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An Alternative Approach to Incorporating Laser Pulses in Particle-in-Cell Simulations

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Numerical modeling of electromagnetic waves is a critical component of particle-in-cell simulation of laser–plasma interactions. Traditionally, laser pulses have been either launched from simulated antennas or initialized in their entirety in the computational domain. Relying on the electromagnetic field update to advance the laser pulse, however, imposes needless computational expense and complexity for a number of emerging applications. As an alternative, we demonstrate that laser pulses can be incorporated using analytic expressions provided that numerical dispersion is matched. The otherwise self-consistent treatment of the plasma reproduces 3-D–like focusing in lower-dimensional simulation, enables direct examination of approximate solutions to Maxwell's equations including Laguerre–Gaussian beams, and facilitates the modeling of novel laser pulses including the spatiotemporally shaped flying focus.

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