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High quality electron beams for plasma based light sources.

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Plasma-based accelerators provide a compact and efficient means of generating ultra-relativistic particles [1], making them strong candidates for next-generation light sources. These X-ray sources are inherently ultrafast, highly-collimated, and energetic, with applications in many fields.

One of the most well-established mechanisms for X-ray generation in plasma accelerators is nonlinear Thomson-scattering [2]. While these sources are compact, tunable and cost-effective, their main limitation is the lack of temporal-coherence. Achieving coherence and superradiance would enable plasma-based X-ray sources to rival the brightness of modern X-ray free-electron lasers (FELs). However, this requires electron beams with low energy spread and divergence.

This work presents simulations using PIC code OSIRIS for a LWFA designed for a potential EuPRAXIA facility at Rutherford Appleton Laboratory known as EPAC. The accelerated electrons satisfy the stringent demands of next-generation light sources. By investigating nonlinear Thomson-scattering with these beams, we explore generalised superradiance [3] and collective effects, potentially identifying new coherent emission regimes that could enhance X-ray brightness and benefit multiple scientific fields.

References

[1] T. Tajima and J. M. Dawson, Phys. Rev. Lett. 43, 267 (1979).
[2] E. Esarey et al., Phys. Rev. E 48, 3003 (1993).
[3] J. Vieira et al., Nature Physics 17, pages 99–104 (2021).

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