## *SOME SCIENTIFIC CENTRES.*

### XI.—THE PHYSICAL LABORATORIES OF MANCHESTER UNIVERSITY.

SIXTY years ago John Owens, fine-spinner of Manchester, left 97,000*l.* "for providing or aiding the means of instructing and improving young persons of the male sex in such branches of learning and science as are usually taught in the English universities, but subject, nevertheless, to the two following fundamental rules and conditions, that the students, professors and teachers . . . shall not be required to make any declaration as to or submit to the test of any of their religious opinions. . . ."

The trustees rented for the purpose of the college a large private house in Quay Street in the city, formerly inhabited by Richard Cobden. The college was opened in 1851, with a staff of five professors, among whom appears the name of Edward Frankland as first professor of chemistry.

Though the chemical laboratory became almost at once very successful, a special fund of 10,000*l.* being raised for its development, it was not until much later that the chair of physics, or, as it was then called, "natural philosophy," was founded, Prof. A. Sandeman being its first occupant. He was succeeded by Prof. R. B. Clifton, F.R.S., now of Oxford, who was again succeeded in 1866 by Prof. William Jack.

On Prof. Jack's removal to Glasgow, Dr. Balfour Stewart, F.R.S., was called from Kew Observatory, where he was then superintendent. A small physical laboratory was opened by him at Quay Street in 1871, when eight students attended for instruction.

In 1873 the college was removed from the city to its present site in Oxford Street, to the fine new building erected from the designs of Mr. Alfred Waterhouse, R.A. The accommodation assigned to the physical laboratory consisted of three small rooms in the basement, quite at the back of the college. With the addition of a private laboratory for the professor, and a workshop, these constituted Prof. Stewart's quarters for experimental work up to his death, which occurred in 1887. Though much of Prof. Stewart's work while at Kew, such as his classic research on the air-thermometer, was of an experimental character, after he came to Manchester he seems to have devoted his attention more particularly to the theories of terrestrial magnetism and of the sun, rather than to laboratory research. The writer, who attended his classes in 1887, remembers how Prof. Stewart displayed an almost affectionate interest in demonstrating the use of certain instruments, such as, for example, the magnetometer, in which he always showed an especial delight.

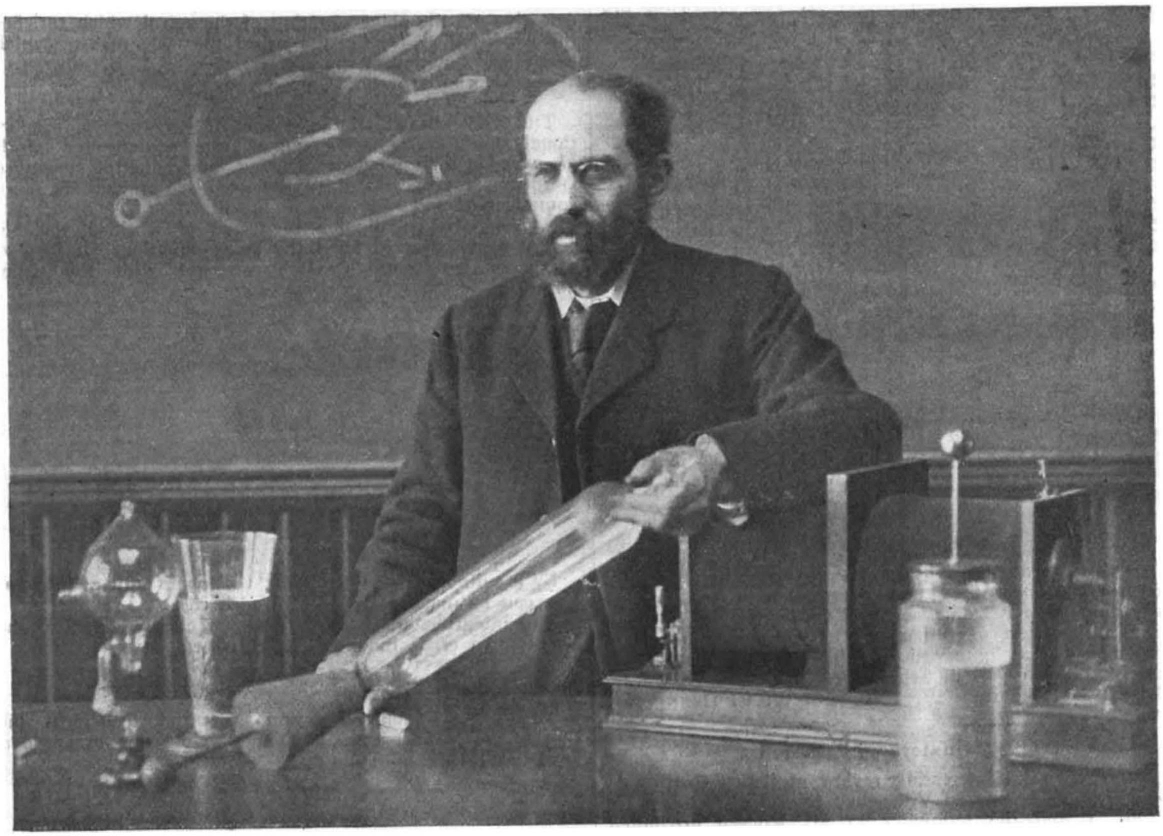

*Photo.*] [*Warwick Brookes, Manchester.*

FIG. 1.—Prof. A. Schuster, F.R.S., in his laboratory.

On Prof. Stewart's death, after an illness brought on by an extremely rough sea voyage from Ireland, Prof. Arthur Schuster, F.R.S., who then occupied the chair of applied mathematics in the college, was called to succeed as Langworthy professor of physics and director of the physical laboratories.

Although from time to time the quarters assigned to physics had been considerably enlarged, the demand for a larger laboratory soon became very urgent, and, a generous donor having promised a large sum for the purpose, the council decided to build a new physical institute on a plot of ground close to the main buildings.

An interesting volume[1] has recently been published giving a description of the new physical laboratories and of the work done at the college during the occupation of the chair of physics by Prof. Schuster. It was compiled in commemoration of the twenty-fifth anniversary of his professorship, which was celebrated last summer by a large gathering of his old students and assistants, a specially bound copy being presented to Dr. Schuster by them on the occasion. Its compilation was largely the work of Dr. Hutton, head of the electrochemical department, who recently succeeded Dr. Lees, F.R.S., as assistant director of the laboratory. This book contains plans of the building and some excellent illustrations of the various departments, together with biographical notes and a bibliography of the scientific achievements of the professor, his staff, and pupils during the period named. The frontispiece of the work is a fine portrait of Prof. Schuster, by Lafayette.

As an account of the new laboratory appeared in these columns previous to its opening by Lord Rayleigh in June, 1900,[2] attention will only be directed here to a few of the more important features, and more particularly those connected with the research work.

From his earliest associations with physical science Prof. Schuster had always been specially interested in spectroscopy, having received his inspiration from contact with the foremost pioneers in this branch; Bunsen, Kirchhoff, and Roscoe. Hence it was only to be expected that the facilities for spectroscopic research in the new laboratory should be of a unique character. Probably one of the most important pieces of special apparatus is the large concave grating of $21\frac{1}{2}$ feet radius, of very high quality, specially ruled by the late Prof. Rowland for Dr. Schuster. The mounting, the details of which have been improved by Prof. Schuster, and subsequently by Mr. Duffield, is arranged so that the grating and camera are fixed to carriages, sliding on specially stout iron beams, so connected that as the camera moves away from the plate the grating moves towards it. With this arrangement, as Rowland showed, the different portions of the spectrum are always in focus, whatever the position of the camera on its beam. Mr. Duffield communicated last year to the British Association a preliminary account of a research in which he has been engaged using this equipment, for the study of the effect of pressure on the arc-spectrum of iron, the pressures being varied up to 100 atmospheres.

Other spectroscopic apparatus are a 33-plate echelon-spectroscope by Hilger; a printing comparator for the measuring of spectrum photographs, from the designs of Prof. Kayser; a quartz spectrograph; and a smaller specially mounted concave Rowland grating of one-metre radius.

A very important development of the special work of the laboratory is the department of electrochemistry, which, owing to the efforts of Dr. Hutton and Dr. Petavel, F.R.S., has now established a wide reputation. The details of the equipment have been previously described,[3] but mention must be made of the special electric furnace in which reactions can be studied in gaseous pressures ranging up to 200 atmospheres, and also of the various modifications of the carbon-resistance furnace, designed by Dr. Hutton for different purposes. Accounts of more than one important research undertaken in the department are now in the press.

No record of the physical work at Manchester would be complete without a reference to the long series of painstaking researches by Dr. Lees on thermal conductivity. Alone, and in conjunction with students as collaborators, he has published during the past fifteen years ten papers, many of them of great importance on the subject. He was the first to work with sufficient accuracy to determine with certainty the sign of the temperature coefficient of thermal conductivity in a number of materials, and the value of his work was recognised by his election as a Fellow of the Royal Society last year.

The physical department at Manchester was one of the first to recognise the importance of electrical engineering, and in the old buildings a considerable sub-department was the "dynamo house," where, under Dr. Lees's tuition, many now occupying high positions in the world of electrotechnics received their training. When the department was reorganised on a larger scale, the Hopkinson Memorial Wing was built and equipped by the friends and relatives of the late Dr. John Hopkinson for the purpose. This was placed under the supervision of Dr. R. Beattie. In this house and its annexes are installed a representative collection of all the more important types of modern machines, including specially designed generators for experimental work of all kinds, as well as some machines of historic interest, such as the pair of early alternators presented by Dr. Henry Wilde, F.R.S., to illustrate the property of synchronous running originally discovered by him.

A meteorological station in Whitworth Park, erected by the generosity of the Whitworth trustees, has been splendidly equipped under the care of Dr. C. G. Simpson, and quite recently a kite station at Glossop Moor on the Derbyshire hills has been fitted up under the superintendence of Dr. Petavel with improved Dines apparatus, for winding in and paying out the steel kite-wires, worked by a small engine. This is the most westerly station in Europe for kite-flying, and may therefore acquire considerable importance in the international scheme for the investigation of the upper atmosphere.

Dr. Petavel's researches on radiation and on high-pressure explosions led to his recently being elected to the Fellowship of the Royal Society, and have caused him to be regarded as an authority on both these branches.

After mention of these particular developments of the work of the laboratory, we may note that in the volume referred to, the mere bibliography of the scientific publications of Prof. Schuster and his pupils occupies no less than eighty pages, covering an extremely wide range. Students have been attracted to the laboratory, not only from all parts of England, but from abroad, especially of late years. This is due in some measure to the splendid provision made for research, but undoubtedly in a greater degree to the eminence Prof. Schuster has attained as an original investigator, and pioneer in many important branches of physics. His early work on the discharge of electricity through gases, carried out in the old building with the help of his extremely able private assistant, the late Mr. Arthur Stanton, contributed largely to laying the foundations of the modern theory of the charged atom, which has seen such marvellous developments at the hands of the Cambridge school of physics. His work as an astrophysicist has taken him almost all over the world on eclipse expeditions, and, as a representative either of the British Government or of the Royal Society, to many scientific con-

1 "The Physical Laboratories of the University of Manchester." A record of twenty-five years' work. Prepared in commemoration of the twenty-fifth anniversary of the election of Dr. A. Schuster, F.R.S., to a Professorship in the Owens College, by his students and assistants. Pp. 142. (Manchester: The University Press.) Price 5s. net.

2 NATURE, vol. lviii., pp. 621–2.

3 Hutton and Petavel, Journ. Inst. Elec. Eng., 1903, vol. xxxii. pp. 222–247.

ferences. His influence on the research done by his pupils at Manchester is easily traced, and all of them would acknowledge the inspiration and encouragement of many a half-hour's chat with the professor, perambulating the corridor to and fro in a thoroughly characteristic manner.

Some months ago Prof. Schuster announced his intention of vacating the chair of physics to allow more leisure for the literary work and theoretical research to which he has recently devoted himself more particularly. To the satisfaction of his colleagues at Manchester, it has been decided, however, that his connection with the college shall not cease, but that he will continue to direct some of the research, and the council has therefore appointed him "honorary professor." His place as Langworthy professor and director of the laboratory has been filled by the appointment of Prof. E. Rutherford, F.R.S., of Montreal, who arrived in Manchester a short time ago and organised some researches, though not nominally in charge of the laboratories until the commencement of the October session. Prof. Schuster at present is engaged in the study of the permeability of iron at high temperatures under high pressures, especially with a view to discover the effect of high pressures in changing the temperature, between 800° and 900° C., when the metal suddenly loses most of its magnetism. Pressures up to 1000 atmospheres are contemplated. A second problem under investigation is the effect on the rate of decomposition of radio-active substances of extremely high pressures, such as are met with deep down in the earth's crust. In both these problems the design of the high-pressure portion of the apparatus has been due to Dr. Petavel, and for the latter purpose Mr. Cook, the university mechanician, has succeeded in constructing a combined pump and ram, in which pressures up to 37,000 pounds per square inch can be maintained without perceptible leak over long periods. The effect on radium of pressures up to 2000 atmospheres has been studied, and an account of the experiments will be ready shortly.

The accompanying photograph of Prof. Schuster in the laboratory was taken specially by Mr. Warwick Brookes.

J. A. HARKER.

## *A NEW METHOD OF COLOUR PHOTOGRAPHY.*

THE latest method of colour photography is distinguished as the "Warner-Powrie" process, and is well illustrated at the first exhibition of the Society of Colour Photographers, which will close on October 26. It will presumably be some little time before the plates are generally obtainable, but so far as can be judged from the examples shown and the details of their preparation, it is a process that will offer special advantages. Mr. Powrie has been working at the subject for many years, and has succeeded in producing a triple-coloured lined screen with better and finer lines than has been possible by previous methods, and without either gap or overlap. He discards ruling in favour of a very ingenious method of printing that does away with all need for the troublesome registration that becomes almost impossible with fine lines. The glass is coated with a bichromated colloid, exposed under a black-lined screen that has spaces half the width of the lines, and developed in warm water. This leaves the colloid in lines with spaces of bare glass twice as wide as the lines. By immersion in a solution of a green dye the lines are stained, and by the application of formalin or chrome alum the colloid is made quite insoluble and the dye fixed. The plate is coated again, exposed under the same black-lined screen, the only precaution being that the green lines already made shall be covered with the black lines of the overlying screen. After exposure and development the plate is immersed in a solution of a red dye to stain the second set of lines, and again treated with a hardening agent. The plate is coated once more, and this time exposed alone with its back to the light, so that the red and green lines already made serve to protect the coating from light action. So after development all the remaining spaces are exactly filled with colloid, and this is then dyed blue. The prepared plate is coated with a suitable photographic emulsion, and can be used in a similar way to the "autochrome" plates of Messrs. Lumière, which we have already described. The chief difference between the two apparent by mere inspection is that the colours are in lines instead of as a random grain. But the lines can be made so fine that they are invisible to a normal eye without assistance.

It is obvious that the "autochrome" and the "Warner-Powrie" plates, and any plates in which the surface is apportioned to three colours for colour reproduction, must absorb about two-thirds of the light that would pass through them if the colours were not there. A simple colour, such as red, is produced by a silver deposit that covers the green and blue colours that are in the area that is required to be red, and this area is therefore one-third red and two-thirds black. A print on a "bleaching-out" paper (as the "Uto") would give its colours mixed with a double area of black, and therefore be uselessly dark. It is difficult, if possible, to obviate this with a random distribution of the colours, but Mr. Powrie, with his plates, overcomes the difficulty by separating the plate and the paper with a thin sheet of celluloid or glass, and by two mirrors on opposite sides of the printing frame gets oblique light in two directions, as well as direct light at right angles to the surface, and so causes each coloured line in the plate to give a line on the printing paper three times its width. In this way, each colour—red, green and blue—produces its effect over the whole surface of the paper, the colour patches are continuous (free from black), and what should be white parts are completely bleached instead of being coloured like the original. In the same way, but using ordinary plates, and red, green and blue light separately for the exposures, a separate negative can be obtained of each of the three colours, with a continuous image on each, and these can be used for any method of three-colour printing. A single exposure on a single plate will thus give all that is necessary for the preparation of the three colour records which hitherto have been obtained by separate and generally consecutive exposures on the original.

C. J.

## *MR. HOWARD SAUNDERS.*

IT is with unfeigned regret that we record the death of Mr. Howard Saunders, after a long and painful illness. Mr. Saunders was born in London in 1835, and was therefore seventy-two at the time of his death. He was educated privately—to a great extent at Dr. Gavin Smith's school at Rottingdean, near Brighton, where he is said to have developed that taste for ornithology by means of which he attained eminence in later years. Immediately after leaving school he entered on a business career, and at the age of twenty joined a mercantile house at Callao. Five years were spent by him in Chili and Peru, where archæological studies appear to have