

Biographical Byways.<sup>1</sup>

By Sir ARTHUR SCHUSTER, F.R.S.

## 4. KIRCHHOFF (1824-1887) AND BUNSEN (1811-1899).

I N the controversies that excited at one time a good deal of feeling with regard to the part played by different men of science in establishing the principles of spectrum analysis, some confusion was caused by the ambiguous meaning of the word "analysis." The term may apply to the separation of the spectrum into its constituent homogeneous radiations, or it may denote a method to identify the constituents of a chemical compound by the light it emits when raised to incandescence. To avoid the ambiguity, I introduced in 1882 the word "Spectroscopy," to indicate the physical side of this branch of science. With regard to the use of the prism as an instrument of chemical analysis, there can be little doubt that Kirchhoff and Bunsen first demonstrated its practical importance, though Wheatstone had clearly indicated its possibility.

I worked for one year with Kirchhoff at Heidelberg (1871-72). Those were not days of extensive and well-equipped laboratories. Next to Kirchhoff's private study, in the building which served as his residence, one room only was available for advanced work. Its chief occupant was Lippmann, who was working at his capillary electrometer. My table was by the side of his, and having placed myself entirely at Kirchhoff's disposal, he asked me to test an instrument he had devised for the study of metallic reflexion. Nothing came of it, partly because the instrument did not prove suitable for the accurate study of elliptic polarisation, and partly because my measurements were not very good owing to the astigmatism of my eyes, which had not at that time been recognised. The only other advanced student was Kamerlingh Onnes, who was experimenting with a pendulum designed to demonstrate the turn of the plane of vibration due to the rotation of the earth. He had to work in the lecture room next door. There was only one other room, and that was used for elementary exercises. One exercise was set aside for each week, and every student—about eight altogether—had a morning or afternoon assigned to him for carrying out the experiment. There was one weekly lecture in which the results were criticised and the succeeding exercise explained.

During my stay at Heidelberg, I was anxious to repeat an experiment I had previously performed on the spectrum of nitrogen. There was no glass-blower in Heidelberg and no means of obtaining a Geissler tube. Kirchhoff, to whom I appealed, advised me to consult Bunsen, who offered to let me use his laboratory, where I could find the necessary appliances. I had to confess that I was not sufficiently expert in glass-blowing to make the tube myself. He seemed rather amused, took me to a little room and spent the next half-hour at the blow-pipe. When the tube was ready, further difficulties arose. Bunsen gave me a very inefficient induction coil and insisted on my using a bichromate battery; but he would not allow the zinc plates to remain in the solution for more than two or three seconds, watching me all the time. I could not get a proper start and had to give up the experiment.

There are always innumerable stories about Bunsen

illustrating his absent-mindedness and simplicity of character. Many of them will be found in Roscoe's "Reminiscences."

I attended Bunsen's elementary lecture course, which began at seven o'clock in the morning during the winter and at six in summer; but one had to be in the lecture theatre well in advance of the hour fixed, because the time was taken from a very erratic clock in this room. Whenever Bunsen was ready to start, he sent his assistant in to set the clock at six or seven as the case might be, beginning the lecture sometimes a quarter of an hour too early or too late by the real time.

There could be no greater contrast both in appearance and manner than that presented by the two men. Kirchhoff, sharp-featured and always correct and precise: Bunsen, with the appearance of a prosperous farmer, and a somewhat cynical but at the same time good-natured smile. New discoveries almost worried Kirchhoff: they amused Bunsen. The effect of light on selenium happened to be first published when I was at home on a holiday, and on returning to Heidelberg I mentioned it to Kirchhoff. His reply was: "I should not have believed that such a curious fact could have remained undiscovered until now." Kirchhoff's lectures were prepared with extreme care and delivered with precision. He is reported never to have missed one during the tenure of his professorship at Heidelberg, but the record was certainly broken on one occasion. "I regret to announce," he said on a certain Thursday at the conclusion of one of his lectures, "that circumstances prevent my meeting you to-morrow." The "circumstances" were that he was going to get married, and the honeymoon lasted from Friday till Monday, when he was at his desk again.

When both men had retired and were nearing the end of their lives—one at Berlin and the other at Heidelberg—I occasionally went to visit them. Kirchhoff's interests were confined to the days that were gone. He admired Maxwell for his work on the kinetic theories of gases. "He is a genius," he said, "but one has to check his calculations before one can accept them." He admired Lord Kelvin for his vortex theory of matter. "I like it," he remarked, "because it excludes everything else," and he added with a sigh: "If only it could explain gravitation." Bunsen liked to talk about new ideas. "Tell me all about the experiments of Hertz," was his first remark on one occasion; and in spite of his almost complete deafness, he had a way of understanding when the subject interested him.

It may be worth while to record the scepticism of Bunsen with regard to the chemical identity of diamond and carbon. He considered the evidence to be insufficient, depending in great part on a single reaction of the gas produced in the combustion of the two bodies. A more convincing test was the demonstration that equal weights of the two bodies produced equal weights of the products of combustion; but all depended here on the accuracy of the measurement, which probably was not very great. My information came from Sir Henry Roscoe, who repeatedly alluded to it in conversation. Engaged at the Cavendish

<sup>1</sup> Continued from p. 89.



laboratory on the spectrum of oxygen, I took the opportunity of placing a diamond inside a platinum spiral in an oxygen vacuum, and raising the spiral to a red heat by means of an electric current. The characteristic spectrum of an oxygen compound of carbon at once appeared, leaving no doubt as to the nature of diamond.

The examination for the doctor's degree at Heidelberg in those days was a purely oral one. The candidate was, in addition, supposed to send in a dissertation, but if this was not ready at the time of the *viva voce*, his degree was conferred on the latter alone, subject to the condition that he deposited a sum of money, which, so far as I recollect, amounted to 10*l.* This was returned if the dissertation was sent in and approved within one year. Three subjects had to be chosen; for example, physics, mathematics, and chemistry, of which one formed the principal and took up an hour. For the two others, half an hour was considered to be sufficient. The candidate, when ready, gave notice to the proper authority, and was in due course summoned to present himself on a certain day at seven or eight o'clock in the evening. No account was taken of attendances or period of study. Kirchhoff had the reputation of being a very strict examiner. When at the beginning of the year which I intended to spend at Heidelberg, I asked him how far I was expected to know the more mathematical branches of the subject, the only answer I got was: "I shall examine you in physics." All professors of the faculty received a fee for being present at the examinations, and the faculty of philosophy included all branches of arts as well as of science: this naturally secured a good attendance.

During my visit to Königsberger, the examiner in mathematics, he told me that Kirchhoff was very fond of asking questions about the potential. This reassured me, as I felt pretty safe in that subject, but it turned out that the examination was all on optics. The candidate sat at a long table, surrounded by about twelve severe-looking individuals, most of whom were perfectly ignorant of scientific subjects. As I had not passed the "Abiturienten Examen," which is the school-

leaving test, I had to submit to an additional examination in Latin; but the examiner told me, during my visit to him, that he would pass me however badly I did, and indicated the particular book in Cæsar's "De Bello Gallico" out of which he would ask me to translate a passage. I have a vivid memory of the mournful shaking of heads that went round the table when I translated "frumentum" with "Korn," which in German means "rye," instead of with the proper word which is "Getreide." An hour's *viva voce* can, of course, cover a good deal of ground, for, as soon as the examiner is satisfied that the candidate can answer a question satisfactorily, he at once passes on to another. After the first hour, a quarter of an hour was spent on light refreshments consisting of wine and cakes, and then the examination in the two secondary subjects began. Finally, the candidate was asked to withdraw, and after a few minutes' interval the result was announced to him. If successful, he was summoned to present himself to the Pro-rector next day. The degree was actually conferred after he had delivered an oath in Latin promising many things, one being that he would not take a degree at another German university.

All through the examination it appeared to me that the examiners rather took the part of advocates of the candidates against the gallery of dummy professors who were paid to be present. When I got into a muddle with Kirchhoff over a question involving the wave surface and he had not spotted my mistake, he only said, "We both have been rather stupid over this," and then started another subject. When I could not answer one of Königsberger's questions he said: "There is no need for you to know this; I only asked you on the chance." As a matter of fact, I did know it, but failed to recognise the German expression which he used.

While I was considering the subject of my promised dissertation, I happened to meet the chief librarian of the university, who expressed the hope that I would default, for the reason that the forfeited deposits became the property of the University Library, which depended on this form of revenue.

### Obituary.

DR. G. D. LIVEING, F.R.S.

BY the death of Dr. George Downing Liveing shortly after his ninety-seventh birthday, the University of Cambridge has lost the last of that small band of men who some sixty years ago set on foot the movement which proved the foundation of the present science school in that University. He was the eldest son of Edward Liveing, of Nayland, Suffolk; entering at St. John's College, Cambridge, in 1847, he was classed as eleventh wrangler in 1850, and as the first among the six who took the Natural Sciences Tripos in 1851, the year of its creation. After a short period of work under Rammelsberg in Berlin, he became a fellow and lecturer at St. John's College in 1853. In 1860 he married Catherine, daughter of the Rev. R. Ingram, of Little Ellingham, Norfolk, and thus automatically vacated his College fellowship in accordance with the old University statutes; in the same year he became professor of chemistry in the Military College at Sand-

hurst, but continued to teach in the St. John's Laboratory.

The Rev. James Cumming, F.R.S., occupied the chair of chemistry from 1815 to 1861, and Liveing, who had acted as deputy during the last two years of Prof. Cumming's life, was elected into the chair in the latter year. Liveing retired from the professorship in 1908; the University then conferred upon him the honorary degree of Sc.D. and appointed him an emeritus professor. He had been a professorial fellow of his College since 1880 and was elected into a fellowship again in 1908; in 1911 he became president of St. John's College. For many years he held the responsible and confidential office of Chancellor's secretary, an honorary official whose duty consisted in keeping the Chancellor of the University informed on all material happenings. In addition he served for long as a Borough and County Justice of the Peace, and was punctilious in the performance of his magisterial duties.