(Franklin Institute). The stacking and twin fault densities, strain, grain size, and orientation were followed in the annealing process. Films as deposited at temperatures near 80°K have a mild (111) structure. A shift to (100) and (311) texture occurs on warming to room temperature or higher. Grain size increases from about 0.05 to 0.1 mm. A strain argument was used to explain the change in orientation on annealing: When the film is warmed from the deposition temperature, the elastic strain energy in the grains increases; however, this increase depends on orientation, because of the different Young's moduli in the different crystalline directions. The increase in strain energy is least for grains oriented with their (100) and (311) planes parallel to the substrate, and most for those oriented (111). To minimize this strain energy there is preferential growth of the (100) and (311) oriented grains at the expense of the (111) and other orientations.

A new degree of complexity is introduced into thin film technology when two or more component systems are involved. Formation of alloy films by the simultaneous deposition from the vapor phase allows mixing of the constituents on an atomic scale. If the substrate temperature is kept low, diffusion can be reduced so that homogeneous solid solutions can be prepared, even if there is no miscibility in the annealed bulk state. S. Mader (I.B.M.) reported on thin films of face-centered cubic solid solutions and amorphous phases of the systems Co-Cu, Cu-Ag, Cu-Mg, and Au-Mg prepared by codeposition. If the difference in the atomic diameter of the constituents exceeds 10 percent, an amorphous phase is found, provided there is not complete miscibility at that concentration.

A paper by F. Arntz and F. Chernow (M.I.T.) was concerned with the optical and structural properties of oxidized titanium films previously deposited in ultrahigh vacuum onto single-crystal or amorphous substrates. On single-crystal substrates, highly oriented titanium films can be deposited. The oxides of these films were not oriented, with the exception of those on CaF_2 substrates, where the oxide was identified as rutile with the (100) plane parallel to the surface of the substrate. The *c*-axes of the rutile were in the plane of the substrate parallel to the three <110> directions. Oxides of nonoriented titanium films were nonoriented or even amorphous.

It has again become clear in this symposium that the variation in structure which can be obtained by thin film deposition is extraordinary. The range from single-crystal to liquid-like amorphous phases was covered. The extreme sensitivity of the thin film structure to preparation conditions was strikingly illustrated.

C. A. NEUGEBAUER
General Electric Research Laboratory, Schenectady, New York

Learning, Remembering, and Forgetting

The New York Academy of Sciences sponsored the second conference on learning, remembering, and forgetting, which was held 27–30 September in Princeton, New Jersey. Karl H. Pribram of Stanford University chaired the conference, and Frank Fremont-Smith, director of the New York Academy of Sciences Interdisciplinary Communications Program, served as sponsor and host.

These conferences are designed to provide an opportunity for interdisciplinary "discussion in depth" on the general topics of learning, remembering, and forgetting. Arthur Melton (University of Michigan) led the first discussion session, which was focused on the organization of short-term memory. Melton covered the subject from the standpoint of human paired-associate learning. The discussion which was evoked was continued during the next session led by Donald Broadbent (Applied Psychology Research Unit, Cambridge, England). Broadbent approached the problem by means of experiments using different simultaneous inputs to the two ears. The discussion at this session dealt with the relative importance of "interference" and "filtering" with respect to what is and what is not remembered. Gordon Bower (Stanford University) discussed a mathematical and structural model of human memory. Edward Walker (University of Michigan) emphasized the importance of the occurrence of some perturbation (as shown by the galvanic skin response) to consolidation of a memory trace. Much of the evidence discussed on this day had to do with the coding processes that are engaged before an experience becomes fixed in memory.

Discussions on the final day of the conference were focused on the organization of memory in the central nervous system. Lawrence Weiskrantz (Cambridge University) discussed behavioral impairments seen in monkeys with frontal or temporal lobe lesions. He presented evidence that subjects with lesions in the frontal lobes had difficulty in controlling irrelevant sensory input, especially when attempting to perform complex tasks, while monkeys with lesions in the temporal lobe had difficulty remembering what they had learned the day previously.

The concluding session was led by E. Roy John (New York Medical College). John presented electrophysiological data recorded from chronically implanted cats working in a variety of training situations. On the basis of his data three categories of central processes important to memory were proposed and various neural structures tentatively placed in each category.

The conference was supported by funds from the National Institute of Child Health and Human Development and the Office of Naval Research. The proceedings will be published under the editorship of Daniel Kimble.

DANIEL KIMBLE
Psychology Department, University of Oregon, Eugene

Radio Astronomy

Radiointerferometers and some recent results on brightness distributions of discrete surfaces, as well as astronomical spectrum analyzers and observations of interstellar gas, were described at a symposium on radio astronomy held as a part of the Northeast Electronics Research and Engineering Meeting (NEREM) in Boston on 5 November.

N. Keen of the National Radio Astronomy Observatory described the recently completed 11-centimeter interferometer. The closest spacing of the two 85-foot (25.9-meter) antennas of this instrument is at present about 1200 meters, and larger spacings up to 2700 meters are provided for. However, smaller projected baselines are obtained by tracking a source over a substantial fraction of a day.

The azimuth of the baseline is 62 degrees east of north. Keen pointed out that the choice of a baseline orientation other than east-west or north-south leads to a particularly accurate determination of the exact orientation. The measurement is made by observ-

ing sources of known position at the time when their diurnal motion is tangent to the interferometer fringes. Keen reported that 11-centimeter observations of the source 3C286 show that its position is 15 seconds of arc from the quasi-stellar object with which it is identified, a discrepancy previously noted by J. S. Hey (*1*).

A. T. Moffet (California Institute of Technology) reviewed the work that has been done with the movable 90-foot (27.4-meter) antennas of Caltech's Owens Valley Observatory. He also described plans for four movable 130-foot (39.6-meter) paraboloid antennas with altazimuth mounts. Moffet showed a model of the double radio source 3C33 deduced from observations at Caltech (*2*); in this source the two components are elongated along the axis which joins them and are brightest at the two outermost edges. This model is consistent with the interpretation that double sources are galaxies that have undergone an explosion in which matter was expelled in two opposite directions. The bright outer edges could then be explained in terms of interaction of the exploded matter with intergalactic gas. The same kind of model applies to Cygnus A and some other sources, according to Moffet. Keen said that measurements at the National Radio Astronomy Observatory gave the same result for Cygnus A.

A. M. Shalloway of NRAO described the 100-channel autocorrelation receiver which is currently connected to the 300-foot (91.4-meter) meridian telescope. This instrument produces a 100-point autocorrelation function every 10 seconds on magnetic tape, and an off-line digital computer is used to calculate the corresponding power spectrum. The maximum width of the measured spectrum is 2.5 megacycles, and narrower spectra can readily be observed with increased resolution.

Miss E. J. Gundermann (Harvard College Observatory) described the Harvard ten-channel radiometer which is in operation at 18 centimeters and her observations of OH absorption lines in the direction of the galactic center. The OH lines are broad enough in several cases that the 1667- and 1665-megacycle transitions overlap. The velocity features at the two transitions are in good agreement, and, in confirmation of a result from Parkes (*3*), the observed intensity ratios depart from the theoretically expected value 9:5. Gundermann detected absorption in the galactic plane throughout the longitude range -1.5 to $+4.0$ degrees. The resulting velocity-longitude diagram cannot be interpreted as simple combinations of rotating and expanding circular arms. The lack of symmetry about the galactic center is marked. She reported an upper limit to the OH absorption or emission of 0.03°K in the direction of the galactic anticenter.

Summaries of the papers are printed in the 1964 *NEREM Record*, which is available from the Institute of Electrical and Electronics Engineers, 313 Washington Street, Newton, Massachusetts.

S. J. GOLDSTEIN, JR.
Harvard College Observatory, Cambridge, Massachusetts

References

1. J. S. Hey, at the Twelfth General Assembly of the International Astronomical Union, Hamburg, 1964.
2. A. T. Moffet, *Science* **146**, 764 (1964); see also J. Lequeux, *Ann. Astrophys.* **25**, 221 (1962).
3. B. J. Robinson, F. F. Gardner, K. J. van Damme, J. G. Bolton, *Nature* **202**, 989 (1964).

Optics—An Action Program

In 1962 the Optical Society of America conducted a study on needs in the field of optics which showed that the need for scientific personnel trained in optics, now and for the foreseeable future, is four times greater than the supply of such personnel. Consequently, the Society initiated *Optics—An Action Program* (under NSF sponsorship) to stimulate research and education in optics. A symposium held at the 49th annual meeting of the Optical Society of America, on 6 October 1964 in New York City, reviewed the status of this program.

In the initial talk, Van Zandt Williams (Perkin-Elmer) reported progress on the six tasks which formed the original program. One of these, a study of the training of opticians and technicians, has been completed by Robert R. Brooks (Perkin-Elmer). Brooks made a thorough study of the need and training status in the United States and abroad and concluded that neither U.S. industry nor government is yet desirous of national training programs. Such programs can be undertaken locally if there is external pressure and guidance, and during the last year two junior colleges in California have initiated 1-year programs, one for opticians and another for optical technicians.

A second task, a study of education in optics, was undertaken by Mary E. Warga (executive secretary, O.S.A.). She is now concerned with getting statistics on current curricula in optics and comparing them with current curriculum needs. There is increasing evidence that the prime teaching requirement may be bringing the teacher up to date in modern optics so that he can better utilize the textbooks and time now available.

A third task is to stimulate academic engineering departments to accept responsibility for training in certain areas of applied optics; much of the present manpower need is for optical engineers. A first attempt to attract representatives of engineering departments to a summer colloquium at the Institute of Optics, the University of Rochester, in 1963 did not achieve that end. A new attempt to stimulate engineering effort is being made by W. L. Wolfe (University of Michigan).

Another task is an attempt to stimulate academic graduate research in optics. As a starting point, L. M. Biberman (Institute for Defense Analyses) directed a postcard survey of members of the O.S.A. in order to learn (i) the replier's field of research interest in optics, and (ii) the area of optics in which lack of research knowledge, data, and so forth most limited the replier's progress in research. It was most interesting that the dominant areas in which such research limitations were found were the technology or "engineering" areas, such as optical characteristics of materials, design and evaluation of optical components, and standardization of definitions, tests, and ratings of optical elements.

J. H. Taylor (Southwestern College, Memphis) discussed another task of the action program. He had conducted a symposium at his college, designed to stimulate undergraduate research in optical physics. With financial support from NSF and ONR, Taylor assembled teacher participants representing almost 100 colleges and universities and 25 speakers who reported on the status of research in various aspects of optics and pedagogy and on current government aid. Further, all participants were assigned to working groups which produced written reports, which were distributed to all members for discussion at a reporting session.

These conference reports, together with some results from other task studies, resulted in proposals for action which were submitted to the board of directors of the O.S.A. The board's ap-