Preface to the Third Edition

Why would an author prepare a new edition of a forty-odd year old physics book? The short answer is that only in the last few years, a century old problem has been solved. The classical dynamics of charged particles has now become a completed theory.

Consider this history: the brilliant work of Hendrick Lorentz and Max Abraham deduced the dynamics of charged particles from Maxwell's equations; that dynamics was relativistically correct although it was developed before 1905 when Einstein published the special theory of relativity. Later, Dirac rederived the Lorentz-Abraham equations in a manifestly relativistic way (1938). For a full century, the Lorentz-Abraham-Dirac (LAD) equations have thus been the generalization to charged particles of Newton's fundamental dynamics.

But during all that time, people knew of a serious flaw in the LAD equations: they violate Newton's fundamental "law of inertia" that a body is not accelerated unless a force acts on it. Despite numerous unsuccessful attempts throughout the twentieth century (supplementing or modifying the LAD equations), this problem remained unsolved. The previous editions of the present book were written under that handicap.

Would it be worth a new edition if, finally, that old problem got solved? This is exactly what happened at the dawn of our new century. The present edition includes the new results. I tell how they came about, and I show how they complete the theory.

But there is more. Of all the symmetries of classical physics, the most recent and most intriguing symmetry is invariance under time reversal. This is the invariance of the fundamental equations under the reversal of time. Such a symmetry has in the past been shown to hold for quantum mechanics and quantum electrodynamics. It was also shown to hold for Maxwell's equations, but it has caused problems for the classical dynamics of charged particles. These problems have now also been resolved. The corresponding sections in the previous edition have been rewritten.

Finally, the theory as a whole must be related to the other physical theories: there is only one real world to be described by science so that the various descriptions by different theories must be interrelated. The present book is framed by this

concern. An introductory discussion on this interrelation (Chapter 1) is followed at the end by placing the classical dynamics of charged particles into the general web of theories (Section 9-5). I show how the foundations of the present theory are now complete within the theory's prescribed validity domain.

This concludes the long answer to the question for a justification of this new edition. There are of course also more conventional reasons for a new edition: better ways of explaining things, more recent and better references, and the correction of the inevitable misprints that plague all printed matter (without introducing new ones).

I want to thank the many people who have helped me over the years to improve my understanding of the subject matter. They have talked to me, written to me, and they published books and articles that were invaluable to me. I cannot possibly recall the names of all those to whom I am indebted for help. The references throughout the book do justice to only a fraction of the many sources I consulted.

Finally, I am grateful to World Scientific for producing such a well-printed book despite the complication due to the many mathematical symbols.

Fritz Rohrlich
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