

abstract theory of physical phenomena in general.”¹ It is only in our day, after the lapse of a quarter of a century, that these ideas have been taken up by others, and that the plan begins to be realised. The reasons why at the time it was abandoned were manifold.

To begin with, it was soon found, notably by Joule, Helmholtz, and William Thomson, that the new principle of the conservation of energy, if applied to various other phenomena outside of the narrower field of thermotics, led to a co-ordination and comprehension of them which was then quite unexpected: opening out new aspects, disclosing unknown properties, and suggesting innumerable experiments. As instances I may refer to the thermo-elastic and thermo-electric phenomena of bodies, which very early occupied the attention of the founders of the theory of energy. The discharge of the Leyden-jar, the generation of electric currents in the voltaic cell, the heat of electrolysis, the actions of permanent magnets and those between

¹ In a paper read before the Philosophical Society of Glasgow, May 1855, entitled “Outlines of the Science of Energetics,” and reprinted in ‘Miscellaneous Papers,’ ed. Millar, p. 209 *sqq.* See for the above definition p. 228. James Thomson’s contribution is to be found in a paper on “Crystallization and Liquefaction,” read before the Royal Society, December 5, 1861, in which he establishes and gives examples of the application of “a general physico-mechanical principle or axiom,” which indicates when a “substance or system will pass into the changed state.” As Helm says, it is a first attempt

to find a general rule for the transformation of energy (‘Lehre von der Energie,’ 1887, p. 63). That such a general rule can in the present state of our knowledge be established on purely energetic principles is upheld by some (Ostwald, Helm) and disputed by others (see especially Planck, ‘Thermodynamik,’ 1897, p. 71 *sqq.*), who state their conviction that the “energy-principle clearly does not suffice for the definition of natural processes.” The whole discussion merges into a philosophical question, of which more later on.