Institutul Național de Fizică și Inginerie Nucleară
Horia Hulubei

IFIN-HH

Seminar general

Quantum processes in short and intensive electromagnetic pulses

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We discuss some aspects of two widely discussed quantum processes. The first one is the non-linear Breit-Wheeler process, i.e. the emission of e^-e^+ pairs off a probe photon propagating through a polarized short-pulsed electromagnetic (e.g.\ laser) wave field. The second one is a photon emission off an electron interacting with the laser pulses (non-linear Compton scattering). Our consideration is done within a QED framework.

We show that the production probability is determined by the interplay of two dynamical effects. The first one is related to the shape and duration of the pulse and the second one is the non-linear dynamics of the interaction of charged fermions with the strong electromagnetic field.

The first effect manifests itself most clearly in the weak-field regime, where the small field intensity is compensated by the rapid variation of the electromagnetic field in a limited space-time region, which intensifies the few-photon events and can enhance the production probability by orders of magnitude compared to an infinitely long pulse. In other words, the short pulses may be considered as powerful amplifiers.

The non-linear dynamics in essentially multi-photon interactions plays a decisive role at large field intensities, where effects of the pulse shape and duration are less important. In the transition regime, both effects must be taken into account simultaneously. We provide suitable expressions for the production probabilities/cross sections for kinematic regions which can be used in transport codes.

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