Ultrafast Coherent Phenomena: Physics and Applications

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Brief Abstract: The basic physics of interactions between matter and short light pulses is of fundamental interest. Such interactions generally result in coherence effects where all molecules of a sample “dance” in unison. As an example, we have used molecular coherence to efficiently generate short bursts of light that are automatically synchronized with respect to the molecular oscillations. Furthermore, our work has shown that an increased and cleverly manipulated molecular coherence enables improvements in optical detection and sensing applications. Short laser pulses provide a unique tool for probing the environment. In particular, femtosecond pulses, when powerful enough, will produce laser filaments that have found intriguing remote-sensing applications. Femtosecond laser filamentation starts when nonlinear self-focusing overcomes beam diffraction, and results in a tightly-confined propagation over distances orders of magnitude longer than the Rayleigh range corresponding to the filament’s transverse dimensions. In a recent experiment we have used filaments for sub-diffraction-limited imaging of remote objects.

Brief Bio: Alexei Sokolov was born on April 14, 1971 in Odessa, Ukraine, to a family of engineers. He obtained his first degree in 1994 from the Moscow Institute of Physics and Technology. In his Diploma work, performed in the Laser Biophysics Laboratory at the General Physics Institute, Russian Academy of Sciences, Sokolov focused on the development of integrated optical sensors that use Langmuir-Blodgett films as sensing elements. In 2001 he received a Ph. D. in Physics from Stanford University, where he worked in the Edward L. Ginzton Laboratory under supervision of Steve Harris. While in the Harris group at Stanford, Sokolov investigated electromagnetically induced transparency (EIT) effects in molecular systems, which lead to collinear generation of a wide coherent Raman spectrum with a possibility of sub-femtosecond pulse compression. After completing his Ph. D. work, Sokolov moved to Texas A&M University, where he currently holds a Professor position in Physics and Astronomy and a Stephen E. Harris Professorship in Quantum Optics. His overall expertise is in the field of laser physics, nonlinear optics, ultrafast science, and spectroscopy. His research interests center around applications of molecular coherence to quantum optics, ultrafast laser science and technology, including generation of sub-cycle optical pulses with prescribed temporal shape, and studies of ultrafast atomic, molecular, and nuclear processes, as well as applications of quantum coherence in biological and defense-oriented areas. Sokolov maintains a well-funded group at Texas A&M; he has supervised a number of postdocs and graduate students who have won numerous student awards.

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