Spin and polarization effects in QED cascades

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The fast development of high-power laser technology enables studies of plasma physics under extreme field strength in the lab. When the fields are strong enough and the plasma is energetic enough, quantum effects could modify the plasma's collective behavior substantially. This system is defined in some literature as a 'QED plasma.' Most of the studies for QED plasma use a PIC code with spin and polarization averaged QED rates, in which the QED processes only depend on the momentum of the particles and the EM field they experience. However, the strong field QED (SFQED) processes are fundamentally spin and polarization dependent. Here, we present our study of the QED cascade process using our newly developed spin and polarization-resolved QED module based on the particle-in-cell code OSIRIS. The QED cascade is one of the most famous predictions of SFQED, in which the energy of the laser field transfers to electrons, positrons, and high-energy photons, causing exponential growth in particle number and creating a hot dense pair plasma. Including spin and polarization allows us to simulate this complicated multistage SFQED process more accurately. We explore how spin and polarization effects in SFQED could possibly influence the evolution of the cascade process as well as correlations in the pair plasma's momentum and spin distribution. The emitted dense, high-energy photons are expected to be polarized, which potentially can be a source of intense polarized gamma rays.