Commun. math. Phys. 35, 49–85 (1974)

Local Observables and Particle Statistics II*

Sergio Doplicher

Istituto Nazionale di Fisica Nucleare and Istituto Matematico G. Castelnuovo, Università di Roma, Roma, Italy

Rudolf Haag and John E. Roberts

II. Institut für Theoretische Physik der Universität, Hamburg, Federal Republic of Germany

Received July 24, 1973

Abstract. Starting from the principles of local relativistic Quantum Theory without long range forces, we study the structure of the set of superselection sectors (charge quantum numbers) and its implications for the particle aspects of the theory. Without assuming the commutation properties (or even the existence) of unobservable fields connecting different sectors (charge-carrying fields), one has a particle-antiparticle symmetry, an intrinsic notion of statistics for identical particles, and a spin-statistics theorem. Particles in "pseudoreal sectors" cannot be their own antiparticles (a variant of Carruthers' theorem). We also show how scattering states and transition probabilities are obtained in this frame.

I. Introduction

In [1] we studied the structure of the set of charge quantum numbers (or superselection rules in elementary particle physics) as far as it follows from the general principles of local quantum physics. The setting and the main results may be sketched as follows. One considers the theory to be specified by the algebra $\mathfrak{A}$ which is generated by the local observables[1]. Assuming the existence of a state[2] ω_0, corresponding to the physical vacuum, we restrict our attention to the class of those states which become indistinguishable from ω_0 in asymptotic observations (observations outside a sufficiently large region of space). The pure states

---

* Partly supported by CNR.

[1] The observables which can be measured in a space-time region $\mathcal{O}$ generate the subalgebra $\mathfrak{A}(\mathcal{O})$. The principle of locality is expressed in terms of these; it requires that two observables commute if they can be measured in spacelike separated regions. Therefore the anticommuting fields occurring in conventional quantum field theory are not affiliated with the algebra of observables.

[2] Mathematically a "state" means an expectation functional over the abstract algebra $\mathfrak{A}$.