Bright synchrotron sources from structured targets driven by ultraintense lasers

L. Gremillet[1], B. Martinez[1,2], M. Lobet[1,2], E. d'Humières[2]

[1]CEA, DAM, DIF, F-91297 Arpajon, France
[2]CELIA, UMR 5107, Université de Bordeaux-CNRS-CEA, 33405 Talence, France

A new breed of high-power laser systems, under development worldwide (e.g. CILEX-Apollon, PULSER, ELI), will soon make it possible to achieve laser intensities exceeding $10^{22}\ \mathrm{Wcm}^{-2}$. Laser-matter interactions under such extreme conditions involve intertwined relativistic plasma and quantum electrodynamics (QED) processes, notably massive generations of γ-ray photons and electron-positron pairs, in a fashion reminiscent of high-energy astrophysical systems [1].

The particle-in-cell (PIC) technique is the most common for simulating the kinetic and collective phenomena at play in intense laser-plasma interactions. Recently, much effort has been expended in implementing numerical models of strong-field synchrotron emission and multiphoton Breit-Wheeler pair production. Such upgraded PIC-QED codes have been extensively exploited to investigate the radiation and pair-modified laser-plasma interaction under various conditions [2].

In this talk, after recalling our previous results on extreme-intensity laser-plasma interactions [3], we will explore strategies to enhance synchrotron radiation at laser intensities $\sim 10^{22}\ \mathrm{Wcm}^{-2}$, thought to be accessible experimentally in the near future. Special emphasis will be put on the use of nanowire-array targets, which are known to boost the absorption of moderate-intensity laser pulses [4]. Under the conditions studied, the irradiated wires rapidly expand during the irradiation, hence forming a fairly homogenized, relativistically hot plasma. Therefore, the major emission mechanisms previously evidenced in homogeneous plasmas [5] still take place in nanowire arrays. Additional radiation channels, however, can be provided by the magnetostatic fields induced around the wires and the reflection of the fast electrons at the target backside. Overall, nanowire arrays can yield bright synchrotron radiation in a more robust way than uniform targets of same average density. Finally, we will discuss their prospects for Bethe-Heitler pair production in an adjacent high-Z target.

References

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