New routes to high-energy photon generation in laser-matter interactions

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Intense laser-plasma and laser-beam interactions are promising routes for producing high-energy photons from compact setups, through, e.g. Compton scattering and bremsstrahlung [1]. The small time and space scales associated with these emission mechanisms give such sources unique properties. However, there are longstanding discussions as to the limit on the achievable photon energies. Over the last decade, rigorous efforts in the development of particle-in-cell (PIC) schemes with corrections from quantum electrodynamics (QED) have resulted in many new and exciting predictions of high-energy photon generation. It has become clear that many earlier concerns regarding the limitations of laser-plasma and laser-beam systems as sources were unwarranted. Here, we will present results based on state-of-the-art QED-PIC and analytical calculations on the generation of high-energy photons from laser-plasma [2]ăand laser-beam systems [3].

Closely connected to the emission of high-energy photons areăelectromagnetic cascades of electron-positron pairs. The latter have the potential to act as high-energy photon sources of unprecedented brightness. In the cascade process, radiation reaction and rapid electron-positron plasma production seemingly restrict the efficient production of photons to sub-GeV energies, in line with the long-standing discussion mentioned above. Here, we show how the interplay between the pair cascade and radiation reaction effects results in the possibility to emit GeV photons. The possibility to use tailored laser fields as well as particular particle sources promises not only the generation of high-energy photons, but also of controlled pair production at very high densities. Such matter?anti-matter/radiation systems could be of importance for laboratory astrophysics.

References

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