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Book Review: *The Scientific Letters and Papers of James Clerk Maxwell*

The Scientific Letters and Papers of James Clerk Maxwell. Vol. 1, 1846–1862. Edited by P. M. Harman, Cambridge University Press, Cambridge.

The title of this book is misleading. It does not represent a new and expanded version of the 1890 edition of Maxwell's scientific papers edited by W. D. Niven and reprinted by Dover in 1965. More usefully, it is a publication of material most of which is available only in manuscript form, and it is therefore complementary to Niven. To derive maximum benefit from the volume, the reader would be well advised to use it in conjunction with the Niven publication and the standard biography of Maxwell's life by Campbell and Garnett (1882, 1884).

An interesting scholarly introduction surveys the manuscript material available, and endeavors to trace the origin of the current collections and to assess how much has gone astray. Virtually all of the letters available to Campbell are no longer extant, and it is fortunate that Campbell published a significant number of them.

Most of the book consists of letters by Maxwell on scientific matters, and they cast light on the development of Maxwell's ideas before they crystallized into published papers. Of particular interest to readers of the present journal is the development of his thinking on the kinetic theory of gases. While he was at Aberdeen University (1856–60) working for his Adams Prize Essay on Saturn's rings, he considered the possibility that the rings might consist of masses of matter not mutually coherent, and he made the perceptive comment, "When we come to deal with collisions among bodies of unknown number, size and shape, we can no longer trace the mathematical laws of their motion with any distinctness." Some time between February and May 1859, he noticed a translation of a paper by Rudolf Clausius published in the *Philosophical Magazine* of February 1859 on the kinetic theory of gases. Clausius introduced a statistical argument to

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calculate the probability of a molecule traveling a given distance (termed the "*mean free path*") without collision. But Clausius assumed that the molecules all had the same velocity. Maxwell realized that the velocity of the molecules would be altered at every collision, and that after a certain time the kinetic energy would be divided among the particles according to a regular statistical law. He used a semiempirical argument to derive this well-known Maxwell distribution.

The speed with which Maxwell applied the basic ideas of Clausius is amazing. In a letter to G. G. Stokes dated May 30th, 1859, he mentions the above distribution, calculates the viscosity, and shows that, surprisingly, it should be independent of the density. By the time he came to make his results public, at the British Association meeting in September 1859, he had added the treatment of diffusion and thermal conductivity, and derived the equipartition of energy; he had calculated the ratio of specific heat at constant pressure to that at constant volume and concluded that it disagreed with experiment.

At the meeting of the British Association held in Oxford during June/July of the following year, he emphasized the final point: "This relation would make the ratio of specific heat ... to be 1.33 whereas we know that for air it is 1.408. This result of the dynamical theory, being at variance with experiment, overturns the whole hypothesis, however satisfactory the other results may be." Incredible honesty and prescience! More than 60 years elapsed before the advent of the quantum theory removed the above discrepancy.

The book is beautifully produced and represents a significant addition to the literature on Maxwell.

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