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Arbitrarily Structured Laser Pulses

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Spatiotemporal control refers to a class of optical techniques for structuring a laser pulse with space-time dependent properties, including moving focal points, dynamic spot sizes, and evolving orbital angular momentum. These structured pulses have the potential to enhance a number of laser-plasma applications, including laser wakefield acceleration (LWFA) [1,2]. Here we introduce the concept of arbitrarily structured laser (ASTRL) pulses which generalizes techniques for spatiotemporal control [3]. The ASTRL formalism employs a superposition of prescribed pulses to create a desired electromagnetic field structure. Explicit ASTRL solutions of Maxwell's equations in vacuum simplify field initialization in simulations of laser-plasma interactions with structured light, expediting study of novel concepts such as dephasingless LWFA with flying focus pulses. The ASTRL framework also enables design of new classes of laser pulses which may enable novel techniques in laser wakefield acceleration and laser-driven ion acceleration.

[1] Palastro et al., PRL 124, 134802 (2020)

[2] Palastro et al., Phys. Plasmas 28, 013109 (2021)

[3] Pierce et al., arXiv:2207.13849, (2022)

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