proceedings

Abstract

Quantum Metrology and Relativistic Symmetries †

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† Presented at Symmetry 2017—The First International Conference on Symmetry, Barcelona, Spain, 16–18 October 2017.

Published: 3 January 2018

Modern metrology is based on quantum and relativistic physics. The second is defined as a fixed integer number of periods of atomic caesium clocks while the meter is derived from the exact value fixed for the speed of light in vacuum c. Clock synchronization, distance measurement (ranging) or localization in space-time (GNSS localization) are built on the remote distribution of electromagnetic field phases. In 2018, the Planck constant h and elementary charge e should be defined to have exact values, replacing the old definitions of the kilogram and Ampere units.

However, the quantum status of time, space and mass observables and its compatibility with relativistic symmetries remain open questions. We address this problem in a quantum algebraic approach where observable positions in space and time are defined so that they obey relativistic and quantum requirements [1]. A mass observable is defined which is no longer a constant as expected from its dimension with respect to dilatation.

The commutators of quantum positions involve spin, and frame transformations to accelerated frames differ from their classical counterparts [2]. Relativistic symmetries nevertheless allow one to extend the covariance rules of general relativity to the quantum algebraic framework [3]. It leads to a quantum version of the Einstein equivalence principle identified to the transformation of the mass observable.

References

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