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Local Algebras of Observables and Pointlike Localized Fields

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Abstract. We present a method to recover Wightman fields from a Haag-Kastler theory of local observables. This may provide a basis for the comparison of different theories and for an algebraic description of high energy behaviour.

1. Introduction

For the discussion of structural properties of quantum field theory, it has turned out to be advantageous to use the framework of algebras of local observables [1]. In this framework one assigns to each bounded region $\mathcal{O}$ of space-time the C^*-algebra $\mathfrak{A}(\mathcal{O})$ which is generated by the observables measurable in $\mathcal{O}$. The "local net" $\mathcal{O} \to \mathfrak{A}(\mathcal{O})$ is subject to the requirements of locality and translation covariance, and according to Haag and Kastler [1], it contains all the physical information which can be obtained from the theory.

This point of view has been very successful in deriving those properties of a quantum field theory which are consequences of general principles, such as the existence of scattering states [2], and the structure of superselection sectors [3]. On the other hand, the algebraic point of view has not yet been equally useful for a discussion of particular properties of a given theory. This comes from the fact that it is difficult to construct the local net explicitly, and no effective notion of "similarity" for different local nets, no perturbative treatment of the algebraic structure has been developed.

We know that in field theory one can use the same set of fields to describe different theories, labeled by parameters like coupling constants and masses. Many properties of the theory are expressed with the aid of these fields. On the other hand, there are in general many other fields which can be used to describe the same theory. Roughly speaking, fields play a role similar to that of

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