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Spectral Phase Tuning for High Energy Narrowband Terahertz Pulses

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Highly–efficient optical generation of narrowband terahertz (THz) radiation could enable unexplored technologies and sciences from compact electron acceleration to charge manipulation in solids. State–of–the–art conversion efficiencies are currently achieved using difference–frequency generation (DFG) driven by temporal beating of chirped pulses, but remain far lower than desired or predicted. We show that third–order spectral phase fundamentally limits the efficiency of narrowband DFG using chirped–pulse beating and resolve this limitation with a novel technique based on tuning the relative spectral phase of the pump pulses. We measure a 13–fold enhancement in conversion efficiency for 1%–bandwidth, 0.361 THz pulses, yielding a record total energy of 0.6 mJ, exceeding previous optically–generated energies by over an order of magnitude. Our results prove the feasibility of demanding applications and provide a framework for more flexible use of chirp–pulse beating via knowledge and control of the higher–order spectral phase of the pump.

SHORT BIO:

Spencer Windhorst Jolly is currently a postdoctoral researcher at the French Commissariat à l’énergie atomique et aux énergies alternatives (CEA) – Saclay, studying spatio–temporal couplings in ultrafast and high–intensity laser pulses, and formerly at the Center for Free–Electron Laser Science (CFEL) and Universität Hamburg in Hamburg, Germany, working on high energy narrowband terahertz generation and laser–plasma acceleration. His broad interests include temporally and spatially structured ultrafast pulses for use in Terahertz generation, high–harmonic generation, particle manipulation and acceleration, among many other applications, along with more fundamental ultrafast laser physics and nonlinear optics phenomena.

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