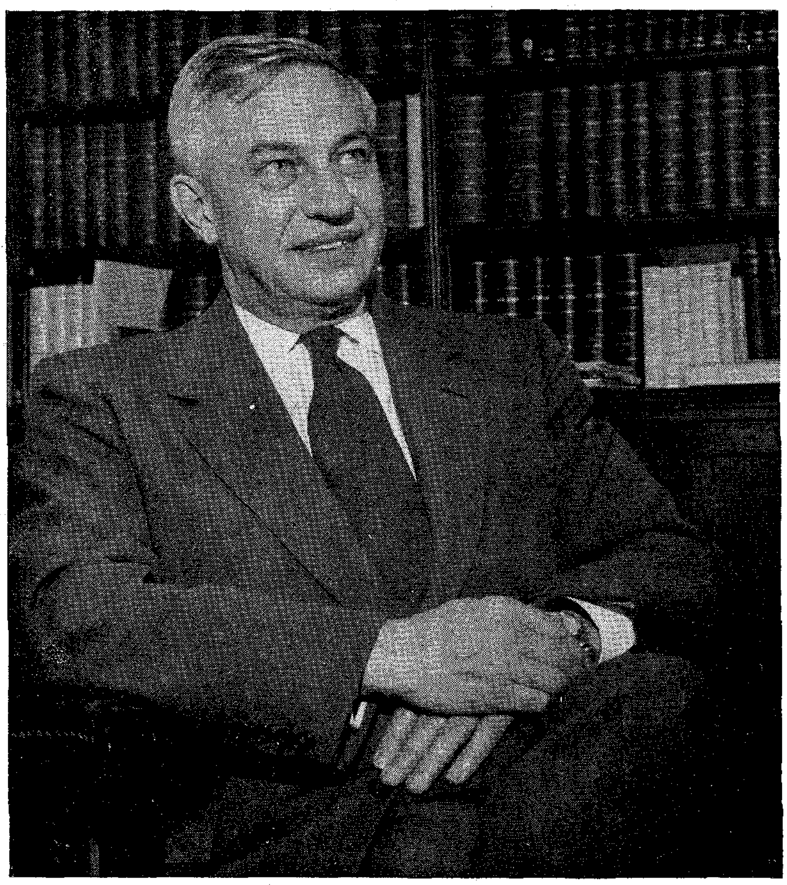

THE PRESIDENT'S REPORT

Some highlights from Dr. DuBridge's 1953-54 report on activities and research of the Institute

IN SHARP CONTRAST to many recent years in which major national and international events have shaken college campuses, the past year appears relatively uneventful. One is tempted to call it a "normal" year—though to define the term "normal" would not be easy. It is certainly not true that the year has been an uneventful one in the world at large. But either the events had a lesser reaction on our universities; or else our universities have become adapted to living in a world of turmoil and have stabilized their operations accordingly.

This latter would certainly appear to be the case at Caltech. American universities have acquired a continuing obligation to aid in strengthening the technology of national defense. Consequently we have for several years past placed our chief contribution in this area—the Jet Propulsion Laboratory—on a long-term basis. We expect to be operating this $12,000,000-a-year defense effort for a considerable time in the future—and are proud of its success.

Similarly, we are enlarging the Southern California Cooperative Wind Tunnel—at a cost to the participating companies of $8,000,000—in order that it may better serve the needs of an advancing aircraft industry.

These two enterprises are managed but not owned by Caltech. Through them we render a service to the community and the government. However, our major interest and service will always be the program of education and research conducted on the campus. Since it is not practical to teach students in one room and do "secret" work in the next, we do not carry forward military projects on the campus. Our campus contributions to the country are more basic than inventing new weapons; we are educating the men and uncovering the new knowledge which are necessary to future weapons—and to future peacetime technology.

Government service

At the same time various members of our faculty continue to devote many man-months of effort each year in direct government service. Professor H. P. Robertson has again been called away for an extended period, this time to serve in Paris as scientific adviser to General Gruenther, Supreme Allied Commander for Europe. Others, including your president, have been absent for many shorter periods. In these days when technology has made it possible for a nation to achieve overnight the destruction of an enemy's industrial and military capacity, and when technology can also offer the hope of preventing such disaster, it is clear that the government can never cease calling on scientists for help. And no loyal scientist will refuse such help.

These are the ways, at Caltech and elsewhere, that science serves the government. How does the government assist science?

The many difficult problems relating to the government support of (nonmilitary) science have not been fully solved but have become more or less stabilized. Although the National Science Foundation was looked upon as a mechanism for improving this situation, Congress has provided such meager funds that the Foundation can not yet be a commanding force. Worse still, Congress reduced the support of other research agencies this year by an amount at least as great as the increase in NSF funds, so that the support of basic science in universities is less than before.

While the national picture is thus somewhat clouded, our own research program at Caltech is of such high quality that we have had no difficulty in obtaining government financial assistance for the more important projects when we need it. Both private (including corporate) and government support for our program have increased and a reasonably stable and satisfactory balance between them now exists.

Selective service

The calls of the military services upon the students remain in a less than comfortable status. Selective service policies are neither uniform nor consistent nor stable. Two students from different districts may receive quite different treatment and this leads to a general uneasiness. The changing policies of the Air Force Reserve Officers Training Corps have also led to uncertainty—and to a drastically lowered enrollment in the Caltech unit. A student can find no way whereby he can plan ahead for his education and his military service so as to make best use of his talents. Indeed, he can adopt no plan which may not be changed suddenly and for no apparent reason. Some students can adapt themselves to such uncertainty; others find it most frustrating.

Such have been a few of the problems of steering a stable course in an uncertain world.

THE CAMPUS

As far as campus facilities are concerned this has been the most eventful year since the year 1938, in which the Mudd and Arms Laboratories were built. Construction was begun this year on both the new athletic center and the Norman Church Laboratory of Chemical Biology. Each structure will be a decisively important addition to our facilities.

These two buildings do not, however, solve all our most difficult space problems. An engineering building, a central library, a permanent health center, a graduate dormitory, a student union building, and an auditorium are still required to complete our campus plan.

FINANCES

The report of the Comptroller shows that again this year we just failed to break even on our current funds, having spent about $139,000 more than the income we received. Our unrestricted surplus fund was thus reduced by this amount. This, however, is well under one percent of our gross income.

Nevertheless, because of additions to capital funds, the net worth of the Institute showed an increase, rising to $55,785,435. Our endowment capital increased by $1,164,000 to the total of $30,007,692. The market value of our portfolio is nearly 8 million dollars higher than the above book value.

One of the most valuable single gifts ever made to the Institute was the bequest, in the form of a trust, of Eudora Hull (Mrs. Keith) Spalding, who died in 1942. This trust, consisting of securities, mineral rights, and the 5000-acre Rancho Sespe (near Fillmore, California) has regularly yielded an income of around $200,000 a year, occasionally reaching as high as $400,000. The Institute owes a great debt to Keith Spalding, trustee of this estate, for his wise management and his generosity in seeking to maximize the Institute's receipts from it.

During this past year the potential value of the Spalding trust was substantially increased by the discovery of oil on Rancho Sespe. Only two wells have been completed and, though they are excellent producers, it is too early to predict how extensive a field has been tapped. Several years of further drilling will be required to test the pool, since it is a very deep one (over 14,000 feet). Oil and gas royalties, which may in the next year or so amount to $150,000 per year, will be credited partly to income and partly to capital, and obviously will be a most welcome addition to our resources. At the same time the magic word "oil" must not lead to unwarranted illusions. A ten percent increase in our endowment income is most welcome, but it does not solve all our financial problems.

The costs of operating the Institute's program of education and research have continued the rise of recent years. The rise is caused partly by additions to and improvements in the program, partly by the general inflationary spiral, and partly by our attempt to increase our wage and salary scales. Our nonacademic pay scales are now comparable to the area rates. Our faculty salaries have been below the levels of those universities whose graduate and research programs are most nearly comparable to ours. We have, however, made good progress in the past two years in closing this gap. We can now say that—figured on the basis of 11 months of service—our annual rates for the younger ranks are about equal to those of the best universities but our top professorial salaries are a little lower. However, one must quickly add that *all* university faculty salaries are tragically low, compared to those of industry.

RESEARCH HIGHLIGHTS

THIS PAST YEAR several divisions of the Institute initiated the preparation of separate research reports. Four divisions each published a volume of from 100 to 200 pages containing a summary of the status of every research project in the division, including the names of participants and the sources of financing.

These are impressive volumes, indeed (available on request to those interested). They show how impossible it is to "summarize" in this present report the work of a division which is carrying forward more than 100 separate research projects (Biology, 144; Geology, 121; Engineering, 133; Chemistry, 119). It is like "summarizing" the Encyclopaedia!

Yet certain projects here and there stand out because of some element of particular interest. A few of these are indicated herewith.

Smog

The Institute has avoided for many reasons undertaking on its campus any extensive project on air pollution. However, when it became plain that smog affects plants in a research greenhouse and affects delicate chemical analyses (and also hides our mountains), it was inevitable that some one would take an interest in it. Several years ago Professor Haagen-Smit—a distinguished biochemist—suggested that most of the objectionable features of Los Angeles smog (which is very different from the old Pittsburgh or St. Louis "soft-coal smog") were caused by oxidized components of gasoline vapors. Laboratory tests enabled him to produce from gasoline and ozone artificial smog which smelled, tasted, and looked like smog—and affected green plants in the same way. This idea broke the back of the scientific mystery about the nature of smog and allowed a concentrated attack on the problem of working out the detailed chemistry of the atmospheric processes, and initiated a search for the most important sources of the offending substances. Elimination of the emissions from refineries and oil storage tanks in Southern California is now well on the way to completion. Gasoline service stations and automobiles are less easy to control. But the attack is in full swing, and with a new and active private organization—the Southern California Air Pollution Foundation—now fully engaged in the effort, there is hope that progress may be accelerated. (See page 11.)

Microsecond chemistry

During the postwar years many startling advances have been made in techniques in both physics and chemistry for dealing, on the one hand, with very tiny amounts of material—a thousandth of a millionth of a gram—and, on the other hand, with very small intervals of time, down to hundredths of a millionth of a second. Physicists are now quite skilled in electronic measurements of exceedingly fast processes involving very short times. Microseconds are important in chemical reactions, too. An explosion, for example, is just a chemical reaction which goes very rapidly, and may be all over in a few millionths of a second. The speed of the reaction is clearly dependent upon how fast the individual atoms and molecules are moving. Hence, a technique for getting a fast "snapshot" of the reaction is useful to determine what is taking place. Recently Professor Norman Davidson and his co-workers have used optical methods to observe reactions caused by the passage of a shock wave through a gas. In this process molecules are dissociated and a quick "picture" of the process can be obtained.

Geochemistry

The measurement of millimicrograms is important in the relatively new field of geochemistry. Here much has been and continues to be learned about the origin and development of the earth by the measurement of tiny quantities of uranium and lead in rocks, in meteorites, or in the ocean. The very slow radioactive decay of uranium into certain isotopes of lead has provided a sort of "clock" which has been running ever since the earth was formed some four and a half billion years ago. As geochemists learn how to read this clock they learn the age not only of the earth itself but also of younger formations of sedimentary or volcanic rock.

Isotopic chemistry—the measurement of the relative abundance of different isotopes of an element—is opening a most powerful tool for many purposes. Thus it appears that in fossil fuels—coal and petroleum— the ratio of the carbon isotope C^{12} to the carbon isotope C^{13} is larger than in present day living plants. However, a study of the C^{12}/C^{13} ratios within successive tree rings of individual living trees has shown that this ratio is larger in the outer rings. Apparently the burning of fossil fuels in homes and industry has increased the carbon dioxide content of the air and also the C^{12}/C^{13} ratio during the past 100 years, and trees and other plants which absorb carbon dioxide indicate this changing carbon content.

This is but one interesting example of how a new technique yields new information about the earth's history.

Turbulent flow

When a gas or liquid is pumped through a pipe, forced into a reservoir or into a combustion chamber, or caused to stream past an object in a wind tunnel, the flow is generally not smooth like a quiet deep river, but is turbulent like a mountain torrent. When the turbulent fluid stream strikes a surface, hot or cold, it transfers to it momentum (and this results in a force) and the fluid also gives up, or takes away, heat. A good share of the chemical, oil and aircraft industries can be said to be based on phenomena of turbulent flow. Yet the detailed characteristics of momentum and heat transfer in such flow are not fully understood. The chemical engineering group at Caltech has had this as a major field of interest for many years. The aim is to develop a basic theory and to make measurements of specific materials which will allow accurate predictions of the behavior of the fluids in a new chemical processing plant, for example. One particular problem recently examined was the rate of evaporation of a liquid droplet falling through a gas.

The synchrotron

When very high energy X-rays (above 250 million volts) fall on a hydrogen nucleus—a proton—the charge on the nucleus is "peeled off" in the form of a meson, leaving a neutron behind. There is nothing startling about this to a physicist. It was discovered several years ago that mesons could be "created" in the vicinity of nuclei by X-rays or gamma-rays. But it was startling to find from a detailed study of this process, carried up to over 500 million volts with the Caltech synchrotron, that the meson had a sort of virtual existence in (or near) the proton *before* its "creation". Thus, one more fact of meson physics is added to our store of knowledge. This particular fact, however, is very puzzling to the physicists and seems to deepen rather than reduce the mysteries of nuclear physics.

The synchrotron has been shut down temporarily while alterations are being made which will allow it to accelerate electrons to over a billion electron-volts energy—double the present level. This modification was planned from the start of the synchrotron project but it was deemed desirable to begin operation and gain some experience for a couple of years at the lower energy.

The synchrotron, incidentally, has proved a spectacularly successful machine and it has been most productive. In these days of "nuclear secrecy" it should be emphasized that neither the synchrotron nor any of its results are secret. It is located in the building where the 200-inch Palomar mirror was ground, and the same observation balcony overlooking the equipment is still open to the public.

Astronomy

The past two years have been exciting ones in the field of astronomy—an excitement which can be largely credited to the new observations made possible by the 200-inch Hale telescope. The performance of this instrument and the new results on the nature and structure of the universe have certainly exceeded the highest hopes of George Ellery Hale and the others who dreamed of and built this magnificent instrument.

The first surprising discovery was that of Dr. Walter Baade several years ago when he found, contrary to supposition, that the stars in the vicinity of the sun are not typical of all the stars in our Milky Way Galaxy. Our sun is far out near the edge of the Galaxy in one of the spiral arms. It now appears that such stars are probably younger than the stars near the center and have quite different characteristics and composition. This has required a revision in the scale of distances as determined by the apparent brightness of certain types of stars. In addition, Dr. Allan Sandage has developed more accurate instruments for measuring brightness, thus correcting certain previous errors. The net result was the discovery that the great spiral nebula in Andromeda—our nearest neighbor universe, similar to our Milky Way—is 2.5 times as far away as had been thought. It is, therefore, 6.25 times as big and as bright as had been assumed—making it a colossal universe of stars, indeed. A second and more distant nebula has been measured and found to be 4 times as far away as previously determined—and hence 16 times as big and bright.

Thus a whole new conception of the distances and sizes of the nebulae has been introduced which gives us a new concept of the size and the age of the universe. It will take much more data, however, before adequate determinations can be made of other nebular distances and hence before new size and age numbers can be deduced. But it seems clear that the faintest and most distant nebulae are not a mere 1 billion light years distant but may be 2 to 4 billion light years away.

The discovery a few years ago that the heavens contain sources which emit radio-frequency energy has opened up a new field of astronomy. We now know that the sun itself emits radio waves and these show irregularities which are synchronized with sunspot disturbances and with large flares at the sun's surface. Also there are sources of radio energy in space, called "radio stars", some of which can be identified with known sources of visible light, and some cannot. These may be dark masses of matter which emit only radio waves. In any case the radio spectrum now has become as important to astronomers as the visible spectrum and it is clear that work in this field must be initiated here. Funds for this purpose are now being sought.