Mathematical Physics

# Unitary representations of the Galilean line group: Quantum mechanical principle of equivalence

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We present a formalism of Galilean quantum mechanics in non-inertial reference frames and discuss its implications for the equivalence principle. This extension of quantum mechanics rests on the Galilean line group, the semidirect product of the real line and the group of analytic functions from the real line to the Euclidean group in three dimensions. This group provides transformations between all inertial and non-inertial reference frames and contains the Galilei group as a subgroup. We construct a certain class of unitary representations of the Galilean line group and show that these representations determine the structure of quantum mechanics in non-inertial reference frames. Our representations of the Galilean line group contain the usual unitary projective representations of the Galilei group, but have a more intricate cocycle structure. The transformation formula for the Hamiltonian under the Galilean line group shows that in a non-inertial reference frame it acquires a fictitious potential energy term that is proportional to the inertial mass, suggesting the equivalence of inertial mass and gravitational mass in quantum mechanics.

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