Minkowski and the development of relativistic mechanics

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Historians and philosophers of science writing about special relativity have largely focused on the theory's consequences for our concepts of space and time. Accordingly, most work on Minkowski's contribution to special relativity focuses on the space-time geometry presented in his famous 1908 talk "Space and time." However, the new kinematics proposed by Einstein and codified geometrically by Minkowski also has profound consequences for mechanics. Contrary to what is suggested by Einstein's 1905 paper, this is not simply a matter of inserting a few factors of gamma into F=ma to produce a Lorentz-invariant version of Newton's second law. In an unpublished review article on special relativity written around 1912, Einstein himself actually identified the development of a new relativistic continuum mechanics in terms of stress-energy-momentum (SEM) tensors to replace Newton's F=ma as the fundamental framework for dynamics as "the most important new advance" in relativity. Einste
in listed the names of Minkowski, Abraham, Planck, and Laue in connection with this development. Einstein himself contributed to it, in particular through his work with Laub in 1908-1909 on the electrodynamics of moving media. It was Minkowski who first introduced the SEM tensor for the electromagnetic field in his 1908 paper "On the fundamental equations for electromagnetic phenomena in moving media." Taking the relevant sections of Pauli's famous 1921 review article and Stachel's editorial note on the Einstein-Laub collaboration in the Einstein edition as our main guides, we examine the debate led by Abraham over the correct form of this particular SEM tensor and trace its generalization by Planck and Laue from a key quantity in relativistic electrodynamics to the central quantity in the new framework for relativistic mechanics.