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Quantum Fields with a Multiplicative Structure

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Abstract. We define quantum fields (giant fields) on a multidimensional space which contain an infinite set of local fields in Minkowski space. The multiplicative structure for the giant fields implies global expansions for products of the local fields. Conformal symmetry is imposed in order to reduce the number of kinematical variables.

1. Giant Fields and Lie Fields

We propose to investigate quantum field theories that possess a multiplicative structure

$$\begin{aligned}\Phi(q_1)\Phi(q_2) &= H_1(q_1, q_2)\\ &\quad + \int H_2(q_1, q_2, q_3)\Phi(q_3)d\mu(q_3).\end{aligned} \tag{1}$$

Here q runs over a manifold Q that has more than four dimensions and contains the Minkowski space as a subset. The quantum field $\Phi(q)$ will be called a "giant field". H_1 and H_2 are assumed to be corresponding distributions. It is obvious that (1) allows us to express all n-point Wightman functions of $\Phi(q)$ in terms of H_1 and H_2 provided

$$\langle 0|\Phi(q)|0\rangle = 0. \tag{2}$$

We assume that this normalization of $\Phi(q)$ is valid and that $\Phi(q)$ is real (symmetric).

The giant field $\Phi(q)$ can in general be decomposed into a bosonic and fermionic part

$$\Phi(q) = \Phi^B(q) + \Phi^F(q). \tag{3}$$

Equation (1) splits up correspondingly into four equations. In models in which the fermionic part is absent, the antisymmetric parts

$$\begin{aligned}H_1^a(q_1, q_2) &= H_1(q_1, q_2) - H_1(q_2, q_1)\\ H_2^a(q_1, q_2, q_3) &= H_2(q_1, q_2, q_3) - H_2(q_2, q_1, q_3)\end{aligned} \tag{4}$$