compared with the heliometer has, however, lost much of its force; for, as I hope to show next, the highest accuracy attainable with the heliometer can be secured much more easily with a photographic telescope.

The application of photography to the determination of stellar parallax was first made by Pritchard in Oxford between 1887 and 1889. He took a large number of photographs and measured on them the angular distance of the star which he was considering from four of its neighbours. In this way he determined the parallax of five stars. He began this work late in life, and it was left for others to develop the photographic method and find what accuracy could be attained with it. At first sight it seems very easy, but experience shows that there are a number of small errors which can creep in and vitiate the results, unless care is taken to avoid them.

It has gradually become clear that with a few simple precautions and contrivances, a greater accuracy can be reached in the determination of parallax by photography and with much less trouble than by any other method. Between 1895 and 1905, several astronomers succeeded in obtaining from a few plates results as accurate as could be obtained from many nights' observations with the heliometer by the most skilled observers. In the last five years a large number of determinations have been made. In 1910 Schlesinger published the parallaxes of twenty-five stars from photographs taken with the 40-in. refractor of the Yerkes Observatory, and in 1911 Russell published the parallaxes of forty stars from photographs taken by Hinks and himself at Cambridge. The opinion expressed by Gill on these observations (*M.N.*, vol. lxii., p. 325), was that but for the wonderful precision of the Yerkes observations, the Cambridge results would have been regarded as of the highest class. The facility with which the Yerkes results are obtainable is expressed very tersely by Schlesinger—"the number of stellar parallaxes that can be determined per annum, will in the long run be about equal to the number of clear nights available for the work." With the heliometer at least ten times as much time would have been required. During the last year two further instalments of the results of the Yerkes Observatory have been published by Slocum and Mitchell, giving the parallaxes of more than fifty stars. It might be thought that the high accuracy attained by them is largely attributable to the great length of the telescope. From experience at Greenwich, I do not think this is the case, and believe that similar results are obtainable with telescopes of shorter focal length. As several observatories are now occupied with this work, we may expect that the number of stars the distances of which are fairly well known will soon amount to thousands, as compared with three in 1838, about twenty in 1880, about sixty in 1900, and now perhaps two hundred.

The stars the distances of which have been measured have generally been specially selected on account of their brightness or large proper-motion. Each star has been examined individually. Kapteyn has suggested that instead of examining stars singly in this way, photography gives an opportunity of examining all the stars in a small area of the sky simultaneously, and picking out the near ones. The method has been tried by Kapteyn and others—among them Dr. Rambaut. The idea is very attractive, because it examines the average star and not the bright star or star of larger proper-motion. It is liable, however, to some errors of systematic character, especially as regards stars of different magnitudes. Comparison of the results so obtained with those found otherwise will demonstrate whether these errors can be kept sufficiently small by great care in taking the photographs. Until this is done no opinion can be expressed on the success of this experiment, which is worth careful trial.

The question may be asked, How near must a star be to us for its distance to be measurable? I think we may say ten million times the sun's distance. This corresponds to the small angle 0·02″ for the parallax. If a star's parallax amounts to this, there are, I believe, several observatories where it could be detected with reasonable security, though we shall know more certainly by the comparison of the results of different observations when they accumulate.

You will readily imagine that an accurate knowledge of the distances of many stars will be of great service to astronomy. There are ample data to determine the positions, velocities, luminosities, and masses of many stars if only the distances can be found. Thus we know the distance of Sirius, and we are able to say that it is travelling in a certain direction with a velocity of so many miles per second: that it gives out forty-eight times as much light as the sun, but is only two and a half times as massive. The collection and classification of particulars of this kind is certain to give many interesting and perhaps surprising results. But it is not my purpose to deal with this to-night. The task I set before myself in this lecture was to give an idea of the difficulties which astronomers have gradually surmounted, and the extent to which they have succeeded in measuring the distances of the stars.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

CAMBRIDGE.—The Rev. T. C. Fitzpatrick, president of Queens' College, has been elected Vice-Chancellor for the coming academic year.

The council of the Senate has announced that the Board of Education has agreed to make a grant in aid of the medical departments of the University, and that the amount to be received on account of the present year is 5873*l.*; it proposes that a new committee, to be called the Medical Grant Committee, should be appointed for the purpose of administering the annual grant.

Mr. H. Scott, of Trinity College, has been appointed curator in entomology for five years from March last.

A grant of 50*l.* has been made from the Balfour Fund to enable Mr. G. Matthai, of Emmanuel College, to visit America in furtherance of his researches on the comparative anatomy and classification of the Madreporaria.

GLASGOW.—By an Order in Council dated May 27, 1915, the King has reappointed Sir Donald MacAlister and Mr. Otto Beit, and has appointed Mr. R. E. Prothero, to be members of the governing body of the Imperial College of Science and Technology for a term of four years from June 1, 1915.

LONDON.—Owing to Prof. Brodie's services being required for military purposes, the course of advanced lectures in physiology arranged to be given by him at King's College (as announced last week) will not be delivered.

OXFORD.—The report of the delegates of the University Museum for 1914, together with the departmental reports of the professors and readers teaching within the Museum, has just been published. In the general report attention is directed to the departure of large numbers of the teaching and service staff, and also of research workers, for military duties. This has affected both the Museum itself and also the several departments. Mention is made of the billeting of the 9th Battalion of the Hampshire Regiment for a night in some of the laboratories; of the presentation to the University of Mr. Hope Pinker's

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statue of Roger Bacon; and of the completion of the carving in the upper corridor, under the bequest of the late Rev. H. T. Morgan.

The report of the Professor of Pathology records the fact that from an early date in August the department and the whole of its staff were engaged in services connected with the war. About 6000 inoculations were performed, and a quantity of vaccine was sent to Belgium. The Professor of Physiology includes in his report a tribute to the services rendered by the late Dr. G. J. Burch, F.R.S., and an account of the arrangements for the memorial to the late Prof. Francis Gotch, F.R.S. Most of the departmental reports, including that of the Curator of the Pitt-Rivers Museum, contain long lists of donations to the respective collections, and full records of the research work which, in spite of all obstacles, has been carried on in the various laboratories and workrooms of the Museum.

The new building for engineering science was finished at Christmas. The new chemical laboratory is still in course of erection, but the professor hopes that it will be ready for occupation by next October.

Science announces that the Michigan Legislature has granted 70,000*l.* for the erection of a new university library building for the University of Michigan.

THE fiftieth anniversary celebration of the Worcester Polytechnic Institute, Worcester, Massachusetts, is to be held on June 6–10. President Wilson, who gave the opening address on a similar occasion twenty-five years ago, hopes, if the pressure of public business makes it possible, to attend the meetings on June 9. General G. W. Goethals has also accepted an invitation to be present. On June 10, honours are to be conferred and various bronze tablets unveiled.

A FREE scholarship of the value of 30*l.*, open to all-comers, and tenable at the Northampton Polytechnic Institute (London), is being offered to students. In view of the opportunities for advancement which the calling and craft of optics now offer on account of the shutting off of alien supplies due to the war, the "Aitchison Memorial Scholarship," which has for its special object the encouragement of recruits for the optical industry, should prove very attractive to intelligent youths. The subjects of examination include English, mathematics, and elementary physics. The conditions of the scholarship have been laid down by a committee which includes Dr. R. Mullineux Walmsley, Prof. Silvanus P. Thompson, and Dr. J. W Ettles. Full particulars can be had of the hon. secretary and treasurer, Mr. Henry F. Purser, 35 Charles Street, Hatton Garden, London, E.C.

SOCIETIES AND ACADEMIES.

LONDON.

Royal Society, May 20.—Sir William Crookes, president, in the chair.—H. **Moore**: The corpuscular radiation liberated in vapours by homogeneous X-radiation. —H. **Richardson**: The absorption in lead of γ rays emitted by radium B and radium C. (1) The absorption curves in lead of the radiations emitted by radium B and radium C have been determined and analysed. (2) In addition to the penetrating type of radiation for which $\mu=0.5$ (cm.$^{-1}$) in lead, radium C has been found to emit soft types for which $\mu=46$, $\mu=6.0$, and $\mu=1.5$, and which are practically absorbed by 1.5 cm. of lead. (3) The analysis of the radium B absorption curve shows that in addition to the radiation $\mu=40$ in aluminium, the rays emitted consist of three types for which $\mu=46$, $\mu=6.0$, and $\mu=1.5$ for lead. The close similarity of this latter radiation with that of the soft portion emitted by radium C, already observed by Rutherford and Andrade, has been established. (4) The absorption of the radiations in different elements has been examined and the bearing of the results discussed. No evidence of anomalous absorption has been found in the case of the penetrating radiations.—T. R. **Merton**: The application of interference methods to the study of the origin of certain spectrum lines. By measuring the limiting orders at which interference can be detected for different radiations, certain deductions may be made as to the mass of the luminous particles and the temperature of the source. If the only circumstance which could possibly influence the width of spectrum lines at low pressures were the Doppler effect due to the motion of the luminous particles in the line of sight, the relative masses of particles emitting radiations from the same source of light might be calculated. As, however, there is reason to doubt the validity of this assumption under certain conditions, the conclusions which may be drawn with certainty from measurements of this kind are an inferior limit for the mass of the luminous particles if the temperature of the source is known, or a superior limit to the temperature if the mass of the luminous particles is assumed. It is shown in the paper that the flame lines of calcium, strontium, and barium are probably due to molecules, whilst the H and K lines of calcium are to be attributed to calcium atoms. As the flame lines are members of series, it must be recognised that radiations from molecules may give rise to line series as well as band spectra. Lines of the two spectra of argon have been investigated. The width of the lines of the red spectrum would appear to be accounted for by the Doppler effect. The lines of the blue spectrum are very broad in comparison with those of the red spectrum, and a satisfactory explanation of this has not been found. Spectrum lines of the "arc" type are broadened when condensed discharges are used as the method of excitation, but the difference in width of the lines in the blue and red spectra of argon is of another order of magnitude. The band spectrum associated with helium has been found to be enhanced when the gas is cooled to the temperature of liquid air, which might justify the suspicion that more than one atom was concerned in its production, but a comparison of the widths of the lines in the band spectrum with the ordinary helium lines makes it extremely probable that the band spectrum is due to atomic helium.

Physical Society, May 14.—Dr. A. Russell, vice-president, in the chair.—E. H. **Rayner**: Precision resistance measurements with simple apparatus. The paper describes methods by which the comparison of resistances can be made to an accuracy of 1 in 10,000 or higher by using simple apparatus usually available in electrical laboratories, or which can be easily constructed with little skilled assistance. The comparison of nominally equal resistances of 1 ohm and upwards by the usual method of shunting one side of a nearly balanced quadrilateral by a high resistance is mentioned, and variations on this when only part of one resistance is shunted are often useful. The great advantages of having resistances capable of carrying comparatively large currents are illustrated, especially for measuring changes of resistance of commercial apparatus under working conditions. The determination of errors in a volt box for use with a potentiometer is described at some length. This is of especial importance in precision photometry. If a sufficient continuous-current voltage is not available for testing such apparatus as high-potential dividers, it is shown that using sufficient continuous current to secure sensitivity the heating may be supplied by superposed alternating current. Resistances in common use are

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