■ Coherent Time-Domain Far-Infrared Spectroscopy

A new approach to far-infrared spectroscopy uses nonlinear optics and femtosecond optical pulses to generate and measure extremely short electromagnetic transients whose frequency spectra span a large portion of the entire far-infrared spectral range.

Optical rectification of femtosecond optical pulses is used to produce a Cerenkov cone of pulsed far-infrared radiation of approximately one cycle in duration in the terahertz spectral range. The coherent detection of the electric field of these pulses by electro-optical sampling provides a capability to measure precise changes in the shape of the pulse waveform following reflection from or transmission through materials.

Study of elementary excitations in solid materials, including those involving superconducting band gaps, lattice resonances, and impurity levels, requires investigation of this far-infrared region of the electromagnetic spectrum. The new technique offers improved sensitivity and speed of response over previous far-infrared spectroscopy approaches.

One novel feature of the method is the use of the far-infrared pulses to make measurements in the time domain that are equivalent to having a tunable monochromatic source covering the spectral range from 0.1 to 2 THZ.—D.H. Auston and K.F. Cheung, AT&T Bell Laboratories.

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■ Direct Laser Generation of 27-FSEC Ultrashort Optical Pulses

An experimental laser has generated 27-fsec pulses, the shortest optical pulses yet emitted directly from a laser. The laser combines and balances four pulse-shaping mechanisms associated with conventional passive mode-locking and soliton-like pulse shaping, in a single resonator. Conditions were found under which the four mechanisms—self-phase modulation, group-velocity dispersion, saturable absorption, and saturable gain—were balanced to yield transform-limited pulses that are shorter, and more stable, than those previously possible.

For the 27-fsec pulses, typical laser pump powers are 3 to 5 W at 514.5 nm. Stable trains can be generated from as low as 1 W to powers 40% above threshold. Pulse width ranges from less than 40 fsec to more than 500 fsec. Other parameters are a 10-nJ intracavity pulse energy, a 100-MHz repetition rate, and an intracavity beam diameter of 1 mm, with a fluctuation in pulse intensity of less than 2%.

It is anticipated that these techniques could be applied to other ultrashort pulse lasers, including semiconductor lasers.—J.A. Valdmanis, R.L. Fork, and J.P. Gordon, AT&T Bell Laboratories.

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