molecules have been obtained by the flash photolysis technique. The hyperfine structures of the ground states of both stable isotopes of copper have been investigated by the atomic-beam magnetic-resonance method and the hyperfine structure anomaly determined.

The Division of Building Research steadily extended its work, completing a detailed study of the properties of asphalt singles, continuing basic studies of the movement of moisture in solid materials and making good progress in research into the strength of floating sheets of ice. In the Division of Mechanical Engineering the aerodynamics section is examining the possibilities of vertical take-off and landing, while studies with jet aircraft at high subsonic and transonic speeds demonstrated several methods of improving the characteristics of airframes and engines. Work continued in the hydraulics laboratory to provide design data for navigation locks and river improvements for several St. Lawrence Seaway projects. In gas dynamics the major design effort was on a gas turbine unit for railway traction, while much effort was given to the development of rotor de-icing equipment for helicopters, and to problems of dynamics and dynamic loading of structures. Very substantial economy in operation and maintenance of buoy lights has resulted through application of transistor circuits developed by the Radio and Electrical Engineering Division. A transmitter, power supply and antenna are under development which will survive a crash and automatically radiate a signal that can be detected by searching aircraft. A novel circuit has been developed in which a quartz crystal is used to stabilize two variable-frequency oscillators. In high-voltage research successive stages of electric-spark formation in air were photographed by using an image converter as a very high-speed optical shutter, and growth of spark diameter and brightness were correlated with various theories of spark formation. The hazard of sparks created by falling steel objects received much attention, but no ignition was obtained with drops as great as 80 ft. Tests on the St. Lawrence Seaway showed that radar shore installations would be advantageous in scheduling the arrival of vessels at lock entrances so that traffic may be handled more efficiently. A survey conducted for the Government of Newfoundland showed that a very-high-frequency radiotelephony system would provide adequate communications for vessels of the 'long liner' fishing fleets.

## FIELD STUDIES COUNCIL

IN 1957 there was again an increase in the number of students attending the various field centres of the Field Studies Council and at most of them the pressure of attendances was kept up steadily throughout the season. This is brought out in the annual report (pp. 68+8 plates. London: Field Studies Council, 1958) for 1956–57, which shows that the number of students attending in 1951 had almost doubled in 1957. The new centre at Preston Montford opened in March 1957, and by the close of the season it had just managed to top the thousand mark in terms of student-weeks. Once again, the increase in numbers has been general, but in accordance with the Council's policy there has been some development of attendances from secondary modern schools, particularly at Preston Montford, where special 'countryside' courses have been provided.

The pressure at peak times of the year has continued, this being particularly pronounced in the spring, when most of the centres could fill their vacancies two and three times over. Although the opening of the new centre has gone a little way to redress the position, it, in turn, became rapidly over-subscribed at the peak of the spring period.

At the older centres the 'valleys' have been largely filled up, but it would still help if schools could arrange wherever possible to send their first-year sixth-formers at times of year which did not conflict with the peak period of bookings in April.

The Council finds itself still having to face the problem of rising costs, and this, coupled with the prospect of the Ministry of Education's grant being gradually withdrawn after 1958–59, has caused the Committee to raise again the basic charge.

The opening of any further centres is almost entirely dependent on the question of whether adequate initial capital and future support can be forthcoming from outside sources. It seems possible that at some future date an additional centre in the south-west of England might be feasible and, if this should materialize, it would mean that the Council as a whole would have a very satisfactory geographical spread over the counties of England and Wales.

## SCIENTIFIC EDUCATION IN THE UNITED STATES

IN his budget message to Congress on January 13, President Eisenhower emphasized the need to expand the United States efforts in scientific research and said that this is a task for private industry, research foundations and educational institutions as well as for the Government. Supplementary appropriations for 1958 would be requested for the National Advisory Committee for Aeronautics and the National Science Foundation as well as for the Department of Defence. For 1959 new programmes to promote education in science are being recommended and basic research activities are being generally expanded. Total Government expenditure on equipment of the United States forces and those of its allies, on nuclear energy and on scientific research and education will be 21,000 million dollars in 1958 and 21,600 million dollars in 1959 compared with 20,500 million dollars in 1957. This budget, President Eisenhower added, reflects co-ordinated plans for strengthening defence, greater pooling of scientific resources and freer exchange of technological information, as well as closer economic co-operation. Expenditure by the U.S. Atomic Energy Commission will increase to 2,550 million dollars in 1959, compared with 2,300 million dollars in 1958 and 1,990 million dollars in 1957. For technical assistance, 164 million dollars are requested for 1959 and appropriations of 140 million dollars are proposed for the National Science

Foundation—more than three times the current authorization—and of this, 58 million dollars is provided for research grants, facilities and equipment and related purposes; a further 82 million dollars, or five times the present allocation, is for the expansion and improvement of scientific education.

Further details of this educational programme were given in a presidential message on education delivered to Congress on January 27. First, dealing with the National Science Foundation, the Administration recommends an increase in funds to support institutes sponsored by the Foundation for the supplementary training of science and mathematics teachers, and a somewhat larger increase to support teacher fellowships. Secondly, increased funds are sought to enable the Foundation to stimulate the improvement of the content of science courses at all levels of the educational system; thirdly, expansion is proposed of the Foundation's programmes to encourage able students to consider science as a career; while fourthly, increase in the Foundation's graduate fellowship programme is recommended, as well as the provision of funds to enable the Foundation to initiate new programmes of fellowships for secondary school science teachers during the summer months, for graduate teachers who serve during the school year as teaching assistants and for individuals seeking to extend their education and become teachers of science and mathematics in high schools.

To strengthen scientific and general education in State and local school systems, the Administration is recommending legislation to authorize additional Federal programmes for four years in the Department of Health, Education and Welfare. To reduce the waste of talent, authorization is recommended of matching grants to the States to encourage improved testing programmes to identify the potential abilities of students at an early stage in their education and also to strengthen local counselling and guidance services, so that more able students will be encouraged to stay in high school and prepare for higher education. A programme of some 10,000 new Federal scholarships annually, reaching 40,000 in the fourth year, to be closely co-ordinated with the testing and counselling programmes, is also recommended. To strengthen the teaching of science and mathematics, Federal grants to the States on a matching basis are recommended, to be used either to assist the employment of additional qualified science and mathematics teachers, or for the purchase of laboratory equipment or to supplement salaries.

To increase the supply of teachers the Administration is also recommending the provision of graduate fellowships to encourage more students to prepare for college teaching careers, and of Federal grants on a matching basis to institutions of higher education, to assist in expanding their graduate-school capacity. Provision is also recommended of a four-year programme in support of special centres in colleges and universities for instruction in important foreign languages which are not now commonly taught in the United States, and of institutes for those who are already teaching foreign languages in schools and universities where the quality and effectiveness of such teaching could be improved. Finally, the Administration recommends that the Office of Education be authorized to make grants to State agencies for improving the collection of statistical data about the status and progress of education.

Throughout both messages the President emphasizes the bearing of all these educational recommendations on national security.

# SPATIAL AND TEMPORAL VARIATION OF MICROFIBRILLAR ORGANIZATION IN PLANT CELL WALLS

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THE molecular structure of the solid envelope which surrounds every plant cell has been the subject of intensive investigation for many years. This cell wall is composed of a complex mixture of polysaccharides, of which the celluloses have proved to be of greatest importance, both as the major structural component and economically. Theories concerning the micellar structure of this 'skeletal' cellulose aroused much controversy until the advent of the electron microscope, when by means of this instrument it became possible to make direct observations. The first electron micrographs of untreated and undistorted cellulose were obtained in this Department in 1948[1], using the cell wall of the green alga *Valonia*. This cellulose is in the form of long flattened threads, called microfibrils, which range in diameter from 250 to 300 A., and are apparently endless. Afterwards, from examinations of a variety of plant materials, including higher plants, it has become evident that microfibrils are a characteristic feature of plant cell walls. These microfibrils vary between 100 and 300 A. in diameter, depending upon source and pretreatment. As they occur within the cell wall, these microfibrils may be oriented and virtually straight, as, for example, in Fig. 1, or have a random arrangement with the microfibrils intertwined, as in Fig. 2. Despite the striking difference in appearance of these two types, until recently there has been a tendency to assume that all microfibrils are cellulosic in nature. The purpose of this article is to direct attention to the implications of recent work carried out in this and other laboratories, indicating that the situation is more complex.

Let us first consider the condition existing in the types showing oriented microfibrils. The best examples may be found in the mature walls of certain of the green algae, notably *Valonia*, *Cladophora* and *Chaetomorpha*. X-ray diffraction analysis indicates that the microfibrils are highly crystalline and are composed of cellulose I[2,3]. On hydrolysis the cellulosic fraction yields glucose with but a trace of other sugars. These microfibrils may be regarded, therefore, as being composed of pure cellulose.

A study of some examples of cell walls containing only random microfibrils has been made in this Department[3]. A number of species of the red algae have been examined, combining chemical analysis