

Holism and Structuralism in U(1) Gauge Theory

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Abstract

After decades of neglect philosophers of physics have discovered gauge theories--arguably the paradigm of modern field physics--as a genuine topic for foundational and philosophical research. Incidentally, in the last couple of years interest from the philosophy of physics in structural realism--in the eyes of its proponents the best suited realist position towards modern physics--has also raised.

This paper tries to connect both topics and aims to show that structural realism gains further credence from an ontological analysis of gauge theories--in particular U(1) gauge theory. In the first part of the paper the framework of fiber bundle gauge theories is briefly presented and the interpretation of local gauge symmetry will be examined.

In the second part, an ontological underdetermination of gauge theories is carved out by considering the various kinds of non-locality involved in such typical effects as the Aharonov-Bohm effect. The analysis shows that the peculiar form of non-separability figuring in gauge theories is a variant of spatiotemporal holism and can be distinguished from quantum theoretic holism. In the last part of the paper the arguments for a gauge theoretic support of structural realism are laid out and discussed.

Keywords: Gauge theories, gauge symmetry, ontological underdetermination, holism, non-separability, structural realism

[General Issues: Reductionism/Holism](#)

Subjects: [Specific Sciences: Physics: Fields and Particles](#)

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