# Newton Ideas and Methods Motion and Relativity – An Analysis

***Sreedhara.R. Assistant Professor of Physics, Govt. First Grade College, Bangarpet.**

**Abstract**

This paper deals with studying and analyzing primary elements of Newton’s laws of motion and its interpretations. Newton's laws pertain to the motion of massive bodies in an inertial reference frame, sometimes called a Newtonian reference frame, although Newton himself never described such a reference frame. An inertial reference frame can be described as a 3-dimensional coordinate system that is either stationary or in uniform linear motion., i.e., it is not accelerating or rotating. He found that motion within such an inertial reference frame could be described by three simple laws. In particular, laws and qualities must be intelligible in terms of the shape, size, motion and impenetrability (or solidity) of bodies. In this way, one might conclude that Locke and Leibniz actually do not necessarily disagree on whether gravity can be made intelligible in mechanist terms; they simply disagree on the propriety of the contention that God could “superadd” a feature to bodies that cannot be made intelligible in that way.

*Key words: Newton Locke and Leibniz, Principia, motion of massive bodies*

**Introduction**

Leibniz's most extensive debate with the Newtonians would not occur until the very end of his life. His celebrated correspondence with Samuel Clarke, Newton's friend and supporter in London in the early part of the eighteenth century, is his most famous interaction with the Newtonians, occurring right before his death in 1716 (Clarke and Leibniz 1717). Leibniz fomented the correspondence in November of 1715 by sending a short, provocative letter to Princess Caroline of Wales, one designed to provoke a response from Newton's circle in London. Leibniz knew well that Princess Caroline was a leading intellectual and political figure in England at the time, one who would surely wish to see the views of her countrymen defended against Leibniz's rather shocking claims about the religious consequences of Newtonian thinking. He opens his initial letter by mentioning both Locke and Newton, along with the issues about materiality and thinking that arose in his near exchange with Newton in 1712:

**Objective:**

This paper intends to explore three physical laws that, together, laid the foundation for classical mechanics. They describe the relationship between a body and the forces acting upon it, and its motion in response to those forces.

There are some irreducibly nationalist elements in the way that philosophy developed over the course of the eighteenth century, so it may be reasonable to chart Newton's impact country by country. Newton's ideas and methods were certainly most influential in England, where there grew to be a strong “Newtonian” movement—also called the “experimental philosophy” program—by roughly 1700. By the *fin de siecle*, it is probably safe to say that natural philosophy had become heavily Newtonian in England, at least in the sense that it had eclipsed both Cartesianism (Henry 2013: 124 and introduction to Voltaire 1738/1992: 7), and other local movements, such as Cambridge Platonism, which had exhibited a strong influence during the previous generation. One might put the point somewhat differently: to the extent that there was a dominant strand in England by 1700, it was the "experimental philosophy", a view that was associated strongly with figures such as Boyle, Newton and Locke. Figures such as Hobbes had opposed this approach to solving philosophical problems, but had failed to gain nearly as much influence.

**The First Law of Motion** states, "A body at rest will remain at rest, and a body in motion will remain in motion unless it is acted upon by an external force." This simply means that things cannot start, stop, or change direction all by themselves. It takes some force acting on them from the outside to cause such a change. This property of massive bodies to resist changes in their state of motion is sometimes called inertia.

**The Second Law of Motion** describes what happens to a massive body when it is acted upon by an external force. It states, "The force acting on an object is equal to the mass of that object times its acceleration." This is written in mathematical form as F = ma, where F is force, m is mass, and a is acceleration. The bold letters indicate that force and acceleration are vector quantities, which means they have both magnitude and direction. The force can be a single force, or it can be the vector sum of more than one force, which is the net force after all the forces are combined. When a constant force acts on a massive body, it causes it to accelerate, i.e., to change its velocity, at a constant rate. In the simplest case, a force applied to an object at rest causes it to accelerate in the direction of the force. However, if the object is already in motion, or if this situation is viewed from a moving reference frame, that body might appear to speed up, slow down, or change direction depending on the direction of the force and the directions that the object and reference frame are moving relative to each other.

**The Third Law of Motion** states, "For every action, there is an equal and opposite reaction." This law describes what happens to a body when it exerts a force on another body. Forces always occur in pairs, so when one body pushes against another, the second body pushes back just as hard. For example, when you push a cart, the cart pushes back against you; when you pull on a rope, the rope pulls back against you; when gravity pulls you down against the ground, the ground pushes up against your feet; and when a rocket ignites its fuel behind it, the expanding exhaust gas pushes on the rocket causing it to accelerate. If one object is much, much more massive than the other, particularly in the case of the first object being anchored to the Earth, virtually all of the acceleration is imparted to the second object, and the acceleration of the first object can be safely ignored.

For instance, if you were to throw a baseball to the west, you would not have to consider that you actually caused the rotation of the Earth to speed up ever so slightly while the ball was in the air. However, if you were standing on roller skates, and you threw a bowling ball forward, you would start moving backward at a noticeable speed. The three laws have been verified by countless experiments over the past three centuries, and they are still being widely used to this day to describe the kinds of objects and speeds that we encounter in everyday life. They form the foundation of what is now known as classical mechanics, which is the study of massive objects that are larger than the very small scales addressed by quantum mechanics and that are moving slower than the very high speeds addressed by relativistic mechanics.

**Definition of Force**

When a constant force acts on a body, the forces result in the acceleration of the body. However, if the object is already in motion, or if this situation is viewed from a moving frame of reference, the body might appear to speed up or slow down or change its direction depending on the direction of the force.

Mathematically, we express the law as follows:

f∝dPdt⇒f∝mv−mut⇒f∝m(v−u)t⇒f∝ma⇒f=kma

Where k is the constant of proportionality and it comes out to be 1 when the values are taken in SI unit. Hence the final expression will be,

F=ma

Perhaps more importantly, Newton's view of motion, his understanding of space and time, and his approach to achieving knowledge of natural phenomena, helped to shape the agenda of British philosophy for the next fifty years. In addition to Newton's influence on Locke's thinking about matter and causation, explored above, both Berkeley and Hume expended considerable energy grappling with the wider consequences and implications of the Newtonian version of the experimental philosophy. For his part, Berkeley famously derided many Newtonians methods and ideas—sometimes exempting Newton himself from his conception of the worst philosophical excesses of his followers—including the rise of the calculus among mathematicians (in *The Analyst*) and the use of the idea of a force as the basic causal concept in natural philosophy (in *De Motu*—both reprinted in Berkeley 1992). Berkeley's theory of ideas, which arose in part from his reflections of what we would now call Locke's “empiricist” notion of representation, suggested to him that no idea can be abstract: each idea must represent a *particular* rather than a universal. Hence we can have an idea of a particular car, but not of a car in general (not of, as it were, the form of a car); we can have an idea of a particular shade of yellow, perhaps because we've just seen a lovely yellow rose at the florist, but not of yellow in general; and so on. Berkeley then argued that modern mathematics, especially the calculus, and modern natural philosophy, especially Newtonian versions of it, were often reliant on abstract ideas, and therefore philosophically suspect. For instance, he contended that the very idea of absolute motion was suspect because we can represent to ourselves only various motions with particular features related to particular bodies in motion, but “absolute” motion cannot be rendered *particular* in anything like this way; it remains abstract (Downing 2005: 235). Thus although Newtonian views were considered to be essential to the rise of experimental philosophy in Britain, Berkeley derided them as insufficiently experimental, as overly reliant on representations of universals and of universal quantities, rather than on the representation of particulars. In a reflection of Malebranche's influence, Berkeley also argued that some Newtonians wrongly attributed genuine causal powers to ordinary material objects through their use of the concept of impressed force; wrongly, because Berkeley firmly rejected the notion that any body could exert any causal power.

**Kants interpretation**

Kant began grappling with Newtonian ideas at the very beginning of his career—he discussed the inverse-square law in his first publication (Kant 1747: § 10)—and they would remain central both to his magnum opus, the *Critique of Pure Reason* (Kant 1787/1992) and to his *Metaphysical Foundations of Natural Science* (1786/2002). Early in the so-called pre-critical period, Kant diverged sharply from the approach toward natural philosophy defended by many Leibnizians in German-speaking Europe by deciding to accept the Newtonian theory of universal gravity, along with corresponding aspects of the Newtonian conception of matter, as a starting point for philosophical theorizing (Friedman 2012: 485–6). He makes this explicit already in 1763, in *The Only Possible Argument*:

*I will attempt to provide an explanation of the origin of the world system according to the general laws of mechanics, not an explanation of the entire natural order, but only of the great masses of matter and their orbits, which constitute the most crudest foundation of nature … I will presuppose the universal gravitation of matter according to Newton or his followers in this project. If there are any who believe that through a definition of metaphysics formulated according to their own taste they can annihilate* *the conclusions established by men of perspicacity on the basis of observation and by means of mathematical inference—if there are such persons, they can skip the following propositions as something which has only a remote bearing on the main aim of this essay. (Kant 1763: AK 2: 139)*

**Conclusion**

*Again, force, gravity, and terms of that sort are more often used in the concrete (and rightly so) so as to connote the body in motion, the effort of resisting, etc. But when they are used by philosophers to signify certain natures carved out and abstracted from all these things, natures which are not objects of sense, nor can be grasped by any force of intellect, nor pictured by the imagination, then indeed they breed errors and confusion.* There is little doubt, then, that the new British philosophy represented by Locke, Berkeley, and Hume in the early-to-mid eighteenth century was concerned to present interpretations of Newton's work that were consistent with their overarching philosophical commitments, principles and methods, or to alter those commitments, principles and methods as necessary. *Those, however, who assert the absolute reality of space and time, whether they assume it to be subsisting or only inhering, must themselves come into conflict with the principles of experience. For if they decide in favor of the first (which is generally the position of the mathematical investigators of nature), then they must assume two eternal and infinite self-subsisting non-entities (space and time), which exist (yet without there being anything real) only in order to comprehend everything real within themselves. (A39/B56)* If one regards space (like time) as existing independently of all objects and all possible relations, and yet one admits that space is causally inert and imperceptible, as one presumably must in the late eighteenth century, then one is committed to the idea that there is a kind of infinite and eternal non-entity in the world. Space is a kind of non-entity, Kant suggests, because on the one hand it is said to exist independently of everything else, and yet on the other hand, it is said to be causally inert and imperceptible, which would distinguish it from every other sort of thing that exists.

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