, still mainly in the exploring and assembling stage, which appears only incidentally, as regards its remoter ideal sources, in these papers.

The writer has been allowed to counteract any inconvenience arising from discussions recurring in modified forms, by placing index headings along the margins of the pages. It can be held that the practical amenities of an unsystematic collection of papers can thereby in various respects be much enhanced.

Many footnotes and nine appendices have been added. To distinguish them, the footnotes to the original papers are now indicated by numbers, the new ones by asterisks and other such signs. Other incidental additions are enclosed in square brackets. Minor improvements and corrections, especially in algebraic typography, have been freely introduced: but it is hoped that substantial changes have not been made without suitable indications. The collection will be completed in a second volume.

The electromagnetic system of units, employed in Maxwell's and the other earlier classical writings, has been adhered to throughout. It is the foundation of universal electrotechnic practice, as settled long ago internationally: and any introduction now, alongside it, of more recent unitary schemes (see Appendix VI), which though more simple are no whit more rational, would, as troublesome experience shows, only produce confusion. For similar reasons the notation is throughout that of Maxwell's *Treatise*.

As was the custom of the time, the earlier papers on Electrodynamics proceed largely by help of auxiliary conceptual models of dynamical type, representing the aethereal systems that are involved. Afterwards there came a period of wide repudiation of such aids to theoretical construction, on the ground that the legitimate province of theory cannot extend beyond bare description of the course of Nature by means of equations: in contrast with Kelvin's creed that he could never be assured of the internal coherence and consistency of any complex scheme of equations until he could construct some sort of model of a process which they would represent. Abstract mathematicians, with their close attention to existence theorems, ought to be in sympathy. Without Maxwell's provisional models there would have been no electric theory of light. Without a model of an electron (cf. p. 514, *infra*) there would be no dynamically coherent notion, however provisional, of how one electric source can affect another across a distance. Indeed it might be imagined that a deeper knowledge of the electron must be awaited before

Maxwell's pressure of light is fully understood: now traced to a convected momentum of radiation, entirely foreign to the circuital equations of the field as hitherto considered by itself, as Kelvin did not fail to note, yet present and interchangeable on Amperean principles where the rays meet the flux of electrons. A closer scrutiny shows (cf. *infra*, p. 655) that the Maxwellian scheme, as translated into electrons alone, is wholly valid though incomplete: his aethereal medium in which the electrons subsist refuses to pass so entirely into the background. The ultimate foundation, covering relativity and all else, is the specification of the Action throughout this medium: from its analysis in relation to sources comes the electron scheme. But there are other things outstanding, including the momentum of radiation, which can be reduced to that simpler formulation only as regards interaction with aggregations of electrons, not with electrons individually. The absence or latency of the complementary atomic form, the positive electron, in the actual world must however be a deeper and an urgent problem.

More recently, the practice of reasoning by aid of conceptual models of mixed geometric-mechanical type, now more provisional, has been recovering its credit; for no progress at all in theories relating to processes in the interior of the atom is feasible without their assistance. This new development, mainly after the lead of N. Bohr, is in a different plane, recalling in some degree Newton's effort towards fitting together the fragments of an orbital Lunar Theory from the empirical features revealed by the observations, and also the formal constructions of organic chemistry.

Acknowledgment is due, and is now tendered, to the Royal Society, the Royal Society of Edinburgh, the Royal Astronomical Society, the Cambridge Philosophical Society, the London Mathematical Society, the Manchester Literary and Philosophical Society, and the proprietors of the *Philosophical Magazine* and of *Nature*, for consent to the re-publication of material from their collections.

The writer has much pleasure in acknowledging the expert co-operation of the staff of the Cambridge University Press, which has resulted in the production of this handsome volume.

J. L.

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