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Attosecond Electron and γ-Ray Pulse Generation Using Intense Spatiotemporal Optical Vortex Lasers

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Isolated attosecond γ-ray pulses are valuable for probing ultrafast phenomena, particularly in nuclear research. Traditional Gaussian lasers achieve this in the direct acceleration mechanisms but suffer from beam divergence and require dual laser systems, limiting compactness. Here, we demonstrate the generation of an isolated attosecond γ-ray pulse with transverse orbital angular momentum (TOAM) using a circularly polarized spatiotemporal optical vortex (STOV) laser in three-dimensional particle-in-cell simulations. An isolated attosecond electron slice accelerated by the STOV laser collides with its reflected front, producing an isolated attosecond collimated (˜4°), ultra-brilliant γ-ray pulse. This STOV-driven mechanism enables single-laser attosecond γ-ray generation with TOAM, offering new opportunities in ultrafast imaging, nuclear excitation, and detection.

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