20th Advanced Accelerator Concepts Workshop

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Acceleration of positrons generated via photon-photon collisions in a dense laser-irradiated plasma

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In a typical laboratory plasma, there are no native positrons, which complicates attempts to develop a laser-driven positron accelerator. High-power high-intensity lasers provide an attractive opportunity to create positrons directly from light. While most attention has been focused on the multi-photon process, the process that involves two gamma-rays, the linear Breit-Wheeler (BW) process, has been overlooked due to a misconception that it is more difficult to realize. To objectively assess the linear BW process, we have developed a first-ever fully kinetic code for predictive simulations of the electron-positron pair production via this process in high-intensity laser-matter interactions and the subsequent positron acceleration. Using this new tool, we have discovered several regimes where one or two laser pulses propagating through a dense plasma form an effective self-organized collider of gamma-rays and an adjoining accelerator for the generated positrons. In contrast to the regimes proposed for the multi-photon process, our regimes only require a peak intensity that is already accessible at most flagship laser facilities to produce from tens of millions to billions of electron-positron pairs. The created positrons are emitted from the plasma as ultra-relativistic beams with a narrow divergence angle, which is likely to facilitate their use for applications.

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