

education authorities, universities and university colleges, technical institutions and industry. The academic boards have stronger representation of universities and technical institutions. The Ministry of Education appoints assessors to all the councils and boards, and provision is often made for other Ministries to be represented.

Details of the constitution and functions of regional advisory councils have been set out in a pamphlet\* together with a list of local authority areas included in each region. Copies can be obtained from the London Regional Advisory Council, Tavistock House South, Tavistock Square, London, W.C.1.

T. H. HAWKINS

\* Constitution and Functions of Regional Advisory Councils and Local Authority Areas included in each Region. Pp. 12. (London: Regional Advisory Council for Higher Technological Education, 1956.) 2s.

## INSTRUMENTATION IN SCIENCE

IN recognition of the important part played by instruments in modern science, technology and business organization, the issue of *Science* of October 25, 1956, is largely devoted to instruments. There are eleven main articles, ranging from data processing for scientists and electronics for measuring human motions, to cryogenic instrumentation and phase microscopy. K. F. Heumann in his article on data processing maintains that scientists will require more assistance from machines in the matter of handling scientific data, and that techniques which have had recent, rapid development in business and accounting applications will prove most useful. He considers two such techniques—integrated data processing (IDP) and electronic data processing (EDP)—and refers to the 'Flexowriter', an electric typewriter equipped with a tape punch and reader; the IBM type 705 EDPM machine, a large-scale general-purpose data processor; and the UNIVAC File-Computer, a medium-size general purpose computer. In an article on cryogenic instrumentation, J. G. Daunt surveys recent progress in low-temperature technology, in particular, large-scale hydrogen and helium liquefaction plants; the separation of hydrogen isotopes by distillation; liquid hydrogen cooled electromagnets; bubble chambers; the magnetic refrigerator; and the thermal rectifier for use below 1° K. In the field of high-temperature research, solar energy is superior to any other form of energy presently available, and T. S. Laszlo's article describing the various forms and advantages of solar furnaces is most valuable, though only a few such furnaces have so far been constructed. "Fixed-Field Alternating Gradient Accelerators", by L. J. Laslett, deals in some detail with the recent new developments in the high-energy particle accelerator art which are mainly the results of study by members of the Mid-Western Universities Research Association.

An important new branch of technology encompassing the analysis, testing and processing of materials and products by the use of mechanical vibrating energy was named 'sonics' by R. H. Bolt and T. F. Hueter about two years ago, and in his article, "Sonic Techniques in Industry", T. F. Hueter gives a most instructive and illuminating survey of the basic physics involved and of the many fields of application ranging from oil-well drilling to medical therapy and molecular analysis. Other articles deal with a new principle of closed-system centrifugation

developed at the Harvard Medical School, Boston, and chiefly applied in the blood field, though it has equal application to virus purification, milk stabilization, and the separation of other multiphase systems; low-level counting methods for isotopic tracers; the design study of a megacurie source; the 'Bendix' time-of-flight mass spectrometer; a device for measuring the performance of people at various work activities using the Doppler effect with sound, called a Universal Operator Performance Analyser (UNOPAR), and operating at 20 kc./s., which is just above the human threshold of hearing at normal levels of intensity; and finally, a review, including an extensive bibliography of 178 items, of published work on phase microscopy during 1954-56.

## AGRICULTURAL METEOROLOGY IN GERMANY

TWO interesting publications on agricultural meteorology have recently been issued by the Weather Service of the German Federal Republic.

The first of them, "Vorträge über Frostschutz" (*Mitteilungen des Deutschen Wetterdienstes*, 3, No. 16; 1956), reports the first meeting of the Association for Protection against Frost, held in Bonn on November 22, 1955, and the Symposium of the Technical Experiences of the German Weather Service in Protection against Frost, held on April 26, 1956, at Mainz. The task of the Association, which was set up by the Ministry of Food, Agriculture and Forests, is to further collaboration between agriculturists and meteorologists in this important subject. The pamphlet contains a list of the meteorological offices and of the centres for research in agricultural meteorology and provision of advice on agricultural meteorological matters, from which it is noteworthy that of the twenty meteorological offices in West Germany, eight are devoted to agricultural matters and three of the others are also agricultural offices. At Stuttgart there are two meteorological offices, one of which is an agricultural office.

The meetings of the Association discussed the education of farmers in frost protection by talks by agricultural meteorologists and the issue of posters drawn up by the Weather Service, giving of advice to local councils on planning to minimize frost damage and the establishment by them of a frost protection officer, and research into frost protection methods and the effects of frost on different plants. The organization for giving warning of the onset of frost by broadcasts and special telegrams is described in detail. Papers read at the symposium described methods of shielding orchards and vineyards from cold katabatic winds by judicious planting of trees and building of walls, and gave a good deal of information on methods of protection by spraying water, heating by oil burners, preventing the formation of a stagnant cold layer near the ground by stirring it up with propellers and screening from radiation by smoke. Excellent diagrams of all these methods are given; those on the diversion of katabatic winds by shelter belts are particularly striking.

The second paper (*Berichte des Deutschen Wetterdienstes*, 5, No. 28; 1956) describes investigations by A. Baumgartner into the heat and water balance of a young pine forest near Munich. The author made measurements of radiation flux, temperature,

humidity, evaporation, wind and dew in, above and alongside the forest, and presents the results in great detail, including even a calculation of the energy used in photosynthesis. Observation shows that on sunny days the highest temperatures and major flux of radiation occur between the tops of the trees, this region forming the so-called 'elevated active

surface'. A detailed energy balance sheet is constructed, from which it appears that on a sunny day 63 per cent of the solar radiation energy is used up in evaporation, 31 per cent returned to the air above the forest, and 2.5 per cent goes to warming the soil. This paper is a major work of micro-meteorology. G. A. BULL

## RADIOSENSITIVE MOLECULAR WEIGHT OF TOBACCO MOSAIC VIRUS NUCLEIC ACID

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WE have studied the X-ray inactivation of the infectious nucleic acid (ribonucleic acid)<sup>1,2</sup> of tobacco mosaic virus. The results indicate that the entire ribonucleic acid complement of the virus acts as a single infectious unit.

The ribonucleic acid was prepared by the method of Fraenkel-Conrat and Williams<sup>3</sup>. The physical, chemical and biological<sup>4</sup> behaviour of the material precluded the possibility that the observed results are due to tobacco mosaic virus contaminants. An X-ray tube with beryllium window operated at 50 kV. delivered  $5.3 \times 10^4$  r./min. at 10 cm. to the ribonucleic acid samples. 0.1-ml. samples at a concentration of about 5 mgm./ml. were pipetted into aluminium cups and frozen on a brass block partially immersed in a 'dry ice'-isopropanol bath. Alternatively, samples were dried on paraffin blocks over 'Drierite' in vacuum. Under these conditions of freezing or drying, the recovery of activity of the nucleic acid was in many cases almost complete. The X-ray inactivation dose was identical within the experimental error for samples under both conditions. Appropriate corrections were made for the thickness of the samples in computing the X-ray dose. Test and control samples were assayed within an hour or two after irradiation on *Nicotiana glutinosa*, using 16-24 half-leaves per sample.

The nucleic acid inactivation curve is presented on Fig. 1 (lower solid line). As shown by different symbols, the curve represents a composite of four separate experiments using four different preparations of nucleic acid. The 37 per cent survival dose ( $D_{0.37}$ ) is  $3.0 \times 10^5$  r. We have calculated that ribonucleic acid will absorb 115 ergs/gm./r., at the wave-lengths of this X-ray beam<sup>5</sup>. But both in the dried and in the frozen material the photo-electrons that ionize the ribonucleic acid will come predominantly from the surrounding medium, which absorbs only about 85 ergs/gm./r. The figure of 110 eV./primary ionization has been well established for high-energy electrons<sup>6</sup>; but there is good reason for believing that a value approximately two-thirds of this is more appropriate for the low-energy photo-electrons produced in this irradiation<sup>7</sup>. Using 85 ergs/gm./r. and 73 eV./primary ionization leads to a molecular weight of  $2.7 \times 10^6$ . The individual experiments give a range of molecular weight between  $2.1$  and  $4.0 \times 10^6$ .

It is of interest that no polydispersity with respect to irradiation sensitivity is indicated by the results. The single slope found implies that the infectivity is carried by particles having identical molecular

weight. This is in contrast to the results with the transforming principle<sup>8,9</sup>.

If the nucleic acid is either frozen or dried in the presence of 2 per cent glutathione, a two-fold decrease in the radiation sensitivity is observed as indicated by the dotted curve (Fig. 1). Calculations on the basis of these results give a molecular weight of  $1.0 \times 10^6$ . However, since there is no indirect effect in the dry material, it would appear that glutathione modifies the direct effect of radiation, thus leading to an under-estimate of the molecular weight. Support for this interpretation of the glutathione effect comes from the work of Alexander and Charlesby<sup>10</sup>, who have shown that thiourea and other compounds modify the direct effects of ionizing radiations on dried films of polymethylmethacrylate.

The results of our X-ray inactivation of the parent tobacco mosaic virus from which the nucleic acid was derived are summarized in Fig. 2. The conditions chosen for irradiation were the same as those employed for the nucleic acid. The  $D_{0.37}$  of  $3.0 \times 10^5$  r.

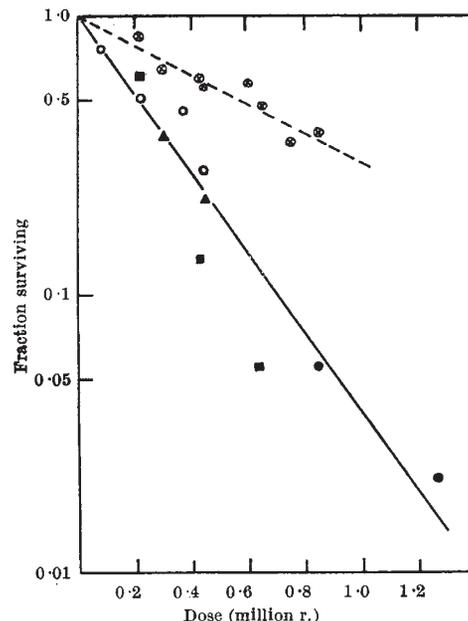


Fig. 1. X-ray inactivation of the ribonucleic acid of tobacco mosaic virus. The survival curve (lower solid line) represents a summary of four separate experiments using frozen or dried samples. The upper broken line shows the effect of glutathione in frozen or dried samples