the general scientific intelligence, revealed itself as the measure of the disorder which prevails in the motion of the ultimate material elements of a system.[1] Faraday's lines of force and the whole elaborate imagery invented and afterwards discarded by Maxwell to describe the interaction of magnets, electric currents, and charged bodies, have proved to be most valuable instruments of thought—a useful scientific shorthand—in the hands of the teacher, as in those of the practical electrician. And although the illustrious propounder of the vortex-atom theory of matter seems latterly to have discouraged the use of this kinetic contrivance as not likely to lead to any great revelations regarding the ultimate constitution of matter or the nature of the imponderable,[2] the

[1] Helmholtz, in his first memoir on the thermo-dynamics of chemical processes ('Sitzungsberichte der Akademie zu Berlin,' 2nd February 1882), after having established the formulæ for the free energy in isothermal processes without reference to kinetic hypothesis, concludes his exposition with the following remarks: "We require, finally, an expression in order to be able to distinguish clearly what in theoretical mechanics is termed *vis viva* or actual energy from the work equivalents of heat, which are indeed mostly to be regarded likewise as *vis viva* of invisible molecular motion. I would suggest that the former should be called the *vis viva* of orderly motion. I call orderly all motion in which the compounds of velocity of the moving masses are differentiable functions of the space co-ordinates. Disorderly motion would then mean all motion in which the motion of each particle has no similarity to that of its neighbours. We have every reason to believe that heat-motion is of the latter kind, and one might in this sense regard entropy as the measure of disorder. For our means, which compared with molecular structure are coarse, only orderly motion can be freely converted again into other forms of mechanical work" ('Wissenschaftl. Abhandl.,' vol. ii. p. 972).

[2] "I am afraid it is not possible to explain all the properties of matter by the vortex-atom theory alone—that is to say, merely by motion of an incompressible fluid; and I have not found it helpful in respect to crystalline configurations, or electrical, chemical, or gravitational forces. . . . We may expect that the time will come when we shall understand the nature of an atom. With great regret I abandon the idea that a mere configuration of motion suffices" (Lord Kelvin, quoted by Prof. S. W. Holman in 'Matter, Energy, Force, and Work,' New York, 1898, p. 226).