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Pd. 2 4.25.03

"To what extent and in what ways has twentieth-century physics challenged the Newtonian view of the universe and society?" 1986 #6

In the time period that Newton was making his discoveries, about the universe, he developed calculus in order to derive the laws concerning gravity, and laws on inertia. The next person to have discoveries as bold as Newton's was Albert Einstein. Some of the scientific advances that came by way of Einstein were his first special theory of relativity, and then his second theory of relativity that expanded on the first. Now scientists were also not claiming to hold a magical key that unlocked the mysteries of nature, but said that they had the ability to determine and guess at the relationships of nature. Science also went from being changed by one person at a time, to groups of people working together. (For instance, the Manhattan Project, and the atomic bomb.) Some disagreed with this and said that by working together, science was being changed for political goals, and not for human goals. An example of this would be the discovery of the workings of the atom, which lead to the atom bomb. One man who challenged the ideas of Newton was German physicist Max Planck. When he came up with the "quantum theory", there was nothing in Newton's physics that explained it. After the outcome of WWI, the Holocaust, and the dropping of the atomic bomb, people started to doubt whether or not science was helping the human race, or hurting it. This led to pessimism, and most of all the existentialists. Over all, science has looked at Newton's theories, and expanded on them, as well as taking science in a whole new direction.

I. Background on the beliefs on Newton and the beliefs of the time

A. Isaac Newton

1. Newton lived from 1642- 1727
2. Dealt with the quadrature and tangents of curves, later became calculus
3. Law of inertia and motion are:
    a. Massive objects stay in a state of rest until an external force acts upon it
    b. External forces produce acceleration
    c. For every force acting on a body there is a equal and opposite reaction from the body upon its surroundings
4. Described gravity as the force that attracts all particles with a force of proportional to the two masses and inversely proportional to the square of the distance that separates them.

B. Beliefs of the time

1.Many relied on the doctrines of the church to explain the universe
    a. Those who questioned these dogmas were branded heretics
2. Aristotle was the main authority on what to believe about the universe
    a. The geocentric universe
3. Most people believed in the idea that the planets moved in a perfect circle around the earth in impenetrable spheres
5. Science was felt as a new faith to the European population
    a. Many people fell into doubt and superstition of the condition of the world around them
        i. Because of the marauding violence in the cities, that would later be suppressed by disciplined armies
6. The Greeks hypothesized that the atom was like a hard, solid, unstructured billiard ball. They also believed that matter and energy were separate and distinct.
    a. this was also the belief during Newton's time

II. Improvements in science
    A. Albert Einstein (1879-1955)
        1. As a German Jew, Einstein fled from the Nazis in Germany, and came to America
        2. Einstein developed two theories on relativity:
            a. The first was the Special Theory of Relativity
                i. Stated that coordinate space and time are not absolute, and the understood events are dependent on the observer
            b. The second being the General Theory on Relativity, which dealt with Euclidean space and time
        3. Gravitational fields are manifestations of an amount of curving in the space-time
        4.Predicted the bending of star light when near the sun
            a. The famous equation energy= mass multiplied by the square of the light (E=MC^2) came from the idea that:
                i. Mass is a form of energy, interchangeable with other forms according to the relation
    B. Willhelm Konrad Rontgen (1845-1923)
        1. After experimenting with cathode rays he noticed that certain rays held a great penetrating power traveling through heavy paper
            a. Gave the temporary rays the name X-rays
        2. Later awarded the Nobel Prize for physics and was also honored in the field of medicine
    C. Max Planck (1858-1947)
        1. Planck was the first to demonstrate that energy was given off or absorbed in distinct bundles, each called a quantum
            a. Energy was not distinguishable from matter
    D. Pierre and Marie Curie (1858-1906)
            a. They were the first to isolate a radioactive element: radium
    E. Ernest Rutherford (1871-1937)
        1. Used the Curie's discovery to come up with the idea of alpha and beta rays. These were emitted in radioactive atoms, thus developing the theory of radioactivity
    F. Otto Hahn, Fritz Strassman (1938)
        1. Discovered that when they bombarded the atom nucleus of the heavy radioactive element uranium with neutrons it became unstable and split into two
            a. This meant that the energy inside the atom could be released
                i. after this, and a few more discoveries, and alterations, the atom bomb is formed

III. Ways Newton was challenged
    A. Challenged by Planck
        1. Newton believed that the foundation for motion or attraction lied in gravity
            a. Planck proved that radiant energy, from the sun, was given without attraction
        2. Newton's time believed that through calculus and coordinate geometry, the universe could be explained and was predictable
            a. Planck's theory illustrated to the scientific community that science was not absolute
    B. Challenged by Rutherford
        1. Newton's time believed the atom was the smallest particle

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a. Rutherford discovered radioactive elements that gave off minute particles in alpha and beta rays

C. Challenged by Einstein

1. Einstein's theory that instead of gravity acting from a distance, or a form pressure from the outside coming in, he realized that gravity created a field that attracted other objects, or pressure coming from the inside out

a. This was not explained anywhere in Newton's theories or teachings

2. Einstein believed that gravity did not act upon objects interaction, but with space

IV. The New World

A. Nuclear Physics

1.The troubled atmosphere during 1939 made using atomic research for military purposes more probable

a. Research included secretly preparing an atomic bomb in Los Alamos, New Mexico, and testing it in the Alamogordo desert in New Mexico (Also called the Manhattan Project.)
b. Its use was against the Japanese at Hiroshima and Nagasaki in 1945

2. The hydrogen bomb was developed
   a. It was built independently in America and by the Soviets
      i. It involved nuclear fission: the joining of hydrogen and other light elements
         1. This is believed to be responsible for the energy of the sun
3. Nuclear power plants began to create energy
   a. A small amount of uranium, or plutonium is equal to three tons of coal
      i. In the early 1990's 15% of the world's electricity was created by nuclear power plants
4. Since 1945 no nuclear weapon has been used since a clash of arms could mean apocalypse, but nuclear weapons remain part of the world's arsenal

B. Existentialism, pessimism, and doubt

1. The existentialists
   a. Beliefs
      i. They doubted whether humans were actually in control of their own destinies
      ii. They also saw humans as creatures of irrationality
      iii. Existentialists primarily dwelled on the extremes of human behavior: fear, dread, death, and anxiety.
      iv. They saw science as a destoyer of civilization rather than progress. Events that changed their views on civilization were:
         a. WWI
         b. The Depression
         c. WWII
         d. The Holocaust
         e. Hiroshima

f. The Cold War and the threat of nuclear annihilation

v. They said one should live their life as they please because there is no after life

vi. Famous existentialists: Martin Heidegger, Karl Jaspers, Jean-Paul Sartre, and Albert Camus

Throughout time, Newton has been challenged and proven wrong, but despite this, Newtonian principles still obtained in most cases are as solid and predictable as they have ever been. As scientists of all kinds started a revolution in the understanding of matter, the people of the world began to feel a little less certain knowing not everything could be explained. Religion can sometimes be seen as the glue that held together a society that was beginning to fear what they did not know, pushing them back centuries of social progression. By the late 1920s the values of western culture had changed greatly. The recognition of man's irrationality, the new scientific knowledge, and the violence that could accompany popular participation in public life were all threatening what had been believed in the past. The public was warned through essays and sermons of a crisis in values that could not be helped by neither art nor science. As science began to discover weapons of mass destruction, people began to question the values of scientific exploration. Existentialism took root, and its followers believed in a society disturbed by war and oppression, material progress, and moral uncertainty.

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