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On Localisability and Heisenberg's Fundamental Field

ANDRÉS J. KÁLNAY

Centro de Física, Instituto Venezolano de Investigaciones Científicas (IVIC), Apartado 1826, *Caracas* 101, *Venezuela*

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1. *On the 'Urmaterie'*

Heisenberg proposed a unified theory of matter in which a fundamental field (the '*Urmaterie*') would obey a non-linear equation. The different particles would be associated with different solutions of that equation. See Heisenberg (1957), Roman (1960) where earlier references are quoted. The assumed equation is:

$$\gamma^\mu \partial_\mu \psi \propto (\bar{\psi}\,\psi)\,\psi \tag{1.1}$$

where ψ is assumed to be a spinor field.

The main reason for imposing that the '*Urmaterie*' be a spinor was that at that time there was a widespread belief that from bosons (tensors) one could not get fermions (spinors).

However, we have recently proved that quantum Fermi fields can be entirely described in terms of c-numbers and of quantum Bose fields acting on Bose states. See Kálnay, Mac Cotrina & Kademova (1973) where further literature is available. For simpler, but more general formulation, see Kálnay (1974b). The Bose constructed Fermi fields satisfy the Fermi anticommutation relations and have the standard Fermi transformation properties.

As a consequence, equation (1.1) is no more the simplest non-linear equation possible for the '*Urmaterie*'. One can consider instead a scalar or pseudoscalar field ϕ which would be associated (as '*Urmaterie*') to spin zero in the sense that ϕ should be invariant under rotations. The fundamental equation would then be of the form

$$\Box\phi = \rho(\phi) \tag{1.2}$$

where ρ would be a nonlinear function.

We propose in the present Note the simplest form of equation (1.2), i.e.,

$$\Box\phi \propto (\phi^*\phi)\phi \tag{1.3}$$

The field ϕ being an invariant, equation (1.3) would be consistent with all the symmetry properties allowed by equation (1.1). Since scalar Bose fields have properties simpler than spinor Fermi fields, it could be expected that the consequences of equation (1.3) would have been more easily handled than those of the original equation (1.1).

2. *On Localisability*

In a recent letter (Kálnay, 1974a) we have shown that, at least for the more important cases, the relativistic quantum fields of non-zero spin violate a self-consistency requirement (Kálnay, 1970, 1971a, 1971b; Kálnay & Torres, 1973, 1974) concerning localisability. Then, the obvious conclusion arrived at, is that taking into consideration the present-day Quantum Field Theory (and for at least the particles considered in quoted references), there is no non-zero spin Quantum Field with satisfactory properties regarding configuration space.

We conjecture that there may be a deep connection between this restriction on localisability and the matter of the previous section: according to that letter, only Lorentz-Invariant Fields would be consistent with exact localisability as regards to Quantum Field Theory. It is likely that if localisability is a requirement not possessed by all physical quantum fields, then at least the building blocks of the theory should be localisable in space time. This favours equation (1.3) against equation (1.1).

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