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METRIC DESCRIPTION OF INTERACTIONS IN A DEFORMED MINKOWSKI SPACETIME[1]

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A recent analysis of the experimental data on some physical phenomena governed by the four fundamental interactions (i.e. the superluminal propagation of evanescent electromagnetic waves in waveguides; the mean lifetime of the meson K_S^0; the Bose-Einstein correlation in pion production; the slowing-down of clocks in the gravitational field of the Earth) seems to show the possibility of describing such processes (and the corresponding interactions) in terms of a "deformation" of the usual Minkowski spacetime, with a metric whose coefficients depend on the energy of the process considered.

Метрическое описание взаимодействий в деформированном пространстве Минковского
Фабио Кардоне, Роберто Миньяни

Проведенный в последнее время анализ экспериментальных данных о некоторых физических явлениях, связанных с четырьмя фундаментальными взаимодействиями (т.е. о сверхсветовом распространении проходящих электромагнитных волн в волноводах; о среднем времени жизни мезона K_S^0; о бозе-эйнштейновской корреляции рождения пионов; о замедлении часов в гравитационном поле Земли) показывает, что подобные процессы (и соответствующие взаимодействия) можно, по-видимому, описывать как "деформацию" обычного пространства-времени Минковского, с метрикой, коэффициенты которой зависят от энергии рассматриваемого процесса.

The geometric structure of the physical world, both at a large and small scale, has been debated for a long time. After Einstein, the generally accepted view considers the arena of physical phenomena as a four-dimensional spacetime, endowed with a *global,* curved, Riemannian structure and a *local,* flat, Minkowskian geometry.

However, a recent analysis of some experimental data concerning physical phenomena governed by different fundamental interactions seems to provide evidence for a local departure from Minkowski metric [1–6]: among them, the lifetime of the (weakly decaying) K_s^0 meson [7], the Bose-Einstein correlation in (strong) pion production [8] and the superluminal propagation of electromagnetic waves in waveguides [9]. These phenomena seemingly show a (local) breakdown of the Lorentz invariance, together with a plausible inadequacy of the Minkowski metric; on the other hand, they can be interpreted in terms of a deformed Minkowski spacetime, with metric coefficients depending on the energy of the process considered [1–6].

All the above facts suggested a (four-dimensional) generalization of the (local) space-time structure based on an energy-dependent "deformation" of the usual Minkowski geometry, whereby the corresponding deformed metrics ensuing from a fit to the experimental data seem to provide an *effective dynamical description of the relevant interactions* (*at the energy scale and in the energy range considered*).

An analogous energy-dependent metric seems to hold for the gravitational field (at least locally, i.e. in a neighbourhood of the Earth), when analyzing some classical experimental data concerning the slowing down of clocks [10].

Let us shortly review the main ideas and results concerning the (four-dimensional) Minkowski spacetime.

The four-dimensional "deformed" metric scheme introduced in [1-6] is based on the assumption that the spacetime, in a preferred frame which is *fixed* by the

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