that the science is complete and that all the problems it presents have been finally solved. Abstract as these investigations often are, there is ample room for the application of those general principles of scientific research which his earlier training will have helped to develop, and the final test of his mathematical powers will be found in the success with which he extends the scope and methods of the science.

Mathematics as we know it to-day is in living contact with experimental science on the one side; on the other it borders on the domain of philosophy; to each it has some contribution to offer, and in the words of Weierstrass "a mathematician who is not something of a poet will never be a complete mathematician." Is it not, then, a subject worthy of a place in university studies?

DEVELOPMENTS OF ELECTRICAL ENGINEERING.[1]

THIS address deals with a few only of the many recent developments in electrical plant and its application to industrial purposes.

Generators.

The modern tendency is to instal very large units. This is partly due to the large demand made on the power house and the desire to restrict the number of units, and partly to the fact that the advantages of the steam turbine over the reciprocating engine become more pronounced with the increased size of the unit. The General Electric Company of New York have built several turbo-alternators of 14,000-kw., and the British Westinghouse Company inform me that it would be quite feasible to build sets of 15,000 kw. up to 15,000 volts pressure. In water-driven alternators, also, the tendency is towards large units. Thus the power house of the Norwegian Nitrogen Company at Svälgfos, near Notodden, has been fitted with four turbine-driven three-phasers, each for 10,500 kilovolt-ampere, and developing 7000 kw. at 10,000 volts. It is obvious that in these circumstances special ventilating arrangements become necessary. Dr. Kloss, in a paper read before our Institution about a year ago, has pointed out that the scientific way of ventilating turbo-dynamos is to take the air from the outside and discharge it to the outside of the engine-room. It is important that only clean air be used, and for this reason air filters are built into the inlet ducts. These are formed of pockets of porous cloth extended over wooden frames, and so placed that the dust which settles on the cloth may be removed by beating or with a vacuum cleaner. Washing or chemical cleaning is only required after some years of use.

In most modern electricity works the circulating and air pumps are driven by electric motors, but this method has been replaced at the works of the Allgemeine Elektricitäts Gesellschaft by turbo-driven centrifugal pumps. No piston pumps at all are used, and the feed may be regulated without paying attention to the feed pump. The feed water obtained by this method is absolutely free from air, and only 5 per cent. of make-up for the feed is required. Since no piston engines of any kind are used, there is no need for oil filters.

An important development in turbo sets was initiated about ten years ago by Prof. Rateau with his exhaust steam turbine. The cost of adding exhaust steam turbo sets to an existing installation of large size may be taken at from 6*l*. to 10*l*. per kilowatt exclusive of thermal storage. The commercial advantage is considerable. Thus in the Osterfeld Mine a Rateau plant installed at a cost of 53,000*l*. has resulted in an annual saving of about 20,000*l*.

The desire to reduce the cost and complication of switchgear and to make paralleling easy has led to the use of non-synchronous machines as generators. The rotor may be a squirrel-cage of very simple construction and requiring hardly any insulation, no matter how high the pressure produced by the stator may be. The mechanical construction is easier than that of the revolving field of an ordinary turbo-alternator, and since the air space can be made small, the power factor is high. A 5000-kw. non-synchronous generator was last year added to the plant of the Inter-borough Rapid Transit Company, New York.

There is some difficulty in the design of turbo-alternators for very low periodicity, since the speed becomes insufficient for the satisfactory working of the turbine. To meet such cases Mr. E. Ziehl has devised a type of alternator which he calls a "double-field generator." The principle may be explained as follows: Imagine a non-synchronous motor having precisely the same three-phase winding in stator and rotor, and let the circuits be connected either in series or parallel in such way that a three-phase current sent through the machine will produce fields which in stator and rotor revolve in opposite sense. If now the rotor be driven by power in a sense opposite to that of its own field and with a speed corresponding to twice the frequency, the field produced by the rotor currents will in magnitude and direction of motion be identical with that produced by the stator currents. Thus each of the two windings contributes one-half the field common to both. At the same time the demagnetising action of each winding is eliminated by that of the other. Since the E.M.F. is generated in both windings, only half the flux as compared to a synchronous generator is required; hence less hysteresis loss, smaller radial depth of stampings, and less copper weight. The paralleling is easy; the speed need only be approximately right, and if coupled up in a wrong phase position no damage is done, since the inductance is then very great.

Transformers.

In transformers also there is to be noticed a general tendency towards large units, which is not surprising if one considers that for the calcium-carbide industry alone about half a million horse-power in generating plant has been installed throughout Europe, and that most of the power has to flow through transformers to the carbide furnaces.

The General Electric Company of America have built several 10,000-kw. three-phase transformers working at 60 frequency, and giving a pressure of 100,000 volts. The largest European transformers of which I could find a record are some made by the Siemens-Schuckert Werke. They are three-phase 6750-kilovolt-ampere capacity oil cooled, for 66,000 volts on the high-pressure side. The use of oil as a filling medium has made it possible to build transformers for very high pressure. In one American power-transmission plant now under construction the step-up transformers are intended to raise the pressure to 110,000 volts, but even higher pressures can be obtained. Transformers giving extremely high pressure on the secondary are used for testing insulators and insulating material. A transformer of this kind has recently been made by Messrs. Brown-Boveri. It is a 50-kilovolt-ampere transformer wound for a primary pressure of 1000 volts and giving on the secondary 250,000 volts, but even this has been exceeded when the transformer was used in testing the dielectric strength of insulators. From a curve referring to such tests which the makers have sent me I find that the highest pressure recorded was 310,000 volts.

The reduction in weight of transformers due to the use of alloyed iron, large units, and vigorous cooling is very remarkable. As an example of good modern practice, I take a Brown-Boveri transformer where the active material weighs only 3·1 kg. per kilowatt, and the efficiency is 98·6 per cent. at full non-inductive load. In an Oerlikon 3500-kw. transformer the active iron only weighs 7 tons, being at the rate of 2 kg. per kilowatt output. The largest self-cooling oil transformers of which I know are some 1200-kw. three-phase 40-frequency 5000-volt transformers made by the British Westinghouse Company, but for larger unit artificial cooling becomes necessary.

For furnace work it is well to allow a rather large inductive drop so as to reduce the rush of current in the event of a short circuit in the furnace. This means wide spaces between primary and secondary coils, but it also involves the necessity for good mechanical support. The mechanical forces acting on the individual coils may become considerable, and this is probably the reason why some makers prefer the core type with concentric cylindrical coils, the cylinder being the best shape for resisting radial forces.

[1] Abridged from an address delivered before the Institution of Electrical Engineers on November 11 by Prof. Gisbert Kapp, president of the institution.

Motors.

In three-phase motors for railway work, speed regulation has hitherto been obtained either by some kind of cascade arrangement or by changing the number of poles. In either case the rotor has slip-rings, a complication one would gladly avoid. This is now possible, thanks to an ingenious design worked out by Mr. Aichele, the chief designer of Messrs. Brown-Boveri. The motor has been applied in their latest Simplon locomotives. Its rotor is simply a squirrel-cage, and has no slip-rings and no outside electrical connections whatever. The stator has two distinct windings, one for 16 and the other for 12 poles, and each winding can by means of a pole-changer be so grouped as to produce half its normal number of poles. There are thus four normal speeds possible, corresponding respectively to 16, 12, 8, and 6 poles, or to a train speed of from 26 to 70 km. per hour.

A remarkable improvement in single-phase motors has been devised by Mr. Deri, and practically developed by Messrs. Brown-Boveri. Mr. Deri's motor is a "repulsion-motor," with movable *and* fixed brushes. The effect of shifting the former is analogous to changing the impressed voltage on an ordinary continuous-current series motor, and thus by adjusting the brushes the torque and speed may be regulated. This property renders the Deri motor valuable in all cases where delicate speed regulation is essential. It is largely used for working passenger lifts and other hoisting machinery, and also for driving ring-spinning frames, the speed regulation in the latter case being automatic. The result of automatic speed regulation is an increased output from the ring-spinning frames. Another application is for electric railway working, to which I shall refer later.

The Electric Transmission of Power.

There has been a considerable development in this branch of applied electricity in late years, but the development has been on different lines in different countries corresponding to their various topographical, industrial, and commercial conditions. With us it is not so much a question of carrying power a long way as of distributing large amounts of power at numerous points within a restricted and densely populated area. In so-called water-power countries the distance between the source of the power and the points of its delivery is very much greater than in England, and hence the necessity of using much higher pressures in the transmission lines. In raising the pressure a limit is eventually reached at which dispersion of power becomes serious. This critical potential difference in virtual kilovolts is:—

$$KV=\frac{0·115b}{0·5+r}\left(\frac{1}{1+0·013v}\right)r\log\frac{s}{r}.$$

Here b is the barometric pressure in mm. of mercury, r is the radius of the wire in cm., s the distance between the two wires in cm., and v is Mershon's "vapour product," namely, the pressure of saturated steam in mm. of mercury at the given temperature multiplied by the relative humidity, or the ratio $\frac{\text{actual moisture}}{\text{possible moisture}}$.

The protection of power lines against pressure surges due to atmospheric or other causes is a very important matter.

It is well known that the connection of an underground cable with an overhead line constitutes a special danger to the cable from atmospheric discharges. To protect the cable, Mr. Semenza, of Milan, uses a kind of gigantic Faraday cage surrounding the point where the overhead lines are connected to the cables by transformers. The iron parts of the structure are earthed, the roof and the window-frames are of iron, and under the plastering of the walls there is iron netting. If a capacity and inductance tuned to somewhere near the frequency of the surge are placed in series and connected to line and cage, a current of that particular frequency will flow to earth as if the connection were direct. Even if the frequency were only approximately that to which the set was tuned, the reactance would not be excessive and the protection would be sufficient. Thus a set tuned to 1 million frequency would at 10 million frequency have a reactance of 158 ohms and at 100,000 frequency a reactance of 165 ohms. A set tuned to 100,000 frequency would at 20,000 frequency have a reactance of 192 ohms. A set for 1 million frequency may conveniently be formed of two Moscicki condensers in parallel, having together a capacity of 0·01 mf. and an inductance of 2·54 microhenry. The latter is obtained by two turns of 2 mm. copper wire 50 cm. in diameter. A set for 100,000 frequency would require eight condensers in parallel and a coil of ten turns. For the ordinary working frequencies up to 50 either set has of course a practically infinite reactance, that is to say, it has no effect on the power current. The Milan translating station has been at work now for about two years with perfect success. It should be noted that the system not only protects against lightning discharges, but against any abnormal rise of pressure, in so far as this is caused by a high-frequency surge.

Whilst on the subject of safety devices in connection with power transmission, I must refer to another recent invention, the object of which is the prevention of the infiltration of high-pressure current into low-pressure lines. That such a device is urgently needed is shown by the lamentable accident which happened last August in Olgiate, where several persons were killed by contact with nominally low-pressure lighting circuits. The danger of a short or a leak between high- and low-pressure circuits does not lie in the transformer. This can be made absolutely safe; but the switches and leads to the transformer, and especially the outside lines where there are miles of them, are a source of danger. A broken wire or a branch of a tree blown across two lines by the wind are possibilities from which no excellence of workmanship can guard us. Some means should therefore always be provided to cut off the current automatically in the low-pressure circuit as soon as its potential to earth exceeds a predetermined limit. Such an instrument was perfected last year by Mr. Arcioni, of Milan, and is now being gradually taken up on the Continent. Last year I tested the Arcioni safety device on the Milan system, making artificial leaks from the 6000-volt network to a local secondary lighting circuit, and found the action absolutely trustworthy.

The commercial development of electric power distribution on a large scale in this country by companies established for this purpose may be said to have begun with the present century. The public generally, and even some engineers, are still under the impression that a country of abundant water-power offers better opportunities for electric power distribution than a country of cheap coal, but that this is in reality not so is demonstrated by the great development which power supply has reached in this country. In the country of waterfalls industries have to be introduced in order to utilise the power made available through electric transmission, whilst in the coal country highly developed industries of different kinds are already there. As regards capital outlay, the advantage lies generally with the thermal station, quite apart from the extra cost of a steam reserve, which, for at least part of the power, in many cases is unavoidable. If, then, we speak of the cheap water-power of Swiss and Italian hydro-electric works, we do not mean that those works can produce power more cheaply than English thermal stations, but that they can produce it more cheaply than if they had to use imported coal.

Although in this country we have only little water-power, the deficiency is made up by other sources of energy which now mostly run to waste. Mr. C. H. Merz estimates that within the area served by the North-east Coast Power System the gas obtained as a by-product of the coke ovens could be made to yield continuously 150,000 horse-power if burned under boilers, and 250,000 horse-power if used in internal-combustion engines. It is the merit of Mr. Merz to have recognised the enormous commercial importance of these sources of energy, and to have already made a beginning with their utilisation by the establishment of what he calls "waste heat stations."

Electric Railways.

For main lines alternating current is unavoidable, and the only question on which there may be still difference of opinion is whether the current shall be three-phase or single-phase. Electricians prefer the former, railway men the latter mainly on account of the greater simplicity of the overhead work. As the railway men are in reality the customers who give the order to the electrical engineer, it seems likely that the single-phase system will be the one more generally adopted; and, indeed, a very respectable beginning has within the last four years already been made on the Continent, where single-phase vehicles aggregating more than 100,000 horse-power are at work or on order.

In Italy considerable progress is also being made. The Government has decided to electrify eleven sections on the State Railways, aggregating 337 miles of track, but on the three-phase system. Thus the battle of the phases is still undecided. The decision of the Italian State Railways to use three-phases, whilst in Germany, Austria, England, Sweden, and America the single-phase system is preferred, is highly interesting. Mr. Verola, the chief engineer of the electrical department of the Italian State Railways, was good enough to explain the reason for this choice. The following is an abstract of his letter:—

"In the case of the three lines (Pontodecimo-Busalla, Bardonecchia Modane, and Savona-Ceva) which are about to be opened, the service is extremely heavy, trains of 400 tons and over having to be hauled up on long grades of 25 to 35 per mil. at a speed of 45 km. per hour. With the three-phase system it is possible to comply with these conditions by using two locomotives. These weigh each 60 tons, and develop each at the 1-hour rating 2000 horse-power. With the single-phase system the weight of the motors would be at least doubled, resulting in a greater expenditure of energy. The advantages of wider speed adjustment in running and better efficiency in starting are not of importance on these lines. It is probable that also some future electrifications will be on the three-phase system, notably that of the prolongation of the Valtellin line to Milan, which will shortly be taken in hand. It is, however, highly probable that some other lines will be worked single-phase. One of these is the line Turin-Pinerolo-Torre-Pelice, where widely different speeds are necessary, the maximum being 80 km. per hour for 100-ton passenger trains."

In Switzerland the Federal Government appointed some years ago a committee of electrical and railway engineers to report generally on the question of electrifying the Swiss railways. The first report dealt with the amount of power required, the second some standards connected with the future electrical service, whilst a third report dealt with the question of a standard frequency, but on the question whether the single- or the three-phase system is to be chosen the committee has not yet pronounced an opinion. From private conversations I have had with Swiss railway men, I incline to the belief that the decision will be in favour of the single-phase system, especially since, by the use of the Deri type of motor, it has been found possible greatly to simplify and also lighten the accessory equipment. The first test of this motor for traction was made on the three-phase Engelberg railway, one phase only being used. No resistances, auto-transformer, contactors, regulating switches, or controllers of the usual construction are required. The starting and the regulation of the tractive force and speed is effected simply by shifting the brushes. Thus all the driver has to do is to attend to a hand-wheel, the motion of which is transmitted to the brush rockers by positive mechanical gearing.

Winding Engines and Rolling Mills.

Dynamic storage in some such way as first applied by Ilgner to winding engines, and voltage regulation on what may broadly be called the Ward-Leonard system, have made it possible to satisfy the very severe conditions under which winding engines and rolling mills have to work. A good example of modern English practice in direct-current rolling-mill electrification is the plant supplied by the Electric Construction Company, Ltd., of Wolverhampton, to the steel works of Sir Alfred Hickman, Ltd., of Bilston. The makers have given me the following particulars:—The flywheel set consists of a 2000-horse-power direct-current motor, two 28-ton flywheels and two generators capable of giving any voltage between −1000 and +1000 volts. The excitation of the motor is adjusted automatically so as to produce a speed variation of the flywheels between 290 and 350 revolutions per minute. The energy given out when dropping from the higher to the lower speed is 46,000 horse-power seconds. This set supplies power to a cogging and a barring mill. The cogging-mill motor works a 30-inch mill, and when cogging down ingots of 3 tons weight has to develop 4800 horse-power, and for two-second periods once an hour 9600 horse-power. The barring-mill motor works a 24-inch mill, and has to develop 6000 horse-power, and for two-second periods once an hour 12,000 horse-power. The maximum speed is 120 revolutions per minute, and the time occupied in reversing from maximum speed in one direction to that in the other direction is six seconds. As an example of a reversible mill driven by three-phase current I take that supplied by the British Thomson-Houston Company, Ltd., to Messrs. Dorman, Long and Co., Ltd. It is a cogging mill with rolls 28-inch centres, and the normal speed is 70, the maximum speed 90, revolutions per minute. The flywheel set consists of a three-phase 950-horse-power non-synchronous motor, coupled to a 1000-kw. 400-volt direct-current generator and a 30-ton flywheel. The speed limits are 400 and 480 revolutions per minute, and the maximum peripheral speed of the flywheel is 295 feet per second. The mill motor is rated at 1200 horse-power, and has an overload capacity for short periods of 3600 horse-power. The time required for reversing from full speed in one direction to full speed in the other direction is four seconds. The mill deals with 1800-lb. billets 12 inches square, reducing them to 3-inch square bars in fourteen passes. The output is 15 tons per hour.

Electric Steel Furnaces.

In the manufacture of steel from pig and the refining of steel electrically the experimental stage has long been passed, and the practical results obtained are eminently satisfactory. Even where, owing to the price of power, the electric process is no cheaper than the thermic process, the former enables the steel refiner to achieve results with certainty and regularity which under the old methods are hardly attainable at all, or only, so to say, by good luck.

In the furnace electricity is merely used to produce a large amount of heat locally. All furnaces are worked with alternating currents, the heat being produced either in an arc or by the passage of the current through the metal itself. In an arc furnace for a capacity of 2 to 3 tons the average energy required per ton of finished steel is about 1000 kw.-hours when the charge is introduced cold, and about 400 kw.-hours when it is introduced in a molten state.

A drawback inseparable from the employment of electric arcs is the great fluctuation in the load, making it impossible to work an arc furnace from a circuit which supplies other consumers. This difficulty is overcome with the so-called "induction furnace," where the heating is by ohmic resistance. In the latest type of induction furnace the energy required per ton of steel if the charge is introduced in a molten state is 125 kw.-hours for rails and 250 kw.-hours for tool steel.

The electric furnace for steel making and steel refining is now an important accessory in steel works, and thousands of tons of steel are produced annually, both in furnaces of the arc and in those of the induction type.

Fixation of Atmospheric Nitrogen.

Of the many methods devised for fixing atmospheric nitrogen with the object of producing a fertiliser to replace Chili saltpetre, I can only refer to three which have attained considerable importance.

The Birkeland-Eyde process is in use in the Notodden factory. This is fitted with four 7000-kw. generators and thirty-two furnaces, and has a yearly production of 20,000 tons of nitrate of lime, and a second factory on the Rjukan Fall is in course of construction.

The Frank-Caro process is not, strictly speaking, electrical, yet it has only become commercially possible by the aid of electricity. The raw materials for this process are calcium carbide and nitrogen, the former being produced by electricity in the well-known way, and the latter by liquefying air in a Linde machine and subsequent fractional distillation. The carbide is brought to glowing heat in a closed, externally fired retort, and the nitrogen passed through. The reaction is $CaC_2 + N_2 = CaCN_2 + C$.

A new process for the production of nitrous compounds, which is the invention of Messrs. Schoenherr and Heszberger, is being introduced on a large scale in Norway by the Badische Anilin- und Sodafabrik. In this process air is passed through an iron tube in which an alternating-current arc of 5-metre length is maintained under a pressure of 4200 volts. The air enters one end of the tube by a series of tangential holes, and the rotary motion thus produced keeps the arc confined to the axis of the tube. Each arc absorbs 600 horse-power.

Electricity in Agriculture.

The discovery that electrification of the atmosphere immediately above the plant stimulates in certain cases its growth is now being utilised practically under a system worked out by Sir Oliver Lodge, in collaboration with Mr. J. E. Newman and Mr. R. Bomford. A network of galvanised iron wires is stretched over the field to be treated, and suspended 18 feet from the ground from wooden posts and oil insulators. The posts are placed 70 yards apart, so that about one post per acre is required. The network is positively electrified to from 60,000 to 100,000 volts by means of an induction-coil mercury gas break and Lodge rectifying vacuum valves. The induction coil is worked on the primary side by continuous current obtained from an ordinary dynamo. The amount of primary power required per acre is very small, namely, from 10 to 20 watts. The installation is run for five or six months during eight to ten hours each day, and the total expenditure of energy is only about 20 B.O.T. units per annum per acre. Under this treatment the increase in the yield per acre is about 30 per cent., but under certain conditions it may be even more. The system is in use on several farms in this country, on six farms in Germany, and on one farm in Holland.

In the time at my disposal I have only been able to refer to a few of the industries which have benefited by the application of electricity; but when one reflects that nearly every industry in the country has been, or might be, furthered by the use of electricity in one form or another one comes to see that an enormous field of useful work is open to the electrical engineer—not only useful to himself, but even more so to the interests that employ him. How, then, comes it that electrical engineering is not so prosperous as it might be? Some of our members say because we are backward as compared with our foreign competitors. If by that term they mean that our electrical engineering works cannot produce equally good plant as our rivals, I cannot agree. I have frequently visited Continental shops, and, although I am quite willing to admit that excellent work is done there, I am also convinced that British shops can turn out work equally well and generally at a slightly lower prime cost. There is certainly no justification in reproaching the makers of electrical plant with backwardness; and, moreover, it is bad business policy. If, however, the reproach is levelled against the potential users of such plant there is some justification, and also a reason. Our great staple industries are old-established and have been fairly prosperous for generations; those on the Continent are of recent growth, and had to struggle into existence against English competition. To become successful they had to adopt every improvement which science put at their disposal. With them the application of electricity is almost a vital matter; with us only a desirable improvement. Is it, then, to be wondered at if a works manager or owner, who has grown up in the pre-electric days, and has been doing a prosperous business ever since, should be rather slow in embarking in new methods of working which, to his thinking, might entail the possibility of risk and the certainty of greater mental exertion? There are, of course, exceptions, and a good many of them, as witnessed by the great strides which electrical methods applied to our staple industries have already made; but, compared to what the development might be, we must admit that we have as yet only touched the fringe of this vast field. There is progress, but it is not fast enough, and to accelerate it we must educate the potential users of electrical plant. A beginning in this direction has already been made by the managers of electric-light stations. They are educating the householder by local exhibitions and literature that he can understand. On the Continent every large electrical engineering firm has a literary department, the business of which it is to educate possible customers. No sooner is a new winding plant started, or a cotton mill electrically equipped, than well-written, well-printed, and beautifully illustrated leaflets are sent out into the world to tell possible clients of the work done by the firm. Here, such literary departments are the exception; and thus it comes about that we hear so much of the great advances made on the Continent and so little concerning equally good work done here.

Our institution can also do something to accelerate the introduction of electricity into our great industries. It is no doubt very useful if we in our meetings read highly technical papers, and thus educate each other; but this is only part of our work. The other part is to educate the customer, and for this purpose we possess in our organisation of local sections the requisite machinery. By arranging for papers which shall be of interest to the particular industries carried on in the district of each local section, our institution can further the adoption of electricity in these industries, and this will not only be to our own advantage, but even more to the advantage of those whom we serve.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

CAMBRIDGE.—The professorship of biology will be vacant on January 1, 1910, by the resignation of Prof. Bateson as from that date. Candidates for the professorship should communicate with the Vice-Chancellor on or before Monday, January 10. The professor will receive a stipend of 700*l*. a year, with the usual deductions in case he holds a fellowship. It will be the duty of the professor to promote by teaching and research the knowledge of genetics.

The Balfour studentship will be vacant at Christmas, 1909. The names of applicants, together with such information as they may think desirable, should be sent on or before January 15, 1910, to the secretary, Mr. J. W. Clark, Registry of the University, Cambridge.

Dr. Whitehead has been appointed chairman of the examiners for the mathematical tripos, part i., 1910.

Mr. W. B. Hardy has been nominated a manager of the Quick fund from January 1, 1910, to December 31, 1915.

The electors to the Isaac Newton studentships give notice that, in accordance with the regulations, an election to a studentship will be held in the Lent term, 1910. These studentships are for the encouragement of study and research in astronomy (especially gravitational astronomy, but including other branches of astronomy and astronomical physics) and physical optics. The studentship will be tenable for the term of three years from April 15, 1910. The emolument of the student will be 200*l*. per annum, provided that the income of the fund is capable of bearing such charge. Candidates for the studentship should send in their applications to the Vice-Chancellor between January 16 and 26, 1910, together with testimonials and such other evidence as to their qualifications and their proposed course of study or research as they may think fit. Candidates are recommended to send with their applications an account of any work bearing on astronomy or physical optics on which they may have been engaged, and to forward copies of any papers they may have published on these subjects.

The special board for moral science directs attention to the urgent need of more adequate accommodation for the laboratory of experimental psychology. Since 1897, when the lectureship in experimental psychology was first established, this department has been successively housed in various temporary quarters, all totally unfitted for the purpose. At Oxford an excellent laboratory devoted to experimental psychology has recently been erected, presided over by a reader, who is a Cambridge man. This laboratory was built and is maintained at the expense of the University. The board is of opinion that it is essential that a similarly permanent and satisfactory building should be provided without delay in Cambridge if instruction and research in this important new subject are not to cease.