well to develop the novel conceptions which here force themselves upon us. Especially are we indebted to him for the idea—marking an epoch in the history of scientific thought—of the difference between historical knowledge of natural phenomena and a merely statistical summary of average results.[1] If the atomic view of nature has to be adopted seriously, as the development of the kinetic

88. Clerk Maxwell. The statistical view of nature.

[1] See Clerk Maxwell's memoir, 'Illustrations of the Dynamical Theory of Gases' (1859: reprinted in 'Scientific Papers,' vol. i. p. 377). Clausius had in his second paper, "On the average mean path of a particle" (Poggendorf's 'Annalen,' 1858), given an expression for this quantity as depending on the average distance of two particles and on the average diameter of the sphere of action of a particle. As these quantities are all only mean or average quantities, he had been obliged to resort to a method which was then novel in physical science, the method of averages and the calculus of probability, which is its mathematical expression. He had calculated the probability of a certain motion of a particle. Maxwell, who had in 1856 been engaged in writing his Adams prize essay "On the stability of the motion of Saturn's rings," had there considered the possibility of these rings being composed of a cloud of scattered particles moving with all possible velocities towards each other and round some attracting centre: he was thus familiar with physical problems in which the given data could be only average quantities. He now undertook to develop systematically the methods necessary for treating such problems, of which we have only statistical knowledge, and he there developed his famous law which gives the distribution of different velocities in a crowd of particles moving at random and in their collisions obeying the condition of the conservation of energy. This investigation marks an epoch in mathematical physics and in the history of the atomic view of nature. Like all theorems connected with the theory of probability, it has provoked a large literature, the foundations of the proof and the different steps in the logic of the deductions having been examined and criticised in the most searching manner. The expression given by Maxwell has stood all these criticisms,—"he has demonstrated the possibility of calculating in a strict manner the averages which before him had only been estimated, but which were required for a further development of the theory of gases." See O. E. Meyer, 'Die kinetische Theorie der Gase,' 2nd ed., vol. i. p. 45, &c., where also a complete account is given of the various steps by which the doubts which attached to Maxwell's theories and his proofs were at length removed, and the "variety of traps and pit-falls" avoided "which are met with even in the elements of the subject" (see Tait, "On the Foundations of the Kinetic Theory of Gases," 'Trans. of the Royal Soc. of Edinburgh,' 1886, vol. xxxiii. part 1, p. 66). In a later chapter of this history I intend to trace the development of the statistical view of nature, and shall then have occasion to revert to this subject.