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Reply to Leiter's Criticism of a New Theory of Elementary Matter

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In a recent note, Leiter (1973) claimed to have found an error in my formulation of a new theory of elementary matter (Sachs, 1971, 1972a, b). This was in regard to its application to electrodynamics in the quantum domain. He asserts that my formal structure cannot incorporate the Pauli exclusion principle and from this he concludes that the theory must be false. In this note, I will rebut Leiter's comments, indicating the set of technical errors that he makes in the criticism.

The exact form of the mathematical structure of my theory is in terms of a set of coupled, relativistically covariant, nonlinear spinor field equations. Each of the coupled equations corresponds to a particle component of an assumed closed system. These are referred to as 'particle components' only because they have the asymptotic feature (according to the axiomatic basis of the theory) of approaching the particle solutions of the linear formalism of ordinary quantum mechanics, in the limit as the energy and momentum transfer between the components becomes arbitrarily weak. But it is an important feature of this theory that the exact limit is not contained in the structure of the theory (even though it can be approached arbitrarily closely). Another important feature is that all of the nonlinear field solutions are mapped in a single space-time—they are a set of field solutions that represent a closed system that is, in fact, without parts.

Leiter's main error was to claim that an exact solution of my nonlinear formalism, for the Kth particle component of my assumed closed system, is the stationary state eigenfunction

$$\psi^{(K)}(x, t) = \chi^{(K)}(x) \exp(-iE^{(K)}t)$$

This is certainly false, as the relativistically covariant, nonlinear field solutions are not generally factorable into a space part and a time part. The stationary state behavior does not appear until the appropriate set of approximations are applied to the exact form of the equations, in accordance with the correspondence principle that is imposed on this theory. This procedure, leading to the correspondence with the formalism of quantum mechanics, and the Hartree-Fock formalism for a many-particle system, is spelled out in detail in Sachs (1972a).

On the other hand, in contrast with Leiter's comments, the Pauli principle emerges from the exact (unapproximated) mathematical structure of this theory. This is demonstrated in Sachs (1972a). The result is sensitive to (1) the non-linear feature of the formalism, (2) its feature as a closed system of field equations, whose solutions are all mapped in a common space-time, (3) the factorized (first-rank) spinor formulation of the Maxwell fields for electromagnetism, and (4) the interpretation of the field variables of the theory as representing the interaction relation as elementary (rather than derivative) in the conceptual structure of the theory of matter. The first three of these features are mathematical consequences of the theory. The fourth is a logical feature, implying a mathematical restriction–just as the boundary conditions imposed on the equations of mathematical physics, because of the physical interpretation of the solutions of these equations, act to restrict the family of all possible solutions to only those solutions that match the logical content of the theory. In contrast with Leiter's comment on this point, the logical structure of a scientific theory has more than purely philosophical significance, it indeed plays an essential role in regard to the use of its corresponding mathematical formalism.

Again in contrast with Leiter's comments, the actual derivation of the Pauli exclusion principle from the theory did indeed follow from a dyamical relation. It was the containment in the theory of a continuity equation

$$\partial_\mu(\bar{\Psi}\gamma^\mu\Psi) = 0$$

where Ψ is a spinor field, called the 'interaction field amplitude'. This is a connective field relation between the set of all spinor field solutions, $\{\psi^{(K)}(x, t)\}$, of the coupled nonlinear field equations for the closed system described. This continuity equation is not *ad hoc*; it is indeed logically necessitated by the axiomatic basis of the theory which asserts the elementarity of interaction (rather than particle), leading logically to the notion of conservation of interaction. That is, this continuity equation corresponds, in its integral form, to the law of conservation of interaction.

The exact mathematical result discovered was that when any two of a closed system of spinor field components are (1) in the same state of motion, (2) described by a mutually repulsive electromagnetic interaction and (3) equally massive, then the interaction field amplitude, Ψ, for the entire system, vanishes identically. This means that there is no physical observable related to a system that is subject to such conditions–a result that is equivalent to the implications of the Pauli exclusion principle.

It was then shown that when this exact result was incorporated within the formalism, then as the system of coupled nonlinear field equations asymptotically approaches the formal structure of quantum mechanics for a many-particle system, the interaction field amplitude, Ψ, for this system, correspondingly *approaches* the anti-symmetrized form of the many-particle wave function—the form that underlies Fermi–Dirac statistics for the many-particle system, and the Hartree-Fock formalism (rather than the ordinary Hartree formalism, as claimed by Leiter).

To sum up, Leiter's error was to set up a mathematical solution which at the outset automatically excluded the Pauli principle, yet (2) has no relation to the actual exact solutions of my theory. The exact form of this theory does not yield stationary state solutions, but it does yield the Pauli principle, as an exact result of the formalism. The asymptotic limit of the exact solutions, in which stationary states appear, must then incorporate this exact feature of the theory which is the Pauli principle.

References

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