Aspects of Objectivity in Quantum Mechanics

Brown, Harvey R (1998) Aspects of Objectivity in Quantum Mechanics.

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Abstract

The purpose of the paper is to explore different aspects of the covariance of (mostly) non-relativistic quantum mechanics. First, doubts are expressed concerning the claim that gauge fields can be 'generated' by way of imposition of (local) gauge covariance of the single-particle wave equation. Then a brief review is given of Galilean covariance in the general case of external fields, and the connection between Galilean boosts and gauge transformations. Under time-dependent translations (and hence non-instantaneous boosts) the geometric phase associated with Schrödinger evolution is non-invariant, and the significance of this result is briefly analysed. The covariance properties of Schrödinger dynamics are then brought to bear on certain versions of the modal interpretation of quantum mechanics. The conclusion that it is only relational properties that can be considered coordinate- or gauge-independent elements of reality is reinforced by appeal to the theory of quantum reference frames due to Aharonov and Kauffher. (This paper appeared in "From Physics to Philosophy", J. Butterfield and C. Pagonis (eds.), Cambridge University Press (1999); pp. 45-70.)

Keywords:	quantum mechanics, Galilean covariance, gauge invariance, geometric phase, quantum reference frames
Subjects:	Specific Sciences: Physics: Quantum Mechanics
ID Code:	223
Deposited By:	Brown, Harvey R
Deposited On:	11 April 2001