Nikolay Vitanov
Universität Sofia

High-fidelity quantum control and quantum information processing with composite pulses

The technique of composite pulses has been used for a long time in nuclear magnetic resonance and, since recently, in quantum optics and quantum information. This technique replaces the single pulse used traditionally for driving a two-state quantum transition by a sequence of pulses with suitably chosen phases, which are used as control parameters for shaping the excitation profile in a desired manner. Composite pulses produce unitary operations, which combine very high fidelity with robustness to parameter variations. We have developed a pool of composite pulses by using a novel SU(2) approach to design recipes for construction of single-qubit operations, including broadband, narrowband and passband pulses, universal composite pulses, composite adiabatic passage and composite STIRAP, some of which have already been demonstrated in experiments with doped solids. We have also designed efficient and robust composite techniques for construction of highly entangled states, e.g. Dicke and NOON states, and multi-qubit gates, e.g. C-phase, Toffoli, and generally CN-phase gates.