

Referee Report: On the Electrodynamics of Moving Bodies

Francisca Vasconcelos

In this referee report, on behalf of *Annalen der Physik*, I assess the submission *On the Electrodynamics of Moving Bodies*, by Albert Einstein. In this work, the author proposes a radical new way of thinking about time and the propagation of light. While the paper has enormous potential, to at least spur important discussions in the physics community, there are some aspects in which it could be much stronger. I find three main areas of concern: lack of experimentation (performed or referenced), questionable handling of the role of the ether, and issues with one of the postulates. Since the work is quite novel and thought provoking, I am willing to give it the benefit of the doubt, even though I am not fully convinced that the ideas will be proven correct. However, the obvious weaknesses must be addressed. I thus recommend that the paper be resubmitted after a revision addressing the concerns expounded in this report.

Let us begin with the strengths of the paper, which in my opinion justify the resubmission. The author seems to have an unusual background and does not approach the problems discussed in the paper like any other submission I have previously reviewed. Rather than trying to add to existing experimental or theoretical knowledge, he aims for something much more bold: an explanation as to why two existing equations (by Maxwell), appear to explain the same phenomena differently¹. While some may catalogue this goal as futile, I see it as a breath of fresh air that could have significant ramifications for physics. After all, the ultimate goal of our discipline is to derive simple and concise mathematical explanations for the

¹Einstein, Albert. 1905. “On the Electrodynamics of Moving Bodies.” In *Albert Einstein’s Special Theory of Relativity: Emergence (1905) and Early Interpretation (1905-1911)*, ed. Arthur I. Miller (Reading: Addison-Wesley Publishing Company, Inc., 1981), 392-396, on 392

workings of the universe. While it is true that the current understanding of electromagnetism is sufficient to allow precise calculations, I agree with the author that something is missing. Clearly, our understanding cannot be complete if the same physical process can be explained by two entirely different approaches. There must exist some higher order explanation encapsulating the two phenomena, which is exactly Einstein's hypothesis. Hence, while some aspects of the paper are questionable, as will be addressed later, his ideas could be significant. In particular, if his theory holds true, it could unleash an entirely new way of thinking not only about Maxwell's equations, but about the notion of time itself. This could bring forth an entirely new era of physics. In this sense, the work has the potential to be truly revolutionary. Conversely, if it turns out that the author is wrong, it will at least motivate the physics community to reflect on the the most basic physical quantities, such as time, whose definition has mostly been taken for granted. I thus find the Machian approach of Einstein refreshing and believe that the greater physics community will as well.

That being said, I believe the paper is not yet up to the standards of *Annalen der Physik*. While the paper is mostly conceptual, this does not excuse the lack of references to an entire experimental literature on problems related to the one it addresses. Even worse, I think that there is little use for a theoretical paper that does not identify at least some experiments that could be performed to test the theory it proposes. Although the author opens (and justifies) the work with a moving coil and magnet experiment, this is somewhat of a toy experiment. It would be much more convincing to see other real-world phenomena that the theory could explain. The author does use examples involving clocks and measuring rods throughout the paper,² as a means to explain his thought process. However, these are

²Einstein, "Electrodynamics of Moving Bodies," on 393-396

purely thought experiments. In actuality, there exist no devices fast or precise enough to measure the slow-down of a clock or the contraction of a rod, so as to quantify the relativistic effects Einstein describes (the speed of light is far too great!). Particularly concerning is the author's failure to cite the work of Michelson or Lorentz. The paper has clear overlap with the interferometry work performed in the 1880s and Lorentz's transformation (1890s). However, nowhere in the paper are either of these important contributions even footnoted! I find this highly problematic.

A second concern is the quick dismissal, by A. Einstein, of the luminiferous ether, which I find totally unjustified.¹ The ether has been a subject of great attention in the physics community, predating the days of Faraday. The author simply offers a one-sentence dismissal of over a century of work on this topic. To be quite frank, I find this pretentious and off-putting. I thus believe that the connections between Einstein's ideas and the role of the ether should be discussed in detail. More precisely, I think that the paper would benefit tremendously from a discussion on the explicit relationship between relativity and ether. Even if the author believes that the ether simply does not exist, he must present a clear explanation as to why. In summary, the paper must address where the ether fits within this new approach to physics or otherwise prove that the ether does not exist.

My final concern is motivated by the technical content itself. One of the two central postulates proposed by the author is "the constancy of the velocity of light," or that "any ray of light moves in the 'resting' coordinate system with the definite velocity c , which is independent of whether the ray was emitted by a resting or moving body."³ It is unclear to me why this must hold true and why it only pertains to light. Why do soccer balls or waves in the

³Einstein, "Electrodynamics of Moving Bodies," on 395

ocean act any differently from electromagnetic waves in terms of relative motion? While this appears to be the basis for the theory, I have little idea of how it could be justified. Perhaps further elaboration into the thought process, or the proposal of a concrete experiment, would help clarify this point. It is a bold assertion and clearly the author has strong reasons to believe it, given that he used it as a foundation for his entirely new theory. The ensuing equations and logic I find sound. My concern is whether this fundamental postulate is valid.

Overall, I found the paper a breath of fresh air that will, in the least, elicit exciting discussions within the physics community. In particular, I expect this bold new outlook on Maxwell's equations and time in general to be of interest to the readers of the *Annalen der Physik*. However, in order to ensure that journal quality standards are met, I recommend that we ask the author to address the issues of references, discussion of the ether, and clarification of his second postulate, as discussed in this referee report.

Bibliography

Einstein, Albert. 1905. "On the Electrodynamics of Moving Bodies." In *Albert Einstein's Special Theory of Relativity: Emergence (1905) and Early Interpretation (1905-1911)*, ed. Arthur I. Miller, 392-396. Reading: Addison-Wesley Publishing Company, Inc.