MAR06-2005-001439

Abstract for an Invited Paper
for the MAR06 Meeting of
the American Physical Society

Quantum Control with Nonclassical Light

YARON SILBERBERG, Weizmann Institute

Most of the experimental advances in coherent quantum control in recent years have involved ultrashort pulses and pulse shaping techniques. These pulses have been an excellent source of coherent light with precise phase relationship between the various frequency components. In several recent works we have investigated the possibility of using broadband nonclassical light, generated by down-conversion of narrow-band lasers, for coherent control. Such light, for most purposes, exhibit the properties of a broadband thermal noise, but also unique quantum correlations between spectral mode pairs at the signal and idler frequencies that are required for quantum control. We have investigated both the single-photon limit, when the light was composed of individual entangled photon-pairs, and the large signal limit, when the light is not weak but does exhibit nonclassical phase correlations. In the high-intensity limit, we have shown that coherent control of two-photon absorption can be performed with incoherent non-classical light. We showed that the signal-idler phase correlations cause the spectral quantum interference to be completely constructive for two-photon interactions that have a final state energy equal to the pump laser frequency. Consequently, even though the broadband down converted light is neither coherent nor pulsed, it induces two-photon absorption just like a coherent ultrashort pulse, and may likewise be coherently controlled by pulse-shaping techniques. We also demonstrated that pulse shaping techniques can be used in the single-photon limit, where we shape the two-photon correlation function. We demonstrate control of the quantum interference of photons at a beam-splitter, and the generation of Bell-states using polarization pulse-shaping techniques. We believe that the combination of quantum control techniques with quantum optics could add an important ingredient to the toolbox of quantum information and computing.