Comment on "Electromagnetically Induced Quantum Memory"

In a recent Letter [1], Nazarkin *et al.* suggest and attempt to model an approach for eliminating the decoherence caused by radiative decay into a continuum, thus providing a scheme for a quantum memory. They consider the coherence routinely induced through the coherent radiative coupling of two bound states, and propose to defeat the radiative decoherence by means of an additional laser field. The proposed decoherence suppression, as correctively acknowledged in the Erratum [2] by Nazarkin *et al.* is the effect known as laser-induced continuum structure (LICS) [3,4]: the modification of a laser-induced radiative transition rate into a continuum by using a second laser that couples the continuum to another bound state.

However, the model actually presented in [1] is inappropriate for their stated objective: it treats the continuum incorrectly as an incoherent loss and does not include all relevant coupling channels or the other effects present under realistic conditions that mask the desired interference suppression. This becomes immediately evident when one compares their model with the complete theory of LICS (for example, see [5] and the following papers, e.g., [6] directly related to the work by Nazarkin *et al.*), including the density matrix formalism and incorporating not only a full treatment of the continuum with all relevant channels, but also the spectral widths of the lasers from field fluctuations. What Nazarkin *et al.* actually model is a so-called lambda system of three bound states, the upper state of which undergoes decay to a continuum of states outside the system. This is not the problem Ref. [1] claims to address. Furthermore Ref. [1] overlooks serious complications inherent in any actual experiment, such as incoherent channels, matching of spatiotemporal intensity distributions of the laser fields, matching of bandwidths and spectral widths, and dynamic Stark shifts and other effects due to the presence of additional states of the system.

Numerous experiments over many years in smooth and structured continua, confirmed by simulations based on complete theory in realistic systems (for a recent literature survey, see [7]), have revealed that decay suppression through LICS is generally only a small effect, at most a few percent. This has been documented for many instances (for example, see [8]), as well as in LICS applications (for example, see [9]). Demonstrations of substantial, but far from complete reduction of the decay are extremely rare [10,11]. Schemes involving broadband fs pulses, as proposed in Ref. [1], will not enhance the effect.

To summarize, the Letter [1] used an erroneous model for an effect it intended to describe and neglected important details needed for any realistic description of photoionization suppression. The authors' conclusions contradict published experimental work.

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