attack on the problem by refusing to consider supraconductivity as the limiting case of ordinary conductivity and by considering it as a more elementary state in which the whole metal behaves like a large diamagnetic atom. A new equation, $\lambda C \text{ curl } J = -H$, relating current density and

magnetic field, is postulated, this assumption replacing Ohm's Law in a superconductor and leading directly to a solution in which stable persistent currents are possible, these currents being confined to a depth of 10^{-5} cm. below the surface of the conductor.

Obituary

PROF. H. M. MACDONALD, O.B.E., F.R.S.

HECTOR MUNRO MACDONALD was born in 1865 at Fearn, Ross-shire, and educated at Tain Academy, Aberdeen Grammar School and the University of Aberdeen, proceeding in 1886 to Clare College, Cambridge, and taking the Mathematical Tripos in 1889. The list of Wranglers was one of considerable distinction: Sir Gilbert Walker was senior, Sir Frank Dyson second, Macdonald fourth and A. S. Ramsey (president of Magdalene) sixth. He was soon elected to a fellowship at Clare, and in 1891 was Smith's Prizeman.

During Macdonald's formative period, the professorial chairs at Cambridge were occupied by Stokes, Adams (the discoverer of Neptune), Cayley, J. J. Thomson and G. Darwin; while of the other teachers, he seems to have owed most to Routh, Hobson, Glazebrook and Larmor. But perhaps his greatest debt was to Verdet's "Leçons d'optique physique", Maxwell's "Electricity and Magnetism" and the works of Horace Lamb and the third Lord Rayleigh.

Macdonald's first published papers were on hydrodynamics and the mathematical theory of electricity—waves in canals, electrical distributions on conductors of various shapes, and self-induction. In 1897, however, he began to write on pure mathematics—the relation between convergent series and asymptotic expansions, the zeros and the addition theorem of Bessel functions, various Bessel integrals, spherical harmonics and Fourier series. In the paper on the zeros of the Bessel functions (*Proc. Lond. Math. Soc.*, 29; 1898), he gave the result since known as Macdonald's theorem, that the number of zeros of a function $f(z)$ in the region bounded by a contour at each point of which $|f(z)| = a$ constant, exceeds the number of zeros of the derived function $f'(z)$ in the same region by unity, the function $f(z)$ being supposed analytic in the region.

Macdonald's reputation as a discoverer was, however, chiefly due to a third group of researches, which began with his Adams Prize essay of 1902 on electric waves, and was continued in a paper of 1903 on the bending of electric waves round a conducting obstacle, two memoirs on the diffraction of electric waves round obstacles (*Phil. Trans. Roy. Soc.*, 1911–12), several papers on the diffraction of light by opaque prisms, straight edges, etc. (*Proc. Lond. Math. Soc.*, 1913–15), and a series of papers (*Proc. Roy. Soc.*, A) from 1914 onwards on the transmission of electric waves round the earth's surface.

In 1905 Macdonald left Cambridge on being appointed to the chair of mathematics in his old

University of Aberdeen. The value of his work was recognised by the fellowship of the Royal Society in 1901, an honorary fellowship of Clare in 1914, a Royal Medal of the Royal Society in 1916, the presidency of the London Mathematical Society in 1916–18, and the Honorary LL.D. of Glasgow in 1934. During the last thirty years of his life, he took an active part in the administrative work of the University of Aberdeen and of educational institutions in the north-east of Scotland, and was almost invariably one of the delegates appointed to any conference of representatives of the four Scottish Universities. In recognition of his scientific eminence and public services, a subscription portrait was presented to the University of Aberdeen in 1933.

Macdonald never married. He died after a short illness on May 16, 1935. E. T. WHITTAKER.

PROF. W. R. HODGKINSON, C.B.E.

On April 8, at Blackheath, died, at eighty-three years of age, Prof. William Richard Hodgkinson, one of the older school of chemists, whose interests in chemistry covered a wide field. Born at Sheffield in 1851, and educated at the Royal Grammar School there, he early came under the influence of Sorby, the father of metallography, and to this is to be traced his later work on metals and their treatment.

Having gained a scholarship to the Royal School of Chemistry and of Mines in London, Hodgkinson studied geology, and under Sir Edward Frankland organic chemistry, before proceeding to the University of Würzburg, where his natural feeling for research was stimulated by Prof. Wislicenus, whose textbook on "Organic Chemistry" he translated. On returning to England his investigations at the Royal College of Science were mostly in organic chemistry, and in this branch of chemistry he published papers on such subjects as the action of the alkali metals on organic bodies, with W. H. Perkin, junr., and on organic bases and on naphthalene derivatives, with Dr. W. Limpach, whose sister he married nearly fifty years ago.

After a short period at the Royal Military Academy, Hodgkinson became lecturer in chemistry and metallurgy at the Ordnance College, and later professor of chemistry there, retiring in 1921 after thirty-one years of service in the College (now the Military College of Science). Most of Hodgkinson's work was thus carried out at Woolwich, and much of it was directed to Service problems and to training many generations of gunner officers, who look back to this