

duced in Germany, and that especially the ideas of Faraday and Maxwell were popularised, expounded, and submitted to elaborate tests. These culminated in the brilliant discoveries of Hertz already referred to.

As in his earlier researches into the connection of the phenomena of heat and mechanical work, so in these later ones concerning the electro-dynamic laws; Helmholtz seems to have approached his subject primarily in the interest of physiological¹ science. At that time

34.
Helmholtz
on electro-
dynamics.

the British Association and the still older "Lectures" of the Royal Institution. Before his time there were only rare instances—notably those of Bessel, Liebig, and Humboldt—where scientific thinkers of the first rank condescended to influence general opinion and polite literature by stepping down from the university chair into the arena of a popular audience. No other German scientific thinker has left a collection equal to Helmholtz's 'Vorträge und Reden,' not even Bessel, whose 'Populäre Vorlesungen über wissenschaftliche Gegenstände' (ed. Schumacher, Hamburg, 1848) are too little known. Du Bois-Reymond's 'Reden' are a mine of information on the history of science, and von Baer's 'Reden' (Braunschweig, 1886) contain some excellent and original discourses.

¹ Emil du Bois-Reymond, in many passages of his remarkable addresses, and latterly in his appreciative *Éloge* of Helmholtz (Leipzig, 1897), has preserved the historical data for a genetic history of Helmholtz's electrical researches, which, beginning in 1851, and culminating in Hertz's brilliant experiments on the "rays of electric energy" in 1888, completely changed the aspect of electrical science in Germany and to a less degree in France. The older view,

based upon a mathematical development of the fundamental conception of Ampère and mainly associated with the brilliant name of Wilhelm Weber, whose very extensive and accurate measurements largely supplied the material for the modern theory, is practically unknown to electricians in this country. No English text-book contains even a reference to a view which was once dominant abroad, and which for this reason forms a very interesting episode in the history of thought. In the fourth chapter I have referred to this view as, beside the theory of Boscovich, presenting one of the most remarkable applications of the astronomical view of nature, which originated in this country but was mainly cultivated by the French school. I must now briefly refer to the counter-movement, which in Germany is mainly identified with the name of Helmholtz. He may be said to have left the mark of his genius on the scientific history of his country as Lord Kelvin has done on that of England. His collected papers show us—and du Bois-Reymond tells us—how Helmholtz's interest in electrical problems was connected with the remarkable phenomena of animal electricity, to the exploration of which the former devoted his