Attributions and Misattributions at the Origins of Special Relativity

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Abstract. Minkowski wrote that a basic mathematical result (the Lorentz invariance of Maxwell equations) for the newborn special theory of relativity was 'the theorem of relativity by Lorentz'. We explain that this name is unwarranted, and that in fact among the founders of the theory it was Poincaré who came closest to proving it. It is argued that historians should be careful not to rely uncritically on the bits of historical reconstruction that for different purposes scientists insert in their technical papers.

Key words: special relativity; Lorentz transformations; electromagnetism; fields vs. potentials; Lorentz; Poincaré; Einstein; Minkowski.

1 Introduction

The history of science is only in part the business of historians, since it has also very much to do with the search for recognition, which is an obviously important concern for scientists. For this reason in their technical papers scientists: 1) select carefully their references (not always coinciding with their true sources); 2) refer to previous contributions with varying emphasis and acknowledgements; 3) insert explicit bits of historical reconstruction (usually in their introductory sections) about the topic to which they intend to contribute. Then it comes the time when, for

a sufficiently 'mature' research topic, scientists also edit a collection of 'main articles' (a 'reader'), which will become a standard reference for newcomers to the topic and for historians alike, and will favour the oblivion of all the other contributions.[1]

As a rule, historians build their own version of the facts helping themselves with the historical snippets provided in the technical papers and with the standard collections of papers. Also, when the secondary literature has grown to a sufficiently large amount, it tends to surrogate in the work of professional historians the direct consultation of the sources. The risk, as far as historical accuracy is concerned, is that an account which is to a considerable extent influenced, on one hand, by the drive to self-promotion and by school loyalty and, on the other hand, by uncritical reliance on the secondary literature may come to be elevated to historical truth and be perpetuated in science and history textbooks.

The main purpose of this talk is to provide an outline of our account[2] of a case of a remarkable, if neglected, case of 'authoritative misattribution' concerning the rise of special relativity.

2 Unifying the electric and the magnetic fields

The understanding of the relationship between the electric and the magnetic forces is a major research effort in Nineteenth Century physics, with fundamental contributions, either theoretical or experimental, from physicists such as Oersted, Faraday, Ampère, Maxwell and others. The culmination of this process can be seen in the formulation by Heaviside and Hertz of the so-called Maxwell equations, a building block and a model for subsequent theoretical physics. One of the basic mathematical targets of the founders of special relativity (namely, Lorentz, Poincaré,

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1 In the case of the theory of relativity this role was fulfilled by Einstein et al. 1923; the editors of this collection abstained from including any contribution by Poincaré.

2 A full account is given in Mamone Capria, Manini 2013.

Einstein, Minkowski)[3] was to show that those equations were, exactly or approximately, invariant under what Poincaré called in 1906 the *Lorentz transformations* (LT). This task involves, as a necessary ingredient, a derivation of the transformation laws of the electric and magnetic fields under LT.

Hermann Minkowski (1864-1911) gave this result the name of 'the theorem of relativity by Lorentz', emphasizing that it was a 'purely mathematical fact'.[4] It is important to keep in mind that Minkowski, an eminent mathematician, was highly qualified for making such a claim and that surely he was not the kind of scholar who could make it lightly. But was Minkowski's claim correct? And in case it was not, who was the author who came closest to proving that theorem?

An analysis of the main contributions to what is known today as special relativity in the years 1904-1909 leads to a rather surprising result, which can be summarized as follows

Lorentz did not prove the theorem Minkowski attributed to him, and, what is more, he was very far from even *trying* to prove it. Indeed, he was honest enough to admit as much in print some years later (in 1915), when special relativity was quite well received within an authoritative section of the physical community and was soon to be at the same time superseded and consecrated by the forthcoming general relativity (1915-1916).

As to Einstein, there is no doubt that in his electrodynamical paper of 1905 he *endeavoured* to prove that theorem, but his proof can be shown to have fatal flaws (it gives a sufficient, but not a necessary condition for the transformation of the fields), a fact that has passed more or less unnoticed by most commentators.

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3 Lorentz 1904; Poincaré 1905, 1906; Einstein 1905; Minkowski 1908, 1909, 1915.

4 Minkowski 1908, pp. 59, 54 (`Für jene ursprünglichen Gleichungen ist die Kovarianz bei den Lorentz-Transformationen eine rein mathematische Tatsache, die ich das *Theorem der Relativität* nennen will [...]').

It turns out that the first scientist who gave what amounts to a sketch of a correct proof was Poincaré (1854-1912).[5] Our reconstruction of his proof is partly conjectural, which is not surprising given Poincaré's expository style, but it rests on good textual grounds.

The technical part of our reconstruction turns around the way electric and magnetic fields are determined in Maxwell theory by charge and current distributions, and the expression of the fields in terms of retarded potentials obeying inhomogeneous wave equations. Poincaré was well aware of this formulation of Maxwell theory (which actually amounts to a more restrictive version of it), while in his article Einstein worked solely with fields, which made his proof of the uniqueness of the transformation law of fields seriously defective.

Minkowski knew well Poincaré's work, in both pure and applied mathematics, and did cite his main relativity paper.[6] So it is appropriate to ask why Minkowski should have missed an opportunity for giving Poincaré his due on this specific point (not to speak of other aspects of the newborn theory), and preferred instead to credit Lorentz with a mathematical discovery the latter had subsequently to deny having ever made. This is a kind of question which is in general rather difficult to answer, and that in our case is made especially difficult by the circumstance that both Minkowski and Poincaré died prematurely, in particular well before relativity had been widely recognized as a historical landmark by both specialists and cultivated people. However, a plausible answer can be devised by framing this episode in terms of the sociology of the national scientific communities of that time, and of the psychology of the individual scientists involved.[7]

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5 Note that his 1905 outline of the lengthy paper published in 1906 was registered at the French Academy of Sciences some three weeks before *Annalen der Physik* received Einstein's manuscript.

6 Poincaré 1906 is cited in Minkowski 1908, p. 54.

7 Mamone Capria, Manini 2013, sect. 6.

3 Commentary

Special relativity was the outcome of a complex development in the history of physics and of the philosophy of science, and the derivation of the transformation laws of the electric and the magnetic fields is just an ingredient (although a very important one) of the resulting theoretical building. We surmise that the emphasis commonly laid on the role of Einstein as opposed to that of other major scientists, in particular Poincaré, shows a degree of bias and of neglect of the historical and textual evidence. Our investigation provides a specific example where this bias can be proven in a rigorous way and traced back to its sources.

The recognition due to Poincaré has been too long obfuscated by a widespread overreaction to Whittaker's chapter on special relativity in his famous history of electromagnetism (`The relativity theory of Poincaré and Lorentz').[8] While the reconstruction presented there is in several ways unsatisfactory, the stress on the importance and primacy of Poincaré's contribution (to be more carefully separated from Lorentz's than Whittaker did) is on the whole warranted, and our analysis strengthens it in one point that, curiously, was ignored by both Whittaker and his critics. Just to put the whole debate in the right perspective, we should like to emphasize that both Einstein's and Poincaré's contributions to science have been so remarkable and wide-ranging, that although the priority issue concerning special relativity has much to teach from an epistemological and historical point of view, it is of little consequence as to the determination of their place in the scientific pantheon.[9]

We think that the case study we have presented is also relevant to contemporary concerns on the assessment of research and researchers through citation counting. In fact historians can help bibliometric scholars, through detailed examples, to reach a proper awareness that citations, and the failure of citing as well, have many, widely different functions, and

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8 Whittaker 1951-1953, vol. II, pp. 27-77.

9 In particular, as Max Born wrote: `In my opinion [Einstein] would be one of the greatest theoretical physicists of all times even if he had not written a single line on relativity […]' (Schilpp 1970, p. 163).

that in particular they cannot be conceived as evidence for straightforward, objective or even subjective, value judgements.

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