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Nonlinear Thomson Scattering with Ponderomotive Control

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In nonlinear Thomson scattering, a relativistic electron reflects and reradiates the photons of a laser pulse, converting optical light to x rays or beyond. While this extreme frequency conversion offers a promising source for probing high-energy-density materials and driving uncharted regimes of nonlinear quantum electrodynamics, conventional nonlinear Thomson scattering has inherent trade-offs in its scaling with laser intensity. Here we discover that the ponderomotive control afforded by spatiotemporal pulse shaping enables novel regimes of nonlinear Thomson scattering that substantially enhance the scaling of the radiated power, emission angle, and frequency with laser intensity. By appropriately setting the velocity of the intensity peak, a spatiotemporally shaped pulse can increase the power radiated by orders of magnitude. The enhanced scaling with laser intensity allows for operation at significantly lower electron energies and eliminates the need for a high-energy electron accelerator. This material is based upon work supported by the Department of Energy National Nuclear Security Administration under Award Number DE-NA0003856 and by OFES under Award Number DE-SC0019135 and DE-SC00215057.

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