

Two-Photon Fluorescence Detects Ultrashort Pulses

Light pulses shorter than picoseconds can now be directly displayed and measured, according to a group of Bell Telephone Laboratories scientists. Several techniques for generation and measurement of ultrashort, intense light pulses have been known for a number of months. But until now, the resolution limit of pulse-duration measurements has been about 10^{-13} sec. Joseph A. Giordmaine described for *PHYSICS TODAY* a technique that he, Peter M. Rentzepis, Stanley L. Shapiro and Kenneth W. Wecht have developed, which extends this resolution, they believe, below 10^{-14} sec.

Two-photon excitation of fluorescence is the detection mechanism in their simple, elegant technique. A fluorescence cell displays the pulse-train structure of a laser beam that is normally reflected from an immersed mirror. Because fluorescence by two-photon excitation is nonlinear, with emission intensity proportional to the square of the peak input-pulse intensity I , the fluorescence-track intensity, at positions where there is overlap of incoming and reflected pulses, is proportional to between 4 and 6 times I^2 , depending on the degree of input-

pulse coherency. Bright regions appear at these positions along the track because where there is no overlap the intensity is proportional to only $2I^2$. Hence one can readily distinguish overlap positions and measure pulse durations. In the illustration is a typical track from 3-picosecond pulses and a typical densitometer measurement of the track from 2-picosecond pulses. Giordmaine and colleagues have also measured a few 1-picosecond pulses. When suitably corrected for index of refraction and pulse shape, simple measurement of fluorescence-track length yields pulse duration.

Although initial experiments on this technique were with a frequency-doubled glass laser mode locked by the Q-switch dye technique to produce pulse trains, the Bell Labs group has reported that they can display directly single ultrashort pulses, such as from stimulated Raman scattering. The two-photon fluorescence technique thus has a distinct advantage over the several coincidence techniques that have been developed so far for pulse detection and measurement, especially in its simplicity.

This measurement capability will,

it is believed, facilitate a number of experiments with ultrashort light pulses, such as self-induced transparency (*PHYSICS TODAY*, August, page 47) and other nonlinear optics.

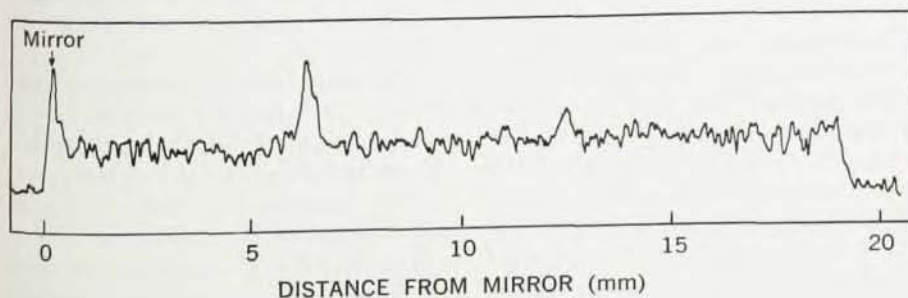
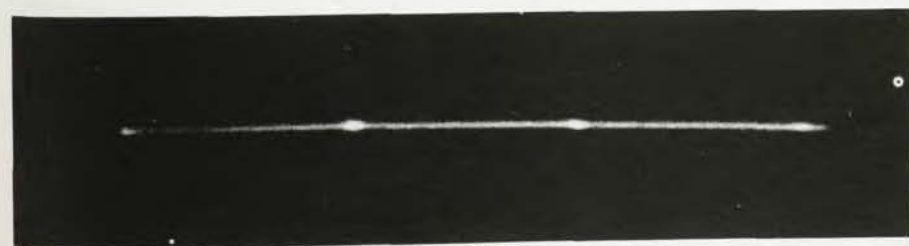
Large-Bore, High-Field Supermagnet Sets Record

NASA's Lewis Research Center has achieved a 140 000-gauss field in the 15.2-cm cylindrical bore of its new superconducting magnet. The magnet, designed and built by RCA, establishes a record for a high-field large-bore combination, not only for superconducting magnets but for continuously operated conventional magnets as well.

In one test the magnet was safely driven to normal conduction at 140 kG with the release of almost 2×10^6 joules of stored magnetic energy. In another test, the magnet sustained a 100-kG field for 62 hours, until the test was terminated.

90 km of RCA superconducting ribbon makes up the windings of this 600-kg magnet. The ribbon is silver-plated, vapor-deposited niobium-tin on a stainless-steel substrate. Mylar-coated copper sheets between layers serve as insulation, and these sheets act also as shorting strips. When the magnet goes normal, the copper shorting strips allow continuation of current with a resulting slower field decay and hence slower energy release.

Ease of fabrication and testing, as well as containment of large forces that develop in the magnet, required that the windings be subdivided into modules. The NASA magnet has 22 of these modules, connected to permit



TWO-PHOTON fluorescence track and densitometer recording from which pulse duration is obtained.