A Short Note on Newton's Law of Motion

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Editorial

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EDITORIAL NOTE

Newton's laws of motion are three classical mechanics laws that describe the relationship between an object's motion and the forces acting on it. These laws can be summed up as follows: Unless acted upon by a force, a body remains at rest or in uniform motion in a straight line [1]. Law 2 states that a body subjected to a force move in such a way that the time rate of change of momentum equals the force. Law 3 states that when two bodies exert forces on each other, the magnitude and direction of the forces are equal. Isaac Newton stated the three laws of motion for the first time in his Philosophi Naturalis Principia Mathematica (Mathematical Principles of Natural Philosophy), which was first published in 1687 [2]. According to the ancient Greek philosopher Aristotle, all objects have a natural place in the universe: heavy objects (such as rocks) want to be at rest on Earth, light objects (such as smoke) want to be at rest in the sky, and stars want to remain in the heavens.

He believed that a body was in its natural state when it was at rest, and that for the body to move in a straight line at a constant speed, an external agent was required to propel it continuously, or else the body would stop moving. Galileo Galilei, on the other hand, realized that while a force is required to change the velocity of a body, no force is required to maintain its velocity [3]. For over 200 years, Newton's laws have been verified by experiment and observation, and they are excellent approximations at the scales and speeds of everyday life. Newton's laws of motion, along with his law of universal gravitation and the mathematical techniques of calculus, provided a unified quantitative explanation for a wide range of physical phenomena for the first time [4]. In the third volume of the Principia, for example, Newton demonstrated that his laws of motion, when combined with the law of universal gravitation, explained Kepler's laws of planetary motion. Newton's laws are applied to bodies idealized as single point masses, in the sense that the size and shape of the body are ignored in order to concentrate on its motion more easily [5]. When the resultant of all external forces acts through the center of mass of the body, this is possible. In this way, even a planet can be idealized as a particle for the purpose of analyzing its orbital motion around a star [6]. Newton's laws of motion, in their original form, are insufficient to characterize the motion of rigid and deformable bodies. In 1750, Leonhard Euler proposed Euler's laws of motion, a generalization of Newton's laws of motion for rigid bodies that was later applied to deformable bodies assumed to be a continuum [7]. If a body is represented as a collection of discrete particles, each of which is governed by Newton's laws of motion, then Euler's laws can be deduced from Newton's laws. Euler's laws, on the other hand, can be regarded as axioms describing the laws of motion for extended bodies independent of particle structure. Newton's laws apply only to a specific set of frames of reference known as Newtonian or inertial reference frames. According to some authors, the first law defines what an inertial reference frame is; therefore, the second law holds only when the observation is made from an inertial reference frame, and the first law cannot be proved as a special case of the second [8]. Other authors consider the first law to be a corollary to the second. Long after Newton's death, the explicit concept of an inertial frame of reference was developed. Under normal conditions, these three laws provide a good approximation for macroscopic objects. As a result, the laws cannot be used to explain phenomena such as semiconductor conduction, optical properties of substances, and errors in non-relativistically corrected GPS systems, and superconductivity [9]. More sophisticated physical theories, such as general relativity and quantum field theory, are required to explain these phenomena. The second law of special relativity holds in its original form $F=dp/dt$, where F and p are four-vectors. When the speeds involved are much slower than the speed of light, special relativity is reduced to Newtonian mechanics. Some also describe a fourth law, which states that forces add like vectors, implying that forces obey the superposition principle [10]. In other cases, the magnitude and direction of the forces are determined jointly by both bodies, so identifying one force as the "action" and the other as the "reaction" is unnecessary. Both the action and the reaction are concurrent, and it makes no difference which is called the action and which is called the reaction; both forces are part of a single interaction, and neither force exists without the other.

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