Commun. Math. Phys. 175, 319–335 (1996)

Communications in
Mathematical
Physics

Scattering States of Plektons (Particles with Braid Group Statistics) in 2 + 1 Dimensional Quantum Field Theory

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Received: 18 October 1994 / in revised form: 28 February 1995

Abstract: A Haag–Ruelle scattering theory for particles with braid group statistics is developed, and the arising structure of the Hilbert space of multiparticle states is analyzed.

1. Introduction

Particles in $2+1$ dimensional spacetime are not necessarily bosons or fermions; in general, their statistics may be described by a unitary representation of Artin's braid group [1]. Such particles will be called plektons, in the following. In a quantum mechanical framework the possible existence of plektons in 2 space dimensions was first observed by Leinaas and Myrheim [17] in their analysis of the principle of indistinguishability of identical particles. In the framework of quantum field theory the presupposed correspondence between particles and local fields seemed to forbid exotic statistics in more than $1+1$ dimensions. But adopting the point of view of algebraic quantum field theory that locality has to be assumed only for observables, Buchholz and one of us showed [2] that even in purely massive theories particles might correspond to non-local fields with the consequence that ordinary statistics could be derived only in $3+1$ (or more) dimensions.

Models for particles with a one dimensional representation of the braid group ("anyons") were first invented by Wilczek [30]. Non-abelian gauge theories with a Chern–Simons term in the action are candidates for models with non-abelian braid group statistics. Anyons are considered to be the excitations which are responsible for the fractional Quantum Hall Effect [16].

In order to predict phenomena caused by plektons a multiparticle formalism is desirable. In the case of permutation group statistics the multiparticle space (as a representation space of the Poincaré group) is obtained by the choice of a Poincaré invariant metric (determined by the statistics) on the tensor product of Poincaré group representations on single particle spaces (see [3]). This is no longer true in the plektonic case because the sum rules for spins involve the statistics [7]. A

★ Partly supported by 'Studienstiftung des deutschen Volkes'.