# THE PRESIDENT'S REPORT

## Highlights from the report, on activities and research at the Institute in 1950-51

by L. A. DuBRIDGE

As was forseen in the President's Report for 1949-1950, the Institute has been called upon during the current year to assist the Federal government in many aspects of its program directed toward national security. The Institute has responded generously to these calls though they have frequently meant serious sacrifices to our normal program of education and research.

Though such sacrifices are gladly made, we must remain cognizant of the fact that our normal program of education and research is also essential to national security. The education of first-quality scientists and engineers is of more critical importance today than ever before. It would also be disastrous to the nation for basic research programs to be abandoned in institutions such as this.

On the other hand, the military services also need immediate help. Fortunately, there is no central agency to tell us how we should balance our effort between these "normal" and "emergency" activities. We must make such decisions ourselves, using our own best judgment of the relative value of the Institute contributions in these two areas, basing our judgment on our own knowledge of the national and international situation. This is a grave responsibility, indeed, and must be approached with farsighted and patriotic unselfishness.

Fortunately, many members of the faculty, the administration and the Board of Trustees are in close touch with military and other national problems and can assist greatly in reaching wise decisions. And if your President seems rather frequently absent from his desk on trips to Washington, it can at least be hoped that his activities there will also help cast light on important Institute decisions.

The largest Institute activity directly related to national defense is the operation of the government-owned Jet Propulsion Laboratory. The increasing tempo of mobilization has naturally meant a substantial increase in activity there, with increased emphasis on the more immediate as against the long-range developments.

Similarly, the Cooperative Wind Tunnel operated by the Institute for a group of aircraft companies, has been exceptionally busy. Plans for enlarging the tunnel to make supersonic tests possible are well along.

### Project Vista

Of more immediate concern to the campus was the initiation of a special project known as Project Vista. The name derived from the fact that quarters to house this project were provided by the Army in what was once the Vista del Arroyo Hotel, later the Army McCornack Hospital, in Pasadena. The name of the project is about the only feature of it which can be made public. A large fraction of the senior faculty members of the Institute have participated and also a number from

*Caltech's President L. A. DuBridge. His services to various government agencies are typical of those of other Caltech faculty members. He is on the Naval Research Advisory Committee and the General Advisory Committee of the AEC, the Advisory Committee on Scientific Manpower of the National Securities Resources Board, the Scientific Advisory Committee of the Office of Defense Mobilization, and the National Science Foundation Board.*

other universities. The project is sponsored jointly by the Army, Navy and Air Force, and the work is of far-reaching importance. The program will be completed on January 1, 1952. Professor W. A. Fowler is performing a superb job as research director of the project.

Members of the faculty continued to be called upon to serve on military advisory committees in many fields. Professor H. P. Robertson was persuaded to extend his year's leave of absence to two years to serve as Scientific Director of the Weapons System Evaluation Group of the U. S. Joint Chiefs of Staff.

Your President's services to various government agencies are typical of those of other faculty members. In addition to his regular service on the Naval Research Advisory Committee and the General Advisory Committee of the Atomic Energy Commission, he has also been appointed by the President of the United States to serve on the Advisory Committee on Scientific Manpower of the National Securities Resources Board (a short term committee), the Scientific Advisory Committee of the Office of Defense Mobilization, and the National Science Foundation Board.

These are mentioned only to illustrate that practically no major national scientific group is any longer established without at least one—sometimes several—representatives of Caltech. The Institute's high achievements in science and engineering have made it a critical national asset, but have also brought attendant obligations.

### Finances

The total net assets of the Institute, including plant assets, stood at $47,580,131 on June 30, 1951, a rise of $2,434,094 for the fiscal year. This figure includes endowment funds of nearly $24,000,000, a plant investment of over $17,000,000, trust funds of just under $3,000,000 and surplus and unexpended income of $2,600,000.

The expenditures for the year amounted to $11,363,984 and this amount was slightly less (by $95,647) than the total income. Of the income about $7,200,000 was received as reimbursement for research carried out under government contracts, the Jet Propulsion Laboratory being the major item. Endowment income amounted to $1,547,936, and current gifts totaled $855,111. The Institute's investments in marketable securities (excluding real estate, trust funds, etc.) yielded an income of 5.3 per cent of the average book value, or 4.6 per cent of the current (June 30) market value. The Institute portfolio now consists of about 27 per cent preferred stocks, 51 per cent common stocks and 3 per cent real estate.

It is gratifying to note that during the past five years the total capital assets of the Institute have increased by about $10,000,000—an average increase of $2,000,000 per year. Assets will probably pass the $50,000,000 mark during this coming year.

Fifty million dollars seems like a lot of money—in nongovernment circles. But measured by Caltech's needs and opportunities it is distressingly inadequate. Faculty salary scales are in urgent need of revision; facilities for education, research and for student life are desperately needed. The thoughtful donor will find here many fine opportunities for a gift that will pay dividends forever.

## Research at the Institute

It is impossible, of course, in the space of a very brief report to convey any adequate idea of the nature and extent of the many important research activities being carried on at the California Institute. As an ex-

ample of the great magnitude of the research effort, it might be mentioned that the Division of Biology for special reasons prepared during the year a complete catalogue of all the research enterprises in progress within that division, with one or two descriptive paragraphs relating to each project. When completed, this report turned out to be a volume of 140 pages.

As in previous years, therefore, it is necessary to confine our attention in this report to a few random samples of research projects of general interest in various fields of current activity at the Institute.

## Astronomy

Regularly scheduled observations with the 200-inch Hale Telescope have continued throughout the year. Most of the observations on moonless nights have been devoted to the cosmological program. This is a systematic step-by-step program planned to extend our knowledge of the distances, dimensions and structural features of the extragalactic nebulae. These are vast stellar systems similar to our own Milky Way, each nebula being made up of millions or even billions of stars.

As a first step in this program, hundreds of photographs have been taken of the Andromeda and other nearby nebulae. Studies of these plates have already indicated that the increased resolution of the 200-inch telescope will make possible the elimination of most of the uncertainties in the earlier determinations of the distance and size of these objects. Another group of plates of more distant nebulae has shown that this same type of direct distance measurement can be extended to several times as many nebulae as could be reached with the 100-inch telescope.

The accurate determination of the absolute sizes and luminosities of a large sample of nebulae will in turn permit a survey with greatly increased accuracy of the distribution of these objects out to the extreme range of the 200-inch telescope, that is, throughout a sphere some 2,000,000,000 light years in diameter.

Another important part of this program has been the study of the spectra of the nebulae which are so distant as to be beyond the range of the 100-inch telescope. An examination of these spectra enables one to determine the velocity at which these nebulae are receding into space. Previous observations have shown that the more distant a nebula is from the observer the greater is its velocity of recession. Recent observations have extended this relation out to new limits. For example, one nebula estimated to be at a distance of 360,000,000 light years from the earth shows a velocity of recession of approximately 38,000 miles per second. This is a speed exceeding 1/5 the velocity of light. New techniques for improving the precision of the measurements of distance and recession velocities will enable astronomers to make far more accurate determinations of the relation between two quantities, and the precise nature of this relation is an important method of testing various cosmological theories.

On the campus, work in astrophysics was continuing its development. Further light on the nature of nuclear reactions in the stars emerged from the joint efforts of physicists and astronomers.

## Biology

During the year 1950-1951 a number of important advances were made in the research and teaching activities of the Division of Biology. An extensive project on radiation genetics, supported largely by the Atomic Energy Commission and the Office of Naval Research, added significantly to our knowledge of the effects of higher energy radiation on living systems.

Another of the noteworthy research activities of the division is that having to do with viruses. One group with Professor James Bonner has investigated higher plant viruses. Others working in Professor Max Delbrück's laboratory have continued study of bacterial viruses. Doctor André Lwoff of the Pasteur Institute of Paris spent two weeks working with this group and was to a large extent responsible for stimulating research on the interesting and important phenomenon of "lysogenesis." This term is used to describe the condition in which bacterial cells carry viruses in a latent condition without harm to the host cells. The special contribution of Lwoff to an understanding of this relation was the discovery that treatment of lysogenic strains of bacteria with ultraviolet radiation under suitable conditions brings about liberation of active viruses capable of infecting sensitive bacterial cells.

With the assistance from the Boswell Foundation for Virus Research, Doctor Renato Dulbecco and associates are attempting to develop a new type of animal virus assay fashioned after the now classical "plaque count" technique widely used in bacterial virology. If this is successful, a serious bottleneck in animal virus research will have been opened up. In order to obtain desired background and the best available advice on this project, Dulbecco spent two months during the early part of 1951 on a trip to various animal virus and tissue culture laboratories. Since his return, active work has been under way with the virus of equine encephalomyelitis in a newly equipped and modernized virus-tissue culture laboratory suite.

As in the past several years, many activities of the division have been performed in close collaboration with members of the Division of Chemistry and Chemical Engineering as a part of the joint Chemistry-Biology Research Program. This program is generously supported by a special seven-year grant from the Rockefeller Foundation.

An example of an area of research in which the activities of the two divisions come close together is found in the various investigations on proteins and protein structure. Professor Linus Pauling and Professor Robert Corey have recently increased our understanding of the molecular structure of proteins in a truly remarkable way. Since proteins are the key molecules of all living

*Chemistry: Research in progress on the problem of determining the structure of protein molecules.*

systems, the impact of this work on the biological sciences is indeed very great.

## Geology

The Division of the Geological Sciences has continued to advance in many fields in spite of the severe shock caused by the death of Professor Chester Stock. For example, there was progress in the improvement of its earthquake recording instruments and the multiplication of its Southern California seismic stations, in fundamental studies on the nature of the earth's core, in studies of past glaciations in California and of the dynamics of desert dunes, and in the development of a fundamental and comprehensive hypothesis on the origin of pegmatites. In addition to many continuing investigations of important industrial minerals, significant studies were completed during the year on mica deposits in the southeastern United States, talc deposits in southeastern California, and gypsum deposits in the Palen Mountains, California.

Much thought and planning on the part of the division staff have been given throughout the year to the relatively new field of geochemistry in anticipation of the arrival of Professor Harrison Brown, under whose leadership an important and far-reaching program in this field will be initiated.

## Chemistry

Many important advances in a number of chemical research programs were made during the year. For example, a penetrating investigation of the nature of enzymes has been under way for some time by Professor Carl Niemann and his associates. This study has involved especially the enzymes that are responsible for the breakdown of proteins and amino acids in the animal body. Important progress has been made toward determining the mechanism of the action of these enzymes and its relation to their structure.

Fifteen years of work by Professor Linus Pauling and Robert B. Corey and their many colleagues on the problem of determining the structure of protein molecules culminated in important and new results. Protein molecules are known to consist of chains of amino acids, but a chain may contain several hundred amino acid residues, and at least 24 different kinds of amino acids are known to occur. The problem of finding the precise way in which these amino acids are arranged in a protein molecule is thus a formidable one. However, new X-ray studies have enabled Pauling and Corey to propose a detailed structure of several important protein molecules and to show that these proposed structures are apparently consistent with all known X-ray data and also to show that previous models of protein structure are inconsistent with the new X-ray data. If further work confirms these findings, this will be an advance of great importance in a field which has occupied the attention of chemists and biologists for many years.

During World War II, Drs. Dan H. Campbell, Linus Pauling and J. B. Koepfli conducted a search for a substance which could be used as a satisfactory substitute for human blood plasma and which could be manufactured in large quantities and stored for long periods and be adaptable to use on the battlefield. A material was developed by chemical treatment of gelatin with glyoxal and hydrogen peroxide and was given the name oxypolygelatin. Clinical tests indicated that the material might be an exceedingly satisfactory plasma substitute. Because of the recently renewed interest in this field, additional investigations have been undertaken and extensive clinical tests are under way in the various medical centers of the U. S. Armed Forces. All the results so far are exceedingly promising.

Work on the problem of the crystal structure of metals has attracted the attention of physicists, chemists and metallurgists for many years. Recently Dr. David P. Shoemaker and Dr. B. Gunnar Bergman have been able to work out the structure of the important so-called sigma phase which occurs in certain alloys such as stainless steel. Many previous attempts to determine the structure of this phase have been unsuccessful but these workers have now succeeded. The structure turns out to be a most unusual one and the success of this work will cast light on many of the problems of the structure of metals and alloys.

## Physics and Mathematics

A major effort during the year was devoted to the construction of the new synchrotron. Preliminary opera-

tion was achieved at very low power levels, showing that no serious problems existed in ejecting electrons into the proper orbits. The new power supply for high power operation was installed and tested and construction was fairly well complete by the fall of 1951. Operation at the initial level of one-half billion volts may be expected by the middle of 1952.

A new cosmic-ray laboratory, built as a wing to the Norman Bridge Laboratory, was completed and Professor Carl D. Anderson and his colleagues are installing new equipment which will make possible a major addition to the Institute's important cosmic-ray program. Professor Anderson's group has added important new information to the nature and behavior of the most puzzling new neutral particle—the "V-particle," which apparently disintegrates into a proton and a negative meson.

Professor Victor Neher and his colleagues made cosmic-ray studies during the summer at Thule, Greenland —the nearest accessible point to the north magnetic pole.

Professor J. W. M. DuMond has continued his astonishingly precise measurements of the wave lengths of gamma-ray lines from various radioactive isotopes. He has also put into operation a new type of instrument, a point-focusing X-ray monochromator for low-angle X-ray diffraction studies of small particles.

Work in the Kellogg Radiation Laboratory on the properties of light nuclei continued to yield a stream of new information, in spite of the disruption during the spring and summer of 1951 caused by participation of many staff members in the Vista Project.

## Engineering

The past year was the first full year of occupancy of the new engineering building. This has given greatly improved facilities for instruction and research in civil and mechanical engineering. A similar building for chemical and electrical engineering is badly needed to relieve overcrowding in those areas.

In civil engineering a new study of water purity problems was initiated by Professor J. E. McKee. Professor F. J. Converse reported important progress on a new vibrational method of compacting soil. Further studies of resistance of structures to shocks and earthquakes have been reported by Professor George Housner. A study of the wind-induced vibration problem in long pipe lines has been initiated.

In electrical engineering Professor G. D. McCann and his colleagues have obtained new data on the characteristics of high-power arcs in air, which are of interest to the three electrical companies sponsoring the work. Applications of the electric analogue computer to many types of engineering problems have rapidly expanded to the point where the Institute Analysis Laboratory can no longer handle the load which industry would like to place on it. Hence the Institute is assisting a number of companies in building their own computers and in training computer personnel. Aircraft vibration problems can be handled in such an effective manner that most major aircraft companies are finding computers of this type to be essential equipment. The Institute will continue the basic research on computer design and application to new types of problems.

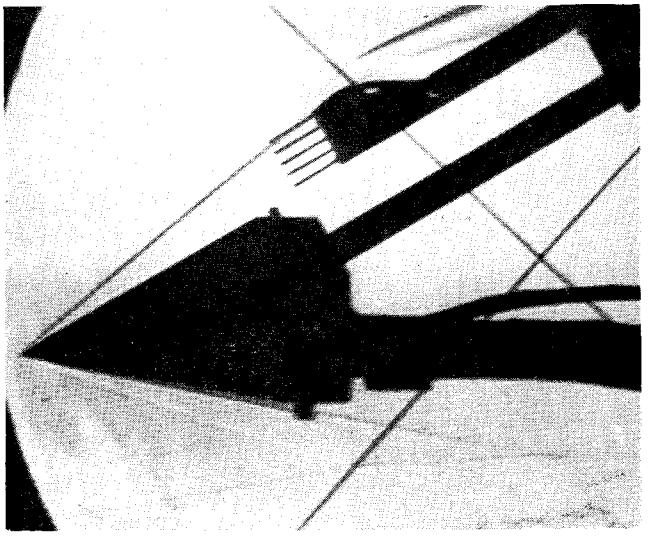
Basic studies in hydrodynamics continued to yield information of value to the Navy, to designers of pumps and turbines. In mechanical engineering new metallurgical studies by Professor Pol Duwez of titanium alloys provided new data of value in developing additional applications of this important metal, whose usefulness has only recently come to be recognized.

In the Guggenheim Aeronautical Laboratory basic research continued on many problems in fluid mechanics, the properties of air flow at hypersonic speeds (5 to 10 times the speed of sound) and in elastic and vibration problems encountered in aircraft structures. In the hypersonic wind tunnels the expansion of the air stream necessary to attain these extremely high speeds is accompanied by extremely low temperatures. Thus, rather surprisingly, new information on the liquefaction of air under these conditions is being obtained.

The very large Cooperative Wind Tunnel was built before supersonic speeds were of such importance—or could be attained. A $6,000,000 modification program now under way will bring this tunnel to the supersonic range, thus vastly increasing its value.

## Acknowledgment

In conclusion, I should like to express appreciation to all members of the Board of Trustees for the active interest which they have taken in the Institute and for their generous contribution of time and energy to Institute affairs. This group of outstanding public-spirited men who assume responsibility for the continued success and financial stability of this great institution are performing a difficult and often thankless task—but one whose value to the community and to the nation can hardly be overestimated.



*Aeronautics: Schlieren picture of model used in investigation of condensation of air in Army Ordnance Galcit Hypersonic Wind Tunnel.*