Commun. math. Phys. 5, 97—105 (1967)

Space-Time and Degrees of Freedom of the Elementary Particle*

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Received February 25, 1967

Abstract. First, a general property of Lie groups is used in the case of the Poincaré group in order to define the one particle phase space. It is eight-dimensional in the general case and six-dimensional for a spinless or massless particle.

Embedding the Poincaré group into the similitude group of space-time permits us to interpret the dilatation operator as a dynamical variable. The connection between the similitude group and field equations is discussed.

LURÇAT's ideas on a possible dynamical role of spin and mass-spin spectra of particles (Regge trajectories) are discussed under the point of view of the degrees of freedom.

I. Introduction

When one compares the usual description of a free particle in classical and quantum mechanical cases, one is faced with two very different approaches: on the one hand, one starts from position and velocity variables and all observables are functions of these variables; on the other hand, the aspect is group theoretical since a particle is associated with an irreducible projective representation of the space time group G (Galileo or Poincaré group). Spin is ignored in the first case but naturally involved in the second one by group theoretical arguments. Several models[1] have been built for the description of a classical spinning particle generally in increasing the number of degrees of freedom, attributing in this way to the particle an internal structure. In our opinion, it is essential to limit the number of new parameters in order that the particle posseses all the characteristics of an *elementary* particle. The usual definition of the particle concept in quantum mechanics suggests that we search for a group theoretical definition of the classical (spinning) particle based on

* This work constitutes a completed version of a preprint entitled "Classical Hamiltonian Formalism for Spin", Argonne, September, 1966.

** On leave from Université de Marseille, France. Work supported in part by the National Science Foundation.

[1] A very large number of articles have been devoted to this subject and it seems not necessary to give here a complete list of references. Nevertheless, we will mention the THOMAS model [1, 2, 7] in which no "internal structure" is involved.