A new massive vector field theory

Zhiyong Wang[1] and Ailin Zhang[2]

[1] P. O. Box 1, Xindu, Chengdu, Sichuan, 610500, P. R. China

[2] Institute of theory Physics, P. O. Box 2735, Beijing, 100080, P. R. China

Abstract

In this paper, we put forth a new massive spin-1 field theory. In contrast to the quantization of traditional vector field, the quantization of the new vector field is carried out in a natural way. The Lorentz invariance of the theory is discussed, where owing to an interesting feature of the new vector field, the Lorentz invariance has a special meaning. In term of formalism analogical to QED(i. e. spinor QED), we develop the quantum electrodynamics concerning the new spin-1 particles, say, vector QED, where the Feynman rules are given. The renormalizability of vector QED is manifest without the aid of Higgs mechanism. As an example, the polarization cross section σ_{polar} for $e^+e^- \to f^+f^-$ is calculated in the lowest order. It turns out that $\sigma_{polar} \sim 0$ and the momentum of f^+ and f^- is purely longitudinal.

1 Introduction

After the introduction of Dirac's equation[1], the search began for similar equations for higher spins. In the past, various approaches have been tried→ equations describing many masses and spins particle, non-Lagrangian theories and theories with indefinite metric[2] *et al*. At first, it was observed that, apart from spin-1/2, none of the other spins obeys a single-particle relativistic wave equation. For example, it was generally believed that for spins 0 and 1, the Klein-Gordon[3]-[4] and Proca equations[5] were unique, respectively. However, more than 60 years ago, it was found that the Kemmer-Duffin-Petian[6]-[8] equations(KDF equations) can describe both spin-0 and spin-1 objects. Since then, many more systems of equations for arbitrary spins, which originate from different assumptions after considering their invariance under Lorentz group, have been found.

Unfortunately, it has been known for a long time that there still exist many difficulties in the construction of higher spins field theories, which has turned out to be the most intriguing and challenging in theoretical physics. Especially, such a theory has touched upon some of the most basic ingredients of present-day physical theory. For example, in those theories, either the usual connection between spin and statics is violated, or the law of causation do not hold, or the negative energy difficulty is still encountered after second quantization having been accomplished, or, in the presence of interactions, the complex energy eigenvalues, superluminal propagation of waves and many other undesirable features[9]-[10] were found too. In particular, these behaviors were exhibited by both the KDP and the Proca equations[11].