ISAAC NEWTON

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Introduction

Sir Isaac Newton is considered by many as a magician and one of the greatest scientists of all time. He is a key personality in the history of scientific revolution. He brought in systematicity to science, and created a platform for scientific knowledge based on observation, experiment and testing of facts, an approach which was not common in science. He conceptualized the thesis of Galileo and energises science into modern light. Before now, science did not attain systematic approach, as Mysticism, Sorcery, Voodooism, Magic, Wizardry, Diablerie, Mojo, Thaumaturgy, Necromancy and many others were all seen to be scientific. Thus, the idea of observation, evaluation and testing of facts came into science as a result of Galileo and Newton's efforts to picture the entire universe mechanistically. Isaac Newton through observation and experimentation postulated laws of mechanics that overturned the long standing ideas of Aristotle which had lasted for decades in science. He gave a sharp distinction among space, time, speed, motion, gravity, light etc. All these, he assigned fundamental unique properties, that control the entire forces of the universe using his laws.

His laws of mechanics introduced determinism to science and gave scientist the power to predict the future with great certainty; meaning through the study of a cause, the effect can be known. And through the observational effect, samples can be gathered, by which an induction is made. This induction is what possibly gave rise to the formation of theories which act as the covering law for science in the formation of further predictions.

The philosophical implications of this tradition led to the formation of empiricism in science, a traditional belief in philosophy that claims reliable scientific knowledge through sense data collection using the five sense organs, sight, hearing, smelling, feeling, and tasting, and through experiment and testing of fact evidence can be achieved. This method guided Newton to give an explicit account of the nature of light, the movement of large bodies (motion) and the state of gravity. Thus, he is a rational genius and a very complex and secretive man that up till now no one can understand the power of his creative thought and the origin of his thought-provoking ideas. He calculated the motion of bodies and revealed that nature can be reduced to a precise mathematical formula, an area in mathematics today known as *Calculus.* He also studied the nature of light, stating all the distinctive properties of light using a prism called Newton's theory of light. Through observation, he postulated the laws of inertia and proved the properties of matter by which objects continue in their existing state or uniform motion in a straight line, unless changed by external force.

The search for the true nature, scope, and origin of the universe was Newton's greatest dream in his entire life. He relied on no one, but himself, he has a fertile mind always ready to accept correction through criticisms. He used natural philosophy to uncover the laws of the universe which led him to certainty in knowledge. By 1664 at the age of 21, he started being troubled by certain philosophical questions, what he called philosophical issues. These issues included time, eternity, comets, atoms, attraction, sun, plant, air, meteors, electrical, vision, colour, light, gravity, vacuum, density, heat and cold, etc. For Newton, these philosophical issues would give him a clear picture of the entire mechanism of the universe. His formulation of the three laws of motion placed the science of mathematics on a solid foundation. By inventing the calculus, Newton gave physical science a new powerful kind of mathematics that is still in vogue in today's study of the natural universe.

In summation, this work is a philosophical investigation of Isaac Newton's discoveries in science and their philosophical implications. We posit that, the philosophical implication of Newton's revolutionary science is one that should not be forgotten in a hurry. This work captures such themes as brief biographical sketch of Newton, specific discoveries of Newton and their philosophical implications and so on.

Biographical Sketch of Isaac Newton

Newton was born on 25 December, 1642 in Woolsthorpe, Lincolnshire, England. His mother was Hannah Newton (nee Ayscough). Newton was her first child. She named the boy Isaac in honour of his father, a farmer who passed on two months earlier at the age of thirty six. Baby Newton was born premature, making his mother to presume that he might not live out his first day. As a child he was not happy because he lost the comfort of living with his biological father due to death. When he was three years, his mother married another man Barnabas Smith, a minister twice her age. At this point Newton was sent to live with his maternal grandmother doing farm work together with his studies. He was separated from his mother for nine years until the death of his step-father in 1653. Because of his experience with women, he had little or no time with women until his death he never married, but focused attention on his career. Newton did not have any hope of becoming a legend in science, because of his poor background and the condition he found himself as a poor boy in the farm with the grandmother. The nine years he spent in Woolsthorpe away from his mother was indeed a painful moment for young Newton, a time until his death was a sobering moment in his life time. In his book *A Portrait of Isaac Newton*, Professor Frank Manuel concluded that the remarriage of his mother was the most critical episode in Newton's entire life (Brennan, 15). This is giving us a strong feeling that Newton never agreed to the remarrying of his mother. He started his career with his famous book *Philosophiae Naturalis Principia Mathematica* (Mathematical Principles of Natural Philosophy) published in 1687. This book astounded the world scholarship and introduced into science a systematic approach of understanding the covering mysteries of the entire universe. With this book, Newton solved the greatest problem in the history of science up to that time, the problem of the mechanics of the universe (Brennan, 12). Newton was actually a complex man; his secretive style would baffle any scientist as to how he got through in his discoveries. When he was at Cambridge, he taught mathematics in Trinity College where he went into complex mathematics that gave way to a new set of mathematical system now called *Calculus.* Before then, he informed no body until when the real success was achieved. This is why Stephen Hawking, in his best-selling book *A Brief History of Time* admitted that "*Newton was not a pleasant man. His relationship with other academics was notorious, with most of his later life spent embroiled in heated disputes" (191).* He was once appointed the President of the Royal Society of London for Improving Natural Knowledge commonly known as the Royal Society, and also served the British government as Warden and Master of the Royal Mint. Newton built the first practical reflecting telescope and developed a theory of colour based on the observation that a prism decomposes white light into the many colours of the visible spectrum. He formulated an empirical law of cooling, studied the speed of sound, and introduced the notion of a Newtonian fluid. In addition to his work on calculus, as a mathematician, Newton contributed to the study of power series, generalised the binomial theorem to non-integer exponents, developed a method for approximating the roots of a function, and classified most of the cubic plane curves.

Newton was a Fellow of Trinity College and the second Lucasian Professor of Mathematics at the University of Cambridge. He was a devout but unorthodox Christian and, unusually for a member of the Cambridge faculty of the day, he refused to take holy orders in the Church of England, perhaps because he privately rejected the doctrine of the Trinity. He died on 20th March, 1726.

Newton's Contributions to Science

In modern science, the ideas and discoveries of Newton are regarded by many as one which have brought in a great revolution to the entire scientific community. His ideas span through physics, chemistry, astronomy, religion and numerous disciplines. He was a master of his own. He believed that nature is controlled by certain absolute force, and that the universe exists because of the agreement between its components and the forces on it. This force, according to Newton, is what gives rise to the way objects behave; he called this the force of gravity. Let us examine most of Newton's contributions to science.

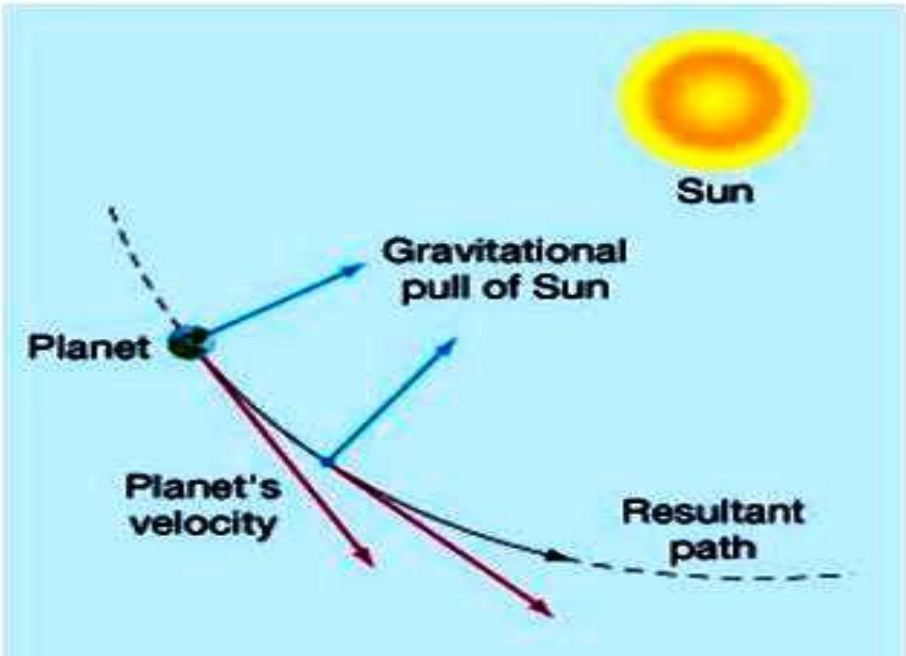
Isaac Newton on Gravitation

In 1679, Newton returned to his work on (celestial) mechanics by considering gravitation and its effect on the orbits of planets with reference to Kepler's laws of planetary motion. In physics, the term gravitation is quite synonymous with gravity. Gravity is a scientific concept used in describing the force that attracts a body towards the centre of the earth or towards any other physical objects with mass. This force can also be called gravitational force; it is the mutual force of attraction between any two objects in the universe; thus the weakest of the fundamental forces (Serway, 83). However, according to Newton, every object with mass is affected by this force. It is the universal force that controls all the properties and behaviours of large scale bodies. This force is called the gravitational force. It is described by many as a single magical force that runs across the universe. Newton combines mathematics and mysticism to uncover the force that controls the entire universe. The force of gravity is seen as a vital agent that holds and controls the entire Milky Way, solar energy, and causes the dropping of rain, the positioning of the moon, the rotation of earth around the sun, and also the existence of million stars in the galaxy. By further application, it is the agent that gives weight to objects with mass and causes them to fall to the ground when dropped. We have four fundamental interactions of nature; the first is Gravitational force (attractive force between objects due to their masses), Electromagnetic force (between electric charges at rest or in motion), Strong nuclear forces (between subatomic particles), and Weak nuclear force (accompanying the process of radioactive decay) (Serway 63; Igwe 350). Thus, gravity is what causes the earth to exist and pivot around the sun, the sun, moon and stars and most macroscopic objects that exist in space. The moon stays around the earth because it is held by gravity, and thus the entire mechanism of the universe is propelled by the universal law of gravity.

Modern work on gravitational theory began with the work of Galileo Galilee in the late 16th and early 17th centuries in his famous experiment of dropping of heavy and lighter balls from the Tower of Pisa. This experiment shows that gravitation accelerates all objects at the same rate, thus refuting the Aristotelian theory that heavier bodies fall faster than lighter ones. By implication, all free falling objects will fall towards the earth at the same time irrespective of their weight (Igwe 351). This Galilean notion influenced Newton to see the entire universe as the handwork massive clock built by a complete mechanism called gravity. All celestial bodies obey this law through the force of attraction that exists between two objects with masses.

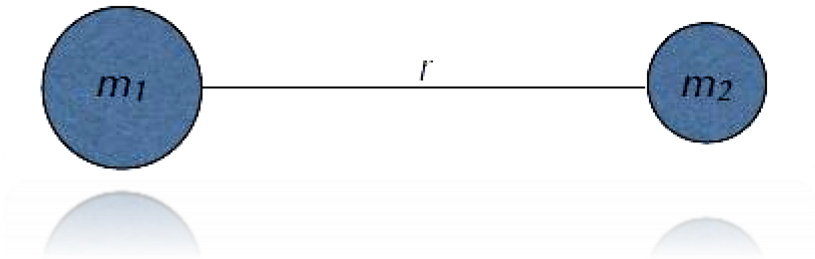
Isaac Newton through physical observation of the nature of the universe discovered that objects are attracted to one another in so far as these objects possess some element of masses. Thus, these objects obey certain natural law called the law of gravity. It is natural, because it is not created by man and thus states that the force of attraction between two objects is directly proportional to the product of their masses and inversely proportional to the square of the distance between them. Newton showed that the same laws of nature are applicable to every object with masses; the gravitational force that attracts apples to the ground is identical with the gravitational force that keeps the planets in their orbits; all are guided by the same law.

In the law of gravitation, Newton found the solution to the problem of planetary motion and gave science a powerful tool for understanding natural phenomena, explaining that it is only by gravitational pull that the planets and sun are held together as shown in the diagram bellow.



Through this understanding, Newton realized that to make a planet take an ecliptical or circular orbit required an attractive force between the planet and the sun, he then formulated the law of universal gravitation, stating that the attractive force between any two bodies is proportional to the products of their masses (kg) divided by the square of the distance between them. This can be described symbolically as:

$$F = G\frac{m_1 m_2}{r^2}$$



The above formula is one of Newton's greatest equations in 20th century Physics that gave more strength to determinism in science. Where F= force, G=gravity, m_1= mass of object one and m_2= the mass of object two and r^2 = the square of the distance. When you have the same figures at various points, it is possible to achieve certainty in your findings anytime, and anywhere you ever want your findings. Thus, this is what gives rise to objectivism in science.

The Notion of Motion in Newton's Cosmology

The idea of gravity extensively deals with the movement of planetary bodies around its orbits through what is described in modern science as motion. Motion can be defined as the displacement of body from one point to another in space and time. Therefore, a free falling body moving freely under the influence of gravity must participate in some actions of motion. In other words, when a body or an object changes its position with respect to time and it goes on continuously, we say that the object moves. This movement is what can be described as object in motion.

Before Newton the idea of motion was not new to science. Aristotle had earlier articulated his idea of motion of bodies. For Aristotle, everywhere we find evidence of design and rational plan. No doctrine of physics can ignore the fundamental notions of motion, space, and time. Motion is the passage of matter into form, and it is of four kinds:

(1) Motion which affects the substance of a thing, particularly its beginning and its ending;

(2) Motion which brings about changes in quality;

(3) Motion which brings about changes in quantity, by increasing it and decreasing it; and

(4) Motion which brings about locomotion, or change of place. Of these the last is the most fundamental and important (Cited in http://www.iep.utm.edu/aristotl/).

` This notion of motion by Aristotle laid the foundation for modern theory of motion, and therefore led Newton to develop a new set of rules that control all bodies in motion. This he called the laws of motion.

Newton on Laws of Motion

Newton through observation gave a distinctive interpretation of every object that moves within the natural universe as that which obeys what he called the laws of motion. These laws serve as an operational criterion for every object in motion or at state of rest. The ways objects behave in space, on the sea, land and in the air are all connected to the laws of motion. He conceptualized these laws into three; and these include:

1. **First Law of Motion (Law of Inertia)**

Newton's first law also called the law of Inertia, states that an object at rest will remain at rest and an object in motion will remain in motion with a constant velocity unless acted on by a net external force**.**

Newton's first law effectively says that the natural motion of an object at rest remains at rest, or, if it is moving, moves in a straight line at constant speed. In other words, if there are no forces acting on an object it will either remain at rest or move with constant speed in a straight line. According to Newton, it takes only an external force to change either the speed or the direction of motion. Philosophically, if we agree on Newton's first law, what will be the consequences of the moon in space, if there was no force on it? This may inform us that over there in the space, the movement of the planets, the trajectory of the moon around the sun is held by the force of gravity, proving the validity of Newton's first law. Thus, the result of this law is that, in all acceleration there is a force.

2. **Newton's Second Law (Law of Acceleration)**

Newton’s second law, the law of acceleration, states that the acceleration of an object is directly proportional to the net force acting on it and inversely proportional to its mass. Thus, the direction of the acceleration is the direction of the net force.

Force change in quantity of motion per unit time. If mass is constant, then this becomes:

Force (mass) x (change in velocity per unit time), and since

Acceleration = (change in velocity)/time,

F = (mass) x (acceleration).

F = ma.

Where F= force, m = mass, and a = acceleration.

The philosophical implication of this second law is that, when different forces act upon the same mass, the greater force produces the greater acceleration, and when the same force acts upon different masses, the greater mass receives the smaller acceleration, thus the acceleration will occur in the same direction as force.

3. **Newton’s Third Law (Law of Action-Reaction)**

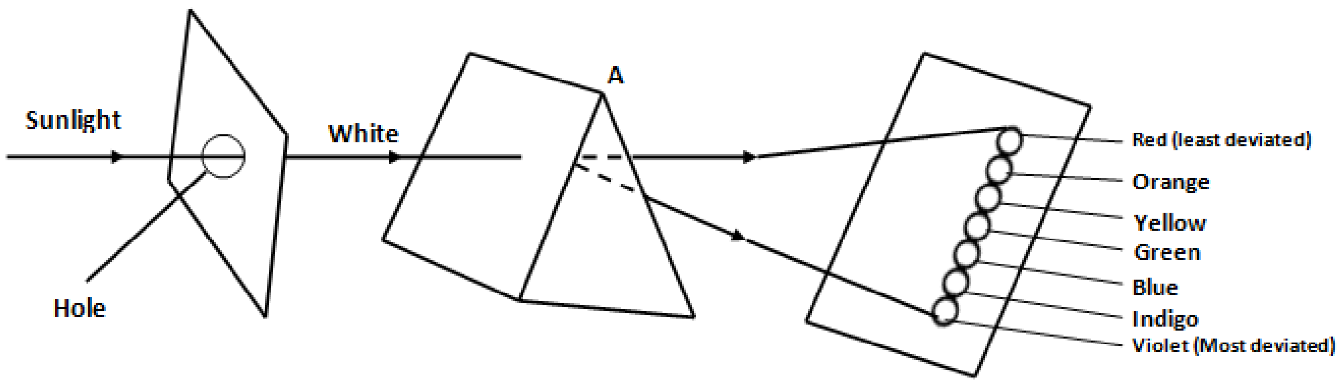
Newton’s third law, the law of action-reaction, states that when two bodies interact, the force which body “1” exerts on body “2” (the action force) is equal in magnitude and opposite in direction to the force which body “2” exerts on body “1” (the reaction force) **(**Serway, 64**).**

The implication of Newton’s third law is that, when we push a car to move upward, there is always a reacting force from the car stubbornly resisting smooth movement of the car. Thus, this reacting force from the car sends back a reaction exerting a force on the pusher. In other words, we cannot exert a force on the car without it exerting a force on us. Because of this experience, Newton came up with his third law stating that for every force there is an equal and opposite reaction, meaning that whenever one object exerts a force on a second object, the second exerts an equal force in the opposite direction on the first. Also, when a man pushes backward on the earth with his foot, the earth pushes forward on him. It is the later reaction force that leads to his forward motion.

Isaac Newton on Optics

On the question, does light really exist? What is the nature and property of light? To solve this problem in physics was one of Newton's great dreams. He so much believed that without proper investigation on the nature of light, man would continue to operate with vagueness and certainty in science will a great failure.

In 1666, Newton carried out an experiment on light using a prism (In Optics, a prism is a triangular transparent object used to separate white light to spectrum of colours). Thus, he observed that the spectrum of colours exiting a prism in the position of minimum deviation is oblong, even when the light ray entering the prism is circular, which is to say, the prism refracts different colours by different angles. This led him to conclude that colour is a property intrinsic to light, a point which had been debated in prior years. Thus, the outcome of Newton's experiment on light shows that, the light we receive from the sun or from an incandescent lamp is usually considered to be white light. But this light is, according to Newton, composed of many colours. We can observe the breakup of white light into its component colours by passing the light though a triangular piece of glass called prism (Marion,420).



NEWTON'S PRISM EXPERIMENT

The diagram above shows a schematic representation of white light, consisting of all colours, passing through a triangular glass prism, the white light is dispersed into a spectrum of colours. The red light refracted least and appears on the left-hand side of the spectrum, followed by orange, yellow, green, blue and violets. The reason that light disperses into different colours is because light is can act as a wave at a time and can also act as a particle in another point.

From 1670 to 1672, Newton had lectured on optics and during this period he investigated the refraction of light, demonstrating that the multicoloured spectrum produced by a prism could be recomposed into white light by a lens and a second prism. Modern scholarship has revealed that Newton's analysis and re-synthesis of white light owes a debt to corpuscular alchemy. He also showed that coloured light does not change its properties by separating out a coloured beam and shining it on various objects. Newton noted that regardless of whether it was reflected, scattered, or transmitted, it remained the same colour. Thus, he observed that colour is the result of objects interacting with already-coloured light rather than objects generating the coloured themselves. In other words, the colours that object posses exist extrinsically by the object which exists intrinsically by light. This is known as Newton's theory of colour.

Philosophical Implications of Newton's Contributions to Science

1. **On Determinism and Causality**

Determinism is a philosophical doctrine that asserts that all events and action are determined by causes. And in causality, in every cause there is an effect. The effect must necessitate from the cause. In other words, nothing happens by chance, the universe that rotates the shining nature of stars, the heart of the sun, the cold nature of ice, dropping of water from the sky and the break and fall of the night are all events that are covered within the laws of determinism and causality. Classical mechanics, which is known by many as the physics of Isaac Newton has the embodiment of all laws of the physical universe. Its studies the laws guiding the behaviour of large bodies and the way these bodies interact with other objects, the space they occupy and the limit of time they can move from one place to another; all these could be achieved with certainty. In other words, Newton brought certainty to science as against the then speculative approach of understanding the universe. Newton through his laws of motion and universal gravity asserts that, an object can cause another to behave in a different direction in accordance to the law. Through observation and experimentation it was possible for the cause and effect to be determined, which gave power for prediction to be made, and provided science the ability to predict and determine future occurrences with great certainty.

Determinism in classical mechanics was possible because of the great postulations of the greatest genius in science called Isaac Newton. Many may ask, how? Newton through experiment and observation of the entire universe discovered the magic of how large bodies behave with one another from time to time. Through this he came out with the universal laws guiding the movement of all seen bodies, the way they react with one another. These laws shaped the way he understood the universe and the way scientists make predictions.

2. On Empiricism

Empiricism is the belief in sense perception, induction, and, that, there are no innate ideas. G.O. Ozumba in his work entitled "*Isms in Philosophy"* stated that empiricism is a "School of thought that holds that knowledge is got through sense experience. The five senses of hearing, seeing, smelling, tasting and feeling are five important ways of getting acquainted with the external world" (*A Concise Introduction to Philosophy and Logic* 47). He further defines empiricism in his *Concise Introduction to Epistemology* as an epistemological school that based knowledge on experience, observation or on experiment rather than theory. Like any other school of philosophy, empiricism is of the view that, the only means for certainty in knowledge can be derived from observational factors or facts that are capable of being experienced. Isaac Newton's philosophical search for the substance of the universe can be seen as the powerhouse of empiricism. He never believed in what cannot be practically experienced. His works on optics was achieved through careful experimentation of light to capture the nature of light. His laws of motion and universal laws of gravity were all empirically based and thus, strengthened the place of sense data collection in science. Though a Christian, he doubted the existence of trinity (the belief of three in one God), which was then seen as heresy by the church.

Limitations of Newtonian Science

One of the greatest defects of Newton's science is that it is only operational at the level of the macro world. In Physics, his laws are only applicable to seen objects, that is, objects "out there". This is why it was possible to apply Newton's law in solving the problems of the rotation of the earth, the shining stars, moon, sun, etc. Thus, Igwe admitted that Newton's laws are applicable to objects of our everyday experience to solve our problems (355).

The limitation of Newtonian laws is the inability to penetrate into micro world, the world of the very small, and the world of sub-microscopic reality. Microscopic world is the realm studied by Quantum theory alone. The laws of Newton cease to exist at the realm of quantum mechanics because such realm is not penetratable using human senses. Our eyes cannot see quantum events, or observe the nature of photons or electrons, we cannot hear the sound of Plasmas neither can we torch an atom. It can only be studied using the foundation of quantum theory; the only existing theory that studies spins, quarks, mesons, electrons, etc. To this effect, Newtonian laws only study large objects under classical mechanics, while Quantum theory studies small objects under Quantum mechanics.

Conclusion

Isaac Newton is regarded by many as one of the greatest scientists in 20th century. He clearly reveals the physical universe as a clock work mechanism, with a set of fixed knowable laws, the laws of motion and the universal law of gravitation. This background and fixed attitude influenced a lot of things in his career and gave rise to his notion in mathematics called *Calculus.* He reduced all forms of natural phenomenon, the world of matter, and all abstract entities into a precise mathematical code called the calculus. This mathematical code models modern scientists to apply exactitudes in all scientific findings. But the most challenging aspect of calculus was that it was too difficult to understand, and up till today, very many still find it difficult to understand. All his ideas helped to shape modern science, and philosophically they paved way for certainty in science. Certainty here implies that, with the application of the laws of Newton, one can arrive at a universal objectivity in all findings. Newton's theory enjoyed its greatest success when it was applied to predict the existence of another planet called the Neptune. This was possible based on the motion of other existing planets, thus paving way for more planets to be discovered.

In today's Physics, the most challenging moment of Newton's mechanistic understanding of the universe is that, his theories do not work when applied to objects moving at the speed of light. It also ceases to work when subjected to the micro-world of matter. It is only operational at the macro world, the world at the very large.

Because of some these inadequacies, quantum mechanics has come to shatter most of the fundamental laws of Newton to explicitly explain the nature of subatomic particles like quarks, photons, plasmas, mesons, electron, neutrons, and many others. In any case the laws of Newton have not failed scientists when dealing with objects at the very large, their predictive powers are still applicable at all moving large objects, and gravity is still operational because objects are still in a constant interaction with one another.

Finally, many would admit that despite some of the philosophical limitations of Newton's discoveries in science, he is still a great scientist when it comes to his enormous contributions to science.

Works Cited

"Aristotle" in www.iep.utm.edu/aristotl/. Retrieved on 9th, June 2015. Web.

Brennan, Richard P. *Heisenberg Probably Slept Here: The Lives Times, and Ideas of the Great Physicists of the 20th Century.* Canada: John Wiley & Sons, inc. 1997. Print.

Hawking, S.W. *A Brief History of Time.* London: Bantam Book, 1988. Print

Heisenberg, Werner. *The Representation of Nature in Contemporary Physics*. London: Unwin Hyman Publishers, 1955. Print

Herbert Butterfield, *The Origin of Modern Science*. New York: The Free Press, 1966. Print

Igwe Denis Ejikeme, "Newton and the Theory of Universal Gravitation" *Philosophy and the Rise Of Modern Science*. Uduigwomen, A.F. (Ed.) Uyo: El-johns Publishers, 2011.

Marion Jerry, *Physics in the Modern World*. London: Academic Press, 1981. Print

Mendie, Patrick Johnson, and Mary Julius Egbai. "An examination of the nexus between Thomas Hobbes‟ concept of human nature and theory of the state." *Sophia: An African Journal of Philosophy* 15.2 (2015): 101-107.

Mendie, Patrick Johnson. "Asouzu's Critique of Philosophy of Essence and Its Implication for the Growth of Science." *Philosophy* 5.5 (2015): 233-243.

Ozumba, G. O. "ISMS in Philosophy". *A Concise Introduction to Philosophy and Logic*, Uduigwomen, A.F. and Ozumba G.O. (Eds.), Calabar: Jochrisam Publishers, 1995. Print

----------- *A Concise Introduction to Epistemology.* Calabar: Jochrisam Publishers, 2001. Print

Serway, Raymond (et al). *Principles of Physics.* San Diego: Harcourt Brace College Publishers, 1998. Print.