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SUMMARY OF A NON-UNIQUENESS PROBLEM OF THE COVARIANT DIRAC THEORY AND OF TWO SOLUTIONS OF IT

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Abstract. We present a summary of: 1) the non-uniqueness problem of the Hamiltonian and energy operators associated, in any given coordinate system, with the generally-covariant Dirac equation, 2) two different ways to restrict the gauge freedom so as to solve that problem, 3) the application of these two ways to the case of a uniformly rotating reference frame in Minkowski spacetime. We find that a spin-rotation coupling term is there only with one of these two ways.

1. Introduction

1.1. Experimental Context

The following quantum effects in the classical gravitational field are observed on Earth for neutrons (which are spin $\frac{1}{2}$ particles) and for atoms

- The COW effect - the gravity-induced phase shift was measured by neutron [14] and atom [25] interferometry
- The Sagnac effect - the Earth-rotation-induced phase shift was measured by neutron [29] and atom [17] interferometry
- The Granit effect - the quantization of the energy levels was proved by observing a threshold in the neutron transmission through a thin horizontal slit [21].

To this author's knowledge, these are the only observed effects of the gravity-quantum coupling. This motivates work on the curved-spacetime Dirac equation (thus first-quantized theory).