Book Review


Despite its title and the reputation of its author as a relativist, this book only deals with special relativity and electromagnetism, and does not go into general relativity. It will probably be Laurent’s last work, having been completed just before his untimely death in 1993, and brought to press by his long-serving colleague Stig Flodmark. As such it is a very suitable book by which to remember a highly respected colleague and friend, whose influence went well beyond the impact of his own work by virtue of his leadership of the well-regarded Stockholm group.

One might justifiably groan at the prospect of yet another book on special relativity, but the approach taken here is rather different from the conventional one. Laurent begins by assuming there is no need to give reasons for the introduction of relativity or to arrive at it by an analysis of the experiments which showed that preceding theories were unsatisfactory. Instead he tells us he aimed to provide “a course on relativity for those who already believe in it”. The book is divided into three parts, Principles and Basic Applications, Tensors, and Electrodynamics, but the unapologetic approach and strong geometric flavour carry through all three.

To achieve his purpose, Laurent starts from a discussion of the measurement of time and acceleration (the Hafele–Keating experiment appears on the 6th page of text, although not all the experimental tests of special relativity are even mentioned, let alone discussed), and goes quickly to the ideas of space-time diagrams and parallelism of world lines. The maximal proper time concept is later used to explain the twin paradox.

The physical aspects are interleaved with the mathematical background. The first example is that a quick resumé of vector algebra, assuming familiarity with Euclidean vectors, brings us to the discussion of vectors in spacetime, which are the main vehicle for the discussion of the geometry and kinematics of special relativity. This is largely done in a
coordinate-free manner, of which I very much approve, but with frequent reference to a (3+1) split.

The concepts of the null cone, the split of timelike and spacelike vectors, future and past, the Lorentz transformation, and Lorentz contraction are all derived from this point of view. Plane waves are then introduced and used to derive Doppler shift and aberration (though Laurent omits the very neat form of this in terms of half-angles which is due to Penrose). Then come particle kinematics and conservation laws. This avoids the messy component-based calculations one finds in many texts in favour of an approach based on four-dimensional scalar products. Since this is the same approach I use myself, I naturally welcome its appearance here! To finish the first part, accelerated ("curved") worldlines are discussed, with the examples of constant acceleration, the well-known ‘fitting a car into a garage’ problem, and the rotating wheel, in which case Laurent mentions the fact, apparently unknown to some authors of papers submitted to this and other journals, that accelerated rigid rotation is impossible in relativity.

The introduction to tensors begins in a coordinate-free manner, and the very useful index notation is only introduced after its justification in terms of ‘abstract indices’ (also due to Penrose) has been mentioned. The approach is ingenious, starting with one-forms and rank two tensors and gradually building up the theory and its interpretation. The drawback is that it is perhaps more mathematically demanding than a conventional approach based on coordinates and components; in this it is more in line with a general relativity text. Volume is introduced without a metric and cleverly handled, including a derivation of the identities for alternating forms which was new to me. The part ends with a discussion of conserved currents.

All the ingredients are now in place for the third part, whose argument is to show how Maxwell’s equations can be arrived at by some intelligent postulates in four-dimensional terms starting from ideas of the wave equation and the necessity of restricting the possibilities as much as possible without eliminating any plane wave solutions. It works its way through the theory, finishing with the Liénard–Wiechert potential.

I found much to admire here, in particular the fact that great care had clearly been taken to think out anew how to present the subject. (Some of the things I found novel may of course appear elsewhere, but they are certainly not in the standard texts I know well.) On the other hand, there are good reasons for the conventional treatments being the way they are, not only because students find them easier to handle but also because they then fit well into a schedule of other courses. I would certainly recommend