

Gauge Theories and Holisms

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Abstract

Those looking for holism in contemporary physics have focused their attention primarily on quantum entanglement. But some gauge theories arguably also manifest the related phenomenon of nonseparability. While the argument is strong for the classical gauge theory describing electromagnetic interactions with quantum "particles", it fails in the case of general relativity even though that theory may also be formulated in terms of a connection on a principal fiber bundle. Anandan has highlighted the key difference in his analysis of a supposed gravitational analog to the Aharonov-Bohm effect. By contrast with electromagnetism in the original Aharonov-Bohm effect, gravitation is separable and exhibits no novel holism in this case. Whether the nonseparability of classical gauge theories of non-gravitational interactions is associated with holism depends on what counts as the relevant part-whole relation. Loop representations of quantized gauge theories of non-gravitational interactions suggest that these conclusions about holism and nonseparability may extend also to quantum theories of the associated fields.

Keywords: holism, gauge, nonseparability, electromagnetism, gravitation, Yang-Mills

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