FEW-CYCLE PULSES IN AN OPTICAL PARAMETRIC OSCILLATOR

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Optical parametric oscillators (OPOs) based on aperiodically-poled lithium niobate (APPLN) have generated 53 fs idler pulses at 3μm that are nearly transform limited, and contain only five optical cycles[1]; laser pulses with less than three optical cycles have been generated in other contexts[2]. This means the slowly-varying envelope approximations traditionally used to model such processes are no longer valid.

We present a theory for modelling few-cycle pulses that includes diffraction, dispersion, multiple fields, and a wide range of nonlinearities. We build upon the work of Brabec and Krausz[3] and Porras[4], but a characteristic feature of our approach is that no approximations are made until the final stage when a particular problem is considered: it is left entirely to choice which terms in the exact solution to retain, and to what order approximations should be applied. We can now rigorously study what combination of approximations affords the most efficient method for treating a given nonlinear interaction involving few-cycle pulses.

We apply this to an OPO, using dispersion, multiple fields and its second-order nonlinearity. We show numerical simulations involving pulses with different numbers of cycles, including idler pulses containing as few as two cycles. The characteristic differences between the results under various levels of approximation are discussed in detail. Other nonlinear optical processes are also discussed.

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Abstract; Summary; Talk