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On Current-Density Algebras, Gradient Terms and Saturation*

(Conserved Currents)

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Abstract. The equal time limit of commutator matrix elements of conserved currents is rigorously calculated by means of structures which follow from general principles of relativistic quantum field theory and current conservation. We prove: (a) In general derivatives of δ-functions occur (gradient terms). — (b) The proper (non-gradient) part of the equal time limit is exactly given by the divergence-free causal one particle structures constructed from those intermediate one particle states which have the same main quantum numbers (mass, total spin and total isospin) as one of the external states (saturation by two one particles states!). — (c) All the other intermediate discrete one particle states drop out completely and the continuous many particle states contribute at most to gradient terms. — (d) The gradient terms emerging from the remaining two discrete intermediate one particle states can be removed without any restrictions on the form factors. — (e) From current algebras of conserved currents in the form proposed and used in the literature one cannot deduce any predictions for form factors beyond the algebraic conditions for coupling constants which already follow from the algebra of the charges.

I. Introduction

In recent years we have witnessed an ever increasing interest in the field theoretical aspects of current operators. Generalizing group theoretical features of conserved charges to non-conserved charges [1] proved to be very successful in deriving sum rules of various types [2—6]. Encouraged by these results physicists have conjectured algebraic structures also for the current densities. Whereas numerous articles, and lecture notes [7][1] have been published on the applications of these current density algebras, considerably less effort has been devoted to the problem of consistency of the density algebras with quantum field theory.

In addition the combination of the density algebras with simple saturation assumptions (one particle saturation) lead to kinematical inconsistencies of the results [4]. Without looking for possible diseases

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[1] For a general information on current algebras see [7] and the bibliography given there.