the nucleus as a dense core surrounded by a cloud of weakly interacting nucleons, a description which yields readily to the techniques of mathematical physics. The committee reviewed the development of experimental techniques (i.e., the construction of accelerators in the required energy range with extremely homogeneous and reliable beams, the incorporation of very rapid, high-resolution detection equipment in the apparatus, and the integration of high-speed computers in the detection equipment) and concluded that it is now possible to answer critical theoretical questions which could not previously be put to experimental test.

The committee made the following general recommendations: Appropriations for major facilities should be increased immediately; over the next five years sums between $22 million and $35 million per year should be expended. The operating budget for nuclear-structure research should be increased to permit procurement of auxiliary equipment for existing facilities; by 1967 the operating budget should be between $70 million and $90 million. Housing for accelerator laboratories should be underwritten as an integral part of the installation. Replacement of obsolete and inefficient equipment should be encouraged. Support should be given both to fundamental theoretical studies and to studies of the analysis of experimental results by newly developed computational techniques.

In the committee's view, the recommended increases in support for research in nuclear structure would be of benefit to all branches of physics. On the one hand, the study of elementary particles at high energies would benefit from a better understanding of nuclear processes and of the interactions between primary particles. On the other hand, the study of atomic physics and of the physics of gross matter would have a firmer foundation if more were known about the details of nuclear structure. Physics education would also benefit. Compared with other highly active fields of research, the cost of construction and maintenance of low-energy equipment is moderate, and therefore more feasible for smaller academic institutions. Furthermore, experiments can be done by fewer people than are likely to be required in high-energy programs. Thus smaller faculty groups could undertake research, and students would have the opportunity to become vitally involved in the programs.

The chairman of the panel was W. W. Havens, Jr., of Columbia University; other members were the late Tom W. Bonner of Rice University, D. Allan Bromley of Yale, Bernard L. Cohen of the University of Pittsburgh, Herman Feshbach of Massachusetts Institute of Technology, Hans Frauenfelder of the University of Illinois, J. Bruce French of the University of Rochester, Gertrude Goldhaber of Brookhaven National Laboratory, Emil J. Konopinski of Indiana University, Thomas Lauritsen of California Institute of Technology, Rubby Sherr of Princeton, and George M. Temmer of Florida State University. The full report has been issued as NSF document 62–45, *Research Trends: 1962–1967, Nuclear Structure Physics*. A limited number of copies are available on request from the National Science Foundation, Washington 25, D. C.

### *Federal Funds for Science*

During the present fiscal year, basic-research obligations of the federal government are expected to increase about 32 percent, from $1.1 billion in 1962 to $1.5 billion in 1963, largely because of research expenditures in the space program. This parallels the rise in federal funds obligated for research and development generally, which show an increase of 31 percent, from $11.2 billion during fiscal 1962 to $14.7 billion in 1963. An estimated $4.5 billion of this year's obligations supports research, both basic and applied. Of the remainder, $8.5 billion is for development, $1.6 billion for facilities, and $100 million for scientific and technical information. These figures are a result of the most recent annual survey of the subject by the National Science Foundation. Complete results of the survey will be reported in *Federal Funds for Science XI*, to be published by the Government Printing Office.

According to the survey, 4 government agencies out of 27 using research and development funds expect to account for 95 percent of the total. The Department of Defense reports the largest amount, $7.4 billion in 1963 as compared with $6.7 billion in 1962. The National Aeronautics and Space Administration has doubled its expenditures—from $1.4 billion in 1962 to $2.8 billion in 1963. The Atomic Energy Commission and the Department of Health, Education, and Welfare also show large increases.

About four fifths of the funds are for support of work done under contract with the government. Approximately 65 percent of the contract funds go to industry, 12 percent to educational institutions, and the remainder to other organizations.

Federal funds for research and development in 1963 are estimated at sixteen times the figure for 1948. Over the fifteen years, R and D expenditures have increased from 2.5 percent to approximately 13 percent of the total federal budget.

### *Bubble Chamber*

The University of Michigan has announced a program for the construction of what is expected to be the world's largest heavy-liquid bubble chamber. Containing freon or propane or a mixture of both, the chamber will be 40 inches in diameter and 26 inches deep. It will be surrounded by a 300-ton magnet which will generate a field of 40 000 gauss. The entire structure will be 45 feet long and 16 feet high.

The magnet is being assembled at Argonne National Laboratory. After being completed next year, the chamber will be brought to Argonne for use in conjunction with the 12.5-BeV zero-gradient synchrotron which is now under construction there. The entire project is financed by the Atomic Energy Commission at a cost of $550 000. The work at the University of Michigan is

being done by Professors Byron P. Roe, Daniel Sinclair, and John Vander Velde.

### *MSU Cyclotron Facility*

Construction of a building to house a 50-MeV variable-energy sector-focused cyclotron has begun on the campus of Michigan State University. The experimental area includes three separately shielded target rooms with walls and ceilings consisting of large, movable concrete blocks. The cost of the 34 500-square-foot building ($960 054) is being borne by the University, and the structure is scheduled to be completed by the end of August. The National Science Foundation is supplying financial assistance toward the construction of the cyclotron.

### *Colorado Cyclotron Facility*

Plans have been announced for the construction of an addition to the cyclotron building at the University of Colorado with the aid of a grant of $123 300 from the National Science Foundation. The University will allocate funds to match the grant, which will be used to provide additional laboratory, shop, and office space. The four-year-old building houses the Nuclear Physics Laboratory and the only university cyclotron in the Rocky Mountain region, a 30-MeV cyclotron designed for nuclear-structure studies which produced its first beam in April of last year. The Nuclear Physics Laboratory is under the direction of David A. Lind and Jack J. Kraushaar and has a staff of five faculty members and about ten graduate students.

### *Chilean Observatory*

An international optical observatory available for use by astronomers of both the United States and Chile is to be constructed in Chile with funds provided by the National Science Foundation under its program for the development of research centers. The installation will give US astronomers access to an observing site for study of portions of the southern sky that are invisible from North America.

The observatory will be operated for the NSF by the Association of Universities for Research in Astronomy, the organization that now operates the Kitt Peak National Observatory. To emphasize the international nature of the venture, Dr. Federico Rutllant, director of the National Observatory of Chile, has been named to the AURA board of directors.

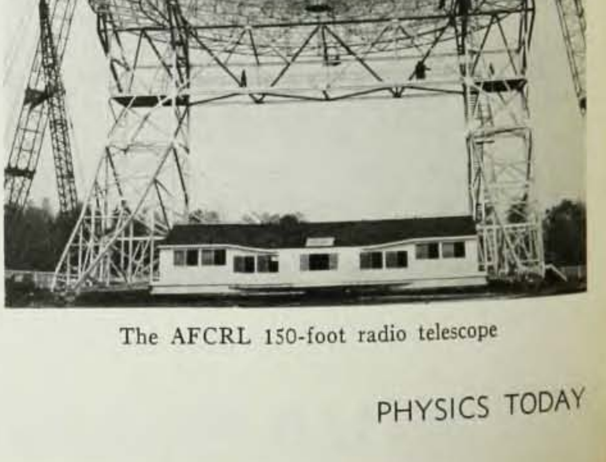
Funds ($750 000) for the major observing instrument, a 60-inch telescope, will be provided by the US Air Force. Various smaller instruments, including a 16-inch telescope that was used in the site-selection surveys, will also be made available. The Foundation has provided a total of $1.05 million for preliminary engineering studies, site development, construction of buildings and purchase of equipment, and the first year of the observatory's operations.

### *Radio Telescope*

The new 150-foot radio telescope of the Air Force Cambridge Research Laboratories Sagamore Hill Radio Astronomy Observatory at Hamilton, Mass., is reported in partial operation. The reflector, which was placed on its supporting towers last September, is capable of motion in the horizontal plane and is now being used to view radio sources as they rise and set. Equipment to control vertical motion and tracking of sources is being installed, and the instrument is expected to be in full operation by the end of the year. Two other radio telescopes of the same size have been placed in operation by Stanford University in Palo Alto, Calif., and by the Naval Research Laboratory at Chesapeake Beach in Maryland.

The Sagamore Hill dish has a reflecting surface of aluminum mesh with a focal length of 68 feet. Its support consists of two 85-foot towers which are joined at the top by a bridge and are mounted on wheels running on a circular track in the concrete base. Horizontal motion is accomplished by revolving the entire structure.

The research program, under the direction of Jules Aarons, chief of the AFCRL Radio Astronomy Branch, will place major emphasis on the study of the earth's ionosphere. When in full operation, the instrument will be used in observing radiations from planets, including blackbody, synchrotron, and burst, to help determine the characteristics of planetary atmospheres. Studies of Jupiter radiation, in particular, may provide information on the earth's atmosphere, the solar corpuscular stream, and solar storms. The new radio telescope will also be employed in studies of the aurora by radio-star scintillation and absorption, thus expanding a program which has been in progress for several years with Sagamore Hill's 84-foot dish, and when the two telescopes are used together, they will provide AFCRL with an extremely sensitive interferometer.



The AFCRL 150-foot radio telescope