bodies surrounding the sun; this theory is supported by the observation that a fair percentage of the light is polarised. The recent observation of Prof. Fowler (NATURE, vol. lxxxi., p. 396, September 30, 1909), who, during an auroral display, was able to detect the aurora line everywhere, "even in the light reflected by a pocket-handerchief," illustrates the danger of attributing the auroral radiation to the spectrum of the Light, simply because it is seen contemporaneously.

To decide the question of the spectrum of the Light, photographic observations, if possible, were desirable, and, in 1883, Mr. Michie Smith attempted the task of photographing it, but was unsuccessful. Now, however, Dr. Fath has succeeded in obtaining a photograph after exercising a great deal of care and ingenuity in overcoming the numerous difficulties.

The first attempts were made, at the instigation of Prof. Campbell, in 1907 at Mount Hamilton. The spectrograph was especially designed and constructed for this research, and has an aperture of 51 mm.; the focal length of the collimator is 814 mm., and that of the camera is 154 mm. Rigidity, to withstand flexure or distortion over long periods, is the main feature of the frame, which is made of well-seasoned pine 13 mm. thick, shellaced inside and out, and put together with glue and screws. The prism is of light flint having a refractive index of 1·611 for $H\gamma$, and was set for the minimum deviation of this ray; the resulting spectrum is about 2·2 mm. in length from λ 5000 to λ 3900.

In the autumn, when the Zodiacal Light appears in the morning above the eastern horizon, less than one hour before sunrise is available for the exposures, which therefore have to be accumulative. As the altitude of the Lick Observatory is 1283 metres, it was expected that dawn might commence before the zenith distance of the sun was 108°, the usually accepted value, and in the first experiments the exposure was always stopped when the computed zenith distance was 111°; later experiments showed this precaution to be unnecessary.

In August, 1907, an exposure was made, over the period August 8 to 15, totalling 6h. 1m., and in the very faint spectrum secured absorption lines at λ 4300 and λ 3950 were suspected.

A stronger spectrum was obtained in October, 1907, with a total exposure of 11h. 9m., but still the traces of absorption were too faint to permit of any definite conclusions. Another attempt in the autumn of 1908 only served to illustrate the numerous pitfalls awaiting the observer of this evanescent spectrum. Jupiter and Venus were above the horizon, reflecting sunlight, and this so complicated matters that the experiments had to be abandoned.

On his translation to Mount Wilson, Dr. Fath resumed the inquiry, and, by the courtesy of Prof. Campbell, was able to use the same instrument. Elaborate precautions were taken to eliminate any chance of "shift" caused by the vibration or change of temperature of the spectrograph; the instrument was also mounted on an azimuth slide, so that it could be moved in azimuth some 5°, in order to follow the brightest part of the Zodiacal Light. The width of the slit employed was 0·41 mm., and at this width the solar lines H and K are not separated in the spectrum. The exposures extended from 1909 September 12 to September 25 under very favourable conditions, and were always arrested a minute or two before the time calculated for the zenith distance of the sun to be 108°. Careful watch was kept for any abnormal dawn or other phenomena which might vitiate the results, but none was observed.

With a total exposure of 12h. 31m., on a Lumière "Sigma" plate, a spectrum was obtained, under these conditions, which, so far as its small size will allow one to judge, resembles the solar spectrum exactly. Two absorption lines are certainly seen, and a comparison spectrum of daylight shows these to be G and a blend of H and K in the solar spectrum. There are no signs of bright lines on any one of the spectra obtained, and therefore, as Dr. Fath concludes, we seem justified, so far as such small, impure spectra can lend justification, in concluding that the Zodiacal Light is nothing more than reflected sunlight.

To support this conclusion it is, of course, desirable that the work should be continued, using a narrow slit to obtain greater purity of spectrum; but this entails the employment of much quicker plates than are at present available, or a much longer exposure. The latter is at present probably the most feasible plan, but when one remembers that the hours of exposure must be moonless, planetless, and clear, it is obvious that several months would be necessary to complete one such exposure. This means that special precautions to secure the constancy of the spectrograph would be necessary, and Dr. Fath suggests the construction of one with a metal frame, which would be less likely to suffer change than a wooden one, and could be maintained at a fairly constant temperature.

W. E. ROLSTON.

TECHNICAL EDUCATION IN GERMANY AND THE UNITED KINGDOM.

AT the request of Mr. R. Blair, the executive officer of the London County Council Education Committee, a valuable memorandum has been drawn up by Dr. F. Rose on the qualifications of the students trained at the German technical high schools in comparison with those of students at British universities and technical institutions of university rank. This memorandum, with the tabular portion abridged, is subjoined, and it contains facts of great interest and importance. Referring to it, Mr. Blair says:—

"The memorandum shows that one or two broad statements of fact may be made, and these deserve, if they do not demand, attention. First, the schools of the United Kingdom do an immense amount of valuable work in the evening—my own view is that the work is unparalleled. So much further education in the evening is partly due to the fact that a life of earning and independence begins earlier in the United Kingdom than in Germany, and is partly an indication of the inadequacy of the day work in these islands. It is hardly possible—and I have not attempted to do it—to assess this evening work in such a way as to place it side by side with the day work in the United Kingdom in comparing the latter with German day work, and such a comparison would also have required an appreciation of the evening work in Germany. But it has much value. Secondly, taking, as far as one can, comparable institutions, there are 12,000 fully qualified students attending day institutions for the highest technical training in Germany, and only about 3600 in the United Kingdom. The German courses are, speaking generally, longer and the previous preparation better. Further, this great difference in quality and quantity of the work done has existed for more than a generation; and these highly qualified German students have found, and do find, their way into agriculture and industry, because the German people believe in the application of trained intelligence to all forms of national activity."

Dr. Rose's report, in an abridged form, is reprinted below.

Although there is little doubt that the majority of students trained in German technical universities actually take up industrial positions upon leaving, it is impossible to give any detailed information, as no statistics on the subject have been published or are obtainable. Nine years ago I carried out an investigation to show to what an extent the German chemical industries had benefited from the chemical instruction available at universities and technical universities. The proportions still hold good for the present day, although the figures have increased. It was found that there were about 4000 academically trained chemists in the different branches of the chemical industry. The value of the annual production of the chemical industries was estimated at 50,000,000*l.*

The total number of chemists trained in Germany was estimated at the same time at about 7000. It would not be going too far to say that at least four-fifths of the German students actually take up positions in industries and technical work when they leave the technical universi-

ties; a very large number of the fully qualified students pass the final diploma examinations.

No account has been taken of the non-fully qualified students, who amount to about 10 or 15 per cent. more. A great many of these students also take up technical positions. In a large number of cases they are the sons or relatives of engineers and manufacturers who, before taking over the family works, wish to study a certain amount of technical science without submitting themselves to the drudgery of an examination.

Although it is almost a matter of impossibility to compare German technical universities with the applied science faculties and departments of English universities and with English polytechnics and technical colleges, an attempt has been made to do so in the tabular statement [here abridged so as to include totals only] given below. The difficulty of comparison arises from the fact that the German technical universities are independent technical institutions, and are organised throughout on a high level and on a uniform scale.

Technical Education in Germany and Great Britain—Educational Year, 1907–8.

Institutions	Number of fully qualified day students (German technical universities). Students taking full courses (English institutions).	Number of non-fully qualified day students (German technical universities).	Number of evening students.	General ages of day students.
GERMANY—				
Ten Technical Universities	11,692	2,299		18 or 19 to 24 and 25 and over Minimum age, 18
UNITED KINGDOM—				
Twenty-three Universities and Colleges of University rank	3,607		16,623	Entrance age, about 16
Eight London Polytechnics, and Technical Schools at Birmingham, Bolton, Leicester, Derby and Salford	461		25,574	Entrance age, about 15

Some of the points of difference may be mentioned. The matriculation for fully qualified students at German technical universities is the completion of the full nine years' secondary-school course at a classical, semi-classical, or modern secondary school. This practically amounts to a B.A. pass degree, say, at Oxford or Cambridge. There are, however, a few exceptions here and there, but they scarcely affect the almost general rule. At English institutions it is in most cases impossible to get any detailed or uniform information on this point, but it is clear that the standard of previous educational qualifications, even at many institutions of university rank, is lower than in Germany. This explains why German students do not commence work at the technical university before eighteen or nineteen, whereas at most English institutions the minimum age limit is sixteen, or there is no limit at all.

The next striking difference is the fact that there are no evening students at German technical universities, whereas in English institutions there are generally more evening students than day students.

Another point of difference is the length of the technical courses. As a rule, these last at least four years in Germany, and most students add one or two additional terms (half-years) to this period. In England the average length of the courses is less in most cases.

With regard to diplomas and degrees, the German procedure is simple and uniform at all the technical universities. The student who has successfully passed through his course of study and passed the necessary examination is awarded a diploma in his special branch. This is sufficient for the needs of the average engineer or manufacturer. If the diploma holder, however, wishes, he can spend one or two years more in research work connected with his particular branch, and can then obtain the degree of doctor of engineering by presenting his thesis and passing a further examination. This arrangement is practically uniform at all the technical universities. English scientific degrees and diplomas, however, are so diverse and numerous that it is almost useless to try and compare them with the German ones.

In addition to the simple diplomas and degrees there are other examinations which must be taken into consideration in dealing with German technical universities. These are the State examinations for State positions in State railways, mines, forests, canals, domains, smelting works; Government building, engineering, and surveying; teaching (secondary schools), post, telegraph, &c., Customs, shipyards, river and coast regulation, pharmacy, food inspection, and so forth. All candidates for these examinations must, of course, be fully qualified students.

The majority of high Government technical officials pass through the classical gymnasia before entering the technical university. The Government examination is, as a rule, more severe than the diploma examination undertaken after a four years' course at some technical universities. The diploma examination is accepted in some parts as equivalent to, or as the first section of, the official State examination for State technical positions. When the numbers of students who pass the diploma and State examinations are compared with the number of students actually at work at a technical university, it will be seen how large a number of German students complete full technical courses and pass the necessary examinations. It should also be mentioned that the majority of German technical universities exact about one year's previous practical work from fully qualified students entering their technical departments. No officials and no persons engaged in the purely commercial aspects of trade may enter as fully qualified or non-fully qualified students.

The German technical universities differ from English institutions, not only in the quality, variety, and length of their technical courses, but in the time devoted to work per day. It does not appear that the whole day is devoted to work at most English institutions. Whilst some work as much as 1000 hours per year, others work less. A minimum of 300 hours has been set up by the Board of Education for statistical purposes. At German technical universities the whole day is devoted to work, and lectures commence at seven in the summer and at eight in the winter, all the remaining time being devoted to work in drawing offices and laboratories.

The final point of difference is that the German technical universities only exist for the purpose of teaching applied science, whereas in England departments for this subject have been grafted upon universities with faculties for science, letters, medicine, law, theology, and so forth. Pure science is, of course, taught at all the older German universities in departments of the philosophical faculties.

No account has been taken in the comparison of the German mono-technical schools—that is to say, technical schools which contain only one, or perhaps two, technical departments, and which admit students about the age of fourteen or sixteen for technical courses lasting from two to four years. Such schools, which may be termed secondary technical schools, provided with fine buildings, full technical equipment, and properly staffed, number about two hundred.

A very large number of technical schools for special branches of trade exist. Such schools have been established for milling, boot-making, tanning, musical instrument making, toy-making, book-making, photography, &c. There are also numerous schools for applied art. It is very difficult to get these schools into line for purposes of comparison. They are of two types, higher and lower; there is a certain amount of overlapping, and the conditions are not uniform. They are in extremely close touch with the industries concerned, and have been founded and developed in their midst. The difference between the technical universities and the best of the technical schools mentioned above may be briefly summed up in the following table of comparison:—

Subject of comparison	At the ten technical universities	At the special engineering schools and other technical schools, with courses in mechanical engineering, building and electro-technics, &c.
Lowest entrance age	18 years	14 and 16 years
General ages	18 to 25 years	14 or 16 to 30 years
Necessary degree of previous education	The completion of the full courses (9 years) of a gymnasium or full "real" school, making, together with the three years at a preparato y school, a total of about 12 years	Qualification for the one-year military service; (6 years at a secondary school); also completion of the "Volkschule" (elementary school) and a knowledge of mathematics and some years' practical work
Scope and manner of instruction	Advanced and complete application of higher mathematics and mathematical sciences. advanced theory and design, facilities for the attendance of lectures in the departments of chemistry, civil engineering, architecture, art, science and literature	A certain measure of instruction complete within certain limits, specially arranged for practical requirements, no higher mathematics. elementary theory and design; no facilities for instruction in other technical departments or in letters, languages, philosophy, &c.
Aim of the instruction	Training of experts, great inventors, high technical State and municipal officials, "captains of industry," owners and managers of great works, professors, secondary teachers, consulting men of science, engineers, architects, chemists, patent agents, &c.	Training of owners and managers of smaller works, foremen, clerks of works, surveyors, minor State and municipal officials, draughtsmen, technical travellers, &c.
Previous period of experience in works	Generally 1 year as minimum, with a tendency to increase	2 to 4 years as minimum, 2 years being exacted almost without exception; very strictly observed
Length of courses ...	4 years in almost all cases, with a tendency to increase	2 to 2½ years, sometimes 1½ years, in rare cases 3 and 2½ years
State and municipal technical appointments open to students who have completed the courses	Higher appointments in the State and municipal technical services	Lower appointments in the State and municipal technical services
Attendance at lectures	No compulsion...	Obligato y

Although English universities have been included in the comparison, no mention has been made of the following German institutions of equal or similar rank :—

The twenty older universities (excluding the theological universities of Braunsberg and Münster)	They contain 48,000 students. Of these a large number study chemistry, which is a department of the faculty of philosophy at all German universities
The three agricultural high schools	Same educational qualifications as at the technical and older universities. Exceptions, however, are allowed. Number of students=1402
Agricultural departments	At seven of the older universities and at one technical university
The five veterinary high schools	Same educational qualifications as at the technical and older universities. Number of students =1321
The four forestry academies	Same educational qualifications as at the technical and older universities. Number of students =262
The forestry departments	At three older universities and one technical university
The three mining high schools	Same educational qualifications as at the technical and older universities. Number of students =791
Various	A mining department at Aix Technical University. A veterinary department at Giessen University

The result of this comparison between German and British technical institutions shows that the former are constituted and organised on a higher level. With the possible exception of the Imperial College of Technology and applied science departments at Cambridge, Edinburgh, Glasgow and Victoria Universities, Trinity College, Dublin, and some university colleges, there do not appear to exist in the United Kingdom technical institutions which can be compared with any of the great German technical universities.

Looked at from the basis of the German standard of previous education and practical work, length, extent, and variety of the courses taken, and the number of diplomas granted, it will probably be found that there are insufficient students in the whole country to fill one of the large German technical universities. Here and there a number of students in a few departments come up to the German level. Good technical institutes and departments in England appear to be more on a level with the best technical schools in Germany rather than with the technical universities. Such schools are, for example, the Prussian higher mechanical engineering schools at Dortmund, Elberfeld, Breslau, and Cologne, the trade academy at Chemnitz, the technical school at Cöthen, and several "Technikums." These schools do not admit students before sixteen, require a six years' certificate from a secondary school and proof of two years' practical work, and have a course of at least two years. They are very numerous in Germany.

In England the tendency during the last ten years has been to graft departments for higher applied science upon the older or modern universities. This was done in Germany very many years ago and soon abandoned. For example, engineering was once taught at Giessen University, higher mechanics at Munich University, and technology at Göttingen and other universities. At the beginning of the nineteenth century lectures on technology were given at Heidelberg, which were suitable in every respect for a technical school. Building, mining, metallurgy, forestry, surveying, and other subjects were also taught. At the present time, with few exceptions, applied science and technology generally have gone to the technical universities and institutions of similar rank and to the technical schools. Only comparatively few departments survive, such as forestry, veterinary and agricultural science, which are still taught partly at the older universities, but principally at independent institutions. A very large amount of chemistry, principally pure chemistry, is taught at all German universities. It forms the great exception to the rule, and was taught so far back as the beginning of the seventeenth century. Different countries have, of course, followed different lines of procedure in the development of their higher technical instruction.

The German technical universities are not, strictly speaking, new creations. They have been developed—with one exception—from technical schools, trade schools, &c., founded in the first quarter of the nineteenth century. One of the great reasons for the foundation of these schools was to render Germany independent of the English manufactures and machinery, which, together with English capital and engineers, overran Germany in the first half of the nineteenth century.

The present organisation of English polytechnics represents a stage of development which German technical education passed through about forty years ago, and out of which nine of the ten technical universities have arisen.

There is little doubt that the rapid development of the German technical universities is owing, to a great extent, to their independent position towards the older universities. They do not enter into competition with them, but supplement them by providing a new type of instruction which the older universities, by reason of their environment, traditions, and organisation into the four faculties of law, medicine, theology, and philosophy, cannot give. The same is true of the semi-classical (Realgymnasia) and modern secondary schools (Oberrealschulen). Instead of attempting to graft a large amount of science, modern languages, mathematics, and drawing upon the older classical gymnasia, new secondary schools were created with the same length of courses, but of a semi-classical or completely modern type. All three types remained independent, and have consequently flourished, although the State still favours the classical gymnasia in State appointments and the liberal professions. As the technical universities developed so did the new types of secondary schools from which they receive so many of their students. Coordination between the older and the technical universities has been effected in a simple manner by making the leaving certificate of the secondary schools (the "Maturitas") the standard of matriculation for both types of university, and by putting university and technical university terms on the same footing as regards the length of study for the final examination.

The Emperor William has greatly influenced the rise of the technical universities by his consistent efforts to raise the status of the three (now four) situated in Prussia. He began by suggesting reforms in the secondary-school system, then called the principals of the technical universities into the Prussian Upper House, and finally conferred upon the Prussian technical universities the power of granting the degree of Doctor of Engineering. The rest of the Empire followed his example, and thus the ten technical universities have been finally placed upon exactly the same footing as the older universities.

One reason why technical-school students in Germany possess a better educational equipment for their work than in England is owing to the fact that the lower divisions of the secondary schools are filled by students who wish to obtain the one-year military certificate which requires six years' attendance at a secondary school. The high proportion of fully qualified students at the technical universities is due to the fact that no examinations can be passed or higher State or municipal positions obtained without proof of the completion of a nine years' secondary-school course. Another reason why so many students attend the secondary schools and various universities in Germany is due to the lowness of the fees and the cheapness of living. To these reasons may be added the general German tendency to obtain as high a standard of schooling as possible before entering life.

Young men in Germany subject themselves to a laborious general and technical training, amounting after the preparatory school to from ten to fifteen or sixteen years, because the majority of those who complete their studies are generally sure of finding positions. The State and municipalities require large numbers for their various technical services. This partly explains the interest of the State in the quality of the instruction and the uniformity of the organisation of the technical universities. Most manufacturers give the preference to students with diplomas or degrees from the universities or technical schools. This is a result of the intimate advisory relations between manufacturers and the technical universities. Students are also sure of finding positions in the surrounding foreign countries, where large numbers of German "techniker" are to be found in all branches of industry. A further incentive to a longer course of study is found in the fact that, owing to the system of marriage dowries in Germany, young men with a technical diploma or degree are able to marry as soon as they obtain a position, even with a very small initial salary.

German students receive very little direct pecuniary assistance. Scholarships on the liberal English scale are practically unknown. There are a few modest "stipendia," and very poor students, upon production of the necessary proof, are allowed to study free and refund the amount of their fees later when they are in a position to do so.

Higher education of all types in Germany has been promoted by two further factors. First, by decentralisation so far as the Empire is concerned, as the various States of which the German Confederation is composed act independently in educational matters, and are constantly competing with one another in the development of their educational resources. Secondly, by the fact that almost all higher education is under direct State control, thereby rendering uniformity of organisation and coordination between institutions more easy.

Finally, it should be borne in mind that the German population exceeds the population of the United Kingdom by about eighteen or nineteen millions.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

CAMBRIDGE.—The Rev. E. A. Woodruffe-Peacock will deliver a lecture at the Botany School on Friday, February 18, at 5.0 p.m., on "A Special Method of Recording the Distribution of Plants." The lecture will be open to all interested in the subject.

Prof. W. Bateson, the Hon. N. C. Rothschild, and Mr. H. Scott, Inceptor in Arts, have been nominated to represent the University at the International Congress of Entomology to be held at Brussels in August, 1910.

Sir J. Larmor has been nominated a member of the board of electors to the professorship of chemistry, Sir Robert Ball to that of the Plumian professorship of astronomy, and Dr. Glaisher a member of the same board; Prof. A. Robinson and Prof. A. Keith have been nominated members of the board of electors to the professorship of anatomy, Dr. Darwin to that of the professorship of botany, Prof. W. W. Watts to that of the Woodwardian professorship of geology, Mr. A. Hutchinson to the same board, Prof. H. B. Dixon to that of the Jacksonian professorship of natural and experimental philosophy, Prof. A. R. Cushny to that of the Downing professorship of medicine, Dr. Hugo Müller to that of the professorship of mineralogy, Dr. R. T. Glazebrook to that of the Cavendish professorship of experimental physics, Dr. W. N. Shaw to that of the professorship of mechanism and applied mechanics, Prof. F. Gotch to that of the professorship of physiology, Sir W. W. Cheyne, Bart., and Mr. C. T. Dent to that of the professorship of surgery, Prof. J. Lorrain Smith to that of the professorship of pathology, and Mr. E. Gardner, M.P., to that of the professorship of agriculture.

LONDON.—In memory of the late Dr. Ludwig Mond's scientific eminence and his generous benefaction of 3000*l.* towards the building of the Institute of Physiology at University College, the college committee has resolved to name the biochemistry research department of the institute "The Ludwig Mond Biochemistry Research Laboratory." The committee will shortly proceed to elect a Crewdson-Benington research student. The studentship, of the value of 50*l.*, tenable for one year in the biometric research laboratory of the college, is for the promotion of research in anthropometry and craniology in relation to evolution. Candidates should send their applications, together with any statement of qualifications that they desire to submit, not later than March 1 to the secretary of University College, Gower Street, W.C., who will furnish particulars of the studentship.

The degree of D.Sc. has been granted to Mr. W. B. Tuck, an internal student, of University College, for a thesis entitled "The Constitution of Hydroxyazo-compounds," and other contributions.

A scheme for the constitution of a board of the faculty of medicine has been approved.

Syllabuses have been approved in geology for intermediate and final pass B.A. examinations for external students. Practical work is provided for in both syllabuses; that for the intermediate examination includes the interpretation of weather charts, and at the final examination candidates must give evidence of adequate instruction in the field.

Prof. A. W. Crossley, F.R.S., has been elected dean of the faculty of science in succession to Prof. J. M. Thomson F.R.S., resigned.

Dr. E. C. Seaton and Mr. W. H. Maxwell have been appointed Chadwick lecturers in hygiene and municipal engineering for the current session.

Convocation has approved the proposals for the establishment of a University of London Club.

AT the South-western Polytechnic Institute, Chelsea, on March 11, Sir William H. White, K.C.B., F.R.S., will present prizes and certificates to students of the evening classes and day college.

THE twelfth annual dinner of the Central Technical College Old Students' Association was held on Saturday, February 12, at the Trocadero Restaurant, Mr. H. A. Humphrey being in the chair. Among the guests of the evening were Sir Philip Magnus, M.P., who, in proposing the toast of the association, mentioned the great progress the Central Technical College has made and the invaluable training received there. Prof. W. J. Pope, F.R.S., was elected president for 1910.

AN interesting address to the junior members of the architect's profession was given on January 31 by Mr. Ernest George, president of the Royal Institute of British Architects, and has been printed in the *Builder* for February 5. Mr. George offered much valuable advice to the student; earnest application is necessary, and a thorough education in science and art, as well as in wider fields of knowledge. There will be no time for idling; an