THE PRESIDENT'S REPORT

Highlights from the report, on activities and research at the Institute in 1949-50

by L. A. DuBRIDGE

ONE YEAR AGO it was possible for me to report that "in the national scene there have been no major events which have had noteworthy impact on Institute activities." That statement is obviously not true today. World events of recent months have already had their impact, and it seems highly probable that in the year to come the Institute will be called upon to render services of many sorts to the nation and to the government in this time of need.

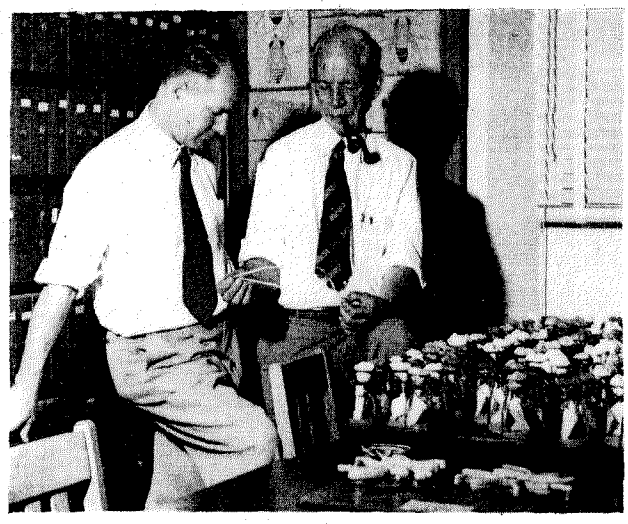
The outbreak of hostilities in Korea resulted in increased demands upon the staff and has called for more intensive work on the part of those already engaged in governmental activities. Dr. C. C. Lauritsen, Professor of Physics, was asked to make a six weeks' trip to Korea to report on the use and requirements of various new weapons. The Institute's Jet Propulsion Laboratory has been called upon to make alterations in its program and increase its efforts in certain areas. It is evident that the expanded program of military research may also involve the Institute in other ways which cannot now be foreseen.

In order to meet some of the present and anticipated problems arising from the emergency, two Faculty committees have been established. One will examine the ways in which the Institute staff and facilities can be most adequately and effectively employed. The other will study problems arising from calls on staff and students from Selective Service or mobilization of Reserve Officers.

In a certain sense, the Institute faces now the problem of mobilizing to serve the nation in time of emergency. However, it must be remembered that in a very real sense the Institute is *always* mobilized. Its regular program of education and research in science and engineering is vital to national welfare and security in peace or in war. To disrupt these activities at this time would be highly dangerous. It is of vital importance to continue and even to accelerate the rate at which our supply of young scientists and engineers is being built up. During the past four years the shortage of scientists and engineers, caused by the cessation of training during World War II, had just about been overcome. Now, however, the demand for such men is taking another upward spurt, and the training schedules should be increased accordingly.

In a period of long-continued emergency, it is also important to continue and accelerate *basic* research. From this research will come the new knowledge from which new applications of importance to national welfare and security will emerge. It would be as foolish to reduce our basic research activities in this country at this time as to reduce our production of steel and other critical materials.

For these reasons, it is essential that the Institute now remain strong, that it conserve its resources and improve its program. To this end it is important that we retain intact, to the greatest extent possible, our "team" of educators and research workers—one of the most competent and most closely integrated of all research teams in the world. Individual members of this team will, of course, be called upon to serve, either in part-time capacities or on leave of absence for short or long periods, in such capacities as are most appropriate to their talents and experience. Furthermore, the members of this team will remain continually alert to the problems of national defense and to possible ways of converting the basic



Biology: Division Head G. W. Beadle, Prof. Alfred H. Sturtevant and bottled drosophila used in genetics research

knowledge of science or engineering to the development of instruments or techniques to assist in solving these problems. But to be of maximum ultimate value the team should remain at "home base".

It is important in this period that a proper balance be maintained in the nation's research program; some effort should be devoted to immediate applications, some to development programs of one, two or three years' duration, and the rest to basic programs of longer range importance. The immediate-and intermediate-range programs will be largely the responsibility of government laboratories, but the universities retain primary responsibility for the longer range programs.

Research at the Institute

THE CALIFORNIA INSTITUTE of Technology is one of the great centers for research in science and engineering in the world. Because its research activities are so extensive and so diverse, the following remarks can be regarded only as a brief review of a few random samples of developments which have occurred during the year.

Astronomy

ABOUT ONE YEAR AGO the Hale 200-inch telescope and the 48-inch Schmidt-type telescope at Palomar went into full routine operation. The Schmidt telescope has now made excellent progress on its four-year program of surveying the entire sky visible from Palomar Mountain, a project which is financed through the generosity of the National Geographic Society. It has now become more clear than ever that the 2,000 or so plates which will be taken in this survey will be by far the most complete, the most detailed, and the most valuable map of the sky which has ever been attempted; and they will constitute an "atlas" which will be a guide to astronomical research for many, many years to come.

The Hale 200-inch telescope is now performing in a manner which equals or surpasses the fondest hopes of those who designed and built it. It is in operation every clear night. By June 30, 1950 a total of 510 direct photographs had been obtained. A large number of these photographic plates have been taken to secure more detailed information about the dimensions, magnitudes and distances of known or newly discovered extra-galactic nebulae (galaxies consisting of millions of stars, each similar to the Milky Way galaxy of which our own sun is a member). From studies of the distance and velocities of such nebulae the most important information about the structure and nature of the universe will be obtained. It will require many years of painstaking studies, however, before any great new generalizations about the nature of the universe can be made. To show the magnitude of the problem of studying nebulae it need only be mentioned that in the ten per cent of the sky which was mapped by the 48-inch Schmidt-type telescope up to July 1950, more than 350 new *clusters* of nebulae had been discovered. Some of these are at distances of approximately 300 million light years.

The astonishing extent of the popular interest in the Palomar Observatory is indicated by the fact that during the past year nearly 150,000 people made the journey to Palomar Mountain to see the Hale telescope. This public interest is in many ways gratifying, but the unexpected volume of visitors presents a practical problem, which can be solved only by providing more adequate facilities for the public on Palomar.

Biology

A NOTABLE EVENT of the past year in the Division of Biology was the inauguration of the full research program in Earhart Plant Research Laboratory. Among numerous projects now under way are (1) the identification of plant-damaging smog constituents and their manner of action on plants; (2) the effects of day and night temperatures on the growth, flowering and fruiting of such plants as the tomato; (3) a determination of conditions favorable for the growth of the plant *Veratrum* and production by it of alkaloids useful in the treatment of hypertension; and (4) an investigation of factors influencing growth and sugar formation by the sugar beet.

Through a generous grant from the James G. Boswell Foundation, the Division is in a position to strengthen greatly its research program in virology. As a means of summarizing the present stage of knowledge of plant, animal and bacterial viruses and of seeking effective ways of gaining new knowledge about these important disease-producing agents, a special three-day virus conference was held at the Institute in March 1950 (E & S, April). With this conference as a background, plans are now being made to extend the Institute's virus research program to include work on animal viruses.

Of several major research activities of the Division the study of protein synthesis may be taken as an example. For some years, Professor Henry Borsook, Professor A.

J. Haagen-Smit and a number of their colleagues, through contract with the Office of Naval Research and the U. S. Atomic Energy Commission, have been investigating the manner in which proteins are made by animals. These giant-molecule compounds are essential constituents of all living things—viruses, bacteria, plants, animals and man. They are of many kinds, all made from a common set of some twenty building blocks compounded end to end to form long chains. The component parts are known as amino acids. Their structures are relatively simple and well understood by chemists, but the way in which they are built up to form proteins remains one of biology's unsolved problems. This is a problem of the most fundamental importance, because proteins are key substances in growth, in reproduction, in heredity, in the structure and function of enzymes, and in many other aspects of the normal functioning of organisms. In fact it can be said that the problem of protein synthesis impinges in one way or another on every branch of biology. By tagging individual amino acid building blocks with radioactive carbon atoms in strategic positions, and allowing these marked smaller molecules to be put together by living cells or suitable preparations made from living cells, the Borsook team is able to recover the resulting proteins marked in certain of their component parts. By carefully breaking up such proteins, much as one would break a pattern of dominoes into sidechains and subgroups, the investigators are finding it possible, since they can follow the distribution of radioactive carbon, to learn a great deal about how the original amino acids were put together to form the large and complex protein molecules.

Engineering

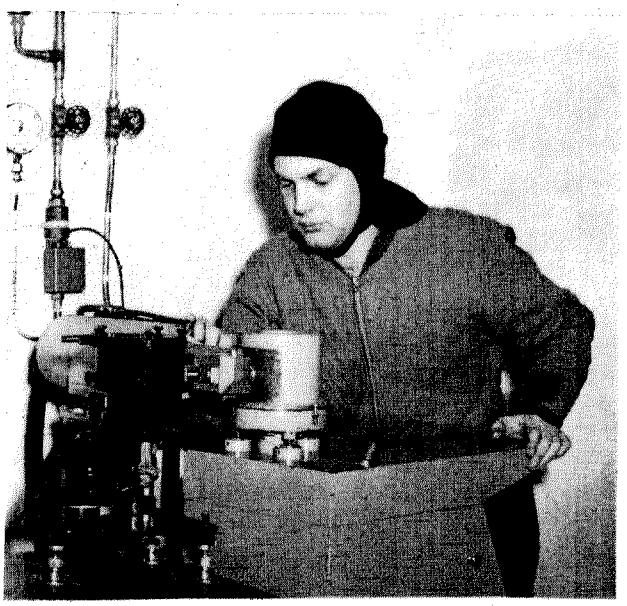
WITH THE SPACE made available by the new Engineering Building, the research program in this division will now be able to move forward at an accelerated rate.

In the field of engineering seismology, important progress was made during the year in the systematic study of the response of typical buildings to actual earthquake waves. Records of typical earthquakes are supplied by the U. S. Coast and Geodetic Survey and the analog computer of the Analysis Laboratory is now able to determine with great reliability and surprising speed the response of various types of structures to different types of earthquake shocks.

The Analysis Laboratory, with its large analog computer, and its newly installed digital computer, is now able to handle a wide variety of engineering calculations. In addition to the studies in seismology above mentioned, important studies of the vibration and flutter of aircraft structures have been carried out, yielding results of enormous value to aircraft engineers.

The number of wind tunnels for aeronautical studies now operating under Caltech auspices was increased to eight with the dedication of the new Merrill Wind Tunnel on August 31, 1950.

With all of these facilities, research in aerodynamics, in structures, and in fluid mechanics continued on a high level during the past year. The advent of supersonic planes and guided missiles has introduced a whole new set of problems in this field and it is now necessary to investigate not only the behavior of air at these very high speeds but the behavior of new types of structures at all available speeds.



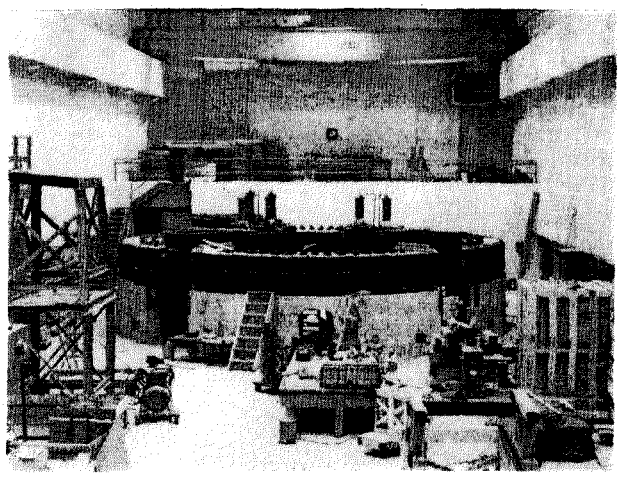
Chemistry: Dr. Sheldon Crane in new cold room designed to further studies of components of protein molecules

The new Guggenheim Center for jet propulsion research has completed its first year of operation with special attention to theoretical research in jet propulsion and the training of students in advanced aspects of this important field.

The Institute's Hydrodynamics Laboratory is without question one of the best equipped laboratories of its kind in the country. Though a knowledge of the flow of liquids around obstacles is as important to the marine engineer as a knowledge of the flow of air around obstacles is to the airplane engineer, it is rather astonishing that the latter field, though younger, is far more highly developed than the former. This is partly because air is a simpler material to work with than water, though it is also partly because experimental studies of liquids have been less vigorously pursued. This situation is being remedied in the Hydrodynamics Laboratory, where two types of water tunnels have yielded important information on fluid flow. The knowledge of hydrodynamics is desired not only by the marine engineer who designs ships, submarines and torpedoes, but also by engineers who are interested in propellers, pumps, turbines, and the flow of liquids through pipes.

Chemistry

THE GATES AND CRELLIN Laboratories of Chemistry are now one of the leading centers in the world for studies in structure of molecules and crystals. These studies



Physics: Construction is well under way on billion-volt synchrotron, world's most powerful electron accelerator

employ an amazing array of modern techniques, including X-ray and electron diffraction, infra-red and microwave spectroscopy, and the use of radioactive tracers.

There is an especial attempt under way to investigate the structure of complex organic molecules, which are of importance in biochemistry. In addition to the work which has been going forward on the structure of amino acids and peptides, good progress has now been made toward a structural determination of chloromycetin and work has also begun on aureomycin and other anti-biotic compounds. A special room, designed for operation at temperatures as low as —40° F and equipped with X-ray facilities, is expected to advance greatly the work on the study of components of protein molecules.

The work in the field of immunochemistry and medical chemistry has shown increased activity. In the annual report of the Institute for 1948-49, Professor Pauling reported that a group working under him with Dr. Itano had discovered that the disease sickle cell anemia is caused by an abnormality in the structure of the hemoglobin molecules in the blood. This was the first human disease which could be identified as a "molecular disease". Further studies of this type of hemoglobin molecule have been made, together with a study of the genetic factors which determine the ratio of abnormal to normal hemoglobin molecules in the blood of those suffering from the disease. In the course of this study a new abnormal form of hemoglobin has been discovered, associated with a new disease which previously had not been differentiated from sickle cell anemia. The individuals suffering from this disease have in their red cells a mixture of two kinds of abnormal hemoglobin, sickle cell anemia hemoglobin, and this new third variety. These two abnormal types seem to be related genetically, one type coming from one parent and the other from the other.

These studies, and many others in chemistry and biology, illustrate again the great advantage of uniting these two great fields of science as they have been united in recent years at the California Institute. The joint program of chemical biology initiated several years ago is yielding remarkable dividends in new knowledge.

Physics

THE MAJOR DEVELOPMENT in the field of physics during the past year was the beginning of the construction of a billion-volt electron synchroton, a project being carried out with the support of the Atomic Energy Commission. This will be the most powerful electron accelerator in the world and will be a most important tool in studying new phenomena in the field of high-energy physics. The synchrotron work will be a connecting link between the low-energy nuclear phenomena, which have been studied here for many years under the direction of Dr. C. C. Lauritsen and his group, and the cosmic-ray physics work which has been carried on by Professor Carl D. Anderson. Preliminary operation at low energies is anticipated by the spring of 1951.

In the field of cosmic rays, Professor Anderson and his colleagues have obtained important evidence for the existence of two new unstable particles. Preliminary evidence for these had been found by two British workers, Rochester and Butler, in 1947, but Anderson's work furnishes definite confirmation and provides further information about the properties of these particles.

Professor C. C. Lauritsen and his colleagues in the Kellogg Radiation Laboratory have continued their work on studying the energy levels of light nuclei and securing further information on nuclear reactions which are of significance in the energy release in the sun and stars. Their results were studied by Professor Bengt Stromgren of the University of Copenhagen while he was a Visiting Lecturer in Astronomy, and he was able to make new calculations of the temperature of the sun. As a result it now seems likely that the nuclear reactions responsible for the production of solar energy may be different from the ones which have usually been assumed in recent years. Specifically, the direct reaction between two protons seems to play a more important role than has been previously thought.

Professor Jesse DuMond has continued his precision measurement of the gamma rays from various artificially radioactive nuclei, and has proceeded with the construction of a precision beta-ray spectrograph for accurate determinations of the energies of the electrons ejected by radioactive nuclei.

Geology

IN THE FIELD OF SEISMOLOGY the Institute group under the leadership of Professor Beno Gutenberg has continued to play a leading role in the rapid advances which have been made in this field in recent years. Improved instrumentation and improved interpretation of seismic phenomena has added greatly to our knowledge of the internal structure of the earth, and there have been great

improvements in the precision and value of seismic measurements. The Institute laboratory now participates in the sea wave warning network inaugurated by the United States Coast and Geodetic Survey, in which reports of strong earthquakes are collected and analyzed in such a way as to give warning to stations in the Pacific of the possible approach of large tidal waves. Further advances have also been made in the study of "microseisms", which are the small seismic disturbances caused by storms at sea. The path of such storms can now be followed and warning given of their approach to various stations.

In the fields of geology a variety of investigations have added to our knowledge of the origin and structure of certain types of rocks and the behavior of unusual geologic formations. There is especial interest in the Southern California area. For example, a new and surprisingly abundant source of the rare metals cerium, lanthium, neodymium, and praseodymium, has been found in San Bernardino County, contained in a new mineral known as bastnasite. This mineral also contains thorium and is therefore radioactive. Other deposits of radioactive minerals have also been found in the desert areas of Southern California.

Professor Robert Sharp has continued his studies on the structure of glaciers in Alaska and on the northeast slope of Mt. Rainier, Washington. This work casts light on the origin and age of glaciers and is expected to contribute to the knowledge of chronology of the ice age.

In the field of paleontology investigations of interesting material found in Mexico promise to yield significant results on the interpretations of the history of life on the North American continent.

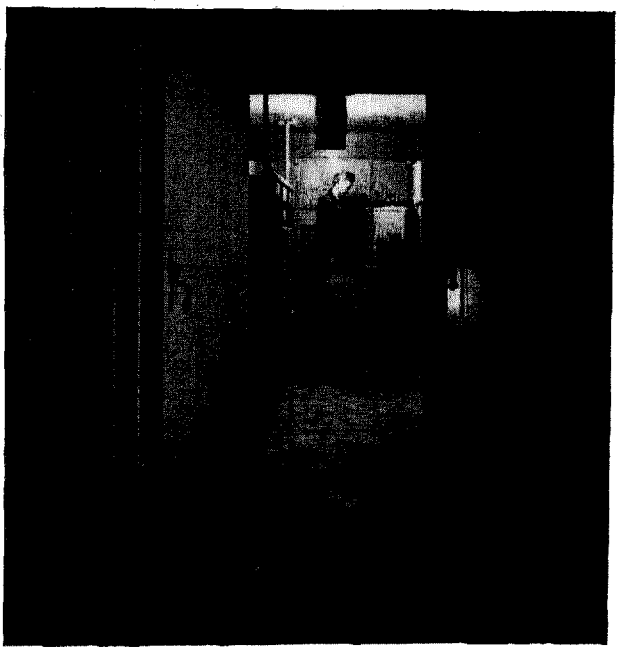
Humanities

THE CHIEF INTEREST in the Division of the Humanities during the past year, and even more during the coming year, has been and will be the examination of the educational program of the Division to determine what forward steps can be taken to improve our offerings to the student body.

Jet Propulsion Laboratory

RECENT WORLD EVENTS have accelerated activities at the Jet Propulsion Laboratory, with increased emphasis, of course, on bringing the results of recent research to bear on the practical problems of design of new types of guided missiles.

Although the Jet Propulsion Laboratory is owned and financed by the Federal Government, it is managed by the Institute under contracts with various defense department agencies, and is an important asset to the Institute's general program of education and research. Much of the work on the design of actual missiles is, of course, kept in a confidential or secret category by the military services. Much of the basic research, however, is not



Geology: Tunnel excavated deep in hill at Seismological Laboratory provides this constant temperature vault

"classified" and is generally published and can be publicly reported.

A considerable amount of work directed toward the investigation of the physical properties, the propulsion performance, and the combustion kinetics of both liquid and solid propellants has been developed and is now ready for the pilot plant stage. The reaction kinetics of nitric oxide have received detailed experimental study because of the importance of this material to acid-based propellants. Detailed information on the combustion of existing propellants, of new propellants, and of new combinations of fuels and oxidizers continues to throw valuable light on the basic elements of jet propulsion processes.

During recent years the major program of the Laboratory has been a study of materials of interest in the construction of jet motors. Much of the laboratory work in this program has now been completed, although new investigations are being made on the properties of titanium and its alloys, a material which has recently come into great prominence.

The problems of heat transfer, critical in all jet motors, have been the subject of many fundamental investigations.

In the engineering field the mechanical and electronic design aspects of the so-called ORDCIT guided missile were brought to completion and a sample of this missile was successfully fired. This is one of the first ground-to-ground guided missiles to be built and flown in the United States.

A new 18-inch by 20-inch supersonic wind tunnel has gone into operation during recent months, and this will contribute greatly to the studies in the flight properties of missiles and jet engines.