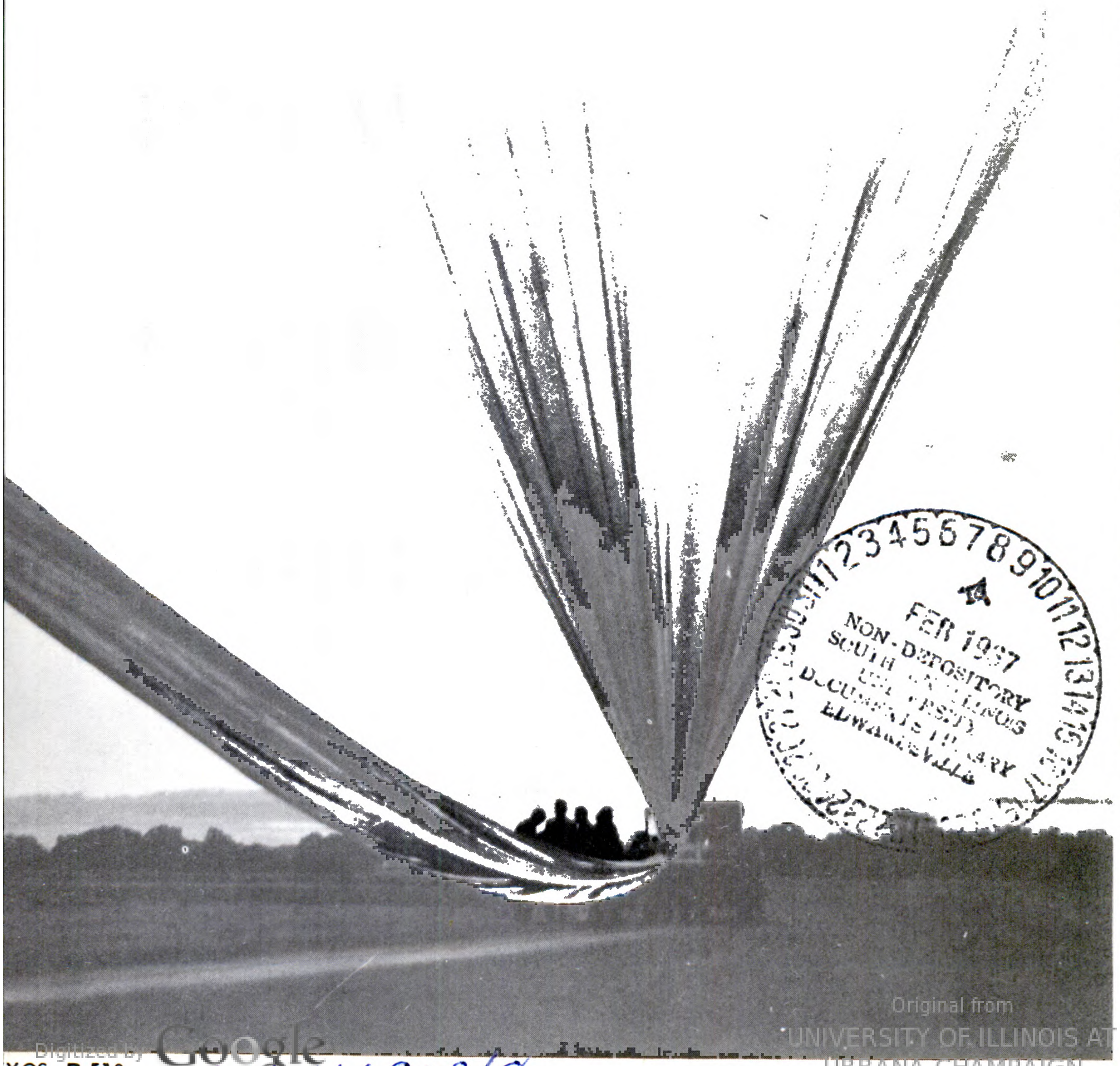
FEB 24 1967
S. I. U. LIBRARY EDW.

NAVAL RESEARCH REVIEWS

AUGUST 1959

DEPARTMENT OF THE NAVY
OFFICE OF NAVAL RESEARCH



FEB 1967
NON-DEPOSITORY
SOUTHERN ILLINOIS
UNIVERSITY
DOCUMENTS LIBRARY
EDWARDSVILLE

XOS P-510 D210.11:959/8

Generated for member (University of Maryland, College Park) on 2014-09-30 20:12 GMT / http://hdl.handle.net/2027/uiug.30112075629110
Public Domain, Google-digitized / http://www.hathitrust.org/access_use#pd-google
Digitized by Google
Original from UNIVERSITY OF ILLINOIS AT URBANA-CHAMPAIGN

The Flying Coronagraph

As this issue of Naval Research Reviews goes to press, preparations are underway to launch a Navy balloon and two scientists into the stratosphere to observe the sun's corona. The flight, sponsored by the Physics Branch, Office of Naval Research, will be made in an open gondola from The Stratobowl near Rapid City, S. Dak., to an altitude of about 40,000 feet. Although at the time this is being written we are too early to tell the full story of the event, we can describe some of the investigations planned. In doing this, we will assume that the flight has already taken place--as it will have by the time this issue of the magazine is distributed, if all goes according to plan.

In making their observations of the sun, the crew--CDR Malcolm D. Ross of the Air Branch, Office of Naval Research, and Robert H. Cooper of the High Altitude Observatory, Boulder, Colo.--utilized the "Flying Coronagraph," an instrument developed by the High Altitude Observatory especially for balloon use. By means of the device, a solar eclipse can be simulated, thus enabling the observers to study the variation in sky brightness near the sun as a function of balloon altitude. The data obtained should also yield important information on the distribution of particulate matter in the atmosphere.

Although extensive pre-flight ground testing was carried out, a number of techniques and components planned for the flight were new and thus had to be checked out in the stratosphere before they could be considered operational. These included the Flying Coronagraph, a rotational control system, and special flight clothing developed to minimize the radiational heat losses in the severe cold of about -60°C. The flying Coronagraph has already been discussed, and the special flight clothing is described in a separate short article appearing (along with picture) on page 32 and the inside back cover. As for the problem of gondola rotation, the vehicle was instrumented to obtain quantitative data regarding the natural rotational characteristics of the system, the effect of the parachute suspension in creating gondola rotation different from that of the balloon, and the ability of the rotational-control system to maintain the flight scientists in such a position that they would encounter no rotational difficulty in making observations.

Physiological information (on respiration, heart action, and body temperatures) was telemetered from the gondola to a specially equipped airplane which accompanied the balloon on its flight. A Navy flight surgeon aboard the plane monitored the telemetered data and thereby kept track of the exact physical condition of the balloon crew at all times. Pre-flight and post-flight data were acquired also to serve as a basis for determining the degree of physiological stress encountered during the flight.

Winzen Research, Inc., Minneapolis, provided its own Sky Car open-gondola for the flight and, under a contract with the Air Branch of ONR, constructed the polyethylene balloon, integrated the overall system, and conducted the launch.

Generated for member (University of Maryland, College Park) on 2014-09-30 20:12 GMT / http://hdl.handle.net/2027/uiug.30112075629110
Public Domain, Google-digitized / http://www.hathitrust.org/access_use#pd-google
Digitized by Google
Original from
UNIVERSITY OF ILLINOIS AT
URBANA-CHAMPAIGN

SUBIC

SUBmarine Integrated Control is the aim of a new program dedicated to the more effective control of all phases of operation of future submarines. It has as an ultimate goal the presentation of all pertinent data in such form that it can be used to best advantage by the commanding officer in carrying out his missions. It is envisioned that through centralized computer techniques and use of more efficient display media it will be possible to increase the overall effectiveness of the submarine while decreasing considerably the size of the crew.

In linking man and machine so closely, the designers of the new system are having to integrate not one, but five fundamental control systems—ships, engineering, communications, weapons, and environmental. Let's look at these systems and see how SUBIC will be applied to them.

Ship Control—A central control computer will provide essential information for displays and such functions as may be automized. All inputs to the computer, such as bathythermograph information, for example, will be so processed as to present a display which is as useful as possible to the commander without being the least redundant. Coupled with this requirement is the need to reduce the time taken to train men to operate submarine controls. To bring about this saving, a "real world" type presentation, such as is utilized in the Army-Navy Instrumentation Program (see Research Reviews, July 1958), will be provided.

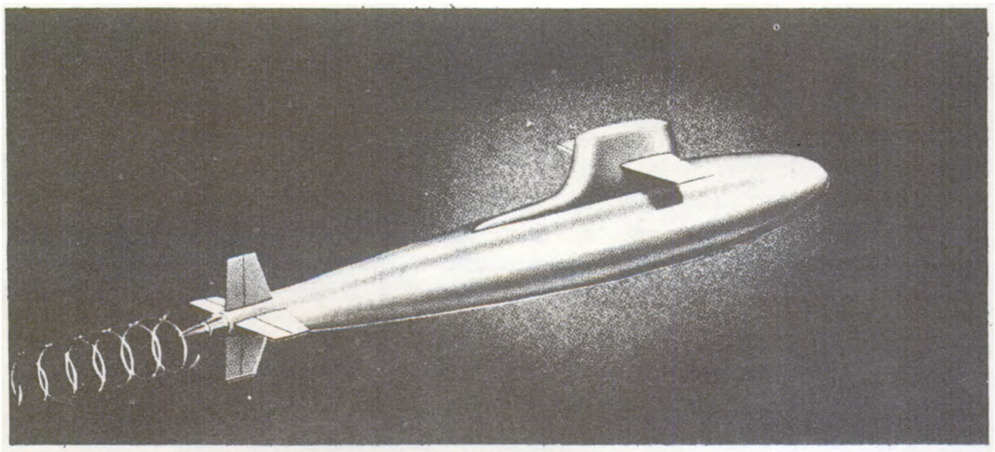
Weapons Control—This function includes the detection of targets, determination of target locations, classification of contacts, precision navigation, and preparation of recommended firing orders for weapons. To effect optimum weapons control, a computer capable of accepting, storing, and processing all available information on targets will be provided. Also planned is a display, in situation-plot form, which will continuously indicate the identity, position, and movement of all targets, as well as the submarine's own position and movement.

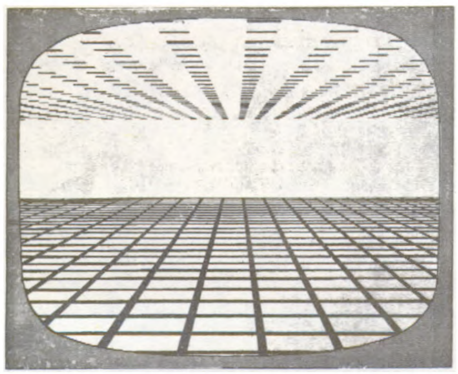
Engineering Control—Engineering control is concerned with the regulation of propulsion power and associated auxiliary equipment. SUBIC's goal is one-man control of the main propulsion plant under normal conditions. The system will provide for a display indicating power-plant operation and status, an automatic means of effecting changes in the operation of the plant under changing conditions, and for automatic storing and processing of all data required for these functions.

Communications Control—To achieve the best in communications control—both within the submarine and between the submarine and other ships—SUBIC will utilize an automatic transmitter-receiver; an automatic encryption-decryption unit; and automatic information-storage, -processing, and -dissemination facilities.

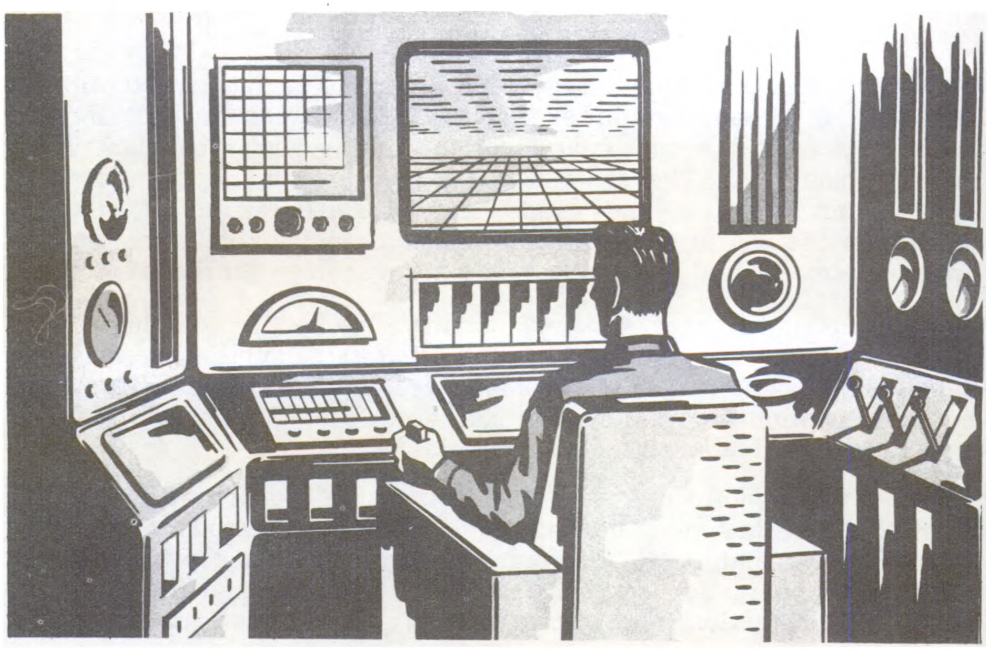
Environmental Control—This function is concerned with the regulation of the submarine's internal environment to insure that all conditions affecting man's efficiency are maintained at an optimum level. SUBIC will provide for continuous air revitalization and for automatic monitoring, detection, and elimination of atmospheric contaminants.

Generated for member (University of Maryland, College Park) on 2014-09-30 20:12 GMT / http://hdl.handle.net/2027/uiug.30112075629110
Public Domain, Google-digitized / http://www.hathitrust.org/access_use#pd-google
Digitized by Google
Original from UNIVERSITY OF ILLINOIS AT URBANA-CHAMPAIGN





For submarines of the future, such as the one drawn above, control stations similar to the one sketched below are being planned. A key element in this arrangement is a screen on which a "real world" presentation is made of information the pilot requires to control his ship. Such a screen is shown at left. On it, two important ocean levels are indicated in relation to the submarine's position--the ocean surface and either the ocean bottom or "test depth," the level the submarine cannot go below without running the risk of being damaged by the increased pressure. Other information, such as the pathway the submarine should follow between these levels, will also be projected on the screen.



Generated for member (University of Maryland, College Park) on 2014-09-30 20:12 GMT / http://hdl.handle.net/2027/uiug.30112075629110
Public Domain, Google-digitized / http://www.hathitrust.org/access_use#pd-google
Digitized by Google
Original from
UNIVERSITY OF ILLINOIS AT
URBANA-CHAMPAIGN

Falling into this category also is damage control through automatic detection and display of equipment failures. Information concerning the submarine's environment will be displayed in such a manner that it can be quickly evaluated and corrective action taken where needed.

One of the key components of the new control system will be a set of display screens. In ship control, for example, one screen will be set up vertically in front of the pilot, and another horizontally. On the vertical screen, a path-like representation of the course the ship's instruments indicate it should follow toward its destination will be made to appear. With the ship exactly on course, this "pathway" will stretch ribbon-like in front of the pilot, just as a road appears when driving a car. The background will be a dynamic three-dimensional presentation of the ocean and ocean bottom. When the pilot is off course, the pathway will appear at one side or below or above him.

On the horizontal screen will be displayed a map of the area, showing the ship's navigational position and the positions of other elements of the environment, such as enemy targets.

The pathway and other pictures displayed on the screens will be artificially generated on board the submarine from the same information sources that feed data to the dials on today's instrument panels. The bulk of the work required to convert this raw data to simple television pictures will be done by a computer. The computer developed to process information for aircraft displays is capable of making 15,000 computations a second, yet is smaller than a breadbox and weighs less than 40 pounds. Similar miniaturized electronic data-processing equipment will be used in SUBIC, permitting up-to-the-minute tracking of contacts and providing the information required for precise navigation and weapons firing.

These features are logically adaptable to the latest submarines, which feature one-man airplane-type controls, and to both small "killer" submarines and large ballistic-missile submarines. The newly commissioned SKIPJACK is an example of the latter type of ship. Whereas eight men have been required to maintain control of submarines of the past, and three men are required to guide most nuclear-powered submarines of today, only one man will be needed for routine control of SUBIC submarines of the future. As a matter of fact, the new system may permit the reduction of the present average 100-man crew of an atomic-powered submarine to 12 men.

The Electric Boat Division of General Dynamics Corporation has been selected by the Office of Naval Research to serve as manager of the industry-Navy team working on the development of SUBIC. Target date for placing the integrated control system into operational use in a nuclear submarine is 1964.

The growing complexity of submarines and submarine operations and the vital role these ships may be called upon to play in possible wars of the future serve to emphasize the importance of SUBIC to modern submarine operations. With the new system, the commanders of undersea vessels will be able to make their craft respond instantaneously and precisely to changing situations in the ocean environment. SUBIC will thus greatly increase the chances that these ships will carry out their missions successfully.

Generated for member (University of Maryland, College Park) on 2014-09-30 20:12 GMT / http://hdl.handle.net/2027/uiug.30112075629110
Public Domain, Google-digitized / http://www.hathitrust.org/access_use#pd-google
Digitized by Google
Original from
UNIVERSITY OF ILLINOIS AT
URBANA-CHAMPAIGN

Optical Pumping*

A. Bloom
Varian Associates
Palo Alto, California

The effect known as "optical pumping" has no direct relationship with vacuum pumping, or any other kind of pumping that people usually associate with the word. Nevertheless, it is a phenomenon which very likely will become of increasing importance in electronic applications, particularly as they concern certain military systems. This article is an attempt to describe the phenomenon in a language as non-technical as is permitted by the nature of the thing, and to discuss the most promising applications.

The term "optical pumping" was coined by Prof. A. Kastler, of the University of Paris, to describe a certain technique he had invented, and although the title may perhaps be more meaningful in its original French, it nevertheless turns out to be a fairly good description of what is going on. Let us consider the use of the word "pumping" in its broadest sense: What is the characteristic that may be said to be common to all types of pumps, whatever they may be? It is the following: A pump is a device which raises a certain kind of matter from a condition of low potential energy to a permanent condition of higher potential energy. This definition holds for all kinds of pumps we can think of: for example, water pumps, compressed air pumps, and vacuum pumps. It also applies to the optical pump. In optical pumping we raise atoms from a condition of low potential energy to a permanent condition of higher potential energy. But to understand the operation of the optical pump, we must digress somewhat and consider the isolated sodium atom, the material which is being pumped.

THE SODIUM ATOM

An isolated sodium atom is a miniature solar system of eleven negatively charged, spinning electrons orbiting around a positively charged, spinning nucleus. The spectacular conclusion to which physicists have been driven by an overwhelming mass of experimental evidence is that motions in the atomic scale are "quantized." This means that there are only a discrete set of orbits in which the electrons can move. Furthermore, the axes about which the electrons and nucleus spin cannot point in random directions; they are restricted to a discrete set of directions. Each allowed configuration of orbits and orientation of spin axes is called a "quantum state" of the atom. Each quantum state has associated with it a total energy (kinetic energy of motion, plus potential energy of the electrons in the electric field of the nucleus, plus potential energy due to the interactions of the magnetic fields produced by the moving electric charges). Thus, when we measure the total energy of a sodium atom, we get a discrete set of numbers—one associated with each allowed quantum state.

*Research on optical pumping carried out by Varian Associates is being sponsored by the Office of Naval Research.

Generated for member (University of Maryland, College Park) on 2014-09-30 20:12 GMT / http://hdl.handle.net/2027/uiug.30112075629110
Public Domain, Google-digitized / http://www.hathitrust.org/access_use#pd-google
Digitized by Google
Original from
UNIVERSITY OF ILLINOIS AT
URBANA-CHAMPAIGN

Figure 1 is a very abbreviated energy-level diagram of an isolated sodium atom. It shows the three lowest allowed values of the total energy of the atom, each representing a different quantum state of the atom. For the purposes of this discussion we shall call them A, B, and C states. Actually, each of these three energy levels is degenerate—that is, under certain conditions each one can be broken down into several energy levels. Thus, the lowest quantum state—the A state—has three such levels (not shown in figure). The A state is the lowest energy state, or ground state, and all others are excited states.

When the atom is in the A state, the electrons occupy the orbits closest to the nucleus; the spins of the inner ten electrons are paired off in opposite directions, and the spin of the outer, eleventh, electron is in essentially the same direction as that of the nucleus. The three A levels become distinguishable from one another only when the atom is placed in an external magnetic field (see diagram on page 10). Then the spin axes of the nucleus and outer electron simultaneously assume one of three possible orientations with respect to the direction of the external field—all the while continuing to maintain the same orientation with respect to each other. The energy of the atom differs in each of these orientations, so that in a magnetic field the A line on the energy-level diagram splits into three closely spaced lines, called m levels.

The second line in Figure 1 represents the energy common to five states of the sodium atom. All of these states differ from the A state only in that the spinning motion of the outer electron is opposite to, rather than the same as, that of the nucleus. When the sodium atom is placed in an external magnetic field, the B line of the energy-level diagram splits into five closely spaced lines corresponding to five possible

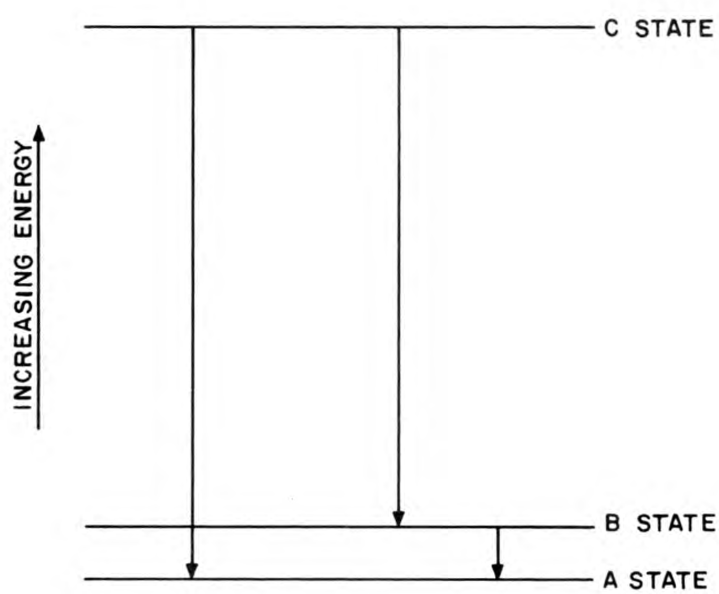
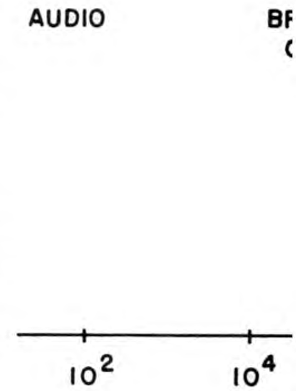


Figure 1--Abbreviated energy-level diagram for sodium (not drawn to scale). Arrows pointing downward indicate transitions between levels.

Generated for member (University of Maryland, College Park) on 2014-09-30 20:12 GMT / http://hdl.handle.net/2027/uiug.30112075629110
Public Domain, Google-digitized / http://www.hathitrust.org/access_use#pd-google
Digitized by Google
Original from
UNIVERSITY OF ILLINOIS AT
URBANA-CHAMPAIGN

Figure 2—The electromagnetic spectrum.



orientations of the combined spin axes with respect to the external field. These new energy levels are also called m levels.

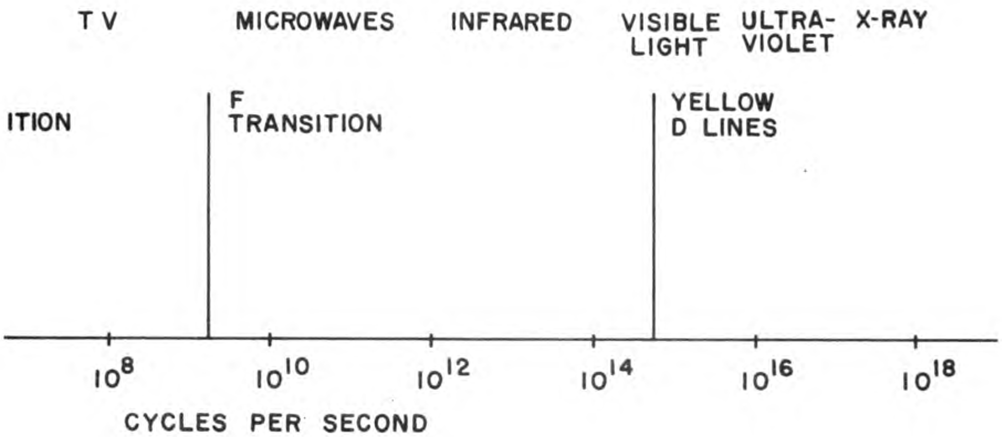
The next allowed quantum state, called the C state, has a much higher energy (Figure 1 is not drawn to scale). In this state, the outermost electron is moved out to a larger orbit. Although this state is degenerate also, its various energy levels (m levels) do not play a role in this discussion.

When external influences are removed from atoms, the natural tendency of their electrons is to fall into the ground state. If one wishes to raise these electrons out of the ground state, he must excite them in some way. Suppose, for example, that he is dealing with sodium vapor in a container. He can raise the atoms in the vapor to excited states by a variety of techniques. One would be to bombard the vapor with beams of electrons or ions. Another would be to heat it, causing the atoms to move faster and collide more often. As a matter of fact, at room temperature, sodium vapor in a container already has a large number of atoms in excited states of low energy simply by virtue of the thermal motion corresponding to room temperature.

After electrons have been raised to an excited state, they fall back immediately into the lower energy states available to them. Simultaneously, they emit electromagnetic radiation, which carries off the energy difference between the initial and final states. The frequency of oscillation of the electromagnetic radiation is directly proportional to its energy. If that energy is large, the atom gives off high-frequency radiation, called X-rays. Lower energy transitions result in the emission of ultra-violet light. At still lower frequency is the visible light, and so on down the scale.

The various regions of the electromagnetic spectrum and the positions of three of the discrete frequencies radiated by excited sodium atoms are shown in Figure 2. The so-called yellow D line refers to the radiation emitted when the atom falls from a C state to an A or B state. It is the brightest line in the entire sodium spectrum, and the characteristic color it gives to sodium vapor lamps can be observed on the highways where such lamps are used for illumination, and in college physics laboratories, where the lamps are used for optics experiments. One of the other lines in Figure 2 has a frequency of 1,772 megacycles per second. This line, which represents the radiation emitted by the atom when it falls from one of the B levels to one of the A levels, can be detected with specialized microwave instruments. Finally, the line at about 10^5 cycles per second represents the radiation emitted when the atom falls from one m level to another while the atom is in a magnetic field. Ordinarily, one does not see spectrum lines that are represented by transitions between the A, B, and m levels because the energy involved is so small that the excited levels can be populated just by the thermal agitation of the atoms. Thus the radiation takes the form of "heat" radiation and as such is

Generated for member (University of Maryland, College Park) on 2014-09-30 20:12 GMT / http://hdl.handle.net/2027/uiug.30112075629110
Public Domain, Google-digitized / http://www.hathitrust.org/access_use#pd-google
Digitized by Google
Original from
UNIVERSITY OF ILLINOIS AT
URBANA-CHAMPAIGN



indistinguishable by a spectrometer from the heat radiation of all the surrounding apparatus.

The purpose of optical pumping is simply this: It counteracts the effects of thermal agitation and provides population difference between A, B, and m levels. It makes possible the construction of a simple and effective spectrograph for observing and using these low-frequency energies.

THE PUMPING PROCESS

In its simplest terms the pumping process is as follows. Suppose we can irradiate the sodium atoms with light of just the right wavelength to excite atoms out of the A state and into the C state. These atoms, after spending a short time in the C state, have nearly equal probability of returning to either the A state or B state. Those atoms which return to the A state can repeat the process. But those which get into the B state are "trapped," because in order to leave this state they must receive light of a very slightly different wavelength, which we assume absent. As long as any atoms are present in the A state the process will go on, putting more and more atoms in the B state, until eventually the entire population will be in the B state. In this way, atoms are "pumped" from one state to a higher energy state.

The thermal agitation process is, of course, in constant competition with the pumping process, so it is really not correct to say that we get 100 percent of the population in the B state. However, as long as the light has enough intensity to pump faster than the thermal agitation can "depump," there will be an effect.

The light used in pumping must be of a very special kind, as was noted above—it must excite atoms out of the A state but not out of the B state. A sodium vapor lamp normally produces light capable of exciting either state. Fortunately, the sodium atoms to be pumped can, themselves, provide the delicate light-filtering action needed to make the process work. When light first enters the absorption cell it finds the sodium atoms equally distributed among the various quantum states. This means that there are 5 atoms in the B level for every 3 in the A level. Correspondingly, light capable of exciting B atoms is attenuated faster than the A light, and this results, farther out in the absorption cell, in an intensity difference of the type required for pumping.

Generated for member (University of Maryland, College Park) on 2014-09-30 20:12 GMT / http://hdl.handle.net/2027/uiug.30112075629110
Public Domain, Google-digitized / http://www.hathitrust.org/access_use#pd-google
Digitized by Google
Original from
UNIVERSITY OF ILLINOIS AT URBANA-CHAMPAIGN

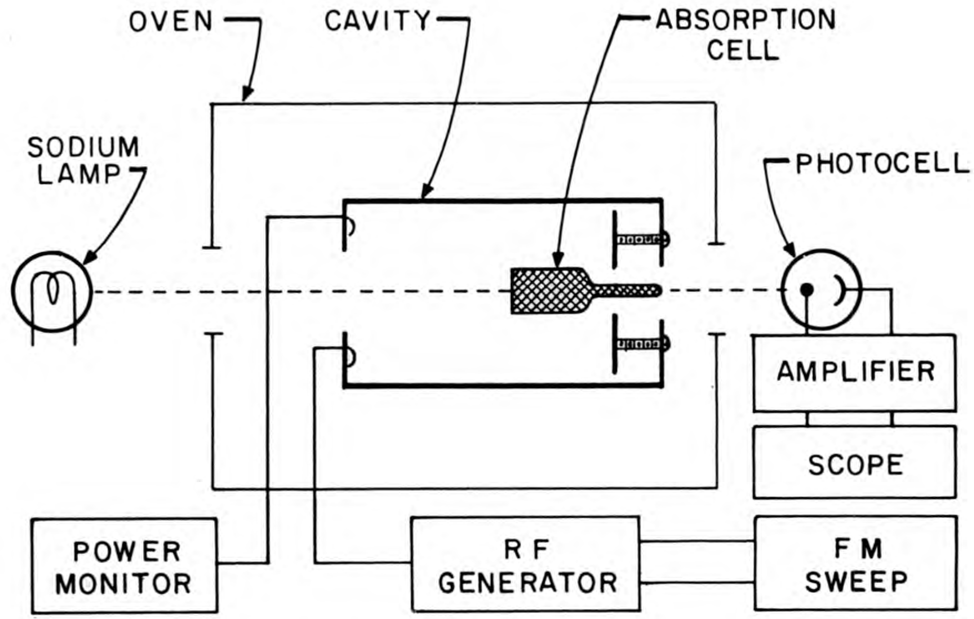


Figure 3--The spectrograph.

THE SPECTROGRAPH

So far we have not discussed how we would observe the pumping process. There are a variety of ways in which it can be done, but one, suggested by H. G. Dehmelt of the University of Washington, Seattle, is outstandingly simple and effective. It is to look at the intensity of the transmitted light. Since only the "unpumped" atoms can absorb light, a system which is 100 percent pumped will be completely transparent to the incident radiation, quite unlike an unpumped sample. Between these extremes are all possible gradations corresponding to various degrees of pumping. Thus, simply by looking at the intensity of the light which gets through the absorption cell, we can tell whether or not sodium atoms are being pumped and to what extent.

The complete spectrograph, then, is a device approximately as depicted in the sketch of Figure 3. Besides the optical pumping system, it includes a means for irradiating the sodium sample with electromagnetic radiation whose frequency corresponds to the low frequency lines which we are trying to observe. For instance, if we wish to observe the spectrum line corresponding to transitions between the A and B levels, we irradiate at a frequency of about 1,772 megacycles. This can be done most conveniently by placing the absorption cell in a cavity which is resonant at that frequency. The effect of electromagnetic radiation which resonates with the atoms at the spectrum lines is to "depump" the sample. Thus, if we slowly vary the frequency of the radiation through resonance we will observe, at the proper point, a sharp dip in the intensity of the transmitted light. This is picked up by a photocell and indicated on the oscilloscope.

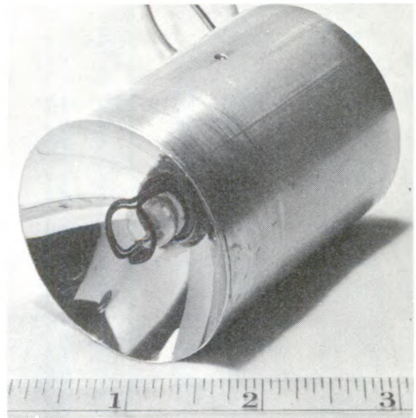
APPLICATIONS

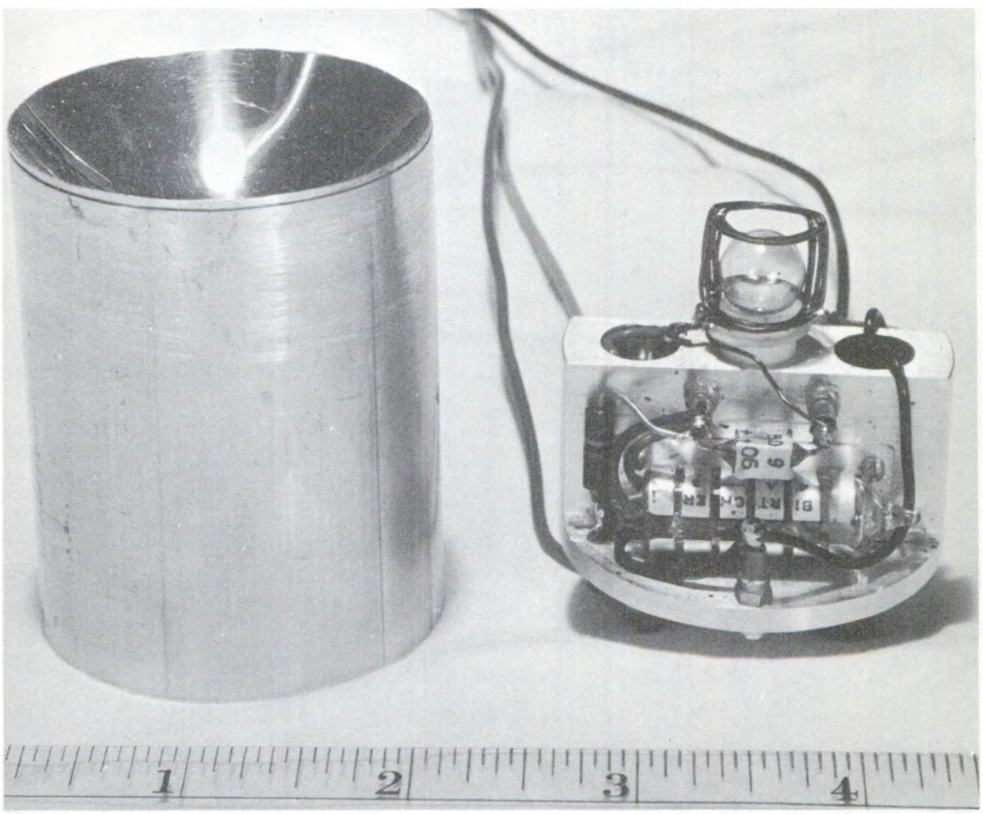
There appear to be two applications for optical pumping that are of immediate usefulness—establishment of frequency standards and

Generated for member (University of Maryland, College Park) on 2014-09-30 20:12 GMT / http://hdl.handle.net/2027/uiug.30112075629110
Public Domain, Google-digitized / http://www.hathitrust.org/access_use#pd-google
Digitized by Google
Original from
UNIVERSITY OF ILLINOIS AT
URBANA-CHAMPAIGN

measurement of weak magnetic fields (Figure 4). In both of these applications we are assisted by the fact that the rf resonances of the sodium atom that are detected by optical pumping are characterized by an extremely high Q (a measure of the sharpness of resonance). In the case of the 1,772-megacycle resonance, the natural Q of the sodium atoms is of the order of 10^7.* R. H. Dicke, of Princeton University, has shown

Figure 4--An electrodeless discharge lamp employed for pumping rubidium vapor in magnetometers and frequency standards. Designed for rocket- and satellite-borne applications where weight and power are at a premium, this lamp consumes only three watts of power, yet puts out more light than earlier lamps requiring ten times as much power. The lamp is shown assembled at right and disassembled below. Note rugged and compact construction.





*If a system has a Q of 10^7, it means that electromagnetic radiation having a frequency which differs from the exact resonance frequency by one part in 5 million will excite only half as many atoms as will radiation having the resonance frequency. This is sharp tuning!

Generated for member (University of Maryland, College Park) on 2014-09-30 20:12 GMT / http://hdl.handle.net/2027/uiug.30112075629110
Public Domain, Google-digitized / http://www.hathitrust.org/access_use#pd-google

Digitized by Google

Original from
UNIVERSITY OF ILLINOIS AT
URBANA-CHAMPAIGN

that the addition of an inert gas such as argon to the sodium vapor can increase the Q to 10^8 This is much higher than can be found in conventional high-Q cavities, and in addition, because the frequency is determined by constants of nature, we are certain at all times that the frequency is the same no matter where and how one observes the resonance. Thus, the hyperfine resonance of sodium (and also of the related elements rubidium and cesium whose resonances occur at somewhat different frequencies) can be used as primary frequency standards to calibrate or control secondary standards such as quartz crystals. It appears probable that the optical-pumping frequency standards can be developed to the point where they will be capable of frequency control to one part in 10^{10} or better.

The application of optical pumping to the measurement of magnetic fields is based on the fact that the energy differences between m levels is directly proportional to the strength of the impressed external magnetic field. Thus, the energy-level diagram for sodium, plotted as a function of magnetic field, appears somewhat as follows:

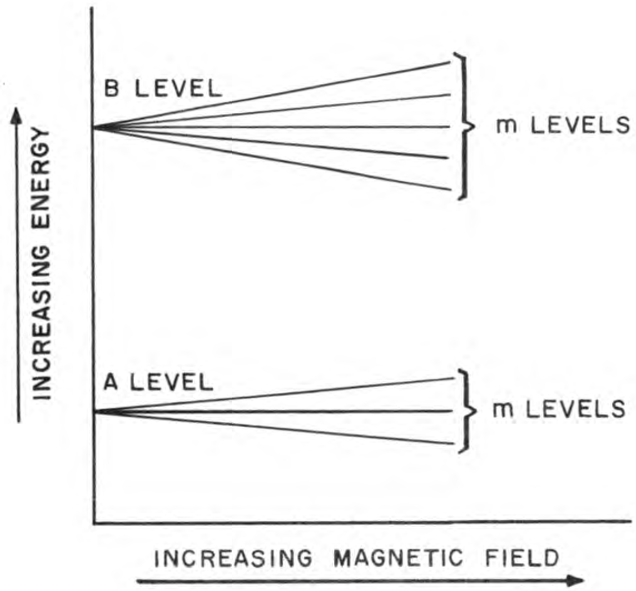


Figure 5--Energy-level diagram for sodium plotted as a function of magnetic field.

In a magnetic-field measuring device, one is not interested so much in high Q as with reproducibility of results; that is, with the fact that the proportionality between field and resonance frequency is a constant of nature. It appears likely that the optical-pumping device will turn out to be quite useful for measuring magnetic fields of the order of the earth's field. It is expected to be particularly useful in measuring extremely weak fields, and may find a place on rockets which penetrate interplanetary space, where it will be capable of measuring fields of the order of 10^{-5} gauss or less with a precision which would not be equalled by any other type of instrument.

Digitized by Google
Original from
UNIVERSITY OF ILLINOIS AT
URBANA-CHAMPAIGN
Generated for member (University of Maryland, College Park) on 2014-09-30 20:12 GMT / http://hdl.handle.net/2027/uiug.30112075629110
Public Domain, Google-digitized / http://www.hathitrust.org/access_use#pd-google

The Navy at Point Mugu

The Pacific Missile Range at Point Mugu, Calif., 50 miles north of Los Angeles, is now in its second year of operation as a research center for missile, satellite, and space-vehicle development for the Department of Defense. Under the command of RADM J. P. Monroe, with headquarters at Point Mugu, the Pacific Missile Range includes also the Naval Missile Facility at Point Arguello. In addition, SAC's Vandenberg Air Force Base provides many facilities for the range, including housing, messing, and other administrative support.

The basic range encompasses a sea test strip 500 miles long paralleling the California coast and extending 250 miles seaward. In addition, there are test corridors extending thousands of miles to sea which are used for the testing of long range ICBMs and IRBMs. There are tracking stations off the California coast and at Midway, Wake, and Eniwetok Islands. RADM Monroe is responsible for these advanced bases as well as the base here at Point Mugu.

The Pacific Missile Range was established to act in concert with the two other national missile ranges—the Atlantic Missile Range near Cape Canaveral, Fla., and the White Sands Missile Range in New Mexico. Each range supplements the other in providing areas in which all services may conduct missile training and experiments.

Missile testing at Point Mugu began in 1946 at what was then the Navy Missile center. In that year the Navy test-fired a modified German V-1 buzz bomb. From that first test 13 years ago, which had a track running 200 yards, the Pacific Missile Range will eventually extend some 10,000 miles to the Indian Ocean. It is expected that the Range will reach full operational capability in the early 1960s.

Operational Test and Evaluation Force

The Navy has established the Operational Test and Evaluation Force (OPTEVFOR) to centralize and strengthen its research and development program. This action follows the recent naming of a Deputy Chief of Naval Operations for Development. OPTEVFOR, headed by RADM William D. Irwin, was formerly the Operational Development Force, Atlantic Fleet.

The mission of the newly formed OPTEVFOR has been expanded to reflect a closer coordination and responsibility for all test and evaluation projects, in addition to research and development. To carry out this assignment, OPTEVFOR will have operational control of more than 20 experimental ships, including OBSERVATION ISLAND, COMPASS ISLAND, and NORTON SOUND. Four air development squadrons of the Atlantic and Pacific Fleets are also part of OPTEVOR. Additional aircraft and ships may be assigned to the Force at various times in order to carry out development and evaluation projects.

Generated for member (University of Maryland, College Park) on 2014-09-30 20:12 GMT / http://hdl.handle.net/2027/uiug.30112075629110
Public Domain, Google-digitized / http://www.hathitrust.org/access_use#pd-google
Digitized by Google
Original from
UNIVERSITY OF ILLINOIS AT
URBANA-CHAMPAIGN

Naval Radio Research Station, Sugar Grove

Since June 1958, the Navy has been unobtrusively preparing ground in a West Virginia valley for construction of the largest radio telescope in the world. When the antenna is completed in 1962, it will be a dish 600 feet in diameter. The entire assembly will be rotatable 360 degrees in azimuth, and the dish itself can be swung from horizontal to vertical.

By way of comparison, the present largest movable reflector is the 250-foot radio telescope operated by the University of Manchester at Jodrell Bank, England. Thus, at 600 feet, the new American "dish" will be nearly two-and-one-half times larger in diameter, and nearly six times larger in area of reflecting surface.

In addition to the main "dish," there will be several other installations at the new station. Already up and in operation is a 60-foot dish atop a small but massively constructed building about a half mile from the main site. It will be used for radio-interference measurements. Scheduled for construction are a fair-size administration-laboratory building, to be located (perhaps underground) near the base of the main antenna, and a complete housing development about three miles away. This will provide living quarters and recreational facilities for an estimated complement of 500 naval personnel and civilian employees. The estimated cost-to-completion of the project is $79,000,000.

Now, what's it all for? Mostly, for communications research, operational use, and for basic research in radio astronomy.

The communications research will be a continuation and supplementation of studies extending back for over a decade by the Naval Research Laboratory. A landmark in these investigations was the announcement at Boulder, Colorado, in 1957, by NRL's James H. Trexler, that the Navy had been able to send and receive discrete signals—readable messages—by bouncing pulses of radiation off the moon. That discovery was followed by successful transmissions from NRL to California, and from NRL to Hawaii, using the earth-moon-earth path.

The Sugar Grove, West Virginia, site was selected only after exhaustive studies and surveys. It has the following advantages: It is in a valley of low population density, yet is only about 170 miles by road from Washington, D.C. The valley is protected from outside electronic interference by 4000-foot mountains, yet the ridges are far enough away from the selected site so that the telescope can be trained to within 5° of the true horizon on every side. It is off established air routes and away from heavily traveled highways and railroads; there is no heavy industry closer than 30 miles. It is off the track of hurricanes or tornadoes, and has no recorded history of earthquakes.

Following selection of the site, weather towers were erected and meteorological instruments were installed for a two-year check on all climatic conditions. Meanwhile, the U.S. Navy Bureau of Yards and Docks contracted with the architectural and engineering firm of Grad, Urbahn, and Seeley to undertake a feasibility study leading to selection of an optimum design for the main antenna. The weather conditions

Digitized by Google

Original from
UNIVERSITY OF ILLINOIS AT
URBANA-CHAMPAIGN

Generated for member (University of Maryland, College Park) on 2014-09-30 20:12 GMT / http://hdl.handle.net/2027/uiug.30112075629110
Public Domain, Google-digitized / http://www.hathitrust.org/access_use#pd-google

proved to be acceptable, and a 600-foot movable structure was declared entirely feasible. The design contract also went to the firm of Grad, Urbahn, and Seeley, but even before the design was completed a grading contract was let, and the first ground was broken about a year ago.

The building of NRRS is under the direct supervision of the Bureau of Yards and Docks, with NRL on hand for technical advice and operating specifications. The prime contractor for the construction is a joint venture of three firms, the Tidewater Construction Company of Norfolk, Va., Peter Kiewit Sons, Omaha, Nebr., and Patterson, Emerson, Comstock of Pittsburgh, Pa.

NRRS will eventually operate as a separate naval command, but during the instrumentation and adjustment phases it will remain a scientific field activity of NRL. Scientists and engineers of the Naval Research Laboratory did all of the background research, they established the design criteria for the principal installations, and they are charged with technical supervision of the Project until it is completed. Later, after the station is completely operational, it is expected that considerable "antenna time" will be available for basic research. So NRL scientists will be at Sugar Grove for a long time to come.

A large radio-astronomy reflector is able to "see" farther into space with greater resolution (accuracy) in much the same way the 200-inch optical reflector has permitted the Mt. Palomar astronomers to see distant planets and stars better than ever before. So the new 600-foot radio telescope, combining enormous size with great accuracy, will be an invaluable tool for basic studies into the secrets of the universe.

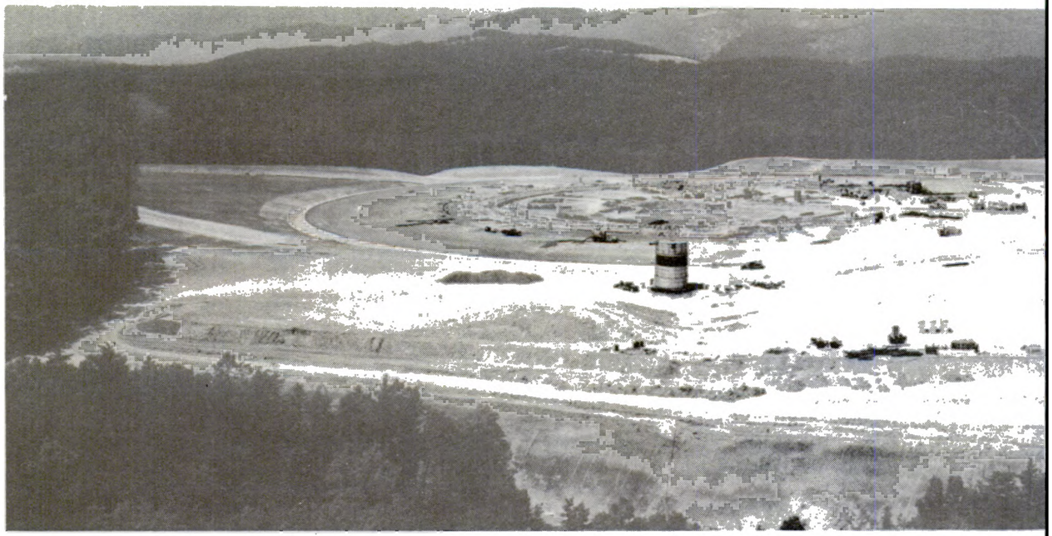
NRL scientists, using their present battery of radio telescopes ranging in size from 10 feet to 84 feet, have already identified "radio stars" in our own galaxy, and have made temperature measurements of the surfaces of Venus, Mars, and Jupiter. They have learned new facts about the intensity of ultraviolet and x-ray emissions from the sun and its corona. When the Sugar Grove instrument becomes available, these studies can be expanded almost limitlessly to galaxies and radio sources billions of light years away. Because the 600-foot reflector will be theoretically able to detect radio emissions so faint they could come from sources that "died" milleniums before the earth was born, it may provide new evidence in the cosmogonic debate as to whether a "steady-state" universe has always existed, or whether it has evolved.

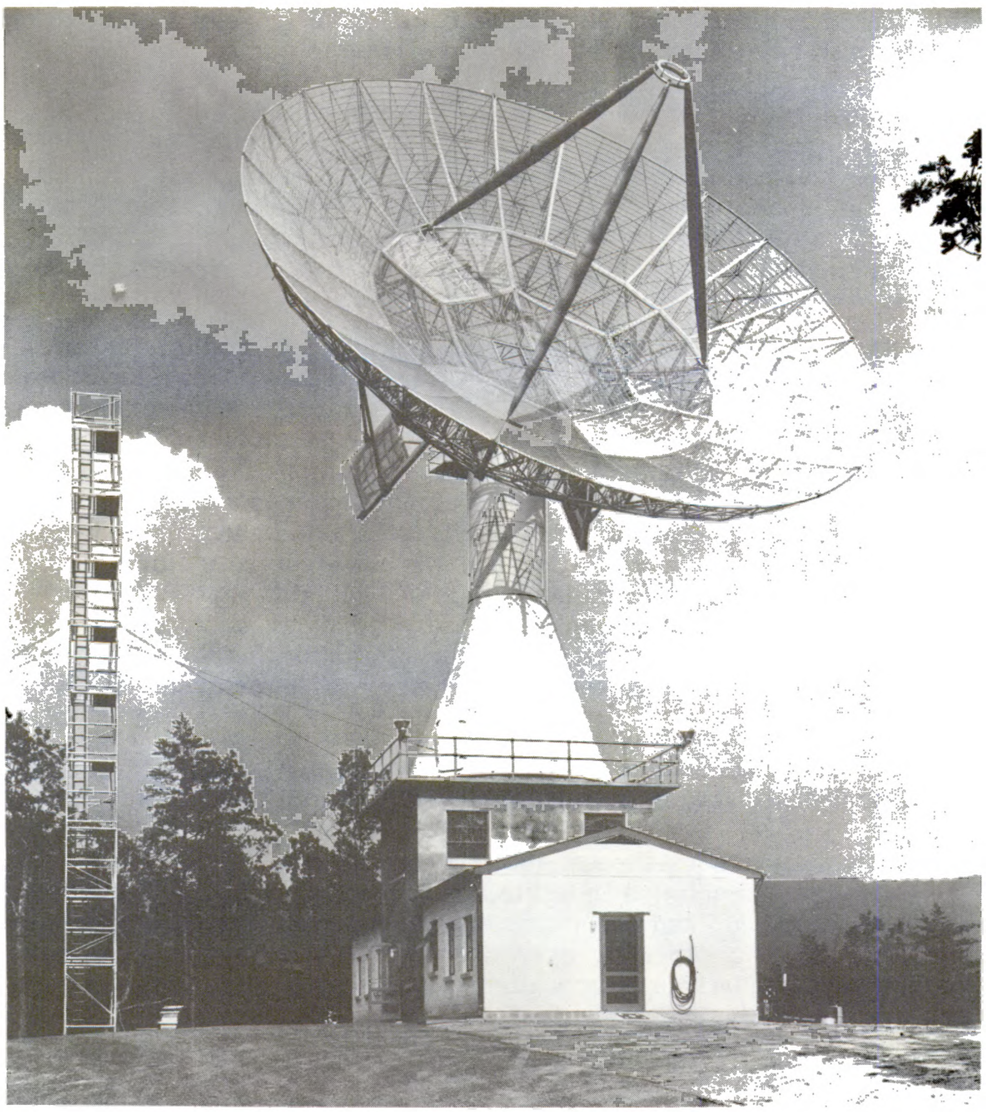
Of possibly more practical use, the telescope is expected to permit a more thorough examination of the ionosphere and its effects on the commonly used lower radio frequencies, from 3 to 30 megacycles.

But just as a construction job, the Sugar Grove Project is well worth following. Erecting a movable land structure of such dimensions is without precedent, and the exactness of specifications far exceeds that of any bridge or building ever designed. Small wonder that men not given to superlatives have called Sugar Grove "the engineering task of the decade."

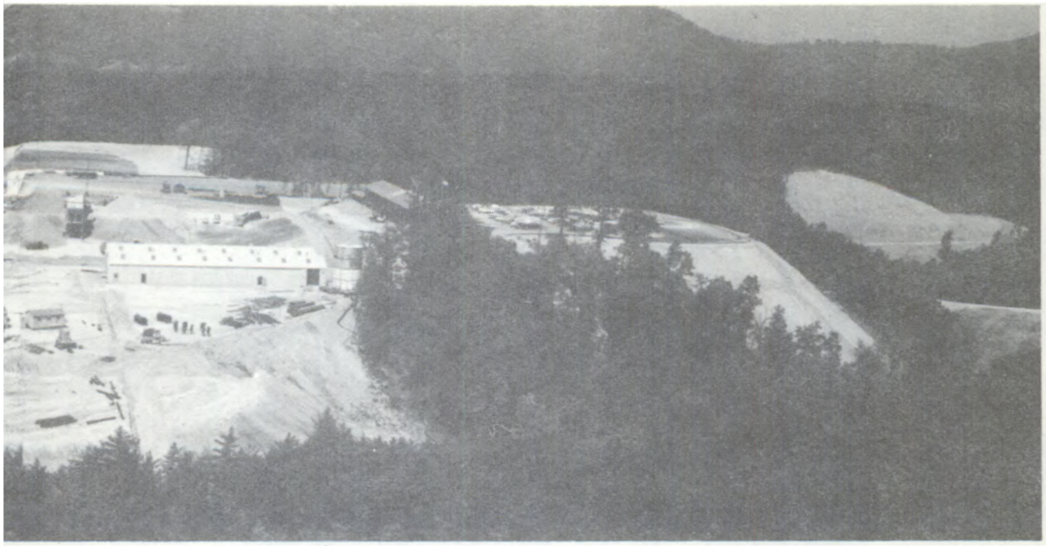
Photographs of the Sugar Grove site, some of the construction activities, and the 60-foot dish appear on the next two pages.

Generated for member (University of Maryland, College Park) on 2014-09-30 20:12 GMT / http://hdl.handle.net/2027/uiug.30112075629110
Public Domain, Google-digitized / http://www.hathitrust.org/access_use#pd-google
Digitized by Google
Original from
UNIVERSITY OF ILLINOIS AT
URBANA-CHAMPAIGN





Generated for member (University of Maryland, College Park) on 2014-09-30 20:12 GMT / http://hdl.handle.net/2027/uiug.30112075629110
Public Domain, Google-digitized / http://www.hathitrust.org/access_use#pd-google
Digitized by Google
Original from
UNIVERSITY OF ILLINOIS AT
URBANA-CHAMPAIGN



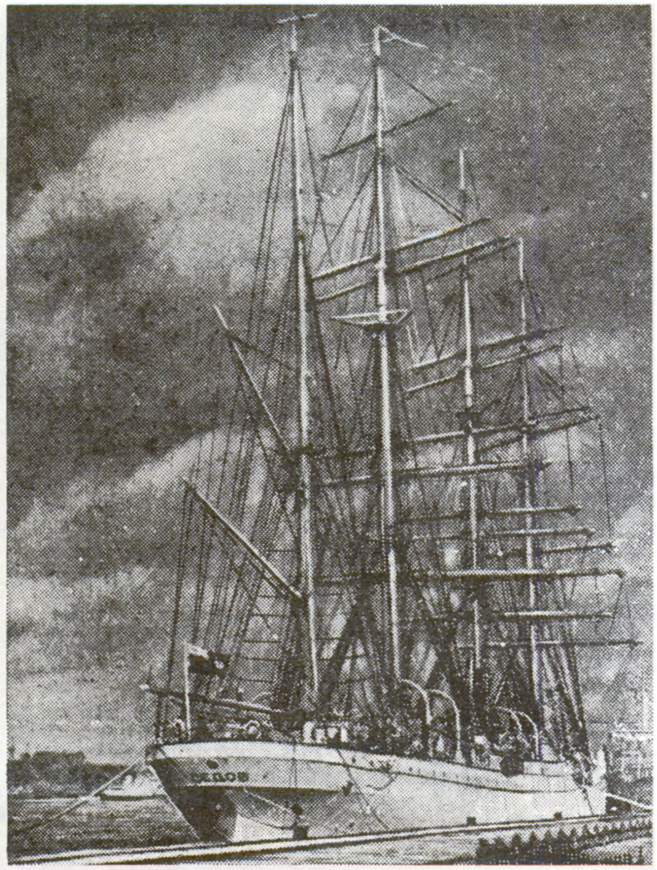
bove, panorama of the
.te for the Naval Radio
esearch Observatory
ear Sugar Grove, W.Va.
he 600-foot radio tele-
cope will be mounted in
rea at left side of photo
ehind tank.

ight center, the town of
ugar Grove, W. Va., as
een from the air.

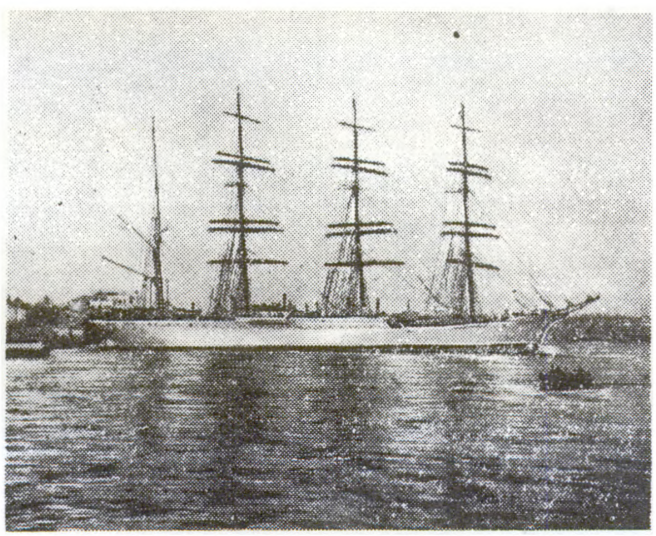
ight bottom, a bulldozer
lears ground at the site
r the 600-foot radio tele-
cope.

eft, the 60-foot dish at
ugar Grove. This an-
nna, located about a half
ile from the main site,
ill be used to detect, lo-
ate, and measure radio
terference.

Generated for member (University of Maryland, College Park) on 2014-09-30 20:12 GMT / http://hdl.handle.net/2027/uiug.30112075629110
Public Domain, Google-digitized / http://www.hathitrust.org/access_use#pd-google
Digitized by Google
Original from
UNIVERSITY OF ILLINOIS AT
URBANA-CHAMPAIGN



Two views of the Soviet oceanographic sailing vessel SEDOV. The ship is here shown moored in Sevastopol, a naval base in the Crimea. The picture above is a reproduction of a photograph published in Sovetsky Flot, No. 9, Jan. 11, 1958. The picture below appeared in Sovetsky Flot, No. 11, Jan. 14, 1958.



Generated for member (University of Maryland, College Park) on 2014-09-30 20:12 GMT / http://hdl.handle.net/2027/uiug.30112075629110
Public Domain, Google-digitized / http://www.hathitrust.org/access_use#pd-google
Digitized by Google
Original from
UNIVERSITY OF ILLINOIS AT
URBANA-CHAMPAIGN

Oceanographic vessel MIKHAIL LOMONOSOV in the Atlantic Ocean. Reproduction of a photograph published in Morskoi Flot, No. 10, Oct. 1958.

Soviet Oceanographic Studies Under the IGY

Victor P. Petrov
Professor, Language Division
U.S. Naval Postgraduate System

A very interesting report was issued last February by the Special Committee on Oceanography of the National Academy of Sciences. It included, in addition to recommendations for a program of research in oceanography for the next ten years, a survey of what has been done in this field in the past. The report says that facilities for ocean research are to "the oceanographer what cyclotrons or reactors are to the nuclear physicist. He simply cannot undertake adequate research without them." Furthermore, the report states that "Our oceanographic research ships are inadequate for the job which must be done. Most of the ships are old and outdated. Many are obsolete and should be replaced by ships of modern design." ("Oceanography 1960 to 1970—A Report of the Committee on Oceanography of the National Academy of Sciences," Feb. 1959, p. 7).

The above statement is especially important in the light of what the Soviet Union is and has been doing in oceanographic research. If we do not step up our own efforts in this field, the Soviet Union may soon become the world leader in oceanographic research, judging by the amount of money and manpower that country is putting into the field. Not long ago, it was reported in Research Reviews that at least seven Soviet oceanographic ships ranging in size from 1,500 to 6,000 tons are in operation. In addition to these ships are two 12,000-ton icebreakers, which are conducting oceanographic research on the side. Our own oceanographic fleet, on the other hand, consists of ships that are small by comparison. (Research Reviews, January 1959, p. 3.)

Generated for member (University of Maryland, College Park) on 2014-09-30 20:12 GMT / http://hdl.handle.net/2027/uiug.30112075629110
Public Domain, Google-digitized / http://www.hathitrust.org/access_use#pd-google
Digitized by Google
Original from
UNIVERSITY OF ILLINOIS AT
URBANA-CHAMPAIGN

What has actually been done and what facilities have been used by the Soviet Government in oceanography under the IGY program? For the answer to this question, let us turn to Soviet literature, which gives a clear picture of Russian activities in this field.

The Soviet Union undertook, under the IGY program, to conduct a vast range of oceanographic studies. For this purpose it assigned more than 30 special vessels to roam the oceans and seas and certain of the inland seas, lakes, and rivers. Of particular interest to American oceanographers is the role of 14 large ocean-going vessels—virtual floating oceanographic laboratories—which were given the task of studying the Atlantic, Pacific, Arctic, and Antarctic Oceans, together with all the seas adjacent to them. Furthermore, at the close of the IGY, the Soviet Navy transferred one of its submarines to a scientific institution, which has the impressive name All-Union Scientific Research Institute of Sea Fishing and Oceanography. This submarine is to be used principally for the study of regions in which Soviet fishing fleets are operating. (Izvestia, Aug. 14, 1958.) Among these large Soviet oceanographic vessels three are of more than 2,000 tons water displacement, and three of more than 5,000 tons. (Sovetsky Flot, Dec. 9, 1958.)

The Pacific Ocean was assigned to the VITIAZ, the flagship of the Soviet oceanographic vessels, and the OKEAN. The VITIAZ was to cover most of the western Pacific from north to south, and the OKEAN was to study the northwestern part of the Pacific. Three large oceanographic ships—the SEVASTOPOL, EKVATOR (Equator), and the brand-new MIKHAIL LOMONOSOV were given the task of studying the Atlantic Ocean. The OB was to explore the Antarctic; in addition to investigating its waters, scientists aboard the OB were to launch rockets from the ship's deck to study the upper layers of the atmosphere. Several smaller ships were assigned to other waters. For example, the PROFESSOR MESIATZEV and the POLIARNIK were assigned to the Norwegian and Greenland Seas, and the PERVENETZ was sent to the Bering Sea. (The USSR Academy of Sciences IGY Information Bulletin, No. 2, 1957, p. 41.) Other Russian ships that took part in the IGY were the AKADEMIK KOVALEVSKY and the PROFESSOR DERIUGIN. The former, a vessel of the USSR Academy of Sciences Sevastopol Biological Station, was utilized in a study of the Rumanian and Bulgarian coastlines of the Black Sea, and the latter, of the Murmansk Biological Station, was used in an investigation of the fish resources of the Barents Sea. (Izvestia, May 1, 1958.)

STUDY OF THE PACIFIC

The VITIAZ is a formidable vessel of 5,500-ton displacement. Originally a cargo dieselship with passenger cabins for 12 people, it was completely overhauled and now can accommodate 137 people, that is, a crew of 64 men and a scientific staff of 73. The cabins are for one, two, or four persons. The ship has been formally a part of the oceanographic fleet since 1949.

This specially reconstructed vessel has a number of unusual technical features. It has a fuel capacity sufficient for 18,000 nautical miles or 66 days at full speed. Fuel is conserved while many oceanographic studies are being conducted, because during these periods the

Generated for member (University of Maryland, College Park) on 2014-09-30 20:12 GMT / http://hdl.handle.net/2027/uiug.30112075629110
Public Domain, Google-digitized / http://www.hathitrust.org/access_use#pd-google
Digitized by Google
Original from
UNIVERSITY OF ILLINOIS AT
URBANA-CHAMPAIGN

ship usually rides at anchor. This allows the vessel to spend from 120 to 130 days at sea without entering a port. The VITIAZ has 13 scientific laboratories, such as hydrological, meteorological, microbiological, plankton, hydrochemical, and others. (Morskoy Flot, No. 5, May 1955, p. 20.) Of its many other special features, the following should be mentioned: a deepwater anchor, which allows the ship to anchor at maximum depths of 32,810 feet; a special trawling installation with a 52,496-foot steel cable, permitting trawling at any depth; and eight hydrological deck winches, of which five can be used for studies at depths as great as 32,810 feet. (Morskoy Flot, No. 5, May 1955, p. 21.)

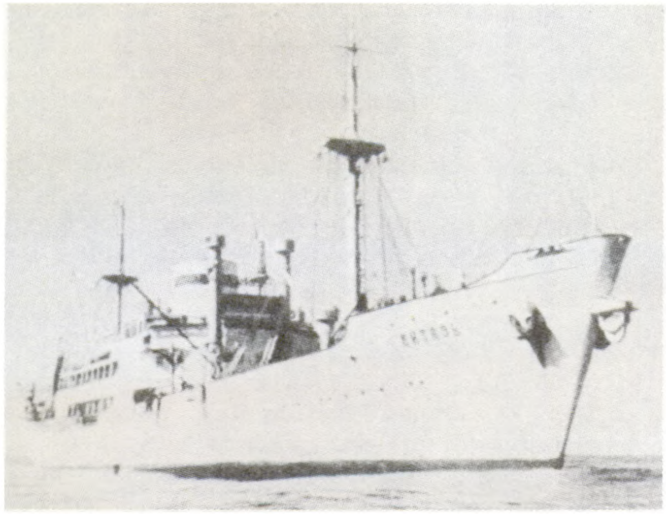
Before the IGY started, the VITIAZ was conducting its regular oceanographic studies, most of which have been made in the northwestern part of the Pacific. One of the discoveries made by its scientists was that the maximum depth of the Kurilo-Kamchatka Deep is 34,057 feet instead of 27,928 feet as previously reported. (Ogonyok, No. 22, May 30, 1954.) Another was that the southwestern section of the Bering Sea is divided into two parts by an underwater range, which was given the name "Academician Shirshov Range." (Vodnyi Transport, No. 108, Sept. 9, 1855.) During one of its regular trips in 1955, the VITIAZ scientists discovered that the Hawaiian underwater range continues much farther north than was reported previously. In fact, this range joins the Obruchev underwater elevation at the spot where the Aleutian and Kurilo-Kamchatka Deeps meet. (Vodnyi Transport, No. 123, Oct. 13, 1955.)

Oceanographic studies have been greatly spurred by the international agreements which concentrated them as a joint effort under the IGY. The IGY officially started on July 1, 1957, and was terminated on Dec. 31, 1958, thus lasting 18 months. According to the IGY program, the VITIAZ was to make 5 trips in the Pacific, each lasting from 3 to 4 months. The purpose of the first trip was to study the area between New Guinea, the Philippines, and Japan. The next assignment was a study of the latitudinal zones of the Pacific (approximately between the 40th parallels). This was to be followed by an investigation of the western part of the ocean to determine the seasonal changes in hydrological conditions. The two last trips were to cover the northwestern part of the Pacific Ocean. (Sovetsky Flot, No. 246, Oct. 17, 1957.)

Even the VITIAZ first voyage in 1957 brought some new significant discoveries. For example, an undersea mountain peak, about 16,405 feet high, was found to the north of Marcus Island. It was given the name "Makarov Peak." Some very rare cephalopod mollusks of the genus Nautilus were trawled in the region of the Molucca Islands. For the first time, according to Soviet scientists, samples of diatomic soil were obtained in southern waters at a depth of 19,686 feet. Previously, these soils were believed to occur only in the Arctic zones. (Sovetsky Flot, No. 246, Oct. 17, 1957.)

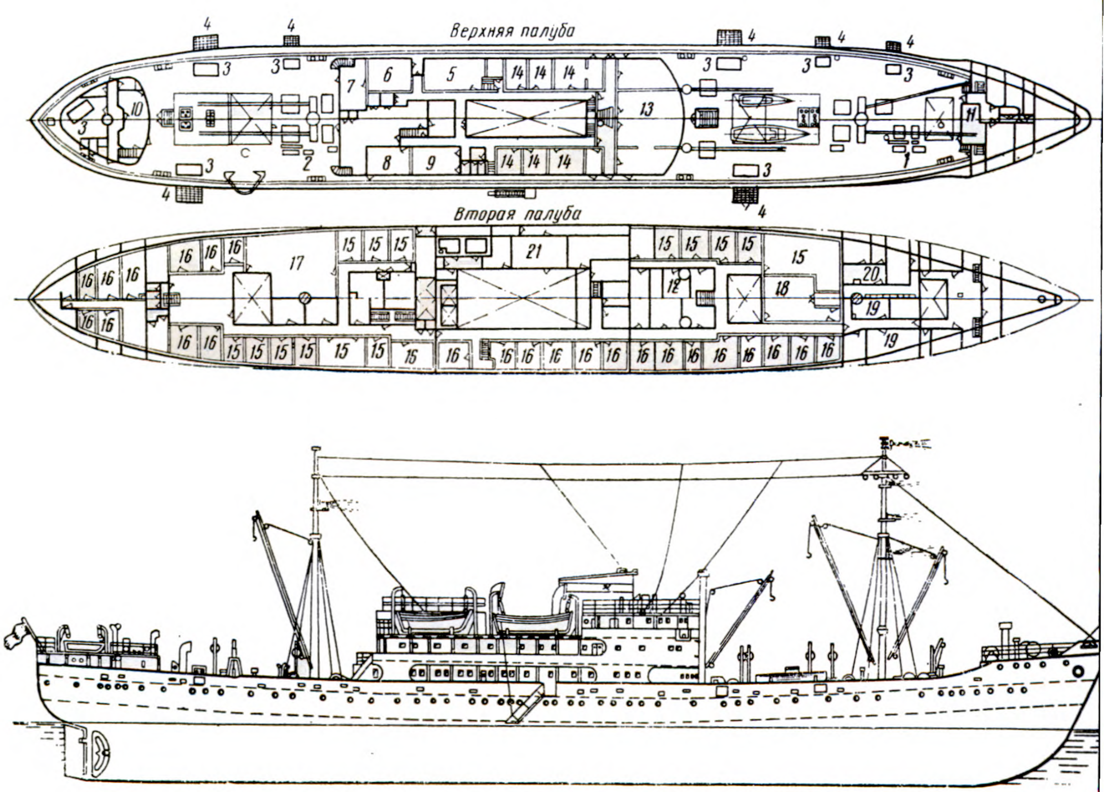
The second voyage of the VITIAZ, covering a distance of over 10,000 miles, took the ship from Vladivostok south along the 174th meridian west longitude and back north from New Zealand along the 172nd meridian east longitude. Many specimens of fishes and mollusks were obtained, the ocean bottom at depths of 29,529 feet was photographed, and a new trough was discovered north of the New Hebrides

Generated for member (University of Maryland, College Park) on 2014-09-30 20:12 GMT / http://hdl.handle.net/2027/uiug.30112075629110
Public Domain, Google-digitized / http://www.hathitrust.org/access_use#pd-google
Digitized by Google
Original from
UNIVERSITY OF ILLINOIS AT
URBANA-CHAMPAIGN



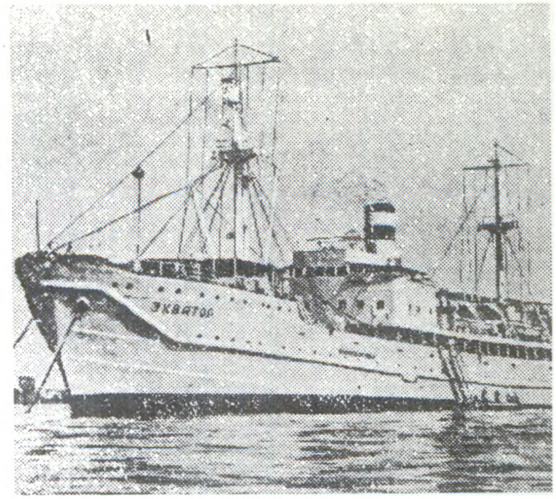
The VITIAZ in the Pacific Ocean. Reproduction of a photograph published in Ogonyok, No. 22, May 30, 1954.

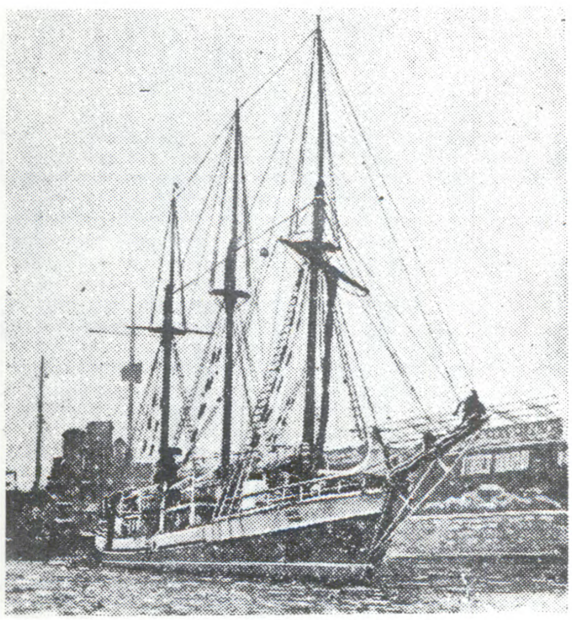
Side view of VITIAZ and plan views of the ship's upper and lower decks. Reproduction of drawings printed in Morskoy Flot, No. 5, May 1955. Ship facilities are indicated by numbers, as follows: 1, anchor winch; 2, trawl winch; 3, oceanographers winches; 4, outboard platforms; 5, hydrological laboratory; 6, plankton laboratory; 7, ichtyology laboratory; 8, geology laboratory; 9, chemistry laboratory; 10, benthos laboratory; 11, hydrochemistry laboratory; 12, photographic laboratory; 13, mess-room; 14, officers quarters; 15, junior scientists quarters; 16, crew quarters; 17, crew mess; 18, lounge; 19, experimental workshop; 20, hospital; 21, shop.



Generated for member (University of Maryland, College Park) on 2014-09-30 20:12 GMT / http://hdl.handle.net/2027/uiug.30112075629110
Public Domain, Google-digitized / http://www.hathitrust.org/access_use#pd-google
Digitized by Google
Original from
UNIVERSITY OF ILLINOIS AT URBANA-CHAMPAIGN

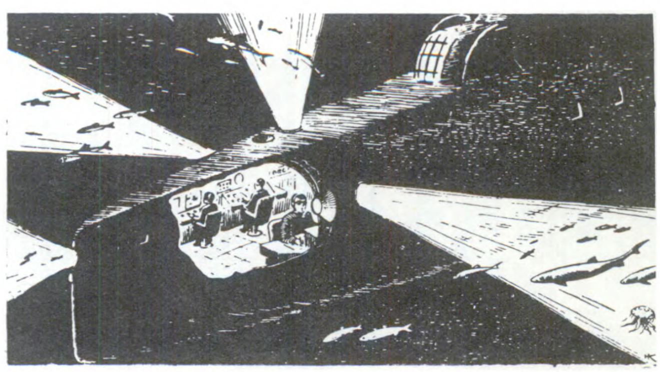
The EKVATOR at anchor. Reproduction of a photograph published in Vodnyi Transport, No. 24, Feb. 23, 1956.





The nonmagnetic schooner ZARIA in Leningrad. Reproduction of a photograph printed in Pravda, No. 235, Aug. 22, 1956.

The oceanographic laboratory in the SEVERIANKA submarine. Reproduction of a drawing printed in Izvestia, No. 194, Aug. 15, 1958.



Generated for member (University of Maryland, College Park) on 2014-09-30 20:12 GMT / http://hdl.handle.net/2027/uiug.30112075629110
Public Domain, Google-digitized / http://www.hathitrust.org/access_use#pd-google
Digitized by Google
Original from
UNIVERSITY OF ILLINOIS AT
URBANA-CHAMPAIGN

Islands. The trough, which is 20,342 feet deep, was named "Vitiaz." (Pravda, Feb. 28, 1958.) Soviet hydrographers aboard the VITIAZ also discovered that the warm Kuroshio Current in the Pacific has shifted 185 to 250 miles northward. In addition, a new record ocean depth of 35,960 feet was discovered in the region of the Mariana Islands. (Izvestia, Apr. 2, 1958.) The deepest point of the Tonga Deep was corrected by the VITIAZ scientists. They found the correct depth to be 35,568 feet. Furthermore, they found a number of strong currents at a depth of 3,280 feet. Up to the present time these depths were considered to be very quiet. (Sovetsky Flot, No. 152, July 1, 1958.)

In addition to discovering another deep in the Pacific (the Vitiaz, mentioned above), the ship's scientists made corrective measurements of some of the other 17 known deeps in this ocean. As pointed out above, three of these corrections were made before the IGY began—of the Kurilo-Kamchatka, Tonga, and Mariana Deeps. During the IGY they determined the correct depths of two others: the Philippine Deep, 33,680 feet; and the Kermadek, 32,908 feet. (Pravda, Aug. 3, 1958.) Another VITIAZ discovery was a submarine mountain peak in the Carolines, 797 feet under the surface. This peak rises 13,124 feet above the ocean floor. Apparently it is of atoll origin. The VITIAZ expedition gave this peak the name "Miklukho-Maklay" for a Russian explorer of the area in the last century. (Izvestia, Aug. 3, 1958.) All in all, the VITIAZ covered more than 62,000 miles of ocean expanse during the 18 months of the IGY. In addition, it visited many foreign ports in the basin, stopping in Japan, Canada, the United States, New Zealand, New Guinea, New Britain, Fiji, New Caledonia, and in other lands. (Izvestia, Jan. 6, 1959.)

Scientists aboard other ships of the Soviet oceanographic fleet working in the Pacific were concerned with the waters adjacent to Russian shores. The OKEAN was given the northwestern part of the Pacific to explore. In addition, several smaller vessels of the Soviet Coast Guard and fishing fleet had scientists aboard. Work conducted on these ships was devoted to the Bering Sea, Chukchee Sea, and other bodies of water in the region.

STUDY OF THE ATLANTIC

Several oceanographic ships were assigned to the study of the Atlantic Ocean. They included the MIKHAIL LOMONOSOV, newest of the Soviet oceanographic vessels; the EKVATOR and the SEVASTOPOL, assigned to the North Atlantic; the PROFESSOR MESIATZEV, the POLIARNIK, and several fishing vessels, which were sent to the Norwegian and Greenland Sea; and the LENA (of Antarctic fame), assigned to study the water and ice exchange in the strait between Greenland and Spitzbergen. (The USSR Illustrated Magazine, No. 8, 1958, p. 49.)

Perhaps most of our attention should be given to the MIKHAIL LOMONOSOV, for of all the ships in the world constructed specially for research, it is the most modern. The vessel was built in the Neptun shipyard at Rostok in East Germany according to specifications supplied by the USSR Academy of Sciences, and upon completion in August 1957, was transferred to the Marine Geophysical Institute. The ship has 16

Generated for member (University of Maryland, College Park) on 2014-09-30 20:12 GMT / http://hdl.handle.net/2027/uiug.30112075629110
Public Domain, Google-digitized / http://www.hathitrust.org/access_use#pd-google
Digitized by Google
Original from
UNIVERSITY OF ILLINOIS AT
URBANA-CHAMPAIGN

scientific laboratories and accommodations for 65 scientists. Its complicated equipment includes nine deep-sea oceanographic winches, trawling equipment suitable for use at any depth in the Atlantic basin, an anchor system which permits the vessel to stand at anchor in any depth, and a sounding device that can measure depths up to 40,000 feet. The MIKHAIL LOMONOSOV has been conducting studies of the North Atlantic between England, the Azores, North America, and Iceland. (Morskoy Flot, No. 10, 1958, pp. 20-21.)

More information on the technical details of the vessel is given in the Annals of the USSR Academy of Sciences. Its displacement is about 6,000 tons. The boat deck has space for one helicopter. One of its depth-sounding devices can be used both for vertical and horizontal soundings, a combination which is useful for locating schools of fish. The range of the ship is 11,000 nautical miles at an average speed of 13 knots. (Vestnik of the USSR Academy of Sciences, No. 4, 1958.) Another source has stated that, in addition to its helicopter, the vessel has a motorboat suitable for several days of independent sailing in the ocean. (Novoye Vremia, No. 12, Mar. 21, 1957.) The MIKHAIL LOMONOSOV, which is more than 335 feet long and has a beam of 47 feet, was given the task of studying the relief of the Atlantic Ocean floor and the geological structure of its sediments. Furthermore, it has been studying the currents at various depths and their characteristics, the magnetic fields, the salinity of waters, the distribution of zoo- and phyto-plankton, and other features. (Priroda, No. 19, Oct. 1957.)

Two other large oceanographic vessels have been assisting the MIKHAIL LOMONOSOV in the study of hydrological cross sections of the North Atlantic. They are the EKVATOR and the SEVASTOPOL (Sovetsky Flot, No. 283, Dec. 3, 1957). During a month-and-a-half cruise in the stormy Atlantic, the EKVATOR completed 49 drifting-station studies and anchored 13 times in the open ocean. (Sovetsky Flot, No. 121, May 25, 1958.)

OCEANOGRAPHIC STUDIES BY SAILING SHIPS

Besides the modern dieselships mentioned above, Soviet scientists have two specially constructed sailing vessels (with auxiliary engines) which have been conducting extensive oceanographic studies during the IGY. They are the SEDOV and the more famous, non-magnetic vessel ZARIA.

The SEDOV left the Kronstadt base in the Baltic Sea on September 25, 1957, and after a three-month voyage across the Baltic and North Seas, the Atlantic Ocean, the Mediterranean, and the Black Sea, berthed at the Soviet Black Sea naval base at Sevastopol. (Sovetsky Flot, No. 9, Jan. 11, 1958.) The oceanographic sailing vessel started on its return trip from Sevastopol to Kronstadt on February 27, 1958, with plans to conduct oceanographic studies for a period of five months on the way. The program provided for the vessel to pass through the Straits of Gibraltar and set its course for Madeira, the Canary Islands, and the Cape Verde Islands. The ship visited Dakar, crossed the Atlantic to Recife in Brazil, sailed north to the English Channel, and then back to Kronstadt. (Sovetsky Flot, No. 50, Feb. 28, 1958.) The scientists made

Digitized by Google
Original from
UNIVERSITY OF ILLINOIS AT
URBANA-CHAMPAIGN
Generated for member (University of Maryland, College Park) on 2014-09-30 20:12 GMT / http://hdl.handle.net/2027/uiug.30112075629110
Public Domain, Google-digitized / http://www.hathitrust.org/access_use#pd-google

oceanographic observations at selected "stations" in the Atlantic every 60 or 70 miles. Extensive scientific material was collected during this trip, such as data on the distribution of temperatures and salinity of water at various depths and the speeds and directions of currents; also, samples of soils were collected from various floor depths, and more than 400 plankton specimens were taken. (Izvestia, Mar. 2, 1958.) The ship returned to Kronstadt on June 9, 1958, having covered a distance of 8700 miles (Sovetsky Flot, No. 135, July 11, 1958).

More interesting and exciting was the voyage of the ZARIA, which, according to Soviet claims, is the only non-magnetic vessel in the world. This three-masted schooner of 580-ton displacement was built with a minimum amount of metal. It was constructed mainly of wood and such non-magnetic metals as bronze and copper. The main purpose of the ship has been to facilitate the study of the magnetic field of the oceans. The ZARIA started its voyage on August 3, 1957, and since that time has sailed more than 40,000 nautical miles. It visited ports in England, Canada, the Azores, Spain, Albania, the Union of South Africa, Puerto Rico, Brazil, Argentina, Uruguay, Australia, Indonesia, Ceylon, and many others. During the IGY, it crossed the Atlantic six times. The scientific value of the work of the ZARIA is very significant, for its scientists discovered a considerable number of magnetic anomalies in the Atlantic. (Vechernaia Moskva, Sept. 25, 1958.)

In addition to its sails, which cover an area of more than 830 square yards, the ZARIA has a 300-horsepower auxiliary engine. It can attain a speed of 6.5 knots under sails, and 9 knots with its engine. The ship is 131 feet long and has a beam of 32.5 feet. With its supply of water and fuel it can sail 3,500 miles without entering a port. The vessel is virtually non-magnetic because she carries only about two tons of iron and steel, an amount which, compared with the 200 tons of other metals with which she was constructed, can have little, if any, influence on the performance of the scientific instruments. (Sovetsky Flot, No. 178, Aug. 3, 1956.) The submerged part of the vessel is sheathed in brass. Its anchor and anchor chains are made of brass and bronze. The propeller shaft is made of non-magnetic steel, while the propeller itself and the rudder are made of bronze. (Zoanie-Sila, No. 6, June 1957, p. 15.)

The ZARIA is supposed to conduct a study of ocean magnetism and then complete its voyage in Vladivostok (Priroda, No. 8, 1958, p. 55). The precise measurements made on the ZARIA will be used to correct magnetic charts (USSR Illustrated Magazine, No. 8, 1958, p. 48).

STUDIES IN THE ANTARCTIC AND ARCTIC

Russian oceanographic studies in the Antarctic have been conducted chiefly by scientists aboard the OB, a ship that regularly sails to the Soviet Antarctic bases, and also by investigators aboard vessels of the Slava sailing fleet. At the same time, oceanographic observations have been made in the Arctic from two drifting-ice stations—the "North Pole-6" and the "North Pole-7." Scientists on these two ice islands have been aided in their work by several oceanographic vessels, such as the TOROS and POLIARNIK. Some sources indicated that the

Generated for member (University of Maryland, College Park) on 2014-09-30 20:12 GMT / http://hdl.handle.net/2027/uiug.30112075629110
Public Domain, Google-digitized / http://www.hathitrust.org/access_use#pd-google
Digitized by Google
Original from
UNIVERSITY OF ILLINOIS AT
URBANA-CHAMPAIGN

LOMONOSOV (not the MIKHAIL LOMONOSOV, but a smaller, older Russian vessel) was to join these two vessels for a study of the hydrological and ice regimens of the Chukchee Sea, East Siberian Sea, Laptev Sea, Kara Sea, and Barents Sea. (Priroda, No. 8, 1958.)

The OB has been especially active in oceanographic work, having spent 757 days in the oceans, and having made one trip around the world. It has studied, in addition to the Antarctic regions, the Atlantic and Indian oceans. It has also made investigations of the upper layers of the atmosphere. For example, from December 31, 1957, to May 7, 1958, twenty-two meterological rockets were launched from the ship in the southern latitudes. (Sovetsky Flot, No. 286, Dec. 8, 1958.) On February 9, 1959, the OB approached the forbidding shores of Queen Maud Land and landed parties there entrusted with the task of establishing a new Soviet Antarctic base, named the "Lazarev." The Lazarev base was to consist of two buildings, which were to be occupied by six members of the expedition this winter. (Pravda, Feb. 16, 1959.) Recent reports indicate that the Lazarev base (Sovetsky Flot, No. 59, Mar. 12, 1959) was officially opened on March 10, 1959.

SUBMARINE FOR OCEANOGRAPHIC STUDIES

According to the Sovetsky Flot, an official newspaper of the Soviet Defense Ministry, the Soviet Navy transferred one of its submarines to the All-Union Research Institute for the Study of Fisheries and Oceanography. This navy submarine, named the SEVERIANKA (Northern Maiden), has been completely overhauled and specially rebuilt to suit the needs of oceanographic studies. The submarine is equipped mainly for the study of fish movements in the oceans for the purpose of assisting fishing fleets in locating schools of fish. However, the ship will be used for making other oceanographic observations as well. Portholes with thick glass panes, able to withstand high pressures, were placed in the hull; searchlights were mounted in such a way that scientists sitting in chairs in front of the windows could switch them on and observe underwater life; and movie and still cameras were installed by each porthole to enable observers to take pictures at will. Schools of fish are first located by the sounding devices, then observed through the portholes. The sounding devices operate both downward and upward to locate schools of fish either below or above the submarine. In addition, scientists are able to obtain soil samples from the sea floors while the submarine is at anchor or while it is lying at depth. (Sovetsky Flot, No. 19, Jan. 23, 1958.)

A TV camera was installed in the bow of the SEVERIANKA to give the observers a "view" of marine life ahead, the picture being projected onto a screen inside the ship. The re-equipment of the submarine was completed in 1958, and it joined the active fishing and oceanographic fleets at the end of that year. (Izvestia, Aug. 14, 1958.) The submarine has already made three experimental voyages, the first in the Barents Sea and the other two in the Atlantic. During these three trial trips all scientific instruments were tested, such as those used to measure temperatures at various depths, salinity, radioactivity of water, and speed of underwater currents. (Ogonyok, No. 5, Jan. 25, 1959.)

Digitized by Google
Original from
UNIVERSITY OF ILLINOIS AT
URBANA-CHAMPAIGN
Generated for member (University of Maryland, College Park) on 2014-09-30 20:12 GMT / http://hdl.handle.net/2027/uiug.30112075629110
Public Domain, Google-digitized / http://www.hathitrust.org/access_use#pd-google

The second trip of the SEVERIANKA was much longer than the first one. It started on New Year's Eve and lasted 24 days, 22 of which were exceptionally stormy. The results apparently were satisfactory. According to the Soviet press, the scientific material already gathered is very valuable. It was observed that at night the fish were very passive, almost lethargic, and were not frightened by the submarine. In the morning, however, they became much livelier and quickly disappeared from the field of observation of scientists aboard the undersea laboratory. (Pravda, Jan. 26, 1959; Izvestia, Jan. 27, 1959.)

What, briefly, does this summary of Soviet oceanographic activity during the IGY tell us? For one thing, it leaves little doubt that Russia has a first-rate research fleet, and for another, it makes clear that she is rapidly increasing her knowledge of the seas.

This intensive activity by Russia should spur United States' efforts to build up its own ocean-research "forces." The report by the Committee on Oceanography of the National Academy of Sciences, mentioned at the beginning of this article, recommends that our present survey fleet of 45 ships, which are mostly of smaller size than the Russian ships, be increased in number to 85 ships by 1970. To achieve this goal it will be necessary for the U.S. to construct 70 new ships, since 30 ships of the present fleet will no longer be servicable by 1970 and will thus have to be replaced.

With the expanded ocean-research facilities which the U.S. is expected to have in the years to come, and with Russia's research fleet, which will undoubtedly expand also, and with the oceanographic "forces" of other nations vitally interested in the oceans—Great Britain and Japan, for example—we can look forward to a period of intensive exploration of the vast ocean frontier. It is to be hoped, of course, that the acquired knowledge will be used by the participants in the same spirit as was that gathered during the IGY—for the benefit of all mankind.

Mr. Skyhook

Veteran Navy balloonist, LCDR M. Lee Lewis was killed in St. Paul, Minn., last month while making a balloon-flight test for Winzen Research, Inc. Ironically, Lewis, who had soared several times to altitudes of more than 70,000 feet, was only about three feet off the ground when the accident occurred. He was making stability tests in an open-basket gondola when a 15-pound steel pulley fell 65 feet, striking him on the head and shoulder. He died within an hour.

With CDR Malcolm D. Ross of the Office of Naval Research (see inside front and back covers), Lewis established a new, unofficial world altitude record of 86,000 feet for a two-man crew in October 1957, and in July 1958 the two men set a new duration record for stratospheric flight by remaining aloft 34 hours and 40 minutes. LCDR Lewis was awarded the RADM William S. Parsons Award for Scientific and Technical Progress and the Harmon International Trophy (Aeronaut), both for the year 1957.

Generated for member (University of Maryland, College Park) on 2014-09-30 20:12 GMT / http://hdl.handle.net/2027/uiug.30112075629110
Public Domain, Google-digitized / http://www.hathitrust.org/access_use#pd-google
Digitized by Google
Original from
UNIVERSITY OF ILLINOIS AT
URBANA-CHAMPAIGN

Viewing the Sun from the Stratosphere

On July 11, a large polyethylene balloon carrying a 12-inch telescope, a 35-millimeter motion picture camera, and a television camera was released from Lake Elmo, Minn., for a flight high into the stratosphere to obtain high-resolution photographs of the sun. After the balloon had ascended to an altitude of about 81,000 feet, its instruments went into action automatically, clicking off thousands of pictures of the solar disc. The telescope assembly remained at peak altitude for several hours, then was separated from the balloon and returned to earth by parachute. It was recovered undamaged. One of the numerous photographs obtained during the flight appears on page 28. It is one of the best pictures that has ever been taken of the sun.

The flight—the third of its kind to be carried out as part of Project STRATOSCOPE (the first two took place in September and October 1957; see Research Reviews, October 1957)—was sponsored by the Office of Naval Research and the National Science Foundation. Project director was Dr. Martin Schwarzschild of Princeton University.

The reason for sending the telescope to such a high altitude was to get it above the earth's atmosphere, which obscures the view of celestial objects. In particular, it was necessary to get it above the tropopause, a turbulent layer at an altitude of about 40,000 feet which causes fluctuations in refraction of light from the sky, resulting in "twinkling" of stars and other phenomena. The effect of the atmosphere on telescope viewing is such that under the best conditions the 200-inch telescope at Mt. Palomar can rarely distinguish between two points on the moon's surface less than 1,800 feet apart, whereas if it did not have to "look" through the atmosphere, it could distinguish between points only 120 feet apart.

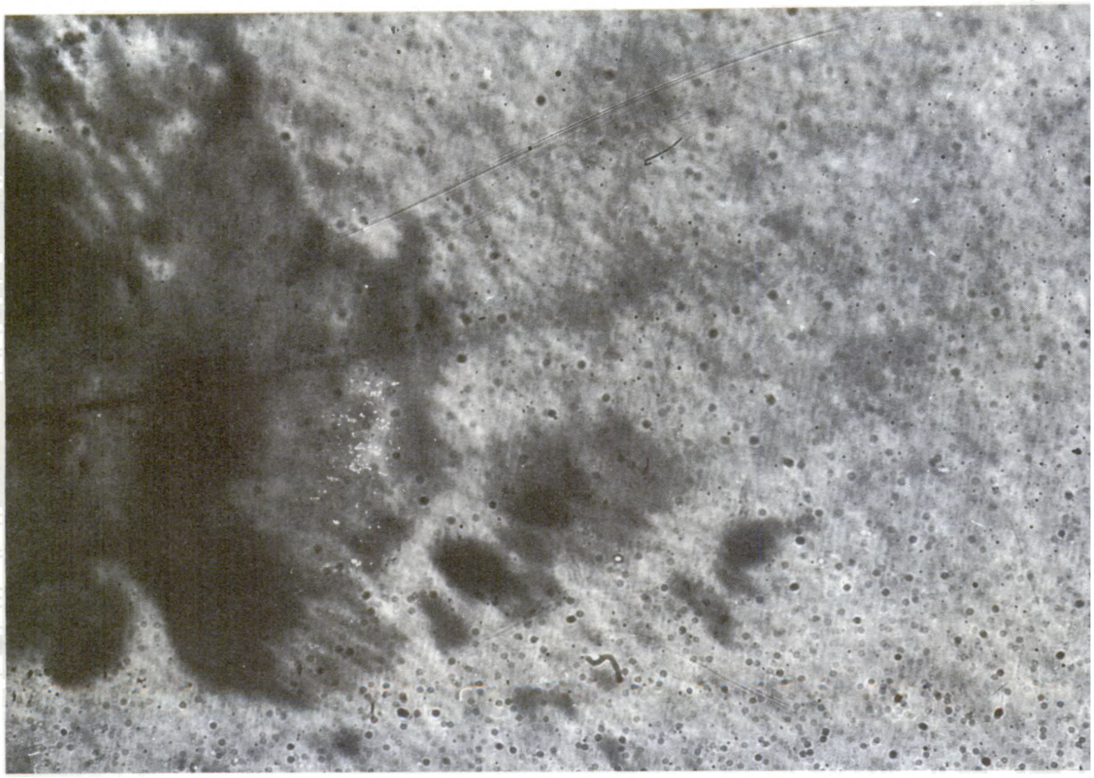
For the first time on the July flight a television camera was used in conjunction with the STRATOSCOPE system. Its purpose was to give astronomers on the ground a second-by-second visual accounting of what the telescope "viewed," thus enabling them—by means of a separate radio-control system—to aim and focus the instrument to best advantage.

The TV camera was mounted on the telescope structure beside the 35-millimeter motion-picture camera, which supplied a permanent photographic record of the observations. The two cameras were linked optically by a mirror and shutter arrangement which caused the telescope image to be reflected during 1/1,000 of a second once each second to the television camera. The TV image was then transmitted to the ground during the remainder of the second, completing the job just in time for the next brief exposure. In this manner, the ground observers received on the TV screens a series of images identical to those being recorded by the motion-picture camera from the telescope.

The third STRATOSCOPE flight was, in essence, a continuation of the series of flights that began in September 1957. That series, called STRATOSCOPE I, will be supplemented in 1961 by a second series, called STRATOSCOPE II, which will involve use of a 36-inch telescope.

Digitized by Google
Original from UNIVERSITY OF ILLINOIS AT URBANA-CHAMPAIGN
Generated for member (University of Maryland, College Park) on 2014-09-30 20:12 GMT / http://hdl.handle.net/2027/uiug.30112075629110
Public Domain, Google-digitized / http://www.hathitrust.org/access_use#pd-google

The purpose of this second series of flights will be to examine objects other than the sun, such as the planets, galaxies, and nebulae. It will also be directed by Dr. Schwarzschild of Princeton University and will be supported jointly by the Office of Naval Research and the National Science Foundation.

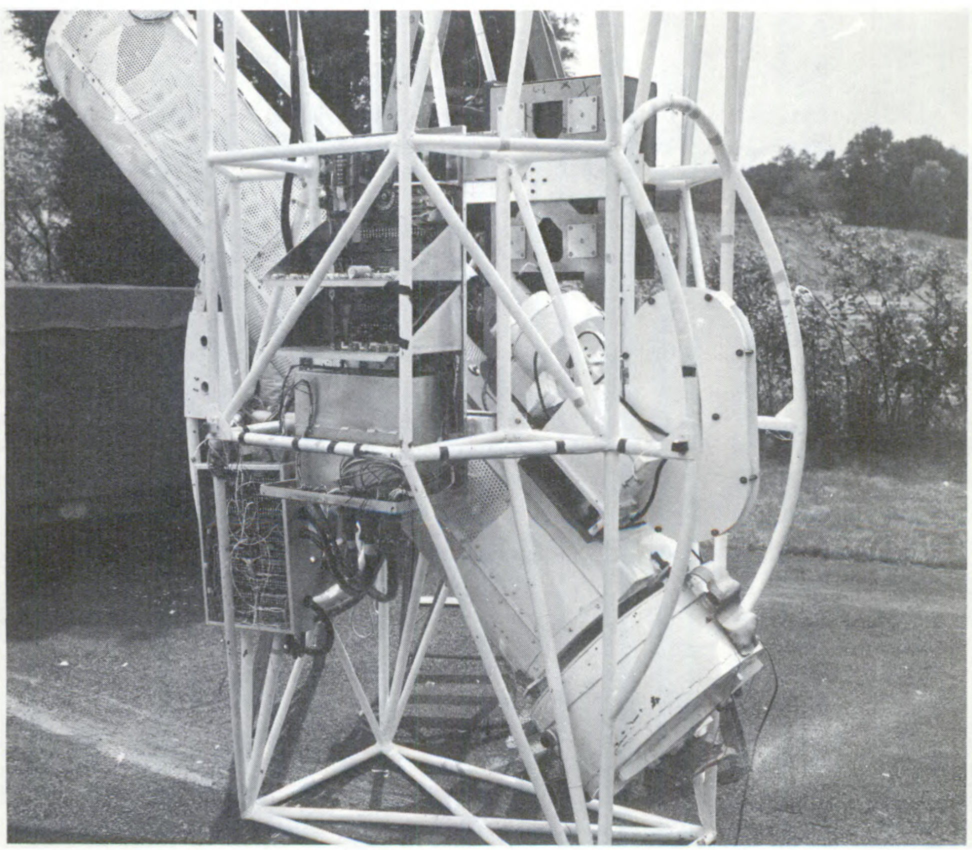


PROJECT STRATOSCOPE Above, a sun spot as "viewed" through a 12-inch telescope from an altitude of 81,000 feet. Easily discernible in the photograph are the umbra (black center of the spot) and the penumbra (lighter colored adjacent areas). The high definition of this photograph makes it possible to study the interrelations between the magnetic field of the sun spot and the surrounding area. In the area of the magnetic field outside the sun spot the polygonal-shaped solar granulations appear hazy and with little contrast. But in the areas outside the magnetic field (for example, at right edge of photograph) they appear somewhat more distinct. The photograph covers an area about 40,000 miles wide by 60,000 miles long, which is roughly equivalent to one-half of one percent of the sun's area.

Top right, some members of the STRATOSCOPE team. Left to right: George Brueske, Perkin-Elmer Corp.; Bob Danielson, Princeton University; John Bahng, Princeton; W. S. Pike, R.C.A.; D. Eichner, Data-Control Systems; Lewis Anthony, Princeton; and Dr. Martin Schwarzschild, Princeton.

Bottom right, the heart of the STRATOSCOPE system. Electronics components used to point telescope are shown on frame at left of telescope. Square box on rear of telescope houses the television camera; the film magazine for telescope camera is next to it, with the telescope camera just in front.

Digitized by Google
Original from
UNIVERSITY OF ILLINOIS AT
URBANA-CHAMPAIGN
Generated for member (University of Maryland, College Park) on 2014-09-30 20:12 GMT / http://hdl.handle.net/2027/uiug.30112075629110
Public Domain, Google-digitized / http://www.hathitrust.org/access_use#pd-google



Generated for member (University of Maryland, College Park) on 2014-09-30 20:12 GMT / http://hdl.handle.net/2027/uiug.30112075629110
Public Domain, Google-digitized / http://www.hathitrust.org/access_use#pd-google

Digitized by Google

Original from
UNIVERSITY OF ILLINOIS AT
URBANA-CHAMPAIGN

On the Naval Research Reserve

Two Companies Observe Tenth Anniversaries

NRRC 9-5

Naval Reserve Research Company 9-5, Ames, Iowa, observed its tenth anniversary at a dinner meeting held on April 22. The meeting was held for the 26 members, their wives, and guests. LT R. K. Larson, Commanding Officer of NRRC 9-5, welcomed the group and served as master of ceremonies.

Special guests included BGEN H. V. Gaskill, USAR, formerly Dean of the Division of Science at Iowa State College, who was instrumental in the organization of NRRC 9-5; CAPT W. M. Drane, USN, Commanding Officer and Professor of Naval Science of the NROTC unit at ISC; CDR K. H. Berkley, USN, Executive Officer of the NROTC unit at ISC; and LT C. S. Lardis, USN, Reserve Assistant, ONR Branch Office, Chicago.

LT Larson read a message from CDR E. S. Churchill, USNR, Specialist Program Officer, Ninth Naval District. In the letter CDR Churchill congratulated the unit on its excellent record and commented that "the Research Companies of this District have continued to be among the most active and best motivated of all Naval Reserve Specialist Companies."

NRRC 9-1

The tenth anniversary of Naval Reserve Research Company 9-1, Chicago, Illinois, was observed at a dinner meeting held in the Naval Armory on June 23.

LCDR B. J. Jaskoski, USNR, Commanding Officer of NRRC 9-1, presided over the meeting and introduced the two guest speakers: CAPT J. P. Aymond, USN, Special Assistant to the Chief of Naval Research (Research Reserve), and CDR E. S. Churchill, USNR, Specialist Program Officer, Ninth Naval District. CDR Churchill was a former Training Officer in the Research Reserve Program. Also present at the meeting were Miss Gwen Thyren of the ONR Branch Office, Chicago, who has served for ten years as secretary to the Reserve Assistants, and Miss Eleanor Kehoe, Training Specialist, Research Reserve Program.

Included among the 33 present members of NRRC 9-1 are six charter members. They are CDR Robert L. Burwell, LCDR Nelson C. Cuddeback, LCDR John J. Kennedy, LT Sanford M. Linick, LCDR Walter E. Peterson, and LCDR Harold M. Piety.

Company members and guests who attended the meeting were presented with an interesting and informative booklet entitled "History of U. S. Naval Reserve Research Company 9-1." The account was prepared by LCDR R. P. Thacker, USNR, with the assistance of LCDR W. E. Peterson, USNR, and LCDR W. A. Bohan, USNR.

Generated for member (University of Maryland, College Park) on 2014-09-30 20:12 GMT / http://hdl.handle.net/2027/uiug.30112075629110
Public Domain, Google-digitized / http://www.hathitrust.org/access_use#pd-google
Digitized by Google
Original from
UNIVERSITY OF ILLINOIS AT
URBANA-CHAMPAIGN

Shown at the tenth anniversary dinner of NRRC 9-5, from left to right: LT C. S. Lardis, USN; CDR O. C. Kreider, USNR, first Commanding Officer of the unit; CAPT W. M. Drane, USN; BGEN H. V. Gaskill, USAR; CDR K. H. Berkley, USN; and LT R. K. Larson, USNR.

Shown at the tenth anniversary dinner of NRRC 9-1, from left to right: LCDR R. P. Thacker, a member of NRRC 9-1; LCDR B. J. Jaskoski, Commanding Officer, NRRC 9-1; Miss Gwen Thyren, ONR Branch Office, Chicago; LT C. R. Lardis, Reserve Assistant, ONR Branch Office, Chicago; and LCDR W. A. Bohan, a member of NRRC 9-1

Generated for member (University of Maryland, College Park) on 2014-09-30 20:12 GMT / http://hdl.handle.net/2027/uiug.30112075629110
Public Domain, Google-digitized / http://www.hathitrust.org/access_use#pd-google
Digitized by Google
Original from
UNIVERSITY OF ILLINOIS AT
URBANA-CHAMPAIGN

Three Research Projects Completed

During recent months Research Reserve members have completed several research projects as part of company activities.

The members of NRRC 9-4, Milwaukee, Wisconsin, under the direction of CDR H. F. Burr, USNR, finished a study entitled "Methods of Measurement of Sea Temperatures."

A second investigation—this one bearing the name "Mechanical Vibrations"—was completed by LTJG John P. Raney, USNR, a member of NRRC 9-7, Lafayette, Indiana.

The members of NRRC 8-1, New Orleans, Louisiana, concluded and submitted a final report on a study of the Iberian Peninsula. This work was done as a part of the regular company drills under the direction of the Commanding Officer, LT R. J. Demint, USNR.

Suit for Aeronauts

The Navy has combined the century-old knowledge of radiant heat transfer with the new technology of metallized fabrics in designing a lightweight, high-insulation garment for high-altitude balloon flights. The suit was to be worn for the first time on a balloon flight early this month by Malcolm D. Ross of the Air Branch, Office of Naval Research, and Robert H. Cooper of the High Altitude Observatory, Boulder, Colo. The two men, shown in the photograph at right wearing the new clothing, were to comprise the crew of an open-gondola which was to be lifted by balloon from a point near Rapid City, S. Dak., to an altitude of about 40,000 feet for the purpose of making observations of the sun's corona. A description of the investigations that were to be conducted on the flight is given on the inside front cover.

The primary insulating assembly of the garmet consists of two rubberized fabrics which have been coated with a very thin aluminum film and arranged so that a spring-like plastic spacer holds them apart. The aluminum surfaces are arranged so that they face each other with the spacer in between. This design provides spacing for good insulation and reduces heat transfer by radiation. In the rarified air of high altitude the assembly works somewhat like a thermos bottle. Laboratory analysis shows that this material has about the same insulating value as conventional woven or fur-like materials, but it weighs only about half as much.

The unusual appearance of the garment stems from the fact that the outside is also surfaced with a bright aluminum film. This metal film serves a twofold purpose. During the daytime the metal surface reflects the sun's heat, which is intense at high altitudes, thereby keeping the wearer more comfortable. At night, on the other hand, the metal surface reduces the loss of radiant heat from the man to the cold sky.

The garment was developed by the Clothing and Textile Division, Naval Supply R&D Facility, Brooklyn, N.Y.

U.S. GOVERNMENT PRINTING OFFICE: 1959 O - 516281

Generated for member (University of Maryland, College Park) on 2014-09-30 20:12 GMT / http://hdl.handle.net/2027/uiug.30112075629110
Public Domain, Google-digitized / http://www.hathitrust.org/access_use#pd-google
Digitized by Google
Original from
UNIVERSITY OF ILLINOIS AT URBANA-CHAMPAIGN

The Navy's new lightweight, high-insulation garment designed for wear on high-altitude balloon flights. The suit was to be tested for the first time on a balloon flight early this month by the two men shown in the picture--Mr. Robert H. Cooper of the High Altitude Observatory, Boulder, Colo., and CDR Malcolm D. Ross of the Air Branch, Office of Naval Research. See facing page and inside front cover.

Generated for member (University of Maryland, College Park) on 2014-09-30 20:12 GMT / http://hdl.handle.net/2027/uiug.30112075629110
Public Domain, Google-digitized / http://www.hathitrust.org/access_use#pd-google
Digitized by Google
Original from
UNIVERSITY OF ILLINOIS AT
URBANA-CHAMPAIGN

IN THIS ISSUE

NAVAL RESEARCH reports highlights of technical progress in research by Navy laboratories and contractors and the development of important naval research facilities. The magazine is listed for sale by the Superintendent of Documents, U. S. Government Printing Office, Washington, D. C. Subscription price: $1.50 per year in U. S. and Canada; $2.00 per year, foreign; $0.15 per individual copy. Changes of address should be sent to Code 740, Office of Naval Research, Washington, D. C. Use of funds for printing this publication was approved by the Director of the Bureau of the Budget, February 12, 1958.

A STRATOSCOPE balloon is inflated preparatory to lifting a 12-inch telescope to an altitude of about 81,000 feet to "view" the sun. See article and pictures on pages 27 through 29.

Digitized by Google

Original from UNIVERSITY OF ILLINOIS AT URBANA-CHAMPAIGN

Generated for member (University of Maryland, College Park) on 2014-09-30 20:12 GMT / http://hdl.handle.net/2027/uiug.30112075629110
Public Domain, Google-digitized / http://www.hathitrust.org/access_use#pd-google