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P2.2017 Radiation emission from twisted plasma acceleration

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The recent experimental and theoretical progresses have shown that plasma accelerators are very promising because they may provide a new generation of more compact particle accelerators and light sources for various technological and scientific applications. Plasma accelerators often use intense laser beams or particle beam drivers to excite relativistic plasma wakefields, which can trap and accelerated particles to high energies. As a result of the rich wakefield structure in the plasma, these particles also execute transverse betatron oscillations that lead to intrinsically ultra-fast bursts of X-ray radiation as they accelerate. Here, using theory, and three-dimensional particle-in-cell simulations using Osiris [1] and the new Radiation Diagnostic for Osiris (RaDiO) [2] together with jRad [3], we investigate betatron radiation emission when the plasma wave has orbital angular momentum [4]. These high amplitude twisted plasma waves can be driven by intense light spring lasers that contain a helical intensity profile [5]. Radiation emission depends on the trajectories followed by the accelerated particles. To compute these trajectories, we first derived the trapping conditions in a twisted plasma wave. By investigating the constants of the motion, we find that trapped particles execute radial betatron oscillations in conjunction with helical trajectories around the wakefield, which can be the dominant one motion in typical conditions. We show that these trajectories can efficiently produce X-ray beams, which contain a strong circular polarization level. In addition to the spin angular momentum, we also compute the optical chirality of the ensuing radiation and its orbital angular momentum contents distribution.

References

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