

## Event Structural Realism and Spacetime Metaphysics

This paper aims to provide a realist interpretation of Minkowski space-time by integrating event ontology and ontic structural realism.

The first part introduces the fundamental concepts of ontic structural realism and briefly demonstrates how space-time can be described within this framework. It also addresses a significant objection against ontic structural realism from a more empiricist standpoint, which criticizes its lack of a consistent metaphysical conception of structure. This deficiency leads, among other issues, to the elimination of the distinction between the mathematical and the physical.

In the second part I introduce the event ontology framework and demonstrate how it contributes to a clearer understanding of the ontological status of structures within scientific discourse. I argue that observation sentences can be reformulated as sentences about occurrences of specific events. Furthermore, I argue that every combination or sequence of events can be regarded as a new, complex event. Building upon this general idea of the event ontology, I argue that all relations between observables can be interpreted as occurrences of events: that is, structures are basically not mathematical entities, superimposed onto physical reality, but they are occurring relations between observable events, that *happen* to be organized in a certain way. From this viewpoint, what there is is not the structure itself but the event of realization of structure.

In the third part, I apply the event structural realism approach to two case studies: the dynamics of free relativistic particles and the fiber bundle description of the electromagnetic field. I argue that event structural realism entails realism about Minkowski space-time.

In the first case study, I demonstrate that the event-structuralist description of the motion of free relativistic particles leads to realism about their world lines. I argue that positing the reality of particles is equivalent to positing the occurrence of their world lines in Minkowski space-time. In other words, the very being of a particle can be interpreted as the occurrence of its world line.

In the second case-study I try to generalize the idea of world line realism, addressing dynamics of the electromagnetic field. I illustrate the transition from the discourse of measurable electric and magnetic fields to that of the  $U(1)$  fiber bundle and argue that, from the perspective of event ontology, the electromagnetic field can be seen as a perduring occurrence of the  $U(1)$  fiber bundle over the Minkowski space. Furthermore, I contend that in this perspective, what should be considered as ontologically real are not the values of the electric and magnetic field strengths at different points, nor the unobservable values of vector potentials, but rather the event-like structural relations that connect the values of these fields in different points. The values of the fields themselves are, in turn, not ontologically independent, but should be considered as elements of the realization of the eventual structure of the fiber bundle of the gauge theory.

Summing up, I demonstrate how in both cases one transitions from the discourse of immediately observable events to that of Minkowski space-time. I assert that any individual observation event is not something independent but is part of a more general event—the evolution of a given physical system in Minkowski space-time. Consequently, I claim that space-time itself can also be described as a background event which is occurring in every observable motion of physical systems.