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Relativistic Quantum Mechanics: a Space-Time Formalism for Spin-Zero Particles.

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Summary. — A single-particle quantum formalism is constructed for spin-zero particles based upon state functions and operators defined on a four-dimensional space-time manifold. This yields a generalized Schrödinger equation having a Hermitian Hamiltonian and a derivative with respect to proper time. This formulation requires that particle mass be treated as an observable, not as a specified constant. A consistent probability interpretation results and a proper classical limit is exhibited. It is proposed that this formalism should properly replace the conventional Klein-Gordon formalism.

1. – The four-space formalism.

The fact that a satisfactory probability interpretation can be attached to the Klein-Gordon (KG) equation *with fields* (*),

$$\left(i\hbar\frac{\partial}{\partial x_\mu}+\frac{e}{c}A^\mu\right)\left(i\hbar\frac{\partial}{\partial x^\mu}+\frac{e}{c}A_\mu\right)\psi=m_0^2c^2\psi\,,$$

only by invoking the Foldy-Wouthuysen approximation technique in the two-component formalism introduced by FESHBACH and VILLARS (1) and elaborated

(*) Here the Einstein notation is used with the metric of signature $g_{00}=1$, $g_{\mu\mu}=-1$, $\mu=1,2,3$, and x_0 being ct.
(1) H. FESHBACH and F. VILLARS: *Rev. Mod. Phys.*, **30**, 24 (1958).