The chairman for the second day was Prof. D. D. Eley (University of Nottingham). In opening the session Prof. Eley paid tribute to Dr. J. J. Kipling, who was a member of the organizing committee of the discussion and whose untimely death occurred at a conference in Moscow earlier in the year.

The first paper was given by Prof. A. Scheludko (Institute of Physical Chemistry, Sofia, Bulgaria), who reported work carried out with Dr. D. Tissen on the damping of ripples on water by soluble surfactants and insoluble monolayers. A novel apparatus has been developed for this problem, consisting of a cylindrical vessel in which standing waves are generated by a vertical sinusoidal vibration. The amplitude of ripples smaller than 30μ could be determined optically with an accuracy of 1 per cent and the damping measured by changing the energy supplied to the vessel. Results were presented for the damping coefficient as a function of concentration (or area) for caproic, capric, myristic, palmitic and propyl-dodecyl acetic acids and for cetyl alcohol on water. With all except the first, a sharp maximum was found at intermediate surface densities and damping coefficients at the maximum exceeded (for a factor of 2-3) the value predicted by the hydrodynamic theory of Levich for damping by a condensed monolayer.

The next paper, by Drs. J. M. Corkill, J. F. Goodman, S. P. Harrold and J. R. Tate (Proctor and Gamble, Newcastle upon Tyne), was concerned with mixed monolayers of both soluble and insoluble salts of the type alkyltrimethylammonium-alkyl-sulphate at the air-solution interface. Insoluble monolayers were examined using a Langmuir trough. It was demonstrated that although second-order effects are present due to the substrate or the particular molecular species involved, maximum interaction invariably occurs at a 1 : 1 ratio of long-chain cation to anion. The composition of the surface layers of the soluble members was measured by radio-tracer techniques. When the long-chain cation and anion had the same chain-length an equimolar surface composition was obtained. However, if the ions had different chain-lengths, the longer chain ion was preferentially adsorbed giving an asymmetric surface layer, the asymmetry being enhanced by the addition of inorganic electrolytes. It was concluded that adsorption is promoted principally by the elimination of alkyl chain-water interface, but this is modified by the electrical interaction between the positive and negative head groups, which is a maximum when the surface composition is equimolar.

A paper by Dr. J. J. Kipling and Dr. C. A. J. Langman (University of Hull) dealt with the surface tension of two component liquid mixtures and the adsorption from these mixtures at the liquid-vapour and liquid-solid interfaces. The surface tensions of a number of binary liquid mixtures of molecules of similar sizes were measured and the results were shown to fit quite well an equation based on a regular solution model, relating surface tension to composition. The adsorption from the mixtures at low-energy solid surfaces was studied and the surface excess of the more strongly adsorbed molecule compared with the corresponding surface excess at the liquid-vapour interface. In all cases presented, these two excesses were similar in magnitude.

Another paper on the surface tensions of binary liquid mixtures, by Dr. R. Aveyard (University of Cambridge), concluded the conference. The surface tensions of a range of two-component mixtures of *n*-alkanes have been measured. The applicability of various equations to the experimental data was tested and it was found that a theory, devised by Prigogine and Maréchal for athermal polymer solutions, was the most satisfactory of those considered. Using this theory, the surface tensions of all the mixtures investigated could be predicted to within 1·0 per cent with the use of physically realistic and self-consistent parameters. Further, the applicability of this theory to the surface tensions of methanol-*n*-decanol and methanol-glycerol mixtures was tested. The agreement between experiment and theory was poor for the former system, but reasonable for the latter. A possible explanation for these differences, and its bearing on the agreement obtained for the *n*-alkane systems, was discussed.

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PHYSICS IN MEDICINE

TECHNOLOGY, rather than science, was the main theme of the first International Conference on Medical Physics, held at Harrogate during September 8–10, but several topics of a more fundamental kind were also illuminated in a programme of more than 100 papers. A majority of the contributions dealt with the clinical and biological applications of ionizing radiations, reflecting a continuing preoccupation with the problems which brought physicists into the hospital service in significant numbers some 30 years ago.

Though the radiotherapist's armamentarium has not changed substantially in recent years, two areas of research at present give promise of greater accuracy in the measurement and control of radiation dosage for clinical purposes. The first problem here is to find a device of small size (preferably in the millimetre range) with a sensitive response independent of radiation energy. Lithium fluoride dosemeters, based on the thermoluminescent effect, satisfy these requirements reasonably well. Large-scale practical applications are, however, restrained by inadequate understanding of the basic processes involved. The preparation of lithium fluoride powder and its treatment before and after irradiation are still largely determined by empirical knowledge, which necessitates caution in the interpretation of experimental findings.

Thermoluminescent dosemeters have been used for the estimation of surface dosage in radiotherapy, but not so far for internal measurements. F. W. Spiers (General Infirmary, Leeds) described methods for the study of radiation dose in specimens of dry bone, using fine-grain lithium fluoride powder which is introduced into the narrow cavities of trabecular bone and removed for assay after irradiation. Work of this kind is useful in assessing clinical, occupational and environmental hazards from radioactive materials. B. E. Bjarngard (Controls for Radiation, Inc., Cambridge, Massachusetts) reported that some of the difficulties associated with the preparation and handling of thermoluminescent powders may be avoided by incorporating the lithium fluoride phosphor in polytetrafluorethylene, which can then be fashioned into rods, disks or foils for various applications. The combination has an effective atomic number close to that of tissue, and its response is independent of radiation energy over a fairly wide range.

Interesting applications are now being found for solid state devices as radiation detectors. P. R. Parker (Institute of Cancer Research, Sutton, Surrey) suggested that many of the desirable properties of the gas-filled ionization chamber may be reproduced, with the advantage of very small bulk, by *p–n* surface barrier detectors. Used as pulse counters, these devices will measure dose-rates of about 10 μrad/h, approximately equal to the natural background radiation in Britain. The radiation-induced potential across the *p–n* junction is found to be a logarithmic function of dose-rate and the short-circuit current is approximately a linear function of dose-rate. Silicon surface barrier detectors offer high sensitivity in small size and may be useful in estimating radiation dosage (from internally administered isotopes) inside the body. The field effect transistor, having high input impedance and high transconductance, may replace an electrometer valve in the input stage of a current amplifier used, for example, in association with an ionization chamber. J. Keller (Central Laboratory for Radiological Protection, Warsaw) described an amplifier, using a single transistor, with a gain of 5×10^5 and excellent temperature stability.

A second problem of immediate interest in radiotherapy concerns the use of electronic computers to tackle the tedious calculations involved in treatment planning and dosage control. The great output delivered by machines such as the linear accelerator makes rapid arithmetic essential, and the complexities of radium dosage are not always adequately recognized in the rules or methods based on manual calculation. Papers presented at the Harrogate Conference showed a relatively unsophisticated approach to these problems and left the impression that a much larger effort is needed (from mathematicians as well as from physicists) if the computer is to make a realistic contribution to the technique of radiotherapy.

Diagnostic and physiological investigations using radioactive tracers are now commonplace, though still capable of extension in a number of clinical specialities. Interesting technical problems are met with in the design and operation of whole-body monitors. In measuring the natural radioactive content of the body (for example, potassium-40 as an index of lean body mass) elaborate electronic equipment and a well-shielded room will be necessary, at a cost which may approach £30,000. When it is desired to investigate, over a period of months, the retention of a particular isotope in the body, a simpler installation can be built for £2,000–£5,000.

Though knowledge of the whole-body content of an isotopic tracer is important, a detailed picture of the distribution in a particular organ or region may be significant (for example, in thyroid disease or in the localization of a tumour). The scintillation scanner and the scintillation camera (which uses the principle of the pinhole camera) are well known in this connexion. Another basically simple device, likely to have useful applications in clinical science, is the spark chamber. The design described by B. R. Pullan (St. George's Hospital, London) has two parallel plates, one of lead and one of aluminium mesh, in an enclosure filled with argon and alcohol vapour. When an appropriate potential difference is maintained between the plates, a spark will occur wherever ions are produced in the gas. A chamber of this kind (used in conjunction with a suitable collimator) should be useful in thyroid studies with radioactive iodine as a tracer.

Among the other topics discussed were (*a*) the use of analogue computers and mathematical models in the study of renal function, urinary excretion and control of ventilation, (*b*) objective measurement of X-ray image quality, (*c*) electron spin resonance in living tissue. A series of eight survey papers, illuminating areas of common interest among physicists, biologists and clinicians, included an interesting account by S. Rowlands (St. Mary's Hospital Medical School, London) of basic studies on blood flow. The apparent viscosity of blood depends on its composition and on the shear rate applied in the experimental equipment. These properties are shared by other biological materials and non-Newtonian fluids. Blood has a unique property, discovered by measurement of flow rates through tubes of less than 0·5 mm diameter. Here it is found that the narrower the tube the smaller the apparent viscosity. It seems likely that hydrodynamic forces drive the red cells from regions near the wall (where the shear rate is high) into the central stream, where the shear rate is lower. In very narrow tubes, of diameter comparable with the diameter of a red cell, further complications occur and the deformability of the cell has an important influence on flow phenomena.

In the realm of medicine there is abundant opportunity for work of social and economic value, amply testing the physicist's experimental skill and mathematical insight. In several countries (including Britain) this opportunity is not being sufficiently exploited at the present time. Many hospital physicists are dispersed in small departments, mainly occupied with work related to the practice of radiotherapy, and not adequately equipped (with staff, material resources and scientific contacts) for work of more basic importance.

During the next decade, it seems likely that the large and well-justified expenditure from public funds in support of scientific research in universities and government laboratories will come under closer scrutiny and its continued growth may even be restrained. If, in these circumstances, some of the less costly fields of endeavour receive increased attention, the collaboration of physics and medicine might be cultivated with advantage to the world of science and to the whole community.

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ENERGY SPECTRUM OF PRIMARY COSMIC-RAYS

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DURING the past decade or so, several measurements have been made of the flux of the cosmic-ray particles in the wide range of energy from 10^9 to 10^{20} eV. These were based at the lower energy end on the flux of nuclei observed at different geomagnetic latitudes and at energies greater than 10^{15} eV on the results of extensive air shower experiments. The data in the intermediate energy range were not so reliable. The pioneer experiments of Lal[1] and Kaplon and Ritson[2], which have played a useful part in giving an estimate of the primary flux in the energy region 10^{12}–10^{13} eV, made use of detectors of alternate sheets of 3 mm brass and 100 μm *G*5 emulsions mounted on 1·3 mm glass. In such a detector the distinction between electromagnetic cascades initiated by electrons or γ-rays entering from outside and those resulting from interactions of nuclear active particles in the detector itself could be quite ambiguous. Further, energy estimates were rather unreliable and the results were based on a small number of events. Values of the flux, at 4×10^{13} and 2×10^{15} eV, due to Barrett *et al.*[3], were obtained from underground measurements on μ-mesons, and therefore depend on the assumed model of high-energy interactions. This article presents our results on the primary flux, both

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