Growth of QED avalanches initiated by intense counter-propagating lasers

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Since Bell and Kirk's suggestion [1], and motivated by the recent advancements in extreme light laser facilities worldwide, there has been a growing interest within the strong-field plasma physics community in generating electron-positron pair plasmas via laser-driven avalanches.

In this work, we address the longstanding problem of predicting the growth rate of such avalanches. We present a simple model [2], applicable to scenarios involving two circularly polarized lasers generating a standing wave. Our approach allows to predict the particle yield across a broad range of intensities capable of initiating an avalanche. Furthermore, we study the limiting effect on the growth rate caused by pair migration away from regions of prolific pair generation. Through our analysis, we establish that beyond a certain intensity threshold, this limiting effect becomes negligible. By leveraging our model, we can predict when abundant pair production induces a back-reaction on the generating field, through plasma collective effects and screening.

Validation of our model against Particle-In-Cell (PIC) simulations (using SMILEI [3]) demonstrates excellent agreement. Our methodology can be employed to investigate electron-positron pair avalanches in more realistic field configurations as envisioned in future experiments at extreme light laser facilities.

References

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