Control of Quantum Interference Between Two- and Three-photon Absorption Processes in Semiconductor

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Quantum interference control (QuIC) is based on adjusting the phases of multiple evolution pathways connecting the same initial and final states of a quantum system. When light with different frequencies is incident upon a semiconductor, quantum interference of different optical absorption pathways can lead to a directional photocurrent. We report the first experiments demonstrating QuIC of currents attributed to two nonlinear optical absorption processes in semiconductors [1,2]. We use optical beams of frequencies ω (1560 nm) and 3ω/2 (1040 nm) incident on AlGaAs, and measure the injection current due to the interference between two- and three-photon (2+3) absorption processes (Fig. 1). The dependence of the QuIC current on the intensities, phases, and polarizations of the incident fields are analyzed. The 2+3 QuIC current can be used to measure the comb offset frequency with only a half-octave-spanning spectra.

Fig. 1. (a) Experimental Setup of QuIC current detection. (b) QuIC current fringe (red) due to interference between two- and three-photon absorption with the associated linear ramp on the 1550-nm interferometer arm.