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Vacuum instability effects in strong field QED with asymmetric electric field of analytic form

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The vacuum instability effect (the Schwinger effect) in an asymmetric electric field of an analytic form is studied nonperturbatively representing a so-called exactly solvable case. Among t-electric potential steps that belong to exactly solvable cases (Sauter-like electric field, T-constant electric field, exponentially increasing and exponentially decreasing electric field, and inverse square electric field) the external field under consideration is, along with the Sauter-like electric field, the second known example when the field and its potential are given by analytic functions and admits explicit exact solutions of the Dirac equation. However, in contrast to the symmetric Sauter-like field, the asymmetric field is free of an artificial symmetry characterizing the vacuum instability. We have found exact solutions of the Dirac equation with the asymmetric electric field and construct with their help the so-called in- and out-states in strong-field QED. On this base, we calculated differential numbers of created pairs and analyzed them in the regimes of a rapidly and slowly varying field. In addition, in the slowly varying case, the total number of created pairs was obtained. This exact result was compared with the one obtained by the help of the slowly varying field approximation demonstrating effectiveness of the latter.

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