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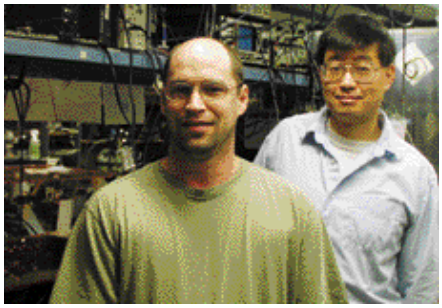
A new approach to working with light

FEMTOSECOND LASERS

The world of ultrafast science has received a boost with the demonstration of a new and flexible approach to the synthesis of coherent light by University of Colorado (CU; Boulder, CO) and National Institute of Standards and Technology (NIST; Boulder, CO) researchers. By successfully combining extremely short pulses of light generated by two independent modelocked femtosecond lasers into a single pulse of light that exhibits the properties of both lasers simultaneously, the door has been opened to a wide-reaching variety of applications in science and technology.

"By combining the two lasers so precisely, we can create new shapes of light pulses that could not be created by either laser individually," explained Robert Shelton, a professional research assistant at the Joint Institute for Laboratory Astrophysics (JILA), a joint program of CU and NIST, who completed the work in the laboratory of Jun Ye, an assistant professor of physics at CU and a JILA Fellow.



A new and flexible approach to the synthesis of coherent light has been demonstrated by researchers Robert Shelton (left) and Jun Ye, shown here in the laboratory. (Photo courtesy of Jun Ye/Science)

In what is believed to be the first experiment to deal with the controlled-phase coherence between independent femtosecond lasers, the researchers generated a coherently synthesized optical pulse from two independent modelocked Ti:sapphire femtosecond lasers (one centered at 760-nm wavelength, the other at 810 nm) operating at a 100-MHz repetition rate by tightly synchronizing and phase-locking them.

The researchers used spectral interferometry and second-order field cross-correlation to demonstrate coherence. Measurements revealed a coherently synthesized pulse with a temporally narrower second-order cross-correlation width that exhibits a larger amplitude than the individual laser outputs.

"One of our goals is to use these lasers to ultimately be able to control molecules and atoms, which would have applications in many different areas," said Shelton. The interaction of coherent light with atoms and molecules, and the "control" of atoms and molecules, has been a prominent scientific theme in recent years. Being able to combine the characteristics of two or more pulsed lasers working at different wavelengths will give scientists a more flexible approach in their work with light and matter, according to Shelton.

Applications of the technology include wide-bandwidth pump-probe configurations and coherent control; mid-infrared generation through difference frequency mixing; laser synchronization with x-rays or electron beams from synchrotrons; particle acceleration with phase-locked pulsed laser arrays; and synthesis of light pulses with durations shorter than those attainable from any individual laser.

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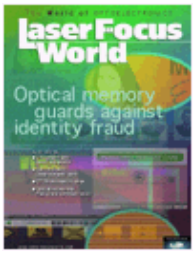

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REFERENCE

1. R. K. Shelton et al., Science 293, 1286 (Aug. 17, 2001).

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