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Perturvative and non-perturbative phenomena in QED: the scattering by a solenoidal magnetic field

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Abstract content

The confidence we have now-a-days in the quantum field theory stems, between other important results, from the fact that it reduces to the classical calculations in the appropiate regimes. This fact has been exemplified in more elementary textbooks of the area for the case of the Coulombian scattering: the differential cross section of the scattering in the lowest order in perturbation theory, equals to the classic Rutherford's result. Nevertheless, it is surprising that following the equivalent procedure for the scattering by a solenoidal magnetic field, the perturbative results of the quantum electrodynamics (QED) diverge from the classical ones.

In this work we study the classic limit of the scattering by a solenoidal magnetic field,showing a particular case in QED in which the perturbative and no-perturbative results are contrasting.

The different regimes analysed show that the perturbative result, still considering a renormalization to all orders in e^2 of the differential cross section, does not satisfy the Correspondence Principle: the process corresponds to a purely quantum phenomenon.

To recover the classic correspondence of the quantum scattering problem, we show the existence of a suitable methodology for which it is necessary to realise a no-perturbative calculation in which all the action variables involved in the classical process are considered. We explicitly show the success of this methodology for the case of a solenoid of finite and non-zero radius.

Summary

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