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The Schwinger effect during axion inflation

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The production of gauge fields during inflation, in particular, in the axion inflation model, has a lot of phenomenological applications as it may impact the background inflationary dynamics, alter the spectral properties of primordial scalar and tensor perturbations, and give rise to charged particles via the Schwinger effect. The latter can strongly reduce the efficiency of gauge-field production during axion inflation. It is therefore crucial to have a clear understanding and proper description of this phenomenon to obtain reliable predictions for the physical observables in this model. In the present work, we revisit the problem of Schwinger pair-production during axion inflation in the presence of both electric and magnetic fields and improve on the state of the art in two ways: (i) taking into account that the electric- and magnetic-field three-vectors are in general noncollinear, we derive the vector decomposition of the Schwinger-induced current in terms of these fields and determine the corresponding effective electric and magnetic conductivities; (ii) by identifying the physical momentum scale associated with the pair-creation process, we incorporate Schwinger damping of the gauge field in a scale-dependent fashion in the relevant equations of motion. Implementing this new description in the framework of the gradient-expansion formalism, we obtain numerical results in a benchmark scenario of axion inflation and perform a comprehensive comparison with earlier results in the literature. In some cases, the resulting energy densities of the produced gauge fields differ from the old results by more than one order of magnitude, which reflects the importance of taking the new effects into account.

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