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Theoretical Analysis to Prove Equivalence between Planetary Model and Atomic Model

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Abstract: ***Atomic theory originated as a philosophical concept in ancient India and Greece. The word "atom" comes from the ancient Greek word 'atomos', which means indivisible. In the fifth century B.C., Democritus was the first to advocate matter consists of indestructible, indivisible units called atoms. The next major development didn't come along nearly for the next 2300 years. It was John Dalton's oral presentation and publication that marked the dawn of the scientific atomic theory. The succeeding theories presented were Plum Pudding Model by J. J. Thomson, Planetary Model by Ernest Rutherford, Neils Bohr's Model of atom, Quantum Atomic Theory contributed by the likes of Erwin Schro¨dinger, Werner Heisenberg and many more. All these theories were built on one another, correcting and building basis of the earlier proposed theories, and we are still not sure that we know the atom in its entirety. In this paper, we are proposing the planetary model of an atom is more appropriate than the other proposed models. The detailed basis of this conclusion will be provided by theoretical analysis of working of the planet-satellite system, planets-sun i.e. the solar system, and the proposed atomic model.***

1. Introduction

Ever since 1930, when the discovery of the neutron made it plain that the nuclei of atoms were built of protons and neutrons, physicists have been trying to form a picture of the structure of the nucleus. The same task for the rest of the atom was completed in the first quarter of this century. We were able to understand in detail how the electrons move under the attraction of the nucleus, and how their motion is influenced by their mutual repulsion. To achieve such an understanding requires three major steps: First, we must know the forces between the particles. Second, we need to know the mechanical laws which govern their motion under the influence of these forces. Third, we need in most cases a simplified picture, or model, from which to start. Once we have the first two ingredients, we could in principle write down a set of mathematical equations whose solutions would tell us all about the atom, or about the nucleus [1].

Earlier atomic theories fell; notable was J. J. Thompson's model of electrons embedded in a positively charged fluid. Two years later, in 1913, Niels Bohr proposed his famous atomic model consisting of electrons circling the nucleus in quantized orbits [2].

Throughout this century, physics has made use of two quite different descriptions of nature. The first is classical physics, which accounts for the motion of macroscopic objects, such as wheels and pulleys, planets and galaxies. It describes the continuous, usually predictable cause-and-effect relationships among colliding billiard balls or between the earth and orbiting satellites. The second description is quantum physics, which encompasses the microscopic world of atoms, molecules, nuclei and the fundamental particles. Here the behavior of particles is described by probabilistic laws that determine transitions between energy levels and govern tunneling through energy barriers. Because quantum mechanics is the fundamental theory of nature, it should also encompass classical physics. That is, applied to macroscopic phenomena, quantum mechanics should reach a limit at which it becomes equivalent to classical mechanics. (The Classical Limit of an Atom)

A phrase that we come across many times is "to know the working of the universe, find the working of an atom", we believe the vice-a-versa also holds true. So in the following sections the principle of working of satellites along with the solar system is explained and from this how we can study atom is also discussed.

2. Planetary Model

Satellite refers to an object that is orbiting earth, sun or other planetary bodies. Satellites can be artificial or natural. The artificial satellites basically work on principle of projectiles. The only force that works on satellites is gravity. Once launched in an orbit, gravity is the only force governing the motion of the satellite. While a trajectory is a path traced by a moving body, an orbit is a trajectory that is periodically repeated. While the path followed by the motion of an artificial satellite around Earth is an orbit, the path followed by a launch vehicle is a trajectory called the launch trajectory. The motion of different planets of the solar system around the sun and the motion of artificial satellites around Earth are examples of orbital motion. The term 'trajectory', on the other hand, is associated with a path that is not periodically revisited. The path followed by a rocket on its way to the right position for a satellite launch (Figure 1) or the path followed by orbiting satellites when they move from an intermediate orbit to their final destined orbit are examples of trajectories.

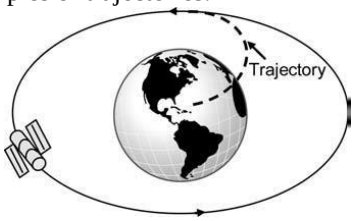

Figure 1: Example of trajectory – path followed by a rocket on its way during satellite launch

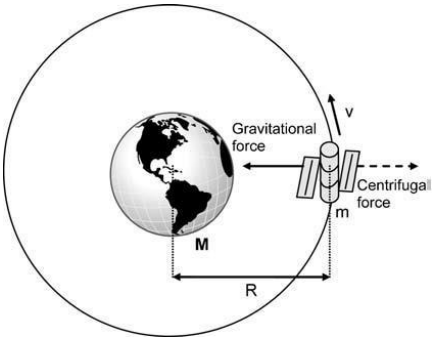

Figure 2: Gravitational force and the centrifugal force acting on bodies orbiting Earth

The rotation and revolution of satellites around Earth, which may be natural and artificial, is determined by two forces [3]. The first is the centripetal force directed towards the center of the Earth, because of the gravitational force exerted by the Earth and the second is the centrifugal force that which is acted outwards from the center of the Earth (Figure 2).

If there is no centripetal force, the satellite would have continued to move in a straight line at a constant speed after its injection in the space. It is due this centripetal force directed at right angles to the satellite's velocity towards the center of the Earth, which transforms the straight line motion to the circular or elliptical one, depending upon the satellite's velocity. Centripetal force further leads to a corresponding acceleration called centripetal acceleration as it causes a change in the direction of the satellite's velocity vector. The centrifugal force is simply the reaction force exerted by the satellite in a direction opposite to that of the centripetal force.

This is in accordance with Newton's third law of motion, which states that for every action there is an equal and opposite reaction [4]. This implies that there is a centrifugal acceleration acting outwards from the center of the Earth due to the centripetal acceleration acting towards the center of the Earth. The only radial force acting on the satellite orbiting Earth is the centripetal force. The centrifugal force is not acting on the satellite; it is only a reaction force exerted by the satellite. The two forces can be explained from Newton's law of gravitation and Newton's second law of motion.

The same laws apply for our solar system as well, wherein the Sun is at the epicenter and due to its gravitational force the planets revolve around it at a certain speed in a specific orbit. These same laws apply to the galaxies and the universe as a whole.

Now it is clear that the Earth revolves around the Sun because of Sun's gravitational force, it is important to note that all the processes taking place on and around the earth are a result of this force and the gravitational force of the earth. Therefore, the energy obtained from these processes such as Wind Energy, Tidal Energy, Hydro-Electric Energy, and many more is not a conversion of some energy but generated indigenously.

3. Atomic Model

We know a structure of an atom consists of electrons, protons, and neutrons. This was accurately presented after several scientists came up with different models. An atom is composed of empty space mostly with electrons orbiting the positively charged nucleus.

The first model that led to our current understanding of atom was presented by Ernest Rutherford in 1911, which proved that the Plum Pudding model of J. J. Thomson was incorrect. Based on the Geiger-Marsden experiment results, Rutherford devised a model for the atom, which consisted a high central charge concentrated into a very small volume in comparison to the rest of the atom and with this central volume also containing the bulk of the atomic mass of the atom [5]. This region would be known as the "nucleus" of the atom.

Further, contribution was made by Neils Bohr in "On the Constitution of Atoms and Molecules" [6]. He presented a picture of atom's model comparing it with the planetary model, which caught the imagination of the public. The model by Neils Bohr came to be known as Rutherford-Bohr model, as he had done modifications in Rutherford's Model, and it was the last model that came under classical mechanics before the development of quantum mechanics. A brief overview of the Rutherford-Bohr model, also known as Bohr model, and few further developments is given below.

An atom is composed of positively charged particles. Major- ity of the mass of an atom was concentrated in a very small region. This region of the atom was called as the nucleus of an atom. It was found out later that the very small and dense nucleus of an atom is composed of neutrons and protons. Atoms nucleus is surrounded by negatively charged particles called electrons. The electrons revolve around the nucleus in a fixed circular path at very high speed. These fixed circular paths were termed as "orbits." "shells" or "energy level."

An atom has no net charge or they are electrically neutral because electrons are negatively charged and the densely concentrated nucleus is positively charged. A strong electro-magnetic force of attractions holds together the nucleus and electrons. The different energy levels are denoted by integers such as n=1 or n=2 or n=3 and so on. These are called as quantum numbers. The range of quantum number may vary and begin from the lowest energy level (nucleus side n=1) to highest energy level. The different energy levels or orbits are represented in two ways such as 1, 2, 3, 4. . . or K, L, M, N. . . .. shells. The lowest energy level of the electron is called the ground state. The change in energy occurs when the electrons jump from one energy level to other. In an atom, the electrons move from lower to higher energy level by acquiring the required energy from a photon. However, when an electron moves from higher to lower energy level it emits a photon and gives its lost energy to the photon.

The Bohr model was not accepted in the scientific community because it gave a perfect representation only of the Hydrogen Atom and could not be applied to other atoms. It was also rejected due to its inefficiency to explain the working of the electron in the ground state. The argument made was if the electron is rotating around the nucleus it has to accelerate and if it accelerates it has to emit a photon losing its energy, and eventually spiral onto the nucleus.

In 1924 de Broglie's proposed a research showing the wave-particle behavior of the matter was put forth [7]. This led to the development of quantum mechanics, wherein researchers like Erwin Schro¨dinger and Werner Heisenberg contributed to the 'Quantum Mechanical Model'.

According to Quantum Mechanical Model, the electron do not move in specific circular orbits but can be found in orbitals given by the wave function of electron [8]. The quantized energy of an electron is the allowed solution of the Schro¨dinger wave equation and it is the result of wave like properties of electron. As per Heisenberg's Uncertainty principle, the exact position and momentum of an electron cannot be determined. So the probability of finding an electron at a point within an atom is proportional to the square of the orbital wave function.

Even if the Quantum Mechanical Model is the latest atomic model we have, but no one can guarantee that it is the final because there is still a world of possibilities. At this point in time also we do not know the exact working of an atom. Therefore, after studying all the models, and the theories related to electrons, we propose below our following understanding of the atom.

We are aware that there are positively charged protons and electrically neutral neutrons in the nucleus, and negatively charge electrons are found around the nucleus continuously moving at high speed. We believe that the argument made with Bohr model that the electron in the ground state would spiral into the nucleus is incorrect. Electrons are revolving around the nucleus because of electromagnetic force between the negatively charged electron and the positively charged nucleus [9], and not because of some kind energy which they will lose. The electromagnetic force acts as a centripetal force on the electrons attracting them towards the centre and there is a centrifugal force due to the speed of the electron which is equal and opposite to the centripetal force. The interaction of these two forces results in electron revolving in a specific orbit, similar to the planets orbiting the sun. The electron's change in orbit, during the absorption and emission of the photon by an electron is associated with its change in velocity, similar to the satellite and planets changing the orbit.

4. Conclusion

The theoretical analysis done in this paper states that the basic principle of working of the planetary model and the atomic model, that means from atom to the universe, is same. It states there is a conservative force present between the central element and the orbiting elements.

The conservative force in case of planetary model is gravitational force and in the case of atomic model is electromagnetic force present due to the attraction between positively charged nucleus and the negatively charged electron. Therefore, the energy obtained due to the acceleration of charged particles is generated indigenously

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