Poincaré on the relativity of space and space-time

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Abstract

One of the enduring challenges for the interpreter of Poincaré is to understand the connections between his analysis of the geometry of space and his view of the development of the theory of space-time. On the one hand, he saw that the invariance group of electrodynamics determines a four-dimensional space with a peculiar metrical structure. On the other hand, he resisted Einstein's special theory of relativity, and continued to regard the Newtonian space-time structure as a sufficient foundation for the laws of physics. Thus Poincaré did not treat the fundamental symmetry that he discovered in the way that Minkowski did, that is, as the fundamental symmetry group of space-time itself. One way of approaching this circumstance is to ask, to what extent was his comparatively conservative treatment of electrodynamics influenced by his conventionalist approach to geometry in general? I propose to begin with a related but quite different question, namely, why did not Poincaré extend to space-time the kind of epistemological analysis that he had applied, with such success, to the notion of space? It might be argued that his argument for resisting relativity was identical to his argument for resisting non-Euclidean spatial geometry: that it is a matter of conventional choice, in which physicists are justified in choosing the simplest possibility. But this is a crucial part of the context, not a complete explanation. I suggest that a fuller understanding requires an understanding of the privileged position that space plays, according to Poincaré, in our conception of the physical world, and particularly in the construction of the fundamental concepts by which physical processes submit to objective measurement. Poincaré's epistemological analysis of the construction of space could be extended to the construction of space-time, and it was Minkowski who argued that, given the new developments in electrodynamics, such an extension was epistemologically necessary. From this perspective, Poincaré's position results from granting the concept of space an epistemological priority that, in the face of modern physics, it was unable to sustain.