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Laser-Plasma Interactions Driven by Spatiotemporally Structured Light Pulses[1]

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The substantial bandwidth of modern laser pulses combined with the creative use of optical elements presents a new paradigm for optimizing or realizing laser-plasma interactions—spatiotemporal pulse shaping. In the far field, a conventional laser pulse has separable space and time dependencies that severely limit how the pulse can be structured. Spatiotemporal pulse shaping provides the flexibility to structure a pulse with advantageous space-time correlations that can be tailored for a desired interaction. As an example, stretching the region over which a laser pulse focuses and adjusting the relative timing at which those foci occur provides control over the velocity of an intensity peak independent of the group velocity and maintains the high intensity of that peak over distances unconstrained by diffraction. Here we will review techniques for spatiotemporal pulse shaping; how it promises to advance applications such as plasma channel formation, Raman amplification, photon acceleration, vacuum laser acceleration, and laser wakefield acceleration; and how it can be used to study fundamental plasma physics such as wavebreaking and Fermi acceleration.

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