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飞秒激光驱动高密度等离子体的 **betatron** 辐射源模拟

摘要

激光驱动高密度等离子体中产生激光尾场加速，可以获得更大电荷量的电子束，从而得到提高 betatron 辐射产额的可能性。本文利用 EPOCH 模拟了飞秒激光驱动尾场加速产生高能电子束以及电子束振荡产生的 X 射线。X 射线的脉冲宽度与驱动激光的脉冲宽度相当，因此单次能够产生时间尺度在 30 飞秒以内的高产额 X 射线。研究发现，增加等离子体密度一般情况下会增加出射 X 射线的散角。本文对比了激光驱动时不同材料时产生的 X 射线的过程。研究表明，在一定范围内，原子序数的提高有助于 X 射线产额的提高。本研究可以为推进飞秒激光驱动 X 射线源的实验提供参考。

关键词

激光等离子体，X 射线，粒子云模拟

Abstract

Laser wakefield acceleration in high-density plasma can produce elec-tron beams with higher charge, thereby enhancing the yield of betatron radiation. In this study, the EPOCH code was employed to simulate the generation of high-energy electron beams via femtosecond laser-driven wakefield acceleration, as well as the Xray emission resulting from electron beam oscillations. The pulse duration of the generated X-rays is comparable to that of the driving laser, enabling the generation of high-yield X-rays with a time scale of less than 30 femtoseconds in a single shot. It was found that, under normal conditions, increasing the plasma density leads to a larger divergence angle of the emitted X-rays. Moreover, we compare the X-ray generation processes when lasers interact with different target materials. The results show that, within a certain range, an increase in atomic number contributes positively to the X-ray yield. This study may offer valuable insights for the development of femtosecond laser-driven X-ray sources.

Keywords

Laser plasma, X ray, Particle-In-Cell simulation

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