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On the Existence of Antiparticles

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Abstract. Without assuming the existence of interpolating fields, it is shown that any particle in a massive quantum field theory possesses a unique antiparticle and carries parastatistics of finite order. This closes a gap in the hitherto existing theoretical argument leading to particle statistics and to the existence of antiparticles.

1. Introduction

The existence of antiparticles is a well established experimental fact in elementary particle physics. In the conventional framework of quantum field theory, the explanation of this fact is given via the TCP-theorem or, more generally, using the Jost-Lehmann-Dyson representation of the two-point-function (see for example [1, II]). In both cases the existence of local fields, interpolating between vacuum and particle states, is crucial.

However, the assumption about the existence of those fields is not very natural for particles which are separated from the vacuum by some superselection rule. Then an interpolating field is not observable by principle, and the locality assumption for these fields has no obvious physical interpretation.

In fact, it is well known that charged particle states in gauge theories cannot have local interpolating fields. Wheras in abelian gauge theories charged particles only exist in the presence of massless particles [2, 3], for nonabelian gauge theories such a result is not known; there might be charged particles also in cases, where there are no physical massless particles.

Now for particles in theories with a gap in the mass spectrum, localization properties have recently been found [4, I] which admit a nearly complete discussion of the structure of multiparticle states [4, II]. This discussion follows closely the investigations of Doplicher et al. [1]. These authors consider only those states as "being of interest for elementary particle physics" which become vacuumlike on the spacelike complement of a sufficiently large bounded region. This selection criterion for states is in some sense a physical interpretation of the

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