

On Hermann Minkowski's scientific methods of discovery and the ontology of the substantial point or the *Weltpunkt* and the *Weltlinien*

In his talk *Raum und Zeit* on September 21, 1908, at Cologne at the *Versammlung der Naturforscher*, Hermann Minkowski invented new concepts in order to explain his mathematical account of relativity. Based on everyday perception the following holds according to Minkowski: „Objects of our perception are always places and times, connected. No one observed a place without at a time, a time without at a place.“¹ He uses this picture to challenge Newtonian mechanics and to fade somehow away space in itself and time in itself, as promised in the introductory paragraph of his talk. This perception graphically shaped results in a connection of the old three-dimensional coordinates x, y, z – taken from classical geometry – with the variable for time, t . As long as Minkowski speaks of values of coordinates, when he defines a *Weltpunkt*, he remains in in the sphere of pure mathematics or analytic geometry, although not classical. But for Minkowski, there exists everywhere and at every particular time something that can be observed, because there cannot be emptiness. Instead of matter or electricity Minkowski uses for this something the word substance, and the *Weltpunkt* is in this sense a *substantial Weltpunkt*. This *substantial Weltpunkt* constitutes a curve in the world, namely a *Weltlinie*, of which the substantial points can be unambiguously related to the parameter t from – infinite until + infinite, where $t = 0$ gets a crucial role in the equalitional system of relativity. In the end the world is constituted by the whole variety of *Weltlinien*.

In my paper I focus on the ontological considerations and assumptions², namely on the substantial points in the *Weltlinien*, which go further than mathematics or physics, and would like to show that Minkowski's trial to fade away space in itself and time in itself and Newtonian mechanics brought about its own limits. Based on that I investigate the scientific methods³ Minkowski used and it seems that he intuitively used a variety of scientific methods, however, specifically the scientific method of abduction, as it was formulated by Charles Sanders Peirce.

