QED Effects in Intense Laser-Plasma Interaction

J-X Li[1], K Z Hatsagortsyan[2], and C. H Keitel[2]

[1] *School of Physics, Xi'an Jiaotong University, No.28, West Xianning Road, Shaanxi, 710049, Xi'an, China*
[2] *Theory Division, Max-Planck-Institut für Kernphysik, 1, Saupfercheckweg 69117, Heidelberg, Germany.*
Contact Phone: +4962215160
Contact Email: jianxing@xjtu.edu.cn

Dense, high-energy monoenergetic proton beams are vital for wide applications, thus modern laser-plasma based ion acceleration methods are aiming to obtain high-energy proton beams with energy spread as low as possible. Here, we put forward a quantum radiative compression method to post-compress a highly accelerated proton beam and convert it to a dense quasi-monoenergetic one. We find that when the relativistic plasma produced by radiation pressure acceleration collides head-on with an ultraintense laser beam, large-amplitude plasma oscillations are excited due to quantum radiation-reaction and the ponderomotive force, which induce compression of the phase space of protons located in its acceleration phase with negative gradient. Our three-dimensional spin-resolved QED particle-in-cell simulations show that hollow-structure proton beams with a peak energy of about GeV, the relative energy spread of few percents and number $N_p \sim 10^{10}$ can be produced in near future laser facilities, which may fulfill the requirements of important applications, such as, for radiography of ultra-thick dense materials, or as injectors of hadron colliders.

Besides, we have also investigated other QED effects (*e.g.*, pair creation and polarization, photon polarization and vacuum birefringence) in laser plasma interaction.