Two-photon pair creation as a dominant mechanism in a plasma driven by high-intensity lasers

Y. He[1], T. Blackburn[2], I. Yeh[3], T. Toncian[4], A. Arefiev[5]
[1] Department of Mechanical and Aerospace Engineering, University of California, San Diego
[2] Department of Physics, University of Gothenburg
[3] Department of Physics, University of California, San Diego
[4] Institute for Radiation Physics, Helmholtz-Zentrum Dresden-Rossendorf e.V.
e-mail (speaker): yuh087@eng.ucsd.edu

Creation of electrons and positrons from light alone is a basic prediction of quantum electrodynamics, but yet to be observed. Our simulations show that the required conditions are achievable using a high-intensity two-beam laser facility and an advanced target design. Dual laser irradiation of a structured target produces high-density γ rays that then create $>10^8$ positrons at intensities of 2×10^{22} W/cm^2. The unique feature of this setup is that the pair creation is primarily driven by the linear Breit-Wheeler process ($\gamma\gamma\rightarrow e^+e^-$), which dominates over the nonlinear Breit-Wheeler and Bethe-Heitler processes. The favorable scaling with laser intensity of the linear process prompts reconsideration of its neglect in simulation studies and also permits positron jet formation at experimentally feasible intensities. Simulations show that the positrons, confined by a quasistatic plasma magnetic field, may be accelerated by the lasers to energies >200 MeV. The considered geometry has the potential to enable the first experimental measurement of two-photon pair creation, driven entirely by real photons. Such interactions will form a major component of the physics investigated in upcoming high-power laser facilities. From the theory perspective, our results also motivate investigation of field-driven corrections to the two-photon cross section.

This works was supported by AFOSR (FA9550-17-1-0382).