Resonances in two-point tree-level amplitudes in a magnetized medium

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The tree-level two-point amplitudes for the transitions $jf \to j'f'$, where f is a fermion and j is a generalized current, in a constant uniform magnetic field of an arbitrary strength and in charged fermion plasma, for the jff interaction vertices of the scalar, pseudoscalar, vector and axial-vector types have been calculated. The generalized current j could mean the field operator of a boson, or a current consisting of fermions, i.e. the neutrino current.

It is remarkable, that all the amplitudes obtained are manifestly Lorentz invariant, due to the choice of the Dirac equation solutions as the eigenfunctions of the covariant operator $\hat{\mu}_z$. In this case, partial contributions to an amplitude from the channels with different fermion polarization states are calculated separately, by direct multiplication of the bispinors and the Dirac matrices. This approach is an alternative to the method where the amplitudes squared are calculated, with summation over the fermion polarization states, and with using the fermion density matrices, see, e.g. Refs. [1, 2]. However, the use of the density matrix in a magnetic field, as is usually done in the absence of a magnetic field, in the case of the two-vertex processes leads to extreme difficulties in analytical calculations.

The possible resonances in tree-level two-point amplitudes for the transitions $jf \to j'f'$ have been analysed. It was shown, that in the case of δ - shaped resonanse peak, the amplitude squared of process $jf \to j'f'$ is factorized by amplitudes squared of processes $jf \to f''$ and $f'' \to j'f'$, where f'' is the intermediate fermion state.

As an illustration of the obtained results, we calculated the cross section of the Compton scattering process, $\gamma e \to \gamma e$, in the conditions of pulsar magnitosphere with taking account of a possible resonance on a virtual electron. It was shown, that the obtained results are agreed with previous calculations [3] for case of wide resonanse peak.

References

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