

aid of the now well-known vacuum tubes of Geissler,<sup>1</sup> of Bonn, began that long series of experiments on the discharge of electricity in rarefied gases, on the influence of magnets upon the course of the luminous rays, and on the spectra of incandescent gases, which subsequently, in the hands of Sir William Crookes<sup>2</sup> in this country, of Hittorf, Goldstein, Elster and Geitel, and of Giese in Germany, and of a great number of other natural phil-

<sup>1</sup> See the Memoir of Plücker in the 'Annalen der Physik und Chemie' (1857); "Ueber die Einwirkung des Magneten auf die elektrischen Entladungen in verdünnten Gasen" (reprinted in 'Gesammelte wissenschaftliche Abhandlungen,' vol. ii. p. 475, &c.) Before Plücker took up the investigation with improved means of exhaustion (later perfected by the well-known Sprengel pump), several French experimentalists—notably Quet, Gassiot, and Abria—had independently marked the difference of the light near the positive and negative poles, mostly in ignorance of the observations recorded by Faraday in his early "Experimental Researches," as far back as 1838, referring to the "dark discharge." Lord Kelvin, in his Presidential Address before the Royal Society (November 1893), refers to the researches of Faraday, and to a long list of contributions to the same subject contained in the Proceedings and Transactions of the Royal Society. Except those of Faraday, they are all later than Plücker's earliest papers. Lord Kelvin himself says: "Fifty years ago it became strongly impressed on my mind that the difference of quality between vitreous and resinous electricity, . . . essentially ignored as it is in the mathematical theories . . . with which I was then much occupied

(and in the whole science of magnetic waves as we have it now), must be studied if we are to learn anything of the nature of electricity and its place among the properties of matter." Cf. the words of Hittorf (Pogg. 'Ann.,' vol. cxxxvi. p. 1), quoted by Rosenberger, 'Geschichte der Physik,' vol. iii. p. 778.

<sup>2</sup> The experiments and discoveries of Sir W. Crookes on "Radiant Matter," beginning with his paper in the 'Transactions' in December 1878, and continued in many subsequent communications, as also in his Address before the Brit. Assoc. in 1879, especially his theoretical explanations based upon conceptions taken from the kinetic theory of gases, made a great sensation and led to much discussion in this country and abroad. The term Radiant Matter was adopted from Faraday (see Rosenberger, *loc. cit.*, vol. iii. p. 779). The corpuscular theory of light was not indeed revived; but in general, after much criticism, Crookes's views have to a large extent been adopted; and if not the corpuscular theory of light, certainly that of electricity has been greatly supported by these brilliant experiments. See J. J. Thomson in the Princeton Lectures (1898), p. 189 *sqq.*, and Prof. Kaufmann's Address, delivered at the Hamburg meeting in September 1901 (translated in the 'Electrician' of November 8, 1901).