

establish the unperturbed dimensions of the polymer chain, which depend on bond-lengths and -angles and on hindrance to free rotation. The theory, developed by Flory, enables, furthermore, an estimation to be made of thermodynamic parameters related to the heat and entropy of dilution of the polymer in a given solvent. It is also possible to explain the marked alteration of the viscosity of polyelectrolyte solutions brought about by changes of pH or ionic strength.

Prof. C. E. H. Bawn discussed intrinsic viscosity relationships for polyisobutylene and polystyrene in mixed solvents, some of the intrinsic viscosities being determined over a range of temperatures. These results were used to examine existing theories of the viscosity of polymer solutions and, in particular, the relationships dealt with by Prof. Flory.

Prof. J. A. V. Butler gave an account of viscosity measurements of two polyelectrolyte solutions, these experiments being done at low concentrations and rates of shear. Some of the results were interpreted with the help of an electrostatic theory of charged thread-like particles. Dr. B. A. Toms described a rheological investigation of about 3 per cent solutions of polymethylmethacrylate. The experiments were carried out with the help of a coaxial cylinder elasto-viscometer. The rheological behaviour of these solutions can be specified by a viscosity coefficient, a relaxation time and a retardation time. The variability of these parameters indicates that relaxation of shear and of rate of strain are effected by different mechanisms.

THE COUNCIL FOR THE PROMOTION OF FIELD STUDIES

AFTER a stringent period of economy caused by financial difficulties, the chairman of the Council for the Promotion of Field Studies, Prof. S. W. Wooldridge, reports that the increased bookings at the field centres and the careful husbanding and disposal of the Council's resources have led to a happier situation and a development of the Council's activities: a grant for equipment has been made to each of the four centres, while the teaching staff of three of them has been augmented by the appointment of a field assistant. In addition, substantial capital expenditure to improve comfort and accommodation has been approved at Dale Fort and Juniper Hall. The fourth annual report of the Council also describes the work at the field centres in 1954*.

At Dale Fort, marine biology again proved the greatest attraction at the centre, only geography with all its variations providing comparable numbers.

At Skokholm, work has been begun on the annual marking of puffin chicks, while many puffins were ringed to throw light on the movements, attainment of maturity, mortality and expectation of life of these birds.

Students again contributed to the long-term research projects at Flatford Mill; these included investigations into the distribution and feeding habits of flounders at the head of the estuary, and

* Council for the Promotion of Field Studies. Annual Report, 1953-54. Pp. 60+8 plates. (London: Council for the Promotion of Field Studies, 1955.)

the study of the vegetational succession taking place on mud-banks forming at the lower edge of Sherbourne Brook.

At Juniper Hall, geographical subjects of all kinds were the main interest of 53 per cent of the total number of students, while biological studies of one kind or another accounted for 39 per cent of the attendance; courses for sixth-form students from grammar schools and public schools formed the most stable element in the centre's economy.

An interesting development at Malham Tarn was the arrangement of a special course for secondary modern school teachers; this was done in conjunction with the West Riding Local Education Authority.

The report also contains details of some of the specialized work that was carried out at different centres.

NEBULÆ AND STAR CLUSTERS

AT the meeting of the Royal Astronomical Society on February 12, 1954, at Burlington House, London, the presidential address (read by Prof. H. Dingle in the unavoidable absence of the president, Dr. J. Jackson) was delivered on the occasion of the award by the Society of its Gold Medal to Dr. Walter Baade, of the Mt. Wilson and Palomar Observatories, for his observational work on galactic and extragalactic objects. The address, which has been published in full (*Mon. Not. Roy. Astro. Soc.*, **114**, 3 (1954); and also *The Observatory*, **74**, No. 879 (April 1954)), commenced with a brief outline of Baade's work with the reflector of 1 m. aperture at Hamburg Observatory from 1919 until 1931, when he joined the staff of the Mt. Wilson Observatory to work with Hubble on the branch which was his chief interest at Hamburg—the direct photography and photometry of nebulae and star clusters. Soon after his arrival at Mt. Wilson Observatory he undertook an investigation for determining the distance of the wispy cloud in Cygnus, a region to which he had given special attention when he was at Hamburg and in which he had found that many of the variable stars were eclipsing variables. Three classes of stars were used from Mt. Wilson observations for determining the distance—the eclipsing variables; long-period variables; and early B-type stars—and they indicated distance moduli of 12.5, 13.0 and 12.7, respectively, the latter being adopted. The question of the absorption of light in space then arose, and from the colour indices of eighty stars of type B8 to A5 a colour excess of 0.25 was found. On the assumption that this was due to pure Rayleigh scattering, Baade deduced that the Cygnus cloud was 2,630 parsecs distant; if no correction for absorption had been applied, a distance of 3,500 parsecs would follow from the adopted modulus. The few Cepheid variables found in the cloud gave very unsatisfactory results: four of long period were so faint that they could not be fitted in with the adopted modulus; two could be explained by heavy absorption; and two others might be much farther off than the cloud. In addition, five short-period cluster-type variables could not be fitted into the general result, but it was possible to explain them as belonging to the general galactic field of such objects.

The address next turned to another branch of Baade's work—that connected with novae and supernovae. The discovery by Ritchey in 1917 of a nova

in the spiral nebula N.G.C. 6946 was followed by the discovery of many other novæ in other extragalactic systems, and these discoveries opened up a new way for the determination of the distances of these systems if an absolute magnitude could be attributed to them. The results of the first efforts at this determination proved disappointing because of the very large range of magnitudes in the luminosities of the novæ observed. This unusually large range—up to eleven magnitudes—indicated one of two things: either there was a very large dispersion in the absolute magnitudes of the novæ; or there existed two groups of novæ differing in luminosity by a factor of the order ten thousand. The second alternative was shown to be the correct one as a result of Hubble's investigations of the Andromeda nebula, and Baade concluded that, in addition to the class of fainter novæ, to which most of our galactic novæ belong, there was also a class of supernovæ the average magnitude of which was about ten magnitudes brighter and hence they were visible in nebulae so distant that the fainter novæ could not be observed there. The spectra of six supernovæ which were quite distinct from those of other stars, including ordinary novæ, obtained about the time of Baade's deductions confirmed Baade's views, which are now universally accepted. Dr. Jackson's address then went on to discuss fully the developments in this branch.

Turning now to other features in Baade's work, about a century ago Prof. G. P. Bond, in reporting on the rapid progress in photography, announced that stars to the sixth magnitude could be photographed; he then made the optimistic forecast that on some lofty mountain and in a purer atmosphere stars up to eighth magnitude might be photographed, and, by increasing the aperture threefold, all the stars up to the tenth and eleventh magnitude could be photographed. Bond lived long enough to see the aperture increase from 15 to 45 in. with a corresponding increase of about $2\frac{1}{2}$ magnitudes in the stars that could be photographed. Dr. Jackson points out that there are other methods for increasing the photographic powers of telescopes, such as changing from a long-focus refractor to a short-focus reflector (which happened when he was at Greenwich) and improvement in clockwork and engineering; but unfortunately the stage is approaching in which fogging due to the light of the night sky is of the same order of intensity as that of the images formed by the faintest stars. The hope for the future lies with the sensitive plates, and at the meeting of the International Astronomical Union in Stockholm in 1938, Baade showed photographs of obscured regions of the sky taken with a new brand of red-sensitive plate. He stated that one plate showed eight hundred thousand stars to the square degree and that, with the optical means available, the limit had not yet been reached. It was a great triumph in 1942 when plates of the Andromeda nebula, taken with the 100-in. reflector, revealed for the first time "signs of incipient resolution in the hitherto apparently amorphous central region—signs which left no doubt that a comparatively small additional gain in limiting magnitude, of perhaps 0.3 to 0.5 mag., would bring out the brightest stars in large numbers". After this it was merely a matter of time for further investigations before successful plates were secured for about the restricted range of wave-length used, 6300–6700 Å., so that the most troublesome part of the night sky was cut out.

Dr. Jackson's address dealt at length with the results obtained with these red-sensitive plates, and the following is a summary of Baade's view regarding Population i and Population ii in different regions of space (see *Astrophys. J.*, Sept. 1944). The method was applied to *M* 31 and the two companion nebulae *M* 32 and N.G.C. 205, and, following their resolution into stars, Baade suggested that there are two types of stellar populations. Population i, in which bright giants and supergiant stars are common, is found in the arms of spiral galaxies but not in their central regions, and this population includes a higher proportion of binary stars but less novæ and supernovæ than Population ii. The latter includes no stars brighter than a normal giant, absolute magnitude about -2 , with comparatively low temperature, and also the high-velocity stars, stars found in globular clusters, in elliptical nebulae and in the central unresolved regions of spiral nebulae. In connexion with this subject, Baade's work on the Sagittarius cloud provides very interesting corroboration of the general view that our galaxy is a spiral nebula like the Andromeda nebula; if this resemblance is complete, the Sagittarius cloud, in the direction of which the centre of our galaxy lies, should contain stars of Population ii. Baade's investigations of this region with red-sensitive plates has shown that this is actually the case. Not only was the similarity to *M* 31 thus shown but also, allowing for a colour excess of 0.37 which involved a correction to the distance modulus of 2.6, the distance modulus was reduced to 14.7, indicating a distance of about 9 kiloparsecs. This is close to the generally accepted value for the distance to the centre of our galaxy, which is believed to be very similar in its contents to the Andromeda nebula—an intermediate spiral of type *Sb*.

At the end of Dr. Jackson's address, reference is made to the unsatisfactory position regarding determinations of very remote objects by the classical Cepheids and to the scheme which is being planned for settling the zero point. Direct trigonometric methods have supplied the distances of many stars of types *F* to *K* and, from these, reliable absolute magnitudes can be calculated. Baade hopes to observe such stars in the near future; but the work must necessarily occupy a long time as it involves not only accurate apparent magnitudes but also spectral classification or at least colour indices of very faint stars in clusters. In this scheme there lies great hope of deducing accurate absolute magnitudes not only of Cepheids but also of any other objects in the systems, and hence their distances. It is admitted, however, that the lack of transparency of space "remains a challenge but also a means of determining something about the contents of interstellar space".

JAPANESE FORESTRY RESEARCH

THREE Bulletins (Nos. 63, 64 and 65) of the Government Forest Experiment Station (Meguro-Ku, Tokyo, 1953) have been received. Nos. 63 and 65 deal with various research inquiries and studies dealing with forestry work. No. 64 is confined to research connected with studies on fog-prevention forests. Fog in Japan has a very serious effect both on agricultural and other operations in the Islands, and a study of the Bulletin is of considerable interest since it presents aspects of a danger which is little known elsewhere except as a nuisance.