ELECTROMAGNETIC MULTipoLE MoMENTS OF SPIN 3/2 PARTICLES IN NKR FORMALISM

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Introduction

Recently, a new formalism for the description of particles with spin was proposed [1]. The special case of spin 1/2 offers advantages with respect to the commonly used Bethe-Salpeter (BS) formalism. Unlike the BS method, in the Formation of [1] formalism free electrons get a natural place in the presence of electromagnetic fields. In a previous work we calculated Compton scattering of spin 1/2 particles in the NKR framework, we took the central classical limit and calculated cross section for all values of mass energy up to the mass of the spin 1/2 particles. However, in the high energy limit, we obtain a cross section that vanishes identically. In this work we calculate the electromagnetic moments of NKR particles.

NKR Formalism

In the NKR formalism, the equation of motion for a particle with spin is the projection equation into the eigenstates of the Angular Momentum operator, the spectral form factor is developed and the spin angular momentum is decoupled from the motion. The propagator can be obtained as the inverse of the operator:

\[ \mathcal{M}_{\mu
u} = \frac{1}{\sqrt{\lambda_\mu} \lambda_\nu} \mathcal{M}_{\alpha \beta \mu \nu} \mathcal{M}_{\alpha \beta \mu \nu} \]

where \( \mathcal{M}_{\alpha \beta \mu \nu} \) are the generators of the Hilbert space. If \( \mathcal{M}_{\alpha \beta \mu \nu} = \mathcal{M}_{\beta \alpha \mu \nu} \), the operator \( \mathcal{M} \) can be written as:

\[ \mathcal{M} = \mathcal{M}_{\varepsilon \mu \nu} \mathcal{M}_{\varepsilon \mu \nu} \]

Spin 1 Case

The simplest case in which this formalism can be applied is the spin 1 case, here one obtains the equation of motion as:

\[ L = \frac{1}{\sqrt{\lambda_\mu} \lambda_\nu} \mathcal{M}_{\alpha \beta \mu \nu} \mathcal{M}_{\alpha \beta \mu \nu} \mathcal{M}_{\alpha \beta \mu \nu} \]

In the case of spin 1, at very high energies one gets a divergent cross section for arbitrary parameter \( g \) and, in order to determine whether there are any values that preserves unitarity, one has to integrate the differential cross section from \( \sqrt{s} \to \infty \) to \( \sqrt{s} \to m \) where \( m \) is the mass of the particle.

Compton Scattering

One can use the Compton Scattering process to get more information about the unrenormalized parameters appearing in the interaction currents obtained for spin 1 and spin 3/2 above. However, in the spin 1/2 case, we do not consider any properties of the interaction currents. The asymmetric curve corresponding to the classical limit \( \sigma^3 \) and the other curves associated to spin 1/2 and 3/2.

Spin 3/2 Lagrangian

The Lagrangian density associated with the equation of motion is:

\[ \mathcal{L}_{\text{Spin 3/2}} = \frac{1}{\sqrt{\lambda_\mu} \lambda_\nu} \mathcal{M}_{\alpha \beta \mu \nu} \mathcal{M}_{\alpha \beta \mu \nu} \mathcal{M}_{\alpha \beta \mu \nu} \]

Gauging the Lagrangian we get the interaction term as:

\[ \mathcal{L}_{\text{Interaction}} = \frac{1}{\sqrt{\lambda_\mu} \lambda_\nu} \mathcal{M}_{\alpha \beta \mu \nu} \mathcal{M}_{\alpha \beta \mu \nu} \]

where \( \theta = 0 \). The interaction Lagrangian is:

\[ \mathcal{L}_{\text{Interaction}} = \frac{1}{\sqrt{\lambda_\mu} \lambda_\nu} \mathcal{M}_{\alpha \beta \mu \nu} \mathcal{M}_{\alpha \beta \mu \nu} \]

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References