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In the Department of Terrestrial Magnetism, an investigation was commenced to determine whether any significant statistical relation exists between geomagnetic activity, including the auroral currents in the ionosphere, and the intensity of the outer Van Allen belt along the Earth's radius. Besides investigations on cosmic rays and the Earth's crust and in radioastronomy, including solar studies, radio source positions and radiohydrogen, the Department has been active in developing facilities and programmes in radioastronomy throughout South America, conducted by South Americans trained through the facilities of the Institution. The work of the Mount Wilson and Palomar Observatories has included the discovery of nineteen supernovæ and the strongest magnetic field yet observed in Nature—that of the star *HD215441*. An investigation of the chemical composition of stars, nebulae and other objects brought to light many anomalies in the abundance of the chemical elements, the commonest deviation involving a deficiency in the heavy elements, including the common elements, all by about the same factor below their abundance in the Sun and nearby stars. A new comprehensive theory of the solar magnetic cycle was announced, which predicts a marked dependence of field intensity

on latitude, as a result of which the field becomes amplified to a critical value, exhibiting local instabilities, which commence about three years after the beginning of a sunspot cycle. In the study of radio signals, the spiralling and expanding hydrogen clouds surrounding and enveloping the stars of our own galaxy in the direction of the galactic anti-centre were intensively examined. Besides the optical identification of radio sources, the velocities in clusters of galaxies, the rate of star formation, the frequency of occurrence of metallic binary stars, the optical spectrum of non-thermal radio sources and the chemical composition of interstellar gas were also among the subjects of investigation at the Observatories.

The major emphasis of the Committee on Image Tubes for Telescopes during the year was on promoting the industrial development of magnetically focused image amplifiers, and during the year prototype image tubes became available for tests. Using magnetic focusing and fine-grain phosphorus of high resolving power, three types of image tubes can now be manufactured which provide a gain in sensitivity over traditional photographic methods by a factor of 10 or more, and these tubes have proved strikingly successful in aiding spectroscopic research and the investigation of double stars. A new procedure for aluminizing the 200-in. mirror of the Hale telescope on Palomar Mountain was also developed during the year.

THE MASSACHUSETTS INSTITUTE OF TECHNOLOGY

THE report* of the President of the Massachusetts Institute of Technology for 1961 has something of the quality which characterizes the reports of the Presidents of the Rockefeller Foundation and the Carnegie Institution of Washington, even to the extent of an awareness of the contribution which such an institution can offer to the development of the emerging nations that universities in Britain might do well to note. Beginning his review with some comments on the Institute's centennial celebrations in the spring, Dr. J. A. Stratton's report is indeed throughout concerned strictly with the teaching and research functions of the Institute, but in discussing them his awareness of the implications and opportunities of higher education to-day display an insight which should fittingly be matched here. For example, describing how the successful teaching of economics at the Institute since 1881, with the emergence of a major research programme and strong support of the School of Industrial Management, has now led to the establishment of sections of political science and of psychology within the Departments of Economics and Social Science, Dr. Stratton refers to the association of the former section with the Centre for International Studies. In support of this work a professorship in political science with emphasis on African studies was established, while a grant of 475,000 dollars from the Carnegie Corporation has permitted expansion of research on the problems of nation-building in transition countries and on the newly emerged African and Asian nations. Dr. Stratton stresses particularly the value of the grant in facilitating the sending of students from

the Institute overseas for research in developing areas.

Dr. Stratton's review this year directs particular attention to the state of the social sciences at the Institute, emphasizing the dependence of the overriding practical problems of to-day on joint technical and social analysis and the policy of the Institute to develop more particularly those social sciences which are specially relevant to its central concerns with science and engineering. Special attention has been focused on those fields in which mathematics and statistical techniques play an increasingly important part, but without attempting to build the social sciences in the image of the physical or limiting their freedom to develop in their own way, and in psychology marked progress was made in planning a graduate programme. The section will comprise three general areas: physiological and comparative; experimental; and social and developmental psychology; and in its research it is hoped to create new opportunities for interdisciplinary co-operation. A programme leading to a Ph.D. in linguistics is being offered beginning in the autumn of 1961 and much of the Institute's research in this field has taken place in the Centre for Communication Sciences, where besides a central concern with the structure and logic of language some promising applied projects, including work on mechanical translation and on machine perception and synthesis of human speech, have been undertaken.

The other main features of President Stratton's survey deal with the character of research at the Institute and its bearing on teaching, and with developments in undergraduate education, particularly in engineering. Discussing the first of those topics he refers again to the concept of interdisciplin-

* Report of the President, 1961. Massachusetts Institute of Technology, Cambridge, Mass. Pp. 64.

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ary centres, which he regards as one of the most significant recent developments at the Institute. The oldest of these is the Research Laboratory of Electronics, drawing chiefly on the Departments of Electrical Engineering and of Physics from the direction of its programme but attracting students and faculty from at least nine other fields. Besides the Centre for Earth Sciences, a Centre for Aeronautics and Astronautics is proposed, and a 3.275 million dollars contract for further research in materials has been incorporated into the expanded programme of the Centre for Science Materials and Engineering. With the development of such Centres, however, the level of research activity in the departments has also risen, but while in most the research programmes are purely academic and completely interwoven with the educational objectives, in the Lincoln Laboratory, the Instrumentation Laboratory and the Operations Evaluation Group, considerable effort, amounting to some 57 million dollars in 1961, is directed to basic and critical problems of national defence, and Dr. Stratton emphasizes that work in engineering is nevertheless largely fundamental. During the past five years educational costs have increased 56 per cent, but costs of departmental and interdepartmental 80 per cent, although the number of those associated with sponsored research in the departments and centres increased only 18 per cent. There has been a significant shift from full-time workers on sponsored research staff to faculty, instructors and research associates, but the level of academic research is regarded as in reasonable balance with the academic

budget, and while admitting the need for a re-appraisal of academic responsibilities for teaching by universities generally, Dr. Stratton is confident that the balance is reasonable at the Massachusetts Institute of Technology and also that reserves are being accumulated sufficient to secure continuity in the event of fluctuating State support.

Finally, Dr. Stratton reviews a major programme to stimulate improvements in undergraduate laboratories and in methods and materials of teaching, towards which a grant was received from the Ford Foundation. The Heat Power Laboratory of the Department of Mechanical Engineering has been converted into an interdisciplinary Engineering Projects Laboratory for both teaching and research, and throughout the School of Engineering experiments are being made with the use of motion pictures, television, and other modern teaching aids. Besides serious investigation of methods providing students with opportunities for experimental homework and re-examining the traditional lecture-section method of organizing courses and problems of the tutorial approach, the Science Teaching Centre has made good progress in generating new laboratory experiments and devising new patterns of using experimental equipment. With all these developments, which give full expression to the dynamic character of a university, President Stratton is satisfied that the Institute will remain deeply committed to engineering education, and that its contribution there will be enhanced by the association and competition with neighbouring fields.

PREPACKED FOODS

IN January, each year, the Society for Applied Bacteriology and the Microbiology Group of the Society of Chemical Industry hold a joint meeting on a theme of common interest. This year, on January 10, the choice was "The Effect of the Newer Forms of Packaging on the Microbiology and Storage Life of Various Foods". Prepacked foods are appearing in rapidly mounting quantities; while all except technically enlightened manufacturers assume that packing creates no new problems and so they ignore questions of microbiology.

Because this new industry is largely based on the use of flexible packages made from novel materials, the first paper was devoted to "Some Properties of Food Packaging Materials which Relate to the Microbial Flora of the Contents", by Dr. R. S. Hannan (T. Wall and Sons, Ltd., late of Metal Box Co., Ltd.). After brief mention of questions like cost, transparency, mechanical properties and freedom from toxic constituents (for example, plasticizers), attention was focused on the importance of the permeability of the wrapper to biologically important gases, notably water vapour, oxygen and carbon dioxide. No practicable transparent film was wholly impermeable to any of these: it was a matter of degree, though there was roughly a thousand-fold range between a highly permeable cellulose film and relatively impermeable ones like the polyvinylchloride copolymers. A complete barrier could be made only by laminating with metal foil. With any film, leaks were apt to occur where the film has been sealed or strained.

The permeability depended on the state of the film, especially with polar films which absorb water, like

the cellulose films which were far more permeable when wet. Thus, where a high degree of permeability was desired, as for example in wrapping fresh meat where oxygen is necessary to preserve the bright red colour, it was common to use a cellulose film in contact with the meat, when it became moist and transmitted oxygen readily. Comparative data for different films were presented, with the warning that the values quoted must be regarded with reserve, because of this great dependence on factors like temperature, wetness and mechanical damage. It is indeed a serious shortcoming of existing published values that they have mostly been obtained under conditions not relevant to prepacked foods: for example, the permeability of a film to water vapour may be determined, at say 20° C. with a relative humidity of 100 per cent on one side and of 0 per cent on the other, to yield a figure which may not be even roughly applicable to the same film around a piece of meat in a chilled cabinet. Because of this, it is still essential to test whole packages under the conditions of use.

The permeability of the wrapper to water vapour was important in two respects. It determined the loss in weight by drying, and the relative humidity inside the pack which would be greater the lower the permeability. A film which was too impermeable and non-wettable would be 'fogged' by droplets of condensed water with even a small fall in temperature, the internal humidity being near saturation over a wet food; this was regarded as undesirable, both aesthetically and because it encouraged growth of bacteria.

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