a series of many drop patterns are recorded along a linear seismic spread. This allows "stacking" of the reflected sound waves and the enhancement of usable reflections. Good results at depths of 4500 to 7500 meters (15,000 to 25,000 feet) are being obtained.

The meeting, attended by 4600 registrants, was held in conjunction with the Society of Economic Paleontologists and Mineralogists and the Midwestern Societies of Exploration Geophysicists.

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Optical Masers

An international symposium on optical masers conducted by the Polytechnic Institute of Brooklyn in New York (16–18 April) not only provided a review of research, but also a forum for discussion of major problem areas and findings of interest to engineers, chemists, and physicists. The meeting was a comprehensive integration of the physics and technology bearing directly on the discovery, theory, and application of maser phenomena at optical and infrared frequencies.

N. Bloembergen (Harvard) presented a review of some theoretical problems in quantum electronics. He noted that although the fundamental problems of the interaction between electromagnetic radiation and matter are well understood, the advent of lasers has necessitated a more careful study of both quantum-mechanical and classical aspects of this interaction. Many well-known concepts from the realm of radio and microwaves have to be adapted to the optical region. Quantitative differences occur because several spatial modes are involved and quantum aspects, such as the uncertainty relations between amplitude and phase of the electromagnetic modes, are more prominent. Therefore, coherence, fluctuations, information, and channel capacity in optical fields are being studied with renewed vigor.

Nonlinear electromagnetic properties of materials at optical frequencies provide another illustration of the extension of well-known classical and quantum theories. It is possible to give quantum-mechanical expressions for linear and nonlinear complex susceptibilities with positive or negative imaginary parts. These may be incorporated in Maxwell's equations and describe the properties of lasers, Raman-type lasers, parametric amplifiers, and other nonlinear devices. Although the general framework exists, much detailed theoretical work remains to be done to account for specific geometries, to describe the large variety of materials ranging from mixtures of atomic and molecular gases to crystals with paramagnetic ions or organic molecules, and to broaden our understanding of the various damping mechanisms caused by collisions, lattice vibrations, or other interactions.

E. Wolf (Rochester University), one of the leading authorities in the field of optics, discussed the fact that until very recently optical coherence phenomena were almost exclusively described in terms of second-order correlation functions. Such a description is entirely adequate for the analysis of the usual optical experiments performed with light beams originating in thermal sources. However, in view of the development of the optical maser, and in view of a number of rather unconventional experiments that have been carried out or proposed very recently, the need has arisen for a broadened description.

Recent work on the noble gas optical masers was discussed by C. G. B. Garrett (Bell Telephone Laboratories). This holds out considerable promise for closing the gap between the optical and microwave portions of the spectrum. Oscillation has been achieved on about 150 different transitions. The longest wavelength achieved so far is about 28 microns (in neon). In the very important and even newer field of semiconductor lasers, B. Lax (Lincoln Laboratories, MIT) discussed various schemes which have been proposed for achieving maser action in semiconductors. These include a variety of phenomena involving transitions between impurity levels, interband transitions, and those between magnetic levels. To date, the only successful semiconductor maser has been the electrically pumped p-n junction diode of GaAs and related compounds. Lax described in detail the operation and theory of this device.

An application of the laser of outstanding practical and theoretical interest, namely, the ring laser rotation-rate sensor, was reported upon by W. M. Macek, D. T. M. Davis, Jr., R. W. Olthuis, J. R. Schneider, and G. R. White (Sperry Gyroscope Company). In summary, Olthuis said that the sensing of rotation rate with respect to an inertial frame of reference has been demonstrated using a traveling-wave gas laser in which the light propagates around in a closed loop. Under stationary conditions, a degenerate pair of independent modes exists which consists of waves propagating in opposite directions around identical paths. Rotation of the laser about an axis with a component normal to the plane of the laser path results in an effective lengthening of one path and a shortening of the other. To sustain oscillations, each path must be an integral number of wavelengths long, so the wavelengths of the oscillations must adjust themselves to meet this requirement. This results in a frequency splitting which is proportional to rotation rate. By sampling the output from each of the modes and heterodyning them together on a photocathode, a beat frequency is obtained which is proportional to rotation rate. Beat frequencies as low as 500 cycles per second have been observed corresponding to a rotation rate of two degrees per minute.

The symposium was cosponsored by the Air Force Office of Scientific Research, the Office of Naval Research, and the U.S. Army Research Office and was organized by the Polytechnic Institute of Brooklyn in cooperation with the Institute of Electrical and Electronics Engineers and the Optical Society of America.

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Protein Structure and Crystallography

Protein structure and crystallography have acquired great importance in recent years (as evidenced by the award of the Nobel Prizes last year) and were the subjects of a symposium held at Madras, India (14–18 January). This meeting, organized by the department of physics of the University of Madras, marked the first time that a conference of its type had been held by a university in that country. Outstanding scientists from all over the world attended; of the 100 delegates, nearly 40 foreign participants came from a dozen different countries.

The first half of the symposium was concerned with protein structure; the main themes were x-ray studies, optical studies, electron microscopic studies, chemical studies, and the genetic code.

In his presidential address, W. L. Bragg mentioned that the solutions to the complexity of structures solved by x-ray methods have been increasing steadily and the recent successful studies of myoglobin and hemoglobin by Perutz and Kendrew can be cited as important landmarks in the history of x-ray crystallography. It is also conceivable that the molecular structure of a virus might be forthcoming in the not too distant future. Results of recent x-ray diffraction studies have included a Fourier map at 4-Å resolution of the globular protein, ribonuclease (D. Harker, Roswell Park Memorial Institute) and the discovery that amino acid-transfer RNA has a double helix structure of three and a half turns which is similar to the structure of DNA (M. H. F. Wilkins, London).

In 1954 the first triple helical structure of collagen was discovered by the research of G. N. Ramachandran (University of Madras). Since then the structure has gone through a series of refinements and culminated in the latest version in 1960–61. Ramachandran pointed out how the triple helix and the alpha helix appear to be the two main helical chain configurations which occur in polypeptides and proteins. Additional protein structure work has been carried out on hemoglobin, myoglobin, lysozyme, beta-lactoglobin and alpha-chymotrypsin (D. C. Phillips, Royal Institution, London) and on natural and artificial polypeptides.

An optical method employed in the study of the configuration of proteins has been the use of the ultraviolet absorption spectra. J. T. Edsall (Harvard) has utilized the absorption band near 190 mμ to estimate the extent of helix formation in peptides and proteins. The frequencies and polarizations of infrared absorption bands can also give useful information about the orientation and configuration of the chains in protein structures. According to T. Miyazawa (Institute for Protein Research, Osaka), the alpha form, the beta form, and the random coil can be identified in this manner. Other optical and hydrodynamic studies have shown poly-L-proline-type polypeptides can exist in two forms, both in solution and in the solid state (E. Katchalski). Measurements of polypeptides and proteins by the optical rotatory dispersion technique have been used to determine helix content and the sense of the helix (E. R. Blout, Harvard).

Information obtained by using the