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The Electron Mass from Deformed Special Relativity

Contents

1. Introduction 11

2. Deformed Special Relativity in Four Dimensions (DSR4) 12
2.1. Deformed Minkowski Space-Time 12
2.2. Energy-Dependent Phenomenological Metrics for the Four Interactions 12

3. LLI Breaking Factor and Relativistic Energy in DSR 13

4. The Electron as a Fundamental Particle and Its "Geometrical" Mass 14

5. Conclusions 15

Abstract

Deformed Special Relativity (DSR) is a generalization of Special Relativity based on a deformed Minkowski space, i.e. a four-dimensional space-time with metric coefficients depending on the energy. We show that, in the DSR framework, it is possible to derive the value of the electron mass from the space-time geometry via the experimental knowledge of the parameter of local Lorentz invariance breakdown, and of the minkowskian threshold energy $E_{0,em}$ for the electromagnetic interaction.

1. Introduction

In the last years, two of the present authors (F.C. and R.M.) proposed a generalization of SR based on a "deformation" of space-time, assumed to be endowed with a metric whose coefficients depend on the energy of the process considered[(1)]. Such a formalism (*Deformed Special Relativity*, DSR) applies in principle to *all* four interactions (electromagnetic, weak, strong and gravitational) — at least as far as their nonlocal behavior and nonpotential part is concerned — and provides a metric representation of them (at least for the process and in the energy range considered)[(1–4)]. Moreover, it was shown that such a formalism is actually a five-dimensional one, in the sense that the deformed Minkowski space is embedded in a larger Riemannian manifold, with energy as fifth dimension[(5)].

In this paper, we will show that the DSR formalism yields an expression of the electron mass m_e in terms of the parameter δ of local Lorentz invariance (LLI) breakdown and of the threshold energy for the gravitational metric, $E_{0,grav}$ (i.e. the energy value under which the metric becomes Minkowskian). This allows us to evaluate m_e from the (experimental) knowledge of such parameters.

The organization of the paper is as follows. In Sec. 2 we briefly introduce the concept of deformed Minkowski space, and give the explicit forms of the phenomenological energy-dependent metrics for the four fundamental interactions. The LLI breaking parameter δ_{int} for a given interaction is introduced in Sec.3. In Sec. 4 we assume the existence of a stable fundamental