DEFINITION OF FINITE SIZE AND VARIABLE MASS OF PHOTONS IN THE EXTENDED SPACE MODEL

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In the ESM 5-vectors of energy-momentum-mass are compared to particles and fields. They are a generalization of the usual 4-vectors of energy-momentum. These vectors are belong to the 5-dimensional Extended space G(1, 4). Vectors, which are correspond to free particles, both massive and massless, are isotropic, i.e. their length in the space G(1; 4) is equal to zero. The transformations of such vectors can be described by rotations in the Extended space. These rotations are belonged to group O(1, 4), the Lorentz group O(1, 3) is a subgroup of this group. Using such transformations it is possible to describe an external action at the particle, as well as the particle entering into a certain environment or field. The fifth coordinate of the energy-momentum-mass vector corresponds to the mass of the particle. The transformations of the group O(1; 4) can change this mass. In particular a photon can get non-zero mass, and this mass can be both positive and negative [1-3].

In the frames of the ESM one can establish a connection between the mass of a particle and its dimension. The starting point for us is the analogy between the dispersion relation of a free particle and the dispersion relation of wave mode in a hollow metal waveguide. The dispersion relation for waves in the waveguide contains a term that corresponds to the critical frequency of the waveguide mode. The value of this cut-off frequency is defined by the linear size of the waveguide. In the dispersion relation of a free particle this term corresponds to mass of the particles. With the help this analogy one can associate with a particle a linear parameter, which is determined by its mass. Thus, the scheme by which size is an associate with a particle as follows. In an empty Minkowski space a free particle is described by a plane wave. When it gets into environment, or in an external field, its mass changes, that is described by a hyperbolic rotation in the Extended space. Some linear parameter can be associated with this new mass. We interpret this linear parameter as a particle size. For a photon the formula for a size l reads

$$l = 2\pi c/(\omega \cdot \mathbf{sh}\theta).$$

Here, c – the speed of light, ω - frequency of the photon, and θ - the angle of rotation in the Extended space. The angle θ varies from zero to infinity ∞, therefore the size l varies from infinity ∞ to zero.

References

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