comparing the number of the stars of absolute magnitude 3·5 in the two shells. The values obtained from the magnitudes 0·5 and 1·5 may be neglected. Owing to the exceedingly small number of stars, they must necessarily lead to untrustworthy results. From all the rest I found that the density in the tenth shell must be about 64 per cent. of that in the ninth shell. The proportion between the densities in the other shells was determined in exactly the same way.

A slight defect in our results was then discovered. We should exceed the limits of the time allowed for this lecture by entering into a consideration of this defect. It must be sufficient to state that it was not difficult to remove it. After that it appeared that the density in the first six of our shells is nearly the same. The density in these shells, that is, in the neighbourhood of our sun, is such that about 2000 stars of a luminosity exceeding one-hundredth that of the sun must be contained in *a cubic light-century*. After the sixth shell the density diminishes gradually at such a rate that in the eleventh shell the density has fallen to about 30 per cent. of what it is in the vicinity of the solar system.

In what precedes we tried to give a solution of the problem put at the beginning of this lecture—a solution, however, which embraces only that part of the universe which is contained within a distance of about 2000 light-years from our solar system. Is there no possibility of getting beyond this distance?

I think there is, but, of course, you will not be astonished to find that the certainty of our conclusion diminishes as we get deeper and deeper into the abysses of space.

One of the reasons why the method thus far applied breaks down beyond the eleventh shell is that our data about proper motion are not refined enough to determine this motion with sufficient accuracy as soon as it is below 1″ in a century. Even the somewhat greater motions are rather uncertain. The proper motions thus cannot help us much beyond a certain distance. But we have still one valuable element for the solution of our problem. This element is the total number of stars separately for the apparent magnitudes. Thanks mainly to the photometrical researches at the Harvard Observatory, it has become possible to determine with considerable accuracy the total number of stars of the first, second, &c., to the eleventh magnitude; with a fair degree of accuracy even those for the magnitudes down to the fourteenth (inclusive).

The density in the shells beyond the eleventh, not only for the stars down to the eighth apparent magnitude, but, according to what has been said a moment ago, also for the apparent magnitudes of nine, ten, &c., to fourteen, has to be determined in such a way that the addition of all the numbers in any one vertical column of Fig. 4 produces just these totals for the corresponding apparent magnitudes.

It can be proved that after the eleventh shell the density must, on the whole, continue to diminish. If we assume that this diminution is gradual and proportional to the increase in distance, it becomes very easy to determine the rate of this diminution, and consequently the distance at which the density becomes *zero*, that is, the distance at which we reach the limit of the stellar system. We cannot enter into fuller particulars here. It must be sufficient to say that in this way we are led to conclude that the further diminution of density must be slow, so slow that in the assumption made above the limit of the system is only reached at a distance of some 30,000 light-years.

Hypotheses Underlying the Results.

In conclusion, a few words on the question, In how far are the results now obtained to be considered as established?

The answer must be, They can be considered to be established only in so far, and no further, than we can trust the truth of the hypotheses which still underlie our reasoning.

For future consideration there thus remains the question, In how far can we test the validity of these hypotheses?

These hypotheses are the following:—

(1) The mixture was assumed to be the same at greater and smaller distances from the solar system.

(2) The same was done for different distances from the galaxy.

(3) The universe was assumed to be transparent, that is, it was assumed that the absorption of light in space is *zero*.

Can we get rid of these hypothetical elements?

I think we can, at least to a very great extent.

As to the *first*. Our Fig. 4 already goes far in enabling us to judge whether it is true or not. For evidently both our sixth and our ninth shell give the nature of the mixture, at least of the stars of absolute magnitude 3·5 to 6·5. Therefore, so far as these stars are concerned, we are able to see whether or not the mixture is the same at the distance of 650 light-years as it is at the distance of 170 light-years. Likewise, the figure enables us to make the comparison in other cases. As soon as we possess the necessary data for a longer range of apparent magnitudes, say down to the fourteenth or fifteenth, we shall be able to dispense to a very large extent with our first hypothesis.

As to the second, the possible variation of the mixture with the distance from the Milky Way, it is largely only the question of treating the stars in different galactic latitudes separately. So far as I can see, there are no particular difficulties in the way of such a separate treatment, at least not since the nature of certain anomalies in the distribution of stellar motions has been elucidated.

Absorption of Light in Space.

Last, not least. Is the universe really absolutely transparent? There are reasons which make this seem very doubtful. A couple of years ago I obtained some evidence in the matter which shows that the absorption of light in space, if it exists to an appreciable amount, must at least be so small that over a distance of a hundred light-years not more than a few per cent. of the light can be lost. To determine so small an amount to within a small fraction of its total value will be a difficult task indeed. Still, we can even now see definite ways, which, given the necessary data for very faint stars and nebulæ, will probably enable us to overcome this last difficulty.

This want of data for very faint stars, which, in the present investigation, makes itself felt at every step, has led a number of astronomers to concerted action.

The express purpose of their cooperation is to collect data of every kind for stars down to the faintest that can practically be reached. As complete observation and treatment of these numberless stars is out of the question, the plan is confined to a set of samples distributed over the whole of the sky.

Conclusion.

If, at the end of this lecture, somebody summarises what has been discussed by saying that the results about the structure of the universe are still very limited and not yet free from hypothetical elements, I feel little inclined to contradict him. But I would answer him by summing up in another way, viz.:—

Methods are not wanting which, given the necessary observational data obtainable in a moderate time, may lead us to a true, be it provisionally still not very detailed, insight into the real distribution of stars in space.

I think this time need not exceed some fifteen years. They to whom such a time may still seem somewhat long may be reminded of the fact that we shall have finished our work before any but a very few of our nearest neighbours in space can be aware of the fact that we have begun, even if we could send them a message now by wireless telegraphy travelling at the speed of light.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

ST. ANDREWS.—Besides the gifts of Diplodocus to the British Museum and to the museums of Paris and Berlin, Dr. Andrew Carnegie has, at the instigation of Dr. Holland, presented a neatly mounted example (cast) of the hind limb of Diplodocus to the University Museum, St. Andrews—another of the very munificent donations which mark the period of office of the late Rector of the University.

As the contributions toward the re-endowment of Oxford University have reached a total of more than 100,000*l.*, the second donation of 10,000*l.* promised by Mr. W. W. Astor has now been received by Lord Curzon of Kedleston, the chairman of the fund.

ON July 10 the administrative staff of the technological branch of the Board of Education will remove from South Kensington to the new offices of the Board in Westminster. All correspondence on and after July 9 should be directed to the Secretary, Board of Education, Whitehall, with the exception of letters for the Victoria and Albert Museum, the Royal College of Art, and the Solar Physics Observatory, which should continue to be addressed to the offices of the Board of Education, South Kensington.

ON Tuesday, July 7, the King, accompanied by the Queen, opened the new buildings of the University of Leeds. In the course of his reply to an address presented by the Vice-Chancellor, the King said :—" My interest in the great cause of education is well known, and I note with gratification the ever-widening basis of the instruction now undertaken by our great educational institutions. The high standard of moral and intellectual discipline for which our schools and universities have been distinguished has not been lowered, nor has the pursuit of literary and historical studies been checked by the inclusion in the university curriculum of those scientific studies, and especially of those branches of applied science for which such ample provision has now been made. I rejoice to think that the opportunities open to the young men of our great industrial communities of acquiring a knowledge of subjects of commercial utility in an atmosphere of academic culture are being so greatly increased, and I find it difficult to express my appreciation of the manner in which the great responsibilities which rest with the authorities and teachers of a university such as this have been discharged. It is a source of pleasure to me to know that you have provided also for the study of the theory and practice of agriculture, for I am convinced that the best possible results cannot be derived from the industry and natural ability of our farmers unless they are properly instructed in the scientific aspects of their work." When the University was founded, the Privy Council stipulated that a building fund of 100,000*l.* should be formed, and this amount has now been raised. The new buildings include a number of independent blocks, namely :—(1) extension of main buildings, providing accommodation for arts subjects, zoology, and botany, including new botanical and zoological laboratories; (2) extension of present engineering laboratory in a separate large wing at the rear of the main building; (3) large new block of buildings for electrical engineering; (4) large new block of buildings for mining, fuel, and metallurgy; (5) large temporary building for physical laboratory and organic chemistry laboratory. Increased support from the Treasury is needed if the work provided for in these new buildings is to be carried on efficiently. We hope to give an account of the new buildings in our next issue.

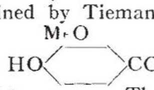
SOCIETIES AND ACADEMIES.

LONDON.

Entomological Society, June 3.—Mr. H. Rowland-Brown, vice-president, in the chair.—*Exhibits.*—H. St. J. **Donisthorpe** : Pseudogynes of *Formica sanguinea*, caused by the presence of the beetle *Lomechusa strumosa* in the nest, from the New Forest.—H. J. **Turner** : Living larvæ of *Coleophora maritimella* on *artemisia*, and also a species of Asilidæ and its prey.—C. J. **Gahan** : (1) Living specimens of a " leaf-insect " from the Seychelles, bred in England by Mr. St. Quentin, probably *Pulchriphyllium crurifolium*, S.; (2) some Lampyridæ of considerable interest collected by Mr. E. E. Green in Ceylon, and including both sexes of the genera Lamprigera and Dioptoma, the females of which had hitherto been unknown, those of both genera being larviform. Attention was directed also to the existence in China, Ceylon, and the Malay Peninsula of remarkable larviform females greatly resembling in form the females of the American group Phengodini, and being somewhat similarly provided with rows of luminous points.—G. C. **Champion** : Specimens of *Dromius angustus*, Brullé, and *Cryptophagus lovendali*, Ganglb., recently recorded by him from Woking and the New Forest respectively; also two species of the Staphylinid genus Leptotyphlus and one of the Curculionid genus Alaocyba, the exhibitor mentioning that these extremely minute blind insects were much smaller than any known British representatives of the S. European groups in question.—Colonel C. **Swinhoe** : Several boxes of butterflies taken during the present year (1908) in the Canary Islands, chiefly from Grand Canary and Teneriffe. Colonel Swinhoe observed that, with the exception of *Lycaena webbianus*, all the species met with suggest a foreign origin.—*Papers.*—Notes on the value of the genitalia of insects as guides in phylogeny : W. **Wesché.**—Certain Nycteribiidæ, with descriptions of two new species from Formosa : Hugh **Scott.**—Further studies of the Tetriginæ (Orthoptera) in the Oxford University Museum : Dr. J. L. **Hancock.**—Mimicry in tropical American butterflies : J. C. **Moulton.**—Heredity in *Papilio dardanus* from Natal, bred by Mr. G. F. Leigh, of Durban : Prof. E. B. **Poulton.**—New species of Hesperiidæ from Central and South America : H. H. **Druce.**

Royal Meteorological Society, June 17.—Dr. H. R. Mill, president, in the chair.—The Hong Kong typhoon of September 18, 1906 : L. **Gibbs.** Judged by anemometer records, the typhoon was by no means a severe one, as the highest average hourly wind velocity was seventy miles.—An elementary explanation of correlation, illustrated by rainfall and depth of water in a well : R. H. **Hooker.**

Chemical Society, June 18.—Sir W. Ramsay, K.C.B., F.R.S., president, in the chair.—The thermal decomposition of hydrocarbons, part i., methane, ethane, ethylene, and acetylene : W. A. **Bone** and H. F. **Coward.** The results of a systematic investigation of the modes of decomposition of the four hydrocarbons at temperatures between 500° and 1200° were described, and it was shown that methane, which is by far the most stable of the four hydrocarbons, and a principal product of the decomposition of the other three, decomposes for the main part directly into carbon and hydrogen. The methane formed during the decomposition of the other three hydrocarbons can be explained on the supposition that " residues " such as :CH and $:CH_2$ are directly " hydrogenised " in an atmosphere rich in hydrogen.—The rusting of iron : W. A. **Tilden.** It was shown that (1) oxygen or air with liquid water are alone necessary to produce rusting of iron; (2) that water alone attacks iron slowly, producing a film of what is probably ferrous hydroxide; (3) that iron rust always contains ferrous oxide; and (4) that rusting is due in the first instance to electrolytic action, promoted in all ordinary cases by the existence of carbonic acid in water exposed to the air, and by the presence in iron of various compounds of carbon, silicon, phosphorus, and sulphur.—Studies on zirconium : E. **Wedekind** and S. J. **Lewis.**—The constituents of Canadian hemp, part i., apocynin : H. **Finnemore.** The principal constituent of the root of *Apocynum cannabinum* is identical with the crystalline apocynin of commerce, which is identical with the acetovanillone obtained by Tiemann from *iso*eugenol, and has the constitution



.—A new synthesis of apocynin : H. **Finnemore.** The author has synthesised this substance from vanillin by an application of the Grignard process.—The constitution of diazonium perbromides : F. D. **Chattaway.**—Cholestenone : C. **Dorée** and J. A. **Gardner.** Cholestenone produced by the oxidation of cholesterol reacts with ozone, giving an ozonide which probably has the formula $C_{27}H_{44}O.O_7$. This, when decomposed by water, gives carbon dioxide and a keto-monocarboxylic acid, $C_{26}H_{42}O_3$, identical with that obtained by Windaus. Cholesterol on similar treatment gives an ozonide, $C_{27}H_{46}O.O_3$, which also evolves carbon dioxide on treatment with water.—Solubility of silver chloride in mercuric nitrate solution : B. H. **Buttle** and J. T. **Hewitt.** Morse's view that when mercuric nitrate is present in large excess, chlorine occurs only as HgCl-ions, is confirmed.—The relation between absorption spectra and chemical constitution, part ix., the nitroso- and nitro-