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Bayesian optimisation of second harmonic light generation from plasma apertures modelled in particle-in-cell simulations.

Wednesday, 24 September 2025 19:00 (1h 30m)

Interest in generating higher-order structured light with orbital angular momentum at high intensities (IL ≥ 1018 Wcm-2) has been developing recently due to the ability to exercise control over the spatio-temporal profile and polarization of the resultant light. Potential applications of such light include laser-driven particle acceleration and radiation generation.

When an intense laser pulse interacts with a micron-scale target with a preformed aperture on the order of the laser focal spot, intense light at the fundamental mode, ωL, and higher harmonics frequencies of the laser are produced with distinct spatial structure.

Generation of structured 2ωL light using this novel technique has been demonstrated using particle-in-cell (PIC) simulations varying aperture diameter and thickness of the target yielding a conversion efficiency from the fundamental mode of the laser, ωL to 2ωL of ~ 3 –5 %.

We have developed a new code called BISHOP which uses Bayesian optimization to tune the 2ωL conversion efficiency simulated by the PIC code EPOCH across a multi-dimensional parameter space. The optimisation shows strong sensitivity to target density and a matching condition between aperture size and the laser spot size. We discuss the underlying reasons for these dependencies and experimental routes to achieve similar conditions.

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