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# Can Current — Operators Determine a Complete Theory?

J. LANGERHOLC* and B. SCHROER**

II. Physikalisches Institut der Universität Hamburg

**Abstract.** For the free field currents $j_\mu(x)$ in the sector of charge zero we prove that one can reconstruct the bilocal fields $\psi(x)\ \bar{\psi}(y)$.

## 1. Formulation of the problem

Of all the space-time-dependent operators in local quantum field theory, current densities seem to be the most 'physical'. Certain matrix-elements of such operators (form factors) are directly measurable in electromagnetic and weak interactions. Attempts have been made to formulate relativistic dynamics directly in terms of current operators [1]. The main theoretical problem is the question whether the knowledge of the current operators[1] (i.e. all their vacuum expectation values) completely determines a theory. How, for example, do we compute processes involving charged or baryonic particles if the local operators to be used do not create a charged or baryonic one particle state from the vacuum.

As another application we mention that an answer to this sort of problem would be a prerequisite for a better understanding of quantum electrodynamics within the framework of general quantum field theory. It is well known that there exists no covariant gauge in which the KÄLLÉN-LEHMANN [2] spectral function of the spinors is positive definite; the indefinite metric of the $A_\mu^{(0)}(x)$ field creeps into the spinor — two point function in higher orders of perturbation theory. Therefore in order to obtain a physical (positive definite) Hilbert space one has to consider the vacuum-expectation values of the currents $j_\mu(x)$ (resp. the closely related electromagnetic field strength $F_{\mu\nu}(x)$) only. Hence one runs into the physical completeness problem mentioned before.

It seemed to us worthwhile before trying to understand this problem in the interacting case, to get a complete solution for the free field current. In this paper we show that the free field bilocal operators $\varphi^*(x)\ \varphi(y)$ can be obtained from the free field current operator $j_\mu(x)$ by a certain large

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[1] Here the currents for all space time points (not only for equal times) are needed.