III-H Wave Packet Engineering Using a Phase-Programmable Femtosecond Optical Source

We proposed "wave packet engineering" which realizes mutual conversion between phase information of photonic and quantum wave packets by means of light-matter interaction. A phase-programmable femtosecond optical source is indispensable for such interactive control of photonic and quantum wave packets. We demonstrate control of quantum wave packets in organic molecules and semiconductors using phase-programmed pulses.

III-H-1 Three-Level Picture for Chirp-Dependent Fluorescence Yields under Femtosecond Optical Pulse Irradiation

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We propose a simple model to account for chirp-dependent fluorescence yields from a substance under femtosecond optical pulse irradiation. The model is simple, consisting of a three-level system, and yet it explains the essential feature of the chirp-dependent fluorescence yields experimentally observed, for example, with cyanine dye molecules. Based on the model, the dependence of the fluorescence on the excitation pulse properties such as the chirp rate and pulse intensity has been examined in detail. The results indicate that chirp-dependent fluorescence can be utilized as a convenient means for characterizing phase distortions in optical pulses such as those in optical fiber communication systems.

III-H-2 Femtosecond Wave Packet Engineering in a Cyanine Dye Molecule

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Quantum wave packet engineering is demonstrated using a phase-programmable femtosecond optical source. This paper describes development of a programmable phase modulator and coherent control of quantum wave packets. Wave packet motion in a cyanine dye molecule is observed to be dependent on the chirp direction and rate of excitation pulses. Strong reduction in excited state population is efficient for negatively chirped pulses in the cyanine dye molecule, which is explained in terms of a pump-dump process. We discuss a possibility of mutual conversion between the optical and electronic phase information by means of nonlinear light-matter interaction.

III-H-3 Femtosecond Chirp Variable Device Using a Chirped Mirror Pair for Quantum Coherent Control

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We demonstrate a femtosecond chirp variable device with a chirped mirror pair to manipulate the chirp rate of pulses precisely. The device is simple, easy-to-use, and compact with high energy durability and low insertion loss. Negative chirp can be added to the pulse digitally without a deviation of the output optical axis, which gives the group velocity dispersion of –42 fs^2 at each reflection on the chirped mirror. The whole device dimension is 180 mm × 76 mm. The reflectively and damage threshold of the chirped mirror are 99.5% and 0.6 J/cm^2, respectively. Using this chirp variable device, a chirp-dependent fluorescence in cyanine dye molecules (IR140) is observed. The device opens a new possibility to manipulate optical phase information.