STATISTICAL MECHANICS AND ITS APPLICATIONS TO PHYSICS

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I

STATISTICAL MECHANICS as a field of theoretical physics owes its origin and development to theories of atomism. I use the term "atom" in a generalized sense to include molecules, atoms, electrons, quanta of energy. An atomic theory is one that resolves physical reality into discrete constituents, or particles. The most striking characteristic of contemporary physics is the general acceptance of the hypothesis that physical systems consist of particles, at least from a significant point of view. The idea goes back to Democritus and similarly minded Greek philosophers, who invented the concept of the atom in order to reconcile the rational demand for unity and permanence in reality with the mutability of observable phenomena. The atomic theory, however, did not make significant quantitative progress until the nineteenth century. Then Dalton proposed his atomic theory for chemical systems. Subsequently Clausius, Maxwell, and Boltzmann developed the kinetic theory of gases. Later, it was found that electrical theory required atoms of electric charge. Since the beginning of the present century atomistic conceptions have found their way into the theory of energy, and have become the instruments of a quantum theory which is based on discontinuity in natural processes. The physiochemical systems which contemporary science investigates are conceived to be composed of many particles, corpuscles, atoms.

The problem posited by atomism arises in the following way: The classical physicist investigated and described physical phenomena in terms of concepts which expressed quantities that were relatively directly determined by experiments. If, for example, he wished to describe the observable properties of a gaseous system he employed the concept of volume, which is measurable by operations performed with a standard rod; the concept of temperature, which is measurable by a thermometer; the concept of pressure, which is measurable by a manometer. Between these measurable quantities the physicist sought functional relations which would involve empirical constants. There was a period in the nineteenth century when an influential school of thought taught that physics should not go beyond the establishment of generalizations concerning the observable properties of physical systems. To this school of energetics, classical thermodynamics was the ideal of physical theory. The course of development, however, has been guided by physicists who were not content with such a restricted goal. These physicists sought a deeper, more detailed description and explanation of physical phenomena. They have explained large-scale, observable processes in terms of fine-scale processes which are beyond the range of ordinary perception. Thus a kinetic-molecular theory