Bright half-cycle optical radiation from relativistic wavebreaking

BO MIAO, ANDY GOERS, GEORGE HINE, LINUS FEDER, FATHOLAH SALEHI, JARED WAHLSTRAND, HOWARD MILCHBERG, Institute for Research in Electronics and Applied Physics, University of Maryland, College Park, MD 20742 — Wavebreaking injection of electrons into relativistic plasma wakes generated in near-critical density hydrogen plasmas by sub-terawatt laser pulses is observed to generate an extremely energetic and ultra-broadband radiation flash. The flash is coherent, with a bandwidth of $\Delta \lambda / \lambda \sim 0.7$ consistent with half-cycle optical emission of duration $\sim 1$ fs from violent unidirectional acceleration of electrons to light speed from rest over a distance much less than the radiated wavelength. We studied the temporal duration and coherence of the flash by interfering it in the frequency domain with a well-characterized Xe supercontinuum pulse. Fringes across the full flash spectrum were observed with high visibility, and the extracted flash spectral phase supports it being a nearly transform-limited pulse. To our knowledge, this is the first evidence of bright half-cycle optical emission.

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