physical sciences notes

PHOTOCHEMISTRY

Resonance studies of excited molecules

Nuclear magnetic resonance has been used, reportedly for the first time, to study certain molecules which have been excited into higher energy states by light. This experiment is important to research both in photochemistry and in nuclear magnetic resonance itself, which is often used for identifying nuclei in different magnetic environments within molecules.

In this initial experiment, Michael Cocivera of Bell Telephone Laboratories in Murray Hill, N.J., was concerned with organic molecules. A solution of anthraquinone in a 14,000-gauss magnetic field was irradiated with intense blue light, to excite the electrons of its molecules from the ground state into a higher energy level. Most of these optically excited molecules immediately drop into a long-lived triplet state before returning to the ground state.

Cocivera found that the nuclear magnetic resonance spectrum of anthraquinone is changed dramatically when the molecules spend some time in the triplet state. Instead of merely absorbing the radio-frequency power from the spectrometer, the sample amplifies the spectrometer's power at the nuclear magnetic resonance frequencies of anthraquinone. This stimulated emission is believed to result from a pumping of the nuclei into a higher energy spin state by the unpaired electrons of the triplet state.

ACOUSTICS

Popping balloons

In principle when a round balloon bursts, the acoustical disturbance that follows should have the shape of the letter N.

Drs. David T. Deihl of Catholic University and F. Roy Carlson Jr. of the University of Southern California report that it is not exactly so. Working at the University of Rochester, where they both were at the time, they exploded balloons in front of a microphone that was connected to an oscillograph. Photographs of the oscillograph traces show deviations from an ideal N shape, they report in the May AMERICAN JOURNAL OF PHYSICS.

They attribute the deviations to a loss of spherical symmetry in the bursting action. They conclude that by careful attention to the experimental technique and by photographing the waveforms from many balloons it should be possible to obtain close approximations to the N shape.

COSMOLOGY

Blackbody spectrum

Three Soviet astronomers report that they have confirmed the existence of cosmic blackbody radiation at a wavelength of 8.2 millimeters. Drs. V. I. Puzanov, A. E. Salomonovich and K. S. Stankevich of the P. N. Lebedev Physics Institute relate, in SOVIET PHYSICS-ASTRONOMY for May-June, that measurements of radio reception at that wavelength shows a component corresponding to a blackbody at a temperature of 2.9 degrees Kelvin.

Such blackbody or thermal radiation is believed to be left over from a so-called cosmic fireball (SN: 6/15, p. 577), the giant explosion with which some theorists think the universe began. Originally created at a temperature around 10 billion degrees, the radiation would have cooled as the universe expanded until now it is only three degrees above absolute zero. A number of other points of this spectrum have been determined, ranging in wavelength from one meter down to the present measurement. The low wavelength end is particularly important since it is there that the blackbody spectrum differs most noticeably from those of other emission mechanisms.

ANALYTIC CHEMISTRY

Regional NMR spectrometer

A nuclear magnetic resonance spectrometer for ultrahigh resolution work will be built at California Institute of Technology under a $216,000 grant from the National Science Foundation.

The new instrument will be used to analyze the structure, bonding and shape of large molecules—especially proteins. The high frequency—220 megahertz—of the new instrument will give it a resolution about 10 times as sharp as the previous generation of NMR spectrometers.

Caltech will make the spectrometer available two days a week to researchers from other academic institutions in southern California. It will be the first spectrometer of this power in an academic institution in the United States; three predecessors are in industrial laboratories.

CRYSTALLOGRAPHY

Analyzing crystal mixtures

As many as seven different crystalline substances in a mixture can now be individually identified in less than a minute, using a computerized X-ray procedure developed at the Pennsylvania State University.

The rapid identification of such crystalline mixtures replaces days or even weeks of tedious thumbing through thousands of literature references to get the same kind of answer, says Dr. Gerald G. Johnson Jr., assistant professor of computer science in the university's materials research laboratory. The procedure could apply to subjects as diverse as lasers, proteins and solid-state electronic devices.

X-ray crystallography consists of measuring the characteristic diffraction of X-rays by the planes of a single crystal or powdered mixture. In the new technique, the diffraction pattern is recorded photographically as a series of parallel lines or peaks of varying intensity. The researcher measures the relative positions and intensities of the peaks and feeds the data to a computer, which sorts through its memory of stored crystallographic signatures and identifies the material, as well as any other components if it is a mixture.

To facilitate the process, Dr. Johnson and the late Prof. Vladimir Vand have been feeding volume after volume of standard reference patterns into the computer's memory for the past three years. The system has been used to identify as many as seven separate components in a mixture sample no larger than the point of a pin in 40 seconds.