Signatures of Vacuum Breakdown in a Magnetic Dipole Wave

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One of the most intriguing effects of quantum electrodynamics (QED) with 10PW-class lasers is the vacuum breakdown. This effect assumes that particle production via QED cascades is faster than particle escape caused by field inhomogeneity. Since now accessible power of a laser beam exceeds the threshold power of the vacuum breakdown, this effect can soon be triggered, and its experimental signatures are of great significance. Note that the generation of a number of positrons is not definite evidence of the breakdown.

In this report, by the example of a magnetic dipole wave, we show that analysis of particle escape and radiation generated by electrons and positrons allow detection of different stages of the vacuum breakdown. We find that the properties of angular distributions of escaping electrons (positrons) and gamma photons clearly indicate the fact of the vacuum breakdown, its linear and nonlinear stages [1]. These stages mean whether the back reaction of the created electron-positron plasma on fields can be neglected or not. Additionally, we show that laser field harmonics generated by the created plasma have unique directivity and give evidence of extreme state formation at the nonlinear stage.

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References

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