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Phase Control of Nonlinear Breit-Wheeler Pair Creation

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High-charge energetic positron beams are a useful tool for probing the Standard Model of particle physics, however, the large scale and cost of accelerators used to conventionally produce such beams (e.g., LEP) have led to the search for smaller and cheaper alternatives. One candidate for $e^- - e^+$ pair creation is to collide an ultra-relativistic electron beam with a high-intensity laser pulse, generating energetic photons through nonlinear Compton scattering which then decay into pairs via the nonlinear Breit-Wheeler process. The next generation of laser facilities will be able to reach intensities of $10^{23} - 10^{24}\ \mathrm{W/cm^2}$, paving the way to drastically increase the number of pairs that can be observed experimentally beyond the current record of $\sim$100. Conventionally, these experiments result in a neutral beam where both electrons and positrons co-propagate. To separate the species, a strong magnetic field must be sustained over a several centimeter scale. Here, we show that using a two-colored laser pulse in a head-on electron-laser collision not only creates electron-positron pairs through the Breit-Wheeler process but naturally causes them to be deflected in opposite asymptotic angles from the moment of creation, which removes the need for magnetic deflection while facilitating the diagnosis of nonlinear Breit-Wheeler pair creation.

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