Linear and Nonlinear Optical Processes Engineered by Simply Inserting Transparent Dispersive Plates

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We show a method that functions uniquely for laser radiation composed of highly discrete spectra and arbitrarily manipulates the amplitude, phase [1–3], and polarization [4] distributions among the spectra. The device is very simple; we may simply place a transparent dispersive plate on an optical axis and precisely manipulate its thickness over a relatively long thickness range (typically the order of mm).

When we apply this method for a linear optical process, we can continuously generate arbitrary amplitude optical waveforms in the visible to infrared region as an electronic instrument, function generator, does in the radio frequency range. The repetition rate of the generated arbitrary optical waveforms exceeds 100 THz. When a cosine-like shaped wave is formed, the pulsed duration reaches 830 as, corresponding to 620 as in the intensity waveform.

Moreover, if we apply this optical method—arbitrary manipulation of amplitude, phase, and polarization—to nonlinear optical processes, we can have a new freedom of manipulating nonlinear optical processes in a variety of ways [5]. In addition to giving a proof-of-principle demonstration of this concept [5–10], we present a study aimed at creating a single-frequency tunable laser in the vacuum ultraviolet regions [5] where no solid optical material is available.

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