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The Limit of Massive Electrodynamics and the Two-Component Photon Field Theory.

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The transition from a massive spin-1 field theory to that of a corresponding massless field has been investigated by many authors (1). In all its previous treatments this problem has been analysed directly from the point of view of the Proca and the Maxwell fields. It is the aim of this paper to report on an elementary analysis of this question from the point of view of the Bargmann-Wigner theory and show that this theory leads us in a natural way to describe the polarized photon field by a two-component theory which is a generalisation of Weyl's equation for the neutrino. This may also be regarded as a result of the postulate that the equation be invariant under the substitution $\Psi \to (\gamma^5 \otimes \gamma^5)\Psi$. The fundamental quantity in this case is the field combination $\boldsymbol{H}-i\boldsymbol{E}$ and it is the commutation relation for this field which is established in this theory. This quantity goes over into its complex conjugate under reflection. This operation transforms therefore Weyl's equation into the equation for the charge conjugate field. The theory is reflection invariant as it must be since Maxwell's equations are deduced from Weyl's equation.

As is well-known, a spin s field with mass m is described, according to the Bargmann-Wigner theory, by a spinor of rank $2s$, symmetric in its spin variables, which obeys a system of $2s$ Dirac's equations:

$$(1) \qquad (i\gamma\cdot\partial - m)_{b_k b}\; \psi_{b_1 \dots b'_k \dots b_{2s}}(x) = 0\,, \qquad k = 1, \dots, 2s\,,$$

where

$$\gamma\cdot\partial = \gamma^0\partial^0 + \gamma^k\partial_k\,.$$

In the case of spin-1, the decomposition of $\psi_{ab}(x)$ in the base of Dirac's matrices

$$(2) \qquad \psi_{ab}(x) = Af^\mu(x)(\gamma_\mu C)_{ab} + B/2\mathscr{G}^{\mu\nu}(x)(\sigma_{\mu\nu}C)_{ab}\,,$$

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(1) See for instance S. DESER: *Ann. Inst. Henri Poincaré*, **16**, 79 (1972), and references therein.

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