Commun. Math. Phys. 131, 51–107 (1990)

Communications in Mathematical Physics

Why There is a Field Algebra with a Compact Gauge Group Describing the Superselection Structure in Particle Physics

Sergio Doplicher[1]* and John E. Roberts[2]

[1] Dipartimento di Matematica, Università di Roma "La Sapienza", I-00185 Roma, Italy
[2] Fachbereich Physik, Universität Osnabrück, D-4500 Osnabrück, Federal Republic of Germany

Abstract. Given the local observables in the vacuum sector fulfilling a few basic principles of local quantum theory, we show that the superselection structure, intrinsically determined a priori, can always be described by a unique compact global gauge group acting on a field algebra generated by field operators which commute or anticommute at spacelike separations. The field algebra and the gauge group are constructed simultaneously from the local observables. There will be sectors obeying parastatistics, an intrinsic notion derived from the observables, if and only if the gauge group is non-Abelian. Topological charges would manifest themselves in field operators associated with spacelike cones but not localizable in bounded regions of Minkowski space. No assumption on the particle spectrum or even on the covariance of the theory is made. However the notion of superselection sector is tailored to theories without massless particles. When translation or Poincaré covariance of the vacuum sector is assumed, our construction leads to a covariant field algebra describing all covariant sectors.

1. Introduction

If one starts from local observables which are assumed to be given a priori and to satisfy a few basic principles characteristic of local quantum theory, then the superselection structure of the theory is determined in an intrinsic manner. In this paper, we solve a long-standing problem by showing that this superselection structure can always be described, in a sense that will be made precise, in terms of a compact group of gauge automorphisms of a field net with normal Bose and Fermi commutation relations.

This is a remarkable result for several reasons: first of all we start from local observables which are by their nature gauge invariant so there is no hint of any gauge symmetry. Secondly, although we do have to define carefully what is meant

* Research supported by Ministero della Pubblica Istruzione and CNR-GNAFA