The Understanding of Michelson's Experiment – Paving the Way for Einstein?

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The label 'Michelson-Morley experiment' is used to describe a series of experiments carried out by ALBERT A. MICHELSON and others. In 1881 and 1887 he performed ether-drift experiments which later became famous. The Michelson-Morley experiment aimed at measuring the earth's velocity relative to the all-pervading ether. But the results seemed to be zero: "*the result of the hypothesis of a stationary ether is thus shown to be incorrect*", MICHELSON wrote. The history of the experiment has been covered in various papers, e. g. by ROBERT S. SHANKLAND and in LOYD S. SWENSON's 1972 book 'The ethereal aether'. The experiment has been seen as a milestone in the history of science and as one of its most fascinating experiments. It has been one of the most popular subjects for case-studies in the history of physics. As an experimental proof for the theory of relativity and as a disproof of the theory of electromagnetic ether, the Michelson-Morley experiment also found its way into science textbooks. After initially being accepted by the majority of historians of science, this traditional perception increasingly has been rejected in the second half of the 20th century.

Did MICHELSON "*pave the way*" for the theory of relativity, as ALBERT EINSTEIN put it in 1931? In my talk I won't discuss to what extent EINSTEIN knew about MICHELSON's results before 1905. I will rather take a look at the historical change of the understanding of the Michelson-Morley experiment and state some interpretations of its contemporary significance.

In 1969 GERALD HOLTON published a survey on science textbooks. One of his results was that in many of them the Michelson-Morley experiment was referred to as a crucial experiment or an empirical proof for special relativity. Here the history of the genesis of relativity is told from a today's point of view. In the 1990s HARRY M. COLLINS and TREVOR J. PINCH obtained equivalent results in a similar analysis. Textbooks use the experiment as a didactical tool in order to motivate the theory of relativity in terms of inductive reasoning and experimental evidence. But this perspective tends to get the facts historically wrong. The so-called 'Whiggish' history of science judges the past by the standards of what currently is accepted as true in science. Moreover, it refuses to take into account contemporary perceptions that meanwhile may have changed. As this perspective tells the historian mainly about his present perception, it hardly bears any historical conclusions. Hence, it is anachronistic to see the Michelson-Morley experiment as a forerunner which inevitably led to special relativity and thus it is no historical analysis at all. Therefore, COLLINS and PINCH emphasized the need "*to see the experiment through Michelson's eyes, as an earth speedometer*".

In the 1960s IMRE LAKATOS denied that the Michelson-Morley experiment was an *experimentum crucis* in its time. There are general objections against the concept of crucial experiments, raised e.g. by PIERRE DUHEM. Also, LAKATOS argues that only in retrospect an experiment can be regarded as decisive. This explains why from a Whiggish point of view the experiment seems to be crucial. In 1983 IAN HACKING criticized LAKATOS' analysis for its lack of historical accuracy. He opposed LAKATOS' theory-dominated description with an experimenter's attitude.

Again, did MICHELSON pave the way for EINSTEIN? This question continues to be controversially discussed, one problem being that the meaning of 'paving the way' is not exactly defined. However, what can be learned from analyzing the history of the understanding of the Michelson-Morley experiment? First of all, it suggests identifying and rejecting Whiggish perceptions of history of science. Further on, following HACKING, it is worthwhile studying if a theory-dominated perspective restricts the possible findings of history of science. I therefore moot the question, if in the case of the ether-drift experiments there is a substantial difference between interpretations given by historians of science with a rather theoretical background in physics and interpretations given by historians of science with a rather experimental background in physics.