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The Law of the Lever According to Mach: historically and critically presented

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One of the first attempts at a coherent integration of history of science [HS] and philosophy of science [PS] is Mach's *Die Mechanik in ihrer Entwicklung: historisch-kritisch dargestellt*, published in 1883. The book's subtitle, "historically and critically presented", suggests a philosophically informed history and, equally, an historically informed philosophy. Indeed, *Die Mechanik* is not a treatise on the application of the principles of mechanics; rather, as Mach states, the "aim is to clear up ideas, expose the real significance of the matter, and get rid of metaphysical obscurities." This is no doubt a philosophical aspiration. But Mach goes on to say that his treatise will enlighten the reader on the way "the principles of mechanics have been ascertained, [and] from what sources they take their origin", which is clearly an historical perspective. He then adds that he seeks "to convince the reader that we cannot make up properties of nature with the help of self-evident suppositions, but that these suppositions must be taken from experience." We will argue that Mach's commitment to this "ideology" was too strong for him to resist appealing to it, so much so that, in Heinz Post's phrase in "Against Ideologies", he did not keep his "critical powder" dry, with the result that his philosophy came to dominate his history. We focus on one case of Mach's historical and philosophical analysis of mechanics, limiting our attention to his account of Archimedes's derivation of the law of the lever.

We consider it productive to draw attention to Mach's treatment of historical sources, especially since it is a common practice among philosophers of science to (mis)use history in the name of one or another philosophical "ideology". Many a philosopher has claimed to have shown "How science works" on the basis of some fictional account of science. Mach provides a good illustration of this widespread practice since he explicitly recognizes the importance of a close reading of the historical record; nevertheless, his interpretation of the text is so ideologically motivated that this account of Archimedes's law of the lever says more about Mach than it does about Archimedes. Moreover, we will see in this case that not only has the history been distorted, but the motivating philosophy was misconceived. Mach proposed to treat HS and PS equally—but we will argue that his practice differed from his stated intention. We will present a brief account of our own view of the case which, we believe, is faithful to the manifesto of &HPS.

We suggest looking—as much as the historical record allows—backwards rather than forward: it is better to examine Archimedes's sources rather than to impose a current view on his work. We ask, Whose science do we explore—ours, or Archimedes's? This issue is critical since taking the former position will consistently exhibit, by the very nature of the method of inquiry, an epistemic uniformity which is incompatible with the historical fact of the growth of scientific knowledge. Our goal is to identify and analyze the underlying philosophical principles of the scientific text at hand—the methodology that had been applied by the author—appealing to concepts and theories that were available to the practitioner at the time, rather than to concepts and theories that were introduced subsequently. Thus, history indicates plurality, while philosophy seeks uniformity. Put differently, history witnesses a variety of different scientific practices; philosophy, on the other hand, searches for a limited number of unifying principles which underpin scientific knowledge. How then should &HPS bring these two poles together?

The key to a possible solution of this problem is an initial suspension of judgment: first examine the nature and meaning of the text; then determine its philosophical underpinning, the methodological framework which will inform the historical account. This process has a complex dynamic. To be sure, we are aware of the fact that the examination of any text inevitably begins with some preconceived ideas, some

assumptions external to the original text, for we are right at the center of the hermeneutic circle. To break it, we suggest introducing a kind of iteration in which history and philosophy “cooperate” with each other as a checking procedure that allows for corrections and fine-tuning. In other words, history and philosophy should interact in a “feedback mechanism” rather than in a linear fashion. The iterative procedure should continue till the analyst is satisfied that he or she has reached a consistent understanding of the text which coheres with its context. The methodological framework clearly puts constraints on the historical account, while history locates the text in context, that is, the relevant background material.

However, we object not only to making HS subservient to PS, but also to the very nature of Mach’s critique, that is, his PS is faulty. Mach applied horizontal bilateral symmetry as a perceptual means of rendering experience into articulated scientific knowledge. But this limited appeal to symmetry misses the great power of this scientific concept—which was already in place at the time Mach published his *Mechanik*—as a principle of knowledge that provides insight into mathematical structures. Such structures are essentially abstract entities (with no perceptual quality), and with them one can identify a priori relations in science. However, Mach failed to take advantage of this aspect of the concept.

Our tale is cautionary. Mach is rightly considered a pioneer in weaving together HS and PS. Mach’s use of HS as a critical means for interpreting and illuminating epistemological problems in science had a liberating influence on the minds of the young scientists of subsequent generations such as Hertz and Einstein. But Mach’s valuable approach to scientific knowledge is achieved at a price: he promoted his own (faulty) philosophical view of scientific knowledge which led to a biased approach to HS.