The Foundations of Dynamics

By Dr. G. J. WHITROW
Department of Mathematics, Imperial College, London

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Galileo, the founder of Dynamics, regarded this discipline partly as a *cosmological* science. He based his Natural Philosophy on a highly mathematical interpretation of Nature which was the foundation of the modern idea of the Uniformity of Nature as contrasted with the Aristotelian distinction between the terrestrial and the celestial realms. The most important influence on Galileo's thinking was Archimedes, but whereas the latter had constructed a geometry of rest, Galileo built a geometry of motion. He introduced, at least implicitly, the revolutionary conception that uniform motion in a straight line is physically equivalent to a state of rest.

Seven different theories of the nature of the law of inertia, regarded as an *axiom* of dynamics, may be distinguished :—

(1) It has been argued, for example by Karl Pearson, that the law as usually stated is false since it does not correctly describe the motion of *bodies* under no forces. Also Leibniz and Berkeley objected to the introduction of the idea of empty space.

(2) After the triumphs of Newtonian mechanics in the eighteenth century, it was maintained, notably by Kant, that the law of inertia is self-evident. This was also the view of Clerk Maxwell, but a detailed criticism of his discussion reveals its inadequacy.

(3) The view that the law is empirical is also inadequate, as the solution contemplated in the usual enunciation of the law is empirically impossible. Moreover, the Aristotelian theory of motion has *prima facie* more observational evidence in its support than Galileo's principle of inertia.

(4) It has been argued by Meyerson that the law is both *a priori* and empirical, a self-contradictory conception.

(5) Hertz in his *Principles of Mechanics* suggested that other formulations of dynamics were possible, based on different principles. The isomorphism of dynamics and Nature is not unique, and the law of inertia is not the only possible first axiom of dynamics.

(6) Thomson and Tait in their *Natural Philosophy* suggested that the law of inertia is a convention, a view which was presented in a much more satisfactory and acute form by Poincaré.

(7) Following this line of reasoning, we come to regard the law of inertia not as a unique postulate about matter, but as a particular rule concerning scientific method. A. Pap, in his recent essay *The A Priori in Physical Theory* asserts that the law is " synthetic *a priori* " in the functional sense of defining with the other laws of motion a method of analysing motions. As C. I. Lewis has argued in *Mind and the World Order*, " In every science there are fundamental laws which are *a priori* because they formulate just such definitive or categorical tests by which investigation alone becomes possible ".

Recently, following the work of Milne, the law of inertia has come to be regarded as a *theorem* rather than an axiom. Kinematic Relativity, however, points to a novel distinction between different classes of inertial frame, *viz.* those at rest relative to the " smoothed-out " universe and those in uniform motion relative to this local background. The implications of this revolutionary suggestion have as yet only been partially explored, but on this view the curious dichotomy between *absolute* rotation and *relative* uniform rectilinear motion, to which Bridgman drew attention in *The Logic of Modern Physics*, disappears.