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Rapid adiabatic passage in nonlinear optics for complete power transfer between ultrabroadband optical pulses

JEFFREY MOSES, Massachusetts Institute of Technology, FRANZ KÄRTNER, Massachusetts Institute of Technology and DESY-Center for Free-Electron Laser Science, Hamburg, Germany , HAIM SUCHOWSKI, Weizmann Institute of Science and UC Berkeley — Rapid adiabatic passage is a central tool for full transfer of level populations in an atomic system. Recent work showed the equation of motions describing three-optical-wave mixing in a dielectric medium through a nonlinear electric susceptibility are isomorphic to the optical Bloch equations for a two-level atom (neglecting radiative losses) when the middle frequency wave is strong. We have exploited this analogy for the first time to prove the principle of complete Landau-Zener adiabatic transfer in nonlinear wave mixing. Using intense laser pulses and a specially designed poled potassium titanyl phosphate nonlinear crystal with an adiabatic longitudinal variation of the poling period, we demonstrate complete energy transfer of a near-IR pulse to the mid-IR. Moreover, we find the principle is upheld for huge laser bandwidths. In our experiment the power transfer covers two-thirds of an octave of bandwidth with preservation of the power spectral density profile. Control of optical power transfer through rapid adiabatic passage thus can serve to optimize sources for coherent control and strong-field physics.

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